

# City of Bellevue 2014 Electric System Reliability Review



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*Bill Foster, Senior Engineer – Distribution System Planning*

*Carol Jaeger, Consulting Engineer – Transmission System Planning*

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# Introductions

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- Andy Swayne – Municipal Liaison Manager
- Chris McVicker – Manager Electric System Planning
- Laura Feinstein – Manager Electric Distribution Planning
- Bill Foster – Distribution System Planner
- Rick Buell – Distribution System Engineering Specialist
- Carol Jaeger – Transmission System Planner
- Dennis Martin – Electric System Senior Engineer
- Keri Pravitz – Community Projects Manager

# Workshop Purpose

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- Provide an overview of PSE electrical system performance in 2014 and our report to the City
- Overall performance
  - Reliability projects completed and proposed
  - Areas addressed at past workshops – updates
  - Maintenance
  - Automation initiatives (smart grid)
  - Information technology initiatives

# 2014 Bellevue Reliability Overview

- Bellevue Performance & Comparison

**SYSTEM AVERAGE INTERRUPTION DURATION INDEX (SAIDI) &  
SYSTEM AVERAGE INTERRUPTION FREQUENCY INDEX (SAIFI)  
FIVE YEAR HISTORY**

SAIDI figures in minutes, all outages including storm  
SAIFI figures in outage events, all non-storm outages

	SAIDI		SAIFI	
	BELLEVUE	PSE	BELLEVUE	PSE
<b>2010</b>	91.1	287.0	0.44	0.86
<b>2011</b>	86.1	281.0	0.60	1.02
<b>2012</b>	52.4	245.0	0.40	0.92
<b>2013</b>	100.7	247.0	0.41	0.86
<b>2014</b>	160.2	312.0	0.60	1.04

PSE SAIDI figures for 2010 - 2014 are five year rolling average figures.

The 2010 - 2012 Bellevue SAIDI figures were calculated as single year figures.

The 2013 Bellevue SAIDI figure was calculated as a four year rolling average for years 2010 - 2013.

The 2014 Bellevue SAIDI figure was calculated as a five year rolling average for years 2010 - 2014.

System Average Interruption Duration Index [SAIDI] SQI 320  
Total customer outage minutes / average total customer count

System Average Interruption Frequency Index [SAIFI] SQI 1.3

Total customers affected / average total customer count



# 2014 Bellevue Reliability Overview

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- Distribution system serving Bellevue in 2014

95 distribution circuits serving Bellevue

70 circuits [74%] had performance better than our system wide average

24 circuits [25%] experienced no unplanned outages

25 circuits [26%] had SAIDI or SAIFI exceeding system wide average figures

# 2014 Bellevue Reliability Overview

- Circuits Exceeding System SAIDI and/or SAIFI 2010 – 2014

CIRCUIT	Repeat Counts					Repeat Counts			
	2010	2011	2012	2013	2014	1	2	3	4
ARD-11	NOT IN SERVICE					1			
ARD-13						1			
ARD-15							1		
BTR-14							1		
BTR-21						1			
BTR-22									1
SOM-13								1	
SOM-15								1	
SOM-16							1		
SOM-17						1			
Totals	22	17	19	20	25	43	13	10	1
	2010	2011	2012	2013	2014	64%	19%	15%	1%

- 65 circuits exceeded system wide average performance ...
  - 43 (64%) once in five years
  - 13 (19%) twice in five years
  - 10 (15%) three times in five years
  - 1 (1%) four times in five years

# 2014 Bellevue Reliability Overview

- Bellevue circuit with SAIDI or SAIFI exceeding system wide figures

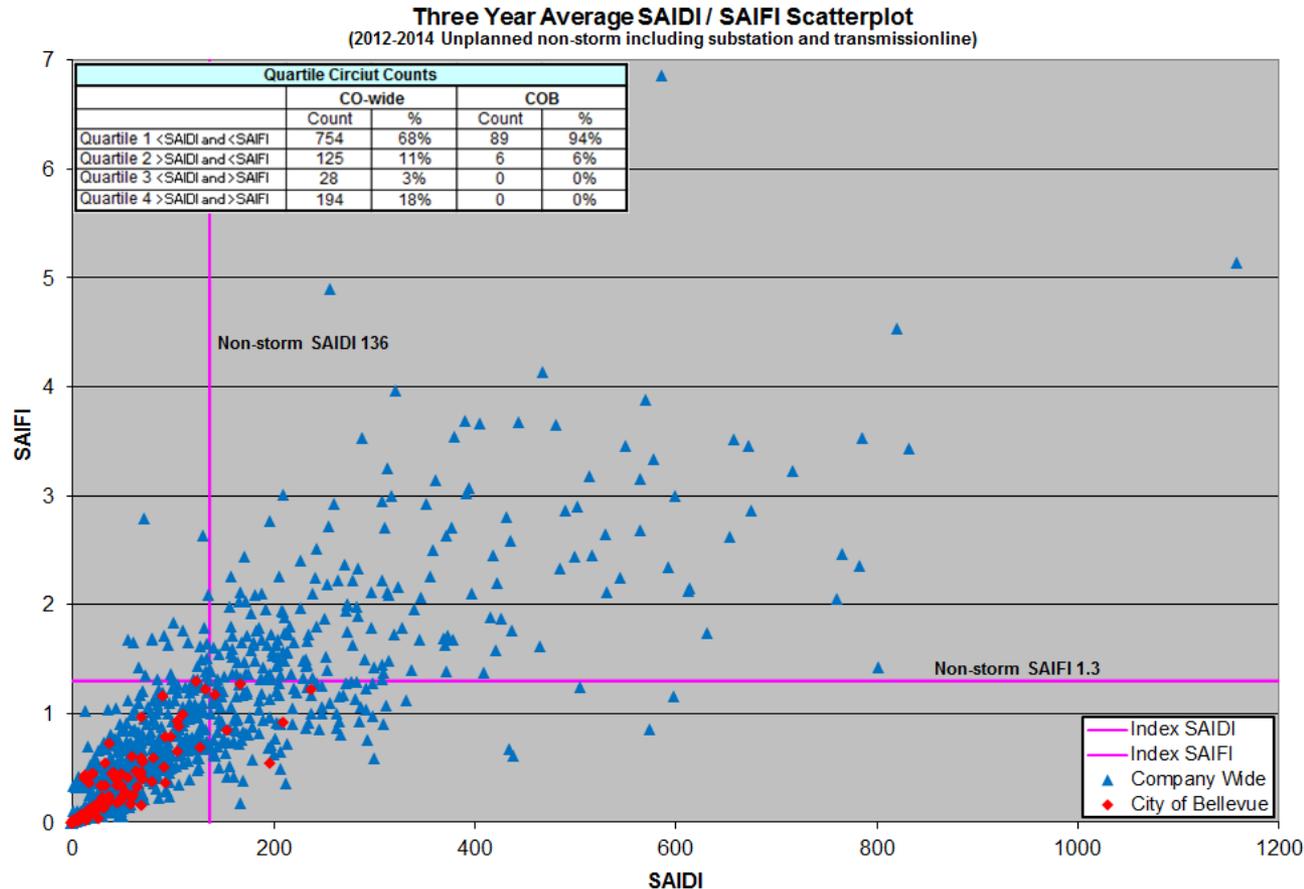
CIRCUITS THAT EXCEED 2014 PSE SYSTEM SAIDI AND/OR SAIFI			Notes: SAIDI figures reflect all outages, scheduled & unscheduled, including storm. SAIFI figures reflect all non-storm outages, scheduled & unscheduled PSE & Bellevue SAIDI are five year rolling average figures for the period 2010 - 2014.		
CIRCUIT	SAIDI	SAIFI	2014 Events Comments	2014 Actions & Projects (completed)	2015 Actions & Projects (planned)
<b>Circuits with planned 2015 actions or investigations</b>					
BTR-22	664.8	0.60	Two storm events contributed 95% of the 2014 SAIDI minutes. A portion of this circuit travel through an undeveloped segment of King County Parks where PSE has an overhead easement.	Overhead overhead feeder lines were inspected and repaired.	PSE has developed a project to underground the segment of feeder with the worst reliability exposure and place the wire on the remaining segment.
OVE-15	524.0	0.36	The overhead Substation was taken out of service for planned upgrades. During this time OVE-15 was fed to MED-35 served from the Medina Substation. Two storm event tree caused outages contributed 95% of the 2014 SAIDI minutes.	Overhead substation upgrades were completed and the distribution circuitry was restored to normal. A project was designed in 2014 to replace the overhead wire on Overlake Drive tree wire. The project was designed in 2014.	Final design and permitting for the overhead tree wire project along Overlake drive is planned for completion for 2015 construction.
NRU-23	483.2	0.06	During a storm event large vegetation fell in to the Northrup Substation isolating of the substation from the transmission line. The substation transformer bank had to be isolated and tested before being placed back in service. One resource priority affected testing and restoration of the substation. This storm event contributed 75% of the total 2014 SAIDI minutes for this circuit.	A decision was taken to develop a new landscape plan to remove danger trees from around Northrup Substation.	PSE plans to engage the Bridge Trails neighborhood and City to develop a new landscape plan to remove danger trees from around Northrup Substation.
NRU-27	357.1	1.21	During a storm event vegetation surrounding the substation fell in to the distribution side of the bus shorting the high voltage fuse. The substation transformer bank had to be isolated and tested before being placed back in service. This event contributed 75% of the total circuit 2014 SAIDI minutes.	A decision was taken to develop a new landscape plan to remove danger trees from around Northrup Substation.	PSE plans to engage the Bridge Trails neighborhood and City to develop a new landscape plan to remove danger trees from around Northrup Substation.
LHL-22	282.3	3.18	A tree limb fell on the radial transmission line feeding Lake Hills Substation. The transmission line was deenergized to allow safe removal of the limb resulting in a brief outage at Lake Hills Substation and at distribution circuits. This outage together with two additional large outages contribute 61% of SAIFI.	The transmission line was reenergized after removal of the tree limb restoring service to the substation and circuits. PGE developed two projects to install tree wire in sections of overhead feeder.	PSE is currently permitting a new transmission line between Lake Hills and Phantom Lake substations which will be able to keep the Lake Hills substation in service in future similar events. Two feeder tree wire projects are expected to be constructed in 2015.
LHL-26	207.0	3.40	A tree limb fell on the radial transmission line feeding Lake Hills Substation. The transmission line was deenergized to allow safe removal of the limb resulting in a brief outage at Lake Hills Substation and at distribution circuits. This outage together with two additional large outages contribute 61% of SAIFI.	The transmission line was reenergized after removal of the tree limb restoring service to the substation and circuits. PGE developed two projects to install tree wire in sections of overhead feeder.	PSE is currently permitting a new transmission line between Lake Hills and Phantom Lake substations which will be able to keep the Lake Hills substation in service in future similar events. Underground cables in the crossroads area continue to be replaced in 2015 and likely beyond.
LHL-23	83.7	1.23	A tree limb fell on the radial transmission line feeding Lake Hills Substation. The transmission line was deenergized to allow safe removal of the limb resulting in a brief outage at Lake Hills Substation and at distribution circuits contributing 61% of SAIFI which caused this circuit to exceed the companywide figure.	The transmission line was reenergized after removal of the tree limb restoring service to the substation and circuits.	PSE is currently permitting a new transmission line between Lake Hills and Phantom Lake substations which will be able to keep the Lake Hills substation in service in future similar events.
LHL-26	52.6	1.18	A tree limb fell on the radial transmission line feeding Lake Hills Substation. The transmission line was deenergized to allow safe removal of the limb resulting in a brief outage at Lake Hills Substation and at distribution circuits contributing 61% of SAIFI which caused this circuit to exceed the companywide figure.	The transmission line was reenergized after removal of the tree limb restoring service to the substation and circuits.	PSE is currently permitting a new transmission line between Lake Hills and Phantom Lake substations which will be able to keep the Lake Hills substation in service in future similar events.
<b>Circuits with completed 2014 actions - no additional corrective action required</b>					
KWH-25	443.5	0.07	Two storm events contributed 95% of the 2014 SAIDI minutes. In both events tree limbs fell into overhead lines along NE 24th off causing circuit outages.	Overhead overhead feeder lines were inspected and repaired.	PSE Planning will monitor circuit performance and look for additional opportunities for circuit reliability upgrades.
SOM-16	388.0	1.78	Two storm events contributed 95% of the 2014 SAIDI minutes. A tree fell into the feeder at Coal Creek PHWKV and Factors BLVD causing a circuit outage.	Overhead overhead feeder lines were inspected and repaired.	PSE Planning will monitor circuit performance and look for additional opportunities for circuit reliability upgrades.
MED-35	338.6	0.17	The overhead Substation was taken out of service for planned upgrades. During this time OVE-15 was fed to MED-35 served from the Medina Substation. Two storm event tree caused outages in the OVE-15 circuit contributed 95% of the 2014 SAIDI minutes.	Overhead substation upgrades were completed and the distribution circuitry was restored to normal.	
CLY-27	168.1	1.39	Equipment failure in the primary distribution system caused a circuit outage contributing 70% of SAIFI which caused this circuit to exceed the companywide figure.	The failed equipment was replaced.	
NOB-24	160.4	1.41	A crew was cutting a conduit to replace to a new box for a new customer and the saw accidentally cut into a conduit with the North Bellevue 24 feeder.	The system was isolated and customer's power was restored. PGE went back and replaced the compromised cables.	
COL-26	136.1	1.51	A squirrel contact with the substation 12.8KV bus tripped the substation transformer bank off-line contributing 66% of SAIFI which caused this circuit to exceed the companywide figure.	The substation bank was tested and reenergized. Animal guards could not be practically installed in the contact area.	
COL-22	96.7	1.50	A squirrel contact with the substation 12.8KV bus tripped the substation transformer bank off-line contributing 67% of SAIFI which caused this circuit to exceed the companywide figure.	The substation bank was tested and reenergized. Animal guards could not be practically installed in the contact area.	
CEN-14	82.3	1.06	A crew contact with the substation 12.8KV bus tripped the substation transformer bank off-line contributing 55% of SAIFI which caused this circuit to exceed the companywide figure.	Animal guards were installed over the B phase bus to prevent future contact. The substation bank was tested and reenergized.	
CEN-11	67.4	1.22	A crew contact with the substation 12.8KV bus tripped the substation transformer bank off-line contributing 52% of SAIFI which caused this circuit to exceed the companywide figure.	Animal guards were installed over the B phase bus to prevent future contact. The substation bank was tested and reenergized.	
COL-25	62.6	1.08	A squirrel contact with the substation 12.8KV bus tripped the substation transformer bank off-line contributing 54% of SAIFI which caused this circuit to exceed the companywide figure.	The substation bank was tested and reenergized. Animal guards could not be practically installed in the contact area.	
<b>Circuits for which no corrective action is required</b>					
SOM-13	329.7	0.14	No significant events occurred on this circuit in 2014. Circuit SAIDI remains above ISO threshold due to 2013 outage events.		
PHA-13	133.6	1.38	While isolating the College Substation bank transformer the crew inadvertently activated the automatic transmission switching scheme when deenergized the radial transmission line to Phantom Lake Substation resulting in a two minute substation outage at Phantom Lake, contributing 74% of SAIFI which caused this circuit to exceed the companywide figure.	The PSE Load office remotely switched and reenergized the transmission line restoring service to Phantom Lake Substation within 2 minutes.	PSE is currently permitting a new transmission line between Lake Hills and Phantom Lake substations which will be able to keep the Phantom Lake substation in service in future similar events.
PHA-16	128.7	1.06	While isolating the College Substation bank transformer the crew inadvertently activated the automatic transmission switching scheme when deenergized the radial transmission line to Phantom Lake Substation resulting in a two minute substation outage at Phantom Lake, contributing 54% of SAIFI which caused this circuit to exceed the companywide figure.	The PSE Load office remotely switched and reenergized the transmission line restoring service to Phantom Lake Substation within 2 minutes.	PSE is currently permitting a new transmission line between Lake Hills and Phantom Lake substations which will be able to keep the Phantom Lake substation in service in future similar events.
PHA-17	128.5	1.06	While isolating the College Substation bank transformer the crew inadvertently activated the automatic transmission switching scheme when deenergized the radial transmission line to Phantom Lake Substation resulting in a two minute substation outage at Phantom Lake, contributing 54% of SAIFI which caused this circuit to exceed the companywide figure.	The PSE Load office remotely switched and reenergized the transmission line restoring service to Phantom Lake Substation within 2 minutes.	PSE is currently permitting a new transmission line between Lake Hills and Phantom Lake substations which will be able to keep the Phantom Lake substation in service in future similar events.
MLK-15	63.2	1.18	A tree fell on the overhead feeder causing an outage contributing 80% of SAIFI which caused this circuit to exceed the companywide figure.	The tree was removed and the circuit restored.	This is the first occurrence of an overhead problem impacting this circuit in the last 5 years. PSE Planning will continue to monitor the performance of this circuit.
PHA-15	62.4	1.05	While isolating the College Substation bank transformer the crew inadvertently activated the automatic transmission switching scheme when deenergized the radial transmission line to Phantom Lake Substation resulting in a two minute substation outage at Phantom Lake, contributing 55% of SAIFI which caused this circuit to exceed the companywide figure.	The PSE Load office remotely switched and reenergized the transmission line restoring service to Phantom Lake Substation within 2 minutes.	PSE is currently permitting a new transmission line between Lake Hills and Phantom Lake substations which will be able to keep the Phantom Lake substation in service in future similar events.
FAC-14	39.1	1.79	Three planned outages for customer requested work at Factors Mall contributed 100% of SAIFI which caused this circuit to exceed the companywide figure.		

  Figure exceeded PSE system wide average figure  
  Figure exceeding system wide average and Service Quality Index  
  SAIFI figure results in part from circuit outages due to 2014 transmission or substation outage

- 25 circuit had SAIDI or SAIFI exceeding system wide figures. 17 of these circuits have been addressed or require no corrective action. The remaining 8 circuits have improvement actions identified.

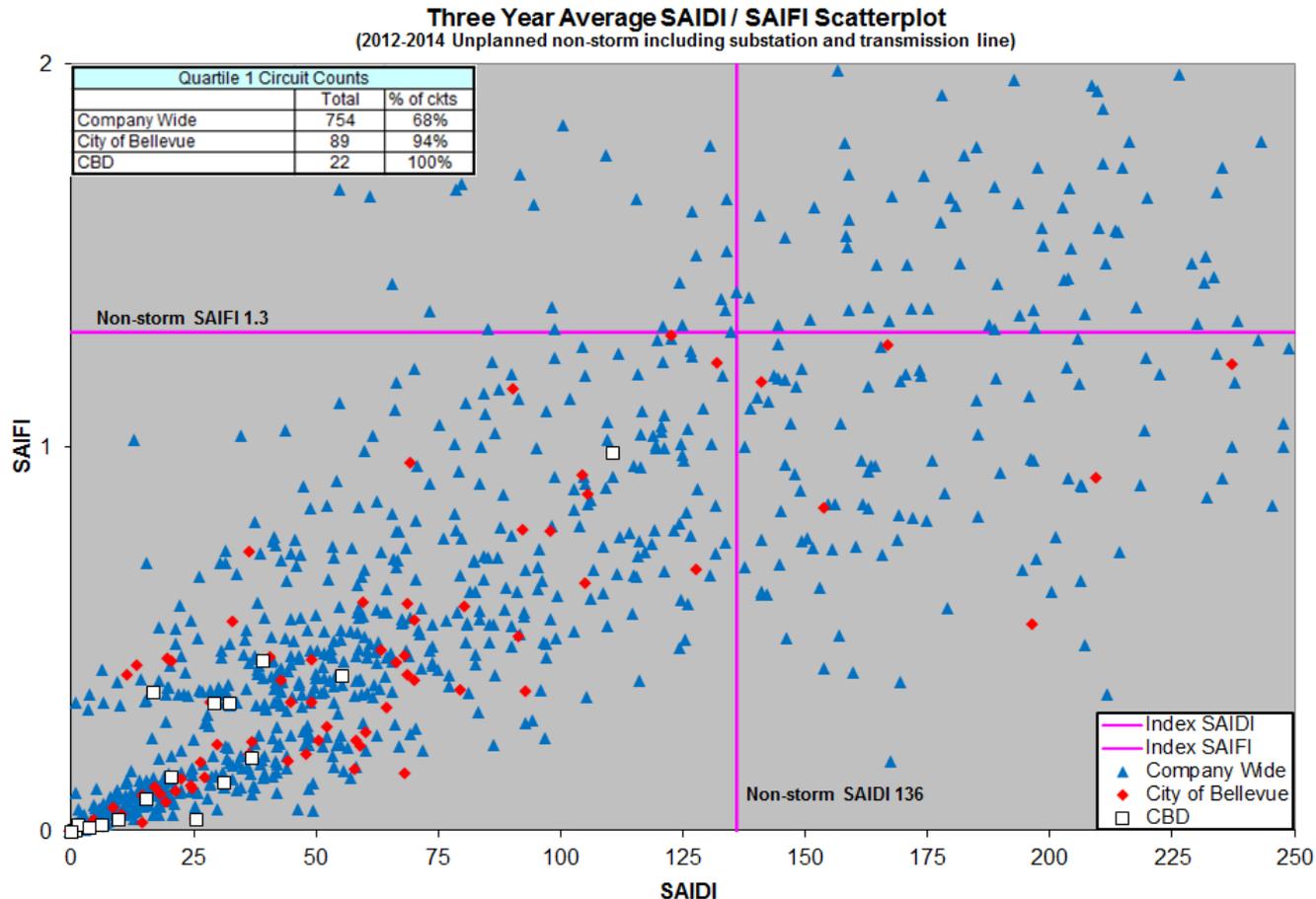


# 2014 Bellevue Reliability Overview



All but 6 circuits serving Bellevue had performance within the 1<sup>st</sup> quadrant

# 2014 Bellevue Reliability Overview



All circuits serving the CBD were within the 1<sup>st</sup> quadrant

# 2014 Bellevue CBD Reliability Overview

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## Bellevue CBD Performance continues to be very good

- 24 circuits from 4 substations serve customers downtown
- 7 reliability circuits provide redundancy for downtown customers
- 2 unplanned outage events affected downtown customers in 2014
  - Center Substation Bank 1 (4 circuits) went out of service when a crow made contact with the distribution bus causing isolation of the transformer. *Animal barriers were installed on B phase bus elements to eliminate potential for reoccurrence.*
  - Center Circuit 25 experienced a circuit outage during a major storm. A tree limb contacted a portion of overhead feeder along the forested wetland area adjacent to 116<sup>th</sup> Ave NE between NE 2<sup>nd</sup> & Main Streets. *A tree wire project has been designed and is being prioritized for construction.*

# Distribution Reliability Projects Completed in 2014

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- Clyde Hill 23 recloser installation on 116<sup>th</sup> AVE NE (near Children's)
- Replacement of two Mark 1 switches
- Tree wire retrofit project on Goodes Corner 13 (serves SE Bellevue)
- Hazelwood 12 recloser installations and sectionalizing switches (serves SW Bellevue)
- 10 cable replacement projects (various circuits – 12,000 circuit feet) including proactive replacements
- 11 SCADA switch installations in the CBD

# Proposed Distribution Reliability Projects

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- Mark 1 switch replacement in the Cherry Crest Neighborhood
- Replacement of four oil-filled switches at Bellevue Square
- Recloser installations on Eastgate 27, Factoria 13 & 25, Northrup 23 and South Bellevue 22 feeder circuits
- Tree wire retrofit projects on Lake Hills 22, Medina 36, Overlake 15 and South Bellevue 26
- Bridle Trails 22 feeder undergrounding west of 140<sup>th</sup> AVE NE
- CBD SCADA switch installation and future automation implementation (continuing)
- 1/0 cable replacements in Crossroads area (continuing)
- 33 cable replacement projects engineered for future construction (55,000 circuit feet)
- 24 cable replacement projects scoped for future engineering (40,000 circuit feet)

# Distribution Areas Addressed At Prior Workshops

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- Circuit Updates

- Clyde Hill 26: The underground distribution system serving an area north of QFC is early 1960's construction.  
*We continue to monitor the performance of this system; we have had no significant reliability issues in this area for the past few years.*
- Eastgate 12: The feeder east of Lakemont around Cougar Mountain is radial.  
*A new distribution circuit from Goodes Corner (Issaquah) is planned to be underbuilt along an existing transmission line in 2015-2016 to provide a looped connection for EGT-12, HAZ-12 and SOM-13.*
- Lake Hills 22: Overhead distribution in the area of NE 4<sup>th</sup> ST and 164<sup>th</sup> AVE NE is susceptible to tree cause outages.  
*Tree-wire retrofit projects along NE 4<sup>th</sup> ST and along 164<sup>th</sup> AVE NE are in construction and expected to be in service the end of 2015.*
- Lake Hills 25: Some underground distribution cables in the Crossroads Mall vicinity have experienced high incidents of failure.  
*Cable replacement in this area begun in 2014 will likely extend into 2016 to accommodate scheduling of required outages for project construction.*

# Distribution Areas Addressed At Prior Workshops

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- **Circuit Updates (continued)**
  - Northrup 25: The Cherry Crest neighborhood north of NE 24<sup>th</sup> ST is served by a direct-buried underground distribution system and a mark-1 switch. *We continue to monitor the performance of this system. There have been no additional cable issues, however the mark-1 switch has failed and replacement is expected to be complete by the end of this year.*
  - South Bellevue 23: The underground distribution system serving Bellefield Commercial Park has experienced mechanical subsidence and load growth. *A system reconstruction project is proceeding and it is expected to be completed by the end of 2015.*
  - South Bellevue 25: The distribution system along the south side of Meydenbauer Bay has been inspected and evaluated. *We continue to monitor the performance of this system. A tree-wire retrofit project has been deigned and the project is being prioritized for construction.*

# Transmission System Improvements

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- Recently Completed ...
  - Ardmore Substation – New distribution substation with looped (redundant) 115kV transmission line (2013)
  - Lake Hills Tap 115kV – Extension to Ardmore Substation with automated transmission switching (2014)
- In Progress ...
  - Lake Hills – Phantom Lake 115kV – New transmission line between existing substations to provide redundant (looped) transmission connection for three substations – currently permitting with planned construction 2016-2017
  - Lakeside 115 kV Switching Station Rebuild – Multi-year phased replacement and upgrade of control and operating equipment in the substation for enhanced automation and reliability – planned completion in 2017 .
  - Energize Eastside 230kV – New 230kV transmission line(s) and new transmission station in Bellevue to provide increased system capacity and reliability for Bellevue and the greater Eastside – currently permitting with planned construction in 2017-2018
- On the Near Horizon ...
  - Vernell Substation – New 115kV transmission switching station with local distribution substation for improved transmission system flexibility/reliability and new distribution system capacity to support Spring District development in 2020

# Smart Grid Initiatives Including Automation

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- FLISR (Fault Location, Isolation, Service Restoration) – Evaluated products in 2014. Initial implementation planned in 2015 with expansion to CBD after in the future.
- Remote Data Acquisition Devices (RDADs) – 60 units in place in Bellevue providing remote alert to detected feeder system faults.
- Distribution SCADA Switchgear – The current plan calls for retrofitting 66 switches in the CBD area to add SCADA and integrating them into the EMS so that the system operators can see the distribution system configuration and events in real time. As of December 2014 24 SCADA switches have be retrofitted and integrated. 8 more switches are planned for retrofit in 2015.
- Bellevue Urban Smart – Initiated a program to support downtown businesses in managing building energy use including combinations of behavioral and technology solutions to achieve energy savings.

# CIS, GIS & OMS

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- PSE implemented three new integrated systems in April 2013
  - Customer Information System
  - Geospacial Information System
  - Outage Management System
- All successful though still learning how best to use full capabilities
- Evaluating potential “next step” functionality enhancements
- And in 2014 ... two additional enhancements
  - Tensing map display and query system (internal)
  - Outage Map – PSE.com and mobile apps (external)

# Wrapping Up

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## Questions & Discussion