EXH. DJL-5 (Apdx. C)
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 C (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: Cable Remediation

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):	The Cable Remediation Program is a reliability initiative to remediate primarily direct buried bare concentric neutral cables installed between 1965 and 1990 which have a high failure rate across the industry and within PSE. PSE's high-molecular weight (HMW) cable type fails most prominently but additional early vintage underground cable and neutrals continue to be problematic. By 2015, HWM experienced 50 failures per 100 miles. The nuetral cable is subject to corrosion and insulation of direct bury susceptible to the formation of water trees. By the end of 2020, PSE has remediated 3500 miles, focused on addressing failed and preventing failure of the remaining 1303 miles. A typical underground cable causes on average a 5.7 hour outage with each failure. Often upon failure these cables are switched around to restore customers and the system is left in an abnormal configuration, increasing the risk of greater outage length until the cable is replaced. This population of asset has high impact on SAIDI performance as a result.

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Desired State (Proposed Solution):

The solution is replacement with newer more resilient underground cable in conduit that is more protected from third party damages and can be repaired easier if necessary. In some cases the existing cable can be injected with silicon, but often all three phases are at risk making if more effective to replace all at one time. Since the 1990's the program has replaced on average 100 miles of cable per year increasing in 2016 through 2018 to approximately 140 miles per year, which reduced the number of cable related outages significantly from over 1200 in 2015 to less than 800 in 2020. The program is intended to proactively replace cable before the customer experiences the outages. PSE anticipates completion of this program by 2035 assuming the current general funding level.

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Outcome/Results (What are the anticipated benefits):	Addressing the failure prone cable has been one of PSE's priorities since the 1990's to improve system reliability, address safety and customers concerns, and upgrade its aging infrastructure. This improves the customer experience and overall reliability. The benefits of the plan include reduced outages and avoided customer minute interruptions (CMI) which affect PSE SAIDI. Emergency repairs are avoided which are generally higher in cost than proactive replacement. The program will replace 462 miles of cable between 2022-2026 which brings total benefits of $129M and 27.6M CMI avoided.

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Dependencies: No

Dependencies comment: None.

Escalation Included: No, escalation has not been included.

Total Estimated Costs: $650,000,000

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
Capital	W_R.10009.08.01.02	E UG Cable Remediation Dist	$ -	$ 36,619,365	$ 20,000,000	$ 50,000,000	$ 60,000,000	$ 56,283,760

Incremental O&M: No

Qualitative Benefits:

Primary benefits are avoided outages and CMI. Project benefits are realized upon completion of the project and confirmed 3 years after through a process called backcasting.

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 Customer Minute Interruptions	Other	$ -	$ 25,900,000	$ 25,900,000	$ 25,900,000	$ 25,900,000	$ 25,900,000	$ -	$ -	$ 129,500,000

Risk Summary:

Project risks can include permit delays although this work is primarily designed and constructed by PSE's service provider and historically very successful in completing the annual plan and more.

Benefit risks are minimal as historical backcasting verifies benefits are realized 100% of the time.

System risks without a plan in place or a run to failure approach would mean increased interruptions due to cable failures, customer dissatisfaction and increased emergency repair expenses annually. Cables will fail repeatedly and will only be repaired and eventually replaced on an unplanned basis, which increases emergency O&M repair costs and become a safety concern. Also, repeated outages have a negative impact on system and customer reliability and can lead to customer complaints that get escalated.

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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 information using current business plan information	3/15/2023

PUGET SOUND ENERGY

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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

CABLE REMEDIATION

ENERGY TYPE: ELECTRIC

1. SHORT DESCRIPTION

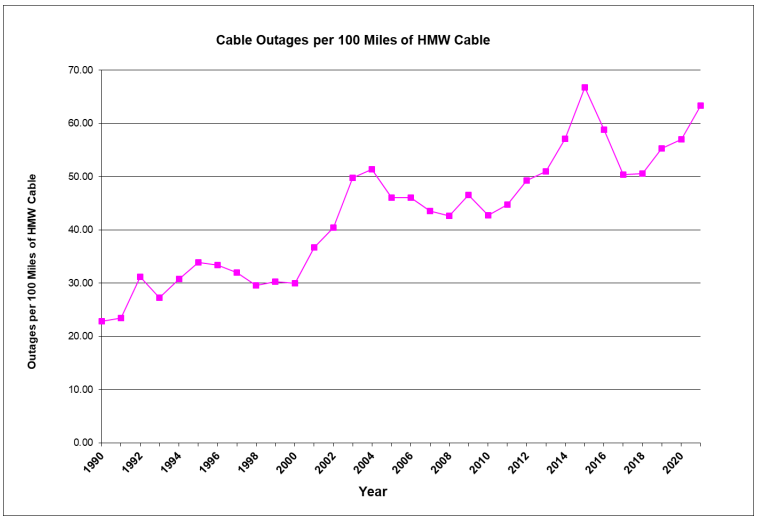
The cable remediation plan is a reliability initiative to remediate primarily direct buried bare concentric neutral cables belonging to Puget Sound Energy's (PSE) underground residential distribution system that have a trended probability of failure, of which high-molecular weight (HMW) cable type is the worst offender.

2. BACKGROUND

PSE began installing direct buried bare concentric neutral HMW underground cables primarily for residential distribution just prior to 1965. This type of cable was installed nation-wide by multiple utilities during the housing construction boom of the 1970's. PSE and other utilities began to experience cable failures just after 20 years of service as the insulation of the cable became susceptible to formation of "water trees" allowing ground water to migrate to the conductor and cause electrical faults. Warm weather can increase the probability of failure.

As part of a 1988 Puget Power (PSE's former name) 'Underground Cable Failure Report', an in-depth analysis of three test years (1985-1988) showed that more than 95% of cable failures were due to pre-1983 HMW insulated cable. Similar failure rates were experienced in utilities across the country, which resulted in industry wide concerns. The report determined that PSE experienced an average failure rate of 25 failures per 100 miles of HMW cable prior to the beginning of this program in 1990. It has now increased to over 65 failures per 100 miles in 2015 and as of 2021, the average failure rate remains high at 63 failures per 100 miles of installed cable.

Figure 1: HWM Cable Failure Caused Outage Per 100 Miles

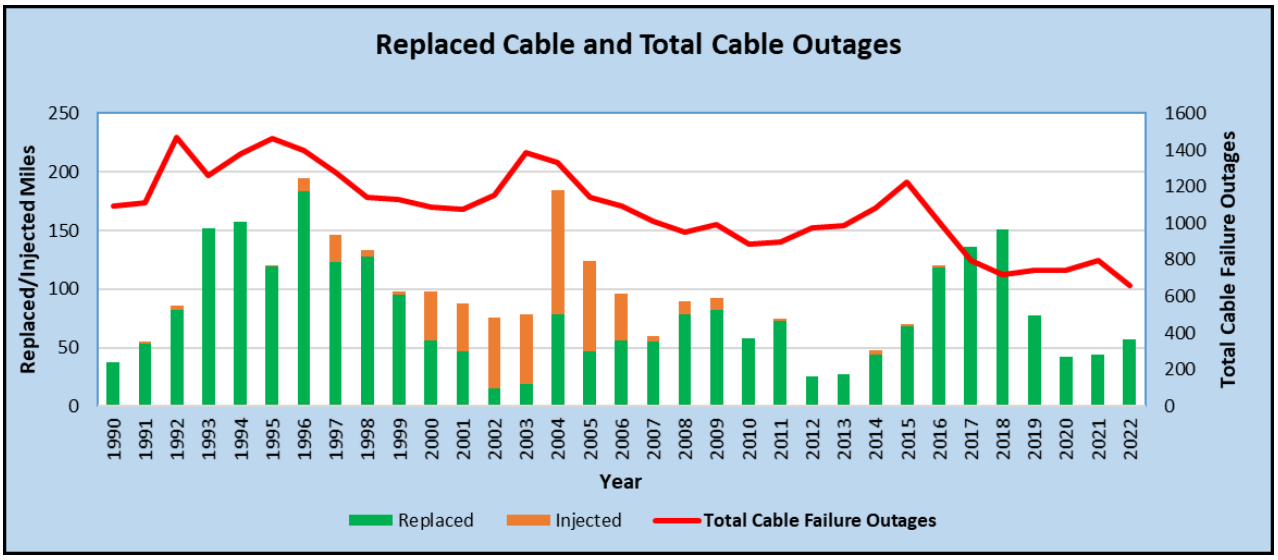


Direct-buried cables of this generation also include a bare concentric neutral cable, which is subject to corrosion over time and will compromise the integrity of the neutral. This poses risks to the customer and people working with the cables.

Other utilities across the US (United States) are also experiencing similar reliability issues with similar direct buried cables. In 1990, the increase in cable failures was the basis and background to initiate the Cable Remediation Plan and in 2016, PSE established the Electric Reliability Plan[1] to ramp up replacement of HMW cable.

Since 1990 PSE has tracked monthly quantity of outages, aggregated by year, and averaged over 1000 failed cable related outages per year until 2016 when the outages began to decrease as shown in Figure 2. Although quantity of annual cable related outages is decreasing because of the plan, the data in Figure 1 makes clear outages per 100 miles of HMW cable remaining in the distribution system are still increasing. This indicates a need to replace remaining cables at a higher rate to keep pace with the growing failure rate.

Figure 2: 1990 – 2022 Annual Cable Failure Outages and Miles of Remediated Cable



The majority of cables have been remediated through replacement; however, a smaller population were injected with silicone to remediate the insulation issue and extend the life of the cable. Since 2016, the plan has focused on replacement, which has delivered notable reduction in cable failures.

3. BUSINESS NEED

This plan targets the improvement of system reliability, aging infrastructure replacement, and reduction of outages due to cable related failures. These failures cause on average 36,000 customer outages each year and contribute approximately 7 minutes of SAIDI annually. PSE's reliability performance index (SAIDI/SAIFI) has scored in the third quartile compared with over 100 other utilities in the US from 2017 to 2020 and scored in the fourth quartile in

[1] 2017 and 2018 Electric Reliability Plan – see supporting documentation section

2021 and 2022 on the IEEE Reliability Benchmarking Survey. Based on this performance, PSE determined the need for continued effort of the programmatic approach to reduce outages caused by failure prone cable.

3.1. NEED DRIVERS

Strategic Alignment: Operate the Business - Reliability

Reliability –Underground cable failures typically have been the largest source of PSE equipment-related failures affecting customers and PSE SAIDI & SAIFI reliability performance indexes. Replacing aging direct buried HMW cable with new TRXLPE cable technology in conduit with modern construction techniques improves customer reliability and eliminates the typical causes of cable outages. Average cable outage duration since 2017 is about 7 hours per outage, which can be a significant impact on customers including potential for loss of food and impact to home life and work. Since HMW type cable is direct buried, it requires more time to locate a failure and repair or replace as opposed to new cable in conduit. Replacing direct buried cables supports grid modernization efforts by improving the reliability of the infrastructure and reduces maintenance repair costs.

Safety – Direct buried cable of this generation includes a bare concentric neutral, which corrodes over time and compromises the integrity of the neutral which could result in stray voltage and safety concerns for employees and the public.

Resilience –By replacing old HMW cable technology and installing new cable in conduit, PSE can make future repairs or replace cables more quickly, thereby reducing future outage duration. New cable and hardware will provide operational flexibility, improved design and better service connection to customers.

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 Cable Remediation 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	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	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 program attempts to annually address the Cable Remediation 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

Since the failure rate of direct buried cables ramped up between the 1980's and the 1990's, the plan has been funded every year since 1990. The table below outlines the history of the HMW cable replacement progress and remaining HMW cable miles.

Table 2: HMW Cable Population

HMW Cable Population	Total miles
Total family of cables installed 1965-1980	4,800
Cables replaced in conduit prior to 1990	-500
Cables silicone injected from 1990 to 2018	-513
Cables replaced from 1990 to 2022	-2,585
Remaining cable miles end of 2022	**1,202**

4.2. PROPOSED COMPLETION DATE

Through the plan, PSE has remediated approximately 3600 miles of the HMW type of cable as of 2022. Based on the average rate of HMW cable replacement since 2020 of 50 miles per year, the estimated forecast completion of the full HMW population is 2047. The completion date may change depending on the level of investment each year in the plan. The program funding request is generally constrained by crew resource and permitting capacity.

4.3. 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:

- Public Engagement Perception
- Public Health & Safety
- Outage Concern

The cable remediation program has delivered measurable SAIDI improvement as shown in Table 3. Additionally the new cable design is resilient to deterioration and dig-ins, which results in less service disruption and enhances public safety. This improves the customer experience and overall reliability.

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

	Total Projects	Total Plan ($M)	Cable Mileage	Non-MED CMI Saved	iDOT B/C Score
2025-2026	453	$110.7	187	5,756,060	1.46

4.5 ESTIMATED COSTS

PSE-estimated program costs are based on historical costs of similar types of projects, considering variations in project scope and including cost increases to account for inflation. Planning level estimates include contingency based on standard project lifecycle assumptions to account for unforeseen conditions associated with projects.

Historical actual costs have varied per year over the life of this plan, ranging from $74 to $118 per cable trench foot depending on location, permit requirements, and soil conditions. The current estimated unit costs are $146 per cable trench foot.

The projected remaining costs to complete the cable remediation of 1,202 miles is estimated at $926 million based on current unit cost estimate. The total completion cost will depend on cost changes, inflation and the rate of replacement each year.

5. ALTERNATIVES

5.1. SOLUTION ALTERNATIVES

No Action - Without a plan in place or a run to failure approach, PSE would face increased interruptions due to cable failures, customer dissatisfaction and increased emergency repairs. Repeated cables failures would drive up UTC complaints and potential penalties.

Like-Kind UG Replacement – Replacing with new TRXLPE (tree retardant cross-linked polyethylene) insulated cables in conduit is the preferred alternative as this minimizes the risk to cable damage and makes it easier to replace cables in the event of a future problem, therefore requiring less maintenance.

Like-Kind Above ground Replacement – There is an alternative to install similar 15kV distribution cable overhead, however this is sometimes not possible due to space constraints. Above ground, overhead wire is also subject to vegetation damage and outages. Overhead work also adds more cost due to easement acquisition on homeowner properties.

Injection – Silicone injection is an option to extend the life of the cable by rejuvenating insulation and dielectric properties**.** However since the cables have a bare concentric neutral

subject to corrosion over time, injection does not fully mitigate the deterioration issues or address neutral failure which makes the cable unsafe.

6. PLAN DOCUMENT HISTORY

Date	Reason(s) for Update	Summary of Significant Change(s)	Modified By
10/25/2019	CRP Business Case - New plan template	Documenting CRP kick-off from 1990 and Program ramp up in 2016 – Summarize historical plans	Stephen Hartnett
4/16/2020	Revision	Need drivers; iDOT categories & benefits	Stephen Hartnett
03/16/2021	Revision	Annual Program Updates	Stephen Hartnett
7/13/2021	Used and Useful Policy guidance	Add alternatives and cost information	Stephen Hartnett
12/1/2021	Annual Review	Minor word and format changes	Stephen Hartnett
08/29/2023	Annual Review	Includes Equity, remove ISP, Updated program completion and costs.	Stephen Hartnett
12/5/2023	2024 MYRP Update	Updated Equity Table, Top 3 Primary iDOT Benefits and Program Summary Table to align with 2025-2026 project submittals	Krista Malmgren

7. SUPPORTING DOCUMENTATION

Document Name
Puget Power Underground Cable Failure report (aka Chicken Little report)
CEATI Assessment Criteria Used to Repair, Refurbish or Replace Underground Cable
IEEE Insulated Conductors Committee – Power Cable Reliability Solution
IEEE - Trends in Underground Residential Distribution Cable Systems
2017 and 2018 Electric Reliability Plan
2022 IEEE Benchmarking Survey