EXH. DRK-3
DOCKETS UE-22___/UG-22___
2022 PSE GENERAL RATE CASE
WITNESS: DAN'L R. KOCH

BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION, **Complainant,** **v.** **PUGET SOUND ENERGY,** **Respondent.**	**Docket UE-22____** **Docket UG-22____**

SECOND EXHIBIT (NONCONFIDENTIAL) TO THE PREFILED DIRECT TESTIMONY OF

DAN'L R. KOCH

ON BEHALF OF PUGET SOUND ENERGY

JANUARY 31, 2022

PUGET SOUND ENERGY

QUANTA TECHNOLOGY

Eastside Needs Assessment Report
Transmission System
King County

Redacted Draft

October 2013

Puget Sound Energy

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Section 1 Executive Summary

The analysis discussed in this report verified that there is a transmission capacity deficiency in the Eastside area of Lake Washington which will develop by the winter of 2017-18. This transmission capacity deficiency is expected to increase beyond that date. Cities in the deficiency area include Redmond, Kirkland, Bellevue, Clyde Hill, Medina, Mercer Island, Newcastle and Renton along with towns of Yarrow Point, Hunts Point, and Beaux Arts.

Assessment Objective

The objective of this needs assessment is to assess the sufficiency of transmission supply within the next 10 years to Puget Sound Energy's customers and communities on the east side of Lake Washington.

As part of the mandatory North American Electric Reliability Corporation (NERC) Compliance Enforcement Program[1], PSE performs an annual comprehensive reliability assessment[2] to determine if any potential adverse impacts to the reliability of delivery of electricity exist on the PSE transmission system. During the 2009 comprehensive reliability assessment[3], PSE determined that there was a transmission reliability supply need developing due to the loss of one of the Talbot Hill Substation[4] transformers.

Since 2009, other issues have also been identified which impact this portion of the PSE system. These issues include concerns over the projected future loading on the Talbot Hill Substation, increasing use of Corrective Action Plans (CAPs) to manage outage risks to customers in this portion of the PSE system, and regional transmission reinforcement needs that were identified by ColumbiaGrid studies to support the movement of power from existing wind generation and hydroelectric generation across the Cascade Mountains to load centers around the Puget Sound.

The study described in this report focused specifically on the central King County portion of the larger PSE system in order to provide a more focused needs assessment. The timing of this study was intended to provide sufficient lead time to implement viable, long term solutions before the issues identified by the study develop. This report discusses the review of the current transmission infrastructure to support the current load and the future load growth in this area.

Method and Criteria

The studies documented by this report are collectively referred to as the "2013 Eastside Needs Assessment." To assess area supply needs, comprehensive reliability analyses were performed to determine the present and future transmission supply to PSE's Eastside area in King County and the Puget Sound area as a whole. In 2009, as part of

[1] NERC Reliability Standards for the Bulk Electric Systems of North America

[2] PSE Planning Studies and Assessment TPL-001 to TPL-004 Compliance Report

[3] 2009 PSE Planning Studies and Assessment TPL-001 to TPL-004 Compliance Report

[4] Talbot Hill Substation is located in Renton

the TPL-001 through TPL-004 Compliance Report, PSE's analysis showed that there was a potential thermal violation with the loss of one of the two transformers at Talbot Hill Substation. For the 2013 Eastside Needs Assessment, PSE performed an updated analysis to evaluate if this potential thermal violation would still exist with updated load forecasts. The 2013 Eastside Needs Assessment was performed consistent with the mandatory NERC TPL annual comprehensive analysis. Supplemental performance studies were also performed to provide a clear understanding of the location and causation of these potential thermal violations.

For the 2013 Eastside Needs Assessment, PSE used the WECC 2012 series base cases to develop the 2013-14, 2017-18, and 2021-22 heavy winter cases. These cases were set up to account for normal weather with 100% of the forecasted level of conservation and were updated with the current PSE system configuration and load information. To better understand the extent of the need and risks faced by customers in this portion of the PSE system, sensitivity studies were conducted to evaluate performance under different levels of conservation. Sensitivities studies were also conducted to assess system performance under extreme weather conditions that are expected to occur once every twenty years.

This assessment also reviewed the near and long-term summer cases run for the 2012 NERC Transmission Planning (TPL) standard requirements. For the TPL report, cases had been developed for heavy summer of 2014 and 2018 using the 2012 WECC series base cases. These cases were set up to account for normal summer weather with 100% of the forecasted level of conservation and were updated with the current PSE system configuration and load information.

This analysis covered PSE facilities that are part of the Bulk Electric System (BES) and the interconnected system covered by the Western Electricity Coordinating Council (WECC). BES facilities must be studied in accordance with the latest approved versions of the mandatory NERC Reliability Standards and the WECC Reliability Standards[5]. These standards set forth the specific methods for studying the performance of the transmission system – 100 kV and above – and govern how that system is planned, operated and maintained.

In addition to the mandatory reliability standards, PSE has also issued Transmission Planning Guidelines[6] which describe how to plan and operate PSE's electric transmission system. These guidelines are in place to encourage the optimal use of the transmission system for service to loads and generators while complying with the mandatory standards. These guidelines also support transfers between utilities, when applicable, to support economic use of available resources.

Performance criteria are also established to determine if a need exists to improve the system. These performance criteria serve as a baseline to measure performance and to identify where reinforcements may be needed. The needs documented in this report were determined by whether or not the study area would perform such that it satisfied all approved applicable NERC, WECC and PSE transmission performance criteria[7].

Study Assumptions

The following key assumptions were adopted to more fully understand the potential reliability impacts:

- The study horizon selected was the ten year period from 2012 to 2022.
- System load levels used the PSE corporate forecast published in June 2012.

[5] TPL-001-WECC-CRT-2 – System Performance Criterion Under Normal Conditions, Following Loss of a Single BES Element, and Following Extreme BES Events

[6] PSE Transmission Planning Guidelines, November 2012

[7] PSE Transmission Planning Guidelines, pages 3-5 & 7, November 2012

- Area forecasts were adjusted by substation to account for expected community developments as identified by PSE customer relations and distribution planning staff.
- Generation dispatch patterns reflected reasonably stressed conditions to account for generation outages as well as expected power transfers from PSE to its interconnected neighbors.
- Winter peak Northern Intertie transfers were 1,500 MW exported to Canada.
- Summer peak Northern Intertie transfers were 2,850 MW imported from Canada.

Specific Areas of Concern

The 2013 Eastside Needs Assessment was a fresh look at current and future system conditions which did not pre-judge the existence of any specific issues on the PSE system. Since 2009 a variety of concerns have been identified and these were investigated in the analysis. During the course of the analysis, some additional potential problems were identified that also were evaluated. The major issues include:

1. **Overload of PSE Facilities in the Eastside Area:** Several previous studies had identified potential overloading of transformers at Sammamish and Talbot Hill Substations[8]. These include the 2008 Initial King County Transformation Study, 2009 PSE TPL Planning Studies and Assessment, and the 2012 PSE TPL Planning Studies and Assessment[9]. Those studies indicated that potential thermal violations may occur on facilities from Talbot Hill Substation to Sammamish Substation. The 2013 Eastside Needs Assessment validated those concerns and identified transmission supply needs that focused on two 230-115 kV supply injections into central King County at Sammamish and Talbot Hill Substations. In the 2013 Eastside Needs Assessment the team found:

   - For the winter peak at approximately 5,200 MW (2017-18 in the model) there are two 115 kV elements with loadings above 98% for Category B (N-1) contingencies and five 115 kV elements above 100% for Category C (N-1-1 & N-2) contingencies.

   - For the summer peak at approximately 3500 MW (2018 in the model), there are two 230 kV elements above 100% and two 115 kV elements above 93% loadings for Category B (N-1) Contingencies. Also there are three elements above 100% loading and one above 99% loading for Category C (N-1-1) contingencies.

2. **Small Margin of Error to Manage Risks from Inherent Load Forecast Uncertainties:** The 2012 Corporate load forecast for winter under normal weather conditions and 100% conservation indicates load increases 138 MW from 2013-14 to 2021-22 (Figure 1-1), or about 17 MW of increased load per year. This annual increase is significantly lower than previous forecasts and is much lower than the 2011 forecast of approximately 22 MW per year[10],

   In extreme weather, system load can be much higher than this forecast. To illustrate, Figure 1-1 shows that the difference in forecast load between normal and extreme winter weather for the year 2014 is actually 497 MW – almost 10 percent of the total PSE load (assuming 100% of the forecast conservation for both). Normal weather represents the projected load at 23° F and extreme weather represents the projected load at 13° F. As the temperature gets close to 13° F, the forecasted load in any given year could easily surpass the entire 138 MW load increase projected for the 10 year study period. This effect has occurred recently on the

[8] Sammamish Substation is located in Redmond. Talbot Hill Substation is located in Renton.

[9] The 2010 and 2011 TPL Planning Studies also identified the Lakeside 230-115 kV transformer as needed and planned for 2016. It did not show up as a deficit in the long term due to being modeled as installed by the long term case year.

[10] 2011 PSE IRP Section H Page H-12 from 2010 to 2017

PSE system. In winter 2009, the system hit an all-time peak of 5038 MW[11] at a temperature of 16˚ F, which was 194 MW higher than the 2009 forecast for normal weather peak load in 2009 . This 2009 actual peak load level is also higher than the 2012 forecast for normal system peak load in 2021.

The 2013 Eastside Needs Assessment shows a load level of need at approximately 5,200 MW winter peak. To illustrate the importance of conservation in our modeling, the team forecasted PSE load levels under a variety of conditions. If only 75% of forecasted conservation materializes, the 5,200 MW load level would be hit as early as 2015 under normal weather conditions. Even if 100% conservation is achieved, under extreme weather conditions PSE could exceed the 5,200 MW level during the winter 2013-14. These winter peak forecast sensitivities are illustrated in Figure 1-1:

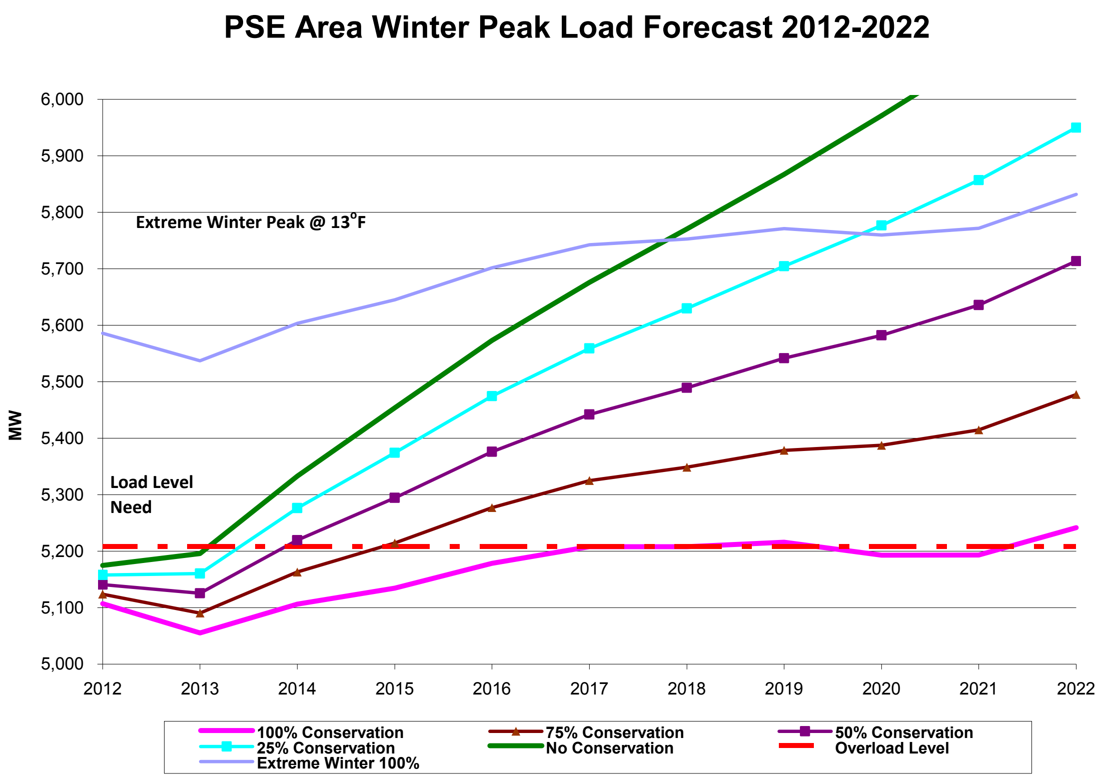

Figure 1-1: Corporate System Load Forecast for Winter 2012 to 2022

The 2013 Eastside Needs Assessment shows a summer load level of need is approximately 3340 MW (Figure 1-2). Summer peak load is calculated for an 86˚ F peak day. This load level could occur as early as 2014 and becomes more likely with time. While PSE has traditionally been a winter peaking utility, the increase in commercial load has driven summer load growth disproportionately higher than the winter growth in recent years. The projected summer peak growth is on average approximately 37 MW per year. The corporate load forecast does not indicate loading for an "extreme summer" peak, which would be expected to be higher than shown on these projections.

[11] This does not include approximately 270 MW of load on PSE's system served by other transmission providers.

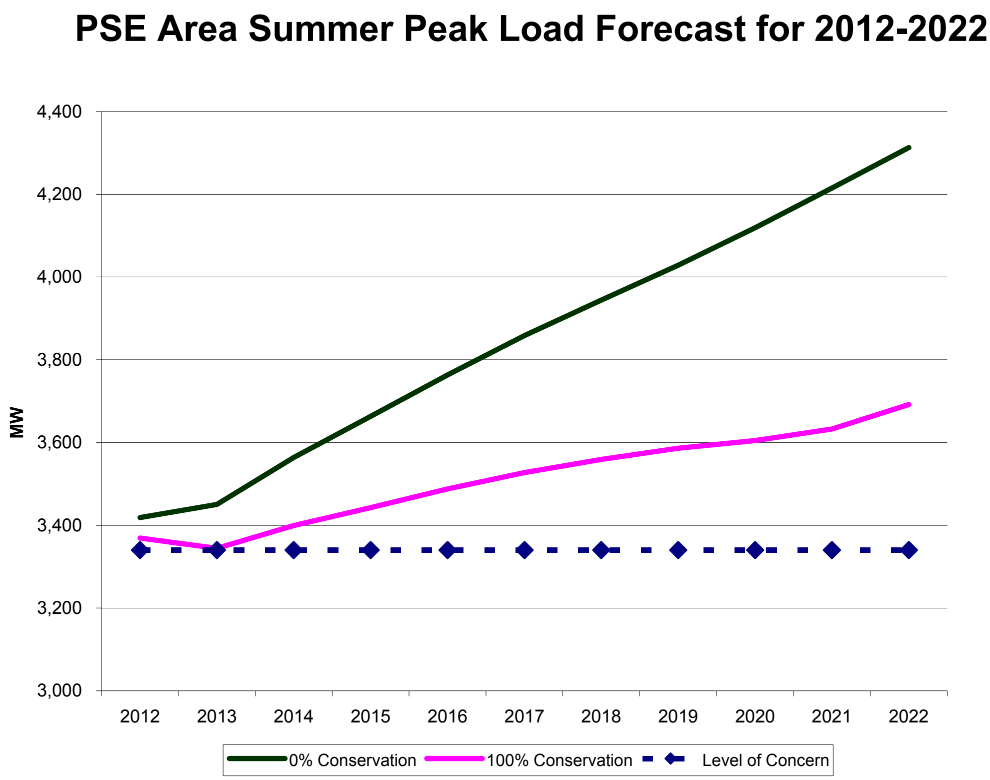

Figure 1-2: Corporate Load Forecast for Summer Peak from 2012 to 2022

3. **Increasing Use and Expansion of Corrective Action Plans:** An existing CAP in place to prevent overloads in the winter on either of the Talbot Hill transformer banks is increasing outage risk to customers. This CAP is to manually open [redacted], which removes [redacted]. Taking this step reduces the inherent reliability of the network since the transmission system cannot handle as many contingencies without overloads, voltage issues or loss of customers' power.

   As the PSE system load grows, the overload of either Talbot Hill transformer at winter peak may not be sufficiently reduced by this CAP. If loading on the overloading transformer is not reduced by use of the existing CAP, then [redacted] and [redacted] will also be opened. In addition to the reduction in reliability discussed above, opening these four 115 kV lines results in splitting northern King County from southern King County and puts approximately 32,400 customers at risk of outage, being served by just 1 transmission line without a backup line available (i.e., "radial supply"). This action also puts an additional 33,000 customers in Bellevue and Kirkland at risk of outage should there be an outage of [redacted] while the north and south systems are operating separately.

   There are two contingencies in the north end of King County that would trigger a CAP under summer conditions. These contingencies are (1) the loss of [redacted] along with the loss of the [redacted]; and (2) the loss of the [redacted] along with the loss of [redacted]. This CAP would open [redacted]. Taking this action places 33,000 customers at risk of outage should an additional

REDACTED INFORMATION IS DESIGNATED AS PSE CEII, AND FOR SAFETY AND SECURITY REASONS WILL NOT BE DISCLOSED IN THIS FILING.

transmission line outage occur. The 33,000 customers are served from two separate lines, so a single line outage would take out approximately half of the 33,000.

4. **Emerging Regional Impacts Identified by ColumbiaGrid:** ColumbiaGrid was formed in 2006 by regional utilities to improve the operational efficiency, reliability, and planned expansion of the Northwest transmission grid through an open and transparent process. The ColumbiaGrid produces a Biennial Transmission Expansion Plan that addresses system needs in the Pacific Northwest, including the PSE system. The latest report indicated a need to improve the dependability of the transfer capability through the Puget Sound Area. This need occurs during high load conditions and much of the rest of the year as facilities such as transmission lines are taken out of service to do required maintenance and improvements. ColumbiaGrid indicated that a reduced risk of curtailments is needed to reliably deliver power from regional and renewable generation such as PSE's wind generation in eastern Washington, to King County. Also, there are regional commitments to increase flows across the Northern Intertie to 2300 MW that will show up in the ten-year time frame.

   To significantly reduce regional curtailments, ColumbiaGrid identified six specific projects which include installing inductors on the 115 kV system in Seattle, adding a 500-230 kV transformer at BPA's Raver Substation in south King County, and increasing 230 kV south-north transmission capacity along the Eastside.

Statements of Need

The 2013 Eastside Needs Assessment confirmed that by winter of 2017-18, there is a transmission supply need on the Eastside of Lake Washington which impacts PSE customers and communities in and around Kirkland, Redmond, Bellevue, and Newcastle along with Clyde Hill, Medina, and Mercer Island. The supply need focuses on the two 230 kV supply injections into central King County at Sammamish Substation in the north and Talbot Hill Substation in the south. The transmission supply becomes a need at a PSE load level of approximately 5,200 MW, where overloads will result in operating conditions that will put thousands of Eastside customers at risk of outages. According to PSE projections, demand is expected to exceed this level in winter 2017-18.

The assessment also identified that higher overloads are expected to develop as load grows beyond the 5,208 MW (100% conservation) shown in 2017-18. For example as shown below, if only 75% of the conservation forecast is achieved - equivalent to 5,300 MW load in that same time period, the overloads will have grown. By the end of the 10 year study period, the study indicates that overloads will continue to grow even with all of the projected conservation in effect. These possible overloads will result in more hours operating under conditions that will put thousands of Eastside customers at risk of outages.

Under both load forecast conditions (full conservation and 75% conservation), the overloads occur for both Category B contingencies which are the loss of a single element (i.e., "N-1") and Category C contingencies which are the loss of more than one element, (i.e., "N-1-1" or "N-2"). Table 1-1 shows the overloads expected by 2017-18 for winter peak under normal weather conditions.

Table 1-1: Potential Thermal Violations for 2017-18 Winter Peak with Normal Weather

	2017-18 Winter Peak	2017-18 Winter Peak
	5208 MW	5325 MW
Contingency	100% Conservation	75% Conservation
Cat B (N-1)	Talbot Hill - Lakeside #1 115 kV line – 98.6%	Talbot Hill - Lakeside #1 115 kV line – 99.9%
	Talbot Hill - Lakeside #2 115 kV line – 98.4%	Talbot Hill - Lakeside #2 115 kV line – 99.8%
	Talbot Hill 230-115 kV transformer #2 – 90.3%	Talbot Hill 230-115 kV transformer #1 – 90.9%
		Talbot Hill 230-115 kV transformer #2 – 92.4%
Cat C (N-1-1)	Talbot Hill-Lakeside #1 115 kV Line - 127.8%	Talbot Hill-Lakeside #1 115 kV Line - 129.9%
	Talbot Hill-Lakeside #2 115 kV Line - 127.6%	Talbot Hill-Lakeside #2 115 kV Line - 129.7%
	Talbot Hill 230-115 kV transformer #1 - 105.7%	Talbot Hill 230-115 kV transformer #1 - 108.1%
	Talbot Hill 230-115 kV transformer #2 - 105.7%	Talbot Hill 230-115 kV transformer #2 – 107.6%
	Talbot Hill-Boeing Renton-Shuffleton 115 kV Line - 110.6%	Talbot Hill-Boeing Renton-Shuffleton 115 kV Line - 112.5%
	Shuffleton – O'Brien 115 kV Line – 97.9%	Shuffleton – O'Brien 115 kV Line – 99.7%
	Shuffleton – Lakeside 115 kV Line – 97.3%	Shuffleton – Lakeside 115 kV Line – 98.9%
Cat C (N-2 or Common Mode)	Talbot Hill-Lakeside #1 115 kV Line - 101.5%	Talbot Hill-Lakeside #1 115 kV Line – 100.5%
	Talbot Hill-Lakeside #2 115 kV Line - 101.1%	Talbot Hill-Lakeside #2 115 kV Line – 103.0%
	Talbot Hill 230-115 kV transformer #1 – 91.8%	Talbot Hill 230-115 kV transformer #1 – 93.8%
	Talbot Hill 230-115 kV transformer #2 – 92.8%	Talbot Hill 230-115 kV transformer #2 – 94.4%

The analysis also identified that overload conditions will occur for Summer Peak conditions under normal weather. These overloads can occur as early as 2014 with a load level of approximately 3,300 MW. These overloads increase by the year 2018 when the load is expected to increase to 3,500 MW. Those issues are listed in Table 1-2.

Table 1-2: Potential Thermal Violations for 2014 and 2018 Summer Peak with Normal Weather

	2014 Summer Peak	2018 Summer Peak
	3343 MW	3554 MW
Contingency	100% Conservation	100% Conservation
Cat B (N-1)	Monroe-Novelty Hill 230 kV line - 132.6%	Monroe-Novelty Hill 230 kV line - 133.0%
	Maple Valley - Sammamish 230 kV line - 111.4%	Maple Valley - Sammamish 230 kV line - 132.3%
		Talbot Hill - Lakeside #1 115 kV line - 93.9%
		Talbot Hill - Lakeside #2 115 kV line - 93.8%
Cat C (N-1-1)	Sammamish 230-115 kV transformer #1 - 95.5%	Sammamish 230-115 kV transformer #1 - 100.7%
	Sammamish 230-115 kV transformer #2 - 100.8%	Sammamish 230-115 kV transformer #2 - 106.4%
		Beverly Park - Cottage Brook 115 kV line - 100.5%
		Sammamish - Lakeside #2 115 kV line - 99.8%

When winter load reaches the point that overloads are possible, PSE or BPA would use CAPs to automatically or manually prevent overloads under the NERC reliability requirements. The CAPs required to prevent N-1-1 overloads would open lines between Sammamish and Talbot Hill. Some of the CAPs place customers at risk of outage due to transmission lines being switched to a radial supply, with no backup transmission line available. Load growth by the end of the 10 year study period will result in additional lines required to be opened, putting over 60,000 customers at risk of resulting outages. Some of the CAPs are set up today as BPA nomograms or PSE manual corrective action plans. If extreme winter weather were to occur today, loading would be high enough that CAPs would be employed to remain NERC compliant.

Future load growth will result in additional lines required to be opened, putting over 60,000 customers at risk of resulting outages. Additional power supply is needed in the central King County area to prevent overloads and outages, see .Figure 1-3.

The diagram below indicates areas at risk of outage if switching is performed to prevent overloads, and then subsequent outages occur on transmission lines that had been switched open. The subsequent outages could be due to radial lines experiencing faults due to car-pole accidents, lightning, or tree limbs. Outages could also occur if PSE dispatchers must drop load to prevent transformer overloads while transmission lines are switched open. In the diagram, green lines indicate a line or transformer whose loss during peak winter load could result in overloads of other system elements. The gold colored lines indicate those lines or transformers at risk of overloading when the green element trips out. The gray shaded areas indicate where customers would be at risk of outage from switching to mitigate the overloads.

This study finds that within the 10 year study period, additional transmission supply to the Eastside is needed to meet future demand growth of the area.

Figure 1-3: Topological View of the Needs Assessment of the Eastside of Lake Washington

Section 2 Introduction and Background Information

2.1 Study Objective

The study objective was to assess the capability of existing transmission infrastructure to supply the communities on the east side of Lake Washington, called the "Eastside", within Puget Sound Energy's (PSE's) central King County area. These communities include Bellevue, Kirkland, Redmond, Mercer Island, and Newcastle as well as the smaller towns along the shore. A review was performed to determine the needs for future transmission supply to the Eastside. This study review was performed due to concerns identified in 2009 TPL studies that were related to the projected future loading on the Talbot Hill Substation, future requirements of the Columbia Grid, and operational issues of PSE's control area. These supply issues were exacerbated by impacts on the PSE system due to Puget Sound Area Northern Intertie (PSANI) related events during winter supply conditions and heavy south to north flows that had been identified in analysis conducted by Columbia Grid.

This present report reviews the entire infrastructure, and design of the transmission system with respect to present and future viability. The following tasks were completed as part of this study review and are discussed in this report: (i) updated the block load forecast of the King County area; (ii) merged this block load forecast into the 2012 PSE system load forecast (iii) conducted future performance simulations of the King County area for the years 2014, 2018 and 2022; (iv) reviewed the Columbia Grid 2013 Biennial Transmission Expansion Plan; and (v) reviewed operational issues with PSE's control area operators; and (vi) aligned the recommendations with the recommendations from the Columbia Grid analysis of PSANI events under heavy south to north flows.

Quanta Technology, LLC., assisted Puget Sound Energy in conducting this study, including research, analysis and documentation.

2.2 Background Information

One of the major drivers in the determination of need for additional transmission facilities is the existing load on the system and the projected load growth that is expected to occur. As early as 2008, PSE had indications that additional transmission supply was needed to support the central King County portion of PSE's service territory. In 2008, PSE conducted a King County Transformation Study that indicated increased loading had occurred at the Talbot Hill Substation, which has two 230-115 kV transformers. Concerns were noted that if load continued to grow in the area, then by 2017-18 one transformer would overload if the other transformer tripped off-line. This study used the F2008 Puget Sound Energy Electric Load Forecast.

The needs for additional transmission sources into central King County were confirmed while performing the mandatory NERC 2009 reliability compliance studies. In that analysis, PSE observed a potential thermal issue when there was a bus fault at Talbot Hill Substation. The bus fault caused the overload of a Talbot Hill transformer for the loss of the other transformer for the 2010-2011 winter peak[12]. Based upon the adjusted 2009 PSE load forecast, the peak load modeled in the 2010-2011 Winter peak case was 5,329 MW[13]. For the 2018-2019 Winter peak case a load of 5,765 MW was modeled.

To resolve this equipment overload, a temporary measure of manually switching out two 115-kV lines from Talbot Hill –Lakeside was identified as a Corrective Action Plan (CAP) that could be used to mitigate the overload[14]. The CAP would be used at a PSE load level of approximately 5,300 MW. At that time, PSE implemented the CAP and has been using it in its operations for managing the reliability of service in that area.

[12] Page 13, 2009 PSE Planning Studies and Assessment TPL-001 to TPL-004 Compliance Report

[13] Page 7, 2009 PSE Planning Studies and Assessment TPL-001 to TPL-004 Compliance Report

[14] Page 22, 2009 PSE Planning Studies and Assessment TPL-001 to TPL-004 Compliance Report

In early 2009, PSE's corporate load forecast group responded to the national economic crisis to re-evaluate the projected load forecast. The resulting revision reduced the forecast 2010-11 winter peak by 3% from the previous year's forecast.

In 2009, PSE set their all-time record loads for both the winter and summer seasons. The 2009 winter peak load was 5,038 MW and the 2009 summer peak was 3,509 MW. This compares with a 2009 forecast of 4,973 MW for winter and 3,086 MW for summer. Neither the forecast number nor the peak load includes the 270 MW of transmission level customers used in the area load. It should be noted that the 2009 winter peak forecast assumed a normal winter temperature of 23° F, while the peak load occurred with a temperature of 16°F. For a discussion of the forecast methodology and the limitations on its use, see Section 4.1.5.

2.3 King County Area Description

King County is a major load center of the Puget Sound Region. The Eastside area is in central King County and includes the cities of Redmond, Kirkland, Bellevue, Mercer Island, Newcastle and Renton, as well as the smaller towns of Yarrow Point, Hunts Point, Medina, Clyde Hill and Beaux Arts. The greater Eastside area also includes towns and cities to the north and east of the core area which are not a focus of this study: Bothell, Woodinville, Duvall, Carnation, Sammamish, Issaquah, Preston, Fall City, Snoqualmie, and North Bend.

Figure 2-1 Street Map of Eastside Area

The load density of north King County is shown below in Figure 2-2. The map shows that the most densely populated areas, shown in red, of King County are Kenmore, Kirkland, Redmond, Bellevue, and Renton.

The easterly border of King County is along the Cascade Mountain Range, which creates a natural obstacle between the densely populated western Washington communities clustered around Seattle and Tacoma, and the sparsely populated arid region of eastern Washington.

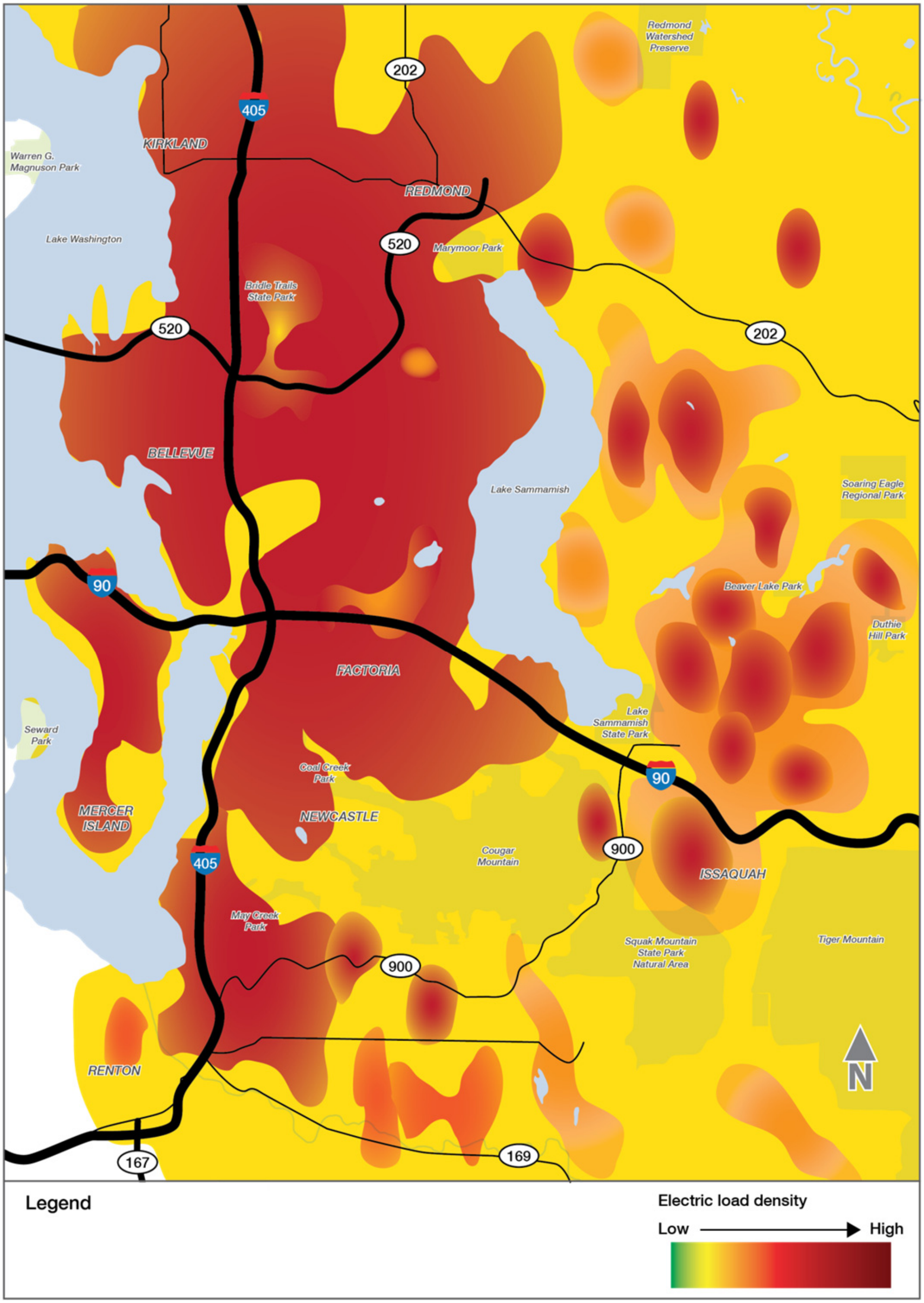

Figure 2-2: King County Load Density Map

The King County load is supplied from Bonneville Power Administration's (BPA) 500 kV sources at Monroe (Monroe), SnoKing (Mill Creek) Maple Valley (Renton), and Covington (Covington) Substations, as well as 500 kV switching stations at Echo Lake (south of Snoqualmie) and Raver (Ravensdale). There is very little generation in King County; a small amount of hydro generation in eastern King County provides less than 5% of the county's peak load requirements. Therefore PSE depends on its transmission system and on transmission interconnections with neighboring utilities to bring power to its load center in King County.

King County also has 230 kV supply from the following substations: Sammamish (Redmond), Novelty Hill (Redmond Ridge), Talbot Hill (Renton), O'Brien (Kent), and Berrydale (Covington). To serve the loads in King County, there are eight 230 kV/115 kV transformers; two at Sammamish, two at Talbot Hill, and one at Novelty Hill, two at O'Brien, and one at Berrydale. North King County load is generally served by Sammamish and Novelty 230 kV sources but due to the interconnecting nature of the system, Talbot Hill transformers serve part of the North King and South King systems. Sammamish and Novelty Hill are both connected to the Monroe-Maple Valley 230 kV line, which is leased from BPA. See Figure 2-3 and Figure 2-4 on the following pages.

Redacted

Figure 2-3: Puget Sound Area System Overview One-Line Diagram

Redacted

Figure 2-4: Major Electrical Infrastructure Supporting the Eastside Area

The 11 - 115 kV lines out of Lakeside Substation serve 15 substations in Bellevue and 14 substations in Newcastle, Issaquah, Mercer Island, Medina, Kirkland and Redmond, as shown in Figure 2-5. Lakeside Substation is supplied by 230-115 kV transformers at Sammamish and Talbot Hill. Lakeside connects to switching stations at Shuffleton (Renton), Lake Tradition (Issaquah) and Ardmore (Bellevue). In the Eastside area, when regional power flows are from south to north the power serving the Eastside will generally flow from south to north. In this case, power for the Eastside starts at Talbot Hill and flows north to Lakeside and continues to Sammamish Substation. When regional flows are north to south, Talbot Hill will still feed north past Lakeside but power will also flow south out of Sammamish Substation which feeds approximately sixty percent of the load between Sammamish and Lakeside Substations during north-south regional flows. Talbot Hill is a strong source of supply between Lakeside and Sammamish Substations.

Redacted

Figure 2-5 One-Line Diagram of Eastside Study Area

All of the 115 kV transmission lines in the Eastside area have been uprated to their maximum capacity ratings, except the two lines to Mercer Island, which operate normally open. PSE has two 115 kV transmission lines on separate structures on a transmission right of way (ROW) between Sammamish and Talbot Hill Substations, which interconnect at Lakeside Substation. There are three 115 kV lines in parallel with this corridor in the north, two lines in parallel in the south, all supplying load to distribution substations.

The Bellevue area is a higher-density load center without a 230 kV bulk transmission source nearby. With 230 kV supplies in the north at Sammamish Substation and the south at Talbot Hill Substation, lower-capacity 115 kV transmission lines bring power to Bellevue from the 230 kV transmission substations in Redmond and Renton.

2.4 Study Horizon

PSE has studied the Eastside area for the near-term (years 1-5) and long-term (years 6-10) horizons. Since PSE peaks during the winter season, the reliability analysis focused on the winter peak for years 2013-14, 2017-18, and 2021-22. Summer peak was also analyzed for years 2014 and 2018 for the annual 2012 NERC TPL analysis; the 2012 NERC TPL summer results were included in this study.

Section 3 Analysis Description

A number of comprehensive reliability analyses were performed to determine the present and future transmission supply to the central King County area. The following detailed studies were performed to assess any adverse conditions to the reliability and operating characteristics of the PSE system or surrounding systems in the context of applicable standards:

2013 Eastside Needs Assessment: Power flow simulations were performed for the near and far-term horizon to determine if there are any thermal or voltage violations to King County's Eastside area. Past studies have shown supply issues to this area. While the recent economic downturn has impacted the future load growth projections of PSE overall, the load within the Eastside continues to grow. This study uses the latest corporate load forecast and adjusts the lumpiness of the load based on PSE's knowledge of future block loads.

2008 Initial King County Transformation Study: Power system simulation studies were performed on the King County system which indicated increased loading at Talbot Hill Substation, pointing to future overloads of either transformer for the loss of the other transformer at Talbot Hill. A bus section fault or loss of one of the lines from BPA Maple Valley Substation could also result in Talbot Hill transformer overloads.

2009 PSE Planning Studies and Assessment-TPL-001 to TPL-004 Compliance Report: As required per the 2009 NERC Compliance Enforcement Program, PSE performed an assessment of the system based on criteria described in NERC Standards TPL-001 through TPL-004. There were a number of potential overloads and voltage violations identified with these studies. The proposed solutions are generally system projects that will mitigate the issues via a topology change, line uprate, or additional transformation. The solutions may also take the form of a Remedial Action Scheme (RAS), as well. PSE demonstrated through a valid assessment that its portion of the interconnected transmission system is planned such that the Network can be operated to supply projected customer demands and projected Firm (non-recallable reserved) Transmission Services, at all demand levels over the range of forecast system demands, under the contingency conditions.

2012 PSE Planning Studies and Assessment-TPL-001 to TPL-004 Compliance Report:
PSE performed an assessment of the system based on criteria described in NERC Standards TPL-001 through TPL-004. There were a number of potential overloads and voltage violations identified with these studies. The proposed solutions are generally system projects that will mitigate the issues via a topology change, line uprate, or additional transformation. The solutions may also take the form of a Remedial Action Scheme (RAS), as well.

BPA Transformation Study: A study was conducted by PSE in 2010 to review the impact of BPA 500-230 kV transformation at Monroe, Maple Valley or Covington which had been identified by BPA as alternative sites for the new transformer. A Covington transformer plus Lakeside 230-115 kV transformation provides better improvements to stressed contingencies than Covington plus Lake Tradition, Berrydale and Christopher 230-115 kV transformers combined. A Maple Valley transformer would stress PSE's system in the Talbot Hill vicinity more than a Covington transformer.

ColumbiaGrid 2013 Biennial Transmission Expansion Plan: ColumbiaGrid 2013 Biennial Transmission Expansion Plan looks out over a ten-year planning horizon (2013 - 2023) and identifies the transmission additions necessary to ensure that the parties to the ColumbiaGrid Planning and Expansion Functional Agreement can meet their commitments to serve load and meet firm transmission service commitments. The Expansion plan still includes the addition of a Lakeside 230-115 kV transformer in the Ten-Year Plan, and the additional 230-115 kV transformation at Lake Tradition in the long term. The new issues in the 2013 Expansion plan include Northern Intertie transfer issues.

A limitation in the 500/230 kV transformation in the Puget Sound area was noted in previous System Assessments. To resolve this issue, The Puget Sound Area Transmission Expansion Plan and the ColumbiaGrid Ten-Year Plan include a new 500-230 kV transformer at Raver which is scheduled to be installed in 2016.

Study Criteria: The following is a list of the criteria, standards and guides which apply to this needs statement:

1. TPL-001- System Performance Under Normal (No Contingency) Conditions (Category A)
2. TPL-001-WECC-CRT-2 – System Performance Criterion Under Normal Conditions, Following Loss of a Single BES Element, and Following Extreme BES Events:
3. TPL-002 - System Performance Following Loss of a Single Bulk Electric System Element (Category B)
4. TPL-003 - System Performance Following Loss of Two or More Bulk Electric System Elements (Category C)
5. TPL-004 - System Performance Following Extreme Events Resulting in the Loss of Two or More Bulk Electric System Elements (Category D)
6. PSE's Transmission Planning Guidelines
7. Northwest Power Pool Coordinated Plan
8. PSE Procedures to Establish and Communicate Operating Limits

Section 4 Study Assumptions

4.1 Steady State Model Assumptions

4.1.1 Study Assumptions

The 230 kV Eastside Area steady state models were developed to be representative of the long term projection of the winter peak system demand level to assess reliability performance under heavy load conditions. The model assumptions included consideration of Puget Sound area generation units' unavailability conditions as well as variations in surrounding area transfer level conditions.

The following assumptions are used in the 2013 Eastside Needs Assessment. The primary focus was on the winter peaks for years 2013-14, 2017-18, and 2021-22 utilizing the latest corporate load forecast modified to reflect the lumpiness of the load by substation. The Eastside load is defined as the sum of the MW flows out of the bus on the Talbot Hill end of the Talbot Hill - Lakeside #1 & #2 115 kV lines, Shuffleton end of the Shuffleton - Lakeside 115 kV line, Lake Tradition end of the Lake Tradition - Goodes Corner - Lakeside 115 kV line, and Sammamish end of the Sammamish - Lakeside #1 & #2, Sammamish - North Bellevue - Lakeside, Sammamish - Lochleven - Lakeside, and Sammamish - Ardmore - Lakeside 115 kV lines.

The difference in winter peak load forecasts with 100% conservation from 2013-14 to 2021-22 is 138 MW, which on average, is only approximately 15 MW per year (see Figure 4-1). Sensitivities on the amount of conservation and weather were run to reflect the inherent risks associated with an essentially flat load growth. Figure 4-1 shows the load levels in the study with various levels of conservation.

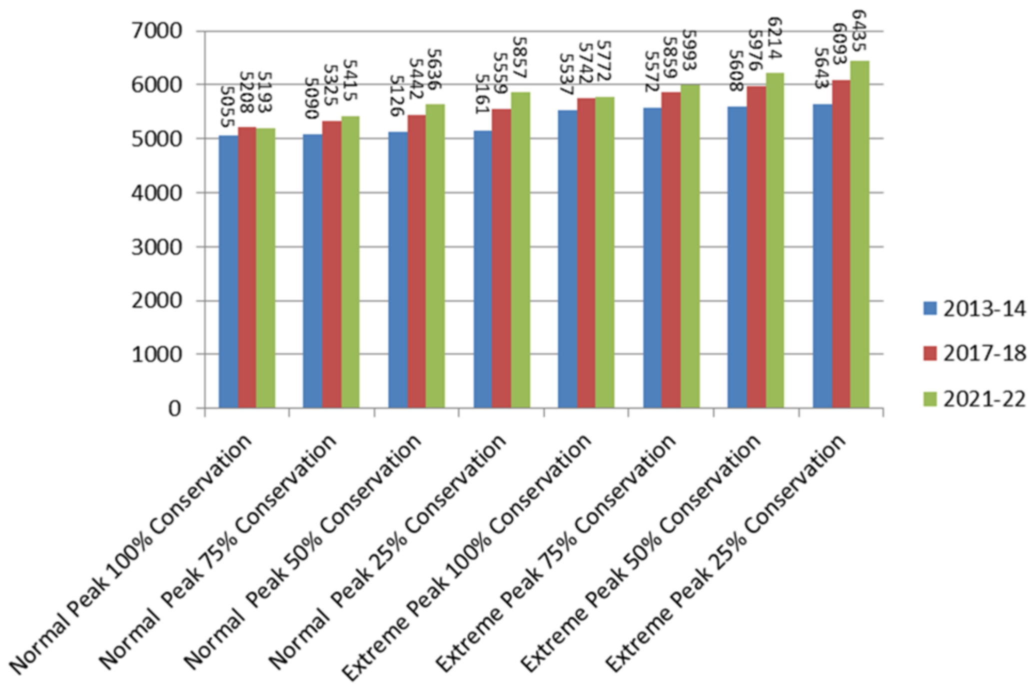

Figure 4-1: Winter Peak Load Growth with Varying Levels of Conservation

The Northern Intertie for the winter peak was modeled with a south to north flow of 1,500 MW into Canada.

The generation dispatches for the winter peak were modeled to reflect the standard way PSE studies the King County area which is to reduce generation in the north of the PSE area to create a greater south to north power flow during contractual flows from the Northwest to Canada. A winter low generation sensitivity case with adjusted Puget Sound area generation was run to identify risks associated with running a no Puget Sound Area generation case.

4.1.2 Source of Power Flow Models

The power flow models used in the study were based on WECC base cases created in 2012 for the winters 2012 -13, 2016 -17 and 2021-22 and for summers 2012 and 2017. These base cases are updated annually by all WECC members to reflect expected load forecasts, planned projects, generation changes and system adjustments. The 2012-13 winter case was modified to model the expected 2013-14 winter, the 2016-17 winter case to 2017-18 winter, the 2012 summer case to 2014 summer, and the 2017 summer case to 2018 summer. The cases were updated to reflect the PSE Corporate load forecast as discussed in Section 4.1.5.

The winter cases were then adjusted to reflect the case where the region sees high south to north power flows with no Puget Sound area generation. In previous studies, this scenario was the one that indicated the greatest problems on the Eastside in the winter. For TPL studies, four other scenarios are also studied:

- High South to North flows on the Northern Intertie with high Puget Sound area generation
- High South to North flows on the Northern Intertie and high south to north flows on the Paul - Raver 500 kV line with no Puget Sound area generation
- High North to South power flows on the Northern Intertie with no Puget Sound area generation
- High North to South power flows on the Northern Intertie with high Puget Sound area generation

The summer cases were run through four generation and Northern Intertie scenarios for PSE's 2012 TPL report; the TPL report summer results were used for this study.

The adjusted cases were then tailored for system improvements. Most improvements had been included already in the WECC cases. Additionally, the Seattle City Light (SCL) inductors and the Raver transformer were modeled. The PSE Lakeside 230 kV project was removed from the 2018 summer and 2021-22 winter cases since this project was proposed for perceived Eastside transmission supply need.

The cases were also adjusted for forecasted load in future years. First a block load adjustment was made where expected load is known for substations in King County. Then the system load for each of the study years was scaled to the level forecasted by PSE's Load Forecast Group in 2012.

4.1.3 Transmission Topology Changes

Projects added to the Eastside Needs Assessment base case are listed in Section 9 - Appendix B Table B-1 and Table B-2.

4.1.4 Generation Additions and Retirements

In addition to the generation increases included in the WECC base case by other utilities, PSE added generation capacity at the Snoqualmie and Lower Baker hydro units in 2013. These increases were modeled in the summer cases. The winter cases used no Puget Sound area generation for low generation scenarios, so the additional hydro generation was not relevant.

4.1.5 Forecasted Load (including assumptions concerning energy efficiency, interruptible loads, etc.)

The 2012 PSE Corporate system load forecast was used as a basis for the demand levels modeled in the study. PSE Corporate Load Forecast Group uses econometric regression models (*not end use models*) to forecast use per customer and customer counts for its electric and gas service area. The regression models are developed by customer class, such as residential, commercial, industrial, and so on.

The use-per-customer and customer equations are driven by a number of regional economic, demographic, weather, binary and other independent variables. The forecasts of the underlying economic and demographic variables are developed using information from Moody's Analytics and other regional sources of economic data.

The use per customer equation is driven primarily by historical data and variables such as unemployment rate, total employment, manufacturing employment, real personal income, retail rates and weather variables like heating and cooling degree days. The base forecast created by the regression model is modified appropriately to account for impacts of conservation programs and any known changes to large customers managed by the major accounts group. The conservation estimates prepared by the Integrated Resource Planning team distribute the implementation of conservation measures based on cost effectiveness analyses. The forecast of conservation savings is a major determinant of the final shape of the load forecast.

Customer count growth is driven by historical data and changes in population, household growth, housing permits, total employment and manufacturing employment in PSE's service area.

A major influence on PSE in the early 1990s was Washington's Growth Management Act (GMA). Elements of the GMA provide direction as to where growth and load will locate. PSE's planning process continues to provide input and updates on future planned transmission and distribution facilities for local jurisdiction Comprehensive Plan revisions to support their growth forecasts. Overall, the GMA and the local Comprehensive Plans coupled with PSE Annual Corporate Customer and Sales Forecasts provide a measure of predictability as to where and when construction of planned facilities will be needed.

PSE Annual Corporate Customer and Sales Forecasts include summer and winter peak load forecasts for a 20 year period. These forecasts include both normal and extreme winter load levels, with and without Demand Side Resources (DSR). Forecasts for Network Loads and other T & D service categories are obtained from customers annually for a 10-year period. Transmission Planning uses the most recent normal peak loads as a starting point and checks sensitivities to forecasted load as set forth in the NERC transmission planning requirements[15].

Table 4-1 shows PSE's 20 year load forecasts for the calendar years of 2010 to 2012 for normal (23° F) and extreme weather (13° F) with 100% conservation. PSE Load Forecast is provided for PSE system load, and does not include the 270 MW of Transmission Customer industrial loads. Transmission Customer loads are included in the area load for the TPL and 2013 Eastside Need Assessment. The load forecasts have decreased from the earlier years. The 2013 Eastside Need Assessment used the latest forecast.

From Table 4-1, the total load growth between 2013 and 2021 for normal weather is 138 MW. The difference in load between normal weather and extreme weather for 2013 is 482 MW. If the temperature on the peak day drops from 23° F to 13° F, the load increase would be approximately 3.5 times the total normal load growth over the study period.

[15] TPL-001-2 R2.1.4: http://www.nerc.com/docs/standards/sar/atfnsdt_recirc_ballot_tpl_001_2_clean_20110711.pdf

Table 4-1: PSE Load Forecasts from 2010 to 2012 for Normal and Extreme Weather

	Forecasted 2010		Forecasted 2011		Forecasted 2012	
Year	**Max of Normal Peak w/ DSR**	**Max of Extreme Peak w/ DSR**	**Max of Normal Peak w/ DSR**	**Max of Extreme Peak w/ DSR**	**Max of Normal Peak w/ DSR**	**Max of Extreme Peak w/ DSR**
2010	4,842	5,260	4,781	5,253		
2011	4,868	5,291	4,878	5,363		
2012	4,913	5,344	4,893	5,388	4,837	5,316
2013	4,947	5,387	4,925	5,433	4,785	5,267
2014	4,961	5,407	4,965	5,487	4,836	5,333
2015	4,947	5,400	4,979	5,513	4,865	5,375
2016	4,954	5,414	5,003	5,548	4,909	5,432
2017	4,967	5,434	5,023	5,579	4,938	5,472
2018	4,989	5,462	5,027	5,593	4,938	5,483
2019	5,017	5,498	5,044	5,622	4,946	5,501
2020	5,063	5,551	5,025	5,615	4,923	5,490
2021	5,141	5,639	5,028	5,630	4,923	5,502
2022	5,222	5,731	5,078	5,693	4,972	5,562
2023	5,302	5,821	5,149	5,775	5,039	5,641
2024	5,383	5,913	5,225	5,865	5,117	5,732
2025	5,466	6,007	5,303	5,955	5,193	5,820
2026	5,547	6,099	5,382	6,047	5,266	5,905
2027	5,629	6,192	5,464	6,142	5,341	5,993
2028	5,711	6,285	5,552	6,244	5,426	6,090
2029	5,795	6,380	5,645	6,351	5,515	6,192
2030			5,490	6,091	5,605	6,296
2031					5,694	6,399
2032					5,785	6,504
2033					5,878	6,610

The conservation in MW, by county, utilized in the 2012 forecast is shown below in Table 4-2.

Table 4-2: Conservation in MW, by County

Conservation Effects by County Normal Peaks (23°F) 100% Target Conservation (MW)										
Year of Study	**King**	**Thurston**	**Pierce**	**Whatcom**	**Skagit**	**Island**	**Kitsap**	**Kittitas**	**Jefferson**	**Total**
2012	33.0	7.8	6.9	5.2	3.4	2.1	7.4	0.8	1.3	67.9
2013	69.6	16.5	14.6	10.8	7.2	4.4	15.5	1.7	2.7	142.9
2014	112.3	26.7	23.6	17.5	11.5	7.0	24.8	2.7	4.3	230.5
2015	158.5	37.8	33.2	24.6	16.2	9.9	34.8	3.9	6.1	324.9
2016	196.1	46.8	41.0	30.3	20.0	12.1	42.7	4.8	7.5	401.5
2017	233.0	55.6	48.6	35.9	23.7	14.3	50.3	5.8	8.9	476.2
2018	280.4	66.9	58.3	43.1	28.4	17.2	60.1	7.1	10.7	572.1
2019	325.4	77.6	67.4	49.8	32.9	19.8	69.2	8.3	12.4	662.9
2020	389.5	92.8	80.4	59.5	39.2	23.5	82.2	10.2	14.9	792.1
2021	443.5	105.6	91.2	67.5	44.6	26.6	92.8	11.7	16.9	900.4
2022	474.0	112.9	97.3	72.0	47.6	28.2	98.4	12.7	18.0	961.1
2023	495.6	118.0	101.4	75.1	49.6	29.3	102.1	13.4	18.8	1003.4
2024	514.9	122.6	105.1	77.9	51.5	30.3	105.3	14.1	19.5	1041.2
2025	535.1	127.3	109.0	80.7	53.3	31.3	108.5	14.7	20.3	1080.3

Figure 4-2 shows the twenty year window of PSE's Winter Normal Peak with 0%, 25%, 50%, 75% and 100% conservation. As Figure 4-2 shows, with 100% conservation, the load levels of PSE are relatively flat for the years of study. The difference between 2013 and 2021 is 138 MW.

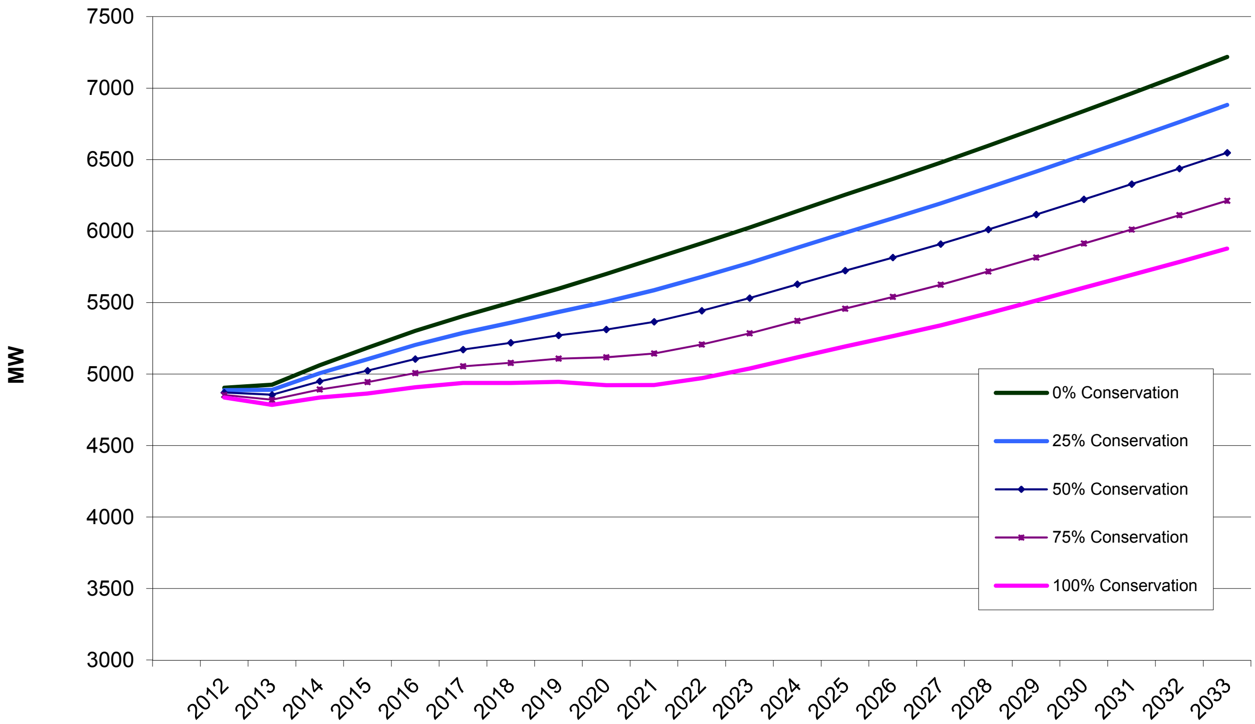

Figure 4-2: Twenty Year Graph of PSE's Forecast Winter Normal Peak with 0%, 25%, 50%, 75% and 100% Conservation

4.1.6 Load Levels Studied

For the power flow studies associated with the 230 kV Eastside Needs Assessment, the heavy winter 2013-14, 2017-18 and 2021-22 cases were used. Substation loading for the PowerWorld cases was developed using the substation loading at the time of the January 18, 2012 system peak as a proxy to the distribution of the load. There were a few substations without Supervisory Control and Data Acquisition (SCADA) load readings. Those substations were assigned values based on manual onsite substation load readings during the same load cycle. Both megawatts (MW) and megavars (MVAR) were determined in this manner.

Small Area Load Forecast: PSE distribution planners keep current on developments planned for their respective planning areas. These anticipated new loads are generally known within a 2-5 year time frame; specific projects are not often known with confidence beyond 5 years in advance. PSE planners reviewed such new loads expected in the King County area within the study period and added those expected loads to the historical load for each substation. These small area load adjustments were included in the substation load spread before the company-wide load was scaled to the corporate load forecast.

Transmission Customer Load: The corporate load forecast together with the interconnected Transmission Customer load, or non PSE load, was used to determine future loads for the power flow studies. The Transmission Customer load typically runs between 250 MW and 300 MW. For purposes of this study, 270 MW was used for a typical value. For example, in the year 2013-2014 the winter peak load forecast for the PSE area is 5055 MW which comprises the projected forecast of 4785 MW plus 270 MW of Transmission Customer loads. Loads were developed similarly for years 2017-18 and 2021-22. For completeness, this non-PSE load was included in the 2013 Eastside Needs Assessment and is shown in Table 4-3.

Table 4-3: Winter Peak Load levels studied in the Eastside Needs Assessment

Area Load Used for Eastside 230 Study													
Year Studied	**Report**	**Season**	**Normal Peak 100% Conservation**	**Normal Peak 75% Conservation**	**Normal Peak 50% Conservation**	**Normal Peak 25% Conservation**	**Normal Peak 0% Conservation**	**Extreme Peak 100% Conservation**	**Extreme Peak 75% Conservation**	**Extreme Peak 50% Conservation**	**Extreme Peak 25% Conservation**	**Extreme Peak 0% Conservation**
2013-14	2012 E230	Winter	5055	5090	5126	5161	5196	5537	5572	5608	5643	5678
2017-18	2012 E230	Winter	5208	5325	5442	5559	5676	5742	5859	5976	6093	6210
2021-22	2012 E230	Winter	5193	5415	5636	5857	6078	5772	5993	6214	6435	6656

Note: PSE Load Forecast is provided for PSE system load, not including the 270 MW of Transmission Customer industrial load. Transmission Customer load is included in the area load for the TPL and Eastside Needs Assessment studies.

Conservation Sensitivities: The winter forecast was adjusted for sensitivities regarding the amount of expected conservation at peak load. PSE's corporate load forecast assumes 100% of the targeted conservation levels are achieved. To understand the reliability risk due to higher than expected load, PSE ran load sensitivity studies which adjusted conservation levels as a proxy for the higher loads. For the load sensitivity studies, conservation was adjusted to 75%, 50%, and 25% of expected values.

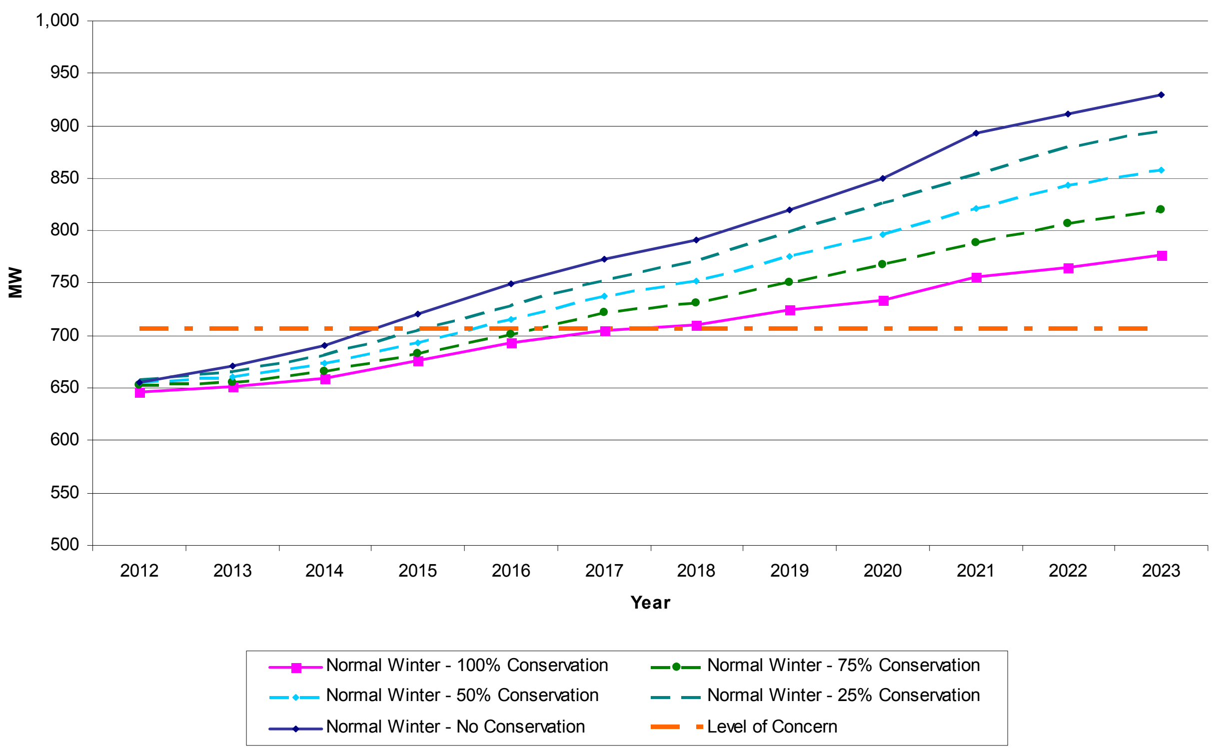

Figure 4-3: Eastside Load Forecast for Normal Winter Load Forecast 2012-2023

4.1.7 Load Power Factor Assumptions

The power factor at each substation was based on the MW and MVAR loadings at the time of the January 18, 2012 system peak. As the load levels changed based on the load forecast, the power factor at each substation did not change.

4.1.8 Transfer Levels

The NI (Northern Intertie) flows were assumed based on season and historic flows; Winter Peak NI-1500 MW S-N and Summer Peak NI-2850 MW N-S.

4.1.9 Generation Dispatch Scenarios

For the winter peak load cases, no PSE and SCL generation west of the Cascades were run. Tacoma Power generation was left on, due certain internal system constraints. The generators off-line in the Eastside Needs Assessment are listed in Table 4-4.

A low-generation case was simulated as a sensitivity. The Puget Sound area generation run during that case is indicated in Table 4-4.

Table 4-4: List of Puget Sound Area Generators Adjusted in the 2013 Eastside Needs Assessment

Generation Plant	Winter MW Rating	Expected MW Output during Winter Peak for Low-Generation Sensitivity Case	Type	Owner	Transmission Delivery Area
Enserch	184.8	125	Natural Gas, Combined Cycle	PSE	Whatcom County
Sumas	139.8	0	Natural Gas, Combined Cycle	PSE	Whatcom County
Ferndale	282.1	0	Natural Gas, Combined Cycle	PSE	Whatcom County
Whitehorn	162.2	0	Natural Gas, Simple Cycle	PSE	Whatcom County
Fredonia	341	0	Natural Gas, Simple Cycle	PSE	Skagit County
Sawmill	31	22	Biomass	Private Owner	Skagit County
Upper Baker	106	80	Hydro Dam	PSE	Skagit County
Lower Baker	78	54	Hydro Dam	PSE	Skagit County
Komo Kulshan	14	0	Hydro Run-of-River	Private Owner	Skagit County
March Point	151.6	134	Natural Gas, Combined Cycle	Shell	Skagit County
Ross	450	295	Hydro Dam	SCL	Snohomish County
Gorge	190.7	157	Hydro Dam	SCL	Snohomish County
Diablo	166	160	Hydro Dam	SCL	Snohomish County
South Tolt River	16.8	0	Hydro Run-of-River	SCL	Northeast King County
Snoqualmie	37.8	0	Hydro Run-of-River	PSE	East King County
Twin Falls	24.6	0	Hydro Run-of-River	Private Owner	East King County
Cedar Falls	30	0	Hydro Run-of-River	SCL	East King County
Freddy 1	270	0	Natural Gas, Combined Cycle	Atlantic Power/PSE	Pierce County
Electron	20	4	Hydro Run-of-River	PSE	Pierce County
Frederickson	162.2	0	Natural Gas, Simple Cycle	PSE	Pierce County
Expected MW output during Winter peak is based off of actual 2011-2012 Winter peak output except for SCL hydro, which is based off of modeled generation levels in WECC winter peak case.					

4.1.10 Reactive Resource and Dispatch Assumptions

All existing and planned area reactive resources were assumed available and dispatched if conditions called for their dispatch. The reactive output of units was constrained to defined limits and shunt reactive resources were dispatched as conditions required.

4.1.11 Conservation Assumptions

PSE employs conservation as a strategic measure to manage energy requirements and provide customer benefits. Conservation programs have been funded for over 20 years and are projected to continue to receive strong funding in the next 20 years. PSE's Energy Efficiency Group has demonstrated the efficacy of its funded programs on a continuing basis. As a result, conservation is included in PSE's Integrated Resource Plan (IRP) as a cost-effective source of new energy.

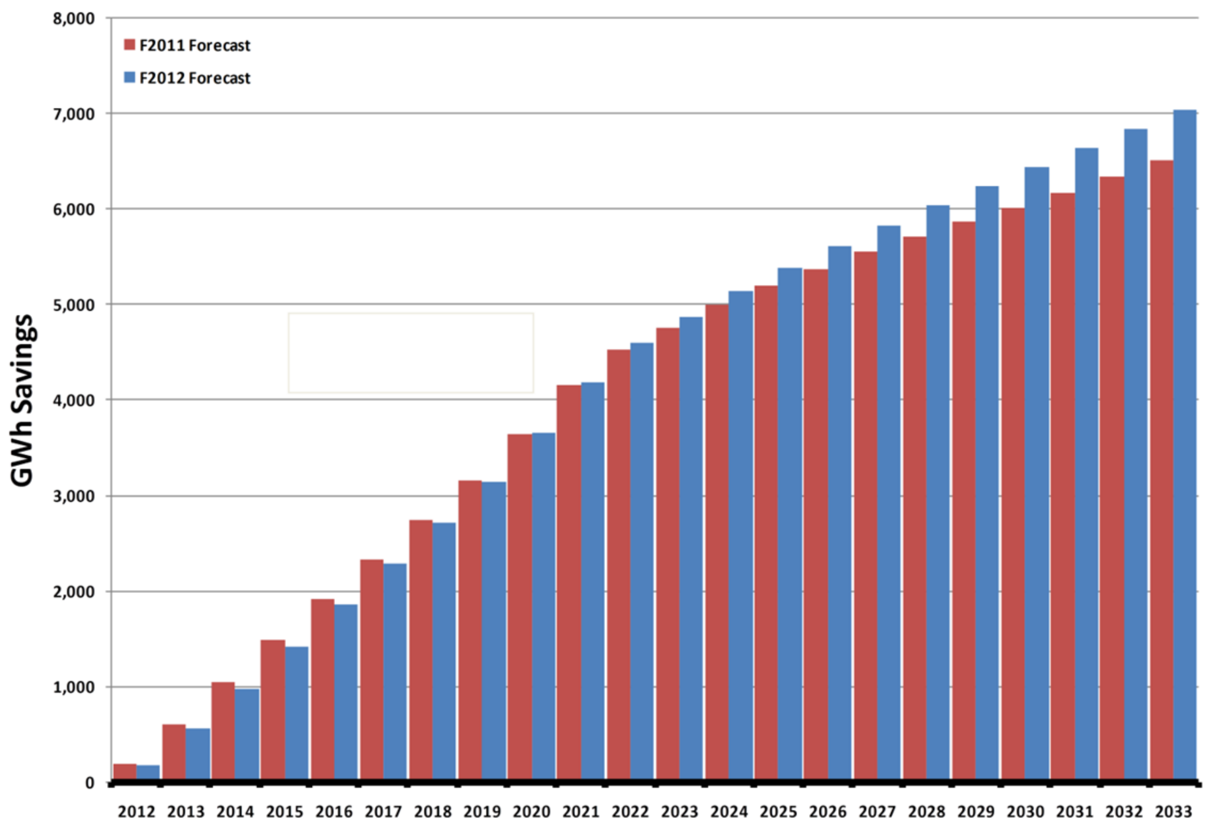

Figure 4-4: PSE Conservation Forecast in 20 year Horizon Measured in Gigawatt-Hours; Comparison of 2012 Forecast to 2011 Forecast

4.1.12 Explanation of Operating Procedures and Other Modeling Assumptions

PSE's Transmission Planning group has prepared a CAP that instructs PSE Transmission Operators to take certain actions in the event of either Talbot Hill 230-115 kV transformers overloading. While the CAP was initiated to address the potential for either transformer to exceed its emergency rating, the CAP can also be used to address the event of either transformer exceeding its operating limit as well.

The CAP instructs the PSE Transmission Operators to open the Talbot Hill – Lakeside #1 & #2 115 kV lines if either Talbot Hill 230-115 kV transformer overloads. The contingency that would cause the transformers to overload would be a double-contingency (N-1-1) loss of a Talbot Hill transformer and the Berrydale transformer during high winter loading.

With future load growth, the CAP may be expanded to state that if the transformer overload is not sufficiently reduced or the Shuffleton – Lakeside 115 kV line overloads as a result of [redacted], then the Transmission operation should open [redacted]

While none of these planned actions would drop load in a system normal configuration, the opening of [redacted] exposes three substations supplying 16,000 customers [redacted] and three substations supplying 17,000 customers on [redacted] to an outage on the lines, as shown in Figure 4-5. Furthermore, if [redacted] are opened, North and Central King County is at risk of manual load shedding for an N-1-1 loss of [redacted]. See Figure 4-5 below that shows areas in jeopardy of outage when transmission lines are opened under the CAP's to prevent overloads of the Talbot Hill and Sammamish transformers.

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Figure 4-5: Topological View of the Needs Assessment of the Eastside of Lake Washington

If, with future load growth, the Talbot Hill 230-115 kV transformers are at risk of overloading for an N-1 loss of one transformer during Winter peak conditions, then the CAP described above would be implemented as a pre-emptive, pre-contingent measure to ensure that overloads don't materialize. In this case [redacted] would be opened during winter peak conditions, regardless of the loading on the Talbot Hill transformers.

There is also a CAP intended for use during the summer peak in the event of the loss of [redacted]. The CAP instructs the PSE Transmission Operators to open [redacted].

While none of these planned actions would drop load in a system normal configuration, the opening of the transmission lines exposes seven substations supplying 23,000 customers on [redacted] and [redacted] to a subsequent outage on the lines. The total customer impact of 33,000 is shown in Figure 4-5.

With future load growth, the CAP may be expanded to state that if the associated overloads are not sufficiently reduced, then the Transmission Operator should also open [redacted].

While none of these additional actions would drop load in a system normal configuration, the opening of [redacted] exposes one substation supplying 6,000 customers on [redacted] and seven substations supplying 23,000 customers on [redacted] to a subsequent outage on the lines.

In the King County area, PSE has eight transmission transformers, any one of which, when tripped, could trigger a CAP. The customers at risk of outages due to the CAPs described above are supplied by four of the eight transmission transformers, located at Talbot Hill and Sammamish. When a transformer trips, it takes substantial time to test and replace: 18-24 hours typically for testing, and 3-5 weeks to replace the damaged transformer with a spare transformer. This is a long duration of exposure if CAPs must be employed during the transformer outage.

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4.2 Changes in Study Assumptions

The Bothell - SnoKing 230 kV #1 & #2 lines, owned by SCL, overloaded for various outages in all cases. These overloads were excluded from the results page, as SCL is planning to upgrade these lines whether or not the Eastside 230 kV project is built. Furthermore, the Eastside 230 kV project scope is not expected to significantly alleviate these line overloads.

SCL's Maple Valley - SnoKing 230 kV #1 & #2 lines overloaded for various outages in all cases; these overloads were observed in the base case and were expected to also occur in the more extreme cases. However, these overloads were caused in large part by the loss of [redacted]. BPA has winter operating procedures in place that will protect against these overloads through use of nomograms.

The [redacted] contingencies did not solve for the majority of the cases, due to the high South to North flows on the Northern Intertie. Therefore, the overloads in more extreme cases were not listed, as the contingency did not solve. The potential issues caused by the high South to North flows are managed through the use of nomograms by BPA.

Certain local 115 kV PSE system overloads within King County were excluded from the listed results, as they were clearly a local system problem that did not contribute to the need for the Eastside 230 kV project. The following systems or lines were excluded: Moorlands three line system, Asbury three line system, Krain Corner 115-55 kV system, and Novelty Hill - Stillwater - Cottage Brook 115 kV lines. These are known system issues with planned projects that are independent in nature from the Eastside 230 kV project.

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Section 5 Performance Requirements

5.1 Planning Standards and Criteria

This study examined thermal overloads for Category A (N-0), Category B (N-1) and Category C (N-2 and N-1-1) outages as required by NERC, WECC and PSE Transmission Planning Guidelines. PSE plans for winter and summer peak, such that no thermal or voltage violations result. While the peaks occur for just a few hours per year, there are many more hours each year where operating flexibility is impacted by system capacity. PSE plans for normal summer and winter temperatures, which are 23ºF in winter and 86ºF in summer. PSE also studies extreme winter peak temperature (13ºF) as an indicator of future deficiencies.

> **NERC TPL-001- System Performance Under Normal (No Contingency) Conditions (Category A):** PSE shall demonstrate through a valid assessment that its portion of the interconnected transmission system is planned such that, with all transmission facilities in service and with normal (pre-contingency) operating procedures in effect, the Network can be operated to supply projected customer demands and projected Firm (non- recallable reserved) Transmission Services at all Demand levels over the range of forecast system demands, under the conditions defined in Category A of Table 1[16].
>
> **NERC TPL-002 – System Performance Following Loss of a Single Bulk Electric System Element (Category B):** PSE shall demonstrate through a valid assessment that its portion of the interconnected transmission system is planned such that the Network can be operated to supply projected customer demands and projected Firm (non-recallable reserved) Transmission Services, at all demand levels over the range of forecast system demands, under the contingency conditions as defined in Category B of Table 1[17].
>
> Category B outages can occur at any time when a single element trips off line. The NERC TPL Standards Table 1 Category B states that there should be no loss of load or curtailed firm transfers with the exception outlined in footnote b of Table 1[18]. Utilities may only shed directly-connected ("consequential") load to stay compliant. Non-consequential load loss is not allowed for Category B events for BES level less than 300 kV. The system shall remain stable. Cascading or uncontrolled islanding shall not occur. Therefore any overloads showing up for a Category B event are very serious.
>
> **NERC TPL-003 – System Performance Following Loss of Two or More Bulk Electric System Elements (Category C):** PSE shall each demonstrate through a valid assessment that its portion of the interconnected transmission systems is planned such that the network can be operated to supply projected customer demands and projected Firm (non-recallable reserved) Transmission Services, at all demand

[16] Table 1 TPL-001 - System Performance Under Normal (No Contingency) Conditions (Category A)

[17] Table 1 TPL-002 - System Performance Following Loss of a Single Bulk Electric System Element (Category B)

[18] Footnote b Table 1 - An objective of the planning process is to minimize the likelihood and magnitude of interruption of firm transfers or Firm Demand following Contingency events. Curtailment of firm transfers is allowed when achieved through the appropriate-dispatch of resources obligated to re-dispatch, where it can be demonstrated that Facilities, internal and external to the Transmission Planner's planning region, remain within applicable Facility Ratings and the re-dispatch does not result in the shedding of any Firm Demand. For purposes of this footnote, the following are not counted as Firm Demand: (1) Demand directly served by the Elements removed from service as a result of the Contingency, and (2) Interruptible Demand or Demand-Side Management Load. In limited circumstances, Firm Demand may be interrupted throughout the planning horizon to ensure that BES performance requirements are met. However, when interruption of Firm Demand is utilized within the Near-Term Transmission Planning Horizon to address BES performance requirements, such interruption is limited to circumstances where the use of Firm Demand interruption meets the conditions shown in Attachment 1. In no case can the planned Firm Demand interruption under footnote 'b' exceed 75 MW for US registered entities. The amount of planned Non-Consequential Load Loss for a non-US Registered Entity should be implemented in a manner that is consistent with, or under the direction of, the applicable governmental authority or its agency in the non-US jurisdiction.

Levels over the range of forecast system demands, under the contingency conditions as defined in Category C of Table 1[19] .

Category C outages have subcategories of N-2 and N-1-1. An N-2 outage is when a single event trips multiple facilities, such as a transmission bus fault tripping all breakers on the bus or a double-circuit transmission line outage. Breaker failure is also included as a Category C outage. For these outages, there is no time allowed for operator response, but the utility is allowed to have automatic processes to shed non-consequential load to stay compliant.

An N-1-1 Category C outage is a Category B outage followed by a period of time to manually adjust the system to a secure state, followed by a second Category B outage. PSE utilizes 30 minutes to make manual system adjustments after the first outage occurs, to prevent overloads upon the second outage event.

TPL-001-WECC-CRT-2: System Performance Criterion Under Normal Conditions, Following Loss of a Single BES Element, and Following Extreme BES Events. System simulations and associated assessments are needed periodically to ensure that reliable systems are developed that meet specified performance requirements with sufficient lead time, and that systems continue to be modified or upgraded as necessary to meet present and future system needs.

PSE Transmission Planning Guidelines, November 2012: The Transmission Planning Guidelines explain the criteria and standards used to assess the ability of Puget Sound Energy's existing and future electric transmission system, and how they are applied to provide safe and reliable service at reasonable cost. The guidelines address both specific and general issues the transmission planner needs to consider. There may be issues specific to site, project, region, or customer that will require plans to be developed on a case-by case basis. However, the Transmission Planning Guidelines are structured in a way that will help achieve consistency across the PSE transmission system.

5.2 Performance Criteria

5.2.1 Steady State Thermal and Voltage Limits

PSE has two thermal operating limits; normal and emergency. The normal operating limit is a specific level of electrical loading that a system, facility, or element can support or withstand through the daily demand cycles without loss of equipment life. The emergency limit is a specific level of electrical loading that a system, facility, or element can support or withstand for a finite period. The emergency rating assumes acceptable loss of equipment life or other physical or safety limitations for the equipment involved. If there is a violation of the emergency limit, a transmission line may not meet applicable clearance, tension and sag criteria. PSE's operating practice is to shift or shed load or dispatch generation to avoid reaching an emergency limit.

System steady state voltages and post contingency voltage deviation shall be within acceptable limits. For PSE system the acceptable limits are: the steady state voltage levels are not above 105% or below 90% for any bus, the voltage deviation for Category B events does not exceed 5%, and the voltage deviation for multiple contingency Category C events does not exceed 10%.[20]

[19] Table 1 TPL-003 - System Performance Following Loss of Two or More Bulk Electric System Elements (Category C)

[20] PSE Transmission Planning Guidelines, November 2012, page 7

5.2.2 Steady State Solution Parameters

Devices with automatic settings were allowed to adjust automatically for base case runs, reflecting manual operation by Transmission Operators where appropriate: LTC's, phase-shifters, and shunt reactive devices. During contingency runs, LTC and phase-shifter operations were disabled. Shunt reactive devices with known fast-acting schemes were allowed to switch. Inter-area AGC was enabled for the analysis since generation or load loss simulations for the Eastside Needs Assessment were all modeled within the Northwest area and AGC response would be expected for those conditions.

Table 5-1: Study Solution Parameters

Case	Area Interchange	Transformer LTCs	Phase Angle Regulators	SVDs & Switched Shunts
Base	Tie Lines Regulating	Stepping	Regulating or Statically Set	Regulating
Contingency	Tie Lines Regulating	Disabled	Disabled	Regulating

5.3 System Testing

5.3.1 System Design Conditions and Sensitivities Tested

Four base scenarios were developed for the additional winter studies run for the 2013 Eastside Needs Assessment. The study plan is shown in Figure 5-1.

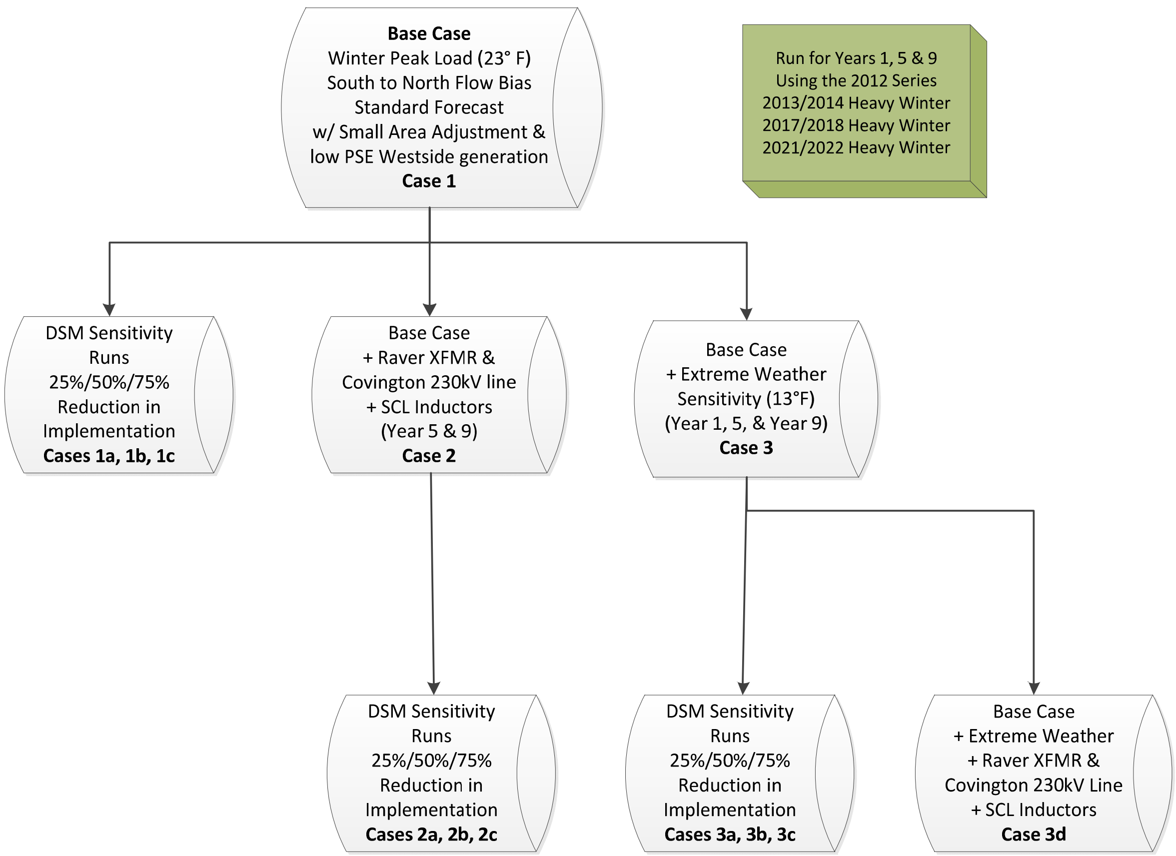

Figure 5-1: Eastside Project Need Validation Study Plan

Case 1 represents base years 2013-14, 2017-18, and 2021-22 winter peaks, normal weather adjusted by substation to reflect the lumpiness of the load. Case 1 includes a south to north bias of 1500 MW with low PSE generation in the Puget Sound area.

Case 2 represents 2017-18 and 2021-22 with additions of a 500 kV/230 kV transformer at Raver, a Raver to Covington 230 kV line, and 115 kV series inductors to the Broad Street - Massachusetts and Broad Street - East Pine 115 kV underground cables in Seattle City Light.

Case 3 represents extreme weather for Case 1.

Case 3d represents extreme weather for Case 2.

The winter cases were run with no generation in the Puget Sound area, a case which PSE normally runs for the annual TPL assessment. However, since it is an extreme case, a low-generation case was run for the 2013 Eastside Needs Assessment as a sensitivity to determine whether some of the violations seen during the power flows could be offset by running generation. The generation levels for the low-generation sensitivity case are shown in Table 4-4, in the column labeled "Expected MW Output during Winter Peak for Low-Generation Sensitivity Case."

Sensitivities on the amount of conservation realized were performed for each of the cases above, to indicate the possible additional violations that could occur should conservation be achieved at a level below the projection or if economic growth should be higher than forecast. This was done because the 10 year load forecast with full projected conservation had such a flat growth profile. The load levels were adjusted to reflect 75%, 50%, and 25% conservation as a proxy for higher loads. The case assumptions are summarized in Table 5-2.

Table 5-2: Winter and Summer Case Study Assumptions

Winter and Summer Case Study Assumptions						
Case Name	**Amount of Conservation**	**System Load**	**Eastside Load**	**Northern Intertie**	**PSE/SCL Westside Gen**	**Other Adjustments Modeled**
1 100% Conservation 2013-14 Winter	100%	5055 MW	652 MW	1500 MW Export	0 MW	Saint Clair 230-115 kV transformer; Talbot Hill - Berrydale #1 line uprate; Starwood autotransformer removal with Tacoma Power voltage increase
1 75% Conservation 2013-14 Winter	75%	5090 MW	656 MW	1500 MW Export	0 MW	Saint Clair 230-115 kV transformer; Talbot Hill - Berrydale #1 line uprate; Starwood autotransformer removal with Tacoma Power voltage increase
2 100% Conservation 2017-18 Winter	100%	5208 MW	706 MW	1500 MW Export	0 MW	Block load allocated per King Co Dist. Planers; Planned improvements include 2013 adjustments + Alderton 230-115 kV transformer; Beverly Park 230-115 kV transformer; Raver 500-230 kV transformer; SCL series inductors
2 75% Conservation 2017-18 Winter	75%	5325 MW	722 MW	1500 MW Export	0 MW	Block load allocated per King Co Dist. Planers; Planned improvements include 2013 adjustments + Alderton 230-115 kV transformer; Beverly Park 230-115 kV transformer; Raver 500-230 kV transformer; SCL series inductors
2 100% Conservation 2021-22 Winter	100%	5126 MW	756 MW	1500 MW Export	0 MW	Block load allocated per King Co Dist. Planers; Planned improvements include 2017-18 adjustments
2 75% Conservation 2021-22 Winter	75%	5415 MW	789 MW	1500 MW Export	0 MW	Block load allocated per King Co Dist. Planers; Planned improvements include 2017-18 adjustments
3 100% Conservation 2013-14 Extreme Winter	100%	5537 MW	718 MW	1500 MW Export	0 MW	Saint Clair 230-115 kV transformer; Talbot Hill - Berrydale #1 line uprate; Starwood autotransformer removal with Tacoma Power voltage increase
3d 100% Conservation 2017-18 Extreme Winter	100%	5742 MW	782 MW	1500 MW Export	0 MW	Block load allocated per King Co Dist. Planers; Planned improvements include 2013 adjustments + Alderton 230-115 kV transformer; Beverly Park 230-115 kV transformer; Raver 500-230 kV transformer; SCL series inductors
3d 100% Conservation 2021-22 Extreme Winter	100%	5772 MW	845 MW	1500 MW Export	0 MW	Block load allocated per King Co Dist. Planers; Planned improvements include 2013 adjustments + Alderton 230-115 kV transformer; Beverly Park 230-115 kV transformer; Raver 500-230 kV transformer; SCL series inductors
2014 Heavy Summer	100%	3343 MW	516 MW	2850 Import	2171 MW	Saint Clair 230-115 kV transformer; Talbot Hill - Berrydale #1 line uprate; Starwood autotransformer removal with Tacoma Power voltage increase
2018 Heavy Summer	100%	3554 MW	552 MW	2850 Import	2276 MW	Planned improvements include 2013 adjustments + Alderton 230-115 kV transformer; Beverly Park 230-115 kV transformer; White River - Electron Heights 115 kV line re-route into Alderton; White River 2nd bus section breaker; Lake Hills - Phantom Lake 115 kV line; Sammamish-Juanita 115 kV line

5.3.2 Steady State Contingencies / Faults Tested

The above cases were tested based on Category A, B, and C contingencies described in the NERC TPL, and WECC standards and PSE's Transmission Planning Guidelines. Descriptions of the type of contingencies tested are listed in Table 5-3.

Table 5-3: Summary of NERC, WECC and/or PSE Category Contingencies Tested

NERC WECC PSE Categories	Description of Outaged Element(s)	Contingencies Modeled
A	All lines in-service	N/A
B A-2; 6.1 a. PP4; 3.1 a.	Loss of a generator, transmission circuit, transformer or single pole DC line	Category B contingencies included all PSE and interconnected transmission lines and transmission transformers,
C A-2; 6.1 a. PP4; 3.1 a.	Normally loss of a bus or circuit breaker; or loss of any category B element followed by another category B element with system adjustments between events; or loss of any two circuits of a multi circuit tower line or loss of a bipolar DC line; or a stuck breaker with delayed clearing of a generator, transmission circuit, transformer or bus section.	Category C: N-2 contingencies included all common-structure double circuit lines, all transmission buses and bus sections with 3 or more transmission elements, and all stuck transmission breakers. Category C: N-1-1 included a pairwise combination of all Category B elements followed by all other Category B elements.
D A-2; 6.1 a. PP4; 3.1 a.	Loss of a generator, transmission circuit, transformer or bus section; or other transmission planning entity selected critical outage or loss of a category B element followed by loss of any two circuits of a multi circuit tower or a stuck breaker	Category D was not performed in this study

Section 6 Results of Analysis

6.1 Overview of Results

The following sections describe the results of the analysis. The thermal loading percentages described below are based on a percentage of the emergency rating for each facility.

6.1.1 N-0 Thermal and Voltage Violation Summary

For all cases, there are no thermal or voltage violations for the all lines in (N-0) state.

2013-14 – Case 1-Winter Peak, Normal Weather: For all elements in service (N-0) state, there were no thermal or voltage violations for 2013-14 winter peak, normal weather with all levels of conservation modeled (i.e. 100%, 75%, 50%, or 25%)

2013-14 – Case 3-Winter Peak, Extreme Weather: For all elements in service (N-0), there were no thermal or voltage violations for 2013-14 winter peak, extreme weather, with all levels of conservation modeled (i.e. 100%, 75%, 50%, or 25%) conservation.

2017-18 – Case 2-Winter Peak, Normal Weather: For all elements in service (N-0), there were no thermal or voltage violations for 2017-18 winter peak, normal weather, with all levels of conservation modeled (i.e. 100%, 75%, 50%, or 25%) conservation.

2017-18 – Case 3-Winter Peak, Extreme Weather: For all elements in service (N-0), there were no thermal or voltage violations for 2017-18 winter peak, extreme weather, with all levels of conservation modeled (i.e. 100%, 75%, 50%, or 25%) conservation.

2021-22 – Case 2-Winter Peak, Normal Weather: For all elements in service (N-0), there were no thermal or voltage violations for 2021-22 winter peak, normal weather, with all levels of conservation modeled (i.e. 100%, 75%, 50%, or 25%) conservation.

2021-22 – Case 3-Winter Peak, Extreme Weather: For all elements in service (N-0), there were no thermal or voltage violations for 2021-22 winter peak, extreme weather, with all levels of conservation modeled (i.e. 100%, 75%, 50%, or 25%) conservation.

6.1.2 2013-14 Thermal Summaries: Winter Peak, Normal and Extreme Weather & Summer Peak Normal Weather

Table 6-1 shows the summary of results for categories B (N-1) and C (N-1-1 & N-2) for 2013-14 winter and 2014 summer peaks with normal weather. Table 6-1 shows that for the winter peak, normal weather, 100% conservation, (PSE Load 5,055 MW), there are no Category B thermal violations but there are five (5) potential thermal violations in the King County area for Category C contingencies. Those five potential violations are as follows and highlighted in yellow in

Table 6-2.

1. Talbot Hill - Lakeside #1 115 kV Line
2. Talbot Hill - Lakeside #2 115 kV Line
3. Talbot Hill 230-115 kV transformer #1
4. Talbot Hill 230-115 kV transformer #2
5. Talbot Hill - Boeing Renton - Shuffleton 115 kV Line

Those Category C contingencies can be mitigated by operational procedures and re-dispatching. Also, Table 6-1 lists six (6) additional facilities within the King County area, which are operating from 90% to 100% of the emergency operating limits and are above the operating limits. Those facilities are highlighted in gray on

Table 6-2.

1. White River 230-115 kV transformer #2 – 97.4%
2. White River 230-115 kV transformer #1 – 96.9%
3. Talbot Hill - Berrydale #1 115 kV line – 96.0%
4. Berrydale 230-115 kV transformer – 92.4%
5. O'Brien 230-115 kV transformer #2 – 94%
6. O'Brien 230-115 kV transformer #1 – 93.2%

Table 6-2 also shows potential thermal overloads of elements outside of PSE's service area. Two lines of notice include Maple Valley - SnoKing #1 & #2 230 kV lines, which pass through the Eastside of King County.

For the 2014 summer peak normal weather, (PSE load of 3343 MW), high generation in the north and high imports from British Columbia (Table 6-1), there is one (1) potential Category B (N-1) thermal violation (Monroe - Novelty Hill 230 kV line) and for the same case with no generation in the north there is one (1) potential Category B thermal violation (Maple Valley - Sammamish 230 kV line). Those potential over loads are the result of losing [redacted]. Those facilities are owned by BPA. There is also one (1) potential Category C (N-1-1) potential thermal violation (Sammamish 230-115 kV transformer #2).

Table 6-3 show the potential impact of extreme winter weather with 100% and 50% conservation in 2013-14, (PSE load of 5,537 MW and 5,608 MW respectively). There are no potential Category B thermal violations, but there are three (3) elements which are operating at 90% or greater of the emergency limits and are above the operating limits; Talbot Hill 230-115 kV transformer #1, Talbot Hill 230-115 kV transformer #2, and White River 230-115 kV transformer #2.

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Table 6-1: Summary of Elements above Emergency and Operating Limits: 2013-14 Winter Peak, Normal Weather & Summer Peak Normal Weather

Year of Study	Normal or Extreme Weather	Case Conditions	Amount of Conservation/ System Load	Type of Contingency	Elements above Emergency Limit	Elements > 90% of Emergency Limit or above Operating Limit
2013-14 Winter	Normal	South-North NI Flow No Western Generation	100% 5055 MW	N-1		
2013-14 Winter	Normal	South-North NI Flow No Western Generation	100% 5055 MW	N-1-1	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 Talbot Hill-Boeing Renton-Shuffleton 115 kV Line	White River 230-115 kV transformer #2 White River 230-115 kV transformer #1 Talbot Hill-Berrydale #1 115 kV line Berrydale 230-115 kV transformer O'Brien 230-115 kV transformer #2 O'Brien 230-115 kV transformer #1
2013-14 Winter	Normal	South-North NI Flow, No Western Generation	100% 5055 MW	N-2 or Common Mode		Talbot Hill-Lakeside #2 115 kV Line Berrydale 230-115 kV transformer
2013-14 Winter	Normal	South-North NI Flow, No Western Generation	75% 5090 MW	N-1		
2013-14 Winter	Normal	South-North NI Flow No Western Generation	75% 5090 MW	N-1-1	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill-Boeing Renton-Shuffleton 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2	White River 230-115 kV transformer #2 White River 230-115 kV transformer #1 Talbot Hill-Berrydale #1 115 kV line Berrydale 230-115 kV transformer O'Brien 230-115 kV transformer #2 O'Brien 230-115 kV transformer #1
2013-14 Winter	Normal	South-North NI Flow, No Western Generation	75% 5090 MW	N-2 or Common Mode		Talbot Hill-Lakeside #2 115 kV Line Berrydale 230-115 kV transformer
2013-14 Winter	Normal	South-North NI Flow, No Western Generation	50% 5126 MW	N-1		
2013-14 Winter	Normal	South-North NI Flow, No Western Generation	50% 5126 MW	N-1-1	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill-Boeing Renton-Shuffleton 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2	White River 230-115 kV transformer #1 White River 230-115 kV transformer #2 Talbot Hill-Berrydale #1 115 kV line Berrydale 230-115 kV transformer O'Brien 230-115 kV transformer #2 O'Brien 230-115 kV transformer #1
2013-14 Winter	Normal	South-North NI Flow, No Western Generation	50% 5126 MW	N-2 or Common Mode		Talbot Hill 230-115 kV transformer #2 Talbot Hill-Lakeside #2 115 kV Line Berrydale 230-115 kV transformer
2014 Heavy Summer	Normal	Hi Gen, Hi Import from BC	100% 3343 MW	N-1	Monroe-Novelty Hill 230 kV line	
2014 Heavy Summer	Normal	No Gen, Hi Export to BC	100% 3343 MW	N-1	Maple Valley - Sammamish 230 kV line	
2014 Heavy Summer	Normal	No Gen, Hi Export to BC	100% 3343 MW	N-1-1	Sammamish 230-115 kV transformer #2	Sammamish 230-115 kV transformer #1

Table 6-2: Elements above Emergency and Operating Limits: 2013-14 Winter Peak, 100% Conservation, Normal Weather, Thermal Loadings (Redacted)

Case	Category	Worst Contingency	Owner of Facilities Out	Element(s)	Owner of Overloaded Facilities	Percent Overload
2013-14 Winter	B	[redacted]	BPA	Maple Valley - SnoKing #1 230 kV line	SCL	110.0%
2013-14 Winter	B	[redacted]	BPA	Maple Valley - SnoKing #2 230 kV line	SCL	107.8%
2013-14 Winter	C	[redacted]	BPA	Maple Valley - SnoKing #1 230 kV line	SCL	124.0%
2013-14 Winter	C	[redacted]	BPA	Maple Valley - SnoKing #2 230 kV line	SCL	123.8%
2013-14 Winter	C	[redacted]	BPA	Talbot Hill - Lakeside #1 115 kV line	PSE	97.1%
2013-14 Winter	C	[redacted]	BPA	Talbot Hill - Lakeside #2 115 kV line	PSE	96.9%
2013-14 Winter	C	[redacted]	PSE	Berrydale 230-115 kV transformer	PSE	96.6%
2013-14 Winter	C	[redacted]	BPA & SCL	Maple Valley - SnoKing #1 230 kV line	SCL	146.7%
2013-14 Winter	C	[redacted]	BPA & SCL	Maple Valley - SnoKing #2 230 kV line	SCL	145.0%
2013-14 Winter	C	[redacted]	PSE	Talbot Hill 230-115 kV transformer #1	PSE	100.9%
2013-14 Winter	C	[redacted]	BPA & PSE	Talbot Hill - Lakeside #1 115 kV line	PSE	115.2%
2013-14 Winter	C	[redacted]	BPA & PSE	Talbot Hill - Lakeside #2 115 kV line	PSE	115.1%
2013-14 Winter	C	[redacted]	BPA & PSE	Talbot Hill - Boeing Renton - Shuffleton 115 kV line	PSE	101.1%

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Table 6-2: Elements above Emergency and Operating Limits: 2013-14 Winter Peak, 100% Conservation, Normal Weather, Thermal Loadings (Redacted) (CONTINUED)

2013-14 Winter	C	[redacted]	PSE	Talbot Hill 230-115 kV transformer #2	PSE	100.5%
2013-14 Winter	C	[redacted]	PSE	White River 230-115 kV transformer #2	PSE	97.4%
2013-14 Winter	C	[redacted]	PSE	White River 230-115 kV transformer #1	PSE	96.9%
2013-14 Winter	C	[redacted]	PSE	Talbot Hill - Berrydale #1 115 kV line	PSE	96.0%
2013-14 Winter	C	[redacted]	PSE	Berrydale 230-115 kV transformer	PSE	92.4%
2013-14 Winter	C	[redacted]	PSE	O'Brien 230-115 kV transformer #2	PSE	94.0%
2013-14 Winter	C	[redacted]	PSE	O'Brien 230-115 kV transformer #1	PSE	93.2%

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Table 6-3: Summary of Elements above Emergency and Operating Limits: 2013-14 Winter Peak, Extreme Weather

Year of Study	Normal or Extreme Weather	Case Conditions	Amount of Conservation/ System Load	Type of Contingency	Elements above Emergency Limit	Elements > 90% of Emergency Limit or above Operating Limit
2013-14 Winter	Extreme	South-North NI Flow No Western Generation	100% 5537 MW	N-1		Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 White River 230-115 kV transformer #2
2013-14 Winter	Extreme	South-North NI Flow No Western Generation	50% 5608 MW	N-1-1	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill-Boeing Renton-Shuffleton 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 White River - Lea Hill - Berrydale 115 kV line Talbot Hill-Berrydale #1 115 kV line Berrydale 230-115 kV transformer O'Brien 230-115 kV transformer #1 O'Brien 230-115 kV transformer #2 White River 230-115 kV transformer #1 White River 230-115 kV transformer #2	Shuffleton-Lakeside 115 kV line O'Brien 115 kV North bus section breaker O'Brien - Asbury 115 kV line Shuffleton - President Park - Lake Tradition 115 kV line
2013-14 Winter	Extreme	South-North NI Flow No Western Generation	50% 5608 MW	N-2 or Common Mode	Talbot Hill-Lakeside #2 115 kV Line Berrydale 230-115 kV transformer	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2

6.1.3 2017-18 Thermal Summaries: Winter Peak, Normal and Extreme Weather & Summer Peak Normal Weather

Table 6-4 shows the summary of results for categories B (N-1) and C (N-1-1 & N-2) for 2017-18 winter and summer peaks with normal weather.

Table 6-4 shows that for the winter peak, normal weather, 100% conservation, (PSE load of 5,208 MW), there are no potential Category B thermal violations but there are three (3) facilities which are loaded from 90% to 100% of the emergency ratings. These facilities are highlighted in gray in Table 6-5.

1. Talbot Hill - Lakeside #1 115 kV line – 98.6%
2. Talbot Hill - Lakeside #2 115 kV line – 98.4%
3. Talbot Hill 230-115 kV transformer #2 – 90.3%

If 50% of conservation is achieved, (PSE load of 5,442 MW), the number of potential Category B thermal overloads increase to two (2) facilities.

1. Talbot Hill - Lakeside #1 115 kV Line
2. Talbot Hill - Lakeside #2 115 kV Line

There are six (6) potential thermal violations (same as 2013-14) of PSE lines or transformers in the King County area for Category C contingencies. These facilities are highlighted in yellow on Table 6-5, which shows that the potential thermal overloads vary up to a high of 128%. Overloads caused by BPA facility outages which are controlled by BPA generation dispatch are not highlighted.

1. Talbot Hill - Lakeside #1 115 kV Line
2. Talbot Hill - Lakeside #2 115 kV Line
3. Talbot Hill 230-115 kV transformer #1
4. Talbot Hill 230-115 kV transformer #2
5. Talbot Hill - Boeing Renton - Shuffleton 115 kV Line
6. Maple Valley - Sammamish 230 kV Line

If 75% of conservation is achieved, (PSE load of 5,325 MW), the number of potential Category C thermal overloads increase to seven (7) facilities and some occur for more than one Category C contingency.

1. Talbot Hill - Lakeside #1 115 kV Line
2. Talbot Hill - Lakeside #2 115 kV Line
3. Talbot Hill - Boeing Renton - Shuffleton 115 kV Line
4. Talbot Hill 230-115 kV transformer #1
5. Talbot Hill 230-115 kV transformer #2
6. White River - Lea Hill - Berrydale 115 kV line
7. Maple Valley - Sammamish 230 kV line

If 50% of conservation is achieved, (PSE load of 5,442 MW), the number of potential Category C thermal overloads increase to ten (10) facilities and some occur for more than one Category C contingency.

1. Talbot Hill- Lakeside #1 115 kV Line
2. Talbot Hill- Lakeside #2 115 kV Line
3. Talbot Hill - Boeing Renton-Shuffleton 115 kV Line
4. Talbot Hill 230-115 kV transformer #1
5. Talbot Hill 230-115 kV transformer #2
6. Maple Valley - Sammamish 230 kV line
7. White River - Lea Hill - Berrydale 115 kV line
8. Talbot Hill - Berrydale #1 115 kV line
9. Shuffleton - O'Brien 115 kV line
10. Shuffleton - Lakeside 115 kV line

For the 2018 summer peak, normal weather, (PSE load of 3,554 MW), high generation in the north and high imports from British Columbia (Table 6-12), there are two (2) potential Category B (N-1) thermal violations (Monroe - Novelty Hill 230 kV line and Maple Valley - Sammamish 230 kV line) and there are three (3) potential Category C (N-1-1 & N-2) thermal violations (Beverly Park - Cottage Brook 115 kV line, Sammamish 230-115 kV transformer #1, and Sammamish 230-115 kV transformer #2). The sections of the Monroe - Novelty Hill 230 kV line and Maple Valley - Sammamish 230 kV line that may overload are owned by BPA.

Table 6-6 shows the results of the generation sensitivity case for 2017-18, in which 1,031 MW of Puget Sound area generation was turned on. For the winter peak, normal weather, 100% conservation, (PSE load of 5,208 MW), and Puget Sound generation of 1,031 MW, there are no potential Category B thermal violations. There are four (4) potential Category C (N-1-1) violations remaining above the emergency limits (Talbot Hill - Lakeside #1 & #2 115 kV lines, and Talbot Hill 230-115 kV transformers #1 and #2). Running this level of generation also resulted in a new transformer operating above 90% for an N-1-1 contingency; the Sammamish transformer #2 will be above 90% if there are outages of both Sammamish transformer #1 and the Novelty Hill transformer. In general, turning on 1,000 MW of generation in the northern part of the Puget Sound area can have a significant impact in reducing transmission line overloads, but minor impact for transformer overloads.

Table 6-7 shows that for the 2017-18 winter peak, extreme weather, (PSE load of 5,742 MW), no generation in the north and high exports to British Columbia, there are two (2) potential Category B (N-1) thermal violations (Talbot Hill - Lakeside #1 & #2 115 kV lines (99.2% & 98.6%)); and there are twelve (12) potential Category C (N-1-1 & N-2) thermal violations.

The operational solution to temporarily remedy the potential overloads on Talbot Hill #1 transformer for the Category C loss of the North Talbot Hill 230 kV bus during extreme winter weather is to open breakers preemptively [redacted]. When that occurs there is added risk of losing load with the next N-1 contingency.

Redacted Information is Designated as PSE CEII, and for safety and security reasons will not be disclosed in this filing.

Table 6-4: Summary of Elements above Emergency and Operating Limits: 2017-18 Winter Peak, Normal Weather & Summer Peak Normal Weather

Year of Study	Normal or Extreme Weather	Case Conditions	Amount of Conservation/ System Load	Type of Contingency	Elements above Emergency Limit	Elements > 90% of Emergency Limit or above Operating Limit
2017-18 Winter	Normal	South-North NI Flow No Western Generation	100% 5208 MW	N-1		Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill 230-115 kV transformer #2
2017-18 Winter	Normal	South-North NI Flow No Western Generation	100% 5208 MW	N-1-1	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 Talbot Hill-Boeing Renton-Shuffleton 115 kV Line Maple Valley-Sammamish 230 kV line	Talbot Hill-Berrydale #1 115 kV line White River - Lea Hill - Berrydale 115 kV Line Shuffleton-O'Brien 115 kV line Shuffleton-Lakeside 115 kV line Berrydale 230-115 kV transformer O'Brien 230-115 kV transformer #2 O'Brien 230-115 kV transformer #1
2017-18 Winter	Normal	South-North NI Flow No Western Generation	100% 5208 MW	N-2 or Common Mode	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line	Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 Berrydale 230-115 kV transformer
2017-18 Winter	Normal	South-North NI Flow No Western Generation	75% 5325 MW	N-1		Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2
2017-18 Winter	Normal	South-North NI Flow No Western Generation	75% 5325 MW	N-1-1	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill-Boeing Renton-Shuffleton 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 White River - Lea Hill - Berrydale 115 kV line Maple Valley - Sammamish 230 kV line	Talbot Hill-Berrydale #1 115 kV line Shuffleton-O'Brien 115 kV line Shuffleton-Lakeside 115 kV line Berrydale 230-115 kV transformer O'Brien 230-115 kV transformer #2 O'Brien 230-115 kV transformer #1 O'Brien 115 kV North bus section breaker O'Brien-Asbury 115 kV line
2017-18 Winter	Normal	South-North NI Flow No Western Generation	75% 5325 MW	N-2 or Common Mode	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line	Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 Berrydale 230-115 kV transformer
2017-18 Winter	Normal	South-North NI Flow No Western Generation	50% 5442 MW	N-1	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line	Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 Talbot Hill-Boeing Renton-Shuffleton 115 kV Line
2017-18 Winter	Normal	South-North NI Flow No Western Generation	50% 5442 MW	N-1-1	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill-Boeing Renton-Shuffleton 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 Maple Valley-Sammamish 230 kV line White River - Lea Hill - Berrydale 115 kV line Talbot Hill-Berrydale #1 115 kV line Shuffleton - O'Brien 115 kV line Shuffleton-Lakeside 115 kV line	Berrydale 230-115 kV transformer O'Brien 230-115 kV transformer #2 O'Brien 230-115 kV transformer #1 O'Brien 115 kV North bus section breaker O'Brien - Asbury 115 kV line Shuffleton - President Park - Lake Tradition 115 kV line
2017-18 Winter	Normal	South-North NI Flow No Western Generation	50% 5442 MW	N-2 or Common Mode	Talbot Hill-Lakeside #2 115 kV Line	Talbot Hill-Lakeside #1 115 kV Line Berrydale 230-115 kV transformer Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2
2018 Heavy Summer	Normal	Hi Gen, Hi Import from BC	100% 3554 MW	N-1	Monroe-Novelty Hill 230 kV line	

Table 6-4: Summary of Elements above Emergency and Operating Limits: 2017-18 – Winter Peak, Normal Weather & Summer Peak Normal Weather (CONTINUED)

2018 Heavy Summer	Normal	No Gen, Hi Export to BC	100% 3554 MW	N-1	Maple Valley - Sammamish 230 kV line	Talbot Hill-Lakeside #1 115 kV line Talbot Hill-Lakeside #2 115 kV line
2018 Heavy Summer	Normal	Hi Gen, Hi Import from BC	100% 3554 MW	N-1-1	Beverly Park - Cottage Brook 115 kV line Sammamish 230-115 kV transformer #1 Sammamish 230-115 kV transformer #2	Novelty Hill 230-115 kV transformer
2018 Heavy Summer	Normal	Hi Gen, Hi Import from BC	100% 3554 MW	N-2 or Common Mode		Sammamish-Lakeside #2 115 kV line

Table 6-5: Elements above Emergency and Operating Limits: 2017-18 Winter Peak, 100% Conservation, Normal Weather, Thermal Loadings (Redacted)

Case	Category	Worst Contingency	Owner of Facilities Out	Element(s)	Owner of Overloaded Facilities	Percent Overload
2017-18 Winter	B	[redacted]	BPA	Maple Valley - SnoKing #1 230 kV line	SCL	119.3%
2017-18 Winter	B	[redacted]	BPA	Maple Valley - SnoKing #2 230 kV line	SCL	118.2%
2017-18 Winter	B	[redacted]	BPA	Talbot Hill - Lakeside #1 115 kV line	PSE	98.6%
2017-18 Winter	B	[redacted]	BPA	Talbot Hill - Lakeside #2 115 kV line	PSE	98.4%
2017-18 Winter	B	[redacted]	PSE	Talbot Hill 230-115 kV transformer #2	PSE	90.3%
2017-18 Winter	C	[redacted]	BPA	Maple Valley - SnoKing #1 230 kV line	SCL	123.9%
2017-18 Winter	C	[redacted]	BPA	Maple Valley - SnoKing #2 230 kV line	SCL	123.3%
2017-18 Winter	C	[redacted]	PSE	Talbot Hill - Lakeside #2 115 kV line	PSE	101.1%
2017-18 Winter	C	[redacted]	BPA	Talbot Hill - Lakeside #1 115 kV line	PSE	101.5%
2017-18 Winter	C	[redacted]	PSE	Talbot Hill 230-115 kV transformer #1	PSE	91.8%
2017-18 Winter	C	[redacted]	PSE	Talbot Hill 230-115 kV transformer #2	PSE	92.8%
2017-18 Winter	C	[redacted]	PSE	Berrydale 230-115 kV transformer	PSE	93.6%
2017-18 Winter	C	[redacted]	BPA & SCL	Maple Valley - SnoKing #1 230 kV line	SCL	176.6%

REDACTED INFORMATION IS DESIGNATED AS PSE CEII, AND FOR SAFETY AND SECURITY REASONS WILL NOT BE DISCLOSED IN THIS FILING.

Table 6-5: Elements above Emergency and Operating Limits: 2017-18 Winter Peak, 100% Conservation, Normal Weather, Thermal Loadings (Redacted) (CONTINUED)

2017-18 Winter	C	[redacted]	BPA & SCL	Maple Valley - SnoKing #2 230 kV line	SCL	157.8%
2017-18 Winter	C	[redacted]	BPA & PSE	Talbot Hill - Lakeside #1 115 kV line (Redispatch not enough)	PSE	127.8%
2017-18 Winter	C	[redacted]	BPA & PSE	Talbot Hill - Lakeside #2 115 kV line (Redispatch not enough)	PSE	127.6%
2017-18 Winter	C	[redacted]	PSE	Talbot Hill 230-115 kV transformer #1 (Redispatch not enough)	PSE	105.7%
2017-18 Winter	C	[redacted]	BPA & PSE	Talbot Hill - Boeing Renton - Shuffleton 115 kV line (Redispatch not enough)	PSE	110.6%
2017-18 Winter	C	[redacted]	PSE	Talbot Hill 230-115 kV transformer #2 (Redispatch not enough)	PSE	105.7%
2017-18 Winter	C	[redacted]	PSE	Talbot Hill - Berrydale #1 115 kV line	PSE	97.6%
2017-18 Winter	C	[redacted]	PSE	White River - Lea Hill - Berrydale 115 kV line	PSE	98.0%
2017-18 Winter	C	[redacted]	BPA & PSE	Shuffleton - O'Brien 115 kV line	PSE	97.9%
2017-18 Winter	C	[redacted]	PSE	Berrydale 230-115 kV transformer	PSE	93.8%
2017-18 Winter	C	[redacted]	BPA & SCL	Maple Valley - Sammamish 230 kV line	BPA	104.4%

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Table 6-6: Elements above Emergency and Operating Limits: 2017-18 Winter Peak, 100% Conservation, Normal Weather, Low Generation Sensitivity Case, Thermal Loadings (Redacted)

						No Gen	With Gen
Case	Category	Worst Contingency	Owner of Facilities Out	Element(s)	Owner of Overloaded Facilities	% Overload	% Overload
2017-18 Winter	B	[redacted]	PSE	Talbot Hill 230-115 kV transformer #2	PSE	90.3%	87.4%
2017-18 Winter	B	[redacted]	BPA	Maple Valley - SnoKing #1 230 kV line	SCL	119.3%	86.5%
2017-18 Winter	B	[redacted]	BPA	Maple Valley - SnoKing #2 230 kV line	SCL	118.2%	84.2%
2017-18 Winter	B	[redacted]	BPA	Talbot Hill - Lakeside #1 115 kV line	PSE	98.6%	84.1%
2017-18 Winter	B	[redacted]	BPA	Talbot Hill - Lakeside #2 115 kV line	PSE	98.4%	83.9%
2017-18 Winter	C	[redacted]	BPA	Maple Valley - SnoKing #1 230 kV line	SCL	123.9%	89.0%
2017-18 Winter	C	[redacted]	BPA	Maple Valley - SnoKing #2 230 kV line	SCL	123.3%	87.1%
2017-18 Winter	C	[redacted]	PSE	Talbot Hill - Lakeside #2 115 kV line	PSE	101.1%	87.2%
2017-18 Winter	C	[redacted]	BPA	Talbot Hill - Lakeside #1 115 kV line	PSE	101.5%	85.8%
2017-18 Winter	C	[redacted]	PSE	Berrydale 230-115 kV transformer	PSE	93.6%	90.2%
2017-18 Winter	C	[redacted]	PSE	Talbot Hill 230-115 kV transformer #1	PSE	91.8%	89.3%
2017-18 Winter	C	[redacted]	PSE	Talbot Hill 230-115 kV transformer #2	PSE	92.8%	90.5%
2017-18 Winter	C	[redacted]	BPA & SCL	Maple Valley - SnoKing #1 230 kV line	SCL	176.6%	112.9%
2017-18 Winter	C	[redacted]	BPA & SCL	Maple Valley - SnoKing #2 230 kV line	SCL	157.8%	110.9%
2017-18 Winter	C	[redacted]	BPA & PSE	Talbot Hill - Lakeside #1 115 kV line	PSE	127.8%	108.7%

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Table 6-6: Elements above Emergency and Operating Limits: 2017-18 Winter Peak, 100% Conservation, Normal Weather, Low Generation Sensitivity Case, Thermal Loadings (Redacted) (CONTINUED)

2017-18 Winter	C	[redacted]	BPA & PSE	Talbot Hill - Lakeside #2 115 kV line	PSE	127.6%	108.5%
2017-18 Winter	C	[redacted]	PSE	Talbot Hill 230-115 kV transformer #2	PSE	105.7%	102.2%
2017-18 Winter	C	[redacted]	PSE	Talbot Hill 230-115 kV transformer #1	PSE	105.7%	102.0%
2017-18 Winter	C	[redacted]	BPA & PSE	Talbot Hill - Boeing Renton - Shuffleton 115 kV line	PSE	110.6%	98.8%
2017-18 Winter	C	[redacted]	PSE	Talbot Hill - Berrydale #1 115 kV line	PSE	97.6%	96.5%
2017-18 Winter	C	[redacted]	PSE	White River - Lea Hill - Berrydale 115 kV line	PSE	98.0%	94.8%
2017-18 Winter	C	[redacted]	PSE	Berrydale 230-115 kV transformer	PSE	93.8%	93.0%
2017-18 Winter	C	[redacted]	PSE	O'Brien 230-115 kV transformer #2	PSE	93.9%	91.3%
2017-18 Winter	C	[redacted]	PSE	O'Brien 230-115 kV transformer #1	PSE	93.1%	90.5%
2017-18 Winter	C	[redacted]	PSE	Sammamish 230-115 kV transformer #2	PSE	83.8%	90.3%
2017-18 Winter	C	[redacted]	BPA & PSE	Shuffleton - O'Brien 115 kV line	PSE	97.9%	86.4%
2017-18 Winter	C	[redacted]	BPA & PSE	O'Brien 115 kV North bus section breaker	PSE	92.5%	85.0%
2017-18 Winter	C	[redacted]	BPA & PSE	Shuffleton - Lakeside 115 kV line	PSE	97.3%	83.6%
2017-18 Winter	C	[redacted]	BPA & SCL	Maple Valley - Sammamish 230 kV line	BPA	104.4%	76.7%

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Table 6-7: Summary of Elements above Emergency and Operating Limits: 2017-18 Winter Peak, Extreme Weather

Year of Study	Normal or Extreme Weather	Case Conditions	Amount of Conservation / System Load	Type of Contingency	Elements above Emergency Limit	Elements > 90% of Emergency Limit or above Operating Limit
2017-18 Winter	Extreme	South-North NI Flow No Western Generation	100% 5742	N-1	Talbot Hill-Lakeside #1 115 kV Line 99.1% Talbot Hill-Lakeside #2 115 kV Line 98.9%	Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 Talbot Hill - Boeing Renton - Shuffleton 115 kV line
2017-18 Winter	Extreme	South-North NI Flow No Western Generation	100% 5742	N-1-1	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill-Boeing Renton-Shuffleton 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 White River - Lea Hill - Berrydale 115 kV line Shuffleton-Lakeside 115 kV line Talbot Hill-Berrydale #1 115 kV line Berrydale 230-115 kV transformer O'Brien 115 kV North bus section breaker O'Brien 230-115 kV transformer #1 O'Brien 230-115 kV transformer #2	O'Brien - Asbury 115 kV line Shuffleton - President Park - Lake Tradition 115 kV line White River 230-115 kV transformer #1 White River 230-115 kV transformer #2 Sammamish 230-115 kV transformer #2
2017-18 Winter	Extreme	South-North NI Flow No Western Generation	75% 5859	N-1	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line	Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 Talbot Hill - Boeing Renton - Shuffleton 115 kV line Berrydale 230-115 kV transformer
2017-18 Winter	Extreme	South-North NI Flow No Western Generation	75% 5859	N-1-1	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill-Boeing Renton-Shuffleton 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 White River - Lea Hill - Berrydale 115 kV line Shuffleton-Lakeside 115 kV line Talbot Hill-Berrydale #1 115 kV line Berrydale 230-115 kV transformer O'Brien 115 kV North bus section breaker O'Brien 230-115 kV transformer #1 O'Brien 230-115 kV transformer #2	O'Brien - Asbury 115 kV line Shuffleton - President Park - Lake Tradition 115 kV line White River 230-115 kV transformer #1 White River 230-115 kV transformer #2 Sammamish 230-115 kV transformer #2 Shuffleton - O'Brien 115 kV line O'Brien - Midway #1 115 kV line Talbot Hill - Lake Tradition #1 115 kV line Sammamish 230-115 kV transformer #1
2017-18 Winter	Extreme	South-North NI Flow No Western Generation	75% 5859	N-2 or Common Mode	Berrydale 230-115 kV transformer Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2	Shuffleton - O'Brien 115 kV line Talbot Hill - Boeing Renton - Shuffleton 115 kV line O'Brien - Midway #1 115 kV line
2017-18 Winter	Extreme	South-North NI Flow No Western Generation	50% 5967 MW	N-1	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill 230-115 kV transformer #1 (99.6%) Talbot Hill 230-115 kV transformer #2 (99.9%)	Berrydale 230-115 kV transformer Talbot Hill - Boeing Renton - Shuffleton 115 kV line
2017-18 Winter	Extreme	South-North NI Flow No Western Generation	50% 5967 MW	N-1-1	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill-Boeing Renton-Shuffleton 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 White River - Lea Hill - Berrydale 115 kV line Shuffleton-Lakeside 115 kV line Talbot Hill-Berrydale #1 115 kV line Berrydale 230-115 kV transformer O'Brien 115 kV North bus section breaker O'Brien 230-115 kV transformer #1 O'Brien 230-115 kV transformer #2	Shuffleton-Lakeside 115 kV line O'Brien 115 kV North bus section breaker O'Brien - Asbury 115 kV line Shuffleton - President Park - Lake Tradition 115 kV line White River 230-115 kV transformer #1 White River 230-115 kV transformer #2 Shuffleton-O'Brien 115 kV line Sammamish 230-115 kV transformer #2
2017-18 Winter	Extreme	South-North NI Flow No Western Generation	50% 5967 MW	N-2 or Common Mode	Berrydale 230-115 kV transformer Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2	Talbot Hill 230-115 kV transformer #2 Shuffleton - O'Brien 115 kV line Talbot Hill - Boeing Renton - Shuffleton 115 kV line O'Brien - Midway #1 115 kV line O'Brien 230-115 kV transformer #2

6.1.4 2021-22: Winter Peak, Normal & Extreme Weather Thermal Summaries

Table 6-8 shows the summary of results for categories B (N-1) and C (N-1-1 & N-2) for 2021-22 winter and summer peaks with normal weather.

Table 6-9 indicates that the PSE load level for the winter peak, normal weather, 100% conservation, for 2021-22 is 5,193 MW. There are no potential Category B (N-1) thermal violations but there are five (5) elements with loadings from 90% to 100% of the emergency ratings. Those facilities are highlighted in gray on Table 6-9.

1. Talbot Hill - Lakeside #1 115 kV Line – 95.2%
2. Talbot Hill - Lakeside #2 115 kV Line – 95.1%
3. Talbot Hill 230-115 kV transformer #1 – 91.0%
4. Talbot Hill 230-115 kV transformer #2 – 91.5%
5. Talbot Hill - Boeing Renton - Shuffleton 115 kV Line – 91.5%

For Category C (N-1-1) contingencies there are six (6) elements above the emergency limits and an additional six (6) elements with loadings above 90% of their emergency limits. Those facilities are highlighted in yellow for overloads.

1. Talbot Hill - Lakeside #1 115 kV Line
2. Talbot Hill - Lakeside #2 115 kV Line
3. Talbot Hill 230-115 kV transformer #1
4. Talbot Hill 230-115 kV transformer #2
5. Talbot Hill - Boeing Renton - Shuffleton 115 kV Line
6. Shuffleton - Lakeside 115 kV Line

The PSE load level for the winter peak, normal weather, 75% conservation, for 2021-22 is 5,415 MW. Table 6-8 indicates that there are no potential Category B (N-1) thermal violations but there are five (5) elements with loadings above 90% of the emergency ratings (Talbot Hill-Lakeside #1 & 2 115 kV Lines, Talbot Hill 230-115 kV transformers #1 & 2, and Talbot Hill-Boeing Renton-Shuffleton 115 kV Line). For Category C (N-1-1) contingencies there are ten (10) elements above the emergency limits and an additional five (5) elements with loadings above 90% of their emergency limits.

Table 6-10 shows that for the 2021-22 winter peak, extreme weather, (PSE load of 5,772 MW), no generation in the north and high exports to British Columbia, there are four (4) potential Category B (N-1) thermal violations (Talbot Hill - Lakeside #1 & #2 115 kV lines, Talbot Hill-Boeing Renton-Shuffleton 115 kV line, and the Talbot Hill 230-115 kV transformer #1). There are fourteen (14) potential Category C (N-1-1 & N-2) thermal violations.

The extreme winter cases are run as an indication of the flexibility and robustness of the electric transmission system in a near or far future year. As shown in Tables 6-7 and 6-10, the increased load to be expected with extremely cold weather could lead to many more overloads than those projected with loads during normal weather, even with reduced conservation effects. While most utilities, including PSE, do not construct facilities on the basis of extreme seasonal temperatures, it does serve as an indicator of system stresses further into the future.

Table 6-8: Summary of Elements above Emergency and Operating Limits: 2021-22 Winter Peak, Normal Weather

Year of Study	Normal or Extreme Weather	Case Conditions	Amount of Conservation/ System Load	Type of Contingency	Elements above Emergency Limit	Elements > 90% of Emergency Limit or above Operating Limit
2021-22 Winter	Normal	South-North NI Flow No Western Generation	100% 5193 MW	N-1		Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 Talbot-Boeing Renton-Shuffleton 115 kV Line
2021-22 Winter	Normal	South-North NI Flow No Western Generation	100% 5193 MW	N-1-1	Talbot Hill-Lakeside #1 115 kV Line Talbot-Lakeside Hill #2 115 kV Line Talbot Hill-Boeing Renton-Shuffleton 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 Shuffleton-Lakeside 115 kV line	White River - Lea Hill - Berrydale 115 kV Line Berrydale 230-115 kV transformer O'Brien 230-115 kV transformer #2 O'Brien 230-115 kV transformer #1 O'Brien 115 kV North bus section breaker Talbot Hill-Berrydale #1 115 kV line
2021-22 Winter	Normal	South-North NI Flow No Western Generation	100% 5193 MW	N-2 or Common Mode	Talbot Hill-Lakeside #2 115 kV Line	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 Berrydale 230-115 kV transformer
2021-22 Winter	Normal	South-North NI Flow No Western Generation	75% 5415 MW	N-1		Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill-Boeing Renton-Shuffleton 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2
2021-22 Winter	Normal	South-North NI Flow No Western Generation	75% 5415 MW	N-1-1	Talbot Hill-Berrydale #1 115 kV line Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill-Boeing Renton-Shuffleton 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 White River - Lea Hill - Berrydale 115 kV line Shuffleton-Lakeside 115 kV line Berrydale 230-115 kV transformer O'Brien 230-115 kV transformer #2	O'Brien 230-115 kV transformer #1 O'Brien 115 kV North bus section breaker O'Brien-Asbury 115 kV line Shuffleton-President Park - Lake Tradition 115 kV line Shuffleton-O'Brien 115 kV Line
2021-22 Winter	Normal	South-North NI Flow No Western Generation	75% 5415 MW	N-2 or Common Mode	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Berrydale 230-115 kV transformer	Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 Shuffleton - O'Brien 115 kV Line Talbot Hill-Boeing Renton-Shuffleton 115 kV Line
2021-22 Winter	Normal	South-North NI Flow No Western Generation	50% 5636 MW	N-1	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line	Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 Berrydale 230-115 kV transformer Talbot Hill - Boeing Renton - Shuffleton 115 kV line
2021-22 Winter	Normal	South-North NI Flow No Western Generation	50% 5636 MW	N-1-1	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill-Boeing Renton-Shuffleton 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 White River - Lea Hill - Berrydale 115 kV line Talbot Hill-Berrydale #1 115 kV line Shuffleton-Lakeside 115 kV line Berrydale 230-115 kV transformer O'Brien 230-115 kV transformer #1 O'Brien 230-115 kV transformer #2 O'Brien 115 kV North bus section breaker	O'Brien - Asbury 115 kV line Shuffleton - President Park - Lake Tradition 115 kV line Shuffleton-O'Brien 115 kV line Sammamish 230-115 kV transformer #2 White River 230-115 kV transformer #1 White River 230-115 kV transformer #2 O'Brien-Midway #1 115 kV Line
2021-22 Winter	Normal	South-North NI Flow No Western Generation	50% 5636 MW	N-2 or Common Mode	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Berrydale 230-115 kV transformer Talbot Hill 230-115 kV transformer #1	Talbot Hill-Boeing Renton-Shuffleton 115 kV Line Talbot Hill 230-115 kV transformer #2 Shuffleton - O'Brien 115 kV line

Table 6-9: Elements above Emergency and Operating Limits: 2021-22 Winter Peak, 100% Conservation, Normal Weather, Thermal Loadings (Redacted)

Case	Category	Worst Contingency	Owner of Facilities Out	Element(s)	Owner of Overloaded Facilities	Percent Overload
2021-22 Winter	B	[redacted]	PSE	Talbot Hill - Lakeside #1 115 kV line	PSE	95.2%
2021-22 Winter	B	[redacted]	PSE	Talbot Hill - Lakeside #2 115 kV line	PSE	95.1%
2021-22 Winter	B	[redacted]	PSE	Talbot Hill 230-115 kV transformer #1	PSE	91.0%
2021-22 Winter	B	[redacted]	PSE	Talbot Hill 230-115 kV transformer #2	PSE	91.5%
2021-22 Winter	B	[redacted]	PSE	Talbot Hill - Boeing Renton - Shuffleton 115 kV line	PSE	91.5%
2021-22 Winter	C	[redacted]	PSE	Talbot Hill - Lakeside #2 115 kV line	PSE	107.1%
2021-22 Winter	C	[redacted]	PSE	Talbot Hill - Lakeside #1 115 kV line	PSE	96.8%
2021-22 Winter	C	[redacted]	PSE	Berrydale 230-115 kV transformer	PSE	95.5%
2021-22 Winter	C	[redacted]	PSE	Talbot Hill 230-115 kV transformer #2	PSE	93.2%
2021-22 Winter	C	[redacted]	PSE	Talbot Hill 230-115 kV transformer #1	PSE	93.6%
2021-22 Winter	C	[redacted]	PSE	Shuffleton - O'Brien 115 kV line	PSE	90.0%
2021-22 Winter	C	[redacted]	PSE	Talbot Hill - Berrydale #1 115 kV line	PSE	97.6%
2021-22 Winter	C	[redacted]	PSE	Talbot Hill 230-115 kV transformer #1	PSE	108.1%

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Table 6-9: Elements above Emergency and Operating Limits: 2021-22 Winter Peak, 100% Conservation, Normal Weather, Thermal Loadings (Redacted) (CONTINUED)

2021-22 Winter	C	[redacted]	PSE	Talbot Hill - Lakeside #1 115 kV line	PSE	117.8%
2021-22 Winter	C	[redacted]	PSE	Talbot Hill - Lakeside #2 115 kV line	PSE	117.7%
2021-22 Winter	C	[redacted]	PSE	Talbot Hill - Boeing Renton - Shuffleton 115 kV line	PSE	107.6%
2021-22 Winter	C	[redacted]	PSE	Talbot Hill 230-115 kV transformer #2	PSE	107.0%
2021-22 Winter	C	[redacted]	PSE	White River - Lea Hill - Berrydale 115 kV line	PSE	99.7%
2021-22 Winter	C	[redacted]	PSE	Shuffleton - Lakeside 115 kV line	PSE	100.8%
2021-22 Winter	C	[redacted]	PSE	Berrydale 230-115 kV transformer	PSE	96.1%
2021-22 Winter	C	[redacted]	PSE	O'Brien 230-115 kV transformer #1	PSE	94.3%
2021-22 Winter	C	[redacted]	PSE	O'Brien 230-115 kV transformer #2	PSE	95.1%
2021-22 Winter	C	[redacted]	PSE	O'Brien 115 kV North bus section breaker	PSE	94.6%
2021-22 Winter	C	[redacted]	PSE	O'Brien - Asbury 115 kV line	PSE	90.9%

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Table 6-10: Summary of Elements above Emergency and Operating Limits: 2021-22 Winter Peak, Extreme Weather Thermal Loadings

Year of Study	Normal or Extreme Weather	Case Conditions	Amount of Conservation/ System Load	Type of Contingency	Elements above Emergency Limit	Elements > 90% of Emergency Limit or above Operating Limit
2021-22 Winter	Extreme	South-North NI Flow No Western Generation	100% 5772 MW	N-1	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill-Boeing Renton-Shuffleton 115 kV Line Talbot Hill 230-115 kV transformer #1	Berrydale 230-115 kV transformer Talbot Hill 230-115 kV transformer #2
2021-22 Winter	Extreme	South-North NI Flow No Western Generation	100% 5772 MW	N-1-1	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill-Boeing Renton-Shuffleton 115 kV Line Talbot Hill 230-115 kV transformer #1 Talbot Hill 230-115 kV transformer #2 White River - Lea Hill - Berrydale 115 kV line Shuffleton-Lakeside 115 kV line Talbot Hill-Berrydale #1 115 kV line Berrydale 230-115 kV transformer O'Brien 115 kV North bus section breaker O'Brien 230-115 kV transformer #1 O'Brien 230-115 kV transformer #2 O'Brien - Asbury 115 kV line Shuffleton-O'Brien 115 kV line	Shuffleton - President Park - Lake Tradition 115 kV line White River 230-115 kV transformer #1 White River 230-115 kV transformer #2 Sammamish 230-115 kV transformer #1 Sammamish 230-115 kV transformer #2 Talbot Hill-Lake Tradition #1 115 kV Line O'Brien-Metro Renton – Talbot Hill 115 kV Line O'Brien – Christopher #1 115 kV Line
2021-22 Winter	Extreme	South-North NI Flow No Western Generation	100% 5772 MW	N-2 or Common Mode	Talbot Hill-Lakeside #1 115 kV Line Talbot Hill-Lakeside #2 115 kV Line Talbot Hill 230-115 kV transformer #1 Shuffleton-O'Brien 115 kV line Berrydale 230-115 kV transformer	Talbot Hill-Boeing Renton-Shuffleton 115 kV Line Talbot Hill 230-115 kV transformer #2 O'Brien 230-115 kV transformer #2 O'Brien - Midway #1 115 kV line

6.1.5 Summary of Potential Thermal Violations

Based on Table 6-11, below, the PSE Winter load level where King County starts to have significant issues is approximately 5200 MW. The elements which are the most susceptible to potential overloads for the winter peak loads are in the Talbot Hill and Lakeside Substation areas.

The sensitivity cases with 75% conservation instead of 100% conservation indicate system performance concerns with higher winter loads. Those sensitivity studies show even higher overloads of the elements already overloaded in the 100% conservation cases. In general, should loads grow faster than forecast, or conservation not provide anticipated peak load relief, the potential overloads will be higher than the results reported. Even when the corporate load does not increase from 2017-18 to 2021-22, the Eastside load has grown, resulting in an increased number of potential violations.

Table 6-11: Summary of Potential Thermal Violations for Winter Peak Load Season

Contingency	2013-14 5055 MW 100% Con	2013-14 5090 MW 75% Con	2017-18 5208 MW 100% Con	2017-18 5325 MW 75% Con	2021-22 5193 MW 100% Con	2021-22 5415 MW 75% Con
Cat B (N-1)			Talbot Hill - Lakeside #1 115 kV line – 98.6%	Talbot Hill - Lakeside #1 115 kV line – 99.9%	Talbot Hill - Lakeside #1 115 kV line – 95.2%	Talbot Hill - Lakeside #1 115 kV line – 99.2%
			Talbot Hill - Lakeside #2 115 kV line – 98.4%	Talbot Hill - Lakeside #2 115 kV line – 99.9%	Talbot Hill - Lakeside #2 115 kV line – 95.1%	Talbot Hill - Lakeside #2 115 kV line – 99.1%
			Talbot Hill 230-115 kV transformer #2 – 90.3%	Talbot Hill 230-115 kV transformer #1 – 90.9%	Talbot Hill 230-115 kV transformer #1 – 91.0%	Talbot Hill 230-115 kV transformer #1 – 94.7%
				Talbot Hill 230-115 kV transformer #2 – 92.4%	Talbot Hill 230-115 kV transformer #2 – 91.5%	Talbot Hill 230-115 kV transformer #2 – 93.6%
						Talbot Hill - Boeing Renton - Shuffleton 115 kV line - 95.4%
Cat C (N-1-1)	Talbot Hill-Lakeside #1 115 kV Line - 115.2%	Talbot Hill-Lakeside #1 115 kV Line - 115.9%	Talbot Hill--Lakeside #1 115 kV Line - 127.8%	Talbot Hill-Lakeside #1 115 kV Line - 129.9%	Talbot Hill--Lakeside #1 115 kV Line - 117.8%	Talbot Hill--Lakeside #1 115 kV Line - 122.9%
	Talbot Hill-Lakeside #2 115 kV Line - 115.1%	Talbot Hill-Lakeside #2 115 kV Line - 115.8%	Talbot Hill--Lakeside #2 115 kV Line - 127.6%	Talbot Hill-Lakeside #2 115 kV Line - 129.7%	Talbot Hill-Lakeside #2 115 kV Line - 117.7%	Talbot Hill-Lakeside #2 115 kV Line - 122.8%
	Talbot Hill 230-115 kV transformer #1 - 100.9%	Talbot Hill 230-115 kV transformer #1 - 101.6%	Talbot Hill 230-115 kV transformer #1 - 105.7%	Talbot Hill 230-115 kV transformer #1 - 108.1%	Talbot Hill 230-115 kV transformer #1 - 108.1%	Talbot Hill 230-115 kV transformer #1 - 112.8%
	Talbot Hill 230-115 kV transformer #2 - 100.5%	Talbot Hill 230-115 kV transformer #2 - 101.6%	Talbot Hill 230-115 kV transformer #2 - 105.7%	Talbot Hill 230-115 kV transformer #2 – 107.6%	Talbot Hill 230-115 kV transformer #2 - 107.0%	Talbot Hill 230-115 kV transformer #2 - 109.8%
	Talbot Hill-Boeing Renton-Shuffleton 115 kV Line -101.1%	Talbot Hill-Boeing Renton-Shuffleton 115 kV Line - 101.7%	Talbot Hill-Boeing Renton-Shuffleton 115 kV Line - 110.6%	Talbot Hill-Boeing Renton-Shuffleton 115 kV Line - 112.5%	Talbot Hill-Boeing Renton-Shuffleton 115 kV Line - 107.6%	Talbot Hill-Boeing Renton-Shuffleton 115 kV Line - 112.3%
				White River - Lea Hill - Berrydale 115 kV line - 100.2%	White River - Lea Hill - Berrydale 115 kV line - 99.7%	White River - Lea Hill - Berrydale 115 kV line - 104.0%
				Maple Valley - Sammamish 230 kV line - 100.5%		Talbot Hill-Berrydale #1 115 kV line - 101.9%
						Shuffleton-Lakeside 115 kV line - 105.2%
						Berrydale 230-115 kV transformer - 100.8%
						O'Brien 230-115 kV transformer #2 - 100.2%
						O'Brien 230-115 kV transformer #1 - 99.4%
Cat C (N-2 or Common Mode)			Talbot Hill-Lakeside #1 115 kV Line - 101.5%	Talbot Hill-Lakeside #1 115 kV Line - 103.0%	Talbot Hill - Lakeside #1 115 kV line – 96.8%	Talbot Hill-Lakeside #1 115 kV Line – 100.7%
			Talbot Hill-Lakeside #2 115 kV Line - 101.1%	Talbot Hill-Lakeside #2 115 kV Line - 100.5%	Talbot Hill - Lakeside #2 115 kV line – 107.1%	Talbot Hill-Lakeside #2 115 kV Line - 111.7%
					Talbot Hill 230-115 kV transformer #1 – 93.6%	Talbot Hill 230-115 kV transformer #1 – 97.3%
					Talbot Hill 230-115 kV transformer #2 – 93.2%	Talbot Hill 230-115 kV transformer #2 – 95.1%
					Berrydale 230-115 kV transformer - 95.5%	Berrydale 230-115 kV transformer - 100.2%

Based on Table 6-12 below, the PSE summer load level where King County starts to have significant issues is approximately 3,500 MW. The elements which are the most susceptible to potential overloads for the summer peak loads are in the Sammamish Substation area.

Table 6-12: Summary of Potential Thermal Violations for Summer Peak Load Season

Contingency	2014 3343 MW 100% Con	2018 3554 MW 100% Con
Cat B (N-1)	Monroe-Novelty Hill 230 kV line - 132.6%	Monroe-Novelty Hill 230 kV line - 133.0%
	Maple Valley - Sammamish 230 kV line - 111.4%	Maple Valley - Sammamish 230 kV line - 132.3%
		Talbot Hill - Lakeside #1 115 kV line - 93.9%
		Talbot Hill - Lakeside #2 115 kV line - 93.8%
Cat C (N-1-1)	Sammamish 230-115 kV transformer #2 - 100.8%	Beverly Park - Cottage Brook 115 kV line - 100.5% (Have solution)
	Sammamish 230-115 kV transformer #1 - 95.5%	Sammamish 230-115 kV transformer #1 - 100.7% (Have solution)
		Sammamish 230-115 kV transformer #2 - 106.4% (Have solution)
Cat C (N-2)		Sammamish - Lakeside #2 115 kV line - 99.8%

6.1.6 Temporary Mitigations and Associated Risks

Based on the analysis described above there are a number of system events that require the Transmission Operators to implement operating procedures in place to temporarily reduce or mitigate the potential thermal violations. Table 6-13 indicates mitigation needed for each of the winter overload contingencies identified in 2017-18.

Table 6-13: Mitigations for Worst Winter 2017-18 Contingencies

Contingency	2013-14 Winter Peak 5208 MW 100% Conservation	2017-18 Winter Peak 5208 MW 100% Conservation	2017-18 Winter Peak 5325 MW 75% Conservation	Contingency Causing Overload	Mitigation Plan - Worst Contingency	Customers at Risk
Cat B (N-1)		Talbot Hill - Lakeside #1 115 kV line – 98.6%	Talbot Hill - Lakeside #1 115 kV line – 99.9%	[redacted]	[redacted]	None
		Talbot Hill - Lakeside #2 115 kV line – 98.4%	Talbot Hill - Lakeside #2 115 kV line – 99.9%	[redacted]	[redacted]	None
		Talbot Hill 230-115 kV transformer #2 – 90.3%	Talbot Hill 230-115 kV transformer #2 – 92.4%	[redacted]	[redacted]	None
			Talbot Hill 230-115 kV transformer #1 – 90.9%	[redacted]	[redacted]	None
Cat C (N-1-1)	Talbot-Lakeside #1 115 kV Line - 115.2%	Talbot-Lakeside #1 115 kV Line - 127.8%	Talbot-Lakeside #1 115 kV Line - 129.9%	[redacted]	[redacted]	49,000 for line outage, 33,000 for transformer outage
	Talbot-Lakeside #2 115 kV Line - 115.1%	Talbot-Lakeside #2 115 kV Line - 127.6%	Talbot-Lakeside #2 115 kV Line - 129.7%	[redacted]	[redacted]	49,000 for line outage, 33,000 for transformer outage
	Talbot Hill 230-115 kV transformer #1 - 100.9%	Talbot Hill 230-115 kV transformer #1 - 105.7%	Talbot Hill 230-115 kV transformer #1 - 108.1%	[redacted]	[redacted]	More lines may need to be opened for next N-1-1 contingencies
	Talbot Hill 230-115 kV transformer #2 - 100.5%	Talbot Hill 230-115 kV transformer #2 - 105.7%	Talbot Hill 230-115 kV transformer #2 – 107.6%	[redacted]	[redacted]	More lines may need to be opened for next N-1-1 contingencies
	Talbot Hill-Boeing Renton-Shuffleton 115 kV Line - 101.1%	Talbot Hill-Boeing Renton-Shuffleton 115 kV Line - 110.6%	Talbot Hill-Boeing Renton-Shuffleton 115 kV Line - 112.5%	[redacted]	[redacted]	23,000 for line outage, 33,000 for transformer outage

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Table 6-13: Mitigations for Worst Winter 2017-18 Contingencies (CONTINUED)

		O'Brien 230-115 kV transformer #1 - 93.1%	O'Brien 230-115 kV transformer #1 - 94.9%	[redacted]	[redacted]	More lines may need to be opened for next N-1-1 contingencies
		O'Brien 230-115 kV transformer #2 - 93.9%	O'Brien 230-115 kV transformer #2 - 95.7%	[redacted]	[redacted]	More lines may need to be opened for next N-1-1 contingencies
		Berrydale 230-115 kV transformer - 93.8%	Berrydale 230-115 kV transformer - 96.0%	[redacted]	[redacted]	More lines may need to be opened for next N-1-1 contingencies
		Talbot Hill-Berrydale #1 115 kV line - 97.6%	Talbot Hill-Berrydale #1 115 kV line - 99.8%	[redacted]	[redacted]	32,000 for line outage, 50,000 for transformer outage
		Shuffleton - Lakeside 115 kV line - 97.3%	Shuffleton - Lakeside 115 kV line - 98.9%	[redacted]	[redacted]	None
			White River - Lea Hill - Berrydale 115 kV line - 100.2%	[redacted]	[redacted]	32,000 for line outage, 50,000 for transformer outage
			Maple Valley - Sammamish 230 kV line - 100.5%	[redacted]	[redacted]	None
Cat C (N-2 or Common Mode)		Talbot-Lakeside #1 115 kV Line - 101.5%	Talbot-Lakeside #1 115 kV Line - 103.0%	[redacted]	[redacted]	32,000 for line outage, 50,000 for transformer outage
		Talbot-Lakeside #2 115 kV Line - 101.1%	Talbot-Lakeside #2 115 kV Line - 100.5%	[redacted]	[redacted]	None
		Talbot Hill 230-115 kV transformer #1 - 91.8%	Talbot Hill 230-115 kV transformer #1 - 93.8%	[redacted]	[redacted]	None
		Talbot Hill 230-115 kV transformer #2 - 92.8%	Talbot Hill 230-115 kV transformer #2 - 94.4%	[redacted]	[redacted]	None

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The following table indicates mitigation needed for each of the summer overload contingencies identified in 2018.

Table 6-14: Mitigation for Worst Summer 2018 Contingencies

Contingency	2014 Summer Peak 3343 MW 100% Conservation	2018 Summer Peak 3554 MW 100% Conservation	Contingency Causing Overload	Mitigation	Customers at Risk
Cat B (N-1)	Monroe-Novelty Hill 230 kV line - 132.6%	Monroe-Novelty Hill 230 kV line - 133.0%	[redacted]	[redacted]	None
	Maple Valley - Sammamish 230 kV line - 111.4%	Maple Valley - Sammamish 230 kV line - 132.3%	[redacted]	[redacted]	None
		Talbot Hill - Lakeside #1 115 kV line - 93.9%	[redacted]	[redacted]	None
		Talbot Hill - Lakeside #2 115 kV line - 93.8%	[redacted]	[redacted]	None
Cat C (N-1-1)	Sammamish 230-115 kV transformer #2 - 100.8%	Sammamish 230-115 kV transformer #2 - 106.4%	[redacted]	[redacted]	33,000
	Sammamish 230-115 kV transformer #1 - 95.5%	Sammamish 230-115 kV transformer #1 - 100.7%	[redacted]	[redacted]	33,000
		Beverly Park - Cottage Brook 115 kV line - 100.5%	[redacted]	[redacted]	27,000
Cat C (N-2)		Sammamish - Lakeside #2 115 kV line - 99.8%	[redacted]	[redacted]	None

6.2 Other Assessment Criteria Compliance

6.2.1 Columbia Grid

As stated in the ColumbiaGrid 2012 System Assessment[21], ColumbiaGrid was formed with seven founding members in 2006 to improve the operational efficiency, reliability, and planned expansion of the northwest transmission grid. Eleven parties have signed ColumbiaGrid's Planning and Expansion Functional Agreement (PEFA) to support and facilitate multi-system transmission planning through an open and transparent process. ColumbiaGrid's primary grid planning activity is to develop a biennial transmission expansion plan that looks out over a ten-year planning horizon and identifies the transmission additions necessary to ensure that the parties to the ColumbiaGrid Planning and Expansion Functional Agreement can meet their commitments to serve load and transmission service commitments. A significant feature of the transmission expansion plan is its single-utility planning approach. The plan has been developed as if the region's transmission grid were owned and operated by a single entity. This approach results in a more comprehensive, efficient, and coordinated plan than would otherwise be developed if each transmission owner completed a separate independent analysis.

[21] ColumbiaGrid 2012System Assessment, page 1 – Executive Summary, July 2012

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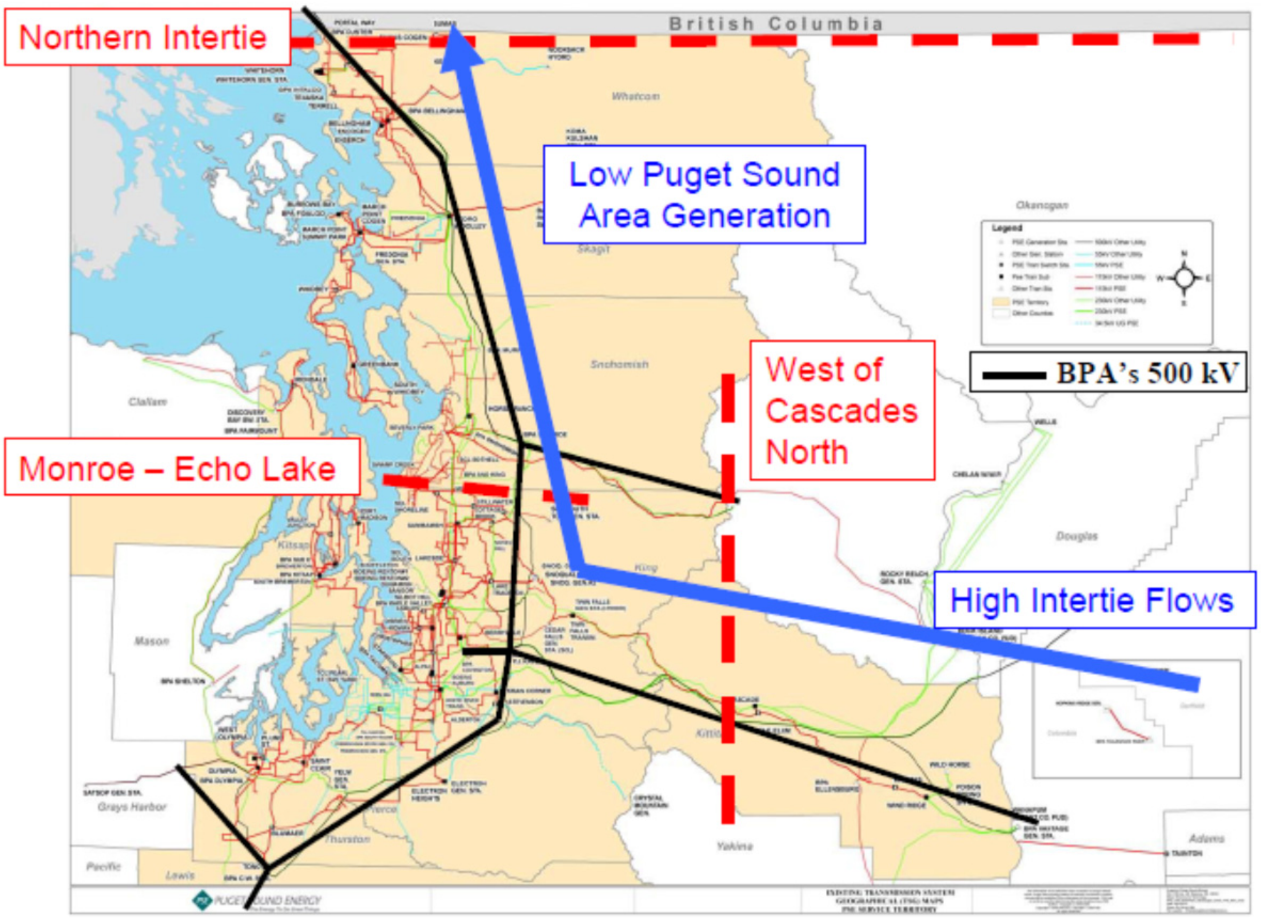
The capacity of the Northern Intertie path in the north to south direction is 2,850 MW on the west- side and 400 MW on the east-side with a combined total transfer capability limit of 3,150 MW (Figure 6-2). The total capacity of the path in the south to north direction is 2,000 MW, with a limit of 400 MW on the east-side (Figure 6-1). Both of these directional flows can impact the ability of the system to serve loads in the Puget Sound area.



[22]

Figure 6-1: Winter Power Flow resulting from Northern Intertie

[22] PSE Attachment K, Puget Sound Area Transmission Meeting, PSE Presentation Slide #9, Dec 18, 2012

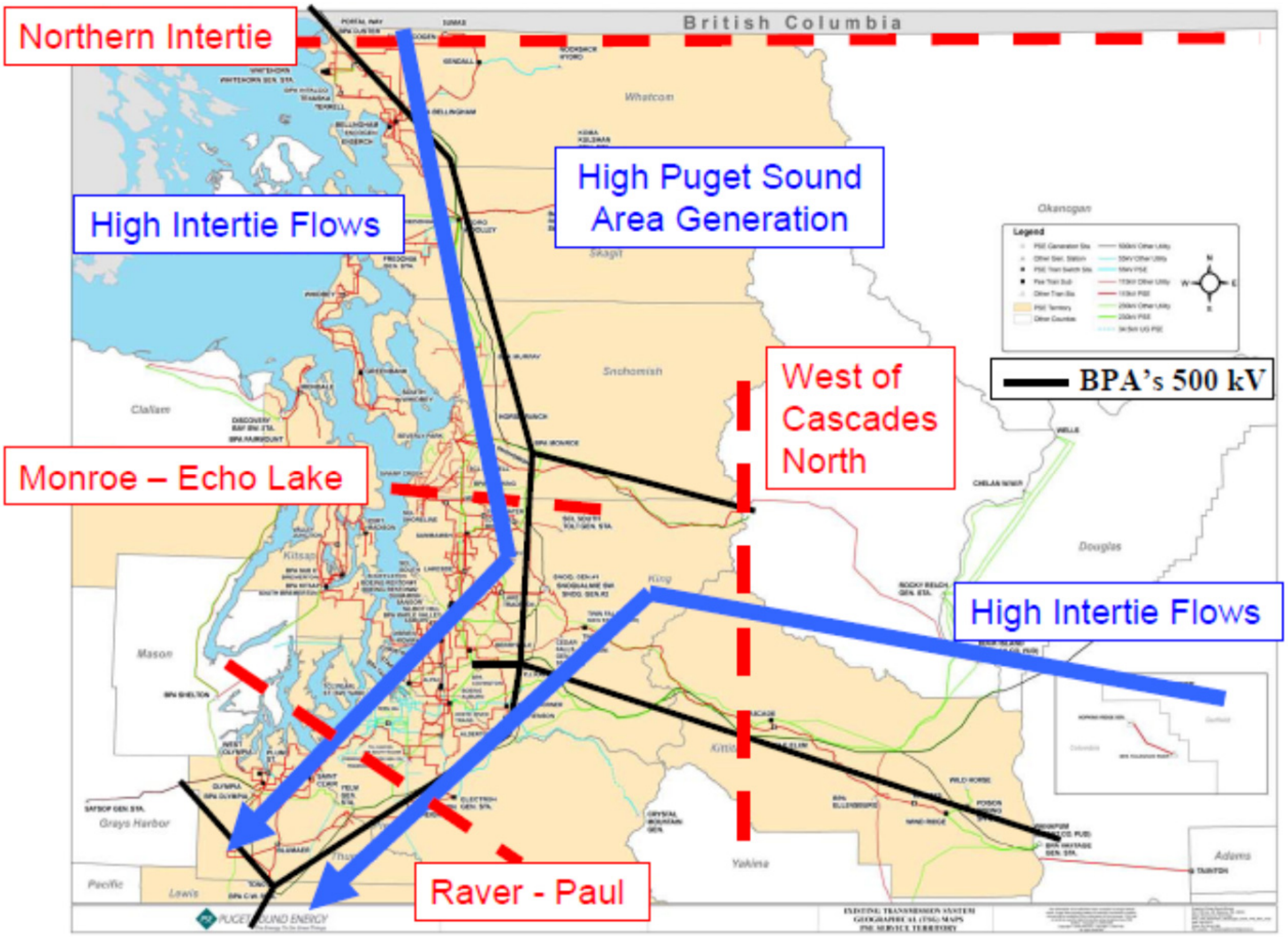


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Figure 6-2: Summer Power Flow Resulting from Northern Intertie

The major issues in the PSE area were identified in the 2012 System Assessment, dated July 2012. The Assessment documented that: BPA is making commitments to increase flows across the Northern Intertie to 2,300 MW through the Network Open Season that will show up in the ten-year time frame. 200 MW of this new commitment is planned to be scheduled on the east side of the Northern Intertie at Nelway. Therefore in the ten- year summer cases this flow will increase to 2,300 MW to cover the additional commitments that are being made on the Northern Intertie including the 200 MW on the east side of the tie at Nelway.

6.2.2 2009 TPL Study Results

Issues associated with loading in the Talbot Hill area under winter conditions and south-north regional transmission flows were first shown in the 2009 TPL study. (The previous year's TPL study had noted high loading on Talbot Hill transformers, although these were not identified as Category B or C overloads in any of the study years used for the 2008 TPL.) As a result, PSE identified short-term mitigation in the form of CAPs and also began studying options for improving the power supply in the central King County area.

Load forecasts used in the 2009 TPL study followed corporate forecasts published in December 2008. There was an updated forecast in June 2009 which projected lower normal peaks. Due to the conservative approach used in the TPL report, it is deemed that the change in the peak loads would not influence any TPL results.

[23] PSE Attachment K, Puget Sound Area Transmission Meeting, PSE Presentation Slide #10, Dec 18, 2012

The 2009 TPL Study assumed no generation in Puget Sound Area as opposed to minimum generation in earlier reports - for the low generation scenarios. Also, the NI (Northern Intertie) flows were assumed realistic based on season and historic flows. This information is tabulated in Table 6-15.

The winter season in years 2010 (2010-11) and 2019 (2018-19) was studied both in Northern Intertie (NI) import and export conditions. Loads used were 1 in 2 year winter peak. The summer season in years 2010 and 2019 was also studied both in Northern Intertie (NI) import and export conditions. Loads used were 1 in 2 year summer peak. PSE's system load peaks during the winter season; summer represents reduced-load conditions. For the near-term cases winter peak load of 5,329 MW and summer peak load of 3,417 MW is modeled. For the long-term cases a winter peak load of 5,765 MW and summer peak load of 3,678 MW is modeled. To cover a broad range of operating conditions, Northern Intertie flows and PSE generation levels were varied in all case studies.

Table 6-15 shows the different scenarios used for the study.

Table 6-15: Scenarios for the 2009 TPL Study

WECC case	Base case	Northern Intertie flows (North-South (N-S) or South –North (S-N)	Puget Sound Area Generation
2009 HS3A APPROVED OPERATING CASE	2010HS-A	N-S 2850/300 MW	Full generation
2009 HS3A APPROVED OPERATING CASE	2010HS-B	N-S 2850/300 MW	No generation
2009 HS3A APPROVED OPERATING CASE	2010HS-C	S-N 2000/0 MW	Full generation
2009 HS3A APPROVED OPERATING CASE	2010HS-D	S-N 2000/0 MW	No generation
2009-10 HW2 OPERATING CASE	2010-11HW-A	S-N 1500/300 MW	No generation
2009-10 HW2 OPERATING CASE	2010-11HW-B	S-N 1500/300 MW	Full generation
2009-10 HW2 OPERATING CASE	2010-11HW-C	N-S 1450/0 MW	No generation
2009-10 HW2 OPERATING CASE	2010-11HW-D	N-S 1450/0 MW	Full generation
2019 HEAVY SUMMER 1 BASE CASE	2019HS-A	N-S 2850/300 MW	Full generation
2019 HEAVY SUMMER 1 BASE CASE	2019HS-B	N-S 2850/300 MW	No generation
2019 HEAVY SUMMER 1 BASE CASE	2019HS-C	S-N 2000/0 MW	Full generation
2019 HEAVY SUMMER 1 BASE CASE	2019HS-D	S-N 2000/0 MW	No generation
2018-19 HW1 BASE CASE	2018-19HW-A	S-N 1500/300 MW	No generation
2018-19 HW1 BASE CASE	2018-19HW-B	S-N 1500/300 MW	Full generation
2018-19 HW1 BASE CASE	2018-19HW-C	N-S 1450/0 MW	No generation
2018-19 HW1 BASE CASE	2018-19HW-D	N-S 1450/0 MW	Full generation

The 2009 TPL study indicated that as soon as the winter of 2010-11, during south-north regional transmission flows with low Puget Sound Area generation, a Category C loss [redacted] or a Category C loss of [redacted] could overload the Talbot Hill transformer #2. The [redacted] outage would load the Talbot Hill transformer to 101% of its emergency limit, which could be mitigated by dispatching generation. The [redacted] outage was shown to result in a 107% load on Talbot Hill transformer #2, which would be mitigated by instituting a CAP to open [redacted]. Installation of 230-115 kV transformation in central King County was identified as a long-term mitigation and studies commenced as to best transformation location and associated system improvements.

REDACTED INFORMATION IS DESIGNATED AS PSE CEII, AND FOR SAFETY AND SECURITY REASONS WILL NOT BE DISCLOSED IN THIS FILING.

Section 7 Conclusions on Needs Assessment

This 2013 Eastside Needs Assessment has shown that PSE is facing a transmission capacity deficiency on the Eastside of Lake Washington. Overloads of Talbot Hill and Sammamish transformers as well as several 115 kV lines point to the need for a new power supply centered in the Eastside area. By the fall of 2017, additional 230-115 kV transformation or generation integrated at the 115 kV level will be required in the Eastside area to relieve the overloads predicted in this study. Depending on the location of a new transformer, additional 115 kV or 230 kV line capacity will also be required.

In multiple contingencies studied, different parts of the transmission system will overload or will be close to overloading within the 10 year study period. When the regional power flows are south to north, as is typical in the winter, there are potential overloads in the Talbot Hill Substation area, on both transformers and transmission lines. When the regional power flows are north to south, as is typical in the summer, there are potential overloads in the Sammamish Substation area. In each case, it is the need to provide power to PSE communities in the Eastside area that is stressing the local power system.

The Eastside area has no utility generation sources. In King County, local generation covers less than 10% of the peak load. Therefore the King County area is quite dependent on transmission interties to Bonneville Power Administration and other neighboring utilities that can transport bulk power from generation located north, south and east of King County, primarily in the east. Bulk power is most often transported at 230 kV or higher voltage. This study has indicated possible overloads of existing 230 kV lines in future years. A 2012 Columbia Grid study has also indicated the need for additional 230 kV capacity in the King County area.

The core area of the Eastside in Bellevue is eight miles from any 230-115 kV source. This has placed a strain on the two nearest substations providing 230-115 kV transformation to the Eastside: Sammamish and Talbot Hill Substations. Continuing load growth in the Eastside area would increase the overload problems being shown in the first 5 years of the study.

This study examined thermal overloads for Category A (N-0), Category B (N-1) and Category C (N-2 and N-1-1) outages as required by NERC, WECC and PSE Transmission Planning Guidelines.

At approximately 5,200 MW PSE system load, as forecast for 2017-18 winter, multiple elements are at risk of overload. If the load growth is higher or conservation goals are not achieved as projected, the overloads will be higher and occur sooner.

PSE uses CAPs to automatically or manually prevent overloads under the NERC reliability requirements. The CAPs required to prevent N-1-1 overloads would open lines between Sammamish and Talbot Hill. Some of the CAPs place customers at risk of outage due to transmission lines being switched into a radial mode, with a feed from just one end. In the future, load growth will result in additional lines required to be opened, putting over 60,000 customers at risk of subsequent outages.

This analysis has shown a transmission capacity deficiency in the Eastside area of Lake Washington will develop by the winter of 2017-18. This transmission capacity deficiency will continue to increase beyond that date.

QUANTA TECHNOLOGY

Appendix A: Load Forecast

Table A-1: 2012 Annual Peak Load Forecast Distribution

	100% Conservation		Net of 100% Conservation			Gross of Conservation (0% Conservation)		
Year	Normal 23°	Extreme 13°	Normal Peak (23°)	Extreme Peak (13°)	ERM Peak (PSO)	Normal Peak (23°)	Extreme Peak (13°)	ERM Peak (PSO)
2012	68	68	4,837	5,316	5,316	4,905	5,384	5,384
2013	140	140	4,785	5,267	5,267	4,926	5,408	5,408
2014	226	226	4,836	5,333	5,333	5,063	5,560	5,560
2015	319	319	4,865	5,375	5,375	5,184	5,694	5,694
2016	394	394	4,909	5,432	5,432	5,303	5,826	5,826
2017	468	468	4,938	5,472	5,472	5,406	5,940	5,940
2018	562	562	4,938	5,483	5,483	5,500	6,045	6,045
2019	651	651	4,946	5,501	5,501	5,597	6,152	6,152
2020	778	778	4,923	5,490	5,490	5,701	6,268	6,268
2021	885	885	4,923	5,502	5,502	5,808	6,386	6,386
2022	944	944	4,972	5,562	5,562	5,916	6,506	6,506
2023	986	986	5,039	5,641	5,641	6,025	6,627	6,627
2024	1,023	1,023	5,117	5,732	5,732	6,140	6,754	6,754
2025	1,061	1,061	5,193	5,820	5,820	6,254	6,881	6,881
2026	1,100	1,100	5,266	5,905	5,905	6,365	7,004	7,004
2027	1,138	1,138	5,341	5,993	5,993	6,479	7,131	7,131
2028	1,172	1,172	5,426	6,090	6,090	6,598	7,262	7,262
2029	1,203	1,203	5,515	6,192	6,192	6,718	7,396	7,396
2030	1,236	1,236	5,605	6,296	6,296	6,840	7,531	7,531
2031	1,270	1,270	5,694	6,399	6,399	6,964	7,668	7,668
2032	1,305	1,305	5,785	6,504	6,504	7,090	7,808	7,808
2033	1,341	1,341	5,878	6,610	6,610	7,219	7,951	7,951

QUANTA TECHNOLOGY

Table A-2: 2012 Annual Peak Load Forecast for Eastside Area

	Normal Peaks (23 ⁰F) Net of Conservation			Extreme Peaks (13 ⁰F) Net of Conservation			Normal Peaks (23 ⁰F) Gross of Conservation		Extreme Peaks (13⁰F) Gross of Conservation	
Year	Eastside % of King Co	**Eastside**	King	Eastside % of King Co	**Eastside**	King	**Eastside**	King	**Eastside**	King
2012	27.5	646	2,348	27.4	709	2,586	655	2,381	718	2,619
2013	27.5	652	2,371	27.5	718	2,615	671	2,440	737	2,685
2014	27.5	660	2,399	27.5	729	2,652	691	2,512	760	2,764
2015	28.0	676	2,413	28.0	748	2,672	720	2,572	793	2,831
2016	28.5	694	2,434	28.5	769	2,699	750	2,630	825	2,896
2017	28.8	706	2,448	28.8	782	2,719	773	2,681	849	2,952
2018	29.0	710	2,449	29.0	790	2,725	792	2,729	872	3,006
2019	29.5	724	2,454	29.5	807	2,735	820	2,779	903	3,061
2020	30.0	733	2,445	30.0	820	2,732	850	2,834	937	3,122
2021	30.9	756	2,449	30.8	845	2,742	893	2,892	982	3,187
2022	30.9	765	2,476	31.0	861	2,776	912	2,950	1,008	3,251
2023	30.9	777	2,514	31.0	874	2,821	930	3,010	1,028	3,317
2024	30.9	790	2,558	31.0	890	2,871	949	3,073	1,050	3,387
2025	30.9	804	2,602	31.0	906	2,922	969	3,137	1,072	3,458
2026	30.9	818	2,646	31.0	922	2,973	989	3,201	1,094	3,530

NOTES:

1. Normal and Extreme County Peaks taken from PSE F2012: Electric County Peaks worksheet.
2. Eastside Normal and Extreme Peaks for years 2013, 2017 and 2021 are taken from the E230 Project worksheet: Eastside Load. The King County load was adjusted for expected block loads known to PSE Planning within the 10-year study period.
3. The Eastside load is calculated for years 2013, 2017 and 2021 based on the expected block loads with interpolation being used to calculate the in between years.

Appendix B: Upgrades Included in Base Cases

Table B-1: Projects Added to the Eastside Needs Assessment Winter Base Case

2013-14	2017-18	2021-22
Beverly Park - Cottage Brook breaker replacement	Beverly Park - Cottage Brook breaker replacement	Beverly Park - Cottage Brook breaker replacement
Cottage Brook - Moorlands line reconductor	Cottage Brook - Moorlands line reconductor	Cottage Brook - Moorlands line reconductor
Saint Clair 230-115 kV transformer	Saint Clair 230-115 kV transformer	Saint Clair 230-115 kV transformer
Talbot Hill - Berrydale #1 line uprate	Talbot Hill - Berrydale #1 line uprate	Talbot Hill - Berrydale #1 line uprate
Starwood autotransformer removal / Tacoma Power voltage increase	Starwood autotransformer removal / Tacoma Power voltage increase	Starwood autotransformer removal / Tacoma Power voltage increase
	Alderton 230-115 kV transformer	Alderton 230-115 kV transformer
	Lake Holm Substation (block load)	Lake Holm Substation (block load)
	Beverly Park 230-115 kV transformer	Beverly Park 230-115 kV transformer
	Sensitivity Study 2: Raver 500-230 kV transformer	Sensitivity Study 2: Raver 500-230 kV transformer
	Sensitivity Study 2: SCL series inductors	Sensitivity Study 2: SCL series inductors

Table B-2: Projects Added to the Summer NERC TPL Base Case for the Eastside Area

2014	2018
Beverly Park - Cottage Brook breaker replacement	Beverly Park - Cottage Brook breaker replacement
Cottage Brook - Moorlands line reconductor	Cottage Brook - Moorlands line reconductor
Saint Clair 230-115 kV transformer	Saint Clair 230-115 kV transformer
Talbot Hill - Berrydale #1 line uprate	Talbot Hill - Berrydale #1 line uprate
Starwood autotransformer removal / Tacoma Power voltage increase	Starwood autotransformer removal / Tacoma Power voltage increase
	Alderton 230-115 kV transformer
	White River - Electron Heights 115 kV line re-route into Alderton
	White River 2nd bus section breaker
	Lake Hills - Phantom Lake 115 kV line
	Lake Holm Substation (block load)
	Cumberland Substation 115 conversion (block load)
	Beverly Park 230-115 kV transformer

Appendix C: Quanta Technology and Puget Sound Energy Author Biographies

Quanta Technology assisted Puget Sound Energy in conducting this study, including research, analysis and documentation. Quanta Technology is an expertise-based, independent consulting company providing business and technical expertise to the energy and utility industries. They assist with deploying strategic and practical solutions to improve a company's business performance. Their mission is to provide value to clients in every engagement with the industry-best technical and business expertise, holistic and practical advice, and industry thought leadership.

Thomas J. Gentile, PE, *Quanta Technology Vice President Transmission Strategy,* is based in Massachusetts and has over 36 years of experience and proven leadership with transmission and distribution system planning, analysis, engineering, program/project management and interfacing with RTOs/ISOs and regulatory agencies. Mr. Gentile has participated in various planning, operating and market committees at NERC, NPCC, NYISO and ISO-NE. Tom received MSEE and BSEE degrees from Iowa State University and Northeastern University. He is a registered professional engineer in the State of Massachusetts.

Donald J. Morrow, PE, *Quanta Technology Partner, Senior Vice President of Corporate Strategy and Quanta Technology Expert*, has more than 30 years of utility and consulting experience. During the course of his career, Don has held a wide range of technical and management responsibilities including system planning, control area operations, transmission operations, energy trading, maintenance scheduling, operator training, protection, distribution operations, energy management systems and natural gas dispatch. Don received his BSEE and MBA from the University of Wisconsin, Madison. Don developed the transmission practice at Quanta Technology and he has led several transmission planning projects since 2006, including the SPP EHV Overlay study, the Smartransmission Project (www.smartstudy.biz), and Companhia de Electricidade de Macau in Macua, China. He is a registered professional engineer in the states of Wisconsin and Arkansas.

Carol O. Jaeger, PE, *Puget Sound Energy Consulting Engineer*, *Transmission Planning*, has over 30 years experience in transmission and distribution planning, distribution design, and substation design and operations. She received her BSEE from the University of Washington and is a registered professional engineer in the state of Washington.

Zach Gill Sanford, *Puget Sound Energy Engineer, Transmission Planning*, has over 4 years experience in transmission planning and NERC compliance. He received his BSEE from the University of Washington.