EXH. DJL-7r (Apdx. Ar)
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 A (NONCONFIDENTIAL) TO THE SIXTH EXHIBIT TO THE PREFILED DIRECT TESTIMONY OF

DAVID J. LANDERS

ON BEHALF OF PUGET SOUND ENERGY

REVISED
MARCH 4, 2024

FEBRUARY 15, 2024

PUGET SOUND ENERGY

Seabeck Area Reliability

Corporate Spending Authorization (CSA)

Date Created:	Friday, February 10, 2023
Discretionary/ Non-Discretionary:	Discretionary
Multi Year Rate Plan:	Specific
Equity Impact:	Yes
Strategic Alignment:	Operate the Business-Customer Experience
Estimated In-Service Date:	Thursday, December 31, 2026
Current State (Business Need):	As detailed in the Seabeck Area Needs Assessment, there are multiple needs in the study area. There are feeder capacity needs for distribution circuits CHI-12 and SIL-15. Both circuits are above the Distribution Planning Guidelines of 83% utilization capacity under normal system configuration for current peak loading levels. Additionally, CHI-12 is over 100% utilization under the contingent event of a step-up transformer failure during current peak loading levels. There are reliability needs with circuits CHI-12 and SIL-15. They are both circuits that historically have had poor reliability performance. These two circuits serve the entire load in this area and continue to have SAIDI and SAIFI scores significantly worse than PSE's average values for SAIDI and SAIFI . Currently there are operational flexibility needs on both circuits during peak loading including low voltages, inability to back up load, and load balance across phases. These operational concerns are exacerbated during N-1 contingencies. Additional growth without system improvements will compound these concerns. There is a concern related to non-standard equipment at both Chico and Silverdale substations. This equipment was standard when it was installed, but has since become out-of-date. At Chico substation there is high-side fusing that is no longer standard. At Silverdale substation there are yellow-jacket getaways, oil-filled capacitor switch, and Mark V circuit switcher that are no longer standard. This equipment should be evaluated as an opportunity for replacement if there is work being done at the substation.

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Seabeck Area Reliability

Corporate Spending Authorization (CSA)

Desired State (Proposed Solution):

Project Scope: 1. New CHI-14 Feeder (12.47 kV) • Install a new circuit from Chico substation (tentatively named CHI-14) to serve customers near the Wildcat Lake area, including a new 12.47kV station breaker and getaway. The new circuit (CHI-14) would include a combination of underground and overhead wire and other distribution service equipment. Specifically, it would include: o Install approximately 2.8 miles of new underground cable in the existing spare conduit along Seabeck Hwy NW from the Chico substation to Seabeck Hwy (Point A). o Convert existing overhead feeder of CHI-12 to underground cable along NW Holly Rd from Seabeck Hwy (Point A) to Tahuyeh Lake Rd NW (Point B). Note the overhead conductor will remain as laterals to feed existing customers. Convert all services on this section to 12.47kV and relocate the existing auto-transformer to a new location near the intersection of NW Holly Rd and Tahuyeh Lake Rd NW. This will create a Normal Open tie to the new CHI-12 East Sub Circuit. o Create a new Normal Open between new CHI-14 and SIL-16 near intersection of Seabeck Highway NW and NW Holly Rd. o Incorporate the new CHI-14 circuit into the existing Distribution Automation Scheme. 2. Express CHI-12 Feeder (34.5 kV) • Construct a new 35kV UG express feeder for approximately 5 miles along NW Holly Rd between Seabeck Hwy (Point A) and NW Seabeck Holly Rd (Point C). • Create 3 CHI-12 sub feeders (north, east, and south) using existing 35kV SCADA reclosers. 3. Transfer Customers via Normal Open changes • Transfer approximately 200 customers from SIL-15 to CHI-12 north sub feeder. This reduces existing SIL-15 load by 50 amps average. • Transfer approximately 180 customers from SIL-15 to new feeder CHI-14, which reduces SIL-15 demand by 40 amps. Total demand reduction on SIL-15 equals 90 amps. Reducing customers on SIL-15 will improve SAIDI and SAIFI by at least 17% by reducing customer exposure on the circuit from 2192 to 1812. • CHI-12 is reduced by approximately 800 customers and 190 amps by transferring customers along NW Holly Rd to new CHI-14 and increased by approximately 200 customers and 50 amps by transferring customers from SIL-15. Overall decrease on CHI-12 is 600 customers and 140 amps. This will improve CHI-12 SAIDI and SAIFI by at least 25% by reducing customer exposure from 2497 to 1897. • The new circuit CHI-14 will have approximately 180 customers and 40 amps from the SIL-15 transfer and 800 customers and 190 amps from the CHI-12 transfer. Total demand on CHI-14 is expected to be 230 amps and 980 customers when completed.

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Outcome/Results (What are the anticipated benefits):	Increased Feeder Capacity and Reliability. Operational flexibility

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Dependencies: no

Dependencies comment: None.

Escalation Included: No, escalation has not been included.

Total Estimated Costs: $11,850,000

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.10040.01.01.01	E Seabeck Area Reliability Improvement	$ -	$ -	$ 2,000,000	$ 8,850,000	$ -	$ -

Incremental O&M: No

Qualitative Benefits: Customers will experience fewer outages and the outages that do occur will be a shorter duration. System will benefit from operational flexibility when a need arises.

Quantitative Benefits:

Quantitative Benefits	Benefit Type	Previous Years	Fiscal 2023	Fiscal 2024	Fiscal 2025	Fiscal 2026	Fiscal 2027	Fiscal 2028	Remaining Costs	Life Total

Risk Summary: Permitting from local juridications. Aquisition of property rights for PSE equipment

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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

PUGET SOUND ENERGY

Seabeck Area Reliability

Corporate Spending Authorization (CSA)

Approval History:

Approved By	Date Approved
Approved by Cost Center Owner: Pagano , Tony	4/3/2023
Approved by Director Sponsor: Roque Bamba	4/6/2023
Approved by Executive Sponsor: Koch , Dan	4/6/2023
CSA Status changed to Approved	4/6/2023
Approved by Cost Center Owner: Lim , Thina	12/5/2023
Approved by Director Sponsor: Lim , Thina	12/5/2023
Approved by Executive Sponsor: Lim , Thina	12/5/2023
CSA Status changed to Approved	12/5/2023
Approved by Cost Center Owner: Pagano , Tony	1/25/2024
Approved by Director Sponsor: Bamba , Roque	1/26/2024
Approved by Executive Sponsor: Vargo , Michelle	2/1/2024
CSA Status changed to Approved	2/1/2024

Seabeck Area
Needs Assessment

Olympic Mountains from Seabeck Conference Center, Seabeck, WA

Strategic System Planning
May 18, 2023

PSE PUGET SOUND ENERGY

Seabeck Area
Needs Assessment

Prepared By:

Colin O'Brien, PE, *Strategic System Planning*
Chad Larson, PE

Approved By:

Ryan Lambert, PE, *Manager - Strategic System Planning*

DocuSigned by:
Ryan Lambert
48EEB5A77F87404... 05/19/2023

Ryan Lambert *Date*
System Planning, Manager

DocuSigned by:
David Landers
B6002897FD5542C... 05/19/2023

David Landers *Date*
System Planning, Director

Strategic System Planning
May 18, 2023

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Executive Summary

PSE's System Planning department regularly assesses communities' electrical systems, throughout the service area, to ensure that PSE can continue to reliably serve its customers. This report is a needs assessment for the distribution system serving Seabeck, Washington and the surrounding area. Among the findings detailed in this report, PSE has identified a need for increased feeder capacity, improved feeder reliability, and improvements in operational flexibility, over a 10-year planning horizon (2022-2032).

The Seabeck study area, shown below in Figure 0-1, is a scenic, rural region at the edge of PSE's service territory in western Kitsap County. Along with the town of Seabeck, it includes Wildcat Lake, the community of Holly, and Guillemot Cove Nature Reserve. There are numerous trails and creeks – with Hood Canal flowing between Kitsap and the Olympic Peninsula.

Within the area, PSE serves approximately 4,700 electric customers (mostly residential), and local homes are typically on large lots in uncondensed neighborhoods. There is no natural gas system in the area.

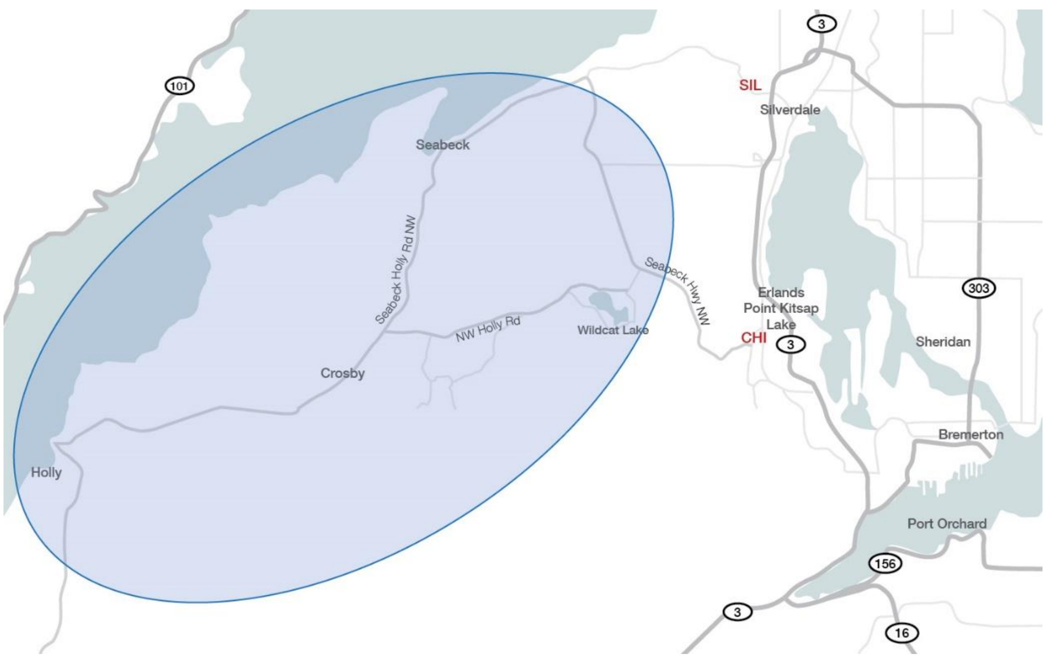

Figure 0-1: Needs assessment study area

The study area is primarily served by two feeders: CHI-12 from Chico substation and SIL-15 from Silverdale substation. Both have poor reliability histories and frequent outages. In fact, CHI-12 is frequently the *worst performing circuit* in all of PSE's service territory. Much of this is due to the circuit's long length and overhead exposure, combined with an abundance of surrounding trees. The local geography can also hamper restoration efforts, making outages last even longer.

With regard to local development, significant residential or commercial growth is not anticipated in this area over the next 10 years. However, PSE's load forecast does indicate a moderate increase, which will further exacerbate the Seabeck area's existing capacity issues.

PSE Needs Assessment Process

PSE defines "need" as a system deficiency that is required to be addressed by a solution, preferably by the identified date of need. A "concern" is a non-critical issue that impacts system operations but is not required to be addressed by a solution; although, a solution that addresses an identified concern provides additional benefit.

For this study, PSE evaluated the following for the Seabeck area's distribution system over the 10-year planning horizon (2022-2032).

Capacity – This is the system's ability to provide enough electricity to meet customer demand (aka "loads"). To project area loads over the 10-year period, this study utilized PSE's F2022 Load Forecast. All forecasted loads in this study factor in PSE's business-as-usual, demand-side management (DSM) [1] energy conservation measures.

When area loads reach approximately 85% of existing capacity under normal conditions, the need to study additional feeder capacity is triggered. This allows time for solutions to be studied and put in place, if needed, before capacity limits are reached.

Reliability – Electric system reliability performance is evaluated through the SAIFI (outage frequency) and SAIDI (outage duration) indexes. CMI (customer minutes of interruption) is another metric used to assess service reliability. PSE's System Planning department monitors outage frequency and durations for each circuit in its service area.

Equipment – Existing infrastructure and equipment is analyzed to determine if it requires replacement, upgrading, or maintenance. This could include identifying new equipment or infrastructure needs.

Operations – This evaluates the electric system's flexibility in adapting to challenges. It includes identifying operational deficiencies and ensuring compliance with transmission and distribution planning guidelines.

PSE's analysis includes testing the electrical system's performance under various planning contingencies. For the Seabeck area assessment, these scenarios were:

N-0 – All system elements in service (no outages)

N-1 – Single contingency (one system element out of service)

[1] DSM measures include energy efficiency, energy conservation and demand response, which are part of PSE's system-wide strategy to incorporate year-round efficiency into its grid operations.

Summary of Seabeck Area Needs and Concerns

The distribution system needs and concerns identified for the Seabeck area are summarized below. As stated earlier, reliability is a currently significant issue for customers. Additionally, within the next 10 years, electrical demand will exceed the existing system's (already strained) capacity limits.

1.1.1 Needs:

- **Feeder Capacity:** Feeders CHI-12 and SIL-15 presently exceed PSE's distribution planning triggers and are forecasted to exceed capacity limits within the 10-year planning period.
  - CHI-12 is forecasted to surpass 100% capacity limit in 2024.
  - CHI-12 has an existing N-1 capacity need in the event of a parallel step-up transformer failure.
  - SIL-15 is forecasted to surpass 100% capacity limit in 2026.
- **Feeder Reliability:** Feeders CHI-12 and SIL-15 have CMI, SAIDI, and SAIFI metrics that are significantly above system average. Reliability improvements are needed for both circuits.
- **Operational Need:** Feeders CHI-12 and SIL-15 experience low voltage under peak demand. Voltage improvements at peak system demand are needed for both feeders.
- **Operational Need:** CHI-12 has phase imbalance during peak loading that exceeds allowable limits. Phase imbalance contributes greatly to system losses due to increased neutral current.

1.1.2 Concerns:

- **Substation Equipment:** There is an existing concern for non-standard substation equipment at both Chico and Silverdale substations. Non-standard equipment includes high-side fusing at Chico substation and yellow jacket getaways, oil-filled capacitor switch, and a Mark V circuit switcher at Silverdale substation. This equipment should be evaluated for replacement when there is planned work at each substation.
- **Non-Standard Operations:** CHI-12 operates at 34.5kV and is the only circuit in Kitsap County at this voltage. This higher voltage class requires specialized equipment and procedures that are non-standard for the region, as well as additional inventory and associated costs.

Conclusion and Next Steps

Energy is essential for communities, and PSE is committed to creating a better energy future for all customers in the Seabeck area.

PSE's assessment of the area's distribution system indicates a need to address its feeder capacity, reliability, and operational flexibility. Additionally, there are concerns about non-standard substation equipment and operating voltage.

The next step in PSE's system planning process is evaluating potential solutions for the needs and concerns identified in this assessment. That analysis will be presented in PSE's forthcoming Seabeck Area Solutions Report.

1 Introduction and Background Information

This document summarizes PSE's distribution needs assessment for the Seabeck area in west Kitsap County. The objective was to identify present and future needs or concerns on the distribution system.

The assessment included:

- Analysis of distribution capacity to serve the study area over the next 10 years (2022-2032)
- Distribution reliability performance
- Distribution operational concerns, including voltage and phase imbalance
- Aging infrastructure analysis

1.1 Existing Distribution System

The Seabeck study area serves approximately 4,700 customers (mostly residential) with a low penetration of natural gas or other fuel commodities. Two distribution circuits (CHI-12 and SIL-15) serve the majority of customers, with a third circuit (SIL-16) that can act as a backup and pick up some customers under light loading conditions. The CHI-12 feeder is supplied from a PSE standard 25 MVA transformer at Chico substation, while SIL-15 and SIL-16 are supplied from the PSE standard 25 MVA transformer at Silverdale substation, as shown in Figure 1-1.

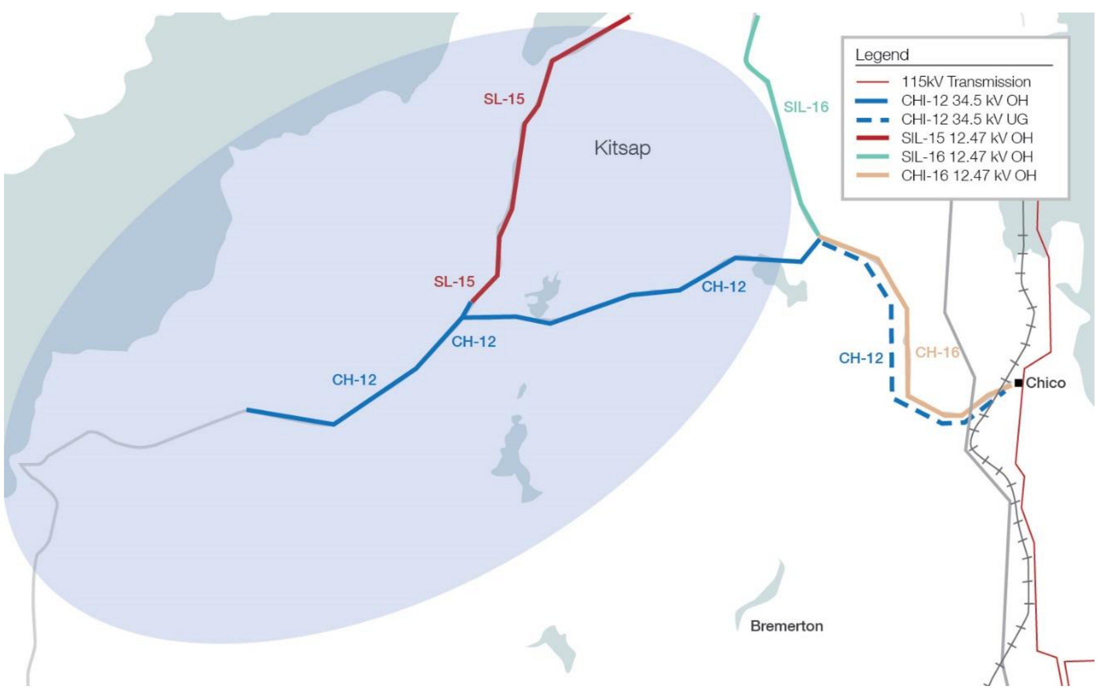

Figure 1-1: Study area distribution system

CHI-12 Description

CHI-12 conductors consists of approximately 3 miles of underground and 8.5 miles of overhead (3.2 miles 4/0 ACSR, 3.4 miles 336 ACSR, and 1.9 miles 397 AAC) three-phase feeder backbone, and approximately 54 miles of overhead laterals. This feeder is served by a 12.47 kV breaker at Chico substation to an overhead 336 ACSR getaway conductor that terminates to parallel underground 750 Al cables, with each set of cables serving one of the two parallel 7.5 MVA, 12.47/34.5kV step-up transformers located within the Chico substation. From the step-up transformers, there are parallel 4/0 Al cables connected to 2.8 miles of 500MCM CU underground cable that then serves the remaining overhead system. The entire feeder system downstream of the step-up transformers is served at 34.5 kV, with several Distribution Automation (DA)[2] enabled reclosers and no voltage regulation equipment.

CHI-12 has two normally-open tie points to neighboring circuits, one to SIL-15 and one to SIL-16. These ties can only be used during light-loading conditions, which generally occur for six to seven months of the year in spring and summer, with only limited application due to concerns with low voltage and high loading on SIL-15 and SIL-16. PSE has added SCADA[3] communication and a DA scheme to the reclosers on CHI-12 and the adjoining normal open on SIL-15. Along with automatic restoration when loading allows, this allows remote switching by system operators and better analysis tools to aid in outage pick up scenarios.

SIL-15 Description

SIL-15 consists of approximately .6 miles of underground 750 AL cable getaways from the Silverdale substation, then 9 miles of overhead three-phase 336 ACSR tree wire feeder backbone, and approximately 34 miles of overhead laterals. SIL-15 is a standard 12.47 kV nominal voltage circuit with two sets of three-phase voltage regulators and several reclosers that have SCADA communication and are included in the area DA scheme. This scheme can only operate during lightly-loaded times of the year for partial back-up and for assisting in restoration after an outage.

SIL-16 Description

SIL-16 ends at the edge of the study area, but provides a tie-point to CHI-12 through a normal-open recloser. This tie can be used to pick up some customers only in the event of a Chico station outage or a cable failure on CHI-12. This tie is not generally effective for backing up CHI-12 in the event of a tree caused outage, especially if the fault location is near the start of the overhead system. SIL-16 is not included in the area's DA scheme.

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[2] Distribution Automation (DA) is a reliability scheme that can automatically operate switches on both sides of faulted equipment to isolate it from the rest of the system and restore service for certain customers during outages.

[3] SCADA (Supervisory Control and Data Acquisition) is telecommunications infrastructure that allows PSE to remotely monitor and control equipment in real time and transmit key information, including circuit breaker status and transformer loading.

2 Key Assumptions and Load Forecast

This section summarizes the study's key assumptions, as well the area's historical and forecasted loads.

2.1 Distribution Study Assumptions

The following key assumptions were utilized for this assessment:

- PSE Distribution Planning Guidelines define performance criteria in this study.
- The assessment horizon selected was the 20-year period from 2022 to 2041 to be in line with the F2022 Load Forecast.
- Historical five-year outage data is used in the assessment.
- There are no known PSE Distributed Energy Resources (DER)[4] on the feeders.
- There is 134kW of interconnected net metering (i.e., customer connected solar) generation capacity on Chico substation on feeders CHI-12 (79kW), CHI-13 (32kW), CHI-15 (5kW), CHI-16 (18kW).
- There is 248kW of interconnected net metering generation capacity on Silverdale substation on feeders SIL-13 (73kW), SIL-15 (106kW), SIL-16 (69kW).

2.2 Kitsap County Historical and Forecasted Load

For this needs assessment, PSE's F2022 Load Forecast was used to model study area loads over the 10-year planning horizon (2022-2032). Kitsap County average annual growth rate varies by year for the study period. See Appendix A for F2022 Kitsap County Load Forecast 2022-2041. Average growth rate for next 10 years with conservation is 0.46%, and without conservation is 1.52%. Average growth rate for next 20 years with conservation is 0.65%, and without conservation is 1.55%.

Historical hourly load data for both distribution substation transformer and distribution feeders were captured for the previous 5 years (2017-2021). The highest temperature-adjusted coincident loading for the identified substation group and feeder group of the previous 3 years (2019-2021) was used and projected for each year of the 10-year planning horizon by applying the annual county growth rates and adding forecasted block loads.

Summer peak loading was identified using historical loading between the months of June to August, while winter peak loading was identified using loading between the months of November to February.

The study area contains some larger pockets of undeveloped property that could see targeted development in the future. This could result in growth levels above the forecasted county levels; these areas were not considered in the analysis as there have been no recent inquiries by developers.

[4] DER (like battery storage and solar panels) are energy resources that are typically sited close to customers and can provide all or some of their immediate electric and power needs. DER can also be used to satisfy the energy, capacity, or ancillary service needs of the distribution grid.

3 Distribution Needs Assessment

3.1 Capacity

PSE regularly monitors the electrical loads throughout its service territory to anticipate and meet system needs, as well as correct deficiencies in the electrical system.

3.1.1 Feeder Capacity

When the loads in an area reach approximately 85% of existing capacity for both overhead (OH) and underground (UG) feeder sections under N-0 system operating conditions the planning need to study adding additional feeder capacity is triggered. This trigger allows for solutions to be studied and put in place before capacity limits are reached and allows for highest loaded phase to remain below capacity limit under acceptable imbalance. When the loads in an area reach 100% of existing capacity, under N-0 and applicable N-1 conditions, there is a need to have the solutions in place to avoid overloads.

3.1.2 Overhead Feeder Capacity

Table 3-1 summarizes the capacity limits for PSE's standard overhead feeder conductors. It applies to the entire overhead portion of feeders in this study that includes CHI-12 and SIL-15.

SIL-15 includes underground sections that are more limiting than the overhead conductors. The 336 ACSR overhead getaway conductor is the limiting factor for CHI-12.

Table 3-1. Distribution Overhead Feeder Capacity Limits[5] [6]

Overhead Feeder Conductor Limits (Amps)		
Conductor	Winter Rating (0°C)	Summer Rating (35°C)
4/0 ACSR	444	325
336 ACSR	659*	483
336 ACSR Tree Wire	645*	440
397 AAC	702*	514
*Note that operations limits N-0 loading to 600A and N-1 to 650A.		

3.1.3 Underground Feeder Capacity

When loading on any UG section reaches limits shown in Table 3-2, the need to add additional feeder capacity is triggered.

Under N-0 and N-1 contingencies, and depending on number of feeder runs in trench, the capacity limit is 394-552 Amps. Any additional load above this capacity limit requires additional feeder capacity to serve the new load. These values apply to the entire underground feeder portion of SIL-15 and the 12.47kV underground feeder portion of CHI-12.

[5] Overhead conductor ratings are based on PSE Standard 0600.0410 effective as of 06/11/2020

[6] Operations limits N-0 loading to 600A and N-1 to 650A based on a standard approach for all system operators to monitor the distribution system.

Table 3-2. Distribution Underground Feeder Capacity Triggers and Capacity Limit

Underground Feeder Conductor - 750 MCM AL (Amps)		
Feeder Runs in Trench	Operational Load (N-0) Planning Trigger (85%)	Capacity Limit (N-0) and Emergency Load (N-1) Planning Trigger (100%)
One	469	552
Two	413	486
Three	368	433
Four	335	394
Five	302	355
Six	271	319

3.1.4 Distribution Substation Capacity

When the loads in an area reach approximately 85% of existing station capacity for a study group of three stations or more, the need to add additional station capacity is triggered to maintain operational flexibility. For individual substations serving load, PSE uses 100% utilization as the capacity limitations of the substation equipment.

Table 3-3 summarizes the N-0 and the N-1 capacity limits for PSE's standard distribution substation transformers. Both the SIL and CHI transformers are standard 25 MVA units.

Table 3-3. Substation Capacity Limits

Single Distribution Substation Loading				
Nominal Rating	Operational Load Limit (N-0)		Emergency Load Limit (N-1)	
	Winter	Summer	Winter	Summer
20 MVA	25.6 MVA	20.6 MVA	28.2 MVA	22 MVA
25 MVA	32 MVA	26 MVA	35 MVA	28 MVA

3.2 Capacity Results

The levels of conservation that can reasonably be achieved in this area are currently difficult to predict. Due to this uncertainty, future capacity needs are studied under multiple scenarios – with predicted system conservation levels and without conservation. The actual need dates presented in this section are based on fully-achieved conservation, as 100% conservation has historically been achieved at a system level. System needs *without* any conservation are also shown to illustrate the earliest need if predicted conservation is not achieved.

3.2.1 Feeder Capacity - CHI-12

Figure 3-1 and Table 3-4 illustrate the historical and projected demand, along with the anticipated capacity need, during the 10-year study period for CHI-12. The highest expected circuit load with and without conservation are also highlighted.

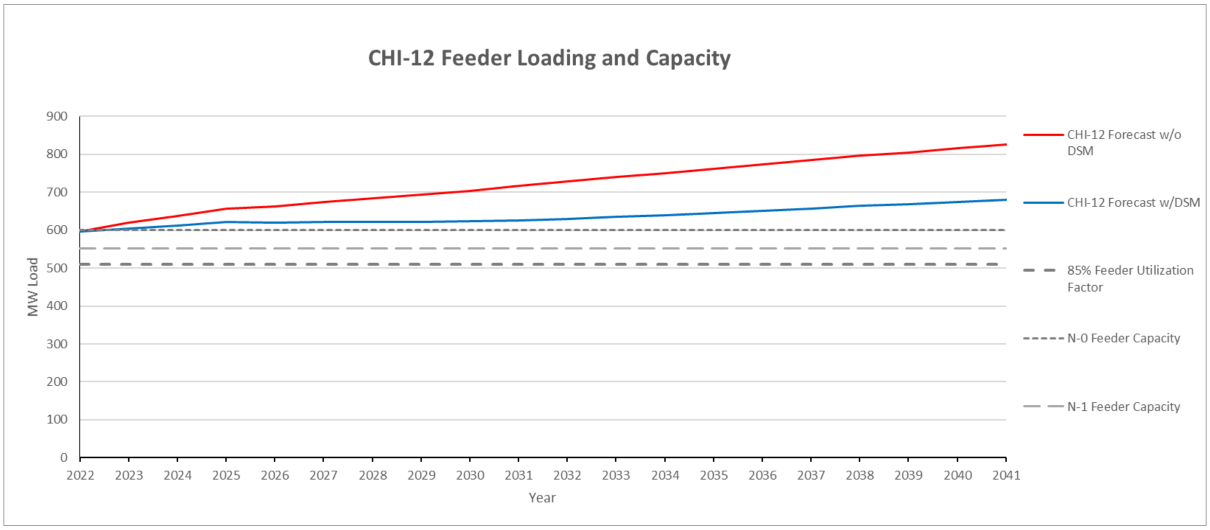


Figure 3-1: CHI-12 Feeder Loading and Capacity

Table 3-4: CHI-12 N-0 Projected Loading w/o Adding Feeder Capacity

CHI-12 Capacity	Feeder Group 85% Utilization		510	Amps		Indicates greater than				
	Feeder Group 100% Utilization		600	Amps		Indicates greater than				
End of year	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
Winter w/DSM	597	599	611	616	618	619	621	622	624	625
Winter w/o DSM	597	601	618	636	642	653	662	671	682	694
Continued (End of year)	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**
Winter w/DSM	631	635	639	643	650	656	656	665	672	680
Winter w/o DSM	717	727	738	749	760	771	780	791	801	812

CHI-12 Capacity Results Summary:

- CHI-12 is presently above the 85% planning trigger to study adding capacity under N-0 conditions during the winter. It is forecasted to exceed the 100% N-0 capacity limit of the feeder in 2024.
- CHI-12 capacity limits for summer are not exceeded within the planning horizon.

3.2.2 N-1 Feeder Capacity – CHI-12

Due to the non-standard nominal voltage and limited tie points for CHI-12, certain N-1 contingencies were considered as part of the needs assessment. The failure of one of the parallel step-up transformers was identified as a risk due to the time associated with replacing this equipment. The CHI-12 circuit is limited to 552A in the event that one of the parallel step-up transformers fails, resulting in the following need on the system:

- CHI-12 is presently above the N-1 contingency limit in the event of the failure of one of the parallel step-up transformers. This contingency would require load shedding of 45 Amps during peak load conditions.

3.2.3 N-0 Feeder Capacity - SIL-15

Figure 3-2 illustrates historical and projected demand for the 10-year study period for SIL-15. Projections are shown with and without conservation. See Table 3-5 for a summary of limits and expected demands, by year, using the F2022 Load Forecast.

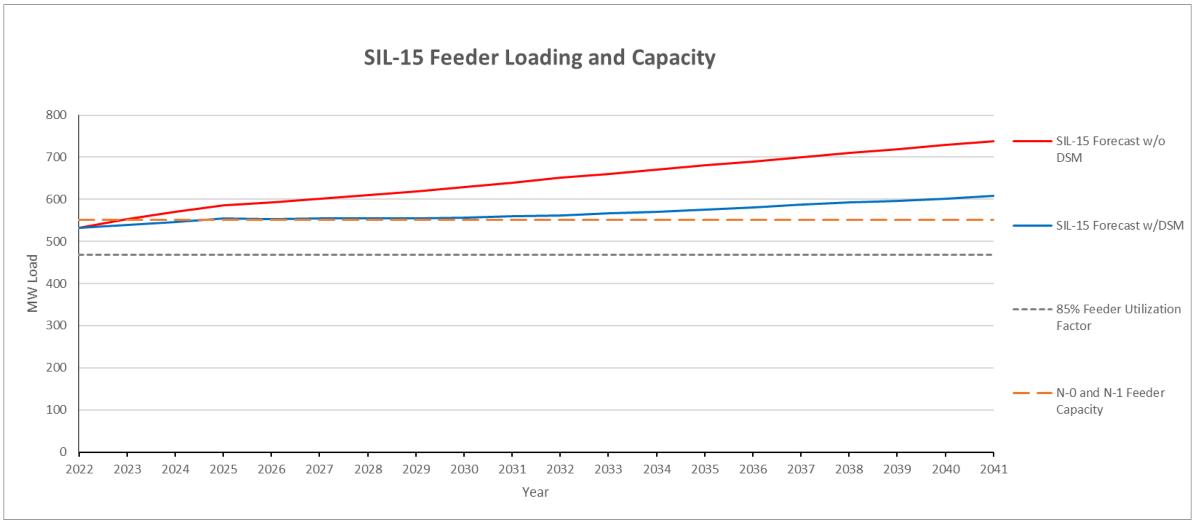


Figure 3-2. SIL-15 Feeder Loading and Capacity

SIL-15 Capacity	Feeder Group 85% Utilization		469 Amps		Indicates greater than				
	Feeder Group 100% Utilization		552 Amps		Indicates greater than				
End of year	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
Winter w/DSM	535	546	550	552	553	554	556	557	558	559
Winter w/o DSM	536	552	568	574	583	591	599	609	620	631
Continued (End of year)	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**
Winter w/DSM	563	567	571	575	581	585	586	594	600	607
Winter w/o DSM	640	649	659	669	679	688	696	706	715	725

Table 3-5: SIL-15 N-0 Projected Loading w/o Adding Feeder Capacity

SIL-15 Capacity Results Summary:

- SIL-15 is presently above the 85% utilization to study adding capacity under N-0 conditions of the OH feeder systems during the winter. It is forecasted to exceed the N-0 capacity of the feeder in 2026.
- SIL-15 capacity limits for summer will not be exceeded within the planning horizon.

3.2.4 Chico Substation Capacity

Figure 3-3 illustrates historical demand and projected demand for the 20-year F2022 Load Forecast period for CHI-1 transformer at the Chico substation. The projected demand includes projections with and without conservation. There are no capacity triggers within the 10-year planning horizon.

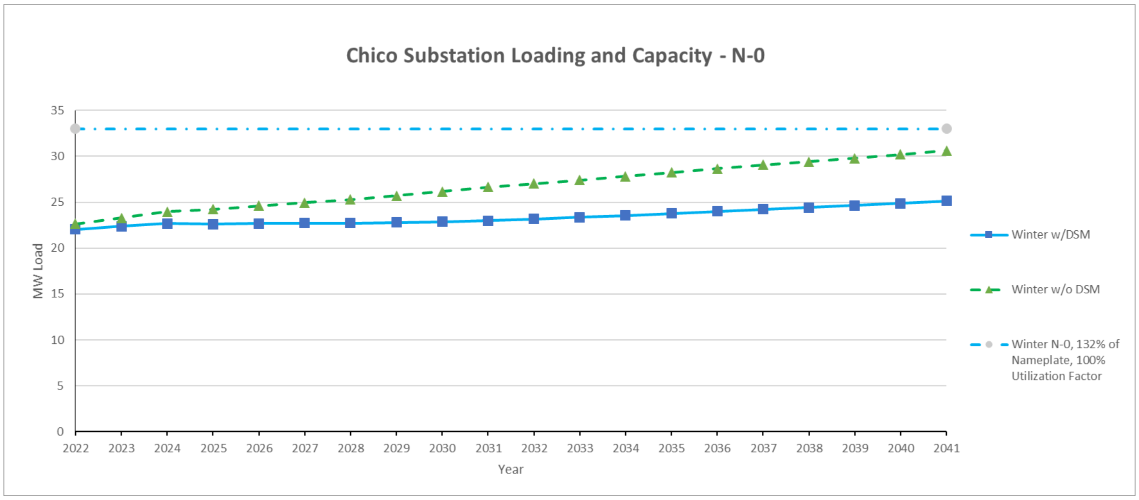


Figure 3-3: Chico Substation N-0 Capacity

3.2.5 Silverdale Substation Capacity

Figure 3-4 illustrates historical demand and projected demand for the 20-year F2022 Load Forecast period for SIL-1 transformer at the Silverdale substation. The projected demand includes projections with and without conservation. There are no capacity triggers within the 10-year planning horizon.

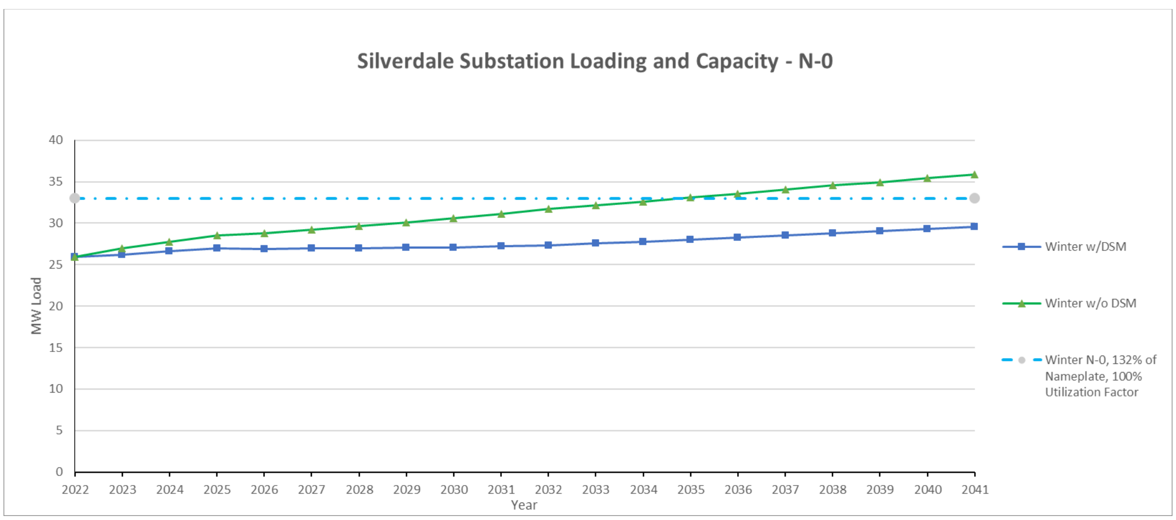


Figure 3-4: Silverdale Substation N-0 Capacity

3.3 Distribution Reliability

The reliability performance of PSE's electric distribution system is evaluated by comparing individual circuits to the system as a whole. The metrics most commonly used to determine reliability performance are Customer Minute Interruptions (CMI), System Average Interruption Frequency Index (SAIFI), and

System Average Interruption Duration Index (SAIDI). These are used to track the frequency and duration of outages experienced by customers on any particular circuit.

Kitsap County is one of PSE's most challenging regions when it comes to maintaining adequate reliability. The area experiences frequent outages, with many that are long-lasting. This is mostly due to large amounts of trees and vegetation, as well as windy conditions associated with the peninsula's geography. Restoring power after an outage is also challenging and time-consuming. The time and effort required to mobilize resources into more rural areas of the county is a contributing factor to the area's longer-duration outages.

CHI-12 has heavy tree exposure along most of the approximately 8.5 miles of overhead three-phase feeder backbone and 54 miles of overhead laterals, which contributes to frequency of outages. There is no existing tree wire on CHI-12 because the feeder is primarily 34.5kV. Presently, 35kV class tree wire is not considered a feasible reliability alternative based on PSE Standard 6550.6060[7], due to construction requirements that limit the viability of the solution. The limited ability to pick up load from adjacent circuits also contributes to longer than average outage durations.

PSE has installed tree wire on the entire OH feeder sections on SIL-15. The installation of tree wire along the feeder sections improved reliability from an average of 580 SAIDI from 2014-2016 to an average of 291 SAIDI from 2017-2021. Even with this improvement, SIL-15 still has poor reliability due to its length – approximately 8.6 miles of overhead three-phase feeder backbone exposure. While tree wire provides the benefit of reducing outages due to limb contact, it does not have the mechanical strength to prevent an outage if a large limb or tree trunk fell into the line. This exposure in heavily-treed areas of the feeder paths contributes to the frequency of outages. The limited ability to pick up load from adjacent circuits also contributes to longer-than-average outage durations.

3.3.1 Reliability Analysis (2017-2021)

Reliability analysis for CHI-12 and SIL-15 was used outage data from 2017-2021. The non-MED[8] CMI, SAIDI, and SAIFI performance of each circuit is compared to the system average over the same timeframe. See 0 for a detailed reliability analysis using data from 2017-2021. Table 3-6 below shows circuit performance in key reliability metrics compared to PSE system average.

Table 3-6. Circuit Reliability Data

Reliability Metric (2017-2021)	PSE Average	SIL-15 (% of Average)	CHI-12 (% of Average)
Non-MED CMI	155,460	629,829 (405%)	1,355,430 (872%)
Non-MED SAIDI	164	291 (177%)	523 (319%)
Non-MED SAIFI	0.96	1.56 (163%)	4.00 (417%)

Analysis shows that the reliability of both CHI-12 and SIL-15 are well above PSE system averages for CMI, SAIFI, and SAIDI. The CMI of SIL-15 is over four times higher, and the CMI of CHI-12 is over eight times

[7] PSE Standard 6550.6060, effective 07/01/2011, explicitly states "Tree wire is not used for 34.5kV circuits".

[8] Non-MED refers to Non-Major Event Day and excluded outages during storm conditions from the reliability analysis.

higher. With all reliability metrics considerably above the PSE system average, distribution reliability in the Seabeck area is identified as a project need.

3.4 Operations

3.4.1 System Voltage

PSE's Distribution Planning Guideline targets a minimum of 119 volts and maximum of 126 volts at the primary side of all distribution service transformers under N-0 (no segment of the system is out of service) conditions. The 119 volt minimum is to allow for up to a 5 volt drop across the service transformer and service conductor to deliver 114 volts minimum at the customer meter or point of service. A minimum of 113 volts is required at the primary side of all distribution service transformers under N-1 (one segment of the system is out of service) conditions to deliver 108 volts minimum at the customer meter or point of service.

Power flow modeling of SIL-15 and CHI-12 shows primary voltage as low as 115 volts on the feeder during peak conditions, which is identified as a need for the Seabeck area.

3.4.2 Phase Balance

Distribution Planning Guidelines state that phase imbalance should be no greater than 100 Amps between any two phases.

During the last 5 years, large phase imbalances were seen at system peak on CHI-12. Winter system peak in 2021 had a maximum phase imbalance of 139 Amps, which is above the planning criteria of 100 Amps.

Phase imbalance contributes greatly to system losses due to increased neutral current. A balanced load has no return current on the neutral, thus eliminating losses. Bringing phases closer to a balanced system will reduce losses on the delivery.

Phase imbalance on CHI-12 is identified as a need for the Seabeck area.

3.4.2.1 Non-Standard Operations

CHI-12 operates at 34.5kV nominal voltage on the feeder backbone. It is the only circuit in Kitsap County that operates at this voltage. The remaining 105 circuits operate at 12.47kV nominal voltage. The higher voltage class requires specialized equipment and procedures that are non-standard in the region, as it represents less than 1% of total circuits. Different equipment needed to serve this unique voltage requires additional inventory to be maintained. This non-standard inventory requires additional yard space and costs to carry before the equipment is installed and placed in service.

The non-standard operating voltage of 34.5kV is identified as a concern for the Seabeck area.

3.4.3 Chico Substation Equipment Condition

One of the two parallel 12.47-34.5kV 7.5 MVA autotransformers at Chico Substation, XFR1384, has shown signs of accelerated aging with an estimated replacement year of 2052. The current asset management plan is to continue monitoring for signs of increased acceleration in the transformer effective age. See 0 for health report on XFR1384. Given its current health condition, this is not considered a need or concern for the system.

The 115/12.5kV 25MVA bank CHI-1, LFR1585, was energized in 2016. There are no present health concerns for the transformer. Most of the station equipment, including 12kV breakers and bus system, was replaced and put in service in 2016. High side fusing is no longer standard, and system planning recommends installing a standard circuit switcher when possible.

There are no other equipment concerns at Chico substation.

3.4.4 Silverdale Substation Equipment Condition

The 115kV/12.5kV 25MVA bank SIL-1, LFR1539, was energized in 2013. There are no present health concerns for the transformer.

The distribution getaway cables are 1970s vintage yellow jacket cables. These cables have a distinct yellow outer layer that makes them easily identifiable. Yellow jacket cables have a history of failures, and PSE generally replaces this type of getaway cable when there is an opportunity to do so. For context, *opportunity* is when other work and/or planned outages can be leveraged to justify replacement. At this time, there are no PSE replacement programs to eliminate yellow jacket cables.

The distribution capacitor switch is oil-filled, which PSE generally upgrades to a vacuum capacitor switch when there is an opportunity to do so. Currently, there is not a replacement program to eliminate existing oil capacitor switches.

There is a 1979 vintage Mark V circuit switcher on the transmission line (GSW0405). This particular switch has not been problematic; however, other switchers of the same model and vintage have been replaced due to failures. Replacement of this switch would be considered if there was opportunity.

There are no other equipment concerns at Silverdale substation.

3.5 Summary of Distribution Needs and Concerns

The identified needs and concerns for the Seabeck study area are summarized below.

Needs:

- **Feeder Capacity:** Feeders CHI-12 and SIL-15 presently exceed PSE's distribution planning triggers and are forecasted to exceed capacity limits within the planning period.
    - CHI-12 is forecasted to surpass 100% capacity limit in 2024
    - CHI-12 has an existing N-1 capacity need in the event of a parallel step-up transformer failure.
    - SIL-15 is forecasted to surpass 100% capacity limit in 2026
- **Feeder Reliability:** Feeders CHI-12 and SIL-15 have CMI, SAIDI, and SAIFI metrics that are significantly above system average. Reliability improvements are needed for both circuits.
- **Operational Need:** Feeders CHI-12 and SIL-15 experience low voltage under peak demand. Voltage improvements at peak system demand are needed for both feeders.
- **Operational Need:** CHI-12 has phase imbalance during peak loading that exceeds allowable limits.

3.5.1 Concerns:

- **Substation Equipment:** There is an existing concern for non-standard substation equipment at both Chico and Silverdale substations. Non-standard equipment includes high-side fusing at

Chico substation and yellow jacket getaways, oil-filled capacitor switch, and a Mark V circuit switcher at Silverdale substation.
This equipment should be evaluated for replacement when there is planned work at each substation.

- **Non-Standard Operations:** CHI-12 operates at 34.5kV, which is a unique operating voltage in Kitsap County and requires additional inventory and costs.

Conclusion and Next Steps

Energy is essential for communities, and PSE is committed to creating a better energy future for all customers in the Seabeck area.

PSE's assessment of the area's distribution system indicates a need to address its feeder capacity, reliability, and operational flexibility. Additionally, there are concerns about non-standard substation equipment and operating voltage.

The next step in PSE's system planning process is evaluating potential solutions for the needs and concerns identified in this assessment. That analysis will be presented in PSE's forthcoming title of Solutions Report.

APPENDIX A: F2022 Kitsap County Winter Load Forecast 2022-2042

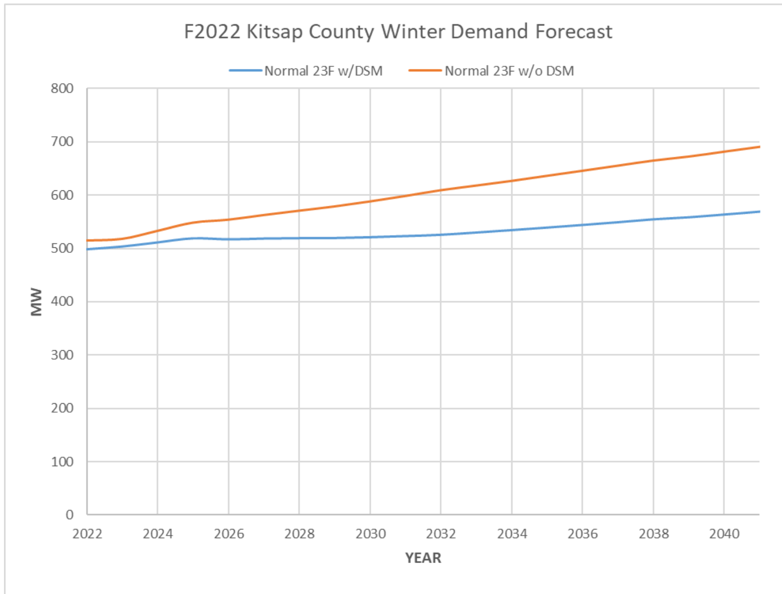


Figure 0-1: F2022 Kitsap County Winter Load Forecast

Table 0-1: Annual Winter Growth Rates F2022 for 2022-2042

F2022 Load Forecast w/DSM			F2022 Load Forecast w/o DSM		
December "Normal" Peak: 23 Degrees			December "Normal" Peak: 23 Degrees		
Year	MW	Annual Rate	Year	MW	Annual Rate
2022	499		2022	515	
2023	504	1.03%	2023	518	0.63%
2024	512	1.51%	2024	533	2.90%
2025	519	1.47%	2025	549	2.90%
2026	517	-0.36%	2026	554	1.01%
2027	519	0.29%	2027	563	1.59%
2028	520	0.14%	2028	571	1.45%
2029	520	0.06%	2029	579	1.40%
2030	521	0.29%	2030	589	1.61%
2031	524	0.40%	2031	599	1.74%
2032	526	0.45%	2032	610	1.81%
2033	530	0.82%	2033	618	1.43%
2034	535	0.84%	2034	627	1.42%
2035	539	0.88%	2035	637	1.52%
2036	544	0.91%	2036	646	1.49%
2037	549	0.93%	2037	656	1.48%
2038	555	0.98%	2038	665	1.46%
2039	558	0.68%	2039	673	1.13%
2040	564	0.92%	2040	682	1.37%
2041	569	0.95%	2041	691	1.32%
2042	576	1.16%	2042	701	1.42%
Avg 10 year (2022 - 2031)		0.48%	Avg 10 year (2022 - 2031		1.52%
Avg 20 year (2023 - 2042)		0.72%	Avg 20 year (2023 - 2042		1.55%

APPENDIX B: F2022 Kitsap County Summer Load Forecast 2022-2042

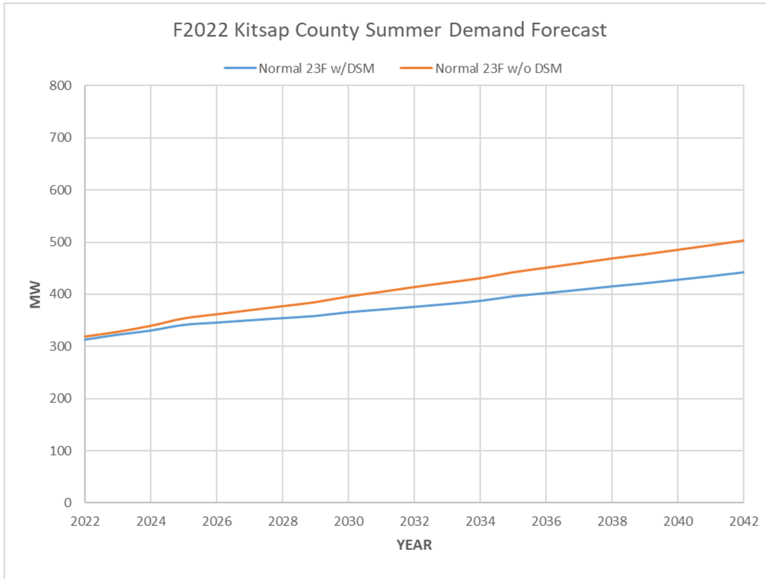


Figure 0-1: F2022 Kitsap County Summer Load Forecast

Table 0-1: Annual Summer Growth Rates F2022 for 2022-2042

F2022 Load Forecast w/DSM			F2022 Load Forecast w/o DSM		
December "Normal" Peak: 23 Degrees			December "Normal" Peak: 23 Degrees		
Year	MW	Annual Rate	Year	MW	Annual Rate
2022	313		2022	319	
2023	323	3.05%	2023	328	2.86%
2024	330	2.44%	2024	340	3.47%
2025	341	3.26%	2025	354	4.20%
2026	346	1.31%	2026	362	2.24%
2027	350	1.27%	2027	369	2.15%
2028	354	1.20%	2028	377	2.10%
2029	358	1.16%	2029	385	2.06%
2030	365	1.98%	2030	396	2.81%
2031	370	1.38%	2031	405	2.25%
2032	376	1.40%	2032	414	2.27%
2033	381	1.43%	2033	422	2.06%
2034	387	1.57%	2034	431	1.99%
2035	396	2.26%	2035	442	2.63%
2036	402	1.53%	2036	451	1.99%
2037	408	1.57%	2037	460	1.95%
2038	415	1.64%	2038	469	1.95%
2039	421	1.41%	2039	477	1.67%
2040	427	1.61%	2040	485	1.83%
2041	434	1.61%	2041	494	1.80%
2042	442	1.69%	2042	503	1.81%
Avg 10 year (2022 - 2031)		1.70%	Avg 10 year (2022 - 2031		2.41%
Avg 20 year (2023 - 2042)		1.74%	Avg 20 year (2023 - 2042		2.30%

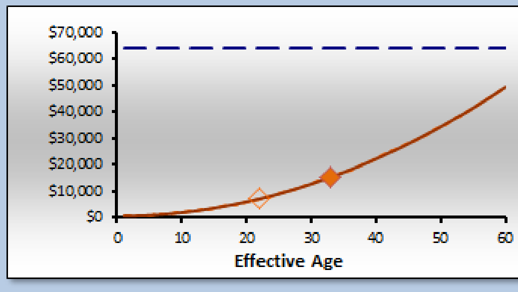
APPENDIX C: Transformer 1384 Health Report

Station Transformer: XFR1384

RELOAD ASSET | SAVE ASSET | CREATE ASSET

DEMOGRAPHICS

Equipment ID	XFR1384
Asset class	Station Transformer
Existing equipment type	XFR DX
Replacement equipment type	XFR DX
Functional location	CHI-1
Project	
Location description	CHICO Bank 1
Equipment description	Station Transformer (MVA)
Manufacturer	EASTERN ELECTRIC
Model number	
Manufacturer serial number	PMR488395
Serial number	XFR1384
City	Bremerton
Location	D-S PENN
Street	NW Crnr.of Northlk.Wy.&
Construction year	1995
Calendar age	22



RESULTS

Age at replacement	68
Years to replacement	35
Year of replacement	2052
Benefit/cost ratio	
Lifecycle cost of new asset	$64,302
Lifecycle interval of new asset	68
Remaining economic value	$519,837

INTERVENTIONS

Emergency premium %	100%
User defined replacement cost	
Replacement cost	$936,800
Emergency premium cost	$0

HEALTH INDEX

Health index	49
Health index is valid?	Yes
Adjustment factor	11
Effective age	33

ADDITIONAL DEMOGRAPHICS

High voltage rating	34.5/0/0
Low voltage rating	12.5/0/0
Cooling	
Number of phases	3
Oil volume (gas)	750 gal
Manufacturer nameplate	
High operating voltage	34.5
Low operating voltage	12.5
Max MVA	7.5
Transformer configuration	
Percent impedance	4.53
Dry shipping weight	
Self cooled MVA	7.5
Tertiary voltage rating	

PROBABILITY OF FAILURE

Existing shape	3
Existing scale	75
FP based on age	0.77%
Existing failure multiplier	1.0
Replacement failure multiplier	1.0

CONSEQUENCE OF FAILURE EXISTING

Normal failure	$1,701,806
Catastrophic failure	$179,482
Concurrent failure	$17,914
	$0
	$0
Consequence of failure	$1,899,202

Figure 0-1: Transformer 1384 Health Report

APPENDIX D: 2017-2021 Reliability Data

Table D-1: SAIDI Performance (2017-2021)

	Non-MED SAIDI By Year					
Circuit	**2017**	**2018**	**2019**	**2020**	**2021**	**Average (2017-2021)**
CHI-12	540	302	396	612	767	523
SIL-15	193	129	227	377	530	291

Table D-2: SAIFI Performance Criteria (2017-2021)

	Non-MED SAIFI By Year					
Circuit	**2017**	**2018**	**2019**	**2020**	**2021**	**Average (2017-2021)**
CHI-12	4.85	2.96	2.72	5.05	4.40	4.00
SIL-15	0.95	0.94	0.97	1.90	3.05	1.56

Table D-3: CMI Performance (2017-2019)

	Non-MED CMI By Year					
Circuit	**2017**	**2018**	**2019**	**2020**	**2021**	**Average (2017-2021)**
CHI-12	1,379,600	773,124	1,021,941	1,591,944	2,010,540	1,355,430
SIL-15	416,518	277,751	491,168	815,846	1,147,863	629,829

Tables D-1 through D-3 show that the reliability of both CHI-12 and SIL-15 are significantly above system PSE averages for SAIDI, SAIFI, and CMI. In particular, CHI-12 continues to have performance that is much worse than system average.

APPENDIX E: Glossary

Term	Definition
Block load	A large expected increase in electric energy demand from an existing or new customer.
Circuit	A circuit is an electrically connected path along which power can flow. This can be at transmission or distribution voltage.
Circuit Breaker	A circuit breaker is an electrical interrupting device designed to protect an electrical circuit from damage caused by an electrical fault.
Concern	A "concern" is a non-critical issue identified in a Needs Assessment that is not required to be addressed by a solution. A solution that addresses an identified concern provides additional benefit.
Conservation	Measures to improve efficiency of customer's electric loads reducing energy use and peak demand.
Consumption	Consumption is the amount of electricity that customers use over a period of time and it's measured in watt-hours (Wh).
Contingency	A contingency is a scenario where the electric system experiences the loss of one or more elements.
Curtailable	A load that may be interrupted to reduce load on system during peak periods. Curtailable customers are on a different rate schedule than non-curtailable (firm) customers.
Demand	The amount of power being required by customers at any given moment, measured in watts.
DR- Demand response	Flexible, price-responsive loads, which may be curtailed or interrupted during system emergencies or when wholesale market prices exceed the utility's supply cost. Demand response is also the voluntary reduction of electricity demand during periods of peak electricity demand or high electricity prices. Demand response provides incentives to customers to temporarily lower their demand at a specific time in exchange for reduced energy costs.
DGA - Dissolved Gas Analysis	Dissolved Gas Analysis (DGA) is used throughout the utility industry to monitor transformer winding and insulation condition. PSE tests transformer oil for seven combustible gases, which are monitored against proven levels that indicate concerns.
Distributed Generation	Generation on the distribution system, like rooftop solar panels, located close to the source of the customer's load.
Distribution Feeder	A distribution feeder is the backbone section of a distribution circuit that is larger wire carrying the entire circuit load.

Term	Definition
Term	**Definition**
Block load	A large expected increase in electric energy demand from an existing or new customer.
Business as Usual Distributed Energy Resources (BAU DER)	Acquiring cost effective energy efficiency as a resource, mitigating both energy and peak demand growth by partnering with customers in their efforts to make high efficiency upgrades in their homes and businesses.
Circuit	A circuit is the electric equipment associated with serving all customers under normal configuration from a specific distribution circuit breaker at a substation.
Concern	A "concern" is a non-critical issue that impacts system operations but is not required to be addressed by a solution; a solution that addresses an identified concern provides additional benefit.
Conservation	Measures to improve efficiency of customer's electric loads reducing energy use and reducing peak demand.
Consumption	Consumption is the amount of electricity that customers use over the course of a year and it's measured in kilowatt hours.
Contingency	Contingencies are a set of transmission system failure modes, when elements are taken out of service (e.g., loss of equipment).
Curtailable	A load that may be interrupted to reduce load on system during peak periods. Curtailable customers are on a different rate schedule than non-curtailable (firm) customers.
Demand	The amount of power being required by customers at any given moment, and it's measured in kilowatts.
DR- Demand response	Flexible, price-responsive loads, which may be curtailed or interrupted during system emergencies or when wholesale market prices exceed the utility's supply cost. Demand response is also the voluntary reduction of electricity demand during periods of peak electricity demand or high electricity prices. Demand response provides incentives to customers to temporarily lower their demand at a specific time in exchange for reduced energy costs.
Distributed Energy Resource (DER)	A resource sited close to customers that can provide all or some of their immediate electric and power needs and can also be used by the system to reduce system demand (such as energy efficiency) or provide supply to satisfy the energy, capacity, or ancillary service needs of the distribution grid. The resources, if providing electricity or thermal energy, are small in scale, connected to the distribution system, and close to load
Distributed generation	Small-scale electricity generators, like rooftop solar panels, located close to the source of the customer's load.

Term	Definition
Distribution line	A distribution line is a medium-voltage (12.5 kV-35 kV) line that carries electricity from a substation to customers. Roughly half of PSE's distribution lines are underground. Distribution voltage is stepped down to service voltage through smaller transformers located along distribution lines. Distribution lines differ from feeder as it includes the large feeder wire and smaller wire laterals.
Distribution System	A distribution system is the medium-voltage (12.5 kV-35 kV) infrastructure that carries electricity from a substation to customers and includes the substation transformer. System is the collective of all of this infrastructure in an entire study area.
EPRI- The Electric Power Research Institute	The Electric Power Research Institute conducts research, development, and demonstration projects for the benefit of the public in the United States and internationally. As an independent, nonprofit organization for public interest energy and environmental research, they focus on electricity generation, delivery, and use.
Feeder	A feeder is the largest conductor section of a circuit and carries the greatest load as it serves all the laterals (branches)) of the circuit.
Institute of Electrical and Electronics Engineers (IEEE)	A professional association, promoting the development and application of electro-technology and allied sciences for the benefit of humanity, the advancement of the profession, and the well-being of our members.
Integrated Resource Plan (IRP)	The Integrated Resource Plan (IRP) is a forecast of conservation resources and supply-side resource additions that appear to be cost effective to meet the growing needs of our customers over the next 20 years. Every two years, utilities are required to update integrated resource plans to reflect changing needs and available information.
Interim Operating Plan (IOP)	A temporary plan to address a transmission system deficiency and meet performance requirements, until a solution takes effect. An IOP may consist of a series of operational steps to radially operate the system, run generation or implement load shedding.
Kilovolt (kV)	A kilovolt (kV) is equal to 1,000 volts of electric energy. PSE uses kilovolts as a standard measurement when discussing things like distribution lines and the energy that reaches our customers.
Load	The total of customer demand plus planning margins and operating reserve obligations.
Load forecast	A load forecast is a projection of how much power PSE’s customers will use in future years. The forecast allows PSE to plan upgrades to its electric system to ensure that current and future customers continue to have reliable power. Federal regulations require that utilities plan a reliable system based on forecasted loads. When developing a load forecast, PSE takes multiple factors into account like current loads, economic and population projections, building permits, conservation goals, and weather events.

Term	Definition
Load shedding	Load shedding is when a utility intentionally causes outages to customers because demand for electricity is exceeding the capacity of the electric grid. Load shedding is the option of last resort and is conducted to protect the integrity of the electric grid components in order to avoid a larger blackout. This is not a practice that PSE endorses as a long-term solution to meet mandatory performance requirements.
Major Event Day (MED)	Any day in which the daily system SAIDI exceeds the annual threshold value. Outages on those days are excluded from the SAIDI performance calculation.
Megawatt (MW)	A megawatt (MW) is equal to 1,000,000 watts of electric energy. PSE uses megawatts as a standard measurement when discussing things like system load and peak demand. MW differs from MVA in that it is generally always lower and translates as energy that performs work. The amount of MW vs MVA is determined by load characteristics. Motor loads generally have a lower power factor (PF) than heating loads for example and as a result. MW=MVA*PF
Mega Volt-Amp (MVA)	A MVA is equal to 1,000,000 (Volt*Amps). MVA is generally slightly higher than MW. Equipment ratings are in MVA as the equipment heat rise is determined by actual MVA.
N-0	This is a planning term describing that the electric grid is operating in a normal condition and no components have failed.
N-1	This is a planning term describing an outage condition when one system component has failed or has been taken out of service for construction or maintenance.
N-1-1	This is a planning term describing outage conditions where two failures occur one after another with a time delay between them.
N-2	This is a planning term describing outage conditions where two failures occur nearly simultaneously.
Native Load Growth	Load growth associated with existing customers or new customers less than 1 MW.
Need	A constraint or limitation on the delivery system in providing safe and reliable electric supply to customers. A need is a “must-have” that is required to be addressed for the system in a timely manner (by a certain Need Date, as determined in a needs assessment)
Non-wires alternatives	Alternatives that are not traditional poles, wires and substations. These alternatives can include demand reduction technologies, battery energy storage systems, and distributed generation.

Term	Definition
NERC- North American Electric Reliability Corporation	NERC establishes the reliability standards for the North American grid. NERC is a not-for-profit international regulatory authority whose mission is to ensure the reliability of the bulk power system in North America, as certified by FERC. NERC develops and enforces Reliability Standards and annually assesses seasonal and long-term reliability. PSE is required to meet the Reliability Standards and is subject to fines if noncompliant.
Peak demand	Customers' highest demand for electricity at any given time, and it's measured in megawatts.
Proven technology	Technology that has successfully operated with acceptable performance and reliability within a set of predefined criteria. It has a documented track record for a defined environment, meaning there are multiple examples of installations with a history of reliable operations. Such documentation shall provide confidence in the technology from practical operations, with respect to the ability of the technology to meet the specified requirements.
Reasonable project cost	Reasonable project cost means holistically comparing costs and benefits to project alternatives. This includes dollar costs, as well as duration of the solution, risk to the electric system associated with the type of solution (e.g., is the solution an untested technology), and impacts to the community.
Right of way	A corridor of land on which electric lines may be located. PSE may own the land in fee, own an easement, or have certain franchise, prescription, or license rights to construct and maintain lines.
Sensitivities	Sensitivities are circumstances or stressors under which the contingencies are tested (e.g., forecasted demand levels, interchange, various generation configurations).
Spacer Cable	Spacer cable is a product by Hendrix that is supported by a strong messenger cable and has insulated phase conductors. This product prevents most tree outages by blocking falling limbs from the phase conductors.
Substation	A substation is a vital component of electricity distribution systems, containing utility circuit protection, voltage regulation and equipment that steps down higher-voltage electricity to a lower voltage before reaching your home or business.
Substation group	A grouping of 2-5 substation transformers that are situated close enough to each other that loads in the study area can be switched from one station to an adjacent station for maintenance, construction, or permanent load shifting. For Seabeck, the substation group includes 2 distribution substations – Silverdale and Chico.
Substation group capacity	The aggregate distribution transformer capacity of the substation group for winter and summer rating, calculated in MVA.

Term	Definition
SAIDI- System Average Interruption Duration Index	SAIDI is the length of non-major-storm power outages per year, per customer. SAIDI is commonly used as a reliability indicator by electric power utilities. Outages longer than 5 minutes are included.
SAIFI- System Average Interruption Frequency Index	SAIFI is the frequency of non-major-storm power outages per year, per customer. SAIFI is commonly used as a reliability indicator by electric power utilities. Interruptions longer than 1 minute are included.
Transformer	A transformer is a device that steps electricity voltage down from a higher voltage, or steps it up to a higher voltage, depending on use. On the distribution system, transformers typically step the voltage down from a distribution voltage (12.5 kV) to 120 to 240 volts for customers' residential use. Transformers are the green boxes in some residences' front yard or the barrel-like canisters on utility poles.
Transmission line	Transmission lines are high-voltage lines that carry electricity from generation plants to substations or from substation to substation. Transformers at the substation "step down" the electricity's transmission voltage (55 to 230 kilovolts) to our primary distribution voltage (12.5 kV).

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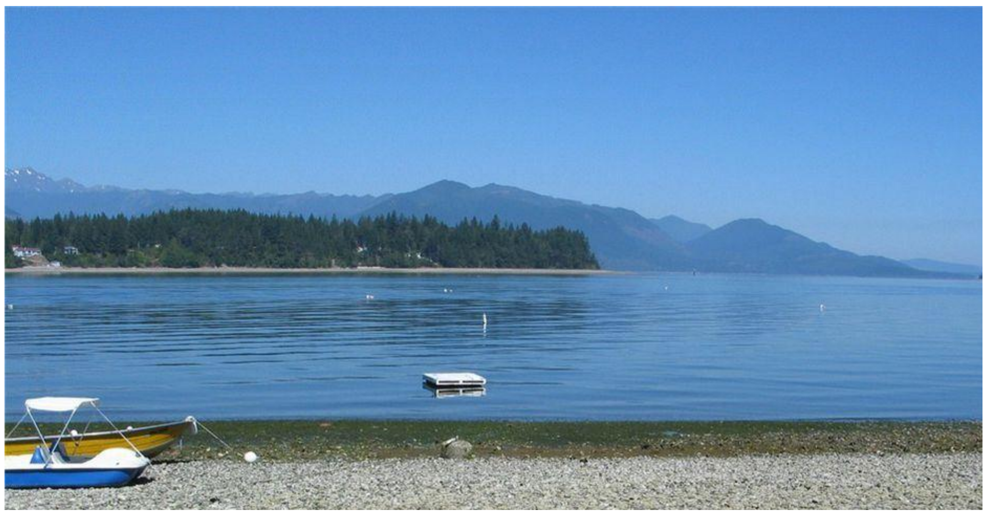
Seabeck Area Solutions Report



Olympic Mountains from Seabeck Conference Center, Seabeck, WA

Strategic System Planning
May 18, 2023

PUGET SOUND ENERGY

Seabeck Area Solutions Report

Prepared By:

Colin O'Brien, PE, *Strategic System Planning*
Chad Larson, PE

Approved By:

Ryan Lambert, PE, *Manager - Strategic System Planning*

DocuSigned by:
Ryan Lambert
48EEB5A77F87404... 05/19/2023

Ryan Lambert *Date*
System Planning, Manager

DocuSigned by:
David Landers
B6002897FD5542C... 05/19/2023

David Landers *Date*
System Planning, Director

Strategic System Planning
May 18, 2023

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Executive Summary

PSE's System Planning department regularly assesses communities' electrical system needs, throughout the service area, to ensure that PSE can reliably serve its customers. The first step in PSE's planning process is completing a *Needs Assessment* for the area being considered. Once those needs have been determined, planners prepare a *Solutions Report* that analyzes a range of feasible approaches to address them – eventually determining a preferred solution.

This document is the Solutions Report for the distribution system serving Seabeck, Washington and the surrounding area. Puget Sound Energy (PSE) and Guidehouse (formerly Navigant Consulting) analyzed traditional wires, non-wires, and hybrid options to determine the ideal solution for addressing the area's distribution needs over a 10-year planning horizon (2022-2032).

The Seabeck study area, shown below in Figure 0-1, is a scenic, rural region at the edge of PSE's service territory in western Kitsap County. Along with the town of Seabeck, it includes Wildcat Lake, the community of Holly, and Guillemot Cove Nature Reserve. There are numerous trails and creeks – with Hood Canal flowing between Kitsap and the Olympic Peninsula.

Within the area, PSE serves approximately 4,700 electric customers (mostly residential), and local homes are typically on large lots in uncondensed neighborhoods. There is no natural gas system in the area.

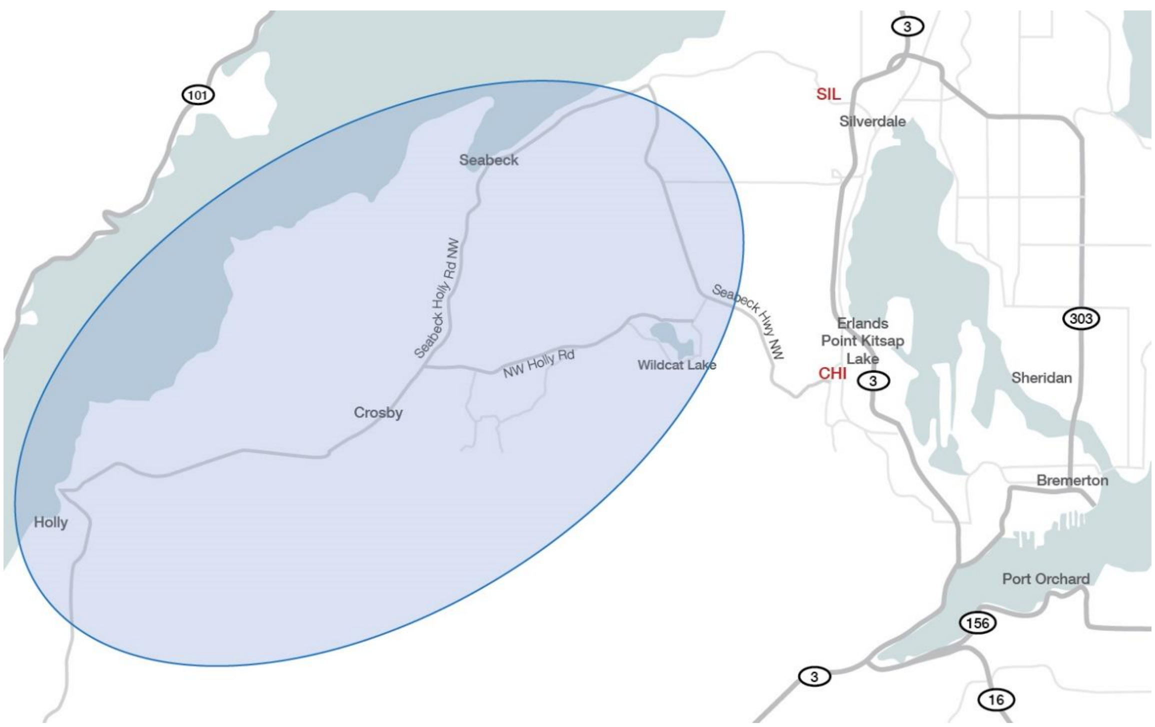

Figure 0-1: Seabeck Needs Assessment Study Area and Existing Distribution System

The study area is primarily served by two feeders: CHI-12 from Chico substation and SIL-15 from Silverdale substation. Both are very heavily loaded and have poor reliability histories, with frequent and often sustained outages. In fact, CHI-12 is oftentimes the *worst performing circuit* in all of PSE's service territory, with SIL-15 in the top 50. Much of this is due to the circuits' long lengths and overhead exposure, combined with an abundance of surrounding trees. The local geography can also hamper restoration efforts, making outages last even longer.

Summary of Seabeck Area Needs and Concerns (detailed in Section 2)

The distribution needs and concerns identified for the Seabeck area are summarized below. As stated earlier, reliability is currently a significant issue for customers. Additionally, within the next 10 years, electrical demand will exceed the existing system's (already strained) capacity limits. Operational issues also negatively impact system function.

Needs:

- **Feeder Capacity:** Feeders CHI-12 and SIL-15 presently exceed PSE's distribution planning triggers and are forecasted to exceed capacity limits within the planning period.
  - CHI-12 is forecasted to surpass 100% capacity limit in 2024.
  - CHI-12 has an existing N-1 capacity need in the event of a parallel step-up transformer failure. N-1 is a planning contingency where one system element is out of service.
  - SIL-15 is forecasted to surpass 100% capacity limit in 2026.
- **Feeder Reliability:** Feeders CHI-12 and SIL-15 have CMI, SAIDI, and SAIFI[1] metrics that are significantly above system average. Reliability improvements are needed for both circuits.
- **Operational Need:** Feeders CHI-12 and SIL-15 experience low voltage under peak demand. Voltage improvements at peak system demand are needed for both feeders.
- **Operational Need:** CHI-12 has phase imbalance during peak loading that exceeds allowable limits. Phase imbalance contributes greatly to system losses due to increased neutral current.

Concerns:

- **Substation Equipment:** There is an existing concern for non-standard substation equipment at both Chico and Silverdale substations. Non-standard equipment includes high-side fusing at Chico substation and yellow jacket getaways, oil-filled capacitor switch, and a Mark V circuit switcher at Silverdale substation. This equipment should be evaluated for replacement when there is planned work at each substation.
- **Non-Standard Operations:** CHI-12 operates at 34.5kV, which is a unique operating voltage in Kitsap County and requires additional inventory and associated costs.

[1] SAIDI (System Average Interruption Duration Index), SAIFI (System Average Interruption Frequency Index), and CMI (Customer Minutes of Interruption) are all metrics used as reliability indicators by electric power utilities.

Solutions Analyzed (detailed in Section 3)

Working with Guidehouse, PSE studied multiple options for meeting the Seabeck area's distribution needs and concerns. This report details the wires alternatives, non-wires alternatives, and hybrid (combination of wires and non-wires) alternatives that were examined for viability using criteria detailed in Section 1.2. The goal of PSE's analysis was to evaluate each alternative's technical and economic feasibility and determine a preferred solution.

PSE began by analyzing multiple wires options and determining four, top wires alternatives:

- **WA-1:** Build a new 115kV-12kV distribution substation near Seabeck
- **WA-2:** Build a new 35kV-12kV distribution substation near Seabeck
- **WA-3:** Install a third parallel step-up transformer at Chico substation
- **WA-4:** Install a new express feeder from Chico substation to segment the existing feeder

Using PSE's wires alternatives as a comparative baseline, Guidehouse analyzed whether there were non-wires alternatives (NWA) capable of meeting the area's needs. The NWA evaluated consisted of battery energy storage systems in combination with other targeted distributed energy resources (DER)[2]:

- **NWA:** A combination of continued business-as-usual (BAU) distributed energy resources (DER) installations, targeted incremental DER installations based on local technical potential, and an Energy Storage (ES) installation to meet remaining capacity needs

Guidehouse's analysis concluded that NWA could not feasibly meet all Seabeck area needs. Key takeaways from their study[3] include:

- The entire Seabeck need cannot be met with a non-wires solution "due to the inability of non-wires solutions to mitigate phase imbalance in a significant manner".
- Adding an energy storage system (ESS) in an appropriate location on the distribution system will improve the Seabeck area's reliability by allowing the distribution automation scheme (DA)[4] to operate more effectively; however, a wires solution will offer a greater reliability improvement. In general, "differences in reliability improvements between the wires and NWA solution need to be considered qualitatively when selecting the preferred solution".
- Guidehouse found a hybrid alternative that meets capacity needs until 2031 that is cost-effective and technically feasible.

Since non-wires alternatives, alone, could not sufficiently solve the area's reliability need, PSE evaluated hybrid alternatives that added other components to NWA options:

- **Hybrid 1:** Combine NWA with targeted phase balancing effort on distribution circuits
- **Hybrid 2:** Combine NWA with underground (UG) conversion of CH-12 feeder along NW Holly Rd

[2] DER are energy resources sited close to customers that can provide all or some of their immediate electric and power needs and can also be used to reduce system demand (such as energy efficiency) or provide supply to satisfy the energy, capacity, or ancillary service needs of the distribution grid.

[3] Seabeck Non-Wires Alternative Analysis, Guidehouse Consulting, March 29, 2021.

[4] Distribution Automation (DA) is a reliability scheme that can automatically operate switches on both sides of faulted equipment to isolate it from the rest of the system and restore service for certain customers during outages.

Figure 0-2 below compares all seven options by cost, benefit, and degree to which they can meet Seabeck area needs.[5]

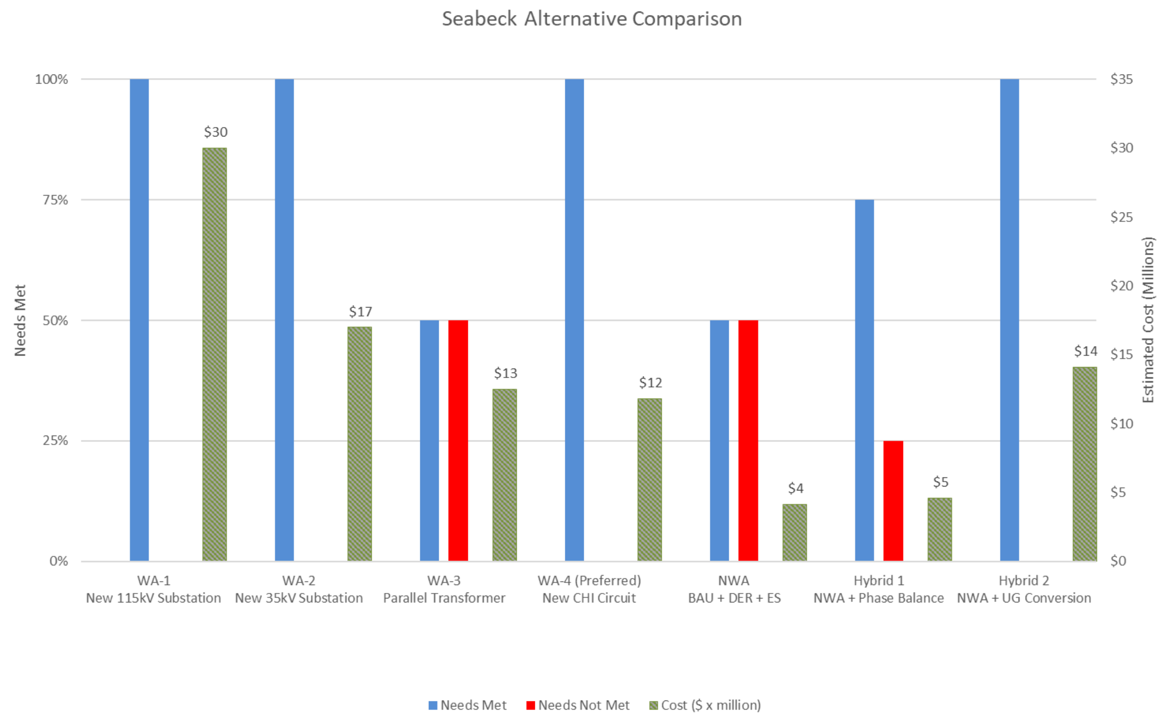

Figure 0-2: Seabeck Alternatives Comparison

Top Alternatives Analysis

Based on the above comparison, PSE selected WA-4 as the top wires alternative – then further evaluated it alongside the non-wires option (NWA) and Hybrid 2.

Table 0-1, on the following page, summarizes each of those three option's benefits, potential risks, and estimated costs. While project costs aren't the only deciding factor, they are an important consideration given their potential impact on PSE customers' energy bills.

Key Takeaways:

- WA-4 offers a 40-year solution vs. 10-year solutions with NWA and Hybrid 2.
- WA-4 is the only solution that would not require additional improvements to accommodate future growth and development in the region.

[5] Cost estimates provided in Figure 0-2 are planning level cost estimates without added contingency.

- WA-4 offers the highest reliability benefit and solves the capacity issue, while also addressing the operational issues.

Table 0-1: Summary of Top Alternatives[6] [7] [8]

		Top Wires Alternative (WA-4)	Full Non-Wires Alternative (NWA)	Hybrid Alternative (Hybrid 2)
Needs	CHI-12 N-1 Capacity	Solved through new Feeder	Solved through Energy Storage and DER improvements	Solved through Energy Storage and DER improvements
	Distribution Feeder Reliability	Improved by reduced tree/vegetation outage exposure and allowing more effective automation, while reducing the number of customers exposed to each outage resulting reduced SAIDI and SAIFI by 25% and 17% for CHI-12 and SIL-15, respectively	Distribution Reliability is not solved in the full non-wire alternative	Improved by reduced tree/vegetation outage exposure and allowing more effective automation
	CHI-12 Phase Balance	Phase imbalance will be spread throughout feeders reducing to less than 100 Amps per feeder.	Phase Balance is not solved in full non-wires alternative	Phase imbalance will be spread throughout feeders reducing to less than 100 Amps per feeder.
	Low Voltage	Reduced loading and express 35kV circuit solves low voltage areas	Reduced loading solves voltage issues	Reduced loading and UG conversion solves voltage issues
Decision Factors	Cost Estimate Range	$11.8 million to $14.8 million	$4.1 million to $5.9 million	$14.1 million to $17.6 million
	Benefits	-40 year solution -Highest reliability benefit -Improved resiliency -Added capacity -Increased operational flexibility -Reduced customer exposure on each circuit	-10 year solution -Local EE and DR	-10 year solution -Improved reliability -Local EE and DR
	Risks	-Easement and Permitting challenges for new construction	-Insufficient Reliability improvement -Easement and Permitting challenges for BESS site -New operational strategies needed -Need additional	-Easement and Permitting challenges for BESS site -New operational strategies needed -Need additional system improvements with growth

[6] Costs are estimated based on similar past projects in other areas of PSE service territory. Does not include site-specific engineering. These costs will be further refined once the project enters later development stages.

[7] Cost estimate range includes base estimate to a high estimate with 25% contingency.

[8] A full non-wires alternative is not considered viable due to the need for phase balancing that cannot be solved by NWAs.

			improvements with growth	

Seabeck Area Preferred Solution (detailed in Section 4)

Based on the above comparison, PSE determined that WA-4 was the preferred solution for meeting Seabeck area distribution system needs. It offers a significant improvement in reliability, capacity, and operational benefits when compared to the non-wires and hybrid alternatives – while also being cost-effective.

In brief, the preferred solution will:

- Increase area capacity by adding a new 12 kV feeder (CHI-14) from the Chico substation
- Improve reliability by transferring loads between area feeders
- Improve reliability by converting approximately 5 miles of CHI-12 to an express underground feeder – and undergrounding a portion of CHI-14
- Address operational needs by balancing phases of both new and existing circuits to be within PSE guidelines

Figure 0-3 illustrates the preferred solution for the Seabeck area's distribution system.

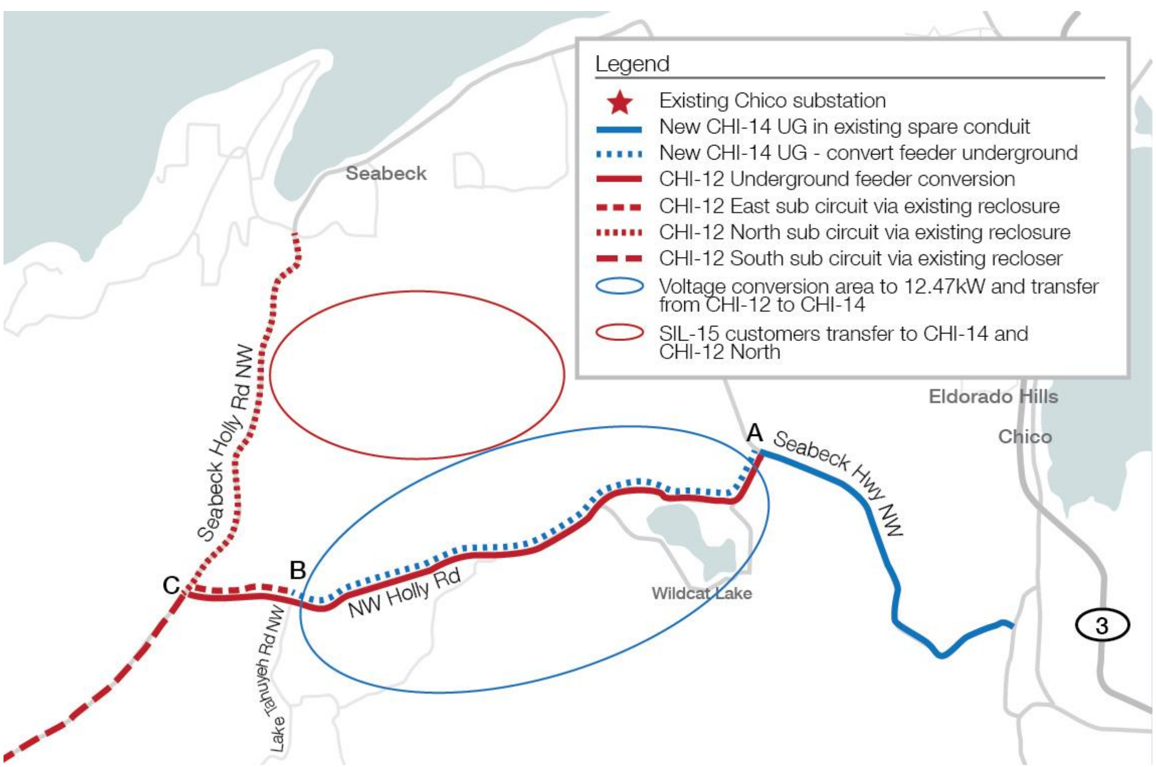

Figure 0-3: Preferred Solution - WA-4

Conclusion

Energy is essential for communities, and PSE is committed to creating a better energy future for all customers in the Seabeck area.

The preferred solution will bring many benefits to the local distribution system, including a substantial reliability improvement. The capacity needs will be solved with the addition of a new circuit, which will also provide significantly improved operational flexibility capable of supporting future growth and development in the region.

Customers will benefit greatly, too. With these improvements, the Seabeck area's history of poor reliability will come to an end. Given the local climate and west Kitsap geography, some outages are inevitable, but their frequency and impact can be greatly reduced for many years to come.

1 Introduction, Methodology, and Solutions Criteria

After completing the Seabeck Area Needs Assessment, PSE and Guidehouse analyzed traditional wires, non-wires, and hybrid alternatives to determine a cost-effective solution capable of addressing the area's needs for the 10-year planning horizon (2022-2032). This report summarizes the results of that analysis.

1.1 Methodology

This solutions study used the following process:

1. Step one: Brainstorm potential solution types to solve the identified system needs, including conventional wires type, non-wires type (DER), and hybrid type that involve combination of wires and non-wires components.
2. Step two: Identify possible alternatives for each solution type. PSE studied conventional wires alternatives and non-wires alternatives.
3. Step three: Assess the most promising alternatives using the solutions criteria for system performance in terms of capacity, reliability, asset life and constructability; and determine "viable" alternatives. An alternative was considered "viable" if it met the solutions criteria.
4. Step four: Identify and compare the most cost effective viable alternatives.
5. Step five: Compare the top alternatives in terms of cost, benefits, drawbacks and risks to identify the proposed solution.

Figure 1-1 shows the process flow for the solutions study methodology.

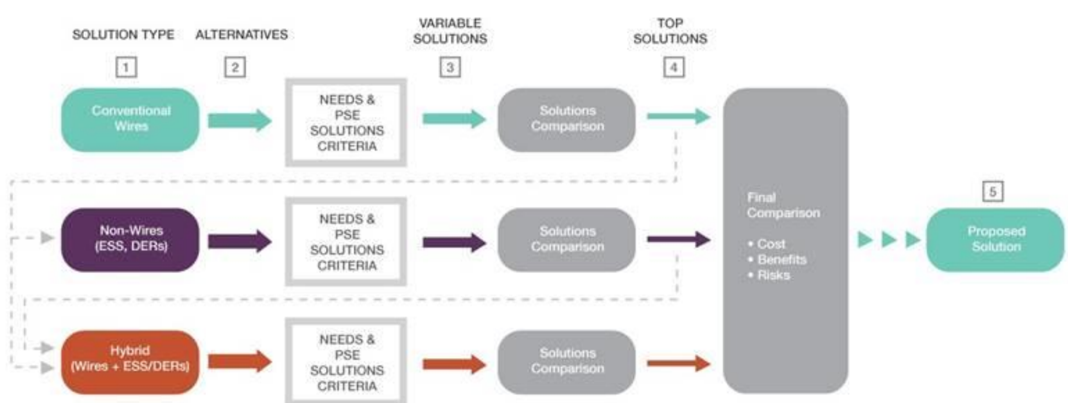

Figure 1-1: PSE Solutions Study Methodology

PSE began its analysis by considering multiple conventional wires alternatives, which were then shortlisted to the most viable alternatives for meeting the solutions criteria. The viable wires alternatives were compared in terms of cost, benefits, drawbacks, and potential risks to generate the preferred wires alternative, which was then used as a reference for developing non-wires and hybrid alternatives. As a final step, the top alternatives for the wires, non-wires, and hybrid categories were compared to determine the preferred solution for best meeting the Seabeck study area's needs.

1.2 Solution Criteria

PSE evaluated all alternatives in this study with electrical and non-electrical criteria. These criteria are based on federal requirements, PSE Planning Guidelines, and industry standards, as well as project implementation considerations.

A proposed alternative is considered viable if it addresses all identified system needs and meets the solutions criteria. A viable alternative is not *required* to address identified concerns, but it may if it's deemed prudent or advantageous to include in the project scope.

Technical Criteria:

1. Must meet all performance criteria:
   - Address needs identified within the 10-year study period (2022-2032)
   - Does not re-trigger any of the needs identified in the Seabeck Area Needs Assessment for 10 years or more after the solution is in service

   Distribution:

   - Applicable PSE Distribution Planning Guidelines as follows:
     - Individual substation utilization in study area ≤ 100% of capacity
     - ≤ 100% of overhead individual feeder limits for N-0 and applicable N-1 scenarios
     - ≤ 100% of underground individual feeder limits for N-0 and applicable N-1 scenarios

   Reliability:

   - For areas with high non-CMI, non-MED[9] SAIDI or non-MED SAIFI, solution must reduce corresponding reliability metric.

   Design Requirements:

   - Must meet applicable Institute of Electrical and Electronics Engineers (IEEE) and NERC standards
   - Must meet Washington Administrative Code (WAC) and National Electrical Safety Code (NESC) safety codes
   - Must use PSE standard equipment and be consistent with the PSE Major Equipment Committee's spare equipment strategy
   - Must meet PSE best practices for operations and maintenance

2. Must address all needs identified in the Needs Assessment report
3. Must not cause any adverse impacts to the reliability or operating characteristics of PSE's or surrounding systems

Non-technical Criteria:

1. Feasible permitting
2. Reasonable project cost

[9] MED (Major Event Day): See definition in Glossary

3. Uses proven technology that may be adopted at a system level[10]

[10] PSE defines "proven technology" as technology that has been operationalized in the utility industry.

2 Needs Summary

As detailed in PSE's Seabeck Area Needs Assessment, multiple distribution system needs were identified in the study area. There are feeder capacity needs for distribution circuits CHI-12 and SIL-15. Both circuits are above PSE Distribution Planning Guidelines of 85% utilization capacity under normal system configuration for current peak loading levels. CHI-12 is forecasted to surpass the N-0 (no elements out of service) loading limit of the circuit by 2024, and SIL-15 is forecasted to surpass the N-0 loading limit by 2026.

CHI-12 has an additional existing capacity need in the event of a parallel step-up transformer failure. The circuit is currently above the conductor loading limitation under this contingency and would require load shedding of up to 45A during peak winder condition.

There are reliability needs with circuits CHI-12 and SIL-15. These circuits have historically had poor reliability performance. Both also serve the area's entire load and continue to have CMI, SAIDI, and SAIFI scores significantly worse than PSE's system-wide averages for those metrics.

Currently, there are operational flexibility needs on both circuits during peak loading, including low voltage conditions and phase imbalance. These operational concerns are exacerbated during N-1 contingencies. Additional growth without system improvements will compound these needs.

Additionally, there is a concern related to non-standard equipment at both Chico and Silverdale substations. This equipment was standard when it was installed, but it has since become outdated. At Chico substation, there is high-side fusing that is no longer standard. At Silverdale substation, there are yellow jacket getaways, oil-filled capacitor switch, and a Mark V circuit switcher that are no longer standard. This equipment should be evaluated as an opportunity for replacement if there is work being done at the substation.

The assessment has identified the following summary of needs and concerns in the study area:

Needs:

- **Feeder Capacity:** Feeders CHI-12 and SIL-15 presently exceed PSE's distribution planning triggers and are forecasted to exceed capacity limits within the planning period.
  - CHI-12 is forecasted to surpass 100% capacity limit in 2024.
  - CHI-12 has an existing N-1 capacity need in the event of a parallel step-up transformer failure.
  - SIL-15 is forecasted to surpass 100% capacity limit in 2026.
- **Feeder Reliability:** Feeders CHI-12 and SIL-15 have CMI, SAIDI, and SAIFI metrics that are significantly above system average. Reliability improvements are needed for both circuits.
- **Operational Need:** Feeders CHI-12 and SIL-15 experience low voltage under peak demand. Voltage improvements at peak system demand are needed for both feeders.
- **Operational Need:** CHI-12 has phase imbalance during peak loading that exceeds allowable limits.

Concerns:

- **Substation Equipment:** There is an existing concern for non-standard substation equipment at both Chico and Silverdale substations. Non-standard equipment includes high-side fusing at Chico substation and yellow jacket getaways, oil-filled capacitor switch, and a Mark V circuit switcher at Silverdale substation. This equipment should be evaluated for replacement when there is planned work at each substation.

- **Non-Standard Operations:** CHI-12 operates at 34.5kV, which is a unique operating voltage in Kitsap County and requires additional inventory and associated costs.

3 Solution Alternatives Analysis

This section of the report details the wires, non-wires, and hybrid alternatives that were considered and examined for viability using the criteria in Section 1.2. The goal of PSE's analysis was to evaluate each alternative's technical and economic feasibility and determine a preferred solution.

Appendix A describes all wires alternatives that were considered in the evaluation. Per PSE Planning Guidelines, each alternative is required to meet the defined solution criteria for the Seabeck area's identified needs. Some alternatives were eliminated and deemed *non-viable* as they did not meet the PSE solution criteria. Alternatives that did meet PSE's solution criteria were deemed *viable* and considered for further evaluation. Viable alternatives for each category were then compared to determine the top alternative for the category.

Key Assumptions for PSE's Solutions Analysis:

For solutions analysis involving battery energy storage systems (BESS), a 4-hour back-up duration was considered sufficient for distribution feeder outage repair and restoration. For outages that exceed the assumed repair duration time, PSE System Operations and crews will have enough time margin, with the BESS backup, to manage area loads and switch the system to restore customers. This approach was considered practical and reasonable for sizing BESS back-up solutions.

3.1 No Action Alternative

Along with assessing multiple alternatives, PSE considered a scenario where *no* action is taken to improve the Seabeck area's distribution capacity and reliability needs.

The advantage to this approach is no initial cost. The disadvantages are that existing capacity and reliability problems would remain and increase over time. This option also does not address the historically poor reliability of the area's circuits, and doing nothing would likely continue that performance trend.

Furthermore, in the event of loss of one of the parallel transformers during peak loading, load shedding might need to be implemented in order to prevent overloads on the remaining in-service transformer[11]. This option would put PSE at risk for being unable to serve customers in the area during peak loading conditions as early as 2024.

Finally, operational needs including low voltage, operational flexibility, and phase imbalance would not be addressed.

3.2 Top Wires Alternative

PSE's top wires alternative is detailed below and illustrated in Figure 3-1. Other wires alternatives that were considered, but not selected, are summarized in Appendix A. This solution was chosen as the top wires alternative as it solved all needs and concerns, and provided the most benefit to customers, at the lowest cost. The benefits are detailed below.

[11] Load shedding involves disconnecting some customers to ensure distribution equipment is not damaged due to overloading. Load shedding is the option of last resort and is not a practice that PSE endorses as a long-term solution to meet mandatory performance requirements.

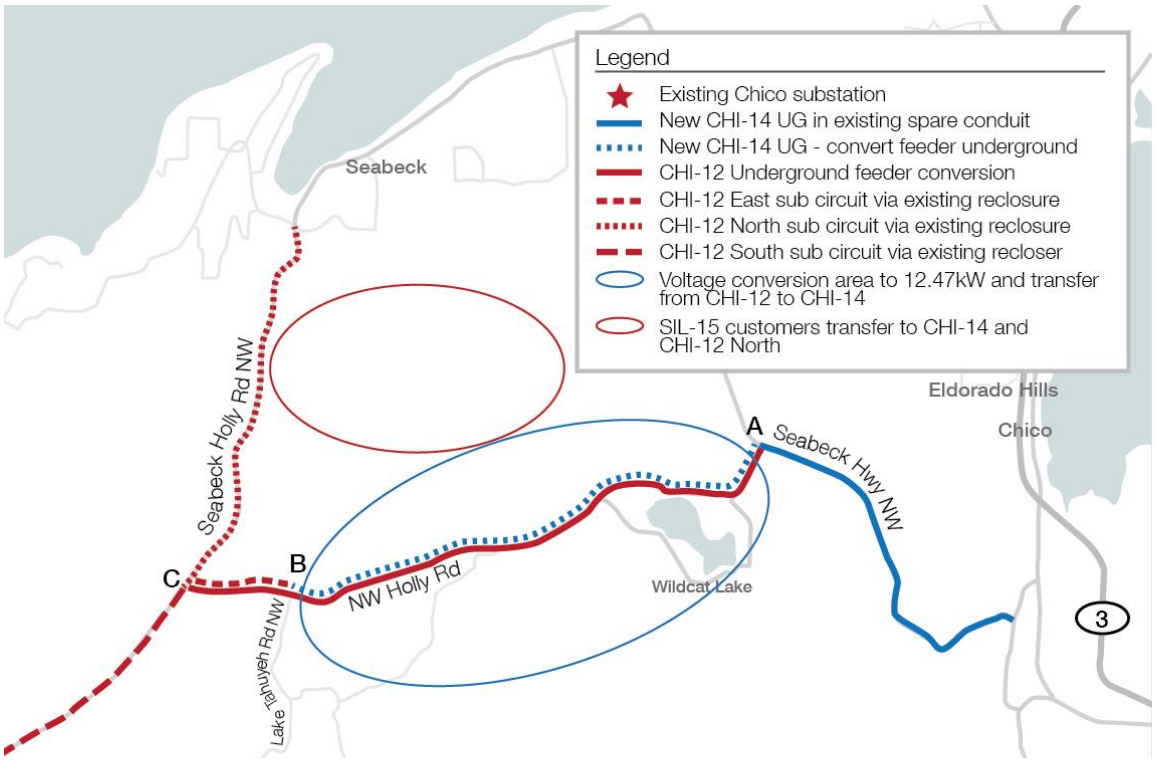

Figure 3-1: Top Wires Alternative

<u>Project Scope:</u>

1. **New CHI-14 Feeder (12.47 kV)**
   - Install a new circuit from Chico substation (tentatively named CHI-14) to serve customers near the Wildcat Lake area, including a new 12.47kV station breaker and getaway. The new circuit (CHI-14) would include a combination of underground and overhead wire and other distribution service equipment. Specifically, it would include:
     - Install approximately 2.8 miles of new underground cable in the existing spare conduit along Seabeck Hwy NW from the Chico substation to Seabeck Hwy (Point A).
     - Convert existing overhead feeder of CHI-12 to underground cable along NW Holly Rd from Seabeck Hwy (Point A) to Tahuyeh Lake Rd NW (Point B). Note that the overhead conductor will remain as laterals to feed existing customers. Convert all services on this section to 12.47kV and relocate the existing auto-transformer to a new location near the intersection of NW Holly Rd and Tahuyeh Lake Rd NW. This will create a normal open tie to the new CHI-12 East Sub Circuit.
     - Create a new normal open between new CHI-14 and SIL-16 near intersection of Seabeck Highway NW and NW Holly Rd.
     - Incorporate the new CHI-14 circuit into the existing distribution automation scheme.

2. **Express CHI-12 Feeder (34.5 kV)**
   - Construct a new 35kV UG express feeder for approximately 5 miles along NW Holly Rd between Seabeck Hwy (Point A) and NW Seabeck Holly Rd (Point C).
   - Create three CHI-12 sub feeders (north, east, and south) using existing 35kV SCADA reclosers.

3. **Transfer Customers via Normal Open Changes**
   - Transfer approximately 200 customers from SIL-15 to CHI-12 north sub feeder. This reduces existing SIL-15 load by 50 amps average.
   - Transfer approximately 180 customers from SIL-15 to new feeder CHI-14, which reduces SIL-15 demand by 40 amps. Total demand reduction on SIL-15 equals 90 amps. Reducing customers on SIL-15 will improve SAIDI and SAIFI by at least 17% by reducing customer exposure on the circuit from 2192 to 1812.
   - CHI-12 is reduced by approximately 800 customers and 190 amps by transferring customers along NW Holly Rd to new CHI-14 and increased by approximately 200 customers and 50 amps by transferring customers from SIL-15. Overall decrease on CHI-12 is 600 customers and 140 amps. This will improve CHI-12 SAIDI and SAIFI by at least 25% by reducing customer exposure from 2497 to 1897.
   - The new circuit CHI-14 will have approximately 180 customers and 40 amps from the SIL-15 transfer and 800 customers and 190 amps from the CHI-12 transfer. Total demand on CHI-14 is expected to be 230 amps and 980 customers when completed. A summary of the new circuit configurations is provided below in Table 3-1.

Table 3-1: Circuit Change Summary

	Existing Configuration		New Configuration	
Circuit	**Customer Count**	**Peak Load (A)**	**Customer Count**	**Peak Load (A)**
CHI-12	2497	561	**1897**	**371**
SIL-15	2192	498	**1812**	**458**
CHI-14	N/A	N/A	**980**	**230**

4. **Additional Project Scope**
   - Balance phases as necessary on CHI-12 and CHI-14 to adhere to PSE's guidelines. This project improves voltage during peak loading for customers at the end of CHI-12, from 116V on the primary to 118V according to distribution modeling software.

<u>**Wires Alternative Benefit Overview:**</u>

- Offers lowest cost of feasible wires alternatives
- Eliminates capacity needs on both CHI-12 and SIL-15 by shifting load to the new CHI-14 circuit Eliminates N-1 contingency need by reducing loading on CHI-12 so that either step-up parallel transformer can carry the peak load without overload
- Improved circuit reliability for customers along CHI-12 and the new CHI-14 feeder due to use of underground construction for the express feeder and underground feeder conversion for the existing overhead feeder. The expected average annual improvement for the system is ~185,000 CMI and ~2100 CI, which corresponds to 71 SAIDI and 0.80 SAIFI
- Improved reliability for customers in the area due to reduced customer exposure on each circuit, meaning any full circuit outage will affect fewer customers
- Improved reliability and operational flexibility; the added circuit and reduced loading on existing circuits will allow the existing distribution automation scheme to operate more frequently, which will further improve reliability and operational flexibility
- Improved voltage on the circuit by reducing loading and phase balancing on all circuits

3.3 Non-wires Solutions

PSE contracted Guidehouse Consulting to perform non-wires analysis to consider the technical and economic feasibility of an alternative that consists of both energy storage and other targeted distributed energy resources (DER).

3.3.1 Guidehouse Analysis

Guidehouse initially reviewed whether distributed energy resources alone could meet the needs of the Seabeck area. Their potential was identified in the context of existing DER programs and realistic DER adoption based on assumptions in PSE's Integrated Resource Plan[12] at the time of the study. Using the needs assessment and preferred wires solution developed by PSE as a baseline, Guidehouse analyzed whether there were comparable non-wire solutions that would meet all Seabeck needs.

While Guidehouse identified multiple non-wires solutions that would meet the Seabeck capacity needs, there was not one full, non-wires solution that could address both reliability and operational flexibility needs. The following is a summary of the key points and decision factors presented in Guidehouse's NWA study:

- The Seabeck area needs identified in the document are less than 10 MW and related to distribution reliability and capacity – which are typical candidates for NWA[13].
- Guidehouse first considered deferring or replacing the entire need with a non-wires solution. However, due to the inability of non-wires solutions to mitigate phase imbalance in a significant manner,[14] this element was removed from NWA analysis consideration[15].
- Improvements to reliability are not currently quantified as part of either the *Basic Analysis* or *Detailed Analysis*, these differences in reliability improvements between the wires and NWA solution need to be considered qualitatively when selecting the preferred solution[16].

Removing phase-balancing from consideration, Guidehouse determined that multiple cost-effective and technically feasible DER solutions exist to meet the capacity needs in the Seabeck area until 2031[17]. The non-wires alternative that was developed to meet the remaining area capacity needs is summarized below. This is also referred to as Hybrid 1.

A cost summary for this option is included in Table 3-2. It includes the additional costs to implement phase imbalance, since this need cannot be met with non-wires alternatives.

  - Option 1—Business-as-usual DER (BAU) + Energy Storage (ES) assumes a continuation of existing DER levels in the Seabeck area, with an additional Energy Storage System (ESS) located on the existing CHI-12 feeder.

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[12] Puget Sound Energy, "Integrated Resource Plan," PSE, https://www.pse.com/pages/energy-supply/resource-planning

Seabeck Non-Wires Alternative Analysis, Guidehouse, Page 1

[14] It is challenging for typical DER to achieve phase balancing without advanced grid analysis. Smart grid distributed intelligence types of technologies can be deployed for phase balancing and DER management system solutions. However, these technologies are still being developed and piloted for phase balancing activities. Given the lack of maturity of these technologies, and after discussion with PSE, Guidhouse removed phase imbalance from the identified needs to be met by the non-wires analysis.

[15] Seabeck Non-Wires Alternative Analysis, Guidehouse, Page 6

[16] Seabeck Non-Wires Alternative Analysis, Guidehouse, Page 8

[17] Seabeck Non-Wires Alternative Analysis, Guidehouse, Page iv

- Option 2—BAU+DER+ES, considers increased DER above and beyond business-as-usual based on an analysis of the technical potential in the area, in addition to an ESS located on the existing CHI-12 feeder.

Table 3-2: Portfolio Cost for Two Non-Wires Alternative Options for Seabeck (Hybrid 1)

Scenario	ESS Size (MW/MWh)	ESS Cost ($)	Incremental DER Cost ($)	Wires Component Cost	Total Portfolio Cost	Wired Solution WA-4 Cost Estimate Including 25% Contingency ($)
BAU + ES	3.1 MW/ 9.5 MWh	$4,736,500	$0	$500,000	$5,236,500	$14,000,000
BAU + DER + ES	2.4 MW/ 7.3 MWh	$3,625,500	$503,100	$500,000	$4,628,600	$14,000,000

- *Source: Guidehouse Analysis*

The overall conclusion of Guidehouse's non-wires study states:

> In both non-wires solution cases, with and without incremental achievable DER, the non-wires solution is lower net cost than the estimated cost of the wires solution. Using cost-effective DER in combination with energy storage has the potential to save approximately $600,000 in net costs relative to a solution that uses storage-only. However, the lower net cost of the NWA solution does not account for the greater reduction in SAIDI and SAIFI resulting from the preferred wires solution of at least 17% estimated on SIL-15 and 25% on CHI-12. Given that these benefits are not considered in the net cost comparison, Guidehouse concludes that both the NWA solution and the preferred wires solution WA-4 merit further consideration[18].

Given the importance of reliability improvement to this part of the distribution system, PSE performed a qualitative analysis comparing the benefits of the NWA solution to the wires solution, as shown in Section 3.3.3.

3.3.2 Analysis of Hybrid Solutions

After further evaluation of the solution criteria and proposed Hybrid 1 NWA alternative, the team determined that the reliability improvement gained by incorporating the battery system into the existing DA scheme did not represent a proven, dependable solution, and that it would have to first be installed and tested through a pilot process to refine operational procedures and establish benefits. Additionally, the improved DA operation would not provide substantial reliability benefit in order to meet the identified need. Due to this determination, a battery system alone was no longer considered to be a viable option for addressing Seabeck area reliability needs.

[18] Seabeck Non-Wires Alternative Analysis, Guidehouse, Page 23

In order to meet the solution criteria identified in Section 1.2 and clarified above, the two alternatives identified by Guidehouse as part of Hybrid 1 were modified to include a proven, quantifiable reliability improvement for CHI-12. The modified hybrid alternative includes converting the existing CHI-12 feeder underground along NW Holly Rd for approximately 5 miles from Seabeck Hwy to Seabeck Holly Rd. Figure 3-2 shows the scope of the modified hybrid alternative[19].

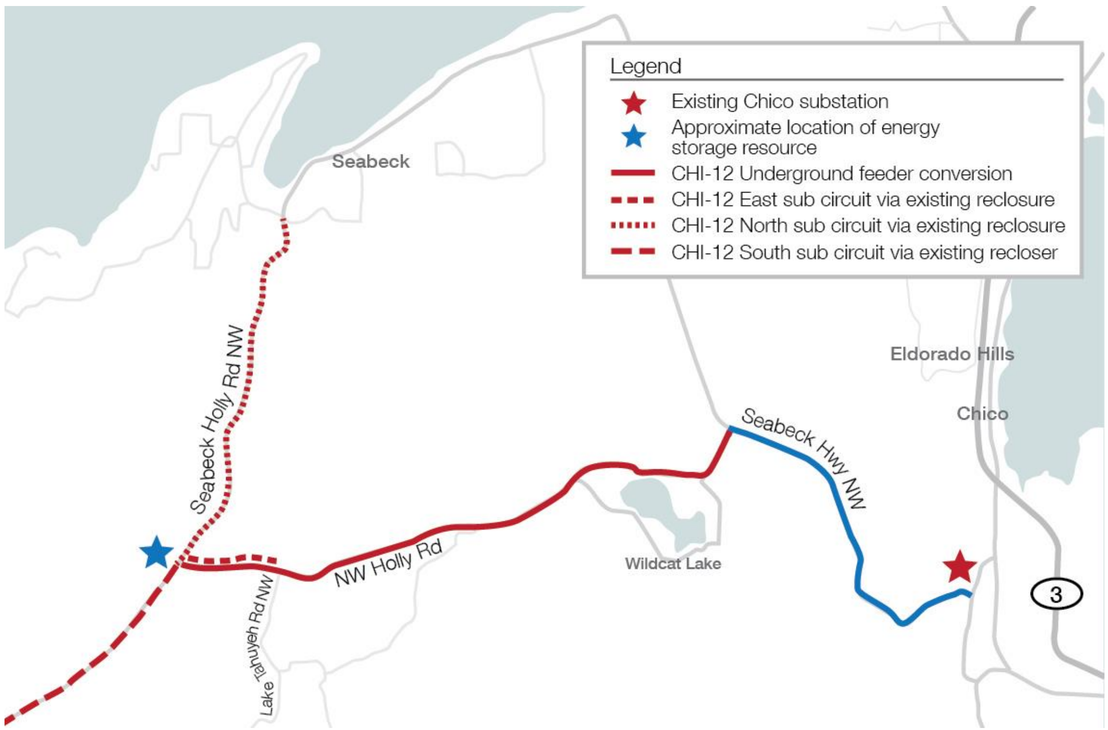

Figure 3-2: Modified Hybrid Alternative (Hybrid 2)

The overall reliability and capacity benefits of the modified hybrid alternative (Hybrid 2) are similar or better than the alternatives proposed in Table 3-2. In order to compare the benefits between the modified hybrid alternative and the top wires alternative, a detailed assessment of each benefit category was performed and summarized in Section 3.3.3.

3.3.3 Qualitative Comparison Between Wires, Non-Wires, and Hybrid Alternatives

The qualitative analysis performed for this area primarily focused on the reliability differences between the wires and non-wires solutions, but also considering the differences in capacity and operational improvements.

The preferred wires alternative has a significant improvement in reliability, capacity, and operational benefits when compared to the non-wires and hybrid alternatives. Table 3-3 below details the comparison between the top wires, non-wires, and hybrid alternative for each of the need categories

[19] The cost estimate for converting the existing feeder underground is significantly more expensive than installing an express underground feeder due to the need for junction boxes and a parallel lateral cable system to feed customers in the area.

addressed by the project. This analysis does not comprehensively list every benefit provided by each solution; however, it does provides an overview of the differences between each alternative and helps inform the overall preferred solution process.

Table 3-3: Wires, Non-Wires, and Hybrid Benefit Comparison

Need Category	Need Attribute	Wires Benefit	Non-Wires Benefit	Hybrid 2 Benefit	Preferred Alternative
Reliability	**Outage Prevention**	Underground conversion eliminates virtually all outages caused by Tree/Vegetation issues along Holly Rd for CHI-12 customers. Underground feeder conversion reduces outages for CHI-14 customers	Outage exposure remains the same	Underground conversion eliminates virtually all outages caused by Tree/Vegetation issues along Holly Rd for CHI-12 customers	**Wires**[20]
	Customer Exposure	Reduces customer exposure to outages by 17% on SIL-15 and 25% on CHI-12	Energy Storage has the potential to island, reducing customer exposure during outages[21]	Energy Storage has the potential to island, reducing customer exposure during outages	**Wires**
	DA Scheme Operation	Improves DA scheme by reducing loading and providing an additional switching option for picking up load	Improves DA scheme by reducing loading during peak conditions	Improves DA scheme by reducing loading during peak conditions	**Wires**
Capacity	**Peak Capacity**	Meets Peak Capacity by adding a new circuit with ~9.6	Meets Peak Capacity by adding 3.1 MW of	Meets Peak Capacity by adding 3.1 MW of	**Non-Wire**[24]

[20] The Wires Alternative is preferred because it meets the need at a lower cost.

[21] Including islanding in the Seabeck battery would require modifications to the distribution system and updates to PSE's operating procedures.

[24] The Non-Wires Alternative is preferred because it meets the need attribute at a lower cost.

		MW of added winter capacity[22]	added DER capacity[23]	added DER capacity	
	Future Capacity	Provides added capacity that meets peak capacity and unexpected future growth	Meets forecasted peak capacity, but does not provide flexibility for future growth	Meets forecasted peak capacity, but does not provide flexibility for future growth	**Wires**
Operations	**Low Voltage**	Reduced loading due to new circuit significantly improves voltage, even during N-1 conditions	Reduced loading improves voltage during peak conditions	Reduced loading improves voltage during peak conditions	**Wires**
	Operational Flexibility	New circuit provides added SCADA controlled switching options for system operators	Circuit configuration remains the same	Circuit configuration remains the same	**Wires**
	Phase Imbalance	Project includes phase balancing	No Phase Balancing included	Project includes phase balancing	**Wires/Hybrid**[25]

After reviewing the comparisons of Table 3-3, it was determined that the top wires alternative provides both quantitative and qualitative benefits that cannot be achieved by the non-wire or hybrid alternatives. Therefore, the top wires alternative is the proposed solution for meeting Seabeck area needs.

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[22] Added capacity based on 4/0 limiting factor of new CHI-14 circuit with a current rating of 444 Amps

[23] The added DER capacity is proposed as one of the following:

1. 3.1 MW Energy Storage system
2. 2.4 MW Energy Storage with targeted Energy Efficiency and Demand Response filling the remainder of the need. PSE has reviewed these values and agrees the proposed DER solution is achievable in the region.

[25] Both the Wires and Hybrid alternatives include equivalent cost for Phase Balancing, making this evaluation equal between the two alternatives. The Non-Wires alternative does not address Phase Balancing.

4 Preferred Solution

Due to the considerable benefits provided by the top wires solution, which cannot be achieved using non-wires alternatives, WA-4 was determined to be the best solution for meeting Seabeck area needs. Refer to Section 3.2 for a detailed description of the proposed solution, including full project scope, estimated cost, and projected benefits.

This solution will have many benefits for the PSE distribution system, including a substantial reliability improvement for an area that has experienced historically poor reliability performance. The capacity needs will be solved with the addition of a new circuit, which will also provide significantly improved operational flexibility and allow for ample future growth in the Seabeck area.

<u>The primary needs being addressed by the proposed solution are:</u>

- Reduced loading on both CHI-12 and SIL-15, which will eliminate forecasted capacity needs and allow CHI-12 load to be carried by either transformer in an N-1 contingency during peak loading.

- Improved circuit reliability for CHI-12 due to use of underground construction for express feeder and underground feeder conversion for overhead conductor. The expected average annual improvement of Non-MED reliability metrics is ~185,000 CMI and ~2100 CI, which corresponds to 71 SAIDI and 0.80 SAIFI. These changes will also improve resiliency during storm situations

- Improved reliability for customers in the area due to reduced customer exposure on each circuit, meaning any full circuit outage will affect fewer customers.

- Added feeder capacity and reduced loading on existing circuits will allow the existing distribution automation scheme to operate more frequently, which will further improve reliability and operational flexibility

- Reduced loading and phase balancing will improve voltage problems at peak loading on all circuits

Conclusion

Energy is essential for communities, and PSE is committed to creating a better energy future for all customers in the Seabeck area.

The preferred solution will bring many benefits to the local distribution system, including a substantial reliability improvement. The capacity needs will be solved with the addition of a new circuit, which will also provide significantly improved operational flexibility capable of supporting future growth and development in the region.

Customers will benefit greatly, too. With these improvements, the Seabeck area’s history of poor reliability will come to an end. Given the local climate and west Kitsap geography, some outages are inevitable, but their frequency and impact can be greatly reduced for many years to come.

Appendix A Alternatives Considered

Appendix A summarizes the alternatives considered while developing the preferred solution. An alternative is considered viable if it meets all system needs and the solutions criteria; otherwise it is deemed non-viable and eliminated from further consideration.

Table A-1 below provides an overview of the wires alternatives that were considered. The preferred alternative, WA-4, is detailed in Section 3.2 and is not included in this appendix.

Table A-1: Wires Alternatives Comparison[26]

		WA-1 Scope	WA-2 Scope	WA-3 Scope	WA-4 Scope
Needs	CHI-12 N-1 Capacity	Solved through new substation	New 35kV Substation	Third Parallel step up transformer	New CHI-14 Circuit taking
	CHI-12 Distribution Feeder Reliability	Improved through transmission restoration priority and spreading customers to multiple feeders	Improved through sub transmission restoration priority and spreading customers to multiple feeders	Improved through UG construction	Improved through express underground feeder and creating sub feeders. Some customers transferred to new circuit
	SIL-15 Distribution Feeder Reliability	Improves SIL-15 CMI by placing some customers on a new circuit	Improves SIL-15 CMI by placing some customers on a new circuit	Does not reduce SIL-15 CMI	Improves SIL-15 CMI by placing some customers on new circuit
	Low Voltage	Solved through shorter feeders and more balanced circuits	Solved through LTC at new 35kV substation and sub placed closer to load center	Solved through addition of regulators and reduced load imbalance	Solved through reduction of load on CHI-12 and SIL-15 and reduced load imbalance
	CHI-12 Phase Balance	Phase imbalance will reduced to less than 100 Amps per feeder. More opportunities to balance load.	Phase imbalance will be reduced to less than 100 Amps per feeder. More opportunities to balance load.	Phase balancing will need to be performed	Phase imbalance will be reduced to less than 100 Amps per feeder. More opportunities to balance load.
Decision Factors	Additional Costs - *Land (ROW, Property)*	Sub. property available, Public ROW	Public ROW	Public ROW	Public ROW + CHI-14 getaway route, New Step-Up Transformer Location
	Cost Estimate	$29.8M to $37.3M	$17M to $21.3M	$12.5M to $15.6M	$11.8M to $14.8M
	Reliability Benefits	High	Moderate	Moderate	High
	Benefits	Highest reliability improvement, eliminates most 35kV, increases operational flexibility	Improves reliability, increases operational flexibility	Improves reliability	Improves reliability, eliminates 35kV exposure, increases operational flexibility
	Drawbacks	High Cost	High Cost	35 KV remains, no improvement to SIL-15 CMI	Some 35kV remains
	Risks	Public opposition to new substation and T-Line	Public opposition to new substation	Permitting Challenges	Permitting Challenges
	B/C Ratio	1.22	2.02	2.36	3.27
	Overall Preference	Lowest due to cost	3rd	2nd	1st Highest B/C ratio

[26] Wires Alternatives descriptions and costs are detailed below in Appendix A

The following table format is utilized in this section to describe the alternatives considered, and the determination of viability of these alternatives.

NAME STATUS	SCOPE SUMMARY	DECISION FACTORS (N) Indicates criteria not met but could be met with cost sharing (X) Indicates criteria not met (Y) Indicates criteria met	

NAME – Name of Alternative

STATUS – Viable or Eliminated

SCOPE SUMMARY – High level description of scope of alternative considered

DECISION FACTORS – N, X or Y (as described above)

Appendix A.1 Wires Alternatives

This section describes the wires alternatives (WA) considered to solve the Seabeck area needs identified in the needs assessment

Table A-1: Alternative Comparison: Wires Alternatives

NAME STATUS	SCOPE SUMMARY	DECISION FACTORS	
WA-1 ELIMINATED HIGH COST	New 115-12kV Distribution Substation	Meets all technical criteria Reasonable project cost Uses proven technology Constructible within reasonable timeframe	Y N Y Y
WA-2 ELIMINATED HIGH COST	New 35-12kV Distribution Substation	Meets all technical criteria Reasonable project cost Uses proven technology Constructible within reasonable timeframe	Y N Y Y
WA-3 ELIMINATED DOES NOT MEET NEEDS	Third Parallel step up transformer	Meets all technical criteria Reasonable project cost Uses proven technology Constructible within reasonable timeframe	X Y Y Y
WA-4 PREFERRED	New CHI-14 Express Feeder from CHI Substation	Meets all technical criteria Reasonable project cost Uses proven technology Constructible within reasonable timeframe	Y Y Y Y Y

Appendix A.1.1 Wires Alternative 1- (WA-1) New 115-12kV Distribution Substation

Construct a new 115-12kV substation and a 115 kV transmission line, over building the existing distribution line, from near the Chico Substation west along Seabeck Hwy then south and west along Holly road for approximately 7 miles. Seabeck Substation would be a 115/12.47 kV, 25 MVA, Y-D-Y substation with 5-12.5 kV circuits. This substation would include SCADA monitoring/control. Cost is estimated at $29.8M.

This scenario presents the following pros and cons:

Benefits

- The existing circuits CHI-12 and SIL-15 are sectionalized from 2 circuits to 7 circuits
- Almost all of the existing OH distributions circuits would be operated at PSE's standard distribution voltage; 12.47 kV
- Eliminates distribution autotransformers
- The transmission lines are trimmed every 3 years, as opposed to every 6 or more years
- Half of the existing distribution poles will be replaced with new transmission poles
- Significant beneficial effect in reducing SAIDI and SAIFI

Drawbacks

- A downed tree can still cause a transmission line and substation outage
- An outage to the transmission line will cause the substation to be out until it is repaired
- The capital cost of this option is the highest at $29.8M
- O&M costs associated with this new infrastructure

Scope Summary:

Construct New Substation with four circuits

Construct 4-12.47 kV underground getaways

Rebuild OH distribution line west to Seabeck-Holly road with two circuits.

Convert 34.5kV to 12.47kV for most customers

Reconstruct the existing OH distribution line to 115kV from the BPA 115 kV line crossing the Seabeck Highway to the new substation site

Install transmission poles and conductors approximately 7 miles

Appendix A.1.2 Wires Alternative 2 (WA-2) New 35-12kV Distribution Substation

Construct New Substation & Complete UG 34.5 kV Sub-and rebuild 35kV overhead to substation to improve reliability using some combination of undergrounding, spacer cable or tree wire. Estimated cost of $17M.

Substation would be a 34.5/12.47 kV, 25 MVA, Y-D-Y substation with 5-12.5 kV circuits. This substation would include SCADA monitoring/control.

This scenario presents the following pros and cons:

Benefits

- The existing circuit is sectionalized from 2 circuits to 7 circuits
- This reduces the load and feeder length of the adjacent circuit; SIL-15
- The third transformer step up transformer at Chico provides the needed redundancy to remove any one transformer from operation for a short period of time.
- The sub-transmission line (34.5 kV), would be bolstered through either undergrounding, spacer cable, or tree wire, or a combination.
- Almost all of the existing OH distributions circuits would be operated at PSE's standard distribution voltage; 12.47 kV
- Eliminates distribution autotransformers
- Significant beneficial effect in reducing SAIDI and SAIFI

Drawbacks

- An outage to the sub-transmission will cause the substation to be out until it is repaired
- De-energizing Chico substation will continue to be difficult and only possible during light loading periods
- The capital cost of a new sub-transmission line and substation

Appendix A.1.3 Wires Alternative 3 (WA-3) Third Parallel Step-Up Transformer

Convert the existing OH 35kV distribution system to underground to improve reliability

Install new third step up transformer and cable at Chico substation to eliminate applicable N-1 scenario overload with loss of an existing transformer.

This scenario presents the following Benefits and Drawbacks:

Benefits

- The additional transformer will reduce loading on existing equipment
- The sub-transmission line (34.5 kV) would have improved reliability
- Improvements to SAIDI and SAIFI

Drawbacks

- This option doesn't reduce feeder length of the adjoining circuit SIL-15
- The existing load may exceed the breaker capacity of CHI-12 and provisions for a large 34.5kV transformer will be required at that time. Currently projected outside of the study period.
- De-energizing Chico substation will continue to be difficult and only possible during light loading

Appendix B Glossary

Term	Definition
Term	**Definition**
Block load	A large expected increase in electric energy demand from an existing or new customer.
Business as Usual Distributed Energy Resources (BAU DER)	Acquiring cost effective energy efficiency as a resource, mitigating both energy and peak demand growth by partnering with customers in their efforts to make high efficiency upgrades in their homes and businesses.
Circuit	A circuit is the electric equipment associated with serving all customers under normal configuration from a specific distribution circuit breaker at a substation.
Concern	A “concern” is a non-critical issue that impacts system operations but is not required to be addressed by a solution; a solution that addresses an identified concern provides additional benefit.
Conservation	Measures to improve efficiency of customer’s electric loads reducing energy use and reducing peak demand.
Consumption	Consumption is the amount of electricity that customers use over the course of a year and it’s measured in kilowatt hours.
Contingency	Contingencies are a set of transmission system failure modes, when elements are taken out of service (e.g., loss of equipment).
Curtailable	A load that may be interrupted to reduce load on system during peak periods. Curtailable customers are on a different rate schedule than non-curtailable (firm) customers.
Demand	The amount of power being required by customers at any given moment, and it’s measured in kilowatts.
DR- Demand response	Flexible, price-responsive loads, which may be curtailed or interrupted during system emergencies or when wholesale market prices exceed the utility’s supply cost. Demand response is also the voluntary reduction of electricity demand during periods of peak electricity demand or high electricity prices. Demand response provides incentives to customers to temporarily lower their demand at a specific time in exchange for reduced energy costs.
Distributed Energy Resource (DER)	A resource sited close to customers that can provide all or some of their immediate electric and power needs and can also be used by the system to reduce system demand (such as energy efficiency) or provide supply to satisfy the energy, capacity, or ancillary service needs of the distribution grid. The resources, if providing electricity or thermal energy, are small in scale, connected to the distribution system, and close to load
Distributed generation	Small-scale electricity generators, like rooftop solar panels, located close to the source of the customer’s load.

Term	Definition
Distribution line	A distribution line is a medium-voltage (12.5 kV-35 kV) line that carries electricity from a substation to customers. Roughly half of PSE's distribution lines are underground. Distribution voltage is stepped down to service voltage through smaller transformers located along distribution lines. Distribution lines differ from feeder as it includes the large feeder wire and smaller wire laterals.
Distribution System	A distribution system is the medium-voltage (12.5 kV-35 kV) infrastructure that carries electricity from a substation to customers and includes the substation transformer. System is the collective of all of this infrastructure in an entire study area.
EPRI- The Electric Power Research Institute	The Electric Power Research Institute conducts research, development, and demonstration projects for the benefit of the public in the United States and internationally. As an independent, nonprofit organization for public interest energy and environmental research, they focus on electricity generation, delivery, and use.
Feeder	A feeder is the largest conductor section of a circuit and carries the greatest load as it serves all the laterals (branches)) of the circuit.
Institute of Electrical and Electronics Engineers (IEEE)	A professional association, promoting the development and application of electro-technology and allied sciences for the benefit of humanity, the advancement of the profession, and the well-being of our members.
Integrated Resource Plan (IRP)	The Integrated Resource Plan (IRP) is a forecast of conservation resources and supply-side resource additions that appear to be cost effective to meet the growing needs of our customers over the next 20 years. Every two years, utilities are required to update integrated resource plans to reflect changing needs and available information.
Interim Operating Plan (IOP)	A temporary plan to address a transmission system deficiency and meet performance requirements, until a solution takes effect. An IOP may consist of a series of operational steps to radially operate the system, run generation or implement load shedding.
Kilovolt (kV)	A kilovolt (kV) is equal to 1,000 volts of electric energy. PSE uses kilovolts as a standard measurement when discussing things like distribution lines and the energy that reaches our customers.
Load	The total of customer demand plus planning margins and operating reserve obligations.
Load forecast	A load forecast is a projection of how much power PSE’s customers will use in future years. The forecast allows PSE to plan upgrades to its electric system to ensure that current and future customers continue to have reliable power. Federal regulations require that utilities plan a reliable system based on forecasted loads. When developing a load forecast, PSE takes multiple factors into account like current loads, economic and population projections, building permits, conservation goals, and weather events.

Term	Definition
Load shedding	Load shedding is when a utility intentionally causes outages to customers because demand for electricity is exceeding the capacity of the electric grid. Load shedding is the option of last resort and is conducted to protect the integrity of the electric grid components in order to avoid a larger blackout. This is not a practice that PSE endorses as a long-term solution to meet mandatory performance requirements.
Major Event Day (MED)	Any day in which the daily system SAIDI exceeds the annual threshold value. Outages on those days are excluded from the SAIDI performance calculation.
Megawatt (MW)	A megawatt (MW) is equal to 1,000,000 watts of electric energy. PSE uses megawatts as a standard measurement when discussing things like system load and peak demand. MW differs from MVA in that it is generally always lower and translates as energy that performs work. The amount of MW vs MVA is determined by load characteristics. Motor loads generally have a lower power factor (PF) than heating loads for example and as a result. MW=MVA*PF
Mega Volt-Amp (MVA)	A MVA is equal to 1,000,000 (Volt*Amps). MVA is generally slightly higher than MW. Equipment ratings are in MVA as the equipment heat rise is determined by actual MVA.
N-0	This is a planning term describing that the electric grid is operating in a normal condition and no components have failed.
N-1	This is a planning term describing an outage condition when one system component has failed or has been taken out of service for construction or maintenance.
N-1-1	This is a planning term describing outage conditions where two failures occur one after another with a time delay between them.
N-2	This is a planning term describing outage conditions where two failures occur nearly simultaneously.
Native Load Growth	Load growth associated with existing customers or new customers less than 1 MW.
Need	A constraint or limitation on the delivery system in providing safe and reliable electric supply to customers. A need is a “must-have” that is required to be addressed for the system in a timely manner (by a certain Need Date, as determined in a needs assessment)
Non-wires alternatives	Alternatives that are not traditional poles, wires and substations. These alternatives can include demand reduction technologies, battery energy storage systems, and distributed generation.
NERC- North American Electric Reliability Corporation	NERC establishes the reliability standards for the North American grid. NERC is a not-for-profit international regulatory authority whose mission is to ensure the reliability of the bulk power system in North America, as certified by FERC. NERC develops and enforces Reliability Standards and annually assesses seasonal and long-term reliability. PSE is required to meet the Reliability Standards and is subject to fines if noncompliant.

Term	Definition
Peak demand	Customers' highest demand for electricity at any given time, and it's measured in megawatts.
Proven technology	Technology that has successfully operated with acceptable performance and reliability within a set of predefined criteria. It has a documented track record for a defined environment, meaning there are multiple examples of installations with a history of reliable operations. Such documentation shall provide confidence in the technology from practical operations, with respect to the ability of the technology to meet the specified requirements.
Reasonable project cost	Reasonable project cost means holistically comparing costs and benefits to project alternatives. This includes dollar costs, as well as duration of the solution, risk to the electric system associated with the type of solution (e.g., is the solution an untested technology), and impacts to the community.
Right of way	A corridor of land on which electric lines may be located. PSE may own the land in fee, own an easement, or have certain franchise, prescription, or license rights to construct and maintain lines.
Sensitivities	Sensitivities are circumstances or stressors under which the contingencies are tested (e.g., forecasted demand levels, interchange, various generation configurations).
Spacer Cable	Spacer cable is a product by Hendrix that is supported by a strong messenger cable and has insulated phase conductors. This product prevents most tree outages by blocking falling limbs from the phase conductors.
Substation	A substation is a vital component of electricity distribution systems, containing utility circuit protection, voltage regulation and equipment that steps down higher-voltage electricity to a lower voltage before reaching your home or business.
Substation group	A grouping of 2-5 substation transformers that are situated close enough to each other that loads in the study area can be switched from one station to an adjacent station for maintenance, construction, or permanent load shifting. For Seabeck, the substation group includes 2 distribution substations – Silverdale and Chico.
Substation group capacity	The aggregate distribution transformer capacity of the substation group for winter and summer rating, calculated in MVA.
SAIDI- System Average Interruption Duration Index	SAIDI is the length of non-major-storm power outages per year, per customer. SAIDI is commonly used as a reliability indicator by electric power utilities. Outages longer than 5 minutes are included.
SAIFI- System Average Interruption Frequency Index	SAIFI is the frequency of non-major-storm power outages per year, per customer. SAIFI is commonly used as a reliability indicator by electric power utilities. Interruptions longer than 1 minute are included.

Term	Definition
Transformer	A transformer is a device that steps electricity voltage down from a higher voltage, or steps it up to a higher voltage, depending on use. On the distribution system, transformers typically step the voltage down from a distribution voltage (12.5 kV) to 120 to 240 volts for customers' residential use. Transformers are the green boxes in some residences' front yard or the barrel-like canisters on utility poles.
Transmission line	Transmission lines are high-voltage lines that carry electricity from generation plants to substations or from substation to substation. Transformers at the substation "step down" the electricity's transmission voltage (55 to 230 kilovolts) to our primary distribution voltage (12.5 kV).

PUGET SOUND ENERGY

PROJECT CHANGE REQUEST (PCR)

PCR # 1

WBS Title & Project Title: **SEABECK RELIABILITY**	**Leading Work Order Number: 101109898** **CAP WBS: W_R.10040.01.01.01** **OMRC WBS:**
Date: **10/11/2023**	**Project Manager: Robert Trombley**
Current Phase: Initiation	**Reason for submittal:** Gate change to Planning

<table>
<tr>
<td>SCOPE: Change to Scope beyond original need, benefit or intent?

Click drop down:

NO

If Yes, explain in summary how system need & alternatives were re-evaluated.</td>
<td>Summary:

New CHI-14 Feeder (12.47 kV)
• Install a new circuit from Chico substation (tentatively named CHI-14) to serve customers near the Wildcat Lake area, including a new 12.47kV station breaker and getaway. The overhead sections of the feeder will reuse existing CHI-12 infrastructure and convert to tree wire for reliability improvement.
Express CHI-12 Feeder (34.5 kV)
• Construct a new 34.5kV UG express feeder for approximately 5 miles along NW Holly Rd between Seabeck Hwy and NW Seabeck Holly Rd
Transfer Customers via Normal Open changes
• Transfer approximately 380 customers from SIL-15 to CHI-12 and new CHI-14. This reduces existing SIL-15 load by 90 amps average.
Additional Equipment Installation
• Install a new Regulator on CHI-14 to provide voltage support phase balancing as necessary on CHI-12 and CHI-14 which will improve voltage from 116v to 118v

Description of Project Plan Documentation updates:
Solutions report.</td>
</tr>
</table>

SCHEDULE: Change to in-service date greater than one year from baselined need: *Click drop down:* *NO* ***If Yes, explain in summary how system Need Date documentation was updated.***	**Summary:** Project is expected to enter the execution phase in 2025 and be completed in 2026. **Description of Project Plan Documentation updates:**

BUDGET: Change to fiscal year, lifetime capital or OMRC budget beyond contingency?

Click drop down:

YES

Current year Capital budget:	$1,000,000				
Increase $		**Decrease $**	**750,000**	**Total $**	**250,000**
Lifetime Capital budget:	$11,850,000				
Increase $		**Decrease $**	**0**	**Total $**	**11,850,000**
Current year OMRC budget:	$0				
Increase $		**Decrease $**		**Total $**	**0**
Lifetime OMRC budget:	$200,000				
Increase $		**Decrease $**		**Total $**	**200,000**

Summary:

The purpose of this PCR is to document the phase gate from initiation to planning and to capture the forecast adjustment for 2023. The 2023 budget has been reduced to align with the current planning phase work plan and resource availability.

Description of Project Documentation Updates;

Benefit and Need Validation:
For Planning to Design and Design to Execution gates the PCR must be signed by the technical requestor (Planner) and Consulting Engineer (Area Lead).

Phase gate (drop down)	Validation: The project scope, schedule and budget are addressing the need? (drop down)
Choose an item.	*Choose an item.*

Brief statement from technical requestor regarding why technical validation was either approved or rejected:

Equity Considerations:
As part of the solution considerations process, PSE evaluates how customer equity is addressed. PSE leverages Customer Benefit Indicators ("CBI") and information established as part of the 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 equity benefit of the project.

This project was planned and a solution chosen prior to equity considerations being required or defined. The Seabeck Reliability project will provide benefit to two distribution circuits fed from the Chico Substation and one distribution circuit fed from the Silverdale Substation, of which 2 circuits serve customers that are identified as High Vulnerability population and 1 circuit identified as Medium Vulnerability population based on current definitions (i.e. prior to the approved CEIP Final Order).

The equity benefit of this project includes the Customer Benefit Indicator of Resilience by providing improvements to the feeders that will improve reliability. This project also improves the Customer Benefit Indicator of Enabling Cleaner Energy by allowing additional circuits to be fed from the substation, which provides additional distribution circuit capacity to support future electrification and DER.

Project development, design and permitting will be completed following jurisdictional permitting processes and requirements that include public notices, hearings, comment opportunities and appropriate communication methods following jurisdictional codes. For construction, the jurisdictional permits will dictate working hours, noise restrictions and restoration requirements.

Electronic signature (DocuSign)
*Acknowledgement from Technical Requestor, **(System Planner)***
Colin O'Brien

DocuSigned by:
Colin O'Brien
FDDD952EBDDD478...

Electronic signature (DocuSign)
*Acknowledgement from Consulting Engineer, **(Area Lead)***
(Required for System Projects only)

Required approvals for this PCR which are based on CPM-20, Commitment Authority and CTM-07, Invoice/Payment Approval limits.

Approvals Necessary as Checked	Approver Title	Approver	Date Signed	Electronic signature (DocuSign)
☒	Manager	Tony Pagano	10/16/2023	DocuSigned by: Tony Pagano C7D3BC09443B4AC...
☒	Director Sponsor	Roque Bamba	10/23/2023	DocuSigned by: Roque Bamba BC203E4E58BB426...
☒	Executive Sponsor	Dan Koch	10/23/2023	DocuSigned by: Dan Koch 7E7434ECBF5B4C0...

Links to source documents included for this submittal:

Description	Links

Seabeck Non-Wires Alternative Analysis

Prepared for:

Puget Sound Energy

Submitted by:

Navigant Consulting, Inc.
1375 Walnut St.
Suite 100,
Boulder, CO 80302

303.728.2500
navigant.com

Reference No.: 205416
March 18, 2019

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DISCLAIMER

This report was prepared by Navigant Consulting, Inc. (Navigant) for Puget Sound Energy (PSE). The work presented in this report represents Navigant's professional judgment based on the information available at the time this report was prepared. Navigant is not responsible for the reader's use of, or reliance upon, the report, nor any decisions based on the report. NAVIGANT MAKES NO REPRESENTATIONS OR WARRANTIES, EXPRESSED OR IMPLIED. Readers of the report are advised that they assume all liabilities incurred by them, or third parties, as a result of their reliance on the report, or the data, information, findings and opinions contained in the report.

EXECUTIVE SUMMARY

Navigant Consulting, Inc. (Navigant) performed an assessment of the potential for non-wires alternatives (NWAs) to meet the range of electricity delivery needs in the Seabeck Area. The process used for the assessment and results of the assessment are provided in this report.

The primary goal of this work is to examine potential NWAs for the Seabeck Area. The work was also used to develop and refine tools and processes for Puget Sound Energy (PSE) to efficiently assess NWAs to help make system planning decisions. The tools and processes are explained in Appendix A and used in the context of the Seabeck-specific analysis that follows, but they will be generalized in a separate document for PSE.

Navigant approached the analysis using the principal of progressive elaboration. First, the team reviewed the needs document[1] and proposed wired solution[2]. Next, the team performed a *Basic Analysis*[3] of an NWA. As an output of the *Basic Analysis* Navigant made recommendations for further *Detailed Analysis* of options that appeared viable from a technical, logistical, and financial perspective. Navigant reviewed the *Basic Analysis* options with PSE and received feedback, corrections, and direction on viability. The Navigant team then performed a *Detailed Analysis* on a subset of the options identified with incorporation of PSE's input. *Detailed Analysis* builds upon the framework identified in the *Basic Analysis*, and it includes performing a detailed needs assessment over the study period. The *Detailed Analysis* refined the load forecast and 8,760 peak behavior. Distributed energy resource (DER) potential was identified in the context of existing DER programs and realistic DER adoption based on assumptions in PSE's most recent Integrated Resource Plan.[4] Finally, the economics analysis examines the Net Present Value (NPV) of the costs of the proposed wired solution versus the non-wires or hybrid non-wires option. By progressively evaluating the most viable options, Navigant and PSE were able to spend their time and effort exploring the most promising options in the Seabeck Area for non-wires solutions.

Two NWA options were developed through this process, as shown in Table 1.

Table 1. Portfolio Cost for Two Non-Wires Alternative Options for Seabeck

Scenario	ESS Size (MW/MWh)	ESS Cost ($)	Incremental DER Cost ($)	Total Portfolio Cost	Wired Solution Cost Estimate ($)
BAU + ES	3.1 MW/ 9.5 MWh	$4,736,524	$0	$4,736,524	$12,000,000
BAU + DER + ES	2.4 MW/ 7.3 MWh	$3,625,519	$503,110	$4,128,629	$12,000,000

Source: Navigant Analysis

Overall, Navigant found that a cost-effective and technically feasible solution exists (with a combination of DER and energy storage systems) to meet the needs in the Seabeck Area until 2031 (Table 1). The details of the analysis approach, including the results of the *Basic* and *Detailed Analyses*, are provided in the following sections.

[1] Puget Sound Energy, "Seabeck Area Needs Assessment (DRAFT)", 11/29/2018.

[2] Puget Sound Energy, "Seabeck Area Solutions Study DRAFT", 11/29/2018.

[3] Navigant has developed a systematic approach to assessing NWA potential using defined *Basic*, *Detailed* and *Advanced* analyses. These approaches are explained in the context of the Seabeck analysis in this report and will be more completely defined in separate documents.

[4] Puget Sound Energy, "Integrated Resource Plan," PSE, https://www.pse.com/pages/energy-supply/resource-planning.

1. ANALYSIS APPROACH

Navigant worked with Puget Sound Energy (PSE) to define the analysis parameters for the Seabeck Area non-wires project and to deconstruct the overall problem into logical components appropriate for analysis. This approach helped the team identify actions that may meet specific portions of the needs, and to understand the timing and costs of those potential actions.

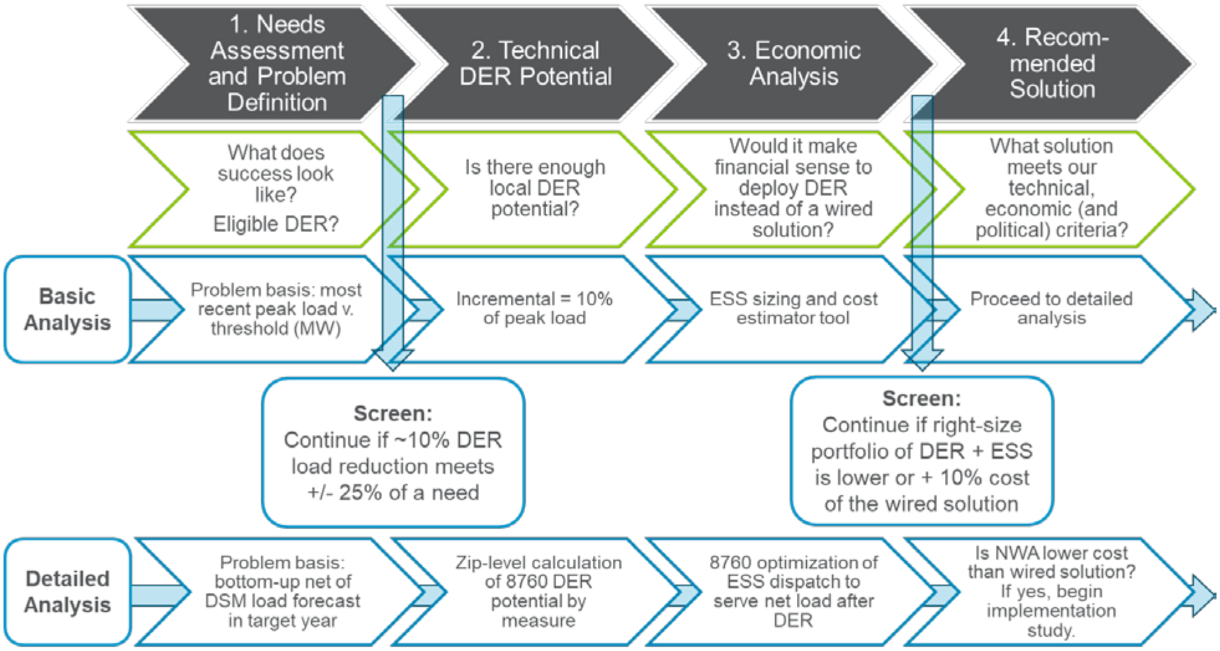
Navigant started with the PSE *Seabeck Area Needs Assessment (DRAFT)*[5] and looked for areas where non-wires alternatives (NWAs) are typical fits. This produced an immediate result: the needs identified in the document are less than 10 MW and related to distribution reliability and capacity—which are typical candidates for NWAs. Navigant next examined the proposed wired solutions and looked for opportunities to replace or defer elements of the solution using non-wires technology consisting of customer-sited distributed energy resources (DER) and grid-sited energy storage systems (ESSs). The team identified a single solution option where non-wires solutions could be technically valid and cost-effective to replace or defer the entire proposed wired solution.

Navigant first performed a *Basic Analysis* on the identified option that showed promise from technical feasibility and economic perspectives. The *Basic Analysis* consists of technical, logistical, economic, and timing assessments of the option identified. The goal of the *Basic Analysis* was to provide an assessment using available information, rules of thumb, and industry experience to determine if identified NWA options are potential candidates to merit *Detailed Analysis*.

The team refined the methodology used previously (i.e., in Bainbridge Island and Kitsap analyses) and employed it in the *Detailed Analysis* by customizing it to consider needs across two distribution feeders. The *Detailed Analysis* used the load forecast over the analysis timeframe, the 8,760 feeder load shapes, in-depth DER and ESS portfolio creation, and economic assessment. Figure 1 compares the *Basic* and *Detailed Analysis* by four key steps identified during previous projects and used in the Seabeck Area analysis. Appendix A provides additional detail on the methodology used.

[5] Puget Sound Energy, "Seabeck Area Needs Assessment (DRAFT)", 11/29/2018.

Figure 1. Non-Wires Alternative Analysis Steps



Source: Navigant Analysis

The needs review, solution approach, and potential options developed are explained in the following subsections.

1.1 Needs Review

The Navigant team reviewed the PSE *Seabeck Area Needs Assessment (DRAFT)* and studied the needs and concerns identified. The needs are centered on the distribution system in the West Kitsap County area near the town of Seabeck associated with distribution circuits CHI-12 and SIL-15. PSE examined capacity, reliability, operational system flexibility, and aging infrastructure considerations over the next 10-year planning period.

PSE noted reliability concerns with circuits CHI-12 and SIL-15. They are both in PSE's worst performing circuit list. These two circuits serve the entire load in this area and continue to have significantly worse SAIDI and SAIFI scores than PSE's average values for SAIDI and SAIFI.

Both circuits, CHI-12 and SIL-15, are above the Distribution Planning Guidelines of 83% utilization capacity, but do not exceed capacity during the study period with forecast conservation. CHI-12 is overloaded during N-1 contingency associated with step-up transformer failure with forecast conservation.

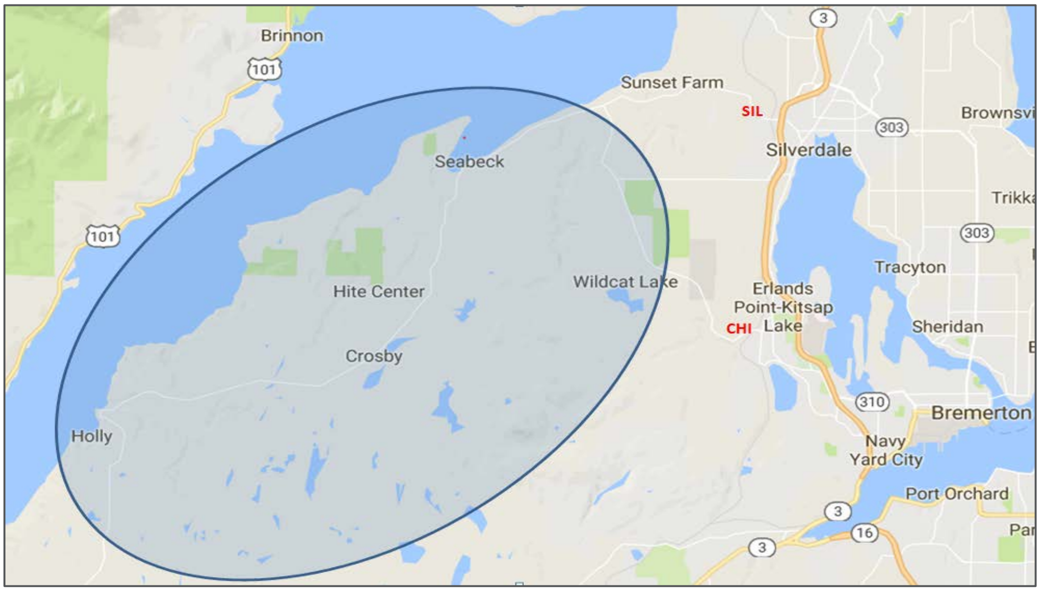
The report also notes that there are currently operational concerns due to low voltages in certain areas of the feeder during peak loading, inability to backup load, load balance across phases, and cold load pickup issues. Specifically, CHI-12 has had phase imbalance at least 26% above the recommended limit of 100 amps. Additional growth without system improvements will compound these concerns.

Finally, there is an aging infrastructure concern with accelerated aging associated with one of the step-up transformers on CHI-12. Failure of this transformer would result in load shedding during peak demand periods.

1.2 Solution Approach

The Navigant team reviewed the proposed wired solution in PSE *Seabeck Area Solutions Study DRAFT* and the needs assessment document mentioned above to develop the potential NWA solutions. Figure 2 shows an overview of the Seabeck Area. Navigant notes that the proposed preferred traditional solution addresses all the needs identified. Navigant reviewed the preferred traditional solution to identify aspects that could be deferred or eliminated by a non-wires solution.

Figure 2. Seabeck Area Overview



Source: Puget Sound Energy, Seabeck Area Solutions Study DRAFT, 11/29/2018

1.3 Solution Options

The proposed potential wires and NWAs are explored in the following sections.

1.3.1 Proposed Wired Solution Summary

PSE proposes three traditional wired solutions to meet the Seabeck Area distribution needs. PSE indicated that Wires Solution 3 was the preferred solution. Initial estimated costs of Wires Solution 3, from the *Seabeck Area Solutions Study DRAFT,* are shown in Table 2.

Table 2. Proposed Wires Solution 3

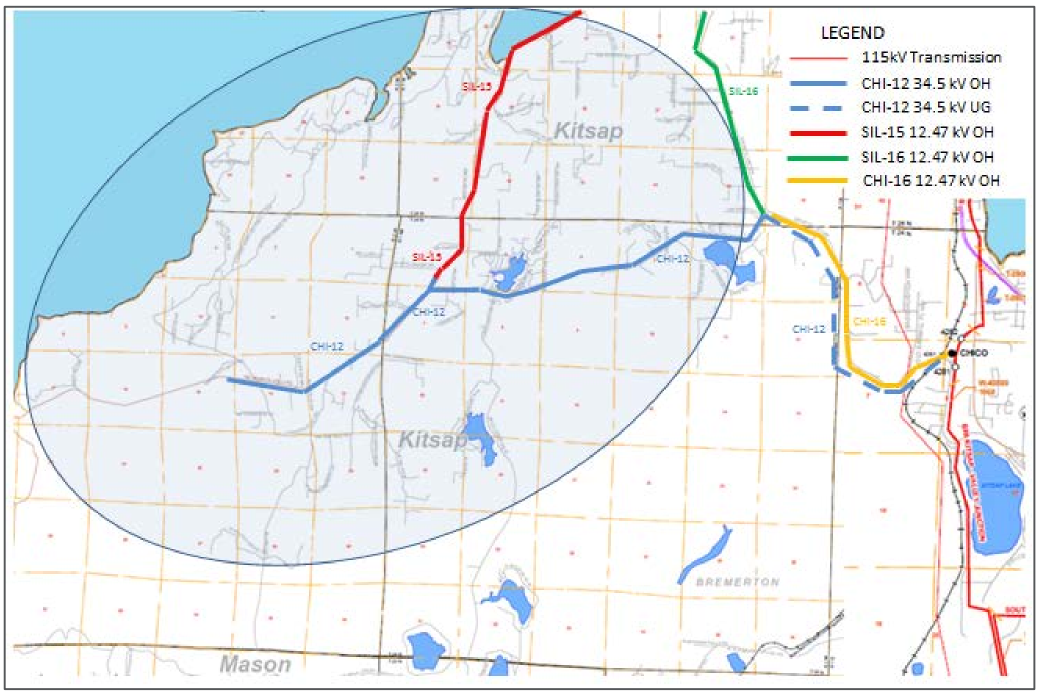
	Scope of Work	2018 Cost Estimate	2018 Cost Estimate with 25% Contingency
1.	Property or Easement Purchases	$100,000	$125,000
2.	34.5 kV Construction, either UG, Spacer Cable, TW, or ROW clearing	$7,500,000	$9,375,000
3.	35 kV Vista switches to segment into five sub-feeders (CMI reduction)	$1,000,000	$1,250,000

	Scope of Work	2018 Cost Estimate	2018 Cost Estimate with 25% Contingency
4.	Phase Balancing (CHI-12 overloading when unbalanced)	$400,000	$500,000
5.	Step-up transformer and parallel cable; third feed from CHI-12, 12.47 kV breaker to 35 kV	$1,000,000	$1,250,000
	Total Cost	**$10,000,000**	**$12,500,000**

Source: Puget Sound Energy, Seabeck Area Solutions Study DRAFT, 11/29/2018

Figure 3 shows the Seabeck study area with the feeder paths for SIL-15 and CHI-12.

Figure 3. Seabeck Study Area with Feeder Paths



Source: Puget Sound Energy, Seabeck Area Needs Assessment (DRAFT), 11/29/2018

1.3.2 Proposed Non-Wires Solution Summary

Navigant first considered deferring or replacing the entire need with a non-wires solution. However, due to the inability of non-wires solutions to mitigate phase imbalance in a significant manner,[6] this element was removed from NWA analysis consideration. This eliminated the need to consider multiple scenarios and the effort focused on a single non-wires option for analysis. Thus, a non-wires solution would need to defer or replace the entire need expressed in the Seabeck Area, excluding the phase imbalance on CHI-12, and would need to defer or replace the wired solution in a technically feasible and economically viable manner. The non-wires solution must meet the needs throughout the solution timeframe to align with the

[6] It is challenging for typical DER to achieve phase balancing without advanced grid analysis. Smart grid distributed intelligence types of technologies can be deployed for phase balancing and DER management system solutions. However, these technologies are still being developed and piloted for phase balancing activities. Given the lack of maturity of these technologies, and after discussion with PSE, Navigant removed the phase imbalance concerns from the identified needs to be met by the non-wires analysis.

traditional solution timeframe. This allowed development of a single NWA, Option 1, to meet the needs as identified in the PSE planning document:

- **Option 1 – Seabeck Area NWA:** Prevent over capacity situation under normal operation and contingencies, reduce the observed reliability problems, and prevent voltage problems on SIL-15 and CHI-12 by limiting peak load using PSE DER potential and ESS.

2. BASIC ANALYSIS OVERVIEW

Basic Analysis is defined as using a simple need assessment, general peak loading behavior, heuristic-based DER potential and cost, as well as a summary-level battery storage potential and cost. The intention of a *Basic Analysis* is to identify non-wires and hybrid non-wires options and to quickly get an indication if there are options that warrant more detailed analysis. It includes a comparison of need versus potential at a snapshot in time, assessment of the DER and ESS, and a simple cost comparison test. This *Basic Analysis* is used instead of a prescriptive suitability criteria-based or screening methodology. It allows for a rapid but more insightful assessment of the identified options and allows avoidance of extensive analysis for options that have little or no chance of meeting the technical, logistical, and financial needs.

2.1 Option 1: Seabeck Area Non-Wires Alternative

As outlined in Section 1.3.1, PSE's preferred wires solution, Wires Solution 3, at a cost of $12.5M including contingency cost, addresses all the needs in the Seabeck Area. This wired solution includes segmenting the existing overhead distribution system and rebuilding 5 miles of the 35 kV overhead line to the substation to improve reliability using some combination of undergrounding, spacer cable, or tree wire. In addition, this solution includes a third step-up transformer and cable at the Chico substation to eliminate the applicable N-1 scenario overload when one of the two existing step-up transformers is lost. In addition, the preferred wires solution includes traditional phase balancing on the CHI-12 feeder. The non-wires solution must meet all the needs addressed by the wires solution except the phase balancing to defer or eliminate constructing the traditional solution.

2.1.1 Situation

The magnitude of the need in the Seabeck Area is approximately 1 MW in 2018 rising to approximately 4 MW by 2031 without considering the impact of any conservation on the forecast load growth. This forecast of load growth is based on PSE's 2018 load forecast for Kitsap County. The forecast uses the maximum load seen on CHI-12 and SIL-15 over the past five winters for the 2018/2019 winter load as the starting point of the load forecast.

2.1.2 Complications

Meeting the need in the Seabeck Area is complicated by the timing of the need and the extent of the phase imbalance.

- **Immediate need:** The N-1 capacity need on CHI-12 feeder has already been surpassed during the winter peak load over the past five winters. If PSE were to experience a N-1 contingency when one of the two step-up transformers is out of service during the winter peak load, it may be necessary to drop load to maintain the load below the CHI-12 N-1 threshold of 552 amps.

- **Phase Imbalance:** The phase imbalance issues on CHI-12 are difficult to solve with existing typical DER solutions. It is possible to employ smart grid distributed intelligence technologies for phase balancing. However, these approaches were determined to be out of scope for the NWA analysis given their lack of maturity.

2.1.3 Key Question

Can a non-wires solution consisting of DER and ESS technically, logistically, and economically replace or defer the proposed wired solution in the 10-year timeframe using DER potential from PSE load in the

Seabeck Area combined with ESS? Furthermore, if PSE wants to size ESS so that leveraging additional DER potential is not required, how does this economically compare?

2.1.4 Basic Analysis

Navigant used the following assumptions in performing the *Basic Analysis* involving the needs, load growth, peak behavior, DER potential, and ESS logistics:

- Seabeck needs are primarily capacity and secondarily reliability and voltage issues.
- Seabeck assumes a 4-hour outage duration on the distribution circuits.
- The Seabeck analysis uses an aggregation of need across SIL-15 and CHI-12. The threshold for each feeder is 552 amps to meet the N-1 capacity trigger for the underground sections of each feeder. When aggregating these two feeders and assuming a power factor of 0.99 (see Section 3.1.1.1), this leads to a MW capacity threshold of 23.61 MW.

Due to the complexity of non-wires projects, Navigant used a *Basic Analysis* spreadsheet tool developed during prior analysis projects, which allows a system planner to assess the viability of a DER plus ESS NWA using five simple inputs that are included in typical needs documents. This tool will be helpful in the future for quickly analyzing many projects and establishing which of those projects warrant further analysis. Appendix A provides more detail about this tool.

2.1.5 Summary

The *Basic Analysis* indicates that non-wires have the potential to meet the near term need at Seabeck. The analysis summary is captured in a screenshot from the *Basic Analysis* tool described above and shown in Table 3.

Table 3. Option 1 Basic Cost Calculation

Option	Option 1
Regions	Seabeck
Assumed Peak Load in 2018/19 Winter (MW)	24
Load in area ineligible for DER (MW)	0
Peak Load Eligible for Incremental DER in 2018 (MW)	24
Business-as-usual DER Discount (% reduction)	0%
Full Achievable Technical DER Discount (% reduction)	10%
Peak Load with business-as-usual (MW)	24
Peak Load w/full Achievable Technical DER (MW)	22
Threshold (MW)	23.61
Portfolio Need Across DER+ESS (MW)	1
DER Cost Estimate ($M/MW)	0.6
Remaining ESS Need (MW)	0
ESS Duration Assumption (hours)	4
ESS Lookup Table Cost Estimate ($M)	$ -
ESS Cost Estimate ($M/MW)	$ -

Option	Option 1
ESS Total Cost Estimate ($M)	$ -
DER Cost Estimate ($M)	$ 0.35
NWA Portfolio Cost Estimate ($M)	$ 0.35
Remaining Wired Component Cost ($M)- Phase Balancing	$ 0.50
Total Solution Cost Estimate ($M)	$ 0.85
Traditional Wired Solution Cost Estimate with 25% Contingency ($M)	$ 12.5
Proceed if NWA/Hybrid is within X% of Traditional Wired Cost w/Contingency	25%
Proceed to *Detailed Analysis*?	YES

Source: Navigant Analysis

Given that the total non-wires solution cost is less than $1 million based on the *Basic Analysis*, Navigant recommends completing a *Detailed Analysis* of the Seabeck region.

3. DETAILED ANALYSIS OVERVIEW

This section contains methodology and results of the *Detailed Analysis* of the NWA options for Seabeck.

3.1 Option 1: Seabeck Area Non-Wires Alternative

Option 1 passed the *Basic Analysis* screen, and therefore warrants *Detailed Analysis*. This section contains methodology and results of the *Detailed Analysis* of NWA Option 1 in the Seabeck Area, described as follows:

- **Option 1 – Kitsap Peninsula NWA:** Prevent over capacity situation under normal and N-1 contingencies, reduce the observed reliability problems, and prevent voltage problems on SIL-15 and CHI-12 by limiting peak load to a 23.61 MW threshold using PSE DER potential and ESS.

3.1.1 Revise and Review the Load Forecast

PSE provided Navigant with load forecasts for the Kitsap region and 8,760 load data at the feeder level for all feeders on the Chico and Silverdale substations for 2018. Navigant used these data to determine the NWAs capacity reduction need at Seabeck on feeders CHI-12 and SIL-15 in future years.

- PSE provided load forecasts in megawatts for the PSE Kitsap Peninsula Native Load based on normal and extreme winter peaks, corresponding to winter peak temperatures of 23°F and 13°F, respectively. PSE provided these forecasts with 0% conservation and 100% conservation.

- PSE also provided the 8,760 load data in megawatts for all the Chico and Silverdale substations for the past 5 years.

- PSE also provided the 8,760 load data in amps for all the feeders on the Chico and Silverdale substations for 2018. This 8,760 data was also provided for each of the three-phases for each feeder on these two substations for 2018.

- PSE provided information on the new loads coming online that were incorporated in the forecasts. Two of these loads were added to account for proposed ferry electrification for a total of 20 MW. The 20 MW load was added over 3 years to the load forecast.

The following sections detail how Navigant used these load forecasts and load growth data.

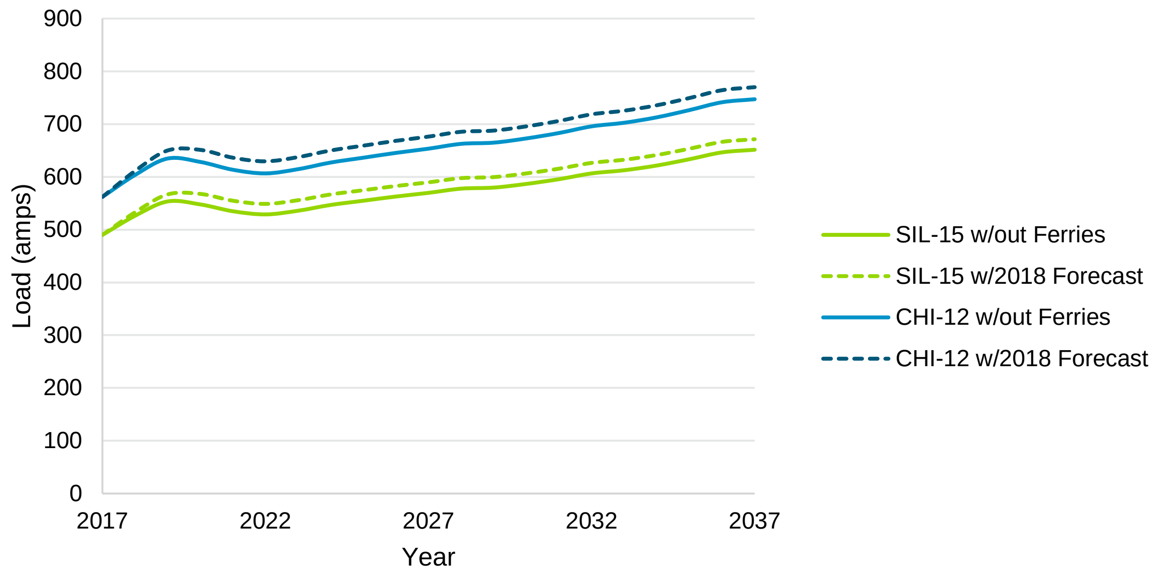
3.1.1.1 Review and Verify PSE's Load Forecast for Kitsap

Navigant reviewed all the data provided by PSE and compared the different sources. Navigant verified that the max of the 8,760 feeder load data for the CHI-12 and SIL-15 feeders aligned closely with the historic peak load for the 2017/2018 winter from the Seabeck needs document. Navigant also verified with PSE the max peak load to use for forecasting the feeder load over the next 20 years without conservation. This max peak load is based on the highest winter load seen over the past 5 years on each feeder.[7]

[7] Load forecasts completed by PSE for the Kitsap peninsula are based on the previous year's peak load. Distribution level forecasts completed by PSE are based on the max of the previous 5 years and in some cases were weather normalized.

After verifying the data consistency, Navigant recalculated the yearly growth rates based on the 2018 PSE native load forecast with the ferry load excluded for normal weather with 0% conservation. Navigant excluded the 20 MW ferry load under the assumption that this load would not impact load within the Seabeck region. Navigant applied these growth rates to the max load over the past 5 years for the CHI-12 and SIL-15 feeders. Figure 4 presents the original 2018 PSE native load forecast and the load forecast without the ferry load developed by Navigant for 2018-2037 for the SIL-15 and CHI-12 feeders in amps.

Figure 4. Normal Weather Load Forecast with and without Ferries and without Conservation for SIL-15 and CHI-12



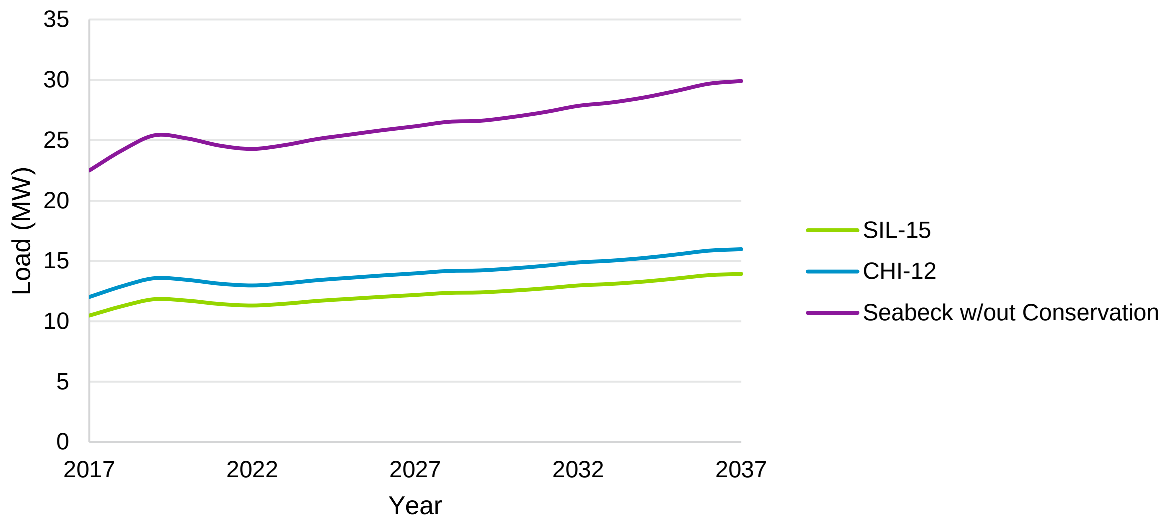
Source: Navigant Analysis

Navigant looked at the Seabeck 8,760 data to estimate the power factor on these feeders. Navigant found a power factor of 0.99 based on comparing the MVA and MW on the peak day in 2018. Navigant applied the power conversion formula listed below to convert the feeder amps to megawatts:

$$P_{(MW)} = \frac{\sqrt{3}\ x\ PF\ x\ I_{(A)}\ x\ 12.47}{1000}$$

Figure 5 presents the results of this power conversion and the total aggregate load across the two feeders without ferries and without conservation in megawatts.

Figure 5. Normal Weather Load Forecast without Ferries and without Conservation in MWs for Seabeck



Source: Navigant Analysis

3.1.1.2 Identify ZIP Codes that Correspond to the Load Associated with Each Solution

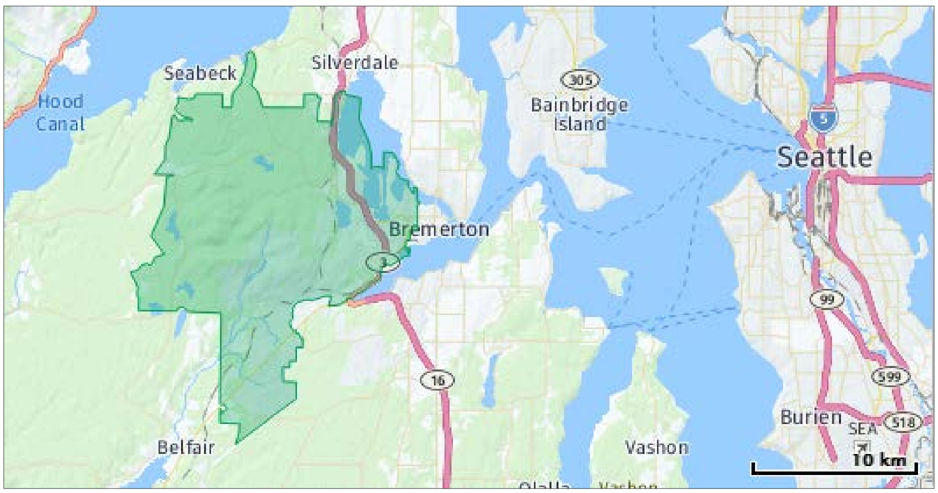
Next, Navigant identified the ZIP codes that correspond best to the CHI-12 and SIL-15 feeders. Because the DER potential model is structured by ZIP code, this is an important step to determine the DER potential eligible for this NWA solution. Navigant used both information provided by PSE on where the Chico and Silverdale substations are located and online maps of ZIP codes to identify that the 98380 ZIP code aligns well with the Seabeck region (Figure 6).

Figure 6. Map of 98380 ZIP Code

Source: ZIP-Codes.com, "ZIP Code 98380, Seabeck, WA," https://www.zip-codes.com/zip-code/98380/zip-code-98380.asp

There are parts of the CHI-12 and SIL-15 feeders that are in the 98312 ZIP code. However, including this ZIP code would have overestimated the DER potential given that the 98312 ZIP code includes many regions outside of the Seabeck Area (Figure 7). For this reason, Navigant only considered only the 98380 ZIP code in the DER potential model.[8] A more specific analysis of DER potential not based on ZIP codes could be undertaken as part of an *Advanced Analysis* step.

Figure 7. Map of 98312 ZIP Code



Source: ZIP-Codes.com, "ZIP Code 98312, Seabeck, WA," https://www.zip-codes.com/zip-code/98380/zip-code-98312.asp

3.1.1.3 Define Success: Identify a Target Year and Load Threshold

The next step was to identify the target year and capacity threshold. The NWA solution needs to satisfy the same solution criteria as the traditional solution to completely defer the need. The traditional solution requires that the need is met for 10 years after construction is complete. Construction of the traditional solution is currently scheduled to be completed by 2021, indicating that the years that the NWA needs to meet the need are from 2021-2031. Navigant picked 2031 as the target year because it had the highest total load without conservation with normal weather. Based on the analysis in the *Seabeck Area Needs Assessment (DRAFT)*, Navigant determined that the load threshold at which the capacity is resolved is the N-1 underground capacity limit of 552 amps for both feeders. That corresponds to 23.61 MW using the power conversion formula and power factor assumptions. This is the threshold which the NWA needs to meet for the *Detailed Analysis* over the 2021-2031 timeframe.

3.1.1.4 Define the Local Peak Period (e.g., Dec-Feb Weekdays and Weekends 8-11 a.m.) Based on Analysis of Historical Hourly Loads

Navigant used 2018 historical load data to define the shape of the load in the Seabeck region. From this data, the team determined the peak period to be generally consistent with the Kitsap peak period—defined as December, January, and February weekdays and weekends from 8:00 a.m. to 11:00 a.m.

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[8] Note: it is possible that this approach may underestimate of the DER potential on the CHI-12 and SIL-15 feeders. A more specific analysis of DER potential not based on ZIP codes could be undertaken as part of an *Advanced Analysis* step.

The peak period is used in the analysis to identify the hours in which demand response (DR) may be called and provide a single estimate of the capacity savings of DER measures[9]. DR is a special type of DER that is considered, because it is both dispatchable and technical potential is limited in duration—while energy efficiency and solar are not dispatchable; and renewable combustion and storage are not limited in duration (from a technical potential perspective). Navigant identified a peak period length that corresponds to a reasonable DR event length (4 hours in the residential sector). The team assumed that DR would be called for the four hours of each day that correspond to the peak period identified here—to decrease the necessary size of the ESSs as much as possible.

Navigant analyzed and plotted the top 100 hours of the year for Seabeck, indicating the most typical peak hours. This is illustrated in Figure 8. If these 100 hours were eliminated from the load-duration curve, the resulting maximum load would be 80.2% of the 2017-2018 peak load in the region.

Figure 8. Heat Map for Seabeck Area Top 100 Hours of Load - 2018

Number of Days in 2017-2018 above the Stated Threshold for each Month and Hour of Day for the Solution 1 Region

Solution 1 Threshold MW: 18.00 Top: 99 Hours; >= 80.2% of 2017-2018 Peak Load in the Solution 1 Region

Hour of Day	January	February	March	April	May	June	July	August	September	October	November	December
1:00 AM	-	-	-	-	-	-	-	-	-	-	-	-
2:00 AM	-	-	-	-	-	-	-	-	-	-	-	-
3:00 AM	-	-	-	-	-	-	-	-	-	-	-	-
4:00 AM	-	-	-	-	-	-	-	-	-	-	-	-
5:00 AM	-	-	-	-	-	-	-	-	-	-	-	-
6:00 AM	-	3	-	-	-	-	-	-	-	-	-	1
7:00 AM	1	6	-	-	-	-	-	-	-	-	-	3
8:00 AM	1	8	1	-	-	-	-	-	-	-	-	4
9:00 AM	1	11	3	-	-	-	-	-	-	-	-	4
10:00 AM	1	11	1	-	-	-	-	-	-	-	-	3
11:00 AM	1	4	-	-	-	-	-	-	-	-	-	2
12:00 PM	1	2	-	-	-	-	-	-	-	-	-	-
1:00 PM	-	-	-	-	-	-	-	-	-	-	-	-
2:00 PM	-	-	-	-	-	-	-	-	-	-	-	-
3:00 PM	-	-	-	-	-	-	-	-	-	-	-	-
4:00 PM	-	-	-	-	-	-	-	-	-	-	-	-
5:00 PM	-	-	-	-	-	-	-	-	-	-	-	-
6:00 PM	-	2	-	-	-	-	-	-	-	-	-	2
7:00 PM	-	5	-	-	-	-	-	-	-	-	-	4
8:00 PM	-	5	-	-	-	-	-	-	-	-	-	1
9:00 PM	-	5	-	-	-	-	-	-	-	-	-	1
10:00 PM	-	1	-	-	-	-	-	-	-	-	-	-
11:00 PM	-	-	-	-	-	-	-	-	-	-	-	-
12:00 AM	-	-	-	-	-	-	-	-	-	-	-	-

Source: Navigant Analysis

This analysis indicated that mornings in December and February are the peak periods, which differed from PSE's system peak period of December weekday nights. Navigant assumed that the peak also extends through January, based on similar typical cold weather during January—even though the January peak was not evident during this particular season in 2018. Additional analysis indicated that the top days with the most consecutive hours in the top 100 occurred on weekends (see Figure 9), which led the team to designate the peak may occur on either weekdays or weekends.

[9] In the *Detailed Analysis*, capacity savings are calculated in two ways to be used for different purposes.

1) When assessing the technical feasibility of the solution, the hourly loads are used to calculate realized capacity savings in a target year. Capacity savings are the difference between the baseline load in the maximum hour and the maximum load after DER and storage are applied.
2) When calculating the Levelized Cost of Capacity on a DER measure-by-measure basis, it is helpful to estimate the MW capacity savings of a single measure. In this case, capacity savings are estimated as the average load reduction across all hours included in the peak period based on analysis of historic hourly loads.

Figure 9. List of Dates with Four or more Consecutive Hours in the Top 100 Hours

Number of Consecutive Hours: 4
Load Greater than: 80.2% of 2017-2018 Peak Load in the Solution 1 Region

Dates in which there was at least one point where load was above 80.2% of the peak load for 4 consecutive hours:

1/1/2018	2/22/2018
2/13/2018	2/23/2018
2/19/2018	2/26/2018
2/20/2018	12/6/2018
2/21/2018	12/7/2018

Source: Navigant Analysis

3.1.1.5 Calculate the Baseline Load Forecast: Recalculate the Load Forecast with Business-as-Usual DER (e.g., DER from IRP LCOE Bundles 1-3)

The technical potential analysis leverages a methodology and definitions that are consistent with PSE's 2017 Integrated Resource Plan (IRP) and accepted in the Pacific Northwest. The analysis focuses on the overall capacity needs for the Seabeck Area, which drives key requirements in PSE's planning criteria. Navigant refined the analysis of baseline load forecast and developed an estimate of achievable load reduction forecast using the DERs selected for the study.

The potential study seeks to identify all incremental achievable technical potential exclusive of what is already incorporated in the net load forecast. Incremental achievable technical potential (ATP) is defined as:

Incremental ATP = achievable technical potential – baseline load forecast with planned DER

Achievable technical potential is a term used in the Pacific Northwest to represent DER potential that is achievable—considering customer economics, technology awareness, and market diffusion. Achievable technical potential is commonly referred to as "market potential" in other jurisdictions. For energy efficiency, achievable technical potential was specified as a percentage of the technical potential. The percentage of technical potential that was deemed achievable was by default 85% based on the Council's planning assumptions.[10] Navigant modeled the effects of time-dependent barriers to market adoption by applying the ramp rates provided by the Council in the Seventh Plan[11] to the maximum achievable technical potential. Navigant used a payback-based market approach in conjunction with a Bass diffusion model to forecast the adoption of PV and DR on Kitsap Peninsula. More details on methodology and data sources are available in the *2017 IRP Demand-Side Resource Conservation Potential Assessment Report*.[12]

To define which portion of the achievable technical potential is "incremental," Navigant assumed baseline, "business-as-usual" procurement of demand-side resources by PSE, assumptions and methodology by resource type are stated below.

- **Energy efficiency and combustion distributed generation (DG):** In the PSE IRP, PSE commits to pursuing levelized cost of energy (LCOE) bundles 1 through 3.[13] Navigant recalculated the PSE net load forecast (net of demand-side resources) at the Seabeck ZIP code

[10] Northwest Power and Conservation Council, *Achievable Savings – A Retrospective Look at the Northwest Power and Conservation Council's Conservation Planning Assumptions*, August 2007, http://www.nwcouncil.org/media/29388/2007_13.pdf.
[11] See https://www.nwcouncil.org/energy/powerplan/7/technical for the supplemental data files that accompany the Council's Seventh Power Plan.
[12] Puget Sound Energy, "Integrated Resource Plan," PSE, https://www.pse.com/pages/energy-supply/resource-planning.
[13] The IRP bundles demand-side resources by levelized cost of energy, from lowest (bundle 1) to highest (bundle 10). During the IRP process, resource planners decided that bundles 1-3 would be cost-effective to pursue, therefore measures in these bundles are not eligible to be pursued as an incremental NWA on Bainbridge Island.

level, assuming measure bundles 1-3 reach their full achievable potential. The analysis of incremental energy efficiency and combustion DG only considers measures that were not in bundles 1 through 3 in the 2017 IRP.

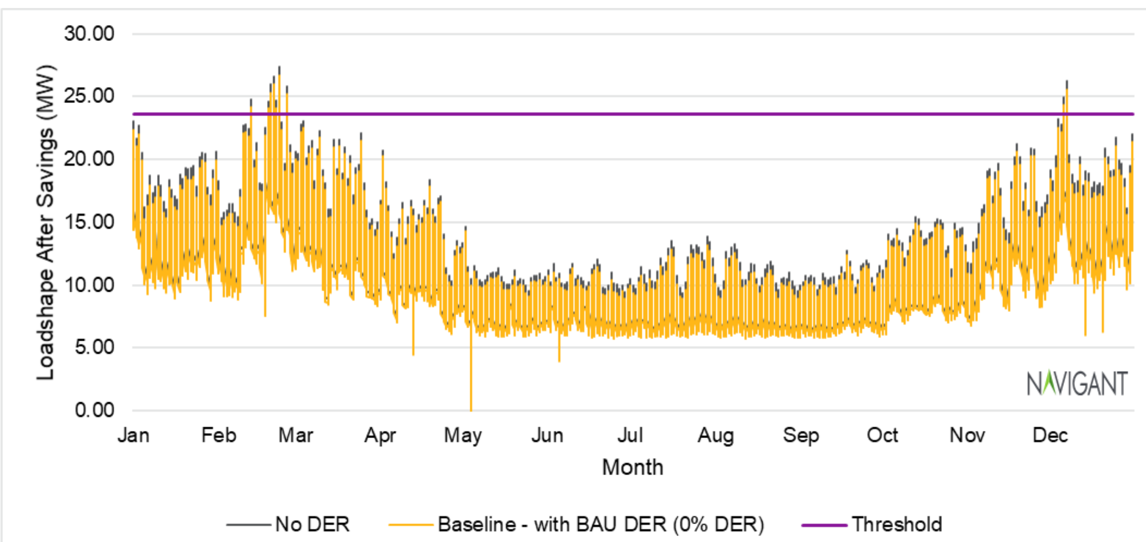
- **PV:** The team assumed PSE has no business-as-usual customer incentives for distributed PV adoption—therefore, all achievable technical PV potential is eligible as incremental potential for the non-wires solution. PV has limited applicability in this case, as the peak period is during the winter.

- **DR:** The team assumed PSE has no immediate plans for DR in the Seabeck Area, therefore, all achievable technical DR potential is available as incremental potential for the non-wires solution. For incremental DR, 4-hour DR events were assumed.

- **Storage:** Technically, storage might be sized to meet essentially the entire need in the Seabeck Area. Thus, the technical potential for storage is almost limitless. Therefore, storage is a special case—and is further explained in Section 3.1.2.2.

The impact of each of these resources is defined based on hourly savings shapes for all resources, compared to the hourly load shape of the Seabeck Area. Figure 10 shows the 8,760 load in 2031 without DER compared to the load including all DER already intended for procurement in the IRP (aka business-as-usual). The latter is the baseline load—against which additional incremental potential for DER will be counted. The graph shows how the load varies throughout the day and that the BAU DER reduces the daily peaks.

Figure 10. 8,760 Load Forecast in 2031 without DER and with BAU Baseline DER



Source: Navigant Analysis

3.1.2 Determine Incremental Achievable Technical DER Potential

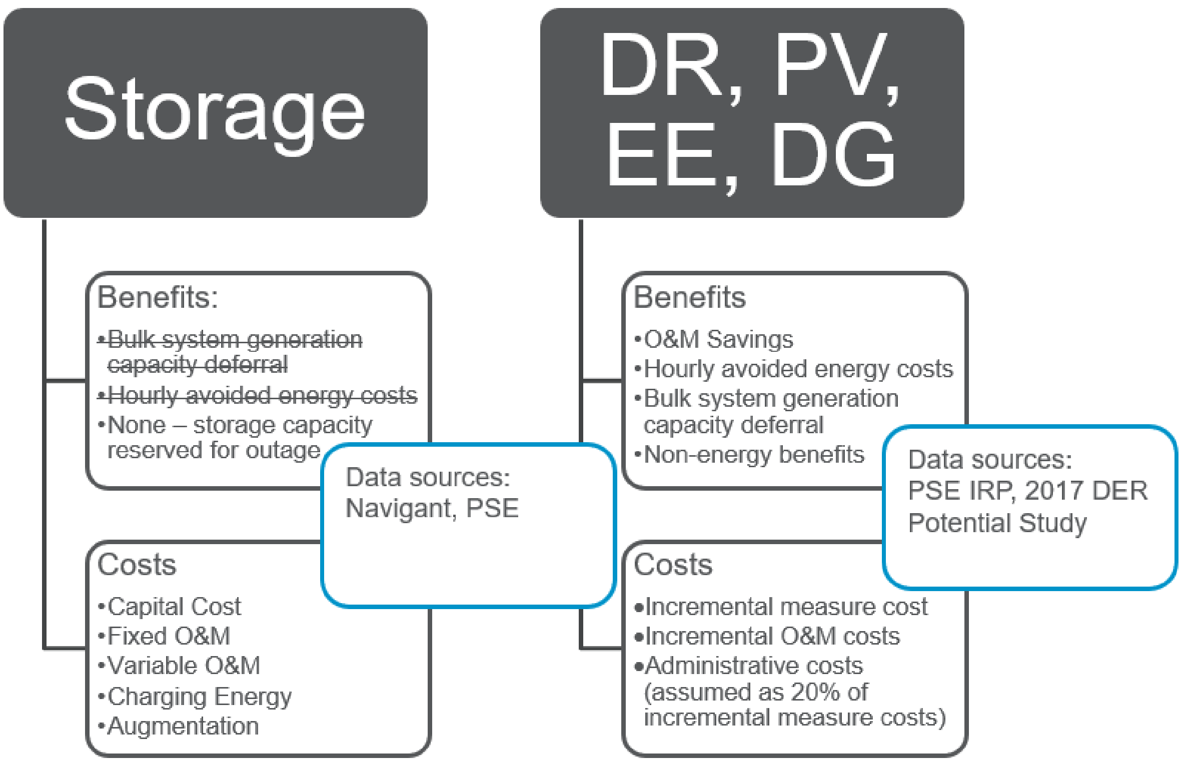
Incremental potential is achievable technical potential for DER above and beyond the business-as-usual baseline load forecast. This is potential not already included in the PSE IRP (e.g., LCOE bundles 4-10). In order to determine which measures of the LCOE bundles 4-10 should be considered in the Seabeck region, Navigant calculated the levelized cost of capacity (LCOC) for each DER measure.

3.1.2.1 Levelized Cost of Capacity

To include ESSs with the other DERs into a single optimal portfolio, Navigant developed a LCOC calculation. This allows comparison of resources based on the present value of the net costs for providing local capacity deferral.

The LCOC accounts for the same costs and benefits for each measure as used in the 2017 IRP, but divided by the substation peak capacity savings of each measure rather than the annual energy savings of each measure. Peak capacity by measures is defined as the average megawatts of savings across all hours in the peak period specified in Section 3.1.1.4. In the case of Seabeck, the energy storage has no additional systemwide benefits. The team assumed the storage for this case is limited from participating in wholesale market arbitrage or system peak capacity savings, because the battery capacity must be full and on standby to serve any unanticipated outage (thus, these benefits are shown as crossed out in Figure 11. Costs and benefits counted for the various resources are outlined in Figure 11.

Figure 11. Value Streams Included in LCOC Calculation



Source: Navigant

The LCOC is a net cost—considering the capital and implementation costs of the measures, net of any benefits. Costs and benefits are in present value terms (in 2020 dollars[14]) levelized over a 20-year horizon using PSE's Weighted Average Cost of Capital (WACC) (7.77%) to stay consistent with the 2017 IRP. Any monetary value for avoided transmission and distribution capacity is excluded from the

[14] Navigant assumed that the investment in a non-wires alternative portfolio—construction of storage or deployment of energy efficiency--would likely occur in 2020 due to realistic timing considerations.

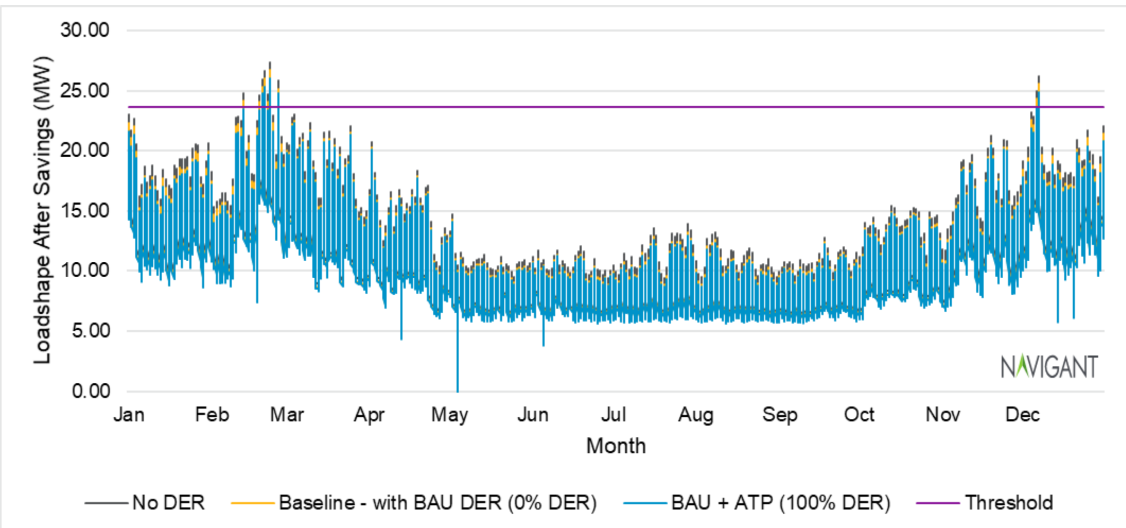
calculation, so that the results can be compared directly with the costs of the distribution components of the conventional wired investment.[15]

$$LCOC\ (\$/MW) = \frac{PV\ of\ Costs\ (\$) - PV\ of\ Benefits\ (\$)}{PV\ of\ Capacity\ Savings\ (MW)}$$

The LCOC value is calculated on a measure-by-measure basis, with the value streams listed in Figure 11. Because the calculation accounts for a number of different value streams in one metric, the LCOC is best used to represent the relative value of each measure, not the absolute value of the portfolio of DER measures, and therefore caution should be used when comparing this portfolio to the cost of the wired solution.[16] For example, the actual expenditure on a portfolio of DER would be higher than the LCOC indicates, since it is a cost net of anticipated benefits. These values should be considered preliminary, as there may be additional costs associated with a targeted DER implementation

Figure 12 shows cost-effective achievable technical potential graphed against the load forecast without DER, with BAU DER, and finally with BAU plus ATP. "ATP" is all cost-effective achievable technical potential from measures with an LCOC less than the storage LCOC. In other words, the analysis assumes all cost-effective DER is pursued up to the cost of storage, and then storage is used to serve any remaining peak load above the threshold. Cost-effective DER has an LCOC of less than $2 million per megawatt of peak savings —which is the cutoff point at which grid-scale energy storage becomes the next-cheapest resource. This cutoff represents the estimated cost of the ESS in $/MW based on size (MWh) and capacity (MW) estimates determined in the *Basic Analysis*, assuming a 4-hour repair duration. Table 4 shows more details of the ESS cost assumptions behind this calculation.

Figure 12. Load Forecast in 2031 without DER, BAU Baseline DER, and 100% of Achievable Technical Potential (BAU + ATP)



Source: Navigant Analysis

Figure 12 shows that in the Seabeck region, cost-effective DER does not achieve enough reduction to meet the need in 2031. Relative to the load forecast without any DER, BAU DER achieve a 2.3%

[15] The 2017 IRP did include a systemwide value of local capacity for DER on a $/MW-year basis. This non-specific value was determined by the Northwest Power and Conservation Council. Navigant did not include this value in the analysis, as these results are intended to be compared as an alternative to a specific local transmission and distribution investment.

[16] The up-front cost of the DER portfolio will be higher than the net cost which incorporates the various benefit streams generated by the portfolio.

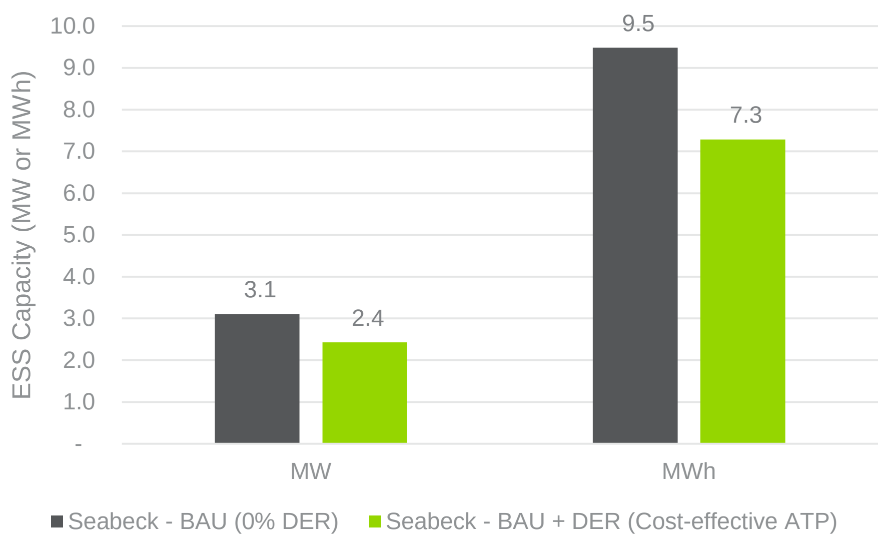
reduction in peak load, and BAU plus ATP achieves a 4.8% reduction in peak load. These reductions are below the 10% rule of thumb that Navigant typically assumes. In this case, the team believes this small potential reduction from DER is due to the misalignment between the customers on the two feeders in the Seabeck Area and the ZIP code-disaggregated DER potential data from the 2017 IRP.

3.1.2.2 Determine the ESS Capacity Need and MWh Size

The ESS capacity need is based on the difference between the net load forecast by DER scenario and the 23.61 MW threshold target.

The ESS MWh size depends on the duration of the need. In an N-1 scenario, the duration of the need depends on the amount of time needed to repair the outage and/or provide power to customers through alternative means (e.g., re-routing power through undamaged lines). The magnitude of the need in each hour is based on the difference between the net load forecast and the threshold, then the total size (in MWh) depends on assumption of repair duration, which here is 4 hours. Navigant simulated a 4-hour outage during peak hours to determine a battery size that could reliably meet the N-1 criteria. The simulation uses the hourly load shape from historical loads, as well as the load forecast, to develop a 2031 8,760 forecast shape. The team then assumed that an outage could occur anytime during the year, which would require the ESS to reduce load from the 2031 forecast shape down to the threshold level. Navigant found that, based on the shape and duration of the peak in 2031, the battery needs to last at most 3 hours and not the full 4 hours of the repair duration. In this case, there were not 4 consecutive hours above the threshold level at any point during the year. The results of this sizing calculation are shown in Figure 13.

Figure 13. ESS Technical Characteristics for a 4-Hour Repair Duration



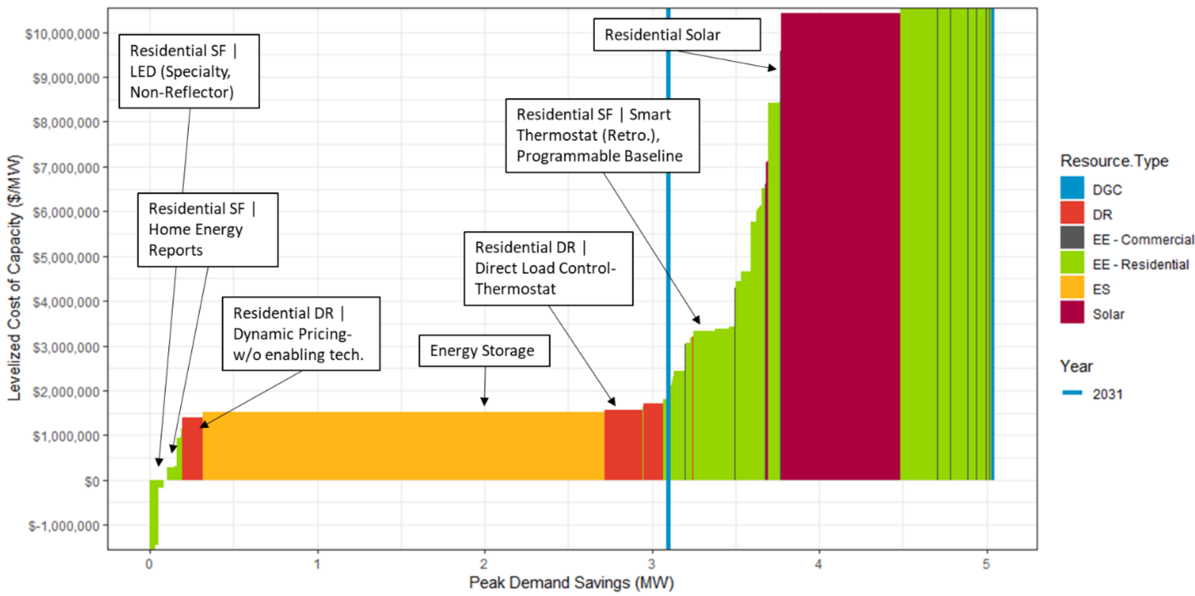
Source: Navigant Analysis

Using cost-effective DER as part of the non-wires solution reduces capacity needs from 3.1 MW to 2.4 MW.

3.1.1 Perform Economic Analysis

The 100% DER case includes all DER with an LCOC of less than $2 million/MW of peak savings. This cutoff point was used to estimate at which point grid-scale energy storage becomes the next-cheapest resource and to account for some uncertainty with the DR costs. The DR costs are currently estimated to be close to the cost of the grid-scale energy storage solution needed at Seabeck, but further evaluation of these costs is recommended. The supply curve shown in Figure 14 illustrates this economic cutoff. The y-axis is the LCOC for each resource—calculated according to the value streams shown in Figure 11. The x-axis represents the capacity provided by each resource (e.g., the width of the bar). The blue line is the capacity reduction needed in 2031—3.1 MW.

Figure 14: Supply Curve Detailing the LCOC and Capacity Contributions of Measures Available in Seabeck in 2031



Source: Navigant Analysis

The net cost (net of DER benefits listed in Figure 11) of the non-wires portfolio in 2019 dollars is $4.13 million, of which about $3.625 million is energy storage and $503,000 is other DER. Details of the assumptions used to estimate energy storage costs are in Table 4. Table 5 shows the cost and size parameters for the two portfolio options—with and without cost-effective incremental achievable potential.

Table 4. Energy Storage Cost Assumptions

Cost Parameter	Assumption
Capital cost[17]	$550/kW of rated power plus $350/kWh of rated energy (2018 basis), decreasing annually at 8%/year through 2022, then 4%/year afterward
Fixed O&M	3% of CAPEX per year, inflated annually
Variable O&M	$2/MWh
Augmentation	Cost of annual battery augmentation based upon degradation (MWh) at forecasted unit battery cost ($/MWh) in each year
Charging	Cost of charging based upon weighted average hourly energy value ($/MWh) when charging and annual energy consumed for charging (MWh)

Source: Navigant Analysis

Table 5. Portfolio Cost for Two Non-Wires Alternative Options for Seabeck

Scenario	ESS Size (MW/MWh)	ESS Net Cost ($)	Incremental DER Net Cost ($)	Total Portfolio Net Cost	Wired Solution Cost Estimate ($)
BAU + ESS	3.1 MW/ 9.5 MWh	$4,736,524	$0	$4,736,524	$12,000,000
BAU + DER + ESS	2.4 MW/ 7.3 MWh	$3,625,519	$503,110	$4,128,629	$12,000,000

Source: Navigant Analysis

3.1.1.1 Conclusions and Next Steps

In both non-wires solution cases, with and without incremental achievable DER, the non-wires solution is substantially lower cost than the estimated cost of the wired solution. Using cost-effective DER in combination with energy storage has the potential to save approximately $600,000 in net costs relative to a solution that uses storage-only. Navigant concludes that the NWA merits further consideration, and recommends proceeding with an *Advanced Analysis* including a specific NWA implementation study (per the last step in the process detailed in Figure 1).

Why does the non-wires solution appear so attractive? A visual analysis of the load in Figure 12 indicates that there are relatively few hours of the year that exceed the capacity threshold. Typically, peaky shapes like this make great candidates for non-wires solutions using targeted DR and storage—along with any cost-effective energy efficiency that has a savings shape coincident with hours of threshold exceedance.

Because there are few hours in this load shape above the capacity threshold, the results of the analysis were not very sensitive to the repair duration assumption. Regardless of whether an outage of 4 or 24 hours or 2 weeks occurs—the storage capacity and duration will need to be roughly the same to keep load below the capacity threshold, because load naturally drops below the threshold without any assistance from DER or ESS. The natural decrease in load due to changing demand throughout the day provides sufficient time and capacity for the battery to recharge before the next peak occurs on the next day.

The team also found that DER reductions as a percent of total load on the substations of interest was lower than our 10% rule of thumb. In this case, we believe this small potential reduction from DER is due to inconsistent data between the load in the Seabeck needs document and the ZIP code-disaggregated

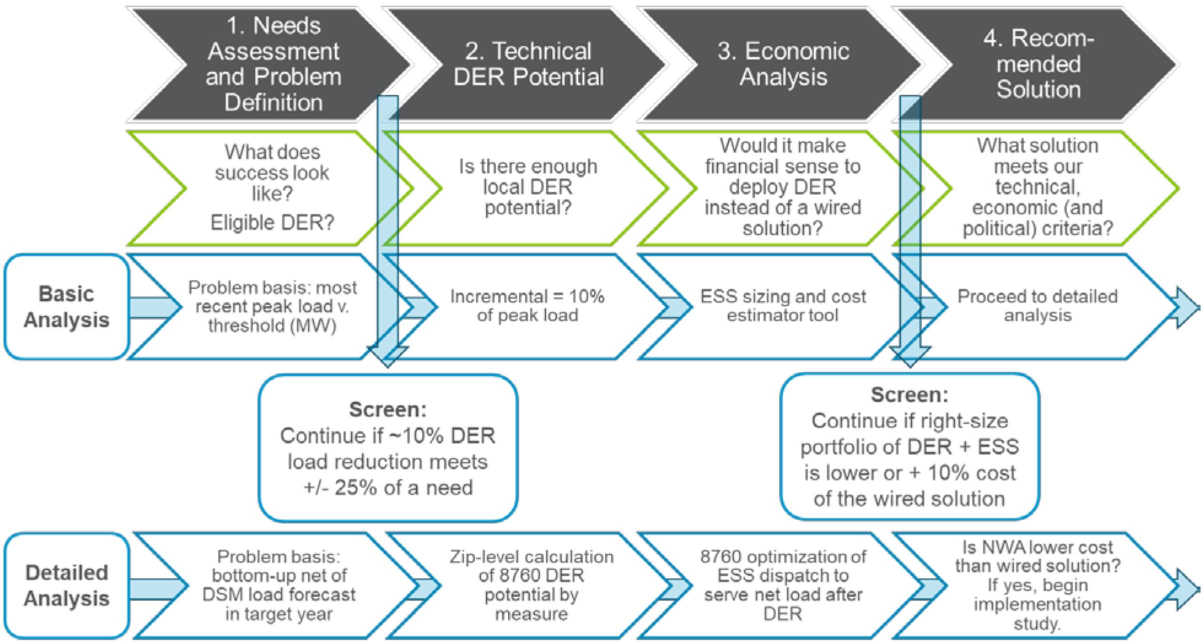
[17] These costs reflect front-of-meter installed cost including a rough estimate of land lease costs for a large bulk system as well as interconnection.

DER potential data from the 2017 IRP. A visual inspection of the area serviced by the SIL and CHI substations and the ZIP code used for DER potential estimates revealed strong overlap between the two areas. However, to quickly and effectively consider DER-based NWA for future strategic system planning decisions, Navigant recommends mapping customers on substations to the ZIP codes of interest (from the IRP) when drafting load forecasts for the needs documents by using locational (GIS) analysis. An accurate load forecast and DER potential estimate are essential to effective NWA planning efforts.

APPENDIX A. ANALYSIS METHODOLOGY OVERVIEW

The four primary steps used in the *Basic* and *Detailed Analysis* of NWAs for Seabeck are shown in Figure A-1 and described below.

Figure A-1. Non-Wires Alternative Analysis Steps



Source: Navigant

1) **Needs Assessment and Problem Definition.** This step is critical for defining the scope of the analysis, and the definition of a successful NWA. In this step, the team must answer the following questions:

    a. What does success look like for this non-wires project? Answering this question requires determining the capacity need, as a function of the peak load and threshold value.

        i. ***Basic***: The need is defined as comparing the most recent historic peak load (2018) against the threshold

        ii. ***Detailed***: The need is defined based on the non-wires project timeframe and a detailed load forecast net of business-as-usual (BAU) DER procurement. Then, the peak capacity in the target year (highest year of load throughout the timeframe) is compared against the threshold.

    b. What DER are eligible to be considered as NWAs for this project? This is consistent across the *Basic* and *Detailed Analysis*.

2) **Technical DER Potential.** This step assesses the contribution that DER can make to the overall need from a technical perspective, without yet considering the economics of the NWA.

- **a.** ***Basic*****:** The technical potential for DER can be estimated as 10% of peak load without any DER.[18] For the basic screening tool, the analyst can assume a total of 10% savings is possible from DER. The *Basic Analysis* does not assume any business-as-usual DER.

- b. ***Detailed*****:** This version of the analysis involves mapping PSE ZIP codes to the area of need, then estimating DER technical potential based on the specific customer loads in each ZIP code. All DER measures have an hourly (8,760) load shape, so technical potential DER savings can be estimated as an hourly shape in each year, then compared against the hourly load shape of the need to determine a more precise estimate of capacity savings from DER.

3) **Economic Analysis.** As the technical potential for storage is essentially limitless, storage can be considered to meet needs that the other DERs cannot, and thus—for example—to fill any capacity needs unmet by EE, DR, etc. Thus, the economics of energy storage systems (ESS) begin to be considered in the analysis, alongside the economics of demand-side DER.

- **a.** ***Basic*****:** Navigant designed a simple spreadsheet tool for PSE to use to estimate both DER and ESS costs. Table A-1 shows a screenshot of the inputs needed for this tool, and Table A-2 shows the specifics of the ESS cost lookup table.

  - **i. DER:** Based on DER costs per MW estimates from previous projects

  - **ii. ESS:** Costs are included in a lookup table that depends on the peak duration assumption (0.5-24 hours) as well as the total capacity that needs to be served with storage.

- **b.** ***Detailed*****:** This version of the analysis uses data from the Analytica-based PSE DER potential model, combined with detailed storage cost estimates.

  - **i. DER:** Costs are determined measure-by-measure using the potential model. Results from this analysis will help PSE to determine which specific measures are least-cost to deploy in the area for an NWA (e.g., the supply curve from the Bainbridge Island analysis).

  - **ii. ESS:** Costs leverage the assumptions in the *Basic Analysis*, with greater details on O&M and augmentation costs, based on the annual charge/discharge cycles from the hourly dispatch model of storage operations, and battery degradation over time.

[18] This estimate assumes winter peak, residential loads, with DR, PV, EE, and renewable distributed combustion as eligible DER.

Table A-1. Screenshot of DER + ESS Portfolio Cost Estimator Tool used in the Basic Analysis

Option	Option 1
Regions	Seabeck
Assumed Peak Load in 2018/19 Winter (MW)	24
Load in area ineligible for DER (MW)	0
Peak Load Eligible for Incremental DER in 2018 (MW)	24
Business-as-usual DER Discount (% reduction)	0%
Full Achievable Technical DER Discount (% reduction)	10%
Peak Load with business-as-usual (MW)	24
Peak Load w/full Achievable Technical DER (MW)	22
Threshold (MW)	23.61
Portfolio Need Across DER+ESS (MW)	1
DER Cost Estimate ($M/MW)	0.6
Remaining ESS Need (MW)	0
ESS Duration Assumption (hours)	4
ESS Lookup Table Cost Estimate ($M)	$ -
ESS Cost Estimate ($M/MW)	$ -
ESS Total Cost Estimate ($M)	$ -
DER Cost Estimate ($M)	$ 0.35
NWA Portfolio Cost Estimate ($M)	$ 0.35
Remaining Wired Component Cost ($M)- Phase Balancing	$ 0.50
Total Solution Cost Estimate ($M)	$ 0.85
Traditional Wired Solution Cost Estimate with 25% Contingency ($M)	$ 12.5
Proceed if NWA/Hybrid is within X% of Traditional Wired Cost w/Contingency	25%
Proceed to *Detailed Analysis*?	YES

Source: Navigant Analysis

Definitions of items in Table A-1:

- **Peak load in 2018/19 winter (MW):** This is the forecast of peak load for the 2018/2019 winter used for the *Basic Analysis*. The *Detailed Analysis* considers the max need during the solution timeline.
- **Load in area ineligible for DER (MW):** This corresponds to any load served by BPA that might be ineligible for participation in PSE's DER programs.
- **Peak load eligible for Incremental DER in 2018:** The difference between the peak load and the ineligible peak load (if any).
- **Business-as-usual DER discount (% reduction):** The tool is set up to include any BAU DER if that is known for the specific region. The *Detailed Analysis* is often needed to identify the BAU DER.
- **Full achievable DER discount (% reduction):** This value is considered the maximum DER that can be achieved as a percent of the total load.
- **Peak load with business-as-usual (MW):** This is the peak load minus any BAU DER if known.
- **Peak load with full achievable technical DER (MW):** This is the peak load minus the full achievable DER assumed.
- **Threshold (MW):** This is the MW threshold below which the capacity needs are met in the region.

- **Portfolio need across DER+ESS:** This is the difference between the threshold and the peak load in 2018/2019 Winter.
- **DER cost estimate ($M/MW):** This is the net cost of cost-effective DER found from the results of the previous studies.
- **Remaining ESS need (MW):** This is the amount of the portfolio need that is not met with the full achievable technical DER and needs to be met with an energy storage system.
- **ESS duration assumption (hours):** This is the repair duration in hours to repair the system after failure.
- **ESS lookup table cost estimate ($M):** See Table A-2 for the lookup table.
- **ESS cost estimate ($M/MW):** The cost pulled from the lookup table divided by the remaining need met by ESS.
- **ESS total cost estimate ($M):** The total cost of the energy storage system.
- **DER cost estimate ($M):** The total cost estimate of the custom sited DER.
- **NWA portfolio cost estimate ($M):** The sum of the DER and ESS cost.
- **Remaining wired component cost ($M):** Any costs remaining to build wired components to meet all the needs in the region.
- **Total solution cost estimate ($M):** The sum of the NWA portfolio cost and the remaining wired component cost (if any).
- **Traditional wired solution cost estimate with 25% contingency ($M):** The cost of the traditional wired solution including the 25% contingency.
- **Proceed if NWA/Hybrid is within X% of traditional wired cost w/contingency:** The bounds of which the results estimated as part of the *Basic Analysis* warrant more review as part of a *Detailed Analysis.*
- **Proceed to *Detailed Analysis:*** Yes/No answer dependent on the cost.

Table A-2. Screenshot of ESS Cost Estimation Table for the Basic Analysis

	2018 Cost								
$/kW	$ 550								
$/kWh	$ 350			Cost Estimates in $M					
				(2h) Winter Peak		(4h) Summer Peak			Resilience
		(# hours) - Energy = MW * #h = MWh							
Size	**MWh --> MW ↓**	**0.5**	**1.0**	**2.0**	**3.0**	**4.0**	**6.0**	**8.0**	**24.0**
Small	**0.5**	$ 0.363	$ 0.450	$ 0.625	$ 0.800	$ 0.975	$ 1.325	$ 1.675	$ 4.475
Medium	**1.0**	$ 0.725	$ 0.900	$ 1.250	$ 1.600	$ 1.950	$ 2.650	$ 3.350	$ 8.950
Large	**2.0**	$ 1.450	$ 1.800	$ 2.500	$ 3.200	$ 3.900	$ 5.300	$ 6.700	$ 17.900
Large	**5.0**	$ 3.625	$ 4.500	$ 6.250	$ 8.000	$ 9.750	$ 13.250	$ 16.750	$ 44.750
V. Large	**10.0**	$ 7.250	$ 9.000	$ 12.500	$ 16.000	$ 19.500	$ 26.500	$ 33.500	$ 89.500
V. Large	**15.0**	$ 10.875	$ 13.500	$ 18.750	$ 24.000	$ 29.250	$ 39.750	$ 50.250	$ 134.250
HUGE	**20.0**	$ 14.500	$ 18.000	$ 25.000	$ 32.000	$ 39.000	$ 53.000	$ 67.000	$ 179.000
HUGE	**25.0**	$ 18.125	$ 22.500	$ 31.250	$ 40.000	$ 48.750	$ 66.250	$ 83.750	$ 223.750
HUGE	**30.0**	$ 21.750	$ 27.000	$ 37.500	$ 48.000	$ 58.500	$ 79.500	$ 100.500	$ 268.500
HUGE	**35.0**	$ 25.375	$ 31.500	$ 43.750	$ 56.000	$ 68.250	$ 92.750	$ 117.250	$ 313.250
HUGE	**40.0**	$ 29.000	$ 36.000	$ 50.000	$ 64.000	$ 78.000	$ 106.000	$ 134.000	$ 358.000
HUGE	**50.0**	$ 36.250	$ 45.000	$ 62.500	$ 80.000	$ 97.500	$ 132.500	$ 167.500	$ 447.500
	(grey)	Typically would look for other solution types at this size							
	(yellow)	May consider different chemestry choices for long-duration usage							
	(green)	BSS "Sweet Spot" from a utility and cost perspective (2018 view)							

Source: Navigant Analysis

4) **Recommended Solution.** The final step quantitatively and qualitatively compares the economics and functionality of the non-wires solution to the wired alternative and recommends a preferred course of action. For both the *Basic* and *Detailed Analysis*, the team must isolate the estimated cost of the wired solution that the non-wired alternative could replace.

   a. ***Basic***: Compare the cost estimates from the spreadsheet tool used in the economic analysis (step 3) to the wired solution cost. If the cost of the non-wired alternative is less than or within 25% of the cost of the wired solution, proceed to the *Detailed Analysis*. The 25% is used to reflect uncertainty in cost of implementing DER in a non-wires solution without completing the more detailed analysis of the DER potential in the region analyzed.

   b. ***Detailed***: Compare the detailed portfolio costs to the cost of the wired solution, across the non-wires analysis timeframe. More advanced calculations of deferral value can be introduced here if non-wires will defer but not replace the wired investment. Consider also functional differences between the wired and non-wired solutions, as well as topics that may not be quantified in the technical and economic analysis (e.g., political considerations, ratepayer impacts, etc.) Finally, if the non-wired alternative is still attractive, PSE should proceed with an *Advanced Analysis* step. This step would entail a *pre-implementation study* of the project—using fieldwork to verify key elements of DER potential, detailed load flow modeling to verify the non-wired alternative will meet the needs identified, locational and siting analysis for ESS solutions identified, etc. *Advanced Analysis* is not the objective of the study performed here, which covers only the *Basic* and *Detailed Analyses*.

APPENDIX B. DEFINITIONS

Including definitions for reference may be useful, and so Navigant has listed some of the terms that can be defined below. This is offered for discussion with PSE to understand its usefulness for future inclusion.

- **Non-Wires Alternative (NWA)/Non-Wires Solution:** A solution that uses a combination of energy efficiency, demand response, battery storage and other measures to defer or eliminate a traditional wired investment need.
- **Hybrid Non-Wires Alternative:** An NWA that includes DER, ESS, and traditional wired solution components.
- **Threshold:** The load threshold below which the electricity delivery needs identified in the region are met.
- **Achievable Technical Potential:** Represents DER potential that is achievable—considering customer economics, technology awareness, and market diffusion. Achievable technical potential is commonly referred to as “market potential” in many jurisdictions.
- **Energy Storage System (ESS):** A battery storage system.
- **Distributed Energy Resources (DER):** Many measures fall under DER. Main ones include energy efficiency, demand response, and distributed generation such as solar PV.
- **Bulk System:** 230 kV transmission lines and transformers.
- **Transmission System:** 115 kV transmission lines and transformers.
- **Distribution System:** Below 115 kV.
- **Cut Plane:** A distinction to indicate load is downstream of a certain grid asset.
- **Overload:** thermal violations predicted on bulk or transmission lines from PowerWorld load flow modeling.
- **Voltage collapse:** inability of the bulk and transmission to maintain voltage levels under contingency.