Electrical Facilities Planning

Energize Eastside Independent Technical Analysis

Bellevue City Council - May 4, 2015

Discussion Topics

- Electrical Facilities Planning
- Energize Eastside – Engagement Process
- Independent Technical Analysis -- USE Report
- Environmental Review (EIS)

Electrical Facilities Planning

- **1993** Comprehensive Plan reflects PSE identification of future electrical facility needs
- **2006** Windstorm (Hanukkah Eve)
- **2007** Comprehensive Plan policies added to address siting electrical facilities
- **2008** Land Use Code amended with specific requirements for permitting and mitigation of electrical facilities
- **2011** Electrical Reliability Study
- **2015** Energize Eastside Independent Technical Analysis – more than a peer review – an audit of PSE's proposal

Energize Eastside
Bellevue Engagement Process

- City, neighborhood, and business participation in PSE Citizens Advisory Group (CAG)
- Community Forum (June 3, 2014) heard directly from residents, business owners and other stakeholders.
- Local and state policies and codes that govern the siting and mitigation of electrical facilities
- Council briefings from PSE
- Electrical Facilities Planning website providing information to public
- Staff Support (Ongoing)
- Eight City Council briefings since beginning of 2014 including public comment
- Commissioned Independent Technical Analysis -- Included stakeholder input

Independent Technical Analysis

OF THE

ENERGIZE EASTSIDE PROJECT

Bellevue City Council Study Session

Monday, May 4, 2015

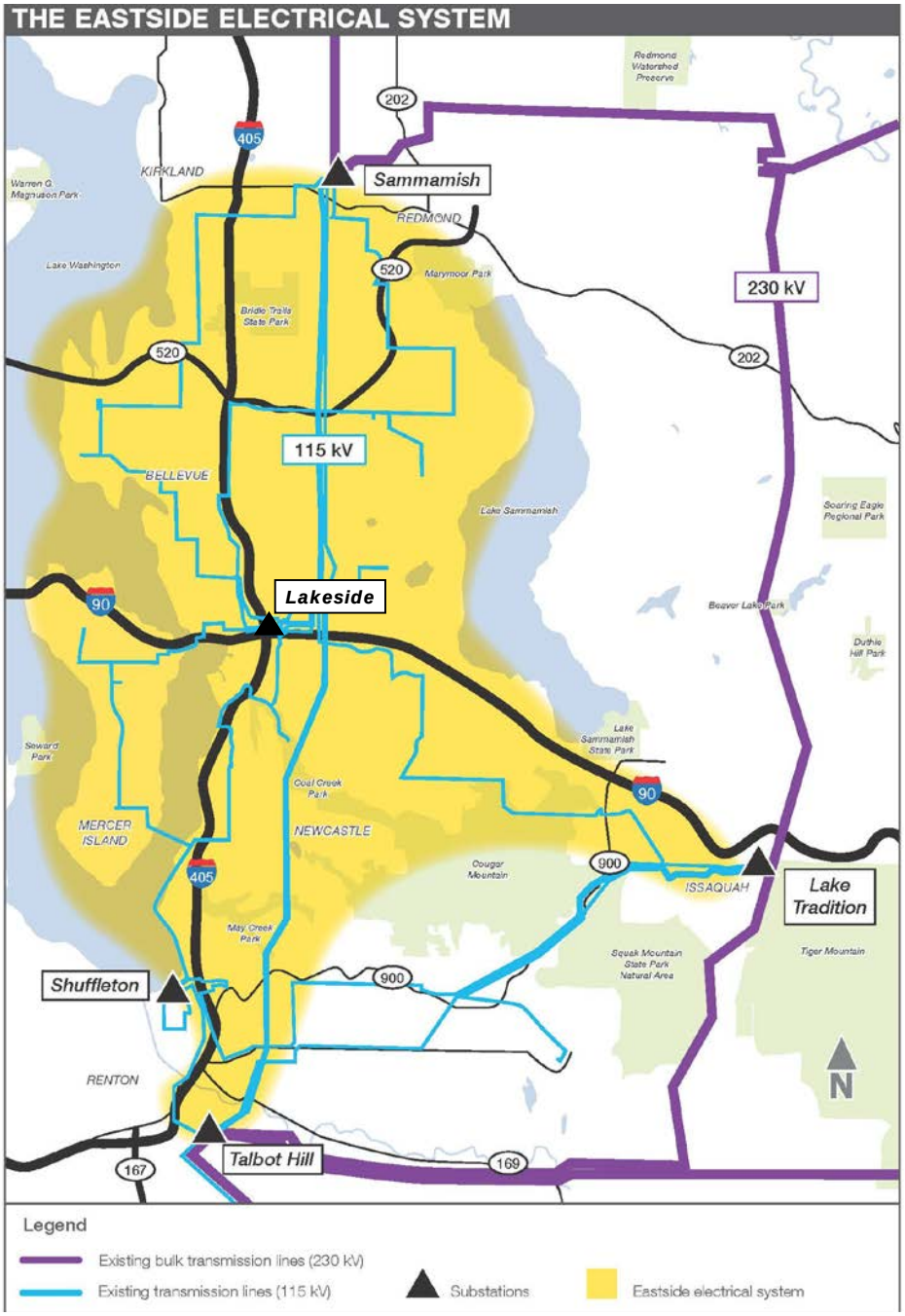
Peter Mackin and Jennifer Geer

Utility System Efficiencies, Inc.

Eastside Area

Encompasses:

- Bellevue, Clyde Hill, Medina, Mercer Island, Newcastle,
- The towns of Yarrow Point, Hunts Point, and Beaux Arts,
- Portions of Kirkland, Redmond, and Renton.



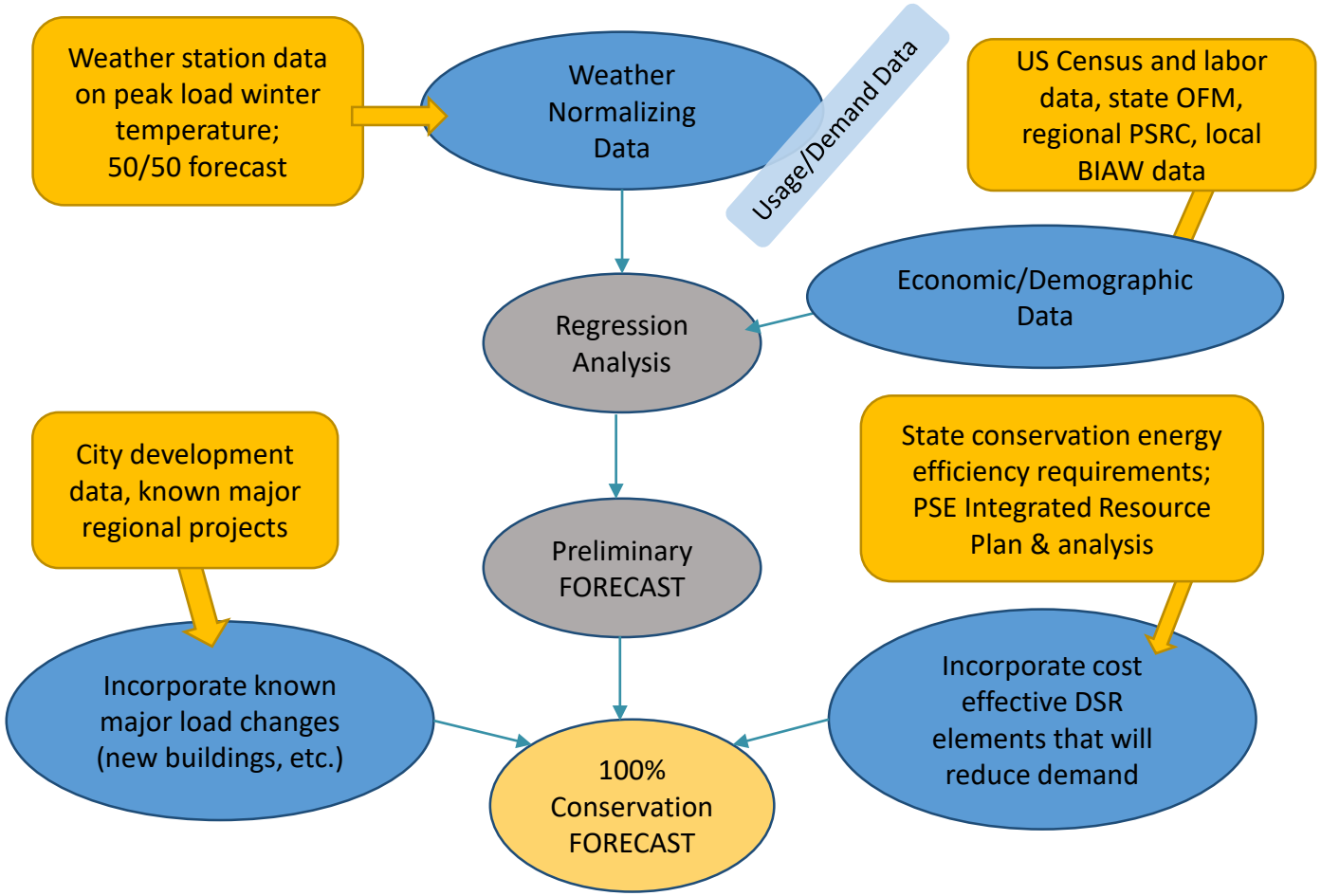
Three Key Questions

- Is there a need for the Energize Eastside Project to address growth in Bellevue?
  - → Examined PSE's Forecasting Methodology
  - → Examined Impact of Forecast on the electric grid (study cases)
- Is the Project needed to address the reliability of the electric grid on the Eastside?
  - → Reviewed standards for grid reliability
  - → Examined Impact of Forecast variations in growth (less growth)
  - → Examined Impact of variation in the amount of Puget Sound Area generation
- Is the Project needed to address regional flows, with imports/exports to Canada?
  - → Examined Impact of regional flows to/from Canada

Is Energize Eastside needed to address growth in Bellevue?

- Step 1: Examine the Forecasting Methodology

Simplified Forecasting Flowchart



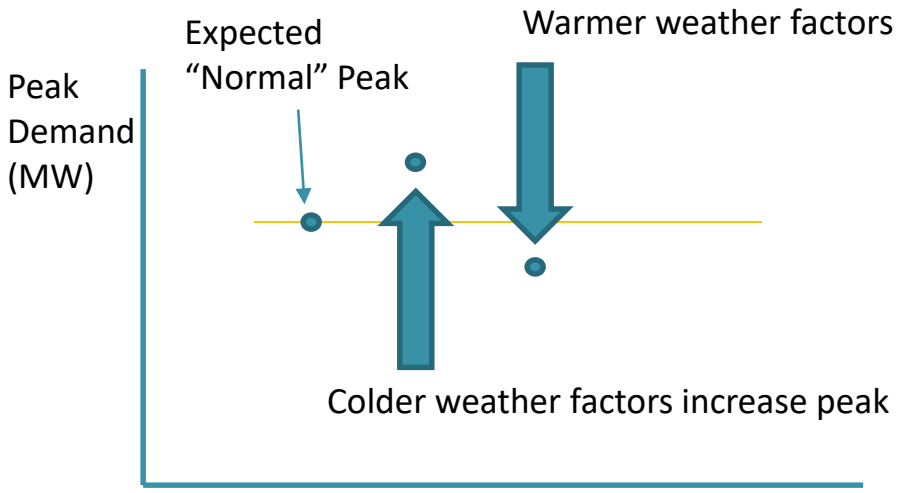
Weather Normalizing: Federal Standards

North American Electric Reliability Corporation (NERC) is a not-for-profit ***international regulatory authority whose mission is to assure the reliability of the bulk power system in North America***. NERC develops and enforces Reliability Standards as one of its duties. NERC's area of responsibility spans the continental United States, Canada, and the northern portion of Baja California, Mexico.

"The Bulk Electric Power System … requires … demand forecasts on a normalized basis."

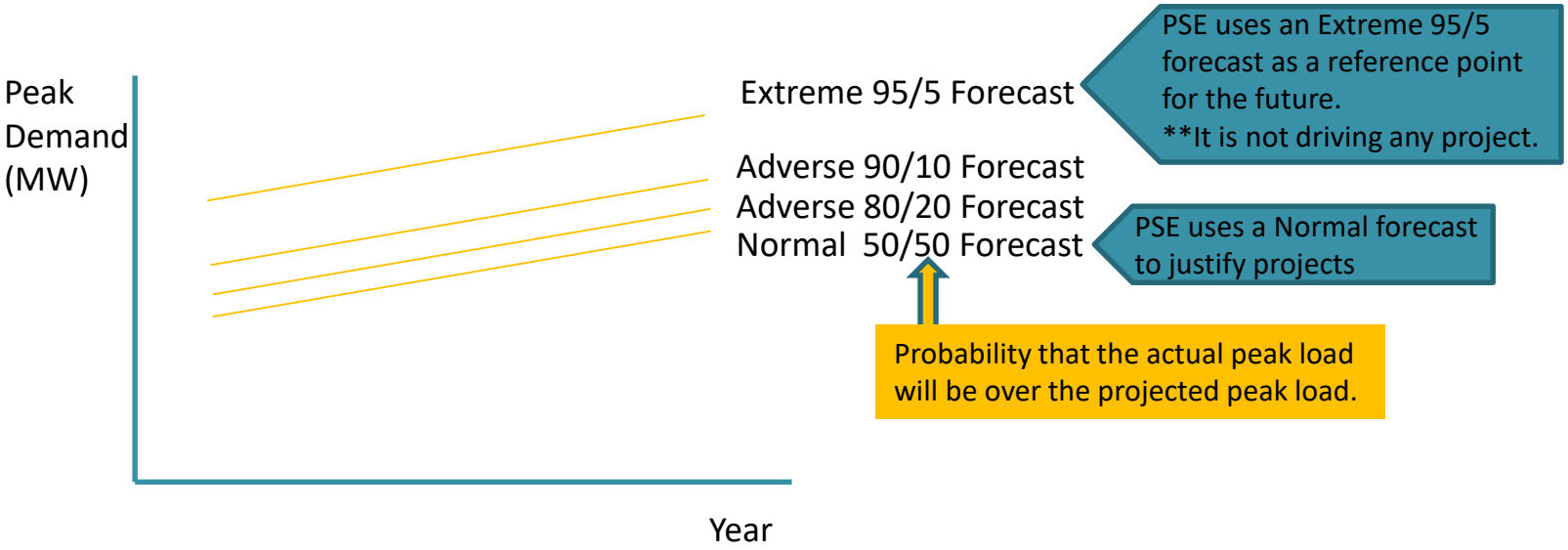
Weather Normalizing

- Adjust load to account for weather variability
- Required by North American Electric Reliability Corporation (NERC)
- Normal forecast reflects average temperature of the annual peak demand and incorporates related weather factors



Actual winter peak loads would disguise the growth trend

Weather Normalizing – Winter Peak Loads



Econometric and Demographic Data

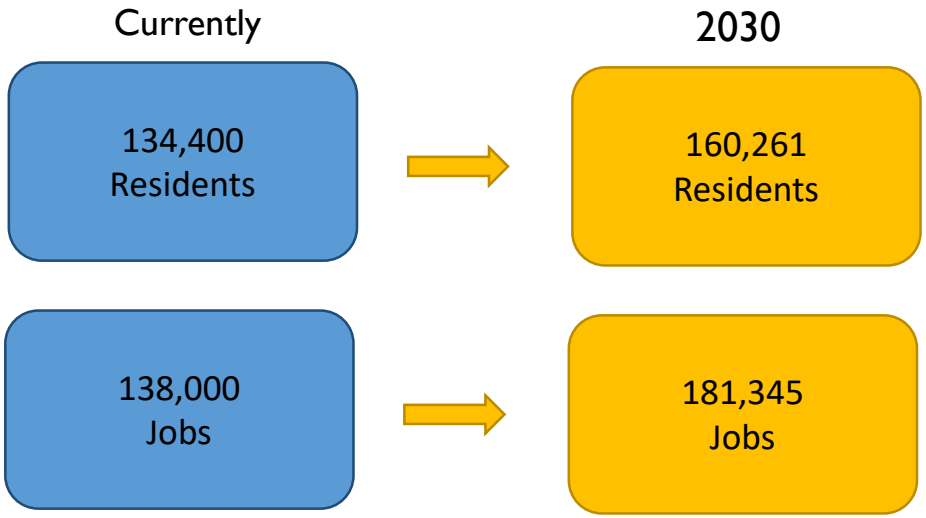
Data Set	Historical Data Frequency	Source of Historical Data	Source of Forecasted Data
County Level Employment			
Labor Force, Employment, Unemployment Rate	Quarterly	US Bureau of Labor Statistics (BLS)	PSE's Economic/Demographic Model
Total Non-Farm Employment Goods Producing & Service Providing Sectors	Monthly	WA State Employment Security Department (ESD), using data from Quarterly Census of Employment & Wages	
County Level Personal Income			
Personal Income, Wages and Salaries	Yearly	US Bureau of Economic Analysis (BEA)	PSE's Economic/Demographic Model
County Level Population and Households			
Population (thousands)	Yearly	US BEA/ WA State Office of Financial Management (OFM)	PSE's Economic/Demographic Model
Households, Single-family & Multi-Family (thousands.)	Annual forecasts	US Census	
Household size, Single- and Multi-family (number)	Quarterly	Building Industry Association of Washington	
Eastside Area by Census Tracts			
Population	Yearly	WA State Office of Financial Management (OFM), 9/28/14	PSRC data, April 2014
Employment	Yearly	PSRC, June 2014	PSRC data, April 2014
US Level Macroeconomy			
GDP ($ x Billions, in year 2000 $), Industrial Production Index	Quarterly	Moody's	Moody's
Employment (mils.), Unemployment Rate (%)			
Personal Income ($ x Billions) Wages & salary disbursements, Other Income			
CPI (82-84=1.00[1]), consumer expenditures deflator (2000=1.0)			
Housing Starts (millions)			
Population (millions)			
T-bill rate, 3 months (%), Conventional mortgage rage (%)			

1 The average of the 1982-1984 data is set to 1.00

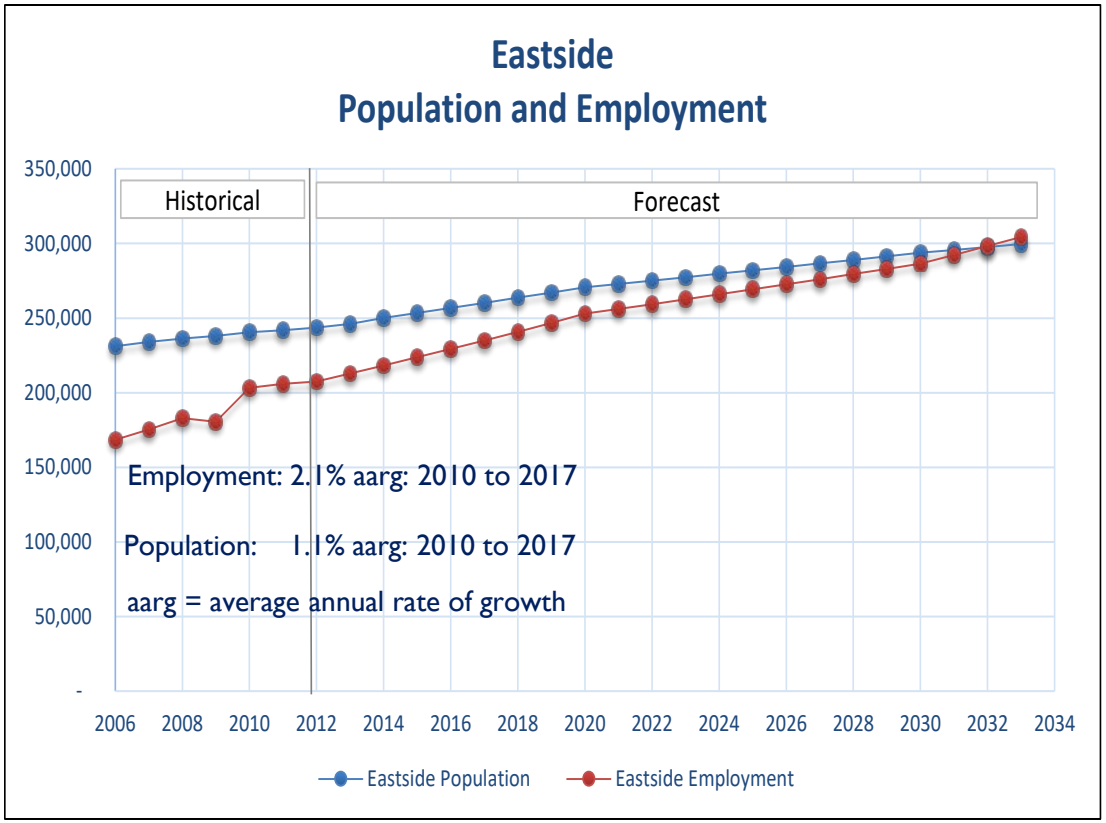
Econometric and Demographic Data

- Puget Sound Regional Council (PSRC)
  - Vision 2040 Regional Growth Strategy: Metropolitan Cities – 32% regional population growth, 42% of regional employment growth

Data provided by the City of Bellevue:



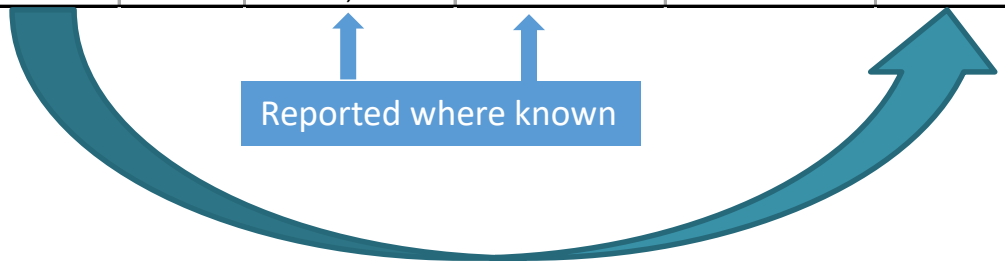
Eastside Demographic Data



Incorporate Known Major Projects/ Known Major Load Changes

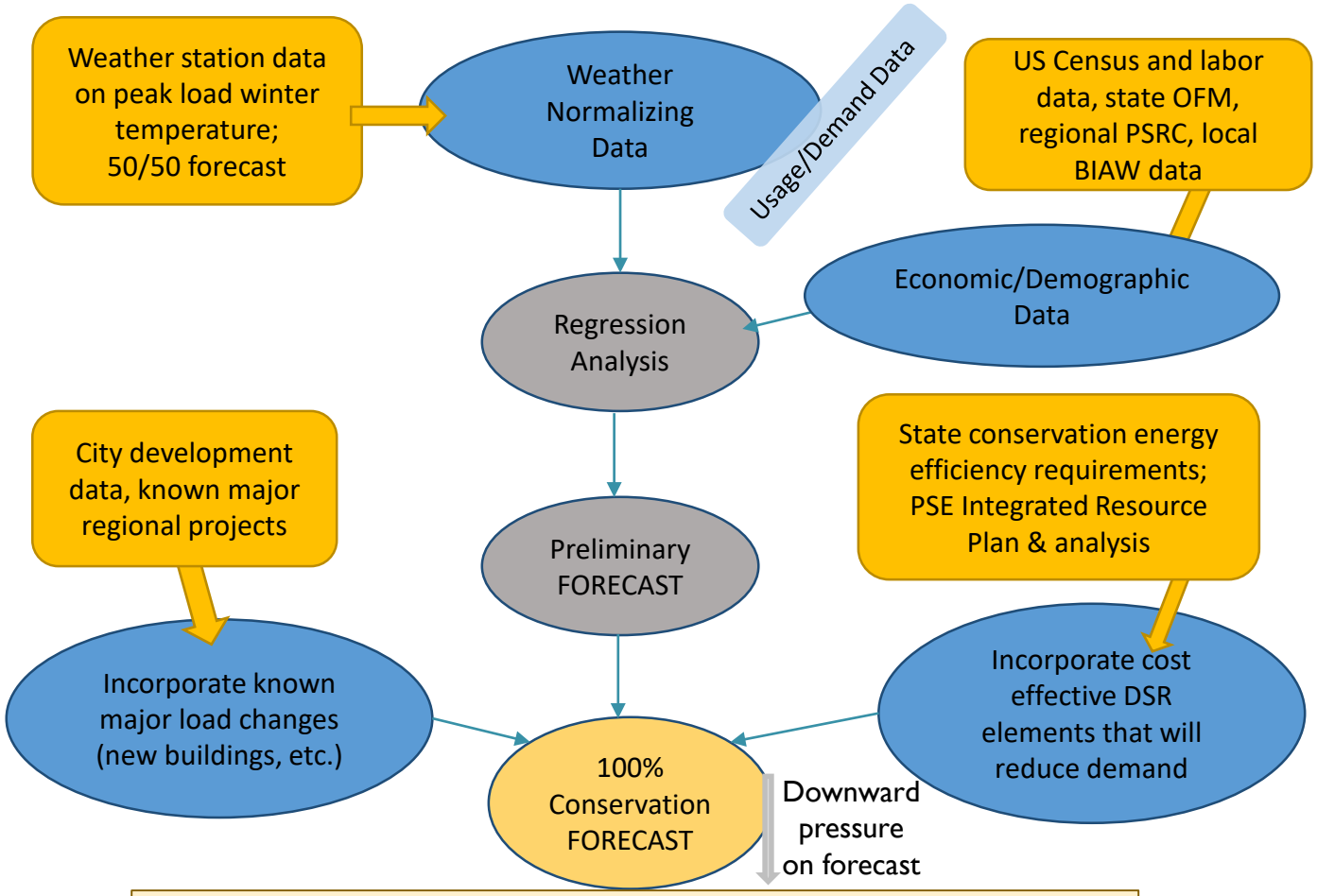
Eastside Area Estimated Completion Year	Assigned Probability	# of Projects	Commercial Sq Footage	# of Multi-family units	MW fully energized this year	MW added to forecast
2014	100%	3	100,000	642	4.4	4.4
2015	100%	9	n/a	1231	5.3	5.3
2016	100%	6	263,000	493	7.0	7
2017	100%	7	2,157,000	1566	25.0	25
2018	50%	4	820,362	n/a	1.0	0.5
2019	50%	6	1,989,340	n/a	21.5	10.75
2020	50%	18	1,316,000	234	16.3	8.15
2021	0%	4	2,010,000	n/a	14.8	0
2022	0%	0	0	0	0.0	0
2023	0%	0	0	0	0.0	0
2024	0%	3	928,000	n/a	8.5	0
2025 and beyond	0%	9	602,000	150	17.8	0

Source: PSE



Summary: Forecast of growth

Simplified Forecasting Flowchart



PSE followed industry practice in forecasting its demand load

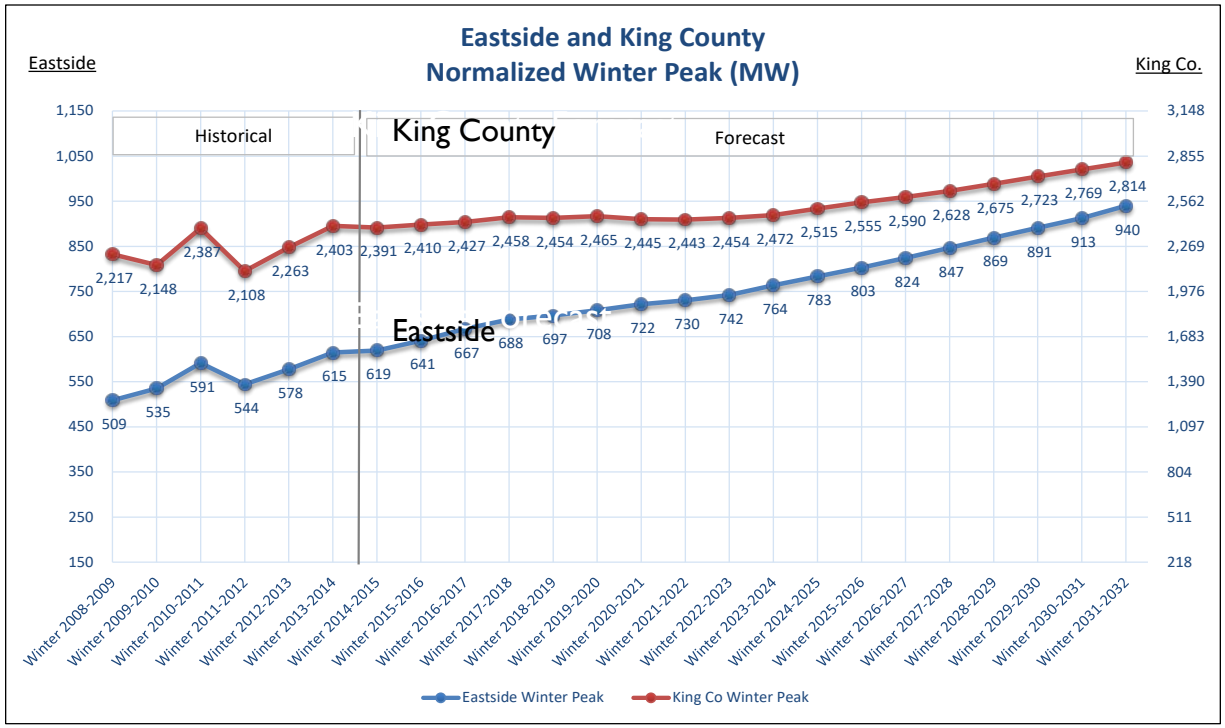
Energy Consumption versus Peak Demand

- Forecasts are developed for both energy consumption and peak demand.
- Energy consumption (MWh) is a cumulative measure of total power produced or consumed over time.
- Demand (MW) is a snapshot of power used. A peak forecast is a demand forecast.

Analogy:
Odometer (cumulative over time) = ENERGY
versus
Speedometer (snapshot) = DEMAND

PSE's 2014 Peak Demand Forecast

(100% Conservation)



Forecast	Comparison of F14 growth to F12 growth
PSE System	F14: lower peak growth
King County (excluding Eastside)	F14: lower peak growth
Eastside area	F14: higher peak growth

PSE's 2014 Eastside Demand Forecast

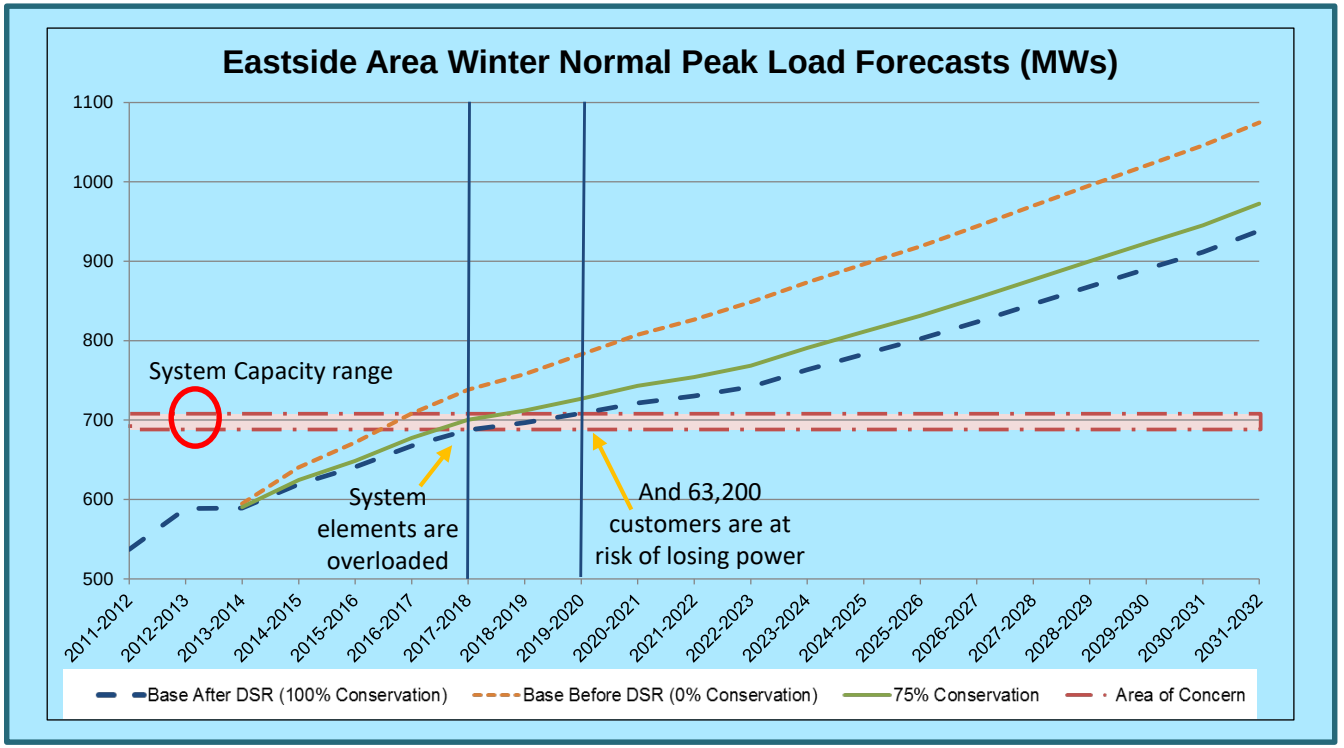
- Higher growth rate
- Lower forecasted 2017/18 demand

Forecast Development Year	2017/18 Winter Peak
2012	699 MW
2014	688 MW

* Normalized actual peak loads for winter 2012/13 and 2013/14 were less than the forecasted peak loads from the F12 forecast.

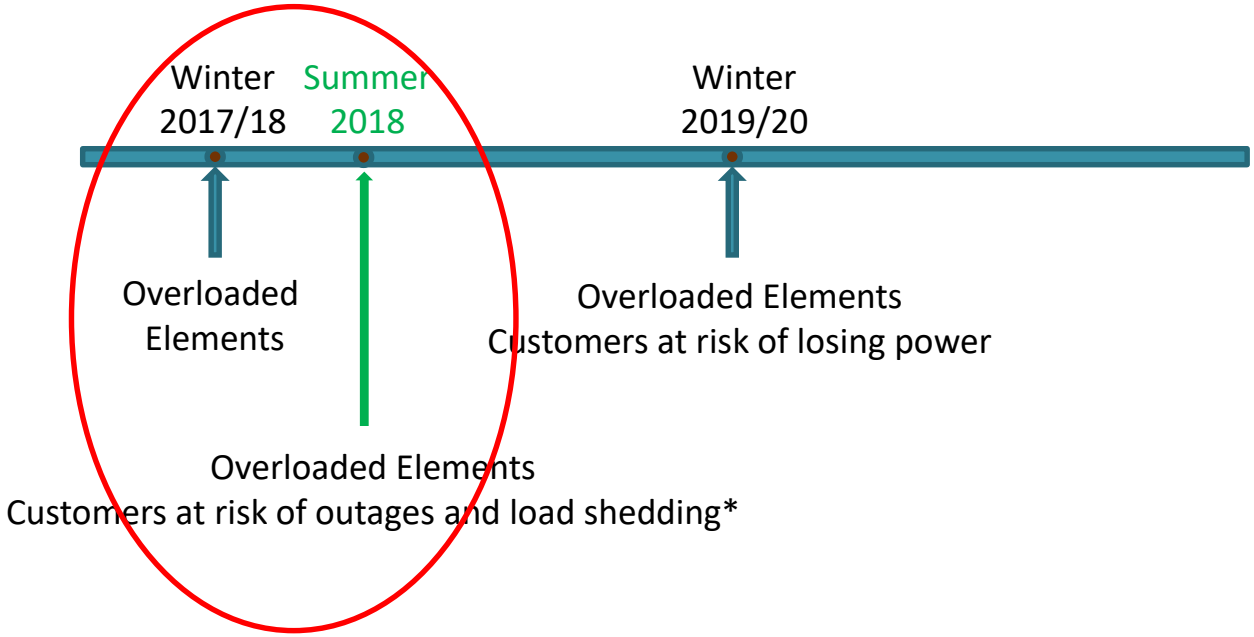
PSE's 2014 Eastside Forecast Peak Demand

PSE's Graph of System Capacity, 2014 Forecast, 100% Planned Conservation



System Capacity driven by:
688 MW in winter 2017/18 – System elements are overloaded
708 MW in winter 2019/20 – And 63,200 customers are at risk of losing power

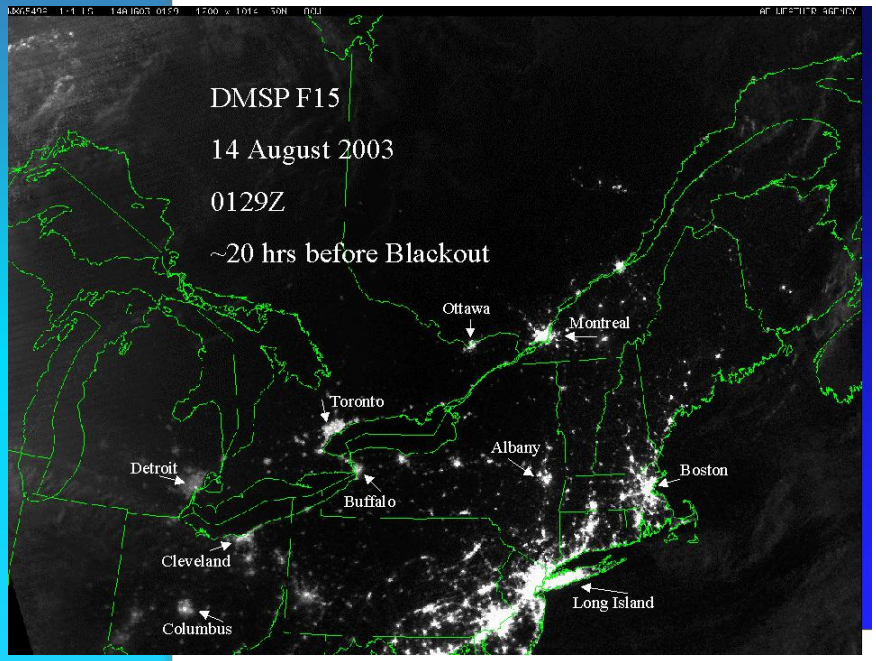
PSE's 2014 Eastside Forecast - Summary



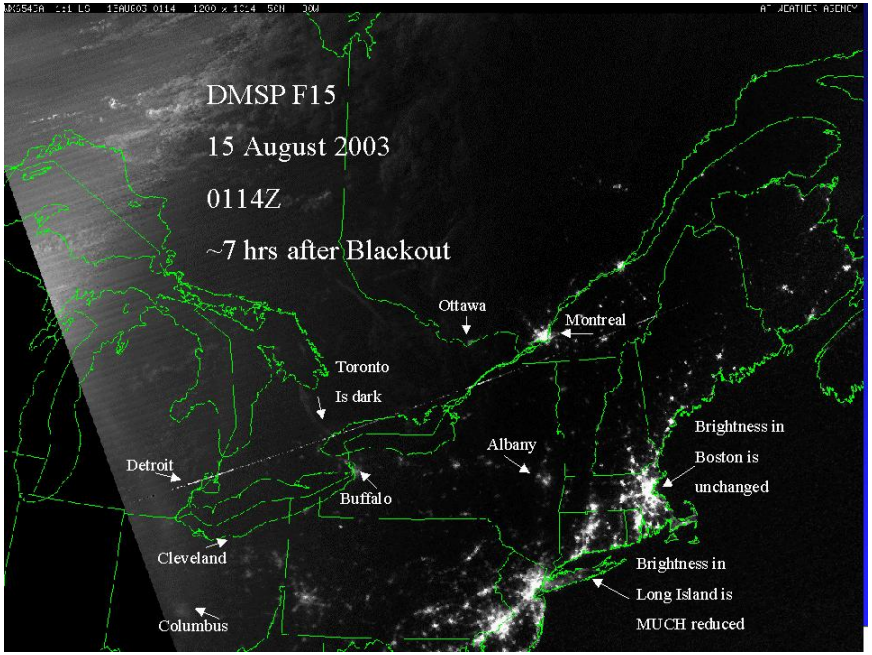
* Load shedding: An intentional electrical power shutdown to a portion of the system (customers experience an outage) to protect the network from a greater impact or from potential damage

NERC Standards

- Background 2003 NE Outage



Before

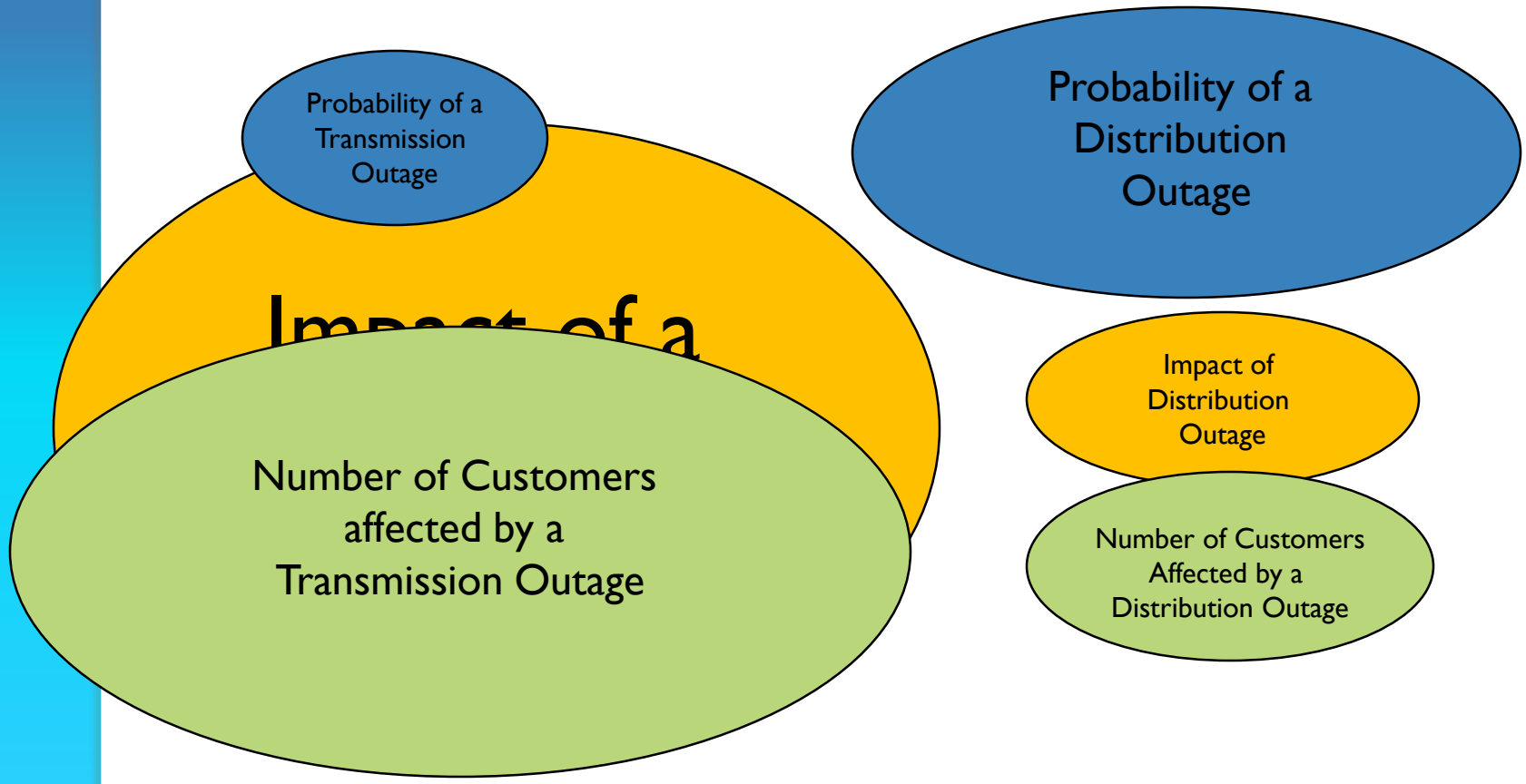


After

NERC Standards

- NERC Standards are mandatory
- Must be able to serve expected load (or demand) and regional transmission requests under transmission outage conditions
- Critical outages for EE need are outages where one element goes out, then after more than 30 minutes have elapsed a second element goes out (N-1-1)

Reliability Impacts of Transmission vs. Distribution Outages



Optional Technical Analysis (OTA) Scenarios

- Reduced Eastside area load growth (1.5%)
- Reduced King County load growth (.25%)
- Increased west of the Cascades generation
  - e.g., March Point and Tenaska (PSE) (Skagit and Snohomish Counties), SnoPUD, and Skagit River (SCL)
- Eliminate regional transfers to/from Canada
- Extreme weather analysis (13°F at time of maximum demand)

OTA Results

Northern Intertie: South to North	2017/18 Normal Winter (23°F) 100% Conservation						2017/18 Extreme Winter (13°F) 100% Conservation		
Overloaded Element (Transmission Line or Transformer)	1) Original PSE Case	2) Reduce Eastside load growth to 1.5%	3) Reduce PSE's King County growth to 0.25%	4) Increase Puget Sound area generation	5) Set Load transfers to Canada = 0 (North. Intertie = 0)	6) Combination of Scenario 4 and & 5	E1) Original PSE Case adjusted for extreme weather	E2) Set Load transfers to Canada = 0 (North. Intertie = 0)	E3) Scenario E2 + Increase Puget Sound area generation
Talbot Hill - [illegible]									
Talbot Hill - [illegible]									
Talbot Hill 23[illegible]									OL
Talbot Hill 23[illegible]									OL
Talbot Hill-Bo[illegible]									
Sammamish [illegible]									OL
Sammamish 230/115 kV transformer #2								OL	OL

Bottom Line:

- Under all scenarios studied there was a local need.
- Note: Scenarios 5, 6, E2, and E3 would not meet the requirements of the NERC Reliability Standards

OL = Overload of Emergency Rating. Source: OTA Results

King County load reduction excluded Eastside load

OTA Results

Northern Intertie: North to South Overloaded Element (Transmission Line or Transformer)	2018 Summer (86°F) 100% Conservation				
	1) Original PSE Case	2) Reduce Eastside load growth	3) Reduce PSE's King County growth	4) Increase Puget Sound area generation	5) Set Load transfers to Canada = 0 (Northern Intertie = 0)
Samn					
Samn					
Novel					
BPA M					
Bever					
Samn					

Bottom Line:

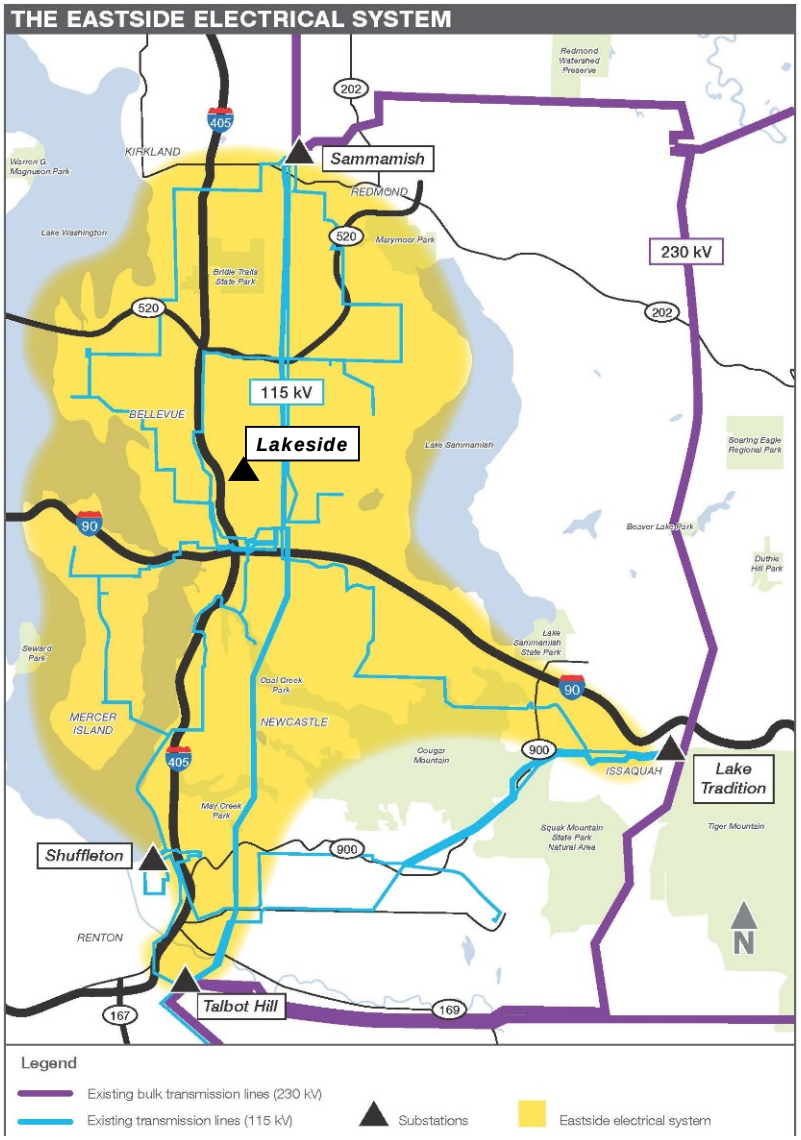
- Under scenarios 1 – 4 there was a local need.
- Scenario 5 showed no local need (summer only)
- However, scenario 5 would not meet the requirements of the NERC Reliability Standards

OL = Overload of Emergency Rating. Source: OTA Results

King County load reduction excluded Eastside load

Three Key Questions Answered

- Is there a need for the Energize Eastside Project to address growth in Bellevue? YES
- Is the Project needed to address the reliability of the electric grid on the Eastside? YES
- Is the Project needed to address regional flows, with imports/exports to Canada? YES

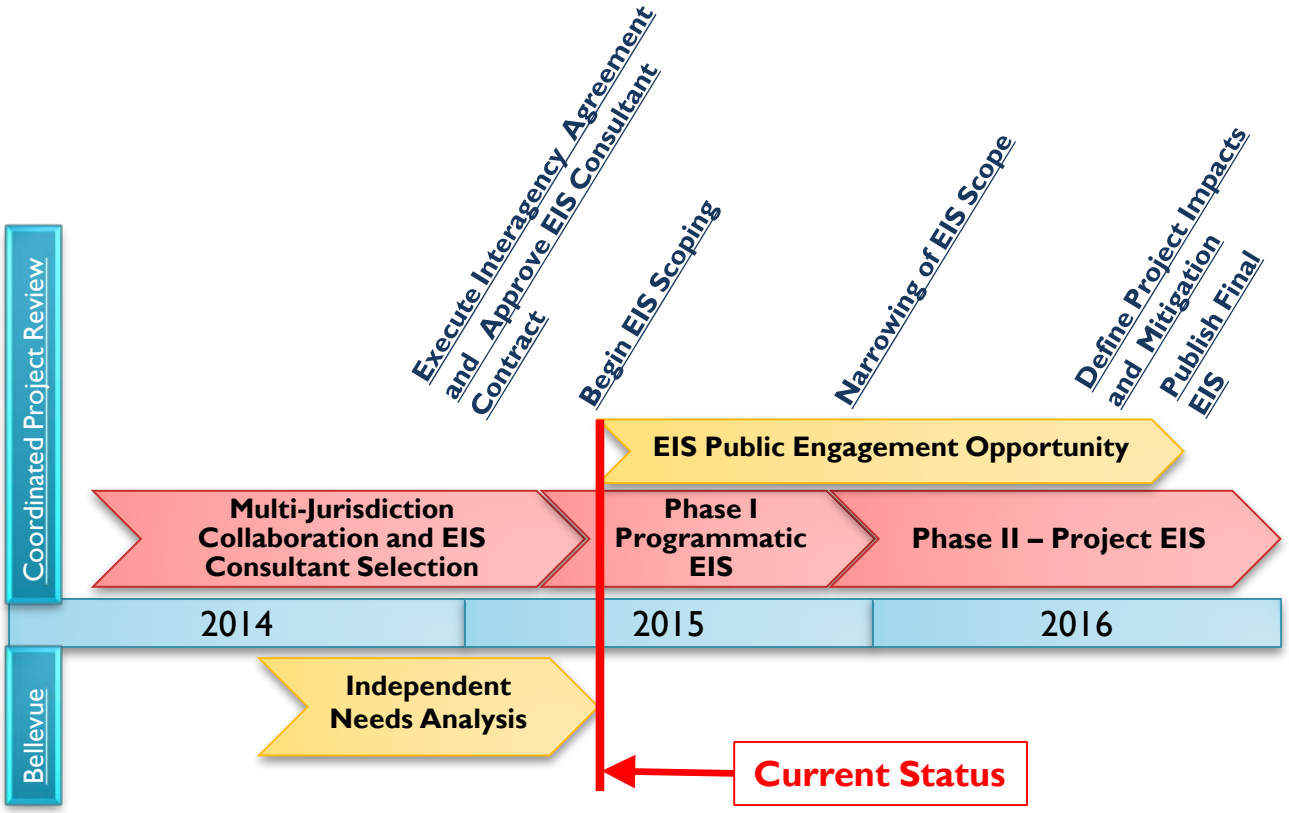


Questions?

Conclusions & Next Steps

- Bellevue has taken seriously its responsibilities to citizens and PSE to evaluate the need for Energize Eastside in the USE report, and City role in project permitting
- The City has invested $500,000 in independent analyses
- ERS and ITA independently confirmed need
- The City determined the project is an Essential Public Facility
- The next step in the project approval process is the EIS.
- The EIS will address alternatives for how the identified power need can be met analyzing Energize Eastside and other alternatives

Energize Eastside
Environmental Review Process

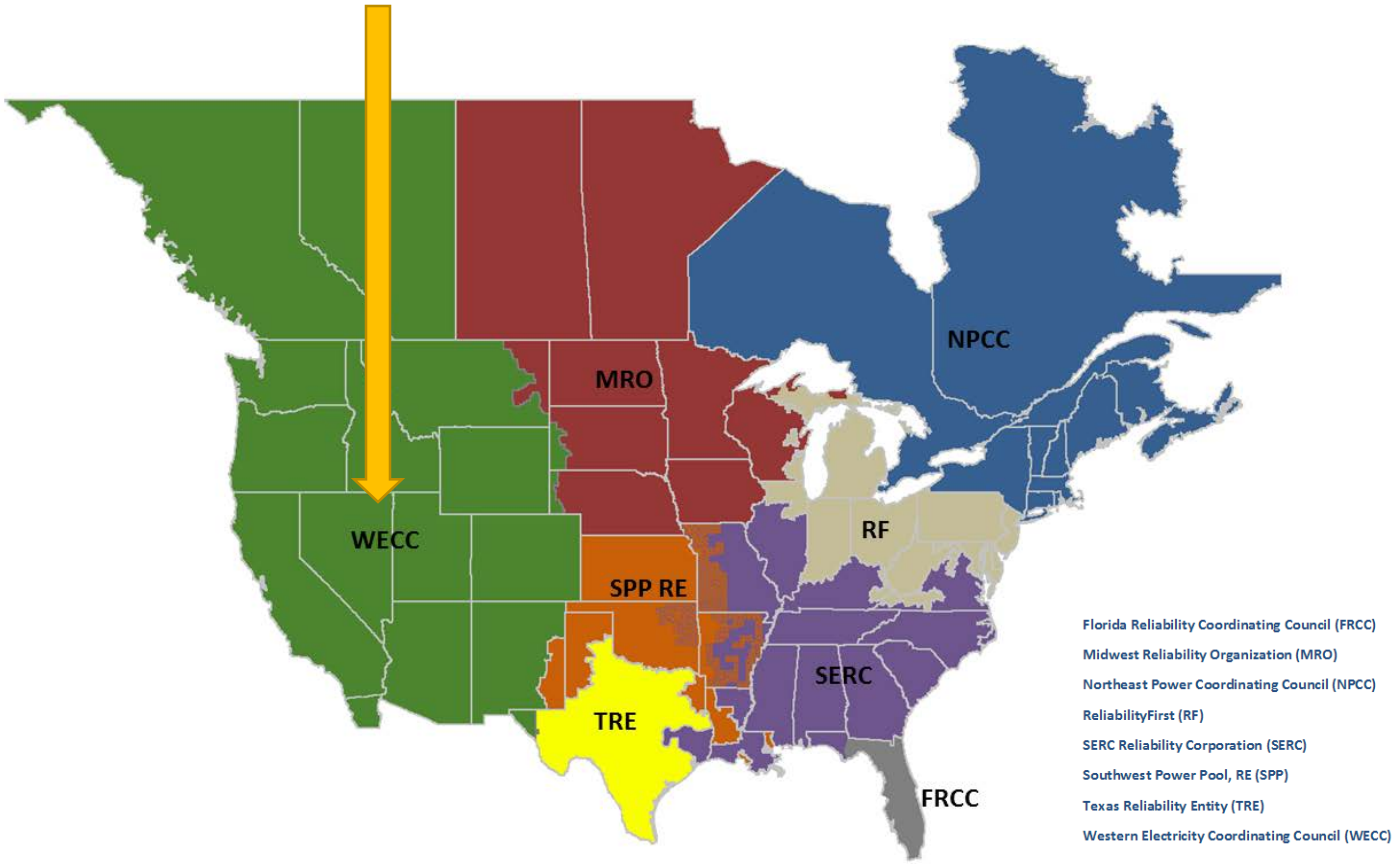


Environmental Review (EIS)

- Scoping Open April 30 – June 15.
  - Scoping Meetings/Open House
    - May 12th — Bellevue
    - May 14th — Renton
    - May 26th — Kirkland
    - May 28th — Newcastle
    - May 30th — Bellevue

Background Slides

Western Electricity Coordinating Council (WECC)



PSE's 2014 Forecast

PSE reached several key conclusions:

- PSE's F14 forecast projected lower peak load growth and peak load levels at the system and King County levels.
    - PSE's F14 system forecast assumed a more gradual recovery of the US economy from recession
    - PSEs F14 system forecast used an updated US population growth forecast from the US Bureau of Census which is lower than what was used in F12.
    - PSE's F14 system forecast resulted in lower customer growth and customer counts because of slower housing recovery.
- PSE's F14 forecast for Eastside showed increased peak loads, based on PSRC's population and employment growth forecasts, projected to grow by 2.4% per year in the next 10 years, driven by growth in commercial sector and high density residential sector. The growth rate is a peak load growth rate and is developed through a regression analysis.

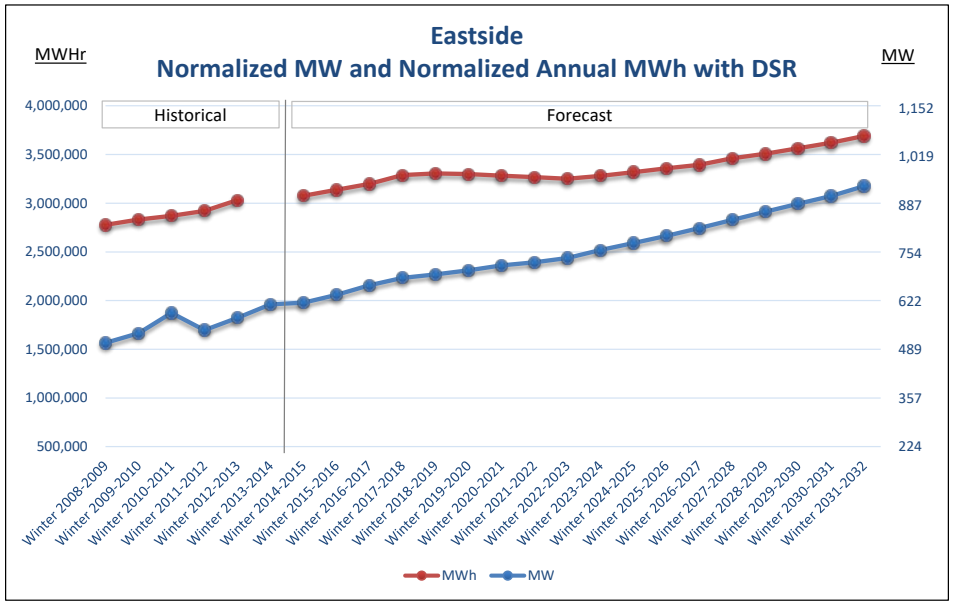
Econometric and Demographic Data

- Employment - County Level
- Personal Income - County Level
- Population and Employment - Eastside Area by Census Tracts
- US Level Macroeconomy (GDP, Employment, Personal Income, Population, Housing Starts, other financial indicators)

PSE Specific Data

- Customer Count by Class
- Rates
- Usage/Demand/Rates

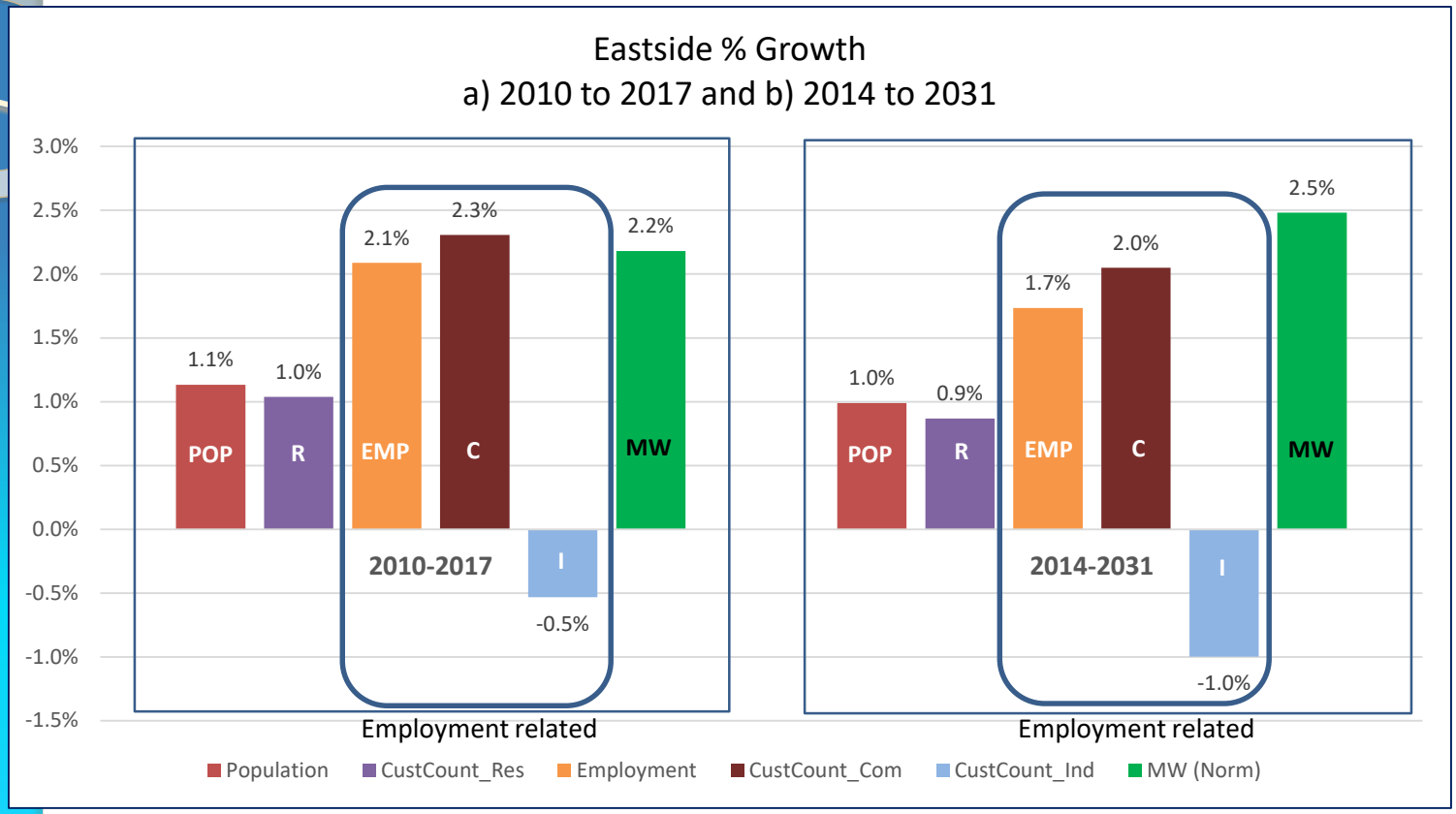
PSE's 2014 Forecast (100% Conservation)



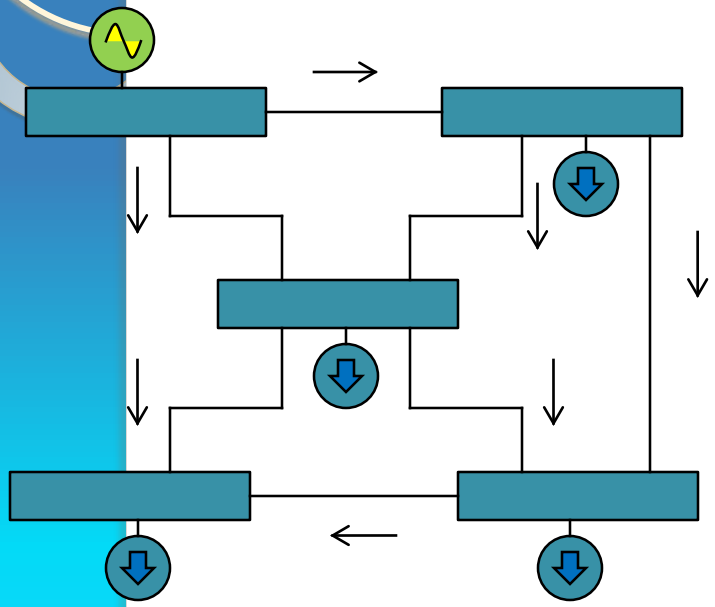
The energy forecast appears to show a stronger impact from conservation compared to the demand forecast. The conservation programs are weighted toward the first 10 years of the forecast (2014-2023). It is also impacted by the block loads which are phased in and then phased out over time. After 2020 no block loads would be phased in, with a few more years of earlier block loads phasing out.

The EE project need is based on the peak demand (MW) forecast for Eastside.

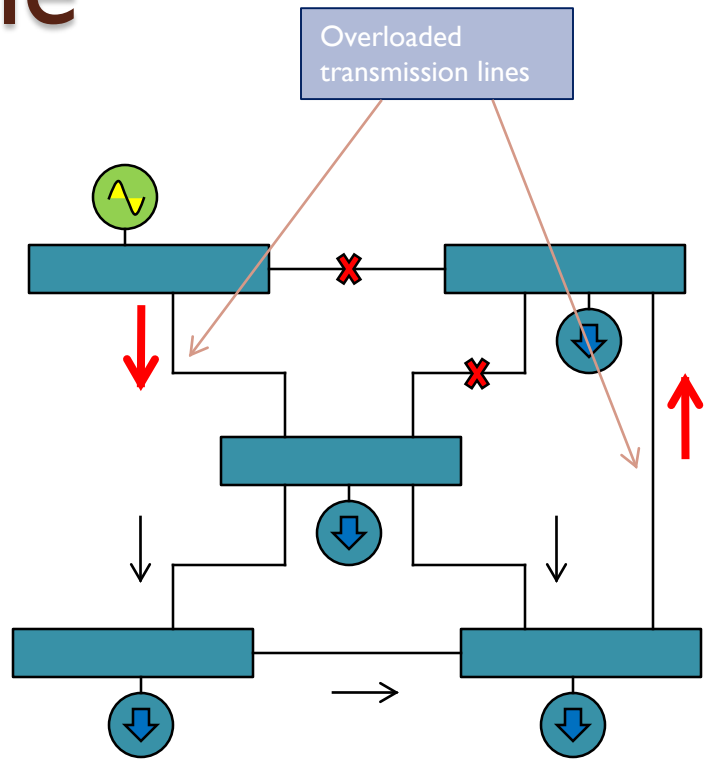
PSE's 2014 Forecast (100% Conservation)



Outage Example



Normal



N-1-1

Key

Customer Load

Generator

Substation

Transmission Line

Line outage

Table 1 – Steady State & Stability Performance Planning Events

Steady State & Stability:

a. The System shall remain stable. Cascading and uncontrolled islanding shall not occur.

b. Consequential Load Loss as well as generation loss is acceptable as a consequence of any event excluding P0.

c. Simulate the removal of all elements that Protection Systems and other controls are expected to automatically disconnect for each event.

d. Simulate Normal Clearing unless otherwise specified.

e. Planned System adjustments such as Transmission configuration changes and re-dispatch of generation are allowed if such adjustments are executable within the time duration applicable to the Facility Ratings.

Steady State Only:

f. Applicable Facility Ratings shall not be exceeded.

g. System steady state voltages and post-Contingency voltage deviations shall be within acceptable limits as established by the Planning Coordinator and the Transmission Planner.

h. Planning event P0 is applicable to steady state only.

i. The response of voltage sensitive Load that is disconnected from the System by end-user equipment associated with an event shall not be used to meet steady state performance requirements.

Stability Only:

j. Transient voltage response shall be within acceptable limits established by the Planning Coordinator and the Transmission Planner.

Category	*Initial Condition*	*Event* [1]	*Fault Type* [2]	*BES Level* [3]	*Interruption of Firm Transmission Service Allowed* [4]	*Non-Consequential Load Loss Allowed*
P0 No Contingency	Normal System	None	N/A	EHV, HV	No	No
P1 Single Contingency	Normal System	Loss of one of the following: 1. Generator 2. Transmission Circuit 3. Transformer [5] 4. Shunt Device [6]	3Ø	EHV, HV	No[9]	No[12]
		5. Single Pole of a DC line	SLG			
P2 Single Contingency	Normal System	1. Opening of a line section w/o a fault [7]	N/A	EHV, HV	No[9]	No[12]
		2. Bus Section Fault	SLG	EHV	No[9]	No
				HV	Yes	Yes
		3. Internal Breaker Fault [8] (non-Bus-tie Breaker)	SLG	EHV	No[9]	No
				HV	Yes	Yes
		4. Internal Breaker Fault (Bus-tie Breaker) [8]	SLG	EHV, HV	Yes	Yes

Standard TPL-001-4 — Transmission System Planning Performance Requirements

Category	*Initial Condition*	*Event* [1]	*Fault Type* [2]	*BES Level* [3]	*Interruption of Firm Transmission Service Allowed* [4]	*Non-Consequential Load Loss Allowed*
P3 Multiple Contingency	Loss of generator unit followed by System adjustments[9]	Loss of one of the following: 1. Generator 2. Transmission Circuit 3. Transformer [5] 4. Shunt Device [6]	3Ø	EHV, HV	No[9]	No[12]
		5. Single pole of a DC line	SLG			
P4 Multiple Contingency *(Fault plus stuck breaker[10])*	Normal System	Loss of multiple elements caused by a stuck breaker [10](non-Bus-tie Breaker) attempting to clear a Fault on one of the following: 1. Generator 2. Transmission Circuit 3. Transformer [5] 4. Shunt Device [6] 5. Bus Section	SLG	EHV	No[9]	No
				HV	Yes	Yes
		6. Loss of multiple elements caused by a stuck breaker[10] (Bus-tie Breaker) attempting to clear a Fault on the associated bus	SLG	EHV, HV	Yes	Yes
P5 Multiple Contingency *(Fault plus relay failure to operate)*	Normal System	Delayed Fault Clearing due to the failure of a non-redundant relay[13] protecting the Faulted element to operate as designed, for one of the following: 1. Generator 2. Transmission Circuit 3. Transformer [5] 4. Shunt Device [6] 5. Bus Section	SLG	EHV	No[9]	No
				HV	Yes	Yes
P6 Multiple Contingency *(Two overlapping singles)*	Loss of one of the following followed by System adjustments,[9] 1. Transmission Circuit 2. Transformer [5] 3. Shunt Device[6] 4. Single pole of a DC line	Loss of one of the following: 1. Transmission Circuit 2. Transformer [5] 3. Shunt Device [6]	3Ø	EHV, HV	Yes	Yes
		4. Single pole of a DC line	SLG	EHV, HV	Yes	Yes

Standard TPL-001-4 — Transmission System Planning Performance Requirements

Category	*Initial Condition*	*Event* [1]	*Fault Type* [2]	*BES Level* [3]	*Interruption of Firm Transmission Service Allowed* [4]	*Non-Consequential Load Loss Allowed*
P7 Multiple Contingency *(Common Structure)*	Normal System	The loss of: 1. Any two adjacent (vertically or horizontally) circuits on common structure [11] 2. Loss of a bipolar DC line	SLG	EHV, HV	Yes	Yes

Table 1 – Steady State & Stability Performance Extreme Events

Steady State & Stability

For all extreme events evaluated:

a. Simulate the removal of all elements that Protection Systems and automatic controls are expected to disconnect for each Contingency.

b. Simulate Normal Clearing unless otherwise specified.

Steady State

1. Loss of a single generator, Transmission Circuit, single pole of a DC Line, shunt device, or transformer forced out of service followed by another single generator, Transmission Circuit, single pole of a different DC Line, shunt device, or transformer forced out of service prior to System adjustments.
2. Local area events affecting the Transmission System such as:
   a. Loss of a tower line with three or more circuits,[11]
   b. Loss of all Transmission lines on a common Right-of-Way[11],
   c. Loss of a switching station or substation (loss of one voltage level plus transformers),
   d. Loss of all generating units at a generating station,
   e. Loss of a large Load or major Load center,
3. Wide area events affecting the Transmission System based on System topology such as:
   a. Loss of two generating stations resulting from conditions such as:
      i. Loss of a large gas pipeline into a region or multiple regions that have significant gas-fired generation.
      ii. Loss of the use of a large body of water as the cooling source for generation,
      iii. Wildfires,
      iv. Severe weather, e.g., hurricanes, tornadoes, etc,
      v. A successful cyber attack,
      vi. Shutdown of a nuclear power plant(s) and related facilities for a day or more for common causes such as problems with similarly designed plants.
   b. Other events based upon operating experience that may result in wide area disturbances,

Stability

1. With an initial condition of a single generator, Transmission circuit, single pole of a DC line, shunt device, or transformer forced out of service, apply a 3Ø fault on another single generator, Transmission circuit, single pole of a different DC line, shunt device, or transformer prior to System adjustments.
2. Local or wide area events affecting the Transmission System such as:
   a. 3Ø fault on generator with stuck breaker[10] or a relay failure[13] resulting in Delayed Fault Clearing.
   b. 3Ø fault on Transmission circuit with stuck breaker[10] or a relay failure[13] resulting in Delayed Fault Clearing.
   c. 3Ø fault on transformer with stuck breaker[10] or a relay failure[13] resulting in Delayed Fault Clearing,
   d. 3Ø fault on bus section with stuck breaker[10] or a relay failure[13] resulting in Delayed Fault Clearing,
   e. 3Ø internal breaker fault,
   f. Other events based upon operating experience, such as consideration of initiating events that experience suggests may result in wide area disturbances

Table 1 – Steady State & Stability Performance Footnotes
(Planning Events and Extreme Events)

1. If the event analyzed involves BES elements at multiple System voltage levels, the lowest System voltage level of the element(s) removed for the analyzed event determines the stated performance criteria regarding allowances for interruptions of Firm Transmission Service and Non-Consequential Load Loss.
2. Unless specified otherwise, simulate Normal Clearing of faults. Single line to ground (SLG) or three-phase (3Ø) are the fault types that must be evaluated in Stability simulations for the event described. A 3Ø or a double line to ground fault study indicating the criteria are being met is sufficient evidence that a SLG condition would also meet the criteria.
3. Bulk Electric System (BES) level references include extra-high voltage (EHV) Facilities defined as greater than 300kV and high voltage (HV) Facilities defined as the 300kV and lower voltage Systems. The designation of EHV and HV is used to distinguish between stated performance criteria allowances for interruption of Firm Transmission Service and Non-Consequential Load Loss.
4. Curtailment of Conditional Firm Transmission Service is allowed when the conditions and/or events being studied formed the basis for the Conditional Firm Transmission Service.
5. For non-generator step up transformer outage events, the reference voltage, as used in footnote 1, applies to the low-side winding (excluding tertiary windings). For generator and Generator Step Up transformer outage events, the reference voltage applies to the BES connected voltage (high-side of the Generator Step Up transformer). Requirements which are applicable to transformers also apply to variable frequency transformers and phase shifting transformers.
6. Requirements which are applicable to shunt devices also apply to FACTS devices that are connected to ground.
7. Opening one end of a line section without a fault on a normally networked Transmission circuit such that the line is possibly serving Load radial from a single source point.
8. An internal breaker fault means a breaker failing internally, thus creating a System fault which must be cleared by protection on both sides of the breaker.
9. An objective of the planning process should be to minimize the likelihood and magnitude of interruption of Firm Transmission Service following Contingency events. Curtailment of Firm Transmission Service is allowed both as a System adjustment (as identified in the column entitled 'Initial Condition') and a corrective action when achieved through the appropriate re-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 any Non-Consequential Load Loss. Where limited options for re-dispatch exist, sensitivities associated with the availability of those resources should be considered.
10. A stuck breaker means that for a gang-operated breaker, all three phases of the breaker have remained closed. For an independent pole operated (IPO) or an independent pole tripping (IPT) breaker, only one pole is assumed to remain closed. A stuck breaker results in Delayed Fault Clearing.
11. Excludes circuits that share a common structure (Planning event P7, Extreme event steady state 2a) or common Right-of-Way (Extreme event, steady state 2b) for 1 mile or less.
12. An objective of the planning process is to minimize the likelihood and magnitude of Non-Consequential Load Loss following planning events. In limited circumstances, Non-Consequential Load Loss may be needed throughout the planning horizon to ensure that BES performance requirements are met. However, when Non-Consequential Load Loss is utilized under footnote 12 within the Near-Term Transmission Planning Horizon to address BES performance requirements, such interruption is limited to circumstances where the Non-Consequential Load Loss meets the conditions shown in Attachment 1. In no case can the planned Non-Consequential Load Loss under footnote 12 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.
13. Applies to the following relay functions or types: pilot (#85), distance (#21), differential (#87), current (#50, 51, and 67), voltage (#27 & 59), directional (#32, & 67), and tripping (#86, & 94).