Technical Conference: Interim Response for Service over the South of Allston Path

Background

- On May 18th, 2017 BPA decided not to construct the I-5 Project.
- On May 31st, 2017, BPA notified customers that it had completed the 2016 Cluster Study.
- BPA's presentations to customers on June 14, 2017, July 26, 2017 and December 6, 2017 and on February 22, 2018 discuss BPA's alternate transmission service.

For Discussion Purposes Only

Technical Conference

- The Technical Conference per section 20 of the BPA OATT is intended to provide a response to TSRs that have gone through a study and for which SOA capacity is required.

For Discussion Purposes Only

South of Allston
I-5 Reinforcement Project Decision

BPA Transmission Planning

February 21, 2018

Presentation Outline

1. History and Decision Not to Build
2. Reinforcement Drivers
   - Reliability Compliance
   - Operational Resiliency
   - Commercial Requests
3. System Improvements and Landscape Changes

For Discussion Purposes Only

History

For Discussion Purposes Only

History

Late 1960s – early 1970's: Construction of a 500-kV link between Portland and Puget Sound started (Keeler-Allston, Paul-Allston, Paul – Olympia, and Raver-Paul)

- 1971, August: Centralia coal power plant started commercial operation
- 1976: 1,130 MW PGE Trojan Nuclear power plant commissioned in May 1976
- 1976: 480 MW PGE Beaver combined cycle plant went into operation
- 1977: Satsop nuclear power plant (WNP-3 and WNP-5) is under construction, planned total capacity of two nuclear plants was 2,480 MW

BPA Planning identified the need for a second 500-kV line between Longview and Portland in late 1970s

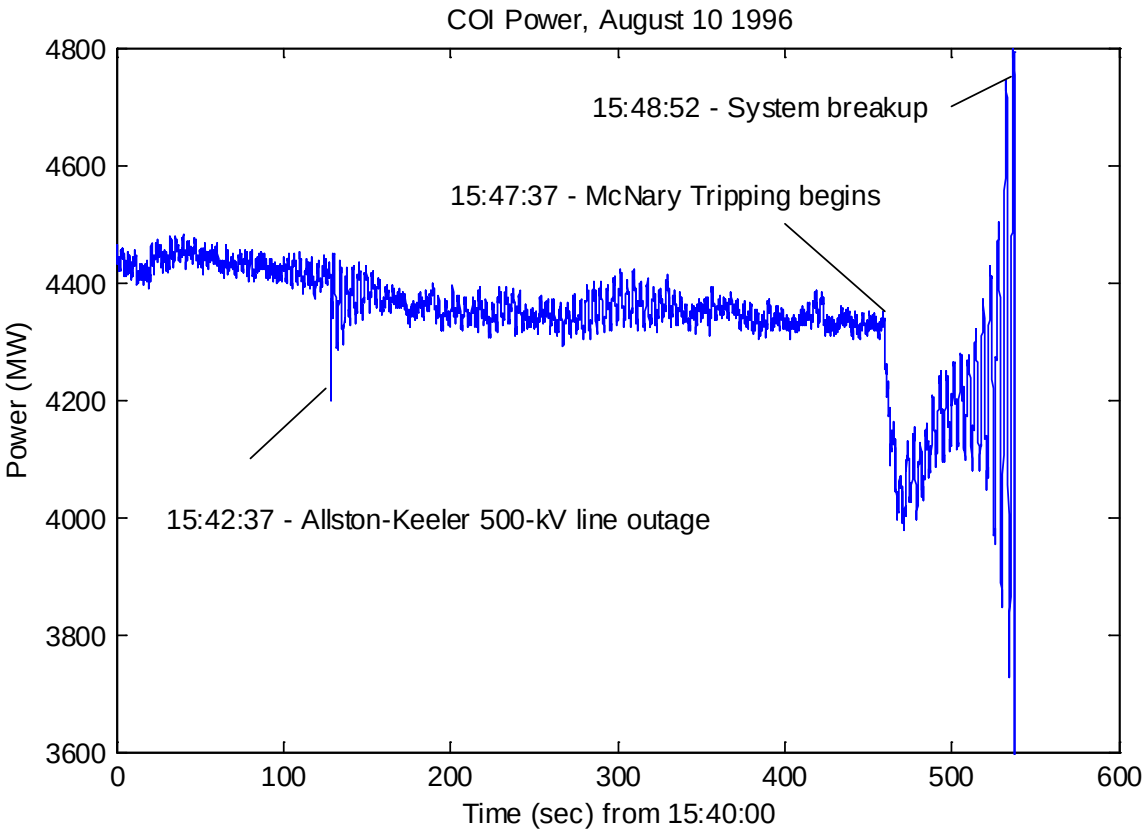
But…

- Load growth rates turned out well below projections
- 1983: Satsop WNP-3 (76% complete) was placed in an extended construction delay
- 1992: Trojan Nuclear Power Plant was shut down

For Discussion Purposes Only

History: August 10, 1996 WSCC Outage

Unplanned outage of Keeler – Allston 500-kV line initiated a sequence of cascading events that led to the Western Interconnection system break up and large-scale power outages in California and Arizona



Yes, it was a bad outage:

- 7.5M customers out of power for up to 9 hours
- Estimated financial impact between $1 to $4 billion

Many things went wrong that led to the outage

WSCC and BPA put processes in place to greatly minimize risk of similar outages

For Discussion Purposes Only

History: I-5 Corridor Gas Generation Boom

- About 2,250 MW of gas generation capacity was added along I-5 corridor from 2002 to 2015
- **The need for the I-5 corridor reinforcement was seen during the interconnection studies**

But …

- Not all proposed projects were actually constructed
- Most of new gas generation was added to SOA RAS
- Retirement of large industrial loads in Portland metro area in early 2000s following 2001 California Energy Crisis:
  - 235 MW Vanalco aluminum smelter in Vancouver (Alcoa)
  - 254 MW Reynolds aluminum smelter in Troutdale
  - 100 MW Pennwalt plant
  - Several paper mills in Willamette Valley

For Discussion Purposes Only

History: Infrastructure Additions

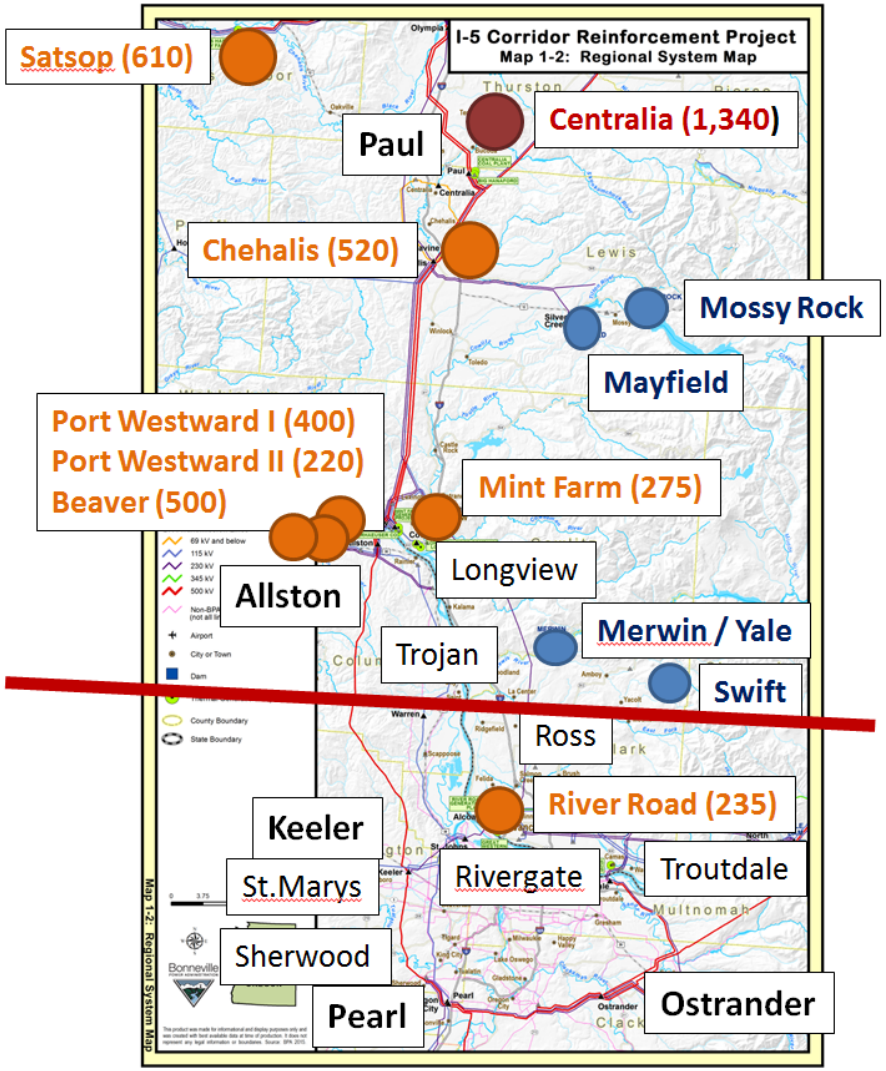
- Major infrastructure additions re-routed power from the I5 corridor:
  - 2005: Schultz – Wautoma 500-kV line
  - 2015: Knight 500-kV substation, Big Eddy – Knight 500-kV line

- Numerous local infrastructure improvements in the area, including:
  - Second Pearl 500/230-kV transformer
  - Allston 230/115-kV transformer
  - Uprate of Ross – Woodland section of Ross – Lexington 230-kV line
  - Harrison 115-kV current-limiting series reactor
  - Keeler – Horizon 230-kV line, Sunset transformer
  - Keeler 230-kV bus sectionalizing

Numerous system infrastructure improvements and industrial load retirement allowed to defer the need for the I-5 500-kV line in early 2000s

For Discussion Purposes Only

South of Allston Path



The South of Allston path was officially established in 2006 by the agreement between BPA, PGE and PacifiCorp

South of Allston Path

- BPA Keeler – Allston 500
- BPA Lexington – Ross 230
- PGE Trojan – Rivergate 230
- PGE Trojan – St.Marys 230
- BPA Allston – Rainier 115
- PAC Merwin – View Tap 115
- PAC Clatsop – Lewis/Clark 115
- PAC Astoria – Astoria Tap 115

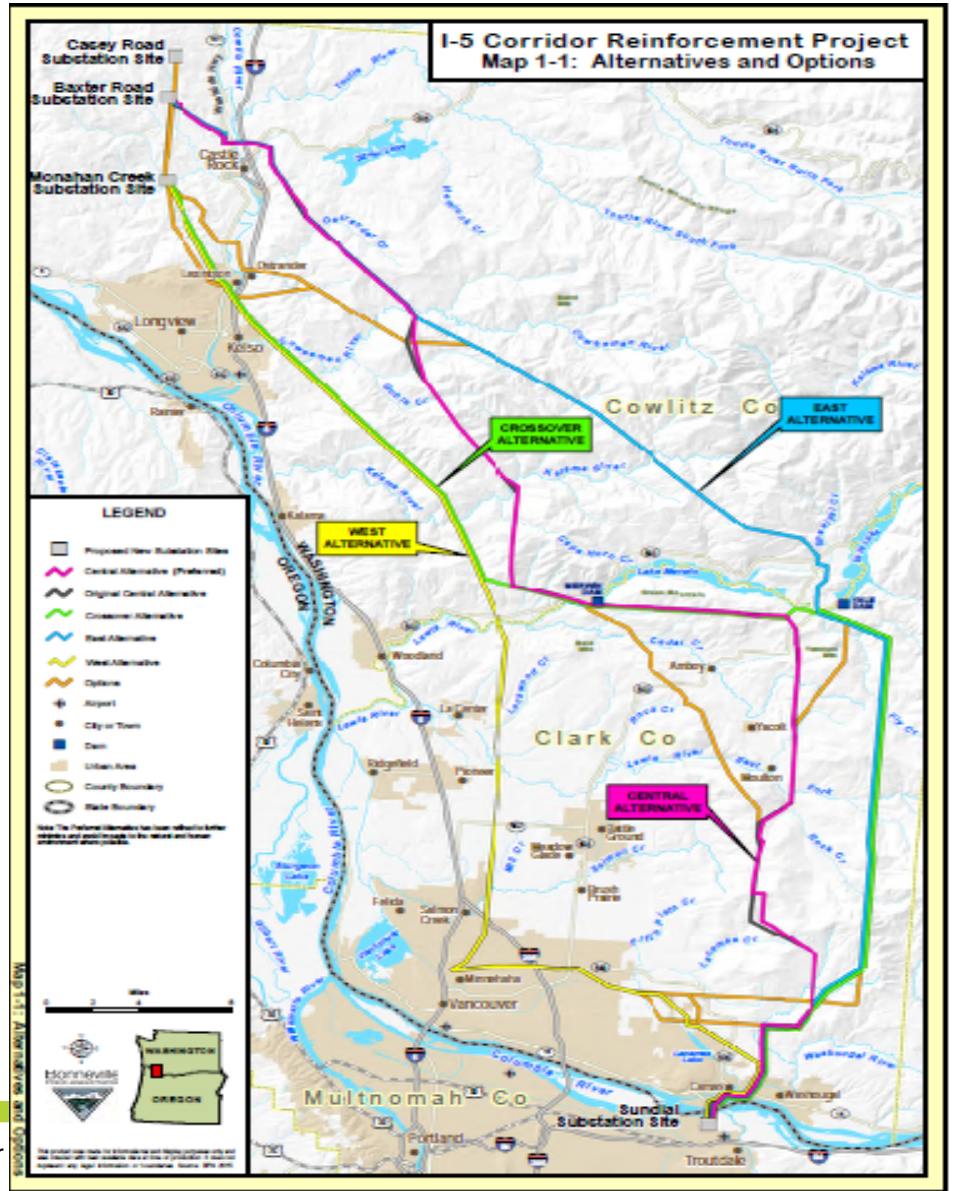
For Discussion Purposes Only

I-5 Corridor Reinforcement Project

- Planning studies in 2007 reconfirmed the reliability need for the Castle Rock – Troutdale 500-kV line, now referred to as the I-5 Corridor Reinforcement Project. In 2007, this project went through the WECC Regional Planning Review Process, which was facilitated by ColumbiaGrid.
- In early 2008, the WECC PCC approved the resulting Regional Planning Project Report for I-5 Corridor Reinforcement Project.
- Planning updated their studies in 2011, 2013, and 2014 with the latest system assumptions and these studies continue to show the need for reinforcement in this area for reliability.
- In addition to meeting reliability requirements, the 2008, 2009, 2010 Network Open Season and 2013 and 2016 Cluster Studies have all identified the need for this project in order to accommodate the Transmission Service Requests (TSRs)

For Discussion Purposes Only

I-5 Corridor Reinforcement Project



- 80 Mile 500-kV transmission line to back up Paul-Allston, South of Allston, and Keeler – Pearl and paths.
- Castle Rock 500-kV substation near Castle Rock, Washington
  - 5 breakers, 3 line positions
  - Interconnects to the Napavine-Allston #1 500-kV line
- Sundial 500-kV substation near Troutdale, Oregon
  - 6 breakers, 3 line positions
  - Interconnects to Troutdale substation
- 500-kV Columbia River Crossing between Camas WA and Troutdale OR
- The new line would have completed a 500 kV loop in SW Washington and NW Oregon.

NEPA Process

- In 2009, BPA initiated the environmental (NEPA) process for the I-5 Corridor Reinforcement Project and held a series of public scoping meetings in the fall of 2009.
- In November 2012, BPA released the draft Environmental Impact Statement (EIS) for public review and comment.
- In February 2016, BPA released the final Environmental Impact Statement
- The project costs increased significantly over the original estimates
- New transmission capacity sales enabled by the project was not sufficient to pay for the project, putting pressure to increase BPA transmission rates

For Discussion Purposes Only

Transmission Planning Review

BPA recognized changes in the environment – coal retirements, solar generation, lower load growth, etc.

BPA Planning and Operations initiated regional Transmission Planning Review with large NW utilities from February to September 2016

- ✓ Reviewed BPA study assumptions on load growth, contingencies and system performance requirements
- ✓ Explored possible smaller scale solutions to address reliability drivers

Regional Effort

BONNEVILLE POWER ADMINISTRATION

PGE Portland General Electric

PACIFICORP

PSE PUGET SOUND ENERGY

Seattle City Light

TACOMA POWER TACOMA PUBLIC UTILITIES

For Discussion Purposes Only

Decision

On May 18 2017, BPA Administrator Elliot Mainzer announced the decision not to build the Castle Rock – Sundial 500-kV line, also known as the I5 Corridor Reinforcement Project.

"My decision today reflects a shift for BPA – from the traditional approach of primarily relying on new construction to meet changing transmission needs, to embracing a more ***flexible, scalable, and economically and operationally efficient approach*** *to managing our transmission system"*

For Discussion Purposes Only

Reinforcement Drivers

Primary drivers included:

- Reliability compliance
- Operational resiliency
- Commercial requests

Reliability Compliance – TPL Standard

- 2005 Energy Policy Act led to the development of mandatory Reliability Standards
- NERC TPL Transmission Planning Standards drive decisions on capital investments
- Reliability Standards are evolving
- The latest version is NERC TPL-001-4 Transmission System Planning Performance Requirements
  - http://www.nerc.com/files/tpl-001-4.pdf
  - Effective date 1/1/2015

For Discussion Purposes Only

Reliability Compliance – TPL Standard

Transmission Planning covers near-term (1 to 5 year) and long-term (up to 10 year) transmission planning horizons

Planners create **study cases** that represent forecasted load levels, expected generation patterns and transfers, expected transmission reinforcements/outages, planned generation additions and retirements

Study cases are subjected to the list of contingencies and checked whether they meet required performance (stability, acceptable voltages, overloads, interruption of firm transmission service, loss of load)

For Discussion Purposes Only

Reliability Compliance – TPL Standard

In simple terms:

- For high likelihood contingencies, e.g. N-1, G-1
  - Generally, firm transmission service can not be interrupted, or non-consequential loss of load is not allowed
- For low likelihood contingencies, e.g. N-2, N-1-1 (P6)
  - Generally, firm transmission service can be interrupted, or non-consequential loss of load is allowed. Certain jurisdictions, e.g. California, require higher performance level for large urban areas and do not permit loss of load
  - BPA evaluates risk and consequence and prioritizes reinforcements that provide the most benefit
  - For BPA, loss of load may be complicated because it is not BPA load that could be lost in majority of situations
- For all contingencies:
  - System must be stable, voltages must be within acceptable limits, applicable Facility Ratings shall not be exceeded

For Discussion Purposes Only

Reliability Compliance: “Need Date”

- Summer 2016 was identified as initial “need date” by 2008 planning studies
  - “Need date” was re-studied every year
  - “Need date” is studied only for **existing obligations**
- “Need date” changed over the years:
  - Slower load growth pushed the “need date” to 2021
  - TPL-001-4 lowered TTC (Total Transfer Capability) because of N-1-1 (P6) requirement
  - Scheduled Centralia retirement, uncertainty with its replacement and other retirements pushed “the need date” out even further
- Most recent analysis (December 2016) shows the “need date” for SOA reinforcement in mid- to-late 2020s

For Discussion Purposes Only

Addressing Reliability Compliance Need

- PGE has several approved **reliability** projects in the area, including Harborton 230-kV substation, Harborton–Horizon 230-kV line, second 230/115 Sunset transformer.
- BPA is working with regional utilities to continue refining smaller builds and non-wires solutions.
- BPA Transmission Planning has launched a study to increase SOA capacity and reduce SOA flows, including series capacitors on the east side, line upgrades, flow control devices and energy storage solutions.

The ultimate portfolio of projects will represent a “flexible, scalable” alternative to the new 500-kV line.

For Discussion Purposes Only

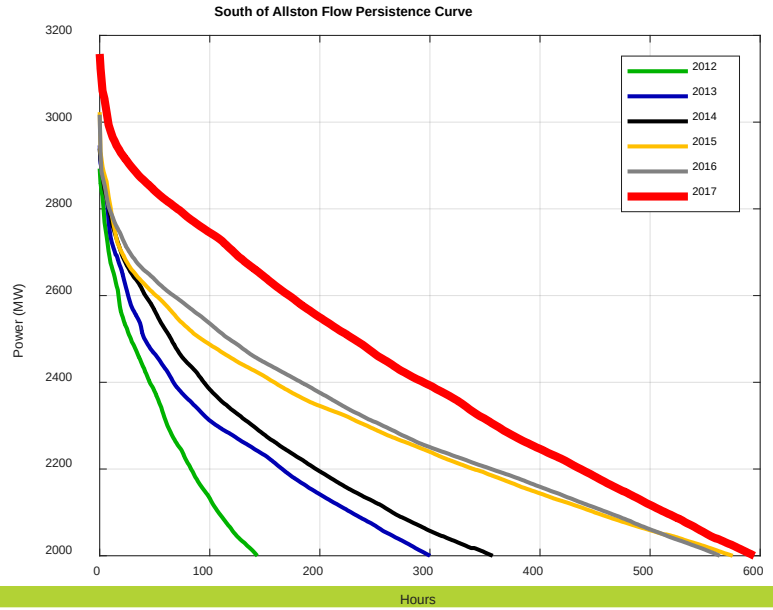
Operational Risks: N-1 RAS

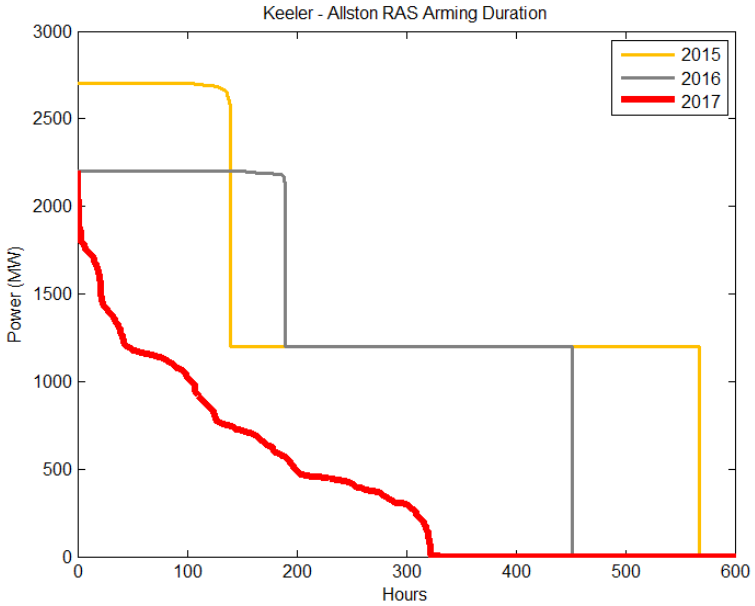
- RAS allows to load transmission lines higher pre-contingency, by taking more aggressive, automatic mitigation actions post-contingency
- RAS makes economic sense and allows further utilization of the system.
- BPA has used RAS for multiple contingencies for decades
  - BPA implemented N-1 RAS for Keeler – Allston outage after 1996
  - BPA armed up to 2,700 MW of generation for a single contingency
  - We have no Keeler – Allston RAS operations in the last 21 years
- While widely accepted for multiple contingencies, use of RAS for N-1 contingencies has been debated in the industry
- Following FERC and NERC directives from September 8 2011 Arizona and Southern California outage, BPA Planning initiated a comprehensive review of its RAS schemes
- Based on the outcome of review, BPA reduced N-1 RAS to 2,200 MW with minimum/no impact on SOA transfer capability

For Discussion Purposes Only

RAS Automation Success

- BPA RAS Automation and Optimization project developed optimized algorithms to arm a more precise amount of generation based on actual system conditions
- South of Allston flows were the highest during 2017 summer (left). Yet optimized algorithms greatly reduced both the amount and hours of RAS arming for SOA (right)





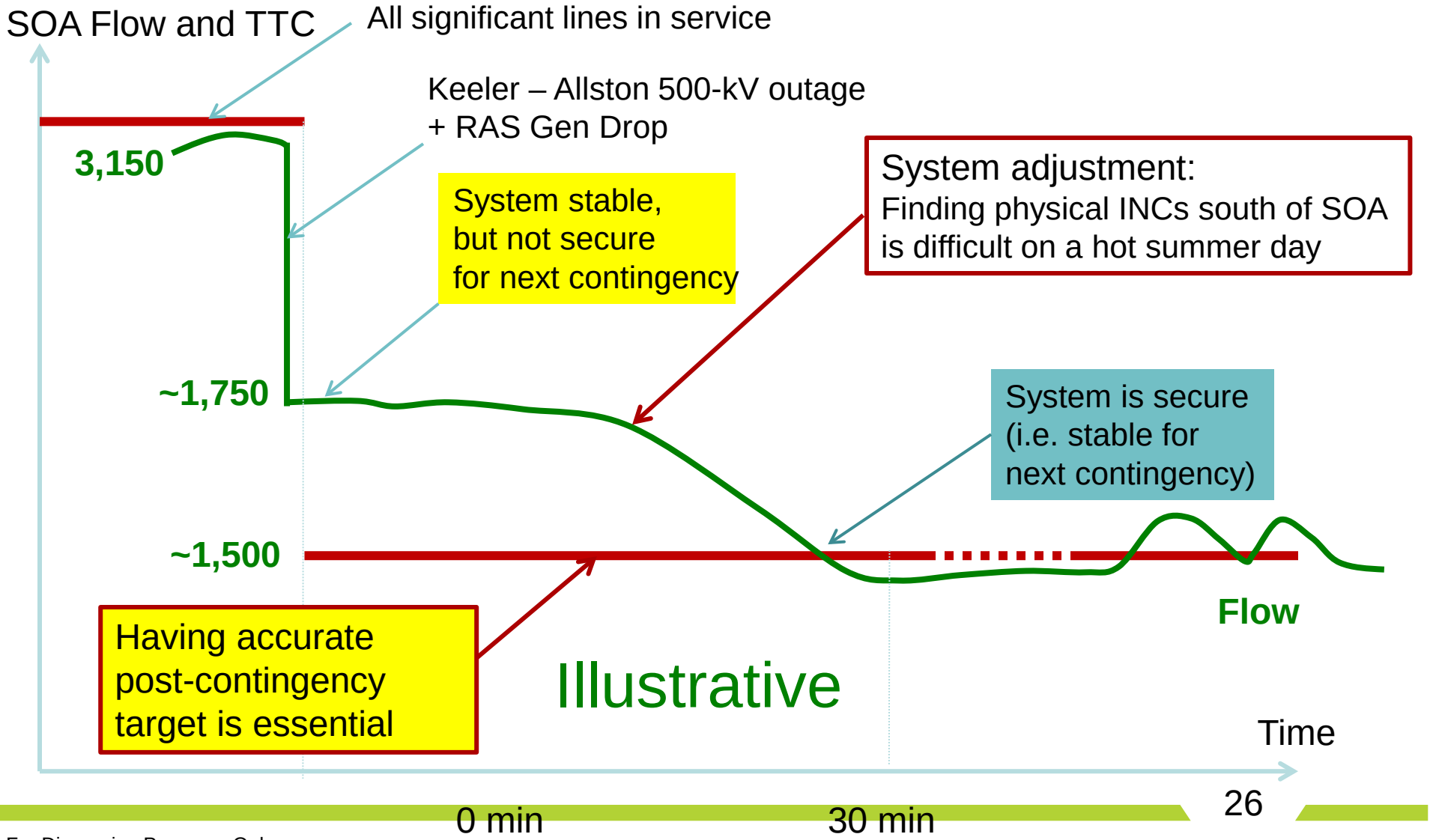
For Discussion Purposes Only

Operational Risks: Outage Resiliency

- Under all lines in service (ALIS):
  - SOA TTC is about 3,200 MW under summer generation patterns
- With Keeler – Allston 500-kV line out of service:
  - SOA TTC is about 1,400 to 1,800 MW, that is 50% of the ALIS TTC
  - Managing the system right after an outage could be very challenging.

For Discussion Purposes Only

Operational Risks: Outage Resiliency



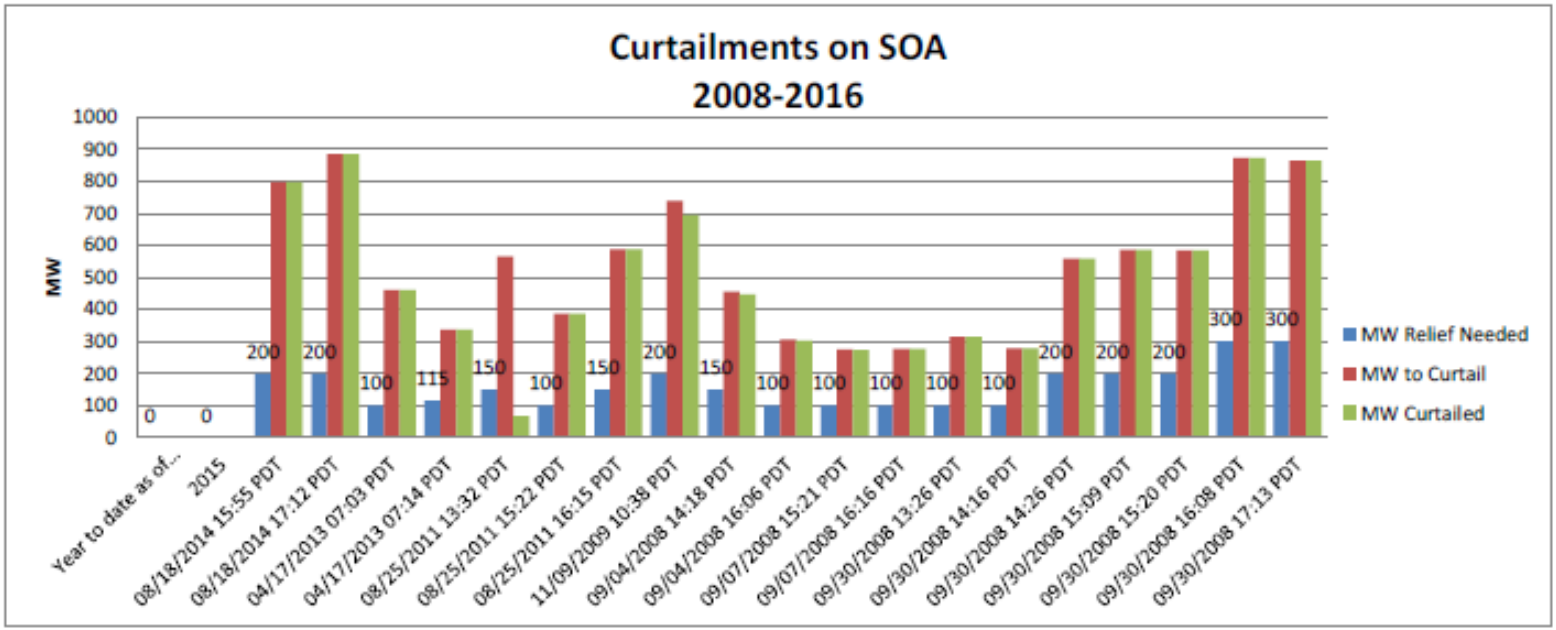
For Discussion Purposes Only

SOA Dynamic TTC and Real-time Reliability Assessment Tools

- SOA TTC varies depending on outages and local generation patterns
- BPA deployed Dynamic TTC on South of Allston in summer 2016
  - The dynamic TTC is determined in real-time based on the actual system conditions
  - SOA dynamic TTC greatly reduced the risk of curtailments.
- April 1, 2017: Real-time reliability assessment tools further reduced the risk of curtailments, and allows operating closer to the true limit of the system

For Discussion Purposes Only

September 30, 2008 Curtailment

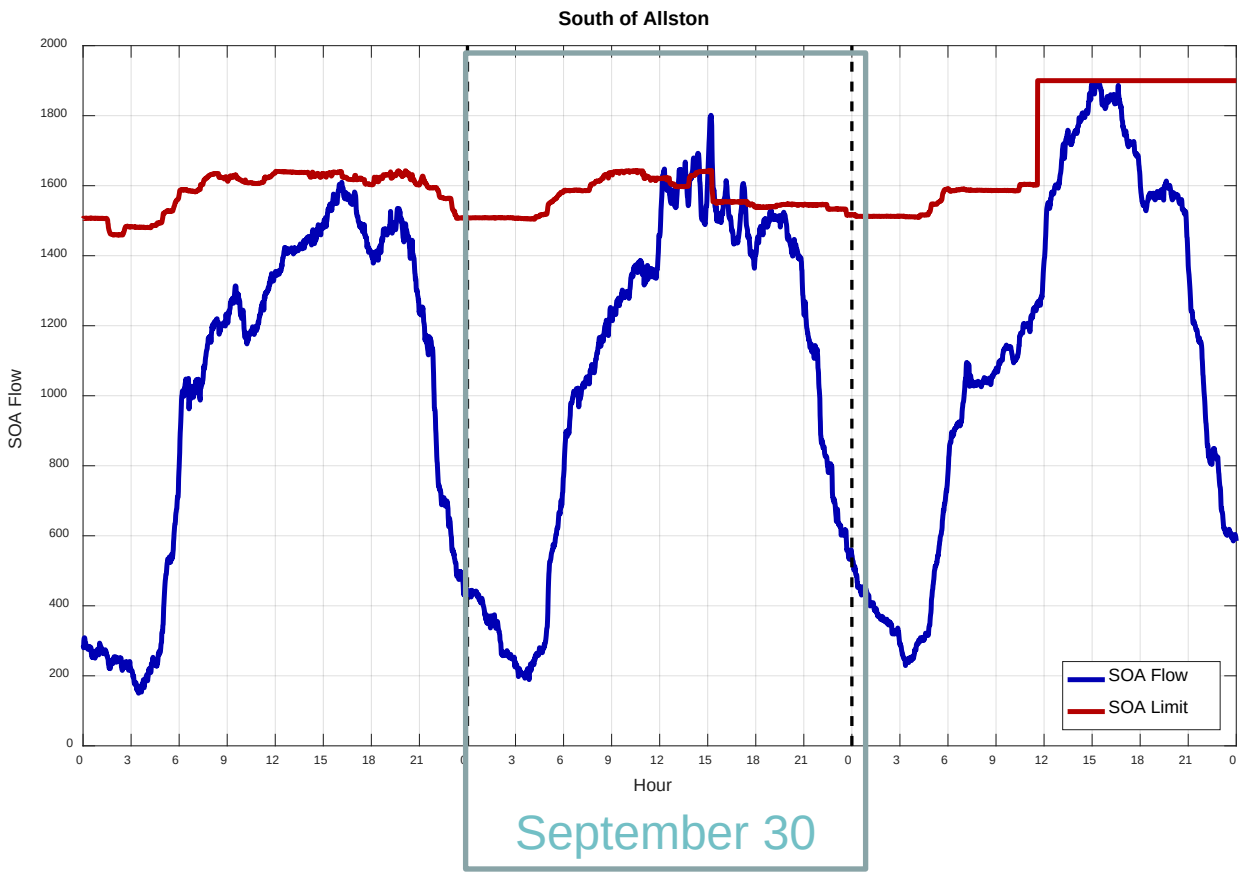


September 30, 2008

SOA curtailments occurred under transmission outage conditions

For Discussion Purposes Only

September 30, 2008 Curtailment

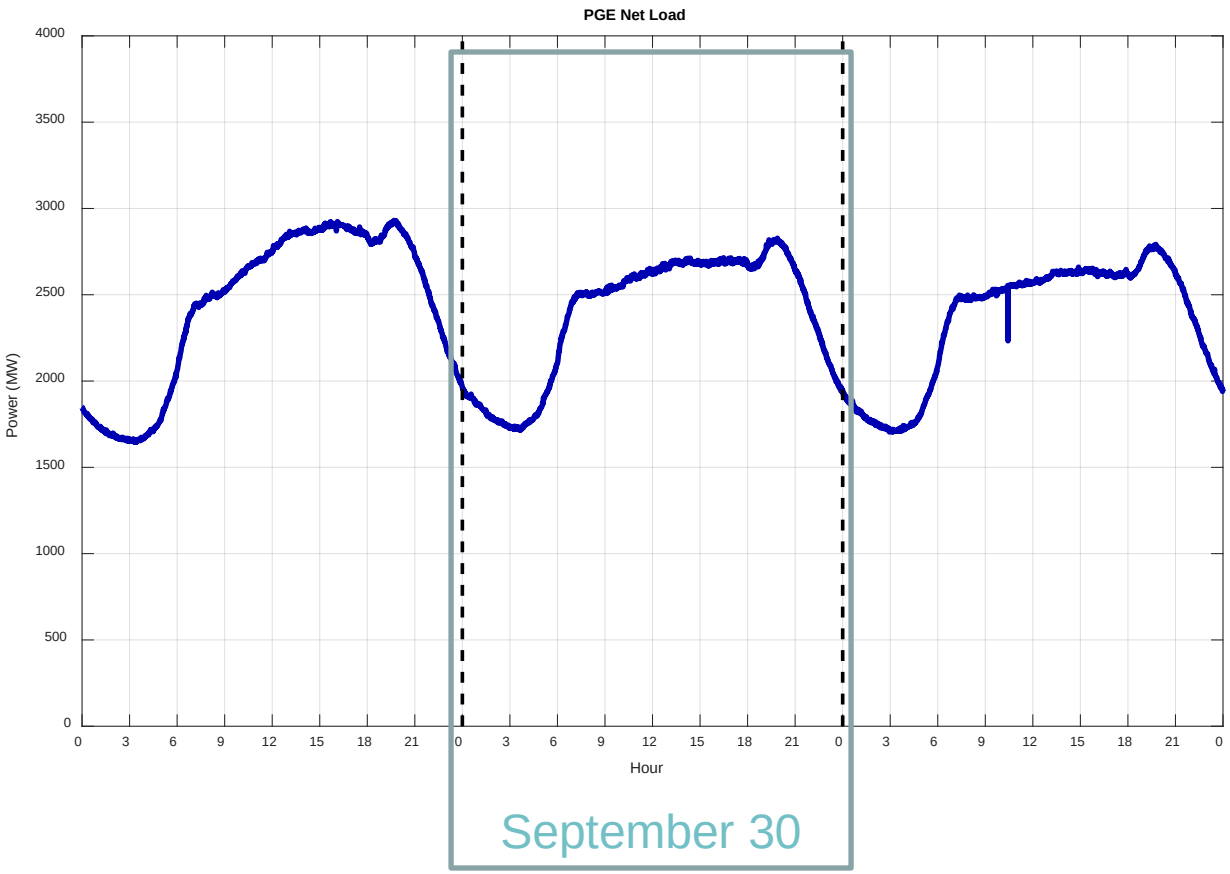


Multiple curtailments (almost hourly) occurred between 12pm and 8 pm on September 30, 2008

Pearl-Keeler 500-kV line was out of service for maintenance, resulting in lower operating limit

For Discussion Purposes Only

September 30, 2008 Curtailment



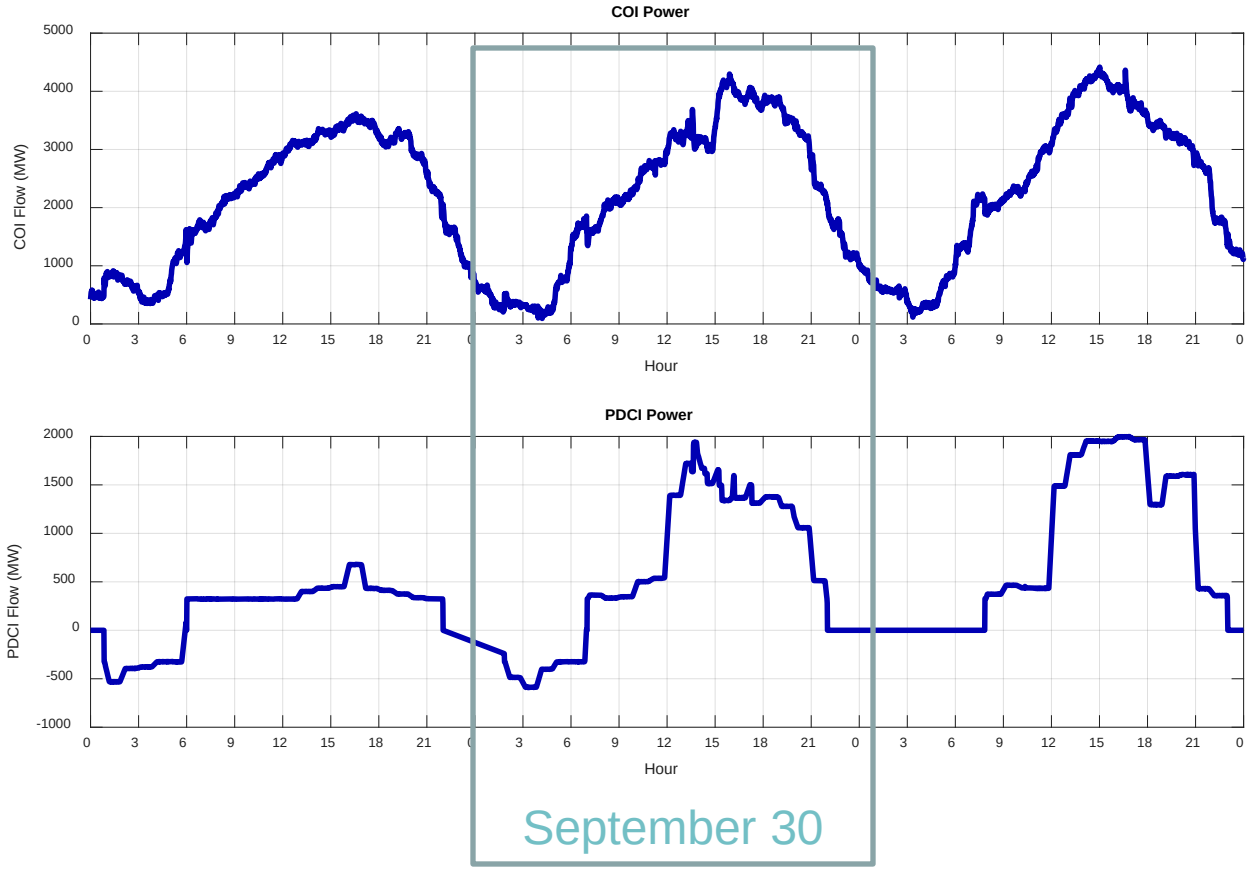
Portland's peak temperature on September 30th was only in the mid 70's (although the temperatures were in the upper 80s on September 29)

Portland loads were quite low – only about 2,750 MW (less than 70% of peak)

… So what then caused high transfers on South of Allston path ?

For Discussion Purposes Only

September 30, 2008 Curtailment



Los Angeles had a heat-wave with temperatures approaching 100 F

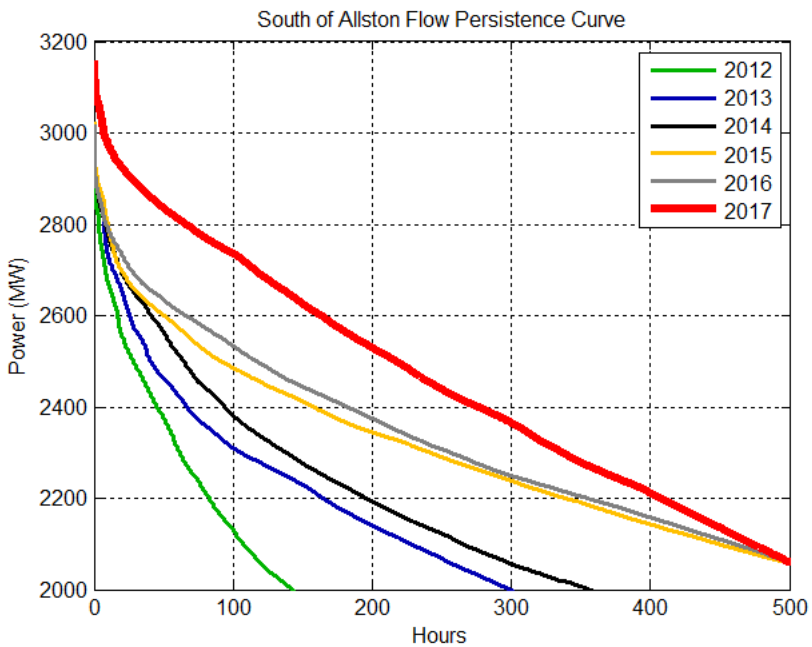
COI and PDCI were heavily exporting to California

For Discussion Purposes Only

2017 Summer Season

2017 SOA Flows

- Heaviest utilization of SOA path
- SOA flows reached 3,160 MW on August 31, 2017
- SOA flows were above 2,800 MW on 25 days



Portland Load

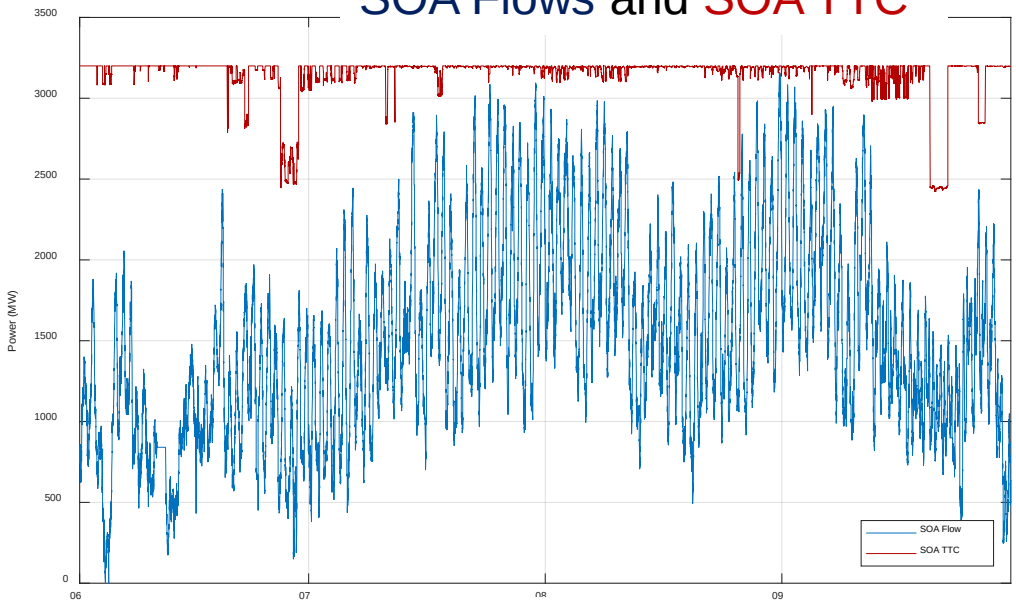
- Portland load set all-time summer peak record on August 2nd and 3rd

Transfers

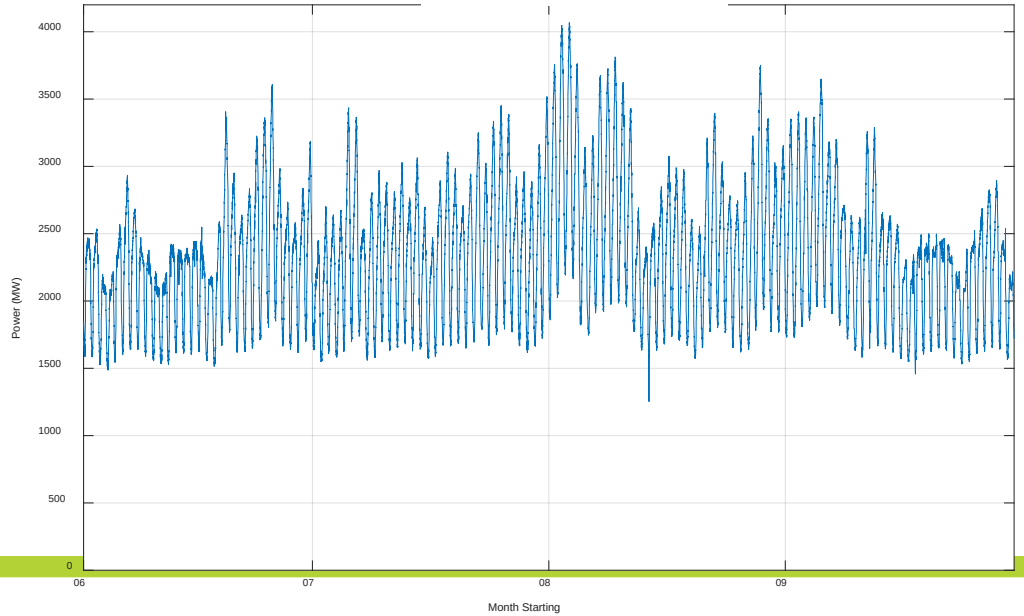
- High through-flows from Canada and Northwest to California, particularly during sunset hours, usually under lower to moderate NW loads
- I5 thermal generation was high during peak load and peak exports

For Discussion Purposes Only

SOA Flows and SOA TTC



PGE Net Load



Multiple days of high flows from mid-July to early September

SOA peak flow of 3,157MW occurred on August 31, 2017

No significant outages, SOA TTC remained close to 3,200 MW most of the summer

No curtailments

High SOA flows were driven by (a) Portland area loads, (b) exports to California during sunset hours

PGE summer peak load of 4,065MW was recorded on August 3, 2017 at 16:43

Commercial Drivers

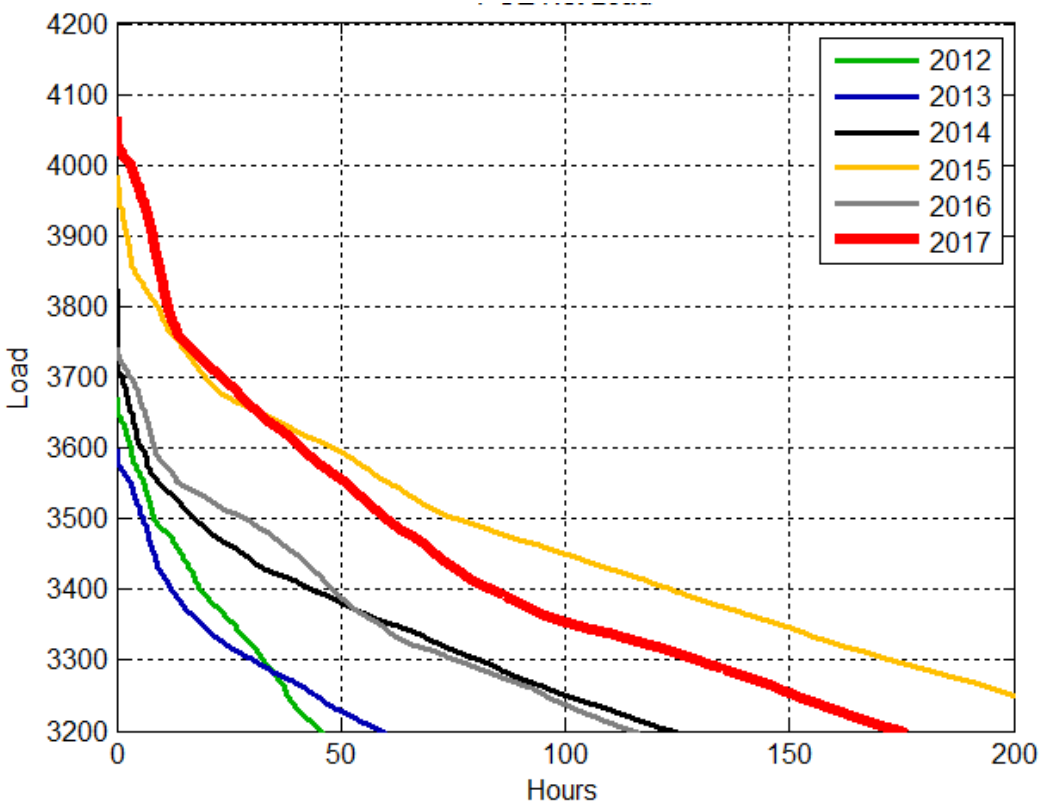
- 2008, 2009, 2010, 2013 Network Open Seasons and 2016 TSEP have all identified the need for the South of Allston Reinforcement to accommodate the Transmission Service Requests (TSRs)
- The I-5 reinforcement project was identified as the plan of service to accommodate the TSRs
- Following “no-build” decision, BPA is studying other alternatives, including non-wire options, to meet the TSRs

For Discussion Purposes Only

System Improvements and Landscape Changes

Portland Loads

Portland summer peak load reached all-time summer peak of ~4,050 MW this year (previous peak was ~4,030 MW in 2009)

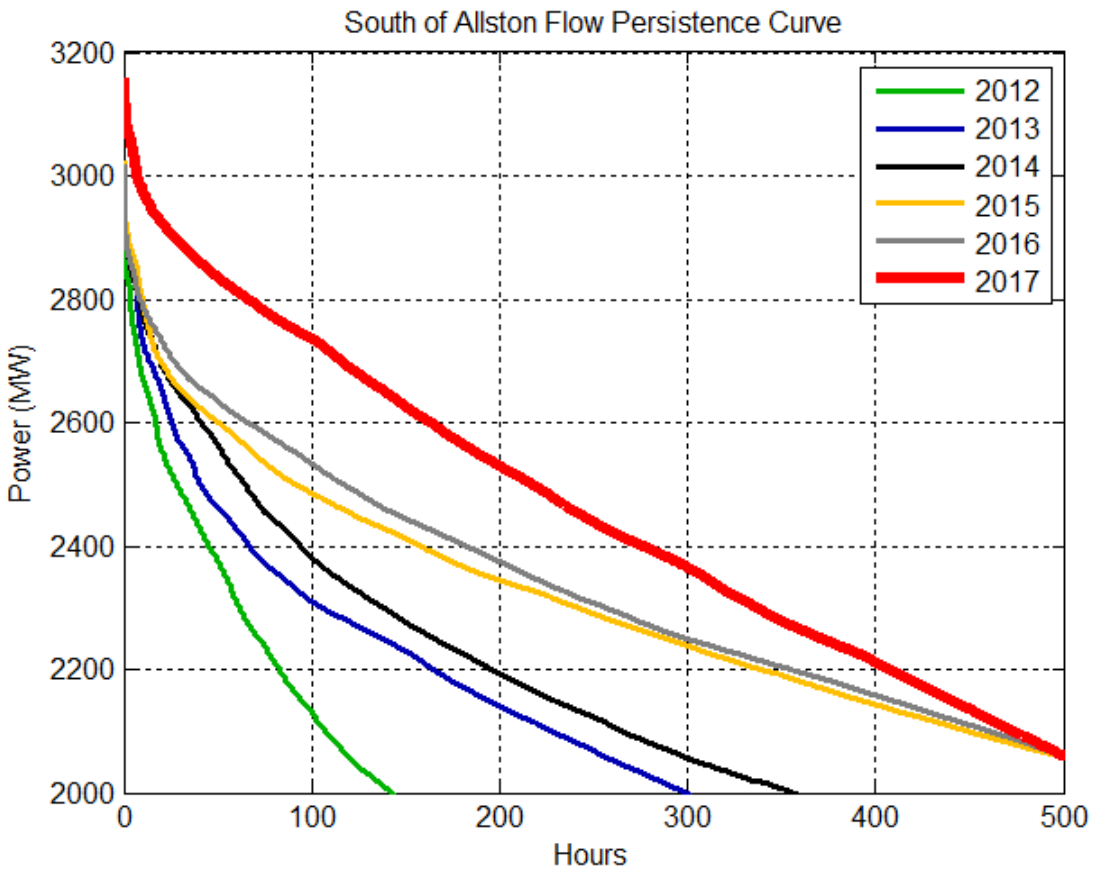


Load-duration curve: more hours of higher loads

For Discussion Purposes Only

South of Allston

South of Allston Flows have been increasing every year last three years



Flow persistence curve: more hours of higher flows

For Discussion Purposes Only

Landscape Changes

"I skate to where the puck is going to be, not to where it has been"

Wayne Gretzky

It is job of system planning to recognize the landscape changes and make investments for the system ahead and not the system behind

Let's take a look how various known things impact South of Allston

For Discussion Purposes Only

Landscape Changes (Font size = impact)

- PGE and BPA System Improvements
- Coal generation retirement
- New Operational Standards
- BC Hydro (2 units at Mica, Site C)
- California and NW Solar
- Large industrial load additions in Portland Metro
- Projected load growth in Portland is on lower end
- Climate Change and Extreme Weather Events
- Energy Storage costs are coming down, could become an economic alternative to new transmission
- Energy Imbalance Market

Green = reduce SOA stress, Red = increased SOA stress

For Discussion Purposes Only

System Improvements - PGE

- PGE plans several system additions that will improve reliability and resiliency of load service
  - Phase I
    - Second Horizon Transformer
    - Horizon tap on Trojan – St.Mary's 230-kV line
  - Phase II
    - Harborton 230-kV substation, loop-in Trojan lines, add 230/115 transformer
- These additions will allow to maintain SOA TTC as the area load is growing
- PGE studies other projects identified in "PGE Company's Long Term Local Transmission Plan"

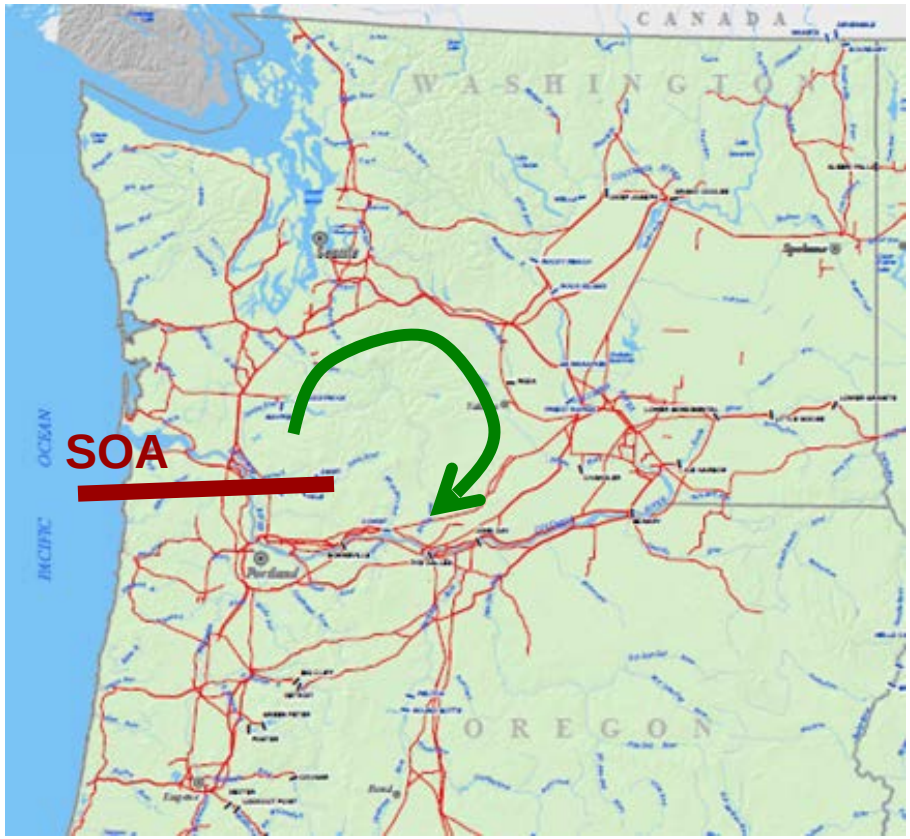
PGE reinforcements greatly improve reliability of load service in Portland

For Discussion Purposes Only

System Improvements - BPA

BPA also identified several reinforcements required to maintain and potentially increase transmission capacity on the South of Allston path

BPA also studies power flow control technologies to re-direct power from the I5 corridor to the east side (illustrated on right)



BPA power flow control solution optimizes utilization of the existing infrastructure

For Discussion Purposes Only

New Operational Standards

- Peak RC implemented a new SOL Methodology on April 1, 2017 in response to updated NERC TOP Standards.
- Key changes
  - Path SOLs are no longer used for thermally limited Paths
    - SOA is a thermally limited path
  - To ensure system reliability, BPA monitors SOA area using real-time reliability assessment tools for thermal and steady-state voltage issues
    - Operations I5 team played a key role in improving the quality and credibility of real-time reliability assessment tools
  - Reduced set of “always credible” multiple contingencies
    - E.g. PGE no longer considers a double line outage of Trojan – Rivergate and Trojan – St. Mary’s as a credible multiple operational contingency

Peak RC Methodology reduces the risk of SOA curtailments

For Discussion Purposes Only

Coal Retirements

Centralia Unit 1 retirement is scheduled for December 2020, and Unit 2 for December 2025

Centralia to California transaction has 50 to 60% impact on SOA

Generation replacement is not committed at this time

Boardman Unit scheduled for December 2020 retirement

Uncertainty of Centralia replacement favors flexible and scalable solution

For Discussion Purposes Only

BC Hydro Capacity Expansion

- BC Hydro added two new generating units, 500 MW each, at Mica Dam on the Columbia River, increasing the plant total capacity to 2,805 MW
- BC Hydro energized Interior to Lower Mainland 500-kV line, 154-mile, series compensated, $743M
- BC Hydro is also developing Site C on Peace River, expected capacity of 1,100 MW, scheduled to be operational in 2024
- BC Hydro will have power surplus and transmission to deliver it to the BC-US border
- PowerEx plans to join Western EIM in April 2018

We expect higher imports from BC to continue during summer peak and sunset hours

For Discussion Purposes Only

Solar Generation

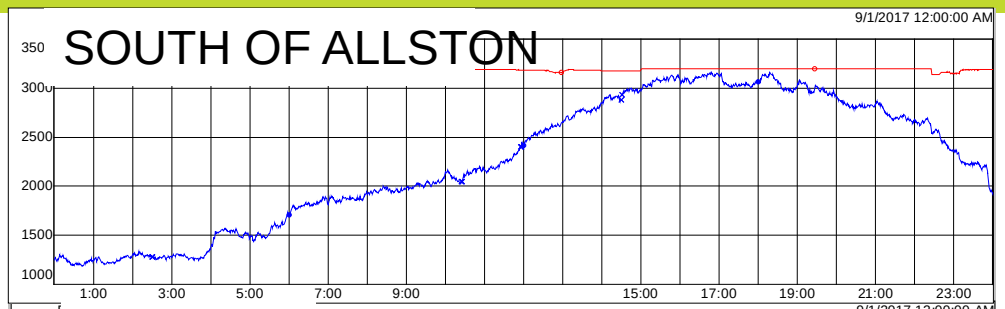
South of Allston Flows are driven by SW Washington / NW Oregon loads and exports to California

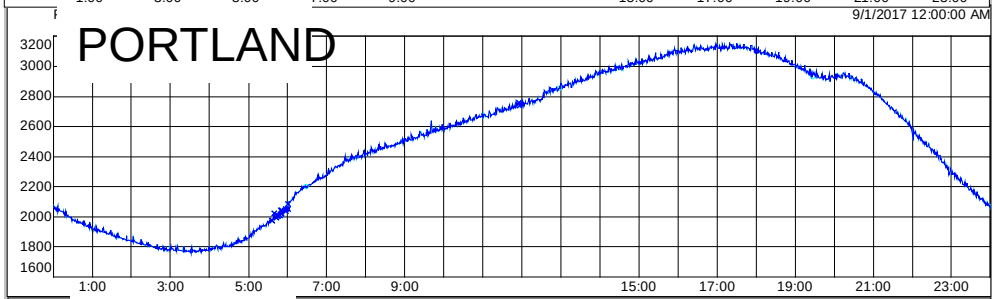
California solar offsets COI and PDCI exports during the day, but increases the exports during sunset hours

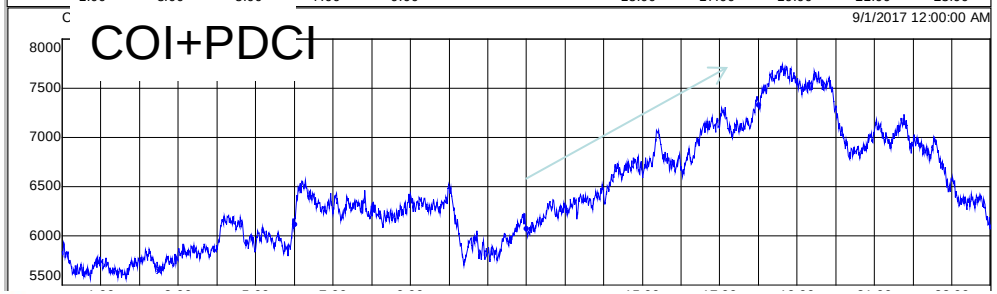
The cumulative effect expands the duration of high SOA flows, as we saw in 2017

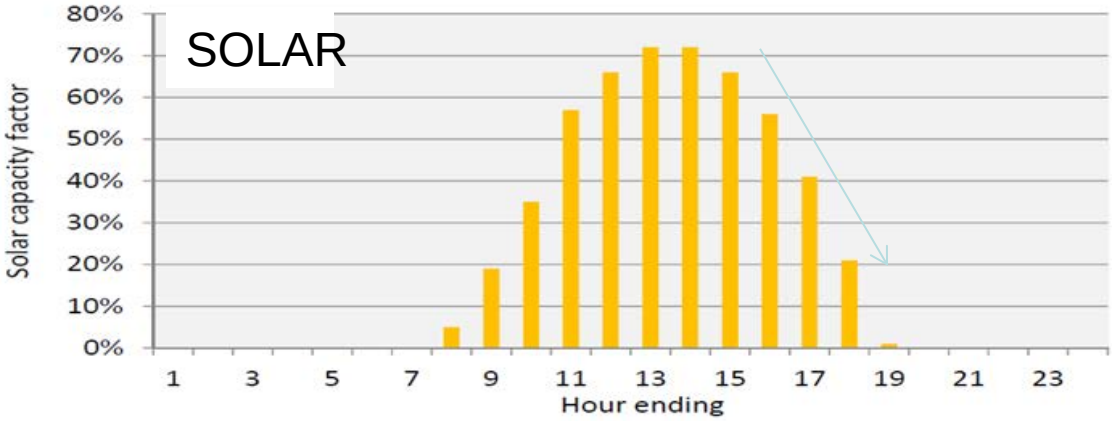
We expect the trend to continue, as there is significant amount of flexible generating capacity north of SOA

- more I5 entities join Western EIM
- BC Hydro expands its generation capacity
- Grand Coulee and Chief Joseph generation returns to its full capacity following a decade-long refurbishment









Energy Storage

- Technology is maturing, modular, and can be installed quickly
- SCE installed 20 MW x 4-hour Tesla battery and SDG&E installed 30 MW x 4-hour Samsung battery in less than 6 months (both are distribution-connected and turn-key designs)

- California and Oregon have energy storage requirements
- Not needed currently to meet reliability compliance on SOA, but needs to make commercial sense

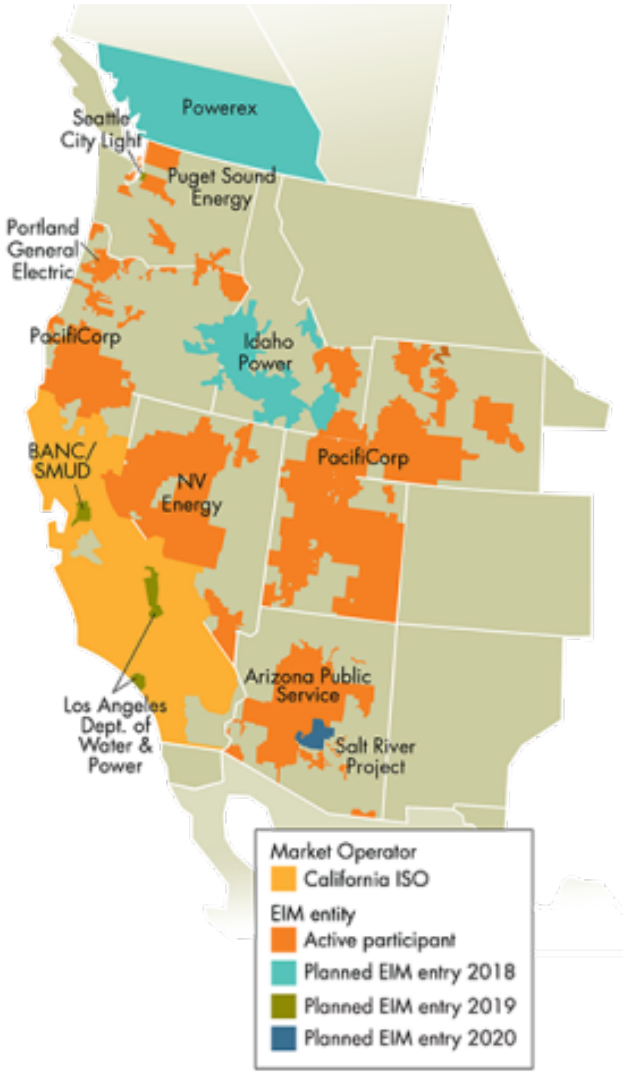
BPA is monitoring technology trends

For Discussion Purposes Only

Western Energy Imbalance Market

Western EIM participants that affect SOA include:

- PacifiCorp
  - Lewis River hydro, Chehalis
- PSE
  - Mint Farm, Puget Sound area peakers
- PGE
  - e.g., Port Westward, Beaver
- PowerEx and Idaho to join in April 2018
- Seattle City Light to join in 2020



BPA-CAISO Coordinated Transmission Agreement

- EIM will re-dispatch participating resources that impact SOA during firm curtailments on SOA

For Discussion Purposes Only

Conclusion

- BPA implemented a series of operational improvements to reduce operational risks on the South of Allston, including RAS automation and optimization, dynamic TTC, and successful implementation of using real-time reliability assessment tools
- BPA and PGE are studying a portfolio of flexible and scalable solutions to address (a) reliability compliance, (b) operational resiliency and flexibility, and (c) commercial needs
- Landscape changes reinforce the BPA path to adopt a flexible and a scalable solution

For Discussion Purposes Only