EXH. DJL-5 (Apdx. E)
DOCKETS UE-240004/UG-240005
2024 PSE GENERAL RATE CASE
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 E (NONCONFIDENTIAL) TO THE FOURTH EXHIBIT TO THE PREFILED DIRECT TESTIMONY OF

DAVID J. LANDERS

ON BEHALF OF PUGET SOUND ENERGY

FEBRUARY 15, 2024

PUGET SOUND ENERGY

Grid Modernization: Electric System Upgrades

Corporate Spending Authorization (CSA)

Date Created:	Friday, February 10, 2023
Discretionary/ Non-Discretionary:	Discretionary
Multi Year Rate Plan:	Programmatic
Equity Impact:	Yes
Strategic Alignment:	Operate the Business-Reliability
Estimated In-Service Date:	Sunday, December 31, 2028
Current State (Business Need):	PSE's electric system is aging physically and technologically in a variety of ways that must be addressed including copper conductor that dates back to the early 1910s, fuse technology that is the cause of 60% of PSE's unnecessary lengthy outages from momentary events that require field visits to manually reset, emerging trends relating to materials or operations found through PSE's root cause analysis work, and focused work in the high tech central Bellevue district to ensure grid technology functions effectively. By 2019 PSE had replaced 161 miles of brittle failure prone copper conductor with 587 circuit miles remaining on 640 circuits. PSE implemented a robust outage root cause analysis program in 2019 that reviews all substation outages in depth and all other outages for trends, an industry practice that has proven to bring significant SAIDI/SAIFI benefits for utilities that have matured this process such as Duke.

PUGET SOUND ENERGY

Grid Modernization: Electric System Upgrades

Corporate Spending Authorization (CSA)

Desired State (Proposed Solution):

The Electric System Upgrades program focuses on replacing PSE's aging electric system assets, investigating root cause analysis of high impact outages to inform effective reliability program development, and addressing reliability issues within the Bellevue Central Business District through switch maintenance and automation. There are six key areas that PSE is investing in over the rate plan: Fusesavers, Resilience Enhancement – Expanded, Resilience Enhancement – Copper Conductor Replacement, Service Transformer Upgrade, Root Cause Analysis, and Bellevue Central Business District.

The Fusesavers Business Plan replaces existing single-operation fuses (100T) on the electric distribution system with specialized protection devices. These devices reduce the frequency of sustained power interruptions by quickly tripping to clear temporary faults and restoring power following a momentary outage.
The Resilience Enhancement Copper Conductor Replacement Business Plan focuses on replacing aging smaller overhead copper (CU) conductors in PSE's primary distribution system. Copper conductor loses mechanical strength as it ages and has an increasing risk of failure. Investments will prioritize sections located in areas of high wildfire risk in addition to historically focusing on sections with the greatest degradation based on history of outages and/or splices on the conductor.

The Resilience Enhancement Expanded Plan includes multiple initiatives to improve and enhance resiliency on vulnerable sections of aging Transmission and Distribution infrastructure, including Condition Monitoring of Substation Transformers, Underground Substation Getaways – yellow jacket cables with shrink-back Transmission Switches, and Distribution Radial Circuits. The plan targets the replacement of aging line assets that weaken resilience of distribution circuits and transmission lines, such as switches and underground assets, which are not addressed under other plans. In addition to replacement of aging assets, PSE aims to improve resiliency of radial distribution circuits, typically located in remote areas without backup power sources, through the use of energy storage batteries. This plan also looks to implement proactive monitoring of major substation assets, providing better insight through real-time condition assessment to monitor transformer health and predict equipment failures.

The Service Transformer Upgrade Plan is an on-going proactive plan to upgrade overloaded service transformers to ensure the continued reliability of PSE's electric distribution system. This plan is driven by growing electrification, including widespread electric vehicle (EV) adoption and increased frequency of severe weather events.

The Root Cause Analysis program investigates causes of high-impact outages through in-depth investigation to ensure PSE understands the cause(s) and future risks to reliability. The core objective of the program is to improve reliability by identifying root causes, addressing immediate issues, and building greater awareness and knowledge to prevent future issues. The program investigates the method of design, maintenance of systems, and restoration procedures to identify and implement solutions for improved reliability. This program also develops and implements specific solutions based upon root cause analysis investigations with recent actions including a Line Spacers program and livefront to deadfront switch transition program. The Line Spacers program was created and implemented by the Customer & System Projects team to reduce the number of outages related to electrical fault-line slap caused by insufficient phase to phase clearance in various distribution line constructions. The livefront to deadfront switch transition program was created to help mitigate system reliability risk from older switches that sit on vaults that cannot easily be replaced on a one-for-one basis on failure due to cost prohibitive civil or line work being required. An additional benefit of transitioning to deadfront switches is the increased reliability they provide compared to livefront switches. Deadfront switches are less prone to faults caused by rodents and contamination.

The Bellevue Central Business District program is focused on addressing reliability challenges encountered in Bellevue's Central Business District area. This program expands existing SCADA infrastructure to provide remote visibility and control in PSE's densest load area. Historic projects have been focused on improving reliability through switch maintenance including switch replacement, refilling gas, and automating existing switches by extending the communication network for connection to PSE's SCADA infrastructure.

PUGET SOUND ENERGY

Grid Modernization: Electric System Upgrades

Corporate Spending Authorization (CSA)

Outcome/Results (What are the anticipated benefits):	PSE's primary benefit of this program is improved reliability and avoided CMI through replacement of aging assets and root cause analysis of high impact outages.

PUGET SOUND ENERGY

Grid Modernization: Electric System Upgrades

Corporate Spending Authorization (CSA)

Dependencies: No

Dependencies comment: None.

Escalation Included: No, escalation has not been included.

Total Estimated Costs: $72,046,803

Estimated Five Year Allocation:

Funds Type	ID	Line Item Description	Previous Years Actuals	Fiscal 2024 Requested	Fiscal 2025 Requested	Fiscal 2026 Requested	Fiscal 2027 Requested	Fiscal 2028 Requested
O&M	79199	5-Year Plan	$ -	$ -	$ -	$ -	$ -	$ -
Capital	W_PLACEHOLDER_196: E Transformers Replacement	W_PLACEHOLDER_196: E Transformers Replacement	$ -	$ 6,500,000	$ 13,500,000	$ 6,175,000	$ 7,500,000	$ 6,150,000
O&M	79435	PLACEHOLDER WBS: E Transformers Replacement	$ -	$ -	$ -	$ -	$ -	$ -
Capital	W_R.10059.03.01.03	E Resilience Enhancement (Non-CEIP)	$ -	$ 9,525,000.00	$ 9,525,000.00	$ 9,525,000.00	$ 9,525,000.00	$ 8,600,000.00
Capital	W_R.10009.12.03.04	E Network and Automate Grid	$ -	$ 350,000.00	$ 350,000.00	$ 300,000.00	$ 309,000.00	$ 300,000.00
Capital	W_R.10009.08.06.01	E Root Cause Analysis	$ -	$ 5,000,000.00	$ 1,000,000.00	$ 2,000,000.00	$ 2,000,000.00	$ 2,000,000.00

Incremental O&M: Both

Qualitative Benefits:

The primary benefit of this program is reliability and avoided CMI either through replacement of aging assets and technology or in year trends.

Quantitative Benefits:

Quantitative Benefits	Benefit Type	Previous Years	Fiscal 2024	Fiscal 2025	Fiscal 2026	Fiscal 2027	Fiscal 2028	Fiscal 2029	Remaining Costs	Life Total
Reliability - avoided CMI	Other	$ 20,260,000	$ 10,130,000	$ 4,030,000	$ 4,030,000	$ 4,030,000	$ 4,030,000	$ -	$ -	$ 46,510,000

Risk Summary:

Project risk is most challenged in replacement of copper as this is often times in alley ways and difficult construction and permitting settings.

Benefit risk is minimized as benefit is realized when work is completed and backcasting verifies the effectiveness.

System risk occurs is projects do not proceed.

PUGET SOUND ENERGY

Grid Modernization: Electric System Upgrades

Corporate Spending Authorization (CSA)

Change Summary:

Planning Cycle	Change Summary	Last Update Date
2022 Baseline Cycle	This CSA has been migrated into the EPPM tool at go-live as part of the Phase 1 EPPM implementation effort. The projects in this CSA were previously approved for the 2023-2027 capital plan. Please refer to the original CSA document for additional information (if available.)	2/10/2023
2023 Cycle 1	Updated from last business plan information and general knowledge and historical information	3/17/2023

PUGET SOUND ENERGY

Grid Modernization: Electric System Upgrades

Corporate Spending Authorization (CSA)

Approval History:

Approved By	Date Approved
Approved by Cost Center Owner: Lambert , Ryan	3/30/2023
Approved by Cost Center Owner: Lambert , Ryan	4/3/2023
Approved by Director Sponsor: Landers , David	4/6/2023
Approved by Executive Sponsor: Jacobs , Josh	4/8/2023
CSA Status changed to Approved	4/8/2023
Approved by Cost Center Owner: Shrum , Bailey	12/4/2023
Approved by Director Sponsor: Shrum , Bailey	12/4/2023
Approved by Executive Sponsor: Shrum , Bailey	12/4/2023
CSA Status changed to Approved	12/4/2023
Approved by Cost Center Owner: Lambert , Ryan	1/29/2024
Approved by Director Sponsor: Landers , David	1/29/2024
Approved by Executive Sponsor: Jacobs , Josh	2/2/2024
CSA Status changed to Approved	2/2/2024

FUSESAVERS

ENERGY TYPE: ELECTRIC

1. SHORT DESCRIPTION

The Fusesaver plan will replace existing fuses (100T) on the electric distribution system with specialized protection devices. These devices work to reduce the frequency of sustained power interruptions by quickly tripping to clear temporary faults and restore power following a momentary outage.

2. BACKGROUND

Industry research suggests that 80% of all outages industry wide are caused by faults that are temporary in nature. PSE analysis indicates that value to be closer to 60% on PSE's overhead system. The addition of these devices that will clear temporary faults automatically should improve PSE's reliability metrics.

A Fusesaver is a single-phase reclosing device that can be installed in series with overhead fuses that, when sensing fault current, will quickly trip open prior to downstream fuses blowing. After an adjustable time period (PSE has selected 5 seconds), the device will reclose and stay closed. If the cause of the fault remains, the appropriate downstream fuse will blow just like it typically would without the Fusesaver present. With these devices temporary faults would be cleared and power restored before customers see a sustained outage. With the automatic restoration of power PSE Electric First Response Troublemen will not be called to the outage, saving the deployment of resources for temporary faults.

3. STATEMENT OF NEED

PSE is committed to providing safe, reliable, affordable energy service to our customers. PSE is also integrating initiatives to modernize the grid. This grid modernization includes implementation of new technologies and devices that, when strategically deployed, can reduce outages through fault clearing and reclosing (a form of automation). Analysis of outage data combined with some assumptions has allowed planning to develop estimates for the impacts of temporary faults on PSE's reliability indices. "Smarter" devices out on the system, such as Fusesavers which record operations, can further assist planning analytics to develop a clearer understanding of the benefits of and the need for temporary fault clearing.

3.1. NEED DRIVERS

- **Grid Modernization -**
    - **Reliability** – Strategic deployment of Fusesavers will reduce CMI, SAIDI, SAIFI, and CEMI by shortening some outages from sustained outages that require Troublemen deployment to momentary outages with no personnel dispatch required. Reliability improvement metrics will vary by location.

- **Smart & Flexible** – It can be difficult to assess which outages of unknown cause are the result of a temporary fault. Fusesavers can provide trip data that can be used to validate planning analytics around the impacts of temporary faults on PSE reliability metrics and inform future planning decisions.

3.2. EQUITY

PSE evaluates equity in the planning process with consideration of the four core tenets of energy justice: Recognition Justice, Procedural Justice, Distributional Justice, and Restorative Justice in various steps of the process.

As specific studies are performed and projects proposed to further a business plan, planners review system, customers, and now equity data to recognize the specific customer burdens, whether there are highly impacted or vulnerable customers that are or will be affected by addressing the specific business need. Planners must prioritize where to focus study each year, thus the full understanding of the historic and ongoing inequities for the entire business plan is extrapolated at this time, maturing over time which greater tools and data.

PSE is building process and tools to enable procedural inclusion in defining the need and solutions through engagement with specific communities and community based organizations, increasing understanding of local needs and consequences to inform specific study development as well as options to address need. Maturity in where and how this occurs will increase over the next several years. Business plans will be updated as informed this collective engagement to reflect broader equity benefits and burdens as this engagement increases over time.

As specific projects are proposed, PSE investment decision optimization tool captures equity benefits. An optimized portfolio of projects across many business plans ensures the distribution of benefits and burdens are spread across all segments of the community and aim to ensure that marginalized and vulnerable communities do not receive an inordinate share of burdens or are denied access to benefits. As an initial step, PSE leverages Customer Benefit Indicators ("CBI") and information established as part of the 2021 Clean Energy Implementation Plan ("CEIP") to identify an equity framework to evaluate system projects. The CBI approach was developed through an iterative process that was coordinated with the Equity Advisory Group. These CBI span the core tenets of energy justice and provide a framework to evaluate the comparative equity benefit of each solution alternative considered. Refer to Table 1 for a brief description of the CBIs that address equity and the applicable benefits for the Fusesaver program. PSE will continue to adjust and refine equity consideration in projects when necessary as the process continues to mature.

Projects will be evaluated on each CBI category and a total equity benefit score will be provided.

Table 1: Equity Applicable Benefits

Customer Benefit Indicator	Description	Program Applicable Benefit
Customer Energy Savings	Solutions that lead customers to use less energy, which leads to less energy that must be purchased and potentially a reduction in planned system upgrades.	No
Greenhouse Gas Emissions	Solutions that lead to a reduction of greenhouse gas emissions, either directly or indirectly	No
Enables Cleaner Energy	Solutions that either directly integrate DER on the system or enable the grid to more readily accommodate future DER.	No
Air Quality	Solutions that either directly eliminate the source of a common pollutant or reduce the risk that could cause a common pollutant to increase, such as enabling Electric Vehicle or DER adoption	No
Resilience	Solutions that address major event outages or harden critical facilities to prevent catastrophic events from creating long duration outages.	Yes
Cost Reduction	Solutions that identify least cost alternatives and therefore reduce costs for all customers	No
Clean Energy Jobs	Solutions that increase clean energy jobs by furthering clean energy technology application, as described in the CEIP	No
Home Comfort	Solutions that deploy residential energy efficiency in either a targeted solution area or by leveraging load reduction from system wide energy efficiency installations	No

The program attempts to annually address the laterals fused with 100T fuses that see a high number of outages with an unknown cause and is programmatically optimized based on total benefit value to cost. Specific program projects are identified based total benefit to cost with named communities receiving additional scored benefit based on vulnerable population designation and highly impact community characteristics, essentially ensuring investments are distributed appropriately to named communities.

Business plans in isolation do not address restorative justice, but continued planning process improvements which include considerations of data, tools, and documentation as well as operational practices will help to restore equity over time.

4. PLAN DETAIL

4.1. PLAN SIZE/POPULATION

There are approximately 1,400 100T fuses on PSE's system. Priority will be given to areas with high numbers of outage events of unknown cause or known to be temporary in nature. Through 2022 81 Fusesavers have been installed. The plan is to install an additional 560 Fusesavers between 2023 and 2026,

4.2. PROPOSED COMPLETION DATE

The proposed plan is to address the highest outage Fuseavers through at least 2028. There are a limited number of locations where Fusesavers are either feasible or beneficial. Initial Planning assessments indicate that retrofitting fuses beyond the initial priority fuse population would return diminishing results. Monitoring of performance of this initial population of devices will drive future decisions on deployment of additional Fusesavers beyond the next five years, and absent future retrofit plans, the device could remain as a tool to address specific reliability issues in the future.

4.3. SUMMARY OF PLAN BENEFITS

Improved Customer Reliability -The primary benefit of this plan is improved reliability for PSE customers. Similar additional reliability benefits are anticipated during major weather events not accounted for in the table. Momentary outage data collection will improve PSE understanding of how temporary faults impact PSE reliability.

Improved Customer Satisfaction/Experience - Improved reliability for customers will result in an improved customer perception of PSE as well as provide the value to customers of avoided outages. Increased reliability also has an overall public benefit when critical and public services are not disrupted, and commercial businesses can operate normally.

4.4. INVESTMENT DECISION BENEFITS

PSE employs an Investment Decision Optimization Tool (iDOT) to evaluate benefits of projects and optimize annual portfolios. The primary iDOT benefits this plan addresses are:

- Outage Concern
- Contribution to Strategy

Table 2. Summary of Plan Benefits, Population and iDOT B/C Score

	Total Projects	Total Plan ($M)	Non-MED CMI Saved	iDOT B/C Score
2025-2026	39	$1.1	79,100	2.42

4.5. ESTIMATED COSTS

For Electric System Planning, estimated costs are generated based on historical costs of similar types of projects with allowances for variations in project scope, increases in project cost due to inflation, and added contingency to account for unforeseen conditions associated with the project.

It is assumed Fusesaver installations will cost $15k for single phase and $35k for multi-phase locations, which is applied in determining the number of proposed installations in future years.

OMRC is estimated to be 5% of project capital costs.

5. ALTERNATIVES

5.1 SOLUTION ALTERNATIVES

No Action - The alternative to a fuse saving protective scheme is fuse blowing. If this fuse saving plan is not implemented, fuse blowing scheme would continue to be used to clear both permanent and temporary faults beyond 100T fuses, requiring a Troubleman response even when faults are temporary. There is also the potential risk of customer dissatisfaction in areas experiencing frequent outages due to blown fuses with unknown causes that could be reasonably addressed by this plan. Other more costly plans such as tree wire may be implemented for high outage locations but may be ineffective or less effective due to the difficulty in identifying the location of temporary faults.

Other Options - Other options for clearing temporary faults were considered. Substation breakers and line reclosers can also be set to clear temporary faults with a fuse saving setting. These options were rejected as they would cause nuisance momentary outages to more customers on the circuits than implementing fuse saving.

Tripsaver devices, which are similar devices from a different manufacturer that offer the same benefit as Fusesavers, were also considered as an option for clearing temporary faults and were piloted. Following the pilot, this option was rejected due to operational concerns and Fusesavers were determined to be the preferred device.

Other reliability solutions such as tree wire, underground conversions, and vegetation management practices are all considered as alternatives, but Fusesavers are an extremely cost-effective solution and much more timely to install and quickly gain benefits in comparison to these other options.

5.2 FUNDING ALTERNATIVES

Increased Funding - There is a finite population of fuses to retrofit. A subset of the population should not be retrofit due to the presence of tree wire, underground cable, or other constructability issues. Areas with particular outage characteristics should also be avoided and overfunding runs the risk of degraded service in some areas with increased momentary outages. There are diminishing returns on this investment over time as the highest priority locations will be addressed earliest in the plan. There is not expected to be additional benefit with increased funding of this plan.

Decreased Funding - Decreased funding would result in fewer locations retrofitted. Only retrofitted areas would see outage reduction benefits and overall, the corporate outage reduction metrics would see less improvement overall.

6. PLAN DOCUMENT HISTORY

Date of Project Summary Revision	Reason(s) for Update	Summary of Significant Change(s)	Created/Modified By
10/25/2019	Initial Plan – New plan template	Initial document – Summarize historical plans	Kit Maret
4/14/2020	Revision	Added budget and IDOT Details	Kit Maret
4/5/2021	Revision	Funding increase, increasing population	Kit Maret
5/5/2021	Revision	Funding decrease	Kit Maret
6/10/2021	Revision – Used and Useful Policy guidance	Director comments – add alternative and cost information	Kit Maret
12/1/2021	Annual Review	Minor word and format changes	Kit Maret
12/1/2023	Revision	Added Equity, Removed ISP, updated estimated costs.	Timothy LoPresto
12/5/2023	2024 MYRP Update	Updated Program Summary Table to align with 2025-2026 project submittals. Deleted Benefit Allocation chart.	Krista Malmgren

7. SUPPORTING DOCUMENTATION

Document Name
FUSE SAVING VS. FUSE BLOWING – ANALYSIS OF POTENTIAL IMPACTS ON THE PSE DISTRIBUTION SYSTEM (5/15/2018)
PSE ELECTRIC DISTRIBUTION LINE CONSTRUCTION STANDARD 6022.1060 – FUSESAVER INSTALLATION

RESILIENCE ENHANCEMENT - EXPANDED

ENERGY TYPE: ELECTRIC

1. SHORT DESCRIPTION

The Resilience Enhancement Plan includes multiple initiatives to improve and enhance resiliency on vulnerable sections of aging Transmission and Distribution infrastructure, including the following:

- Condition Monitoring of Substation Transformers
- Underground Substation Getaways – yellow jacket cables with shrink-back
- Transmission Switches
- Distribution Radial Circuits

The Plan targets the replacement of aging line assets that weaken resilience of distribution circuits and transmission lines, such as switches and underground assets, which are not addressed under other Business Plans.

In addition to replacement of aging assets, PSE aims to improve resiliency of radial distribution circuits, typically located in remote areas without backup power sources, through the use of energy storage batteries.

PSE also looks to implement proactive monitoring of major substation assets, providing better insight through real-time condition assessment to monitor transformer health and predict equipment failures.

2. BACKGROUND

Condition Monitoring of Substation Transformers

Currently, oil from distribution transformers and tap-changer compartments is sampled manually by substation inspectors on 6- and 12-month cycles. The sampling process is labor intensive, the laboratory analysis turn-time is slow, the manual samples are somewhat inconsistent, evaluation of results is manual, and data is entered into a health database in a manual, labor-intensive manner. Transformer health monitoring consists of online dissolved gas analysis (DGA) monitors on substation distribution transformers to evaluate transformer health by measuring gases dissolved in the transformer mineral oil. PSE is also evaluating additional online monitoring capabilities, such as bushing monitors, for future application. The final aim is to integrate complete transformer monitoring systems into asset management software packages to create real-time holistic transformer risk ratings to drive a condition-based maintenance program.

Underground Substation Getaways

Yellow jacket feeder getaway cables are the connection between substation and distribution circuits, they are often excluded from circuit upgrades and substation projects. The aging getaways suffer from jacket shrink-back at the terminations and are a safety concern as well as the risk to failure, and are therefore included in this business plan.

Transmission Switches

Transmission switches are repaired repeatedly due to misalignment of many mechanical parts, which can make it difficult to operate the transmission system or take outages as needed. The switches are replaced reactively with a like-for-like type of switch, which may also experience the same issues over time. PSE's Transmission Engineering and Standards groups have sourced and developed a design & construction standard for new 'Unitized Transmission switches'. The switch is a Vertical-break switch mounted on a steel backplane, which allows for synchronized opening and closing of the switch and eliminates the misalignment and malfunction problems that exist with current Transmission switches.

Distribution Radial Circuits

Radial feeder improvements consist of evaluating and improving the reliability and resiliency of radially fed distribution feeders. This includes evaluation of distributed generation and battery systems that could run in an island configuration to reduce outage duration and severity to customers.

PSE is actively working on enablement for distributed generation facilities as part of CETA efforts in alignment with our overall integrated resource plan.

3. BUSINESS NEED

The development of this program was driven by multiple factors with an intent to improve safety, eliminate repetitive repairs, improve circuit resiliency and introduce condition based monitoring initiatives that will also improve resiliency and reliability of major substation assets.

Condition Monitoring of Substation Transformers

Robust, real-time monitoring of the condition of substation assets is essential as PSE continues to develop a mature asset management system capable of predicting the best use of maintenance and replacement dollars to minimize outages and system downtime for our customers.

Underground Substation Getaways

There are over 270 circuits with substation yellow jacket getaway cables using Joslyn pothead type porcelain terminations that suffer from cable shrink-back. PSE needs to begin replacing these proactively to reduce the risk of exploding porcelain terminations and strengthen the resilience of distribution circuits where PSE has made other substantial capital investments.

Transmission Switches

Malfunctioning Transmission switches require repeated O&M repairs that impact the ability of the Load office to operate the Transmission system as desired. Replacing proactively the most problematic units will improve transmission system operability and reduce the need for repetitive unplanned maintenance.

Distribution Radial Circuits

There are 35 radial distribution circuits, some of which have appeared on the Worst Performing circuits list for many years. Multiple outages on these lines affect remote communities that have no other source of power, such as a temporary tie to another feeder, during major storm events. The time to restore can be slow due to location and challenging conditions delaying access after an event. Average outage durations can run from 6 to 8 hours, and may be longer during larger storm events. PSE is implementing solutions to improve the resiliency of these circuits, such as through expensive undergrounding, but is now looking to Distributed Energy Resources (DER) such as energy storage batteries to improve circuit resiliency by providing backup power to isolated communities multiple times a year while system repairs are made.

3.1. NEED DRIVERS

Grid Modernization

The initiatives covered under this business plan will help advance elements of PSE's grid modernization strategy as follows:

Safety – Reacting to a fault after the fact adds significant safety concerns to the public & employees. Upgrading yellow jacket substation underground getaways to a similar standard as new feeder cables in conduit will reduce risk of failure and unplanned circuit interruptions. Transmission switch replacements to the new, more-reliable unitized transmission switches will ensure operability when transmission system switching is required.

Resiliency – The resiliency efforts of this business plan are focused on high-impact, low frequency (HILF) events. The outages occurring on radially fed lines are generally longer and lead to a higher SAIDI than outages the system as a whole. Application of DERs to benefit distribution radial circuits will significantly improve resiliency and the ability to recover from outage events quicker.

Smart & Flexible – The integration of distributed generation and storage into the electrical system aligns with the larger PSE strategy of flexibility. Additionally, introducing real-time condition assessment monitoring of substation transformers will inform planned maintenance spending and help prioritize assets of concern for timely replacement.

Capacity – By applying DERs to improve reliability of distribution radial circuits, the addition of energy storage batteries can also provide peak shaving benefits to highly loaded

radial circuits and substations. Batteries on the system can also add voltage stability and frequency regulation on remote circuits.

3.2. EQUITY

PSE evaluates equity in the planning process with consideration of the four core tenets of energy justice: Recognition Justice, Procedural Justice, Distributional Justice, and Restorative Justice in various steps of the process.

As specific studies are performed and projects proposed to further a business plan, planners review system, customers, and now equity data to recognize the specific customer burdens, whether there are highly impacted or vulnerable customers that are or will be affected by addressing the specific business need. Planners must prioritize where to focus study each year, thus the full understanding of the historic and ongoing inequities for the entire business plan is extrapolated at this time, maturing over time which greater tools and data.

PSE is building process and tools to enable procedural inclusion in defining the need and solutions through engagement with specific communities and community based organizations, increasing understanding of local needs and consequences to inform specific study development as well as options to address need. Maturity in where and how this occurs will increase over the next several years. Business plans will be updated as informed this collective engagement to reflect broader equity benefits and burdens as this engagement increases over time.

As specific projects are proposed, PSE investment decision optimization tool captures equity benefits. An optimized portfolio of projects across many business plans ensures the distribution of benefits and burdens are spread across all segments of the community and aim to ensure that marginalized and vulnerable communities do not receive an inordinate share of burdens or are denied access to benefits. As an initial step, PSE leverages Customer Benefit Indicators ("CBI") and information established as part of the 2021 Clean Energy Implementation Plan ("CEIP") to identify an equity framework to evaluate system projects. The CBI approach was developed through an iterative process that was coordinated with the Equity Advisory Group. These CBI span the core tenets of energy justice and provide a framework to evaluate the comparative equity benefit of each solution alternative considered. Refer to Table 1 for a brief description of the CBIs that address equity and the applicable benefits for the Resilience Enhancement Plan. PSE will continue to adjust and refine equity consideration in projects when necessary as the process continues to mature.

Projects proposed under this business plan will be evaluated on each CBI category and a total equity benefit score will be provided.

Table 1: Equity Applicable Benefits

Customer Benefit Indicator	Description	Program Applicable Benefit

Customer Energy Savings	Solutions that lead customers to use less energy, which leads to less energy that must be purchased and potentially a reduction in planned system upgrades.	No
Greenhouse Gas Emissions	Solutions that lead to a reduction of greenhouse gas emissions, either directly or indirectly	No
Enables Cleaner Energy	Solutions that either directly integrate DER on the system or enable the grid to more readily accommodate future DER.	Yes
Air Quality	Solutions that either directly eliminate the source of a common pollutant or reduce the risk that could cause a common pollutant to increase, such as enabling Electric Vehicle or DER adoption	No
Resilience	Solutions that address major event outages or harden critical facilities to prevent catastrophic events from creating long duration outages.	Yes
Cost Reduction	Solutions that identify least cost alternatives and therefore reduce costs for all customers	Yes
Clean Energy Jobs	Solutions that increase clean energy jobs by furthering clean energy technology application, as described in the CEIP	No
Home Comfort	Solutions that deploy residential energy efficiency in either a targeted solution area or by leveraging load reduction from system wide energy efficiency installations	No

The Resilience Enhancement Plan is programmatically optimized based on total benefit value to cost. Specific program projects are identified based total benefit-to-cost with named communities receiving additional scored benefit based on vulnerable population designation and highly impact community characteristics, ensuring investments are distributed appropriately to named communities.

Business plans in isolation do not address restorative justice, but continued planning process improvements, which include considerations of data, tools, and documentation as well as operational practices will help to restore equity over time.

4. PROGRAM DETAIL

4.1. PROGRAM SIZE/POPULATION

The current list of assets to be addressed are summarized in Table 2. Installation of DGA monitors and substation getaways are typically completed concurrently with other planned substation work to avoid taking additional outages. However, long term it would be preferable to have DGA monitors pre-installed on transformers by the manufacturer to save on retrofit costs.

Transmission switches have been prioritized based on history of repetitive maintenance and operational problems. There are many older model transmission switches from multiple manufacturers in the system, which when replaced with the latest standard unitized switch will simplify maintenance going forward.

Installation of energy storage batteries is not always a valid approach for radial circuits, as many already have existing underground conversion projects in place, and some circuits do not see many outages.

Following successful installation of online DGA monitors on the initial fleet of distribution transformers, PSE proposes to evaluate and install Online DGA monitoring on all existing transformers and load Tap changers.

Installation of DGA monitoring equipment also requires updating or installing remote access communications to facilitate integration into maintenance server and asset management software.

Table 2: Assets to address

Asset	Total count	Priority
Transmission Switches	232	40
Yellow jacket getaways (Circuits)	273	135
Radial Circuits	41	3
DGA monitors	345	55

4.2. PROPOSED COMPLETION DATE

This phase of the program of system improvements is to address the highest concerns. Ongoing benefit evaluation will determine the effectiveness of the program and be used to inform decisions regarding continuation of the program elements.

4.3. INVESTMENT DECISION BENEFITS

PSE employs an Investment Decision Optimization Tool (iDOT) to evaluate benefits of projects and optimize annual portfolios of work. The primary iDOT Categories this plan addresses are:

- Outage Concern
- Contribution to Strategy
- Flexibility

All of the above resilience initiatives in this business plan provide some or all of the benefits identified in the optimization process through iDOT. See Table 3 of all the assets to be addressed under this Business plan.

By addressing radial circuits that experience many outages and long restoration times, PSE can realize substantial SAIDI benefits by adding energy storage batteries. This will be a positive impact to customers who have experienced multiple outages knowing that there is a mitigation solution to support their community.

Replacement of substation yellow jacket feeder cables and associated terminations will improve safety and make the complete feeder more robust by removing the weakest point.

DGA monitors reduce the amount of manual oil sampling over multiple years for each transformer and reduce O&M costs. With accurate transformer DGA condition assessment, PSE can defer unnecessary capital and maintenance dollars.

Similarly, by replacing aging defective transmission switches, PSE can avoid repetitive O&M expenses on the same switches. The new unitized switches will provide smooth synchronized switch operation, improving resiliency of the transmission grid.

Table 3: Summary of Plan Benefits, Population, and iDOT B/C Score

2025 -2026	Total Projects	Total Plan ($M)	Count of Equipment	Non-MED CMI Saved	iDOT B/C Score
Transmission Switches	32	$6.4	32	640,580	6.82
Substation Getaways circuits	31	$4.7	89	686,447	5.50
DGA Monitors	16	$1.6	16	-	1.21
Radial Circuit Batteries	1	$3.5	1	558,591	1.38
Total	**80**	**$16.2**	**122**	**1,885,618**	**4.71**

4.4. ESTIMATED COSTS

Electric System Planning estimated costs are generated based on historical costs of similar projects, allowing for variations in project scope, increases in project cost due to inflation, and include contingency to account for unforeseen conditions associated with the project.

Total estimated costs are based on:
$2 to $4M for installation of an energy storage battery on a radial feeder
$60K per substation underground circuit getaway; may vary depending on the length
$110k for installation of DGA (dissolved gas analysis) monitoring unit per substation transformer.
$200K for transmission switch replacement on glue laminated structure or steel pole.

5. ALTERNATIVES

5.1. SOLUTION ALTERNATIVES

No Action – No action would lead to lost opportunity for monitoring and trending health conditions for assets. PSE would remain reactive instead of proactive in addressing reliability SAIDI and SAIFI. Continuing to manually sample oil from transformers would mean more unnecessary planned maintenance and replacement of potentially healthy transformers.

Like Kind Transmission Switch Replacement – replacing with similar existing model switch will function fine for a certain amount of time. Repeated use and/or accidental damage misaligns switch components over time, which will eventually result in increased repetitive maintenance needs and potential for failure to operate when needed.

Installing Underground cable instead of Batteries on radial circuits – this is an expensive solution depending on length of sections where the circuit is exposed to vegetated areas. Tree wire is another option; however, some outage events will still take down poles and complete lines leaving communities without power. Given that tree wire is less expensive than undergrounding, it may be a viable option for consideration.

5.2. FUNDING ALTERNATIVES

Increase Funding from Proposed – Increased funding has the opportunity for expanded and accelerated scope of these efforts. The current 5-year proposal is for efforts that have the highest benefit. Enabling this effort more quickly brings benefits sooner to customers and allows for additional efforts to the next phase of locations.

Decrease Funding from Proposed – Decreased funding would result in reduced and delayed scope. PSE would see a delay in realizing the benefits.

6. PLAN DOCUMENT HISTORY

The current version of the project summary supersedes all previous versions.

Date of Project Summary Revision	Reason(s) for Update	Summary of Significant Change(s)	Modified By
12/1/2021	Initial Plan	Initial document	Josh Pelman
10/10/2023	Annual Review	Includes equity, Remove ISP, Updated program completion costs	Stephen Hartnett
12/4/2023	2024 MYRP Update	Updated Equity, Top 3 Primary iDOT categories, and Program Summary Table to align with 2025-2026 project submittals	Krista Malmgren

7. SUPPORTING DOCUMENTATION

Document Name
NONE

RESILIENCE ENHANCEMENT - COPPER CONDUCTOR REPLACEMENT

ENERGY TYPE: ELECTRIC

1. SHORT DESCRIPTION

The Copper Conductor Replacement Plan is a safety, reliability and resiliency initiative to replace aging #6 and smaller overhead copper (CU) conductor in PSE's primary distribution system. This type of conductor becomes more brittle with age reducing its mechanical strength which increases risk of failure. This conductor is typically vulnerable in areas of vegetation and experiences more outages. The identification of projects to be included in this plan will first prioritize:

- Sections located in areas of high wildfire risk – estimated at 3.9 miles.
- Sections most at risk of failure considering their history of outages and/or splices in evidence on the conductor.

Other factors for consideration for prioritization may include:

- Location of the #6 CU in the distribution system
    - High impedance fault risk
    - Vegetation exposure
    - Customer density
- Conductor in the area of other projects such as New Customer Construction, Distribution System, Public Improvement (PI) and Pole Replacement projects.
- Areas of highly impacted communities and vulnerable populations
- Voltage and capacity considerations
- Distribution Automation (DA) needs
- Distributed Energy Resource (DER) hosting capacity needs

The most likely cost effective replacement option is assumed to be #2 Aluminum Conductor Steel Reinforced (ACSR) bare or Tree Wire (TW) conductor. Replacement of existing #6 CU lines with bare or tree wire, removal, re-route and underground conversion will be considered where appropriate.

2. BACKGROUND

The utility industry started using copper conductors in distribution systems in the early 1910s. The switch from copper to aluminum conductors by the industry and PSE was made in the 1960s and early 1970s due to the high price of copper relative to aluminum and other benefits such as weight-to-conductivity ratio. In 1991, PSE officially categorized #4 and smaller CU as "for maintenance use only" but had adopted ACSR conductor as the standard

for overhead lateral distribution construction much earlier. Given the industry and PSE data, it can be assumed that the small copper conductor in PSE's system is an average age of greater than 50 years.

With age, the single strand copper conductor loses mechanical strength and becomes brittle and increasingly prone to failure from tree contact as well as other physical stressors including snow and ice, construction and repair or maintenance activities. This is especially true of # 6 CU conductor due to its small diameter. Other infrastructure in proximity to the CU is often also aging beyond expected life including poles, triple link cut-outs, OH transformers and open wire secondary systems.

The small diameter of #6 CU conductor equates to high resistance making it prone to high impedance faults resulting in an increased risk of it being down and energized in the event of failure. The installation of Fuse Savers or 100T fuses on laterals with #6CU conductor is not suitable for a similar reason. The presence of small #6 CU can also contribute to low voltage in the areas in which it exists especially in situations where it is undersized for load or located at the end of the distribution circuit.

When line crews need to work on sections of #6 CU conductor, especially sections that have had historical failures (existing splices), they are unable to work it energized due to safety considerations around the possibility of a failure of the conductor while it is being handled. This necessary operational practice results in more scheduled service interruptions for PSE customers in order to provide safe working conditions for PSE line crews.

PSE began the replacement of #6 CU in 2010 when funding was allocated specifically for replacement of this wire type. From 2010 through 2019 PSE replaced or retired approximately 161 miles of #6 CU conductor. Similar proactive programs also exist in other US utilities[1] targeting aging small bare CU conductor for replacement to maintain system reliability, accomplish system hardening, facilitate grid modernization, address wildfire risk and improve system safety.

3. STATEMENT OF NEED

PSE is committed to providing safe, reliable service to our customers and safe conditions for PSE employees. This plan targets the improvement of reliability, resiliency, and safety associated with aging #6 CU conductor and other associated aging infrastructure.

3.1. NEED DRIVERS

- **Grid Modernization –**
  - **Safety** – Aging #6 CU conductor is brittle and prone to failure while at the same time is at a higher risk of a high impedance fault due to its small diameter. This leads to an increased risk of a conductor being down and energized which can be a safety risk to both the public and to line workers.
  - **Reliability** – #6 CU conductor is aging, brittle and prone to failure. Replacing it will reduce CMI, SAIDI and SAIFI by eliminating or reducing outages to the customers served by these facilities.

[1] Examples: Duke Energy Florida, Inc 2018 "Distribution Reliability Report", Liberty-NH 2019 "Distribution Line Overarching Strategy", Avista Utilities 2020 "Wildfire Resiliency Plan"

- **Resiliency** - Replacement of #6 CU conductor with appropriate bare, TW or underground conductor will harden PSE's system against failures during major events and decrease restoration times.
- **Smart & Flexible** –Replacement of #6 and smaller copper in PSE's system improves the flexibility of DER adoption and load hosting capacity by increasing capacity and reducing voltage drop in the distribution system.

3.2 EQUITY

PSE evaluates equity in the planning process with consideration of the four core tenets of energy justice: Recognition Justice, Procedural Justice, Distributional Justice, and Restorative Justice in various steps of the process.

As specific studies are performed and projects proposed to further a business plan, planners review system, customers, and now equity data to recognize the specific customer burdens, whether there are highly impacted or vulnerable customers that are or will be affected by addressing the specific business need. Planners must prioritize where to focus study each year, thus the full understanding of the historic and ongoing inequities for the entire business plan is extrapolated at this time, maturing over time which greater tools and data.

PSE is building process and tools to enable procedural inclusion in defining the need and solutions through engagement with specific communities and community based organizations, increasing understanding of local needs and consequences to inform specific study development as well as options to address need. Maturity in where and how this occurs will increase over the next several years. Business plans will be updated as informed this collective engagement to reflect broader equity benefits and burdens as this engagement increases over time.

As specific projects are proposed, PSE investment decision optimization tool captures equity benefits. An optimized portfolio of projects across many business plans ensures the distribution of benefits and burdens are spread across all segments of the community and aim to ensure that marginalized and vulnerable communities do not receive an inordinate share of burdens or are denied access to benefits. As an initial step, PSE leverages Customer Benefit Indicators ("CBI") and information established as part of the 2021 Clean Energy Implementation Plan ("CEIP") to identify an equity framework to evaluate system projects. The CBI approach was developed through an iterative process that was coordinated with the Equity Advisory Group. These CBI span the core tenets of energy justice and provide a framework to evaluate the comparative equity benefit of each solution alternative considered. Refer to Table 1 for a brief description of the CBIs that address equity and the applicable benefits for the Copper Replacement Plan. PSE will continue to adjust and refine equity consideration in projects when necessary as the process continues to mature.

Projects will be evaluated on each CBI category and a total equity benefit score will be provided.

Table 1: Equity Applicable Benefits

Customer Benefit Indicator	Description	Program Applicable Benefit
Customer Energy Savings	Solutions that lead customers to use less energy, which leads to less energy that must be purchased and potentially a reduction in planned system upgrades.	No
Greenhouse Gas Emissions	Solutions that lead to a reduction of greenhouse gas emissions, either directly or indirectly	Yes
Enables Cleaner Energy	Solutions that either directly integrate DER on the system or enable the grid to more readily accommodate future DER.	No
Air Quality	Solutions that either directly eliminate the source of a common pollutant or reduce the risk that could cause a common pollutant to increase, such as enabling Electric Vehicle or DER adoption	No
Resilience	Solutions that address major event outages or harden critical facilities to prevent catastrophic events from creating long duration outages.	Yes
Cost Reduction	Solutions that identify least cost alternatives and therefore reduce costs for all customers	No
Clean Energy Jobs	Solutions that increase clean energy jobs by furthering clean energy technology application, as described in the CEIP	No
Home Comfort	Solutions that deploy residential energy efficiency in either a targeted solution area or by leveraging load reduction from system wide energy efficiency installations	No

The program attempts to annually address aging #6 CU conductor and is programmatically optimized based on total benefit value to cost. Specific program projects are identified based total benefit to cost with named communities receiving additional scored benefit based on vulnerable population designation and highly impact community characteristics, essentially ensure investments are distributed appropriately to named communities.

Business plans in isolation do not address restorative justice, but continued planning process improvements which include considerations of data, tools, and documentation as well as operational practices will help to restore equity over time.

4. PLAN DETAIL

4.1. PLAN SIZE/POPULATION

There are approximately 569 total circuit miles of 1, 2 and 3 phase #6 CU and smaller primary conductor present in PSE's distribution system. Most of this conductor is located on overhead laterals, across 631 circuits.

Table 2: Population of #6 CU and Smaller Conductors by Configuration

	Total Circuit ≤ #6 CU Miles by config				
Conductor	1 ph	2 ph	3 ph	3 ph Mix	Total
#6 CU	444.5	32.5	70.0	20.5	567.5
#8 CU	0.3	0.0	0.0	0.0	0.3
#9 Iron	0.8	0.0	0.0	0.0	0.8

4.2. PROPOSED COMPLETION DATE

This plan is ongoing while #6 CU conductor remains in service. The performance of #6 CU conductors will be weighed alongside system reliability to determine whether the plan scope should be reduced or accelerated to provide improved annual performance and reliability to our customers.

4.3. SUMMARY OF PLAN BENEFITS

Safety – A major benefit of the #6 CU Aging Infrastructure Replacement Plan is increased public and worker health and safety. Replacement of the most failure prone #6CU conductor reduces the risk of exposure of the public and line workers to contact with energized conductor.

Improved Customer Reliability - Replacing aging #6 CU will improve the reliability of PSE customers served by this infrastructure by replacing it with ACSR wire or tree wire if needed, which are less prone to outages caused by vegetation and other physical stressors.

Improved System Resiliency - Replacing brittle, aging #6 CU conductor with new conductor, along with the replacement of associated aging poles, transformers and cut outs as indicated by evaluation of their condition, will harden PSE's system against the impacts of major events.

Capacity – Replacing #6 CU with new, higher capacity, conductor will increase the capacity of distribution circuits to serve growing load and support DER development.

4.4. INVESTMENT DECISION BENEFITS

PSE's employs an Investment Decision Optimization Tool (iDOT) to evaluate benefits of projects and optimize the annual portfolios for construction. The top primary iDOT Benefits this plan addresses are:

- Public Engagement Perception
- Contribution to Strategy
- Environmental Impact

Planned copper replacement work and the expected SAIDI improvements are shown below in Table 2. This work represents projects that have carried over from existing work into the copper replacement plan.

Table 3: Summary of Plan Benefits, Population and iDOT B/C score

	Total Projects	Total Plan ($M)	Conductor Mileage	Non-MED CMI Saved	iDOT B/C Score
2025-2026	12	$3.6	29.1	107,346	12.09

4.5. ESTIMATED TOTAL COSTS

For Electric System Planning, estimated costs are generated based on historical costs of similar types of projects, allows for variations in project scope, increase in project cost due to inflation, and added contingency to account for unforeseen conditions associated with the project. Historically copper replacement projects have averaged a cost of $300,000 per mile when performing like-for-like conductor replacements. Conductor replacement costs are expected to increase going forward, as it is increasingly assumed conductor replacement projects require replacement of additional aging distribution infrastructure such as wooden poles. Projects are now estimated to range to an average cost of $500,000 per mile of conductor replaced as a result of increased scope. Costs will also vary based on the replacement option necessary for each location. For example, areas with elevated wildfire risk or greater exposure to vegetation will require more expensive replacement methods to mitigate additional hazards presented by local conditions.

5. ALTERNATIVES

5.1. SOLUTION ALTERNATIVES

No Action – Lost opportunity to replace a significant quantity of #6 CU conductor in a targeted manner in order to maximize improvement to public and worker health and safety, customer reliability and system resiliency. The system would experience increased failures over time as the conductor and its surrounding infrastructure continues to age resulting in adverse impacts to system reliability, resiliency and increased risk to worker and public safety.

Include as part of other plans/project – This could be replaced as part of other plans such as pole replacement, WPC, Wildfire, targeted reliability or targeted capacity. It is unlikely that we can meet our replacement goals for CU by including this work in other programs due to delays that would occur until other projects become needed on sections of CU conductor. This solution would also result in adverse impacts to reliability, resiliency and increased risk to worker and public safety.

Exclusively perform like-for-like replacement – Rather than undergrounding and installing tree wire in locations where alternative construction methods provide additional benefit, the plan could exclusively replace #6 CU with bare #2 ACSR. This solution would reduce project expense and increase the likelihood that the plan will meet its goals on a desired timelye, but would drastically decrease the plan's ability to reduce risks in wildfire areas and mitigate outage risks in areas prone to vegetation outages.

5.2. FUNDING ALTERNATIVES

Increase Funding from Proposed –With increased funding the plan could be expanded to more-quickly remove additional or all #6 CU conductor from PSE's system. Accelerated replacement would decrease the time needed to remove #6 CU from areas of wildfire risk. Increased funding would result in increased overall plan benefits but cumulative cost may overtake benefits as we replace the most at risk conductors first.

Decrease Funding from Proposed – With decreased annual funding, PSE would replace less #6 CU wire annually while the risk to safety, reliability and resiliency would begin to increase again.

6. PLAN DOCUMENT HISTORY

The current version of the project summary supersedes all previous versions.

Date	Reason(s) for Update	Summary of Significant Change(s)	Modified By
6/30/2020	Original Program Document - New plan template	Original Program Document– Summarize historical plans	Sue Cagampang
5/5/2021	Program Update	Revised budget and program duration.	Sue Cagampang
7/13/2021	Used and Useful Policy guidance	Add alternatives and cost information	Sue Cagampang
12/1/2021	Annual Review	Minor word and format changes	Sue Cagampang
10/1/2023	2024 MYRP update	Includes Equity, removes ISP, remove plan budgetary info	Matthew Fode
12/4/2023	2024 MYRP update	Updated Equity, Top 3 Primary iDOT categories, and Program Summary Table to align with 2025-2026 project submittals	Krista Malmgren

7. SUPPORTING DOCUMENTATION

Document Name
N/A

SERVICE TRANSFORMER UPGRADE

ENERGY TYPE: ELECTRIC

1. SHORT DESCRIPTION

The Service Transformer Upgrade Plan is an on-going proactive plan to upgrade overloaded service transformers to ensure continued reliability of PSE's electric distribution system. Future electric system growth is difficult to precisely predict, especially at the local service level, due to many factors influencing customer purchases of electric vehicles, addition of air-conditioning, transition from natural gas to electricity for space and domestic water heating, etc. This plan is focused on proactively upgrading service transformers becoming overloaded to address future capacity needs. This plan is driven by anticipation of growing electrification, including widespread electric vehicle (EV) adoption, and increased frequency of severe weather events contributing to increased loads on service transformers.

2. BACKGROUND

PSE's Circuit Enablement – EV Impact Plan originally encompassed a range of upgrades to PSE's electric distribution and transmission systems in anticipation of widespread EV adoption. The EV Impact Plan has since been subdivided into distinct strategies. The Service Transformer Upgrade Plan was created to proactively upgrade overloaded service transformers, enabling customer EV adoption while maintaining service transformer reliability. Other transmission and distribution system upgrades driven by EV adoption will be integrated into PSE's Targeted Capacity Plan, which is separate from this plan.

In June 2021, PSE's territory experienced a 3-day period of high ambient temperatures known as a heat dome. 289 distribution transformers failed during this heat dome due to increased loading coupled with high temperatures not allowing transformers to cool. A Root Cause Analysis (RCA) found that the rate of service transformer failures increased at 88°F ambient conditions, with another steep increase at 95°F. This program seeks to mitigate the impact of future severe weather events by reducing the population of overloaded transformers that are likely to fail during periods of high ambient temperatures.

PSE's region is expecting to see a growth in EV utilization in both Light-Duty Vehicles (LDV) and Medium and Heavy-Duty Vehicles (MHDV) driven by industry and government mandates like the Zero-Emission Vehicles (ZEV) bill. LDV classes include passenger cars and light trucks. MHDV classes include delivery trucks, school buses, semi-trucks, and transit buses. Under the 2020 ZEV law, Washington State must reduce its overall greenhouse emissions by 45% by 2030, 70% by 2040, and 95% by 2050. As nearly 45% of Washington State's annual greenhouse gas emissions come from transportation, cleaner LDV and MHDVs are essential to reaching those targets. In addition, Washington State will ban the

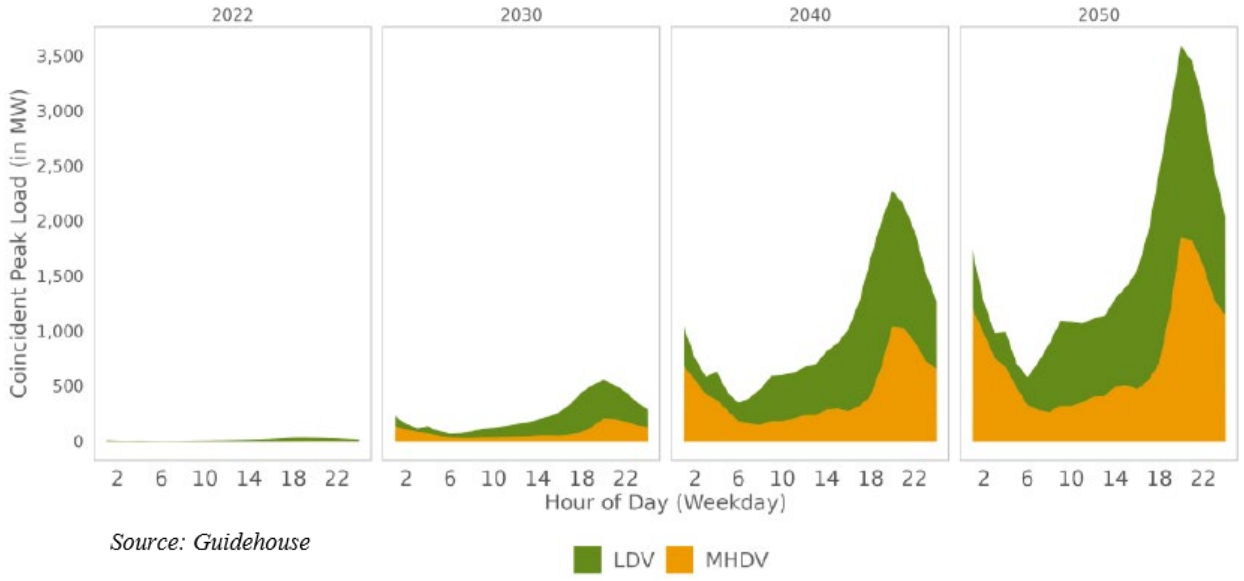
sale of new gas-powered cars beginning in 2035. The Guidehouse[1] PSE 2023 Electric Vehicle Forecast predicts the population of EVs in PSE's territory growing as shown below:

Table 1: EV Population in PSE Service Area (number of vehicles, in thousands)

Duty	2022	2030	2045
LDV	59	475	2,229
MHDV	0	11	76

Source: Guidehouse

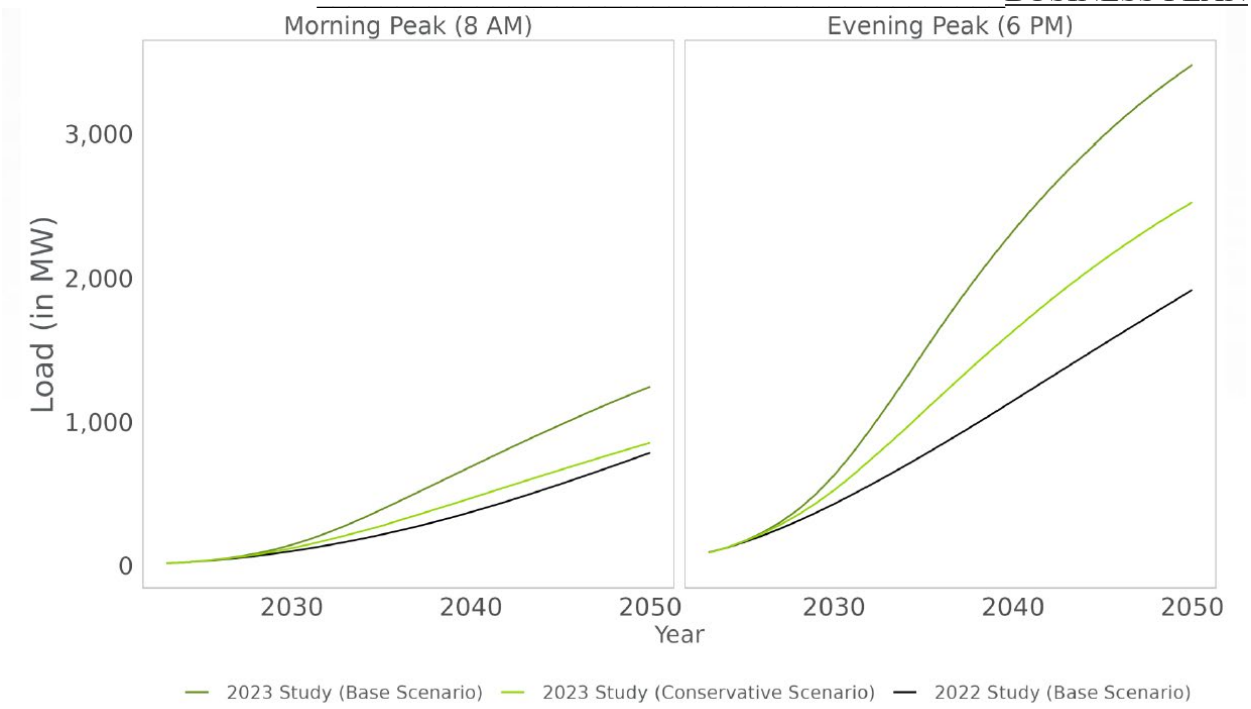
This plan seeks to use existing market studies, asset and customer data to better plan how to accommodate this growth in demand. PSE is ramping up programs to encourage customer EV adoption, incentivizing off-peak charging to limit grid demand, and establishing an EV charging network. However, the pace of EV demand will quickly exacerbate system constraints. PSE is analyzing in-house and 3rd party EV identification analytics using Advanced Metering Infrastructure (AMI) data with the objective of identifying EV penetration at the meter and service transformer levels. By investing in EV identification tools, PSE can prioritize the replacement of overloaded service transformers in geographic areas with high EV adoption and make more informed decisions related to customer EV programs. Figures 1 and 2 below illustrate anticipated growth in EV charging load based on Guidehouse studies.



Source: Guidehouse

Figure 1: Annual EV Coincident Peak Charging Load (Evening – 6 PM)

[1] Guidehouse is an outside consultant tasked with analyzing EV adoption trends in PSE's service territory.



Source: Guidehouse

Figure 2: Daily Peaks by Study

2.1. Residential Demand Data Analytics

Widespread LDV adoption in residential areas significantly impacts PSE's existing distribution infrastructure, specifically service transformers. PSE currently operates approximately 238k single phase service transformers, of which approximately 216k currently have visible loading data from AMI meters.

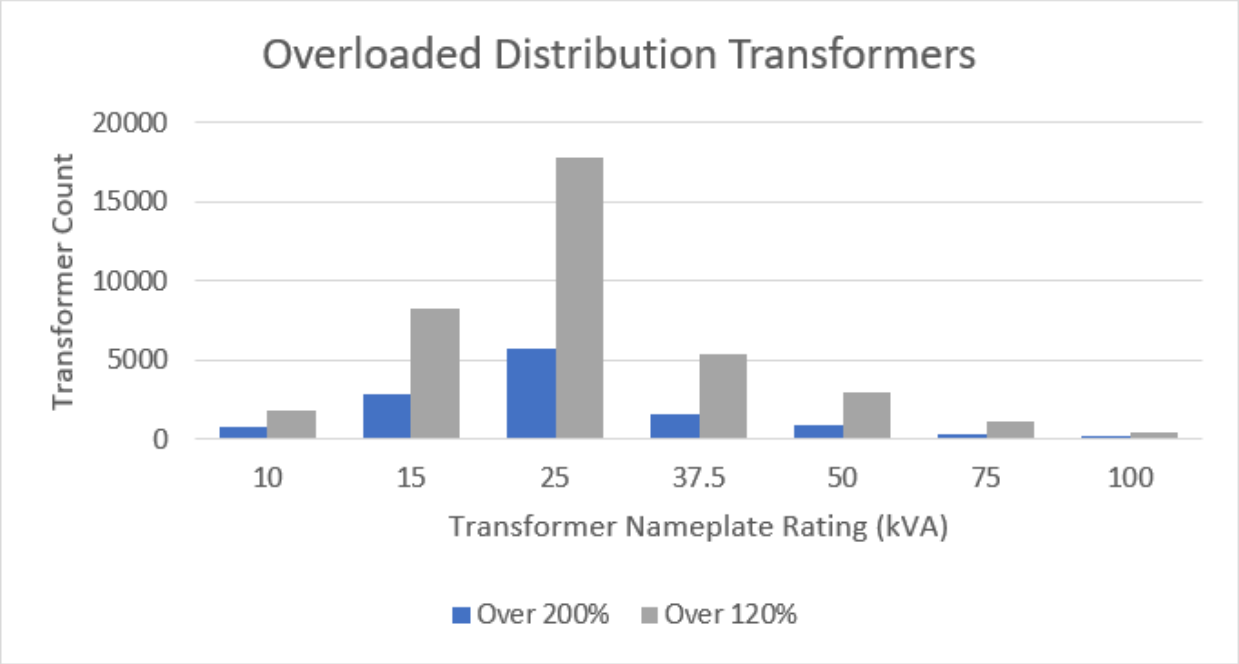


Figure 3: Service Transformers Loaded more than 120% over Nameplate

Based on current AMI data from 2022 – 2023, over 37k distribution transformers are over 120% loaded with approximately 12K of those over 200%. While these units are designed to be overloaded (130%-160% above transformer nameplate rating) during short peak intervals (15 minutes), continuous heavy loading (at least 1 hour) reduces the life of the equipment and leads to more frequent failures and customer outages. Using this Asset Health information, we can proactively target specific circuits and service areas to improve residential capacity.

3. STATEMENT OF NEED

PSE is committed to providing safe, reliable, affordable energy service to PSE's customers and working with them to act on climate change. PSE's 2023 Load Forecast predicts system-wide EV load to increase from 62 MW in 2022 to approximately 566 MW in 2030 from EV's alone, prompting circuit enablement infrastructure investments. The existing distribution system requires upgrades to meet the increasing EV load demand.

3.1. NEED DRIVERS

Grid Modernization –

- **Reliability** – New EV load demand overloading transformers will lead to decreased asset life and more frequent outages, with reduced capacity limiting switching flexibility and extending outage times.
- **Smart & Flexible** –Proactively planning system upgrades using granular customer data to anticipate customer needs and system constraints.
- **Capacity**- According to the 2023 Load Forecast, a ~504 MW peak demand increase from solely EV's is expected for the entire PSE system from 2022 to 2030.

3.2. EQUITY

PSE evaluates equity in the planning process with consideration of the four core tenets of energy justice: Recognition Justice, Procedural Justice, Distributional Justice, and Restorative Justice in various steps of the process.

As specific studies are performed and projects proposed to further a business plan, planners review system, customers, and now equity data to recognize the specific customer burdens, whether there are highly impacted or vulnerable customers that are or will be affected by addressing the specific business need. Planners must prioritize where to focus study each year, thus the full understanding of the historic and ongoing inequities for the entire business plan is extrapolated at this time, maturing over time which greater tools and data.

PSE is building process and tools to enable procedural inclusion in defining the need and solutions through engagement with specific communities and community based organizations, increasing understanding of local needs and consequences to inform specific study development as well as options to address need. Maturity in where and how this occurs will increase over the next several years. Business plans will be updated as informed this collective engagement to reflect broader equity benefits and burdens as this engagement increases over time.

As specific projects are proposed, PSE's investment decision optimization tool captures equity benefits. An optimized portfolio of projects across many business plans ensures the distribution of benefits and burdens are spread across all segments of the community and aim to ensure that marginalized and vulnerable communities do not receive an inordinate share of burdens or are denied access to benefits. As an initial step, PSE leverages Customer Benefit Indicators ("CBI") and information established as part of the 2021 Clean Energy Implementation Plan ("CEIP") to identify an equity framework to evaluate system projects. The CBI approach was developed through an iterative process that was coordinated with the Equity Advisory Group. These CBI span the core tenets of energy justice and provide a framework to evaluate the comparative equity benefit of each solution alternative considered. Refer to Table 1 for a brief description of the CBIs that address equity and the applicable benefits for the Service Transformer Upgrade Plan. PSE will continue to adjust and refine equity consideration in projects when necessary as the process continues to mature.

Projects will be evaluated on each CBI category and a total equity benefit score will be provided.

Table 2: Equity Applicable Benefits

Customer Benefit Indicator	Description	Program Applicable Benefit
Customer Energy Savings	Solutions that lead customers to use less energy, which leads to less energy that must be purchased and potentially a reduction in planned system upgrades.	No

Greenhouse Gas Emissions	Solutions that lead to a reduction of greenhouse gas emissions, either directly or indirectly	Yes
Enables Cleaner Energy	Solutions that either directly integrate DER on the system or enable the grid to more readily accommodate future DER.	Yes
Air Quality	Solutions that either directly eliminate the source of a common pollutant or reduce the risk that could cause a common pollutant to increase, such as enabling Electric Vehicle or DER adoption	Yes
Resilience	Solutions that address major event outages or harden critical facilities to prevent catastrophic events from creating long duration outages.	No
Cost Reduction	Solutions that identify least cost alternatives and therefore reduce costs for all customers	No
Clean Energy Jobs	Solutions that increase clean energy jobs by furthering clean energy technology application, as described in the CEIP	No
Home Comfort	Solutions that deploy residential energy efficiency in either a targeted solution area or by leveraging load reduction from system wide energy efficiency installations	No

The Service Transformer Upgrade Plan is programmatically optimized based on total benefit value to cost. Specific program projects are identified based total benefit to cost with named communities receiving additional scored benefit based on vulnerable population designation and highly impact community characteristics, essentially ensure investments are distributed appropriately to named communities.

Business plans in isolation do not address restorative justice, but continued planning process improvements which include considerations of data, tools, and documentation as well as operational practices will help to restore equity over time.

4. PLAN DETAIL

4.1. PLAN SIZE/POPULATION

This plan addresses emerging capacity needs across PSE's territory, focusing specifically on distribution transformers that are already overloaded and should be upgraded to meet increased loading.

PSE is working to incentivize off-peak loading for residential customers (as commercial customers have a more consistent demand profile.) As more is learned about the results of such efforts, system-wide load forecasts may be reduced and service transformer peak loading may be reduced, but until that information regarding the loading outlook is known, PSE must continue on its path of upgrading service transformers that are experiencing overloading in the near term.

The volume of projects constructed each year is highly dependent on the availability of materials, specifically service transformers, and crew resources. Material and crew

resources are shared between this plan and other planned and unplanned work, including responses to storm outages. As such, the volume of projects constructed each year may be curtailed to dedicate shared materials and crews to other projects. PSE expects to construct an average of 100-450 projects each year in 2024 & 2025 based on these constraints.

4.2. PROPOSED COMPLETION DATE

This plan is ongoing as EV adoption, electrification and more-extreme weather events influenced by climate change continue to affect the health of PSE's service transformers. Current plans are through 2028.

4.3. SUMMARY OF PLAN BENEFITS

The Service Transformer Upgrade plan proactively addresses system infrastructure constraints for growing electrification, electric vehicles and increased demand during severe weather events, which reduces outages due to overloaded service transformers.

EV identification analytics applied in implementing this plan increase DER data knowledge and granularity of evolving customer load information.

4.4. INVESTMENT DECISION BENEFITS

PSE employs an Investment Decision Optimization Tool (iDOT) to evaluate benefits of projects and optimize annual portfolios. The primary iDOT Benefits this plan addresses are::

- Outage Concern:
- Environmental Impact

Table 3: Summary of Plan Benefits, Population, and iDOT B/C Score

	Total Projects	Total Plan ($M)	Number of Transformers	Non-MED CMI Saved	iDOT B/C Score
2024-2025	200-900	13.25	200-900	1,593,000	12.28

4.5. ESTIMATED TOTAL COSTS

The estimated cost and volume of potential transformer upgrades by size is shown below in Table 4. Note that all costs shown are Capital.

Table 4: Upgrade Cost Estimate by Service Transformer Size

Size (kVA)	# Over 200%	Upgrade Cost
10	760	$5,000
15	2,875	$5,000
25	5,668	$5,500
37.5	1,539	$6,500
50	909	$8,500
75	295	$10,000
100	118	$10,000

5. ALTERNATIVES

5.1. SOLUTION ALTERNATIVES

No Action – Customers experience reduced reliability and increased outages as growing demand taxes existing infrastructure. Heavily overloaded transformers will fail at a higher rate, causing unplanned outages and increasing CMI. Unplanned work has a higher cost than planned work. Reduced distribution capacity also makes it more difficult to connect new customers.

5.2. FUNDING ALTERNATIVES

Increase Funding from Proposed – Increased funding could potentially support increased quantities of upgrades and reliability benefit to more customers sooner, but as mentioned in earlier sections, pace of upgrades is currently constrained by availability of materials and crew resource balancing across other programs. Increased funding could also support more investment in modeling tools and expanded use of AMI data to further identify impacted areas that will require service transformer upgrades.

Decrease Funding from Proposed – If the funding is decreased below the level needed to support demand, then we would see an associated decrease in reliability and capacity, similar to No Action being taken.

6. PLAN DOCUMENT HISTORY

Date	Reason(s) for Update	Summary of Significant Change(s)	Modified By
11/10/2023	Initial Plan	Initial document	Erik Engels
12/5/2023	2024 MYRP Update	Update table and iDOT section to align with other business plans	Krista Malmgren

7. SUPPORTING DOCUMENTATION

Document Name
GUIDEHOUSE STUDY
F21 FINAL LOAD FORECAST_072321
ASSET HEALTH DASHBOARD