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Powerex EIM Experience

NWPP ATF and System Schedulers Meeting

Jeff Spires

Oct 23, 2018

Disclaimer

Powerex is committed to full compliance with laws and regulations, including federal and state antitrust laws.

Powerex, the merchant subsidiary of BC Hydro, is here as an active participant in discussions regarding development of Western market solutions.

Powerex is participating in this discussion forum solely to discuss regulatory and market design issues, including those related to regional market initiatives that are currently underway.

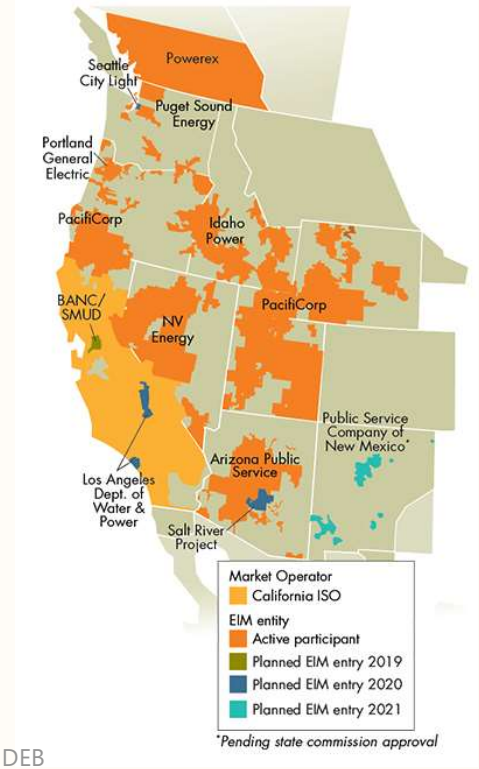
Powerex is not here to discuss any topics or share information that could contribute to or result in possible anticompetitive behavior, and will not share non-public information regarding its pricing, supply, capacity, bids, costs, customers, or strategic plans.

Powerex understands and expects that any views, opinions or positions presented or discussed by meeting participants during this session are the views of the individual meeting participants and their organizations, and are not intended to represent an agreement between meeting participants.

Powerex will, and expects each participant will, continue to make independent business and competitive decisions about its resources and its own participation in Western market initiatives.

Key Features of Powerex's EIM participation

- **Powerex participates under Canadian EIM Entity Agreement**
- **Supported by resources and load located in Canada**
  - EIM area does not extend into Canada
  - Powerex transacts at BC-US Border using aggregated resources and load
- **Transmission rights voluntarily made available to EIM**
  - Set aside ahead of the hour
  - Typically 150 MW to and from Puget Sound Energy at BC-US Border*
  - Typically 150 MW to and from CAISO at Malin*
  - Includes dynamic transfer capability (subject to availability)
- **Participation with aggregate resources**
  - Aggregate Participating Resource (APR)
  - Aggregate Non-Participating Resources (e.g. VER, Load, small hydro, etc.)

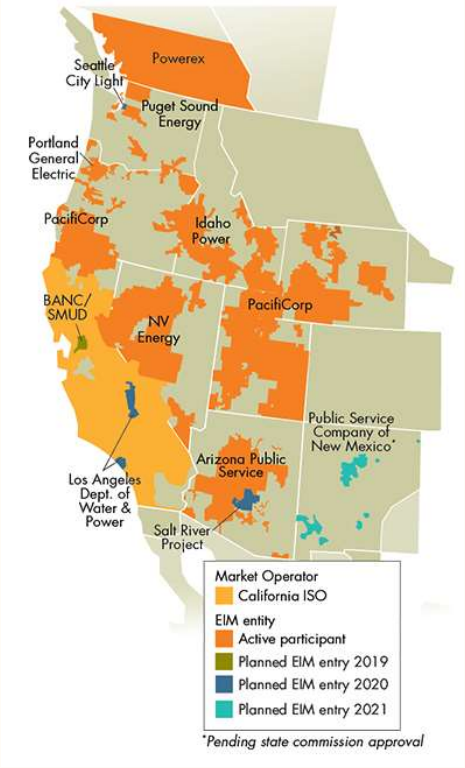


*Powerex has reduced its voluntary provision of transmission rights to mitigate harm associated with CAISO's LMPM and DEB framework

Powerex's EIM Project Implementation: Key Success Factors

- **Extensive experience in CAISO markets**
  - Participated in CAISO's 5-minute markets since 2005
- **Extensive in-house IT development**
  - Most EIM tasks are automated
  - Many existing processes and systems leveraged
    - Settlements system, dynamic scheduling framework
- **Significant co-ordination with BC Hydro, Puget and BPA**
  - Dynamic scheduling, network and transmission modelling, ETSRs
- **High level of support from CAISO staff**
  - Highly knowledgeable project and integration staff
  - Online and on-site training sessions and problem solving

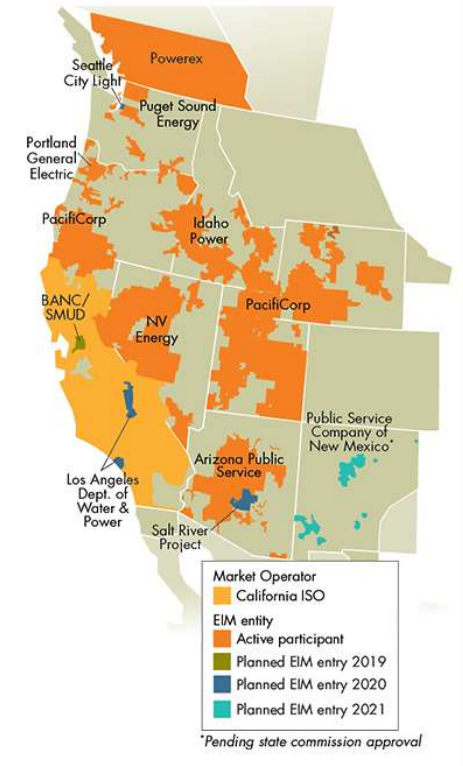
Project completed on schedule (10 months) and under budget



Benefits of Powerex's EIM participation

- **Potential EIM benefits vary by entity and region**
  - Some seek opportunities to more **cost-effectively balance** their load, and solar, wind output
  - Some seek opportunities to **export renewable over-supply** and avoid curtailment of solar, wind output
  - Some seek new opportunities to **monetize flexible generation** capabilities

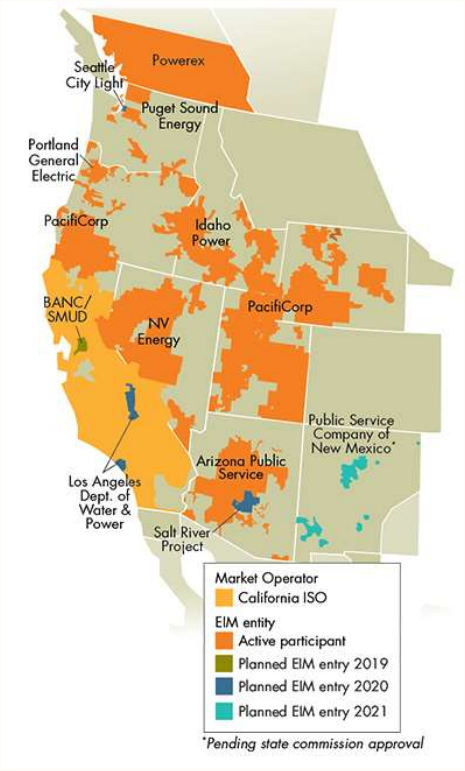
- **Realized Benefits for Powerex**
  - EIM purchases displace BC Hydro generation, conserving water for future use
    - California export fees **waived** in EIM
  - Congestion rent for transmission rights provided, partially offsetting tariff costs



Key EIM Challenges

Key challenges prevent new and improves hydro sales opportunities in EIM

1. **Local Market Power Mitigation (LMPM)**
   - Existing LMPM processes and DEB options **not workable** for external hydro
     - Formula over-rides voluntary bids and offers, resulting in forced sales (stakeholder process underway)
2. **Resource Sufficiency**
   - Diversity benefits have been offset by the need to carry a "buffer" of capacity and flexibility to meet uncertain RS volumetric requirements
   - Evidence suggests RS requirements are not applied equitably to CAISO BAA
3. **GHG**
   - EIM GHG approach is flawed, resulting in benefits to fossil fuel resources and harm to clean resources (partial improvements are expected soon)



Market design enhancements that better balance diverse regional interests will be necessary for continued expansion of the EIM

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Thank You

Powerex Corp.
1300-666 Burrard Street
Vancouver, British Columbia
Canada V6C 2X8

Tel 604 891 5000
Toll Free 1 800 220 4907
www.powerex.com

Energy Imbalance Market: One Year In

10/23/2018

EIM After One Year of Participation

Steve Auradou, BAO Manager
John Walker, Settlements Analyst

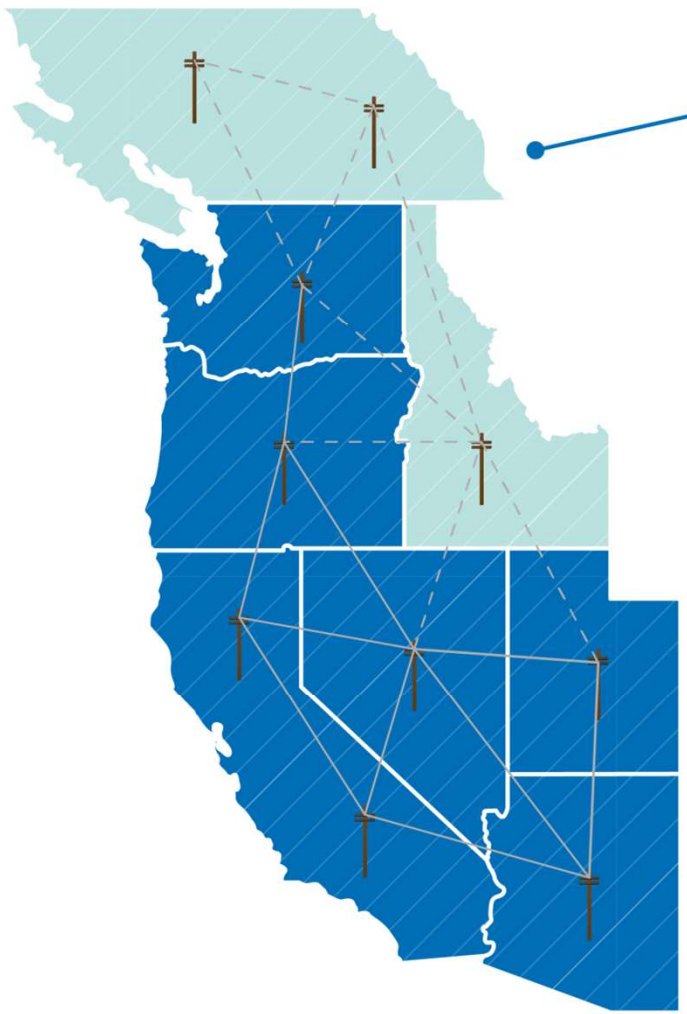
Western Energy Imbalance Market

Enhancing Efficiencies
Integrating Renewables
Lowering Costs for Customers

Joining EIM

EIM Go-Live Dates

- PAC-2014
- NVE-2015
- PSE-2016
- APS-2016
- **PGE-10/1/17**
- IPC-2018
- Powerex-2018
- LADWP-2019
- SMUD-2019
- SRP-2020
- SCL-2020



Automatically dispatches lowest-cost electricity

Helps balance energy supply and demand

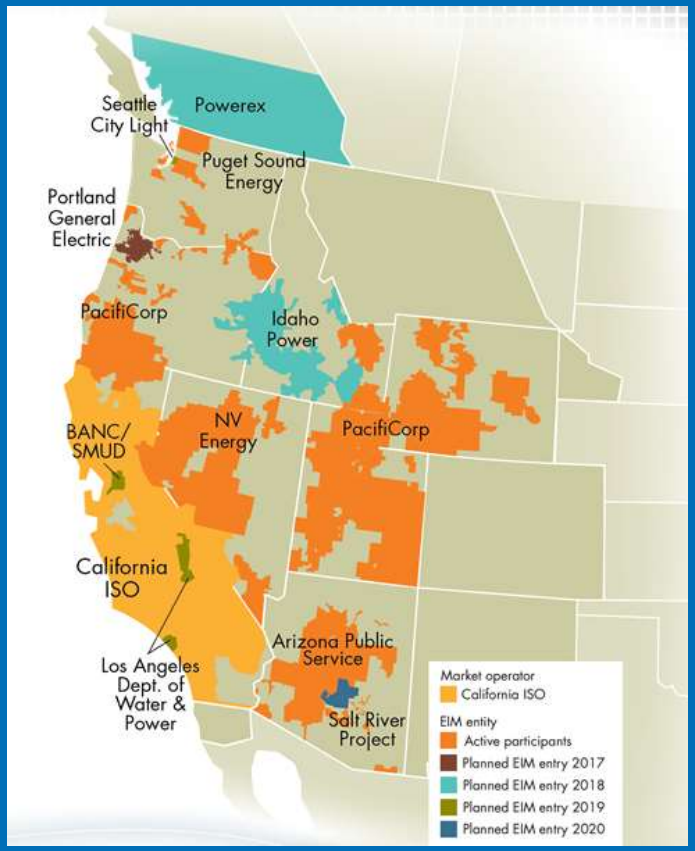
Makes it easier to add more renewables into our mix

Keeps our grid stable, secure and reliable

Joining EIM in 2018

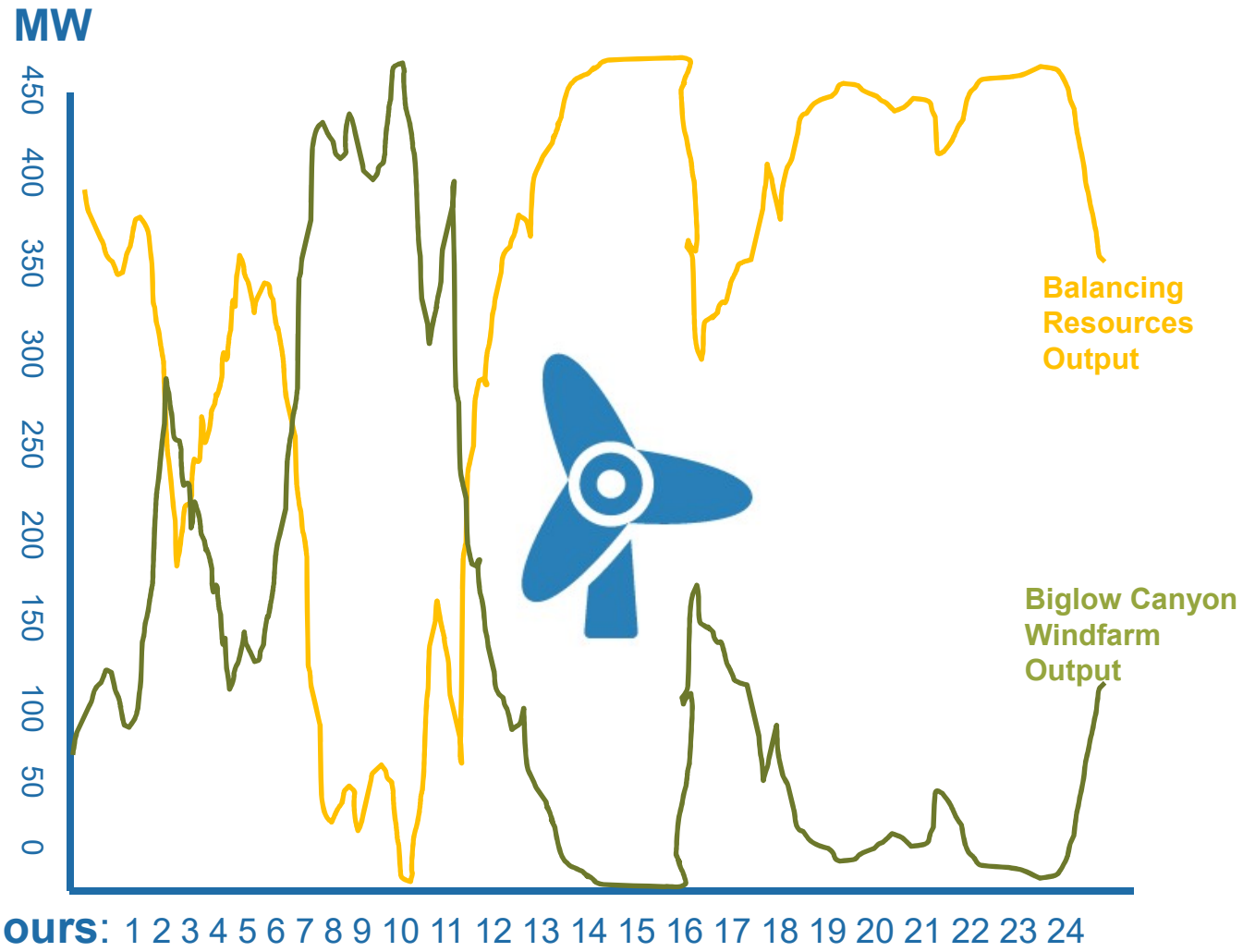
Currently participating in EIM

Appendix


Seattle City Light
Powerex
Puget Sound Energy
Portland General Electric
PacifiCorp
Idaho Power
BANC/ SMUD
NV Energy
PacifiCorp
California ISO
Arizona Public Service
Los Angeles Dept. of Water & Power
Salt River Project
Market operator
California ISO
EIM entity
Active participants
Planned EIM entry 2017
Planned EIM entry 2018
Planned EIM entry 2019
Planned EIM entry 2020

A Balancing Act

- Roughly 15% of PGE's generation comes from qualifying renewables like wind and solar
- By 2040, 50% of PGE's generation must come from qualifying renewables
- Load & generation must balance at all times, so PGE must flex its resources to match renewables outputs



Balancing Wind: A Simplified Look

Why EIM?

50% Renewables Target

Oregon's new 50% renewable portfolio standard means that thermal and hydro plants will experience significant wear-and-tear without balancing help from other utilities in EIM.

Keeping Up with a Changing Industry

Over 2/3 of electric customers in U.S.A. are served by utilities in organized markets, like EIM. That number is rapidly growing, especially in the West.

Regulatory Support

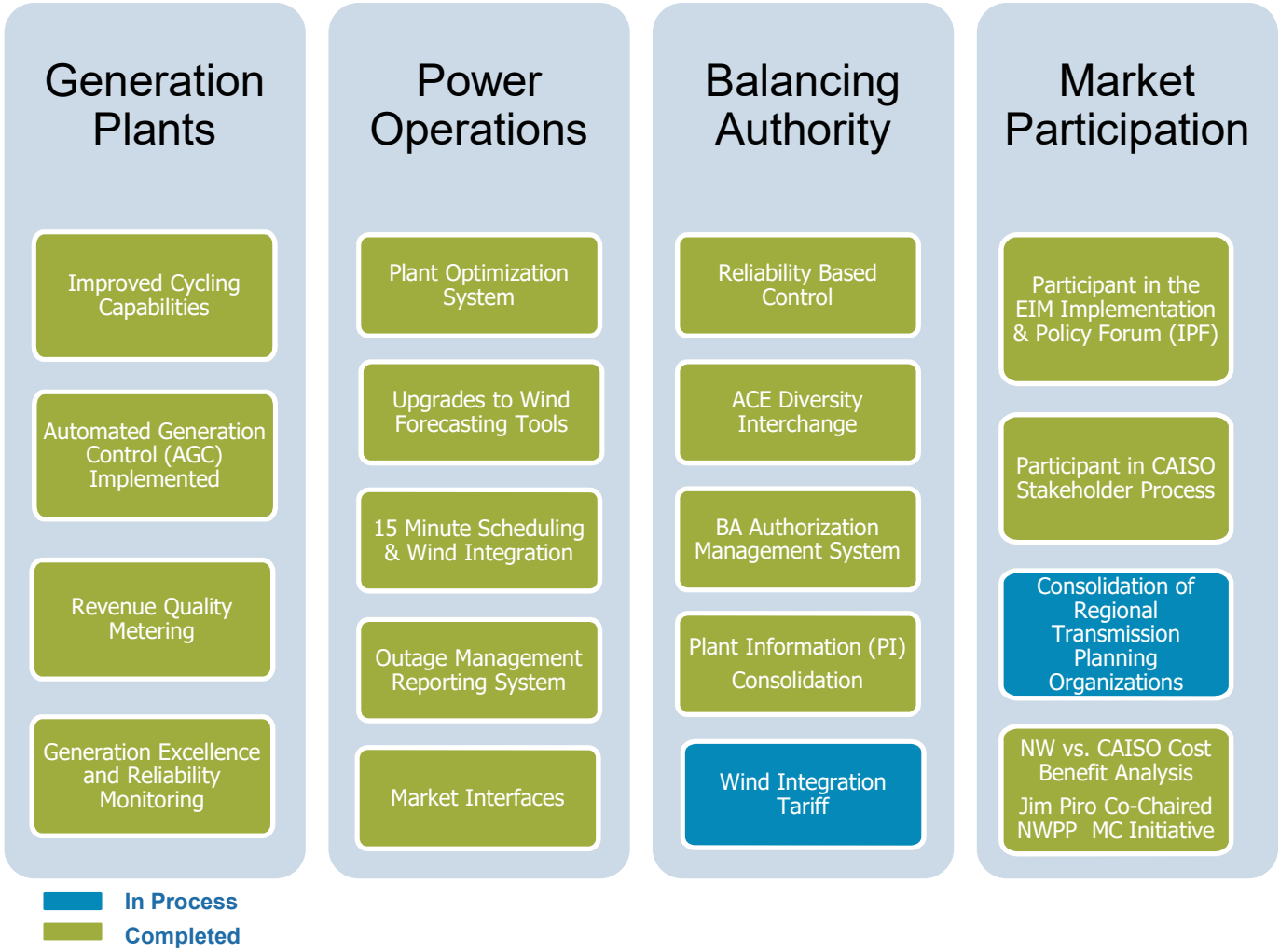
Both FERC and the OPUC are supportive of PGE's participation in EIM, due to benefits such as efficiency & transparency.

Better for Customers

Moving to EIM helps PGE to "self-integrate" its wind, instead of paying BPA. Also, more efficient plant dispatch will lead to savings each year.

PGE's Journey to Self-Integration & EIM

- **Starting in 2013, PGE made incremental system improvements to prepare for EIM**
- **The EIM project was a cross-functional effort resulting in improved communications and work flow processes**



Every day is an opportunity to learn something new

Post Go-Live Improvements

- Operations: BAO & Power Ops
- Systems & Processes
- Financial & Settlements
- CAISO Relations

BPA's Non-Wires Pilot for the South of Allston presented to the Northwest Power Pool

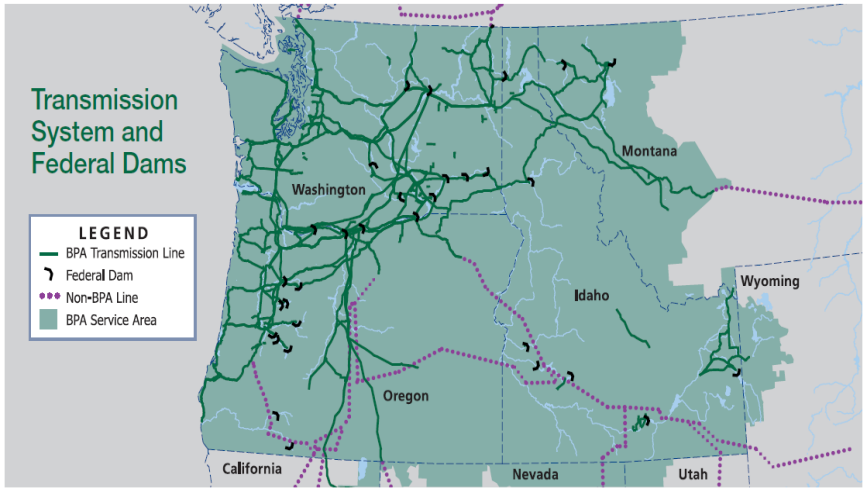
October 24, 2018

Agenda

- About BPA
- SOA Pilot Refresher
- SOA Non-Wires Pilot objectives
- Forecasting Tool
- Key Findings
- Next Steps

About BPA

- The Bonneville Power Administration was established in 1937. BPA is a nonprofit federal power marketing organization based in the Pacific NW.
- BPA is part of the Department of Energy (DOE) however we are self-financed.
- BPA markets power from 31 federal hydro dams, 1 nonfederal nuclear plant, and several nonfederal renewable resources across our service territory spanning 300,000 square miles.
- BPA operates and maintains 75% of the high voltage transmission in our service territory covering: Idaho, Oregon, Washington, Western Montana, and small parts of California, Nevada, Utah and Wyoming.
- BPA promotes energy efficiency, renewable resources and new technologies that improve our ability to deliver our mission.



DOE/BP-4831 • Updated May 2018

- Today's discussion is about how BPA is transitioning from traditional construction approaches to managing transmission congestion toward embracing "a more flexible, scalable, and economically and operationally efficient approach to managing our transmission system."

SOA Pilot Refresher

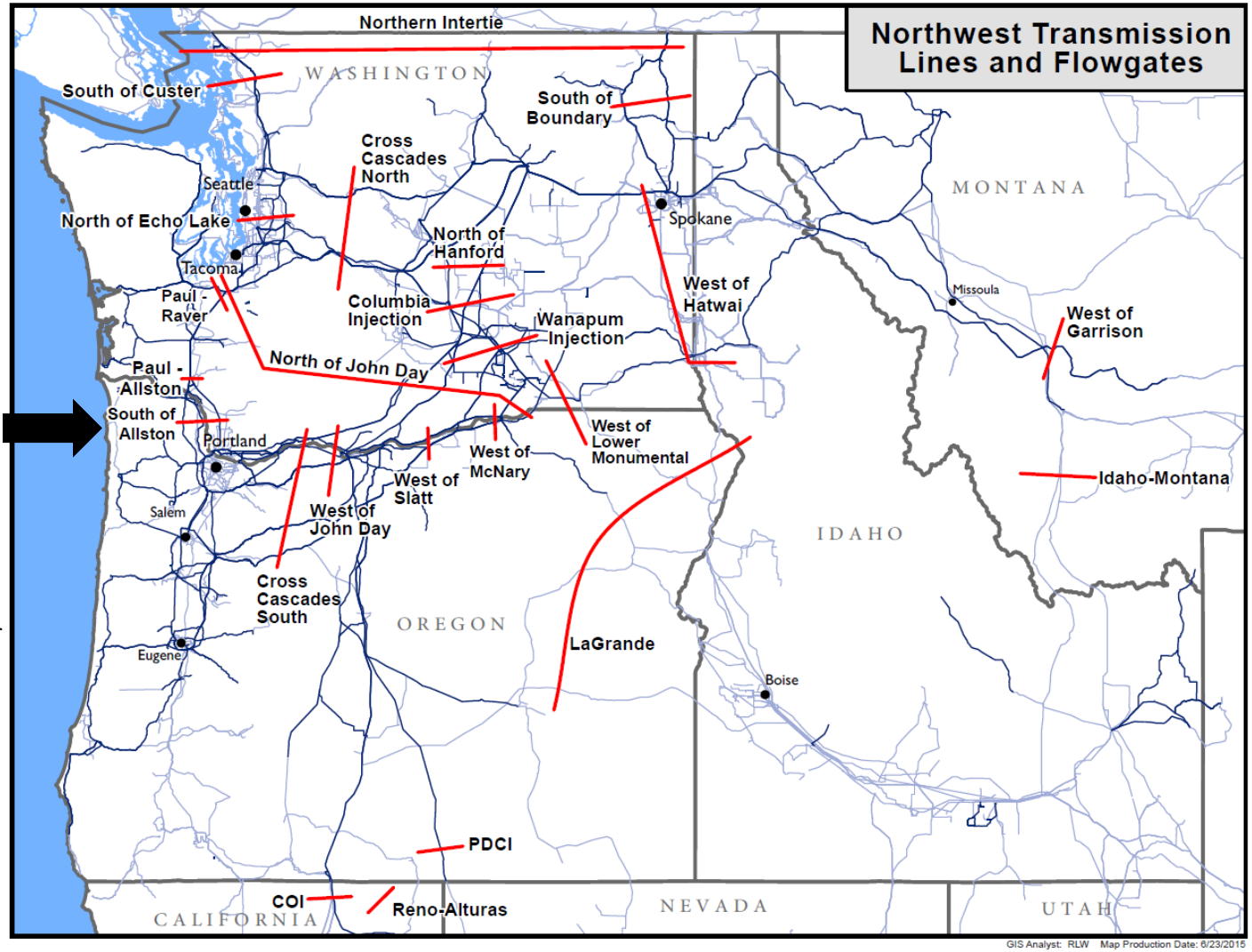
- One of many work streams underway to reduce flows
- BPA acquired two years of incremental and decremental capacity and energy (deployed with day ahead notice) to reduce flows on SOA flowgate during summer peak periods
- Annual transmission budget to fund SOA Pilot program is $5M/year.
- Non-wires portfolio chosen is balanced with roughly 200 MW of incremental capacity and 200 MW of decremental capacity
- SOA Pilot runs weekdays and is deployed as a portfolio in four hour blocks, late afternoon through evening, for up to 40 hours per year
- Third-party suppliers were notified of need to dispatch on a pre-schedule day-ahead basis
- An event notice was posted on OASIS for each event

Pilot Objectives

1. Secure a non-wires portfolio to reduce flows on SOA flowgate during summer peak periods
2. Measure and validate post-event data to determine amount of flow reduction
3. Leverage learning to inform future non-wires program design choices

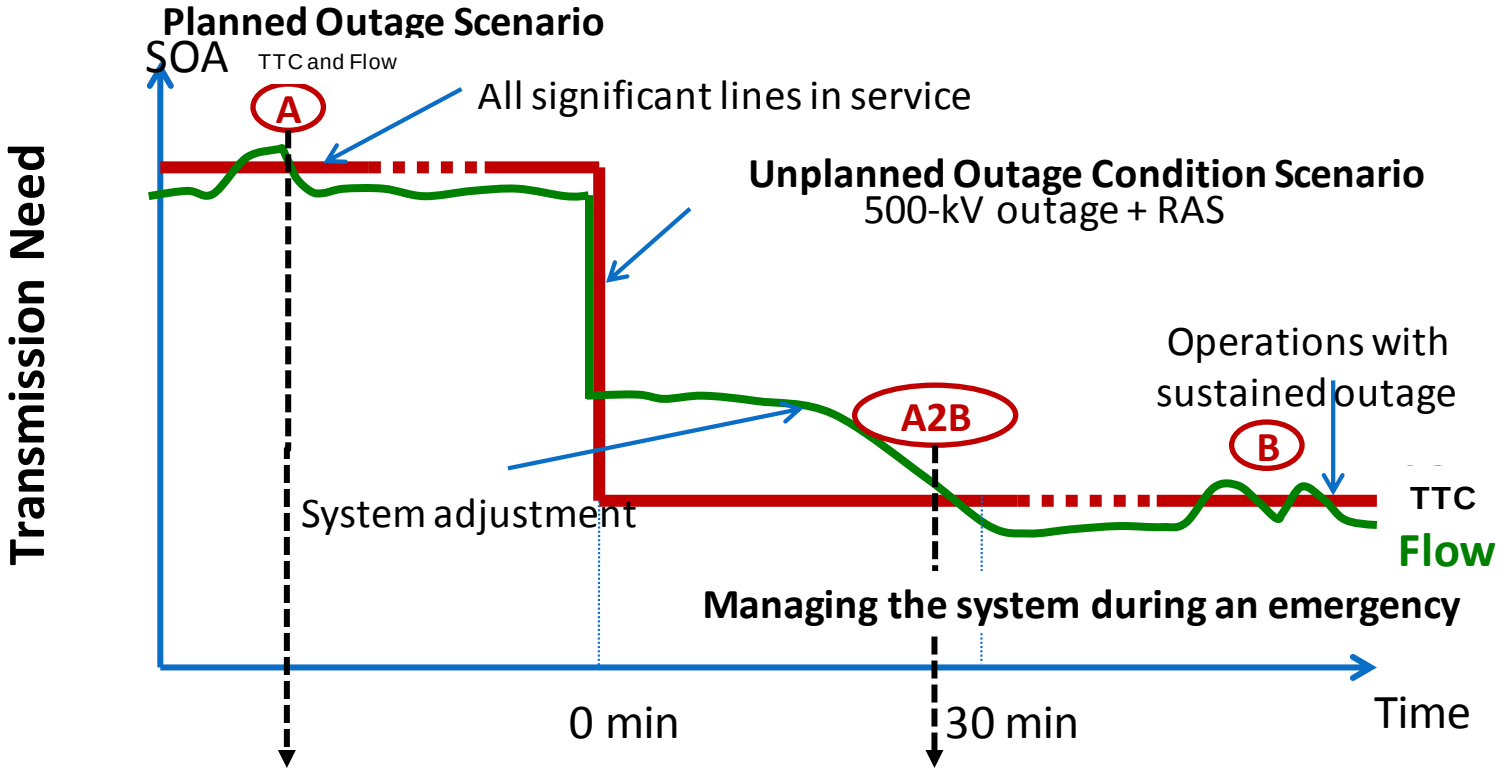
Map of PNW Transmission Paths

The relevance of SOA to the I-5 Reinforcement Project is that it represents a cut-plane between Longview, Washington and the Portland metro area which is used to monitor the reliability of the I-5 Corridor.



Map of flow gates highlighting SOA used by operations to monitor Portland metro area

Scope of SOA Non-Wires Pilot RFO

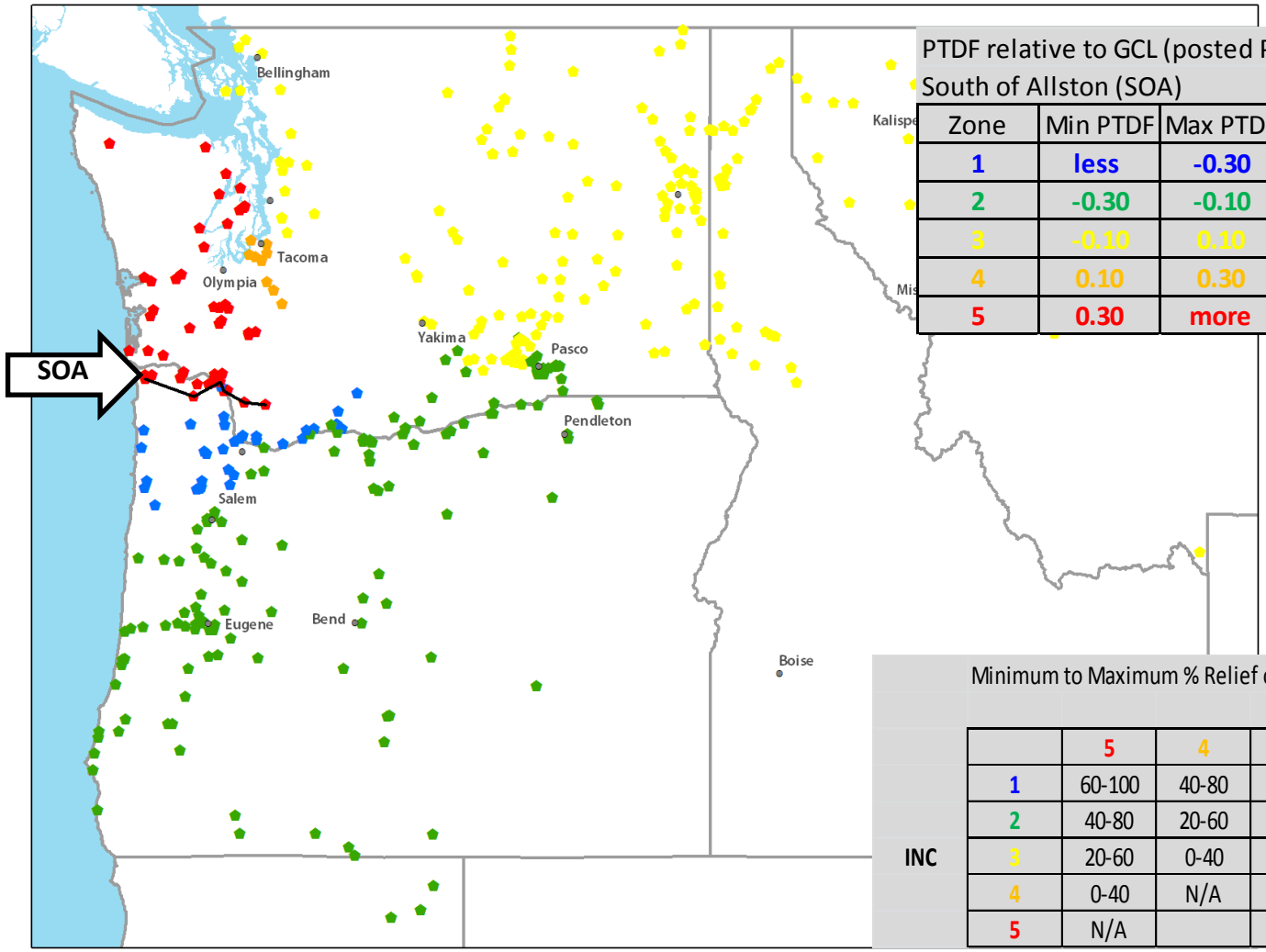


Non-Outage (A)	Outage (A2B)
Day Ahead Notice Incremental capacity, Decremental capacity, DSM/Demand Response	**Within Hour notice** used to manage the transmission system post contingency. This is outside of the scope of BPA's SOA Pilot.

Non-Wires

Scope of RFO on "A problem" to mitigate high flow risk (preventative, pre-contingency focus)

Congestion Map



PTDF relative to GCL (posted PTDFs)
South of Allston (SOA)

Zone	Min PTDF	Max PTDF	INC/DEC
1	less	-0.30	Best INC
2	-0.30	-0.10	Good INC
3	-0.10	0.10	Potential INC or DEC
4	0.10	0.30	Good DEC
5	0.30	more	Best DEC

Minimum to Maximum % Relief on SOA by INC and DEC Zone

INC \ DEC	5	4	3	2	1
1	60-100	40-80	20-60	0-40	N/A
2	40-80	20-60	0-40	N/A	
3	20-60	0-40	N/A		
4	0-40	N/A			
5	N/A				

This map was created by BPA for prospective bidders to respond to BPA's RFO seeking non-wires

Forecasting Tool

- Internal trigger tool generates daily peak flow forecast on SOA flowgate
  - Indicates when to deploy pilot based on next day's forecasted flow relative to forecasted TTC
- Utilizes historical data from June through September dating back to 2012. Statistical method is ridge regression model. Predictor variables in the model:
  - Portland area Load Forecasts
  - California Load Forecasts
  - Generation forecasts of generators located near the SOA flowgate
  - BPA total wind generation forecasts
  - Lower Columbia river hydro generation forecasts (i.e., BON, TDA, JDA, MCN)
  - Total Transmission Capacity (TTC) from OATI web data

Forecasting Tool

- Forecast is calculated at 04:05 on preschedule day for eight hour window (14:00-22:00)
  - After considering system conditions and outages, BPA decides whether or not to deploy the SOA Non-Wires Pilot
- There were times when the tool forecasted high flows and the pilot was not implemented
- There were other times when the tool did not forecast high flows that did end up materializing

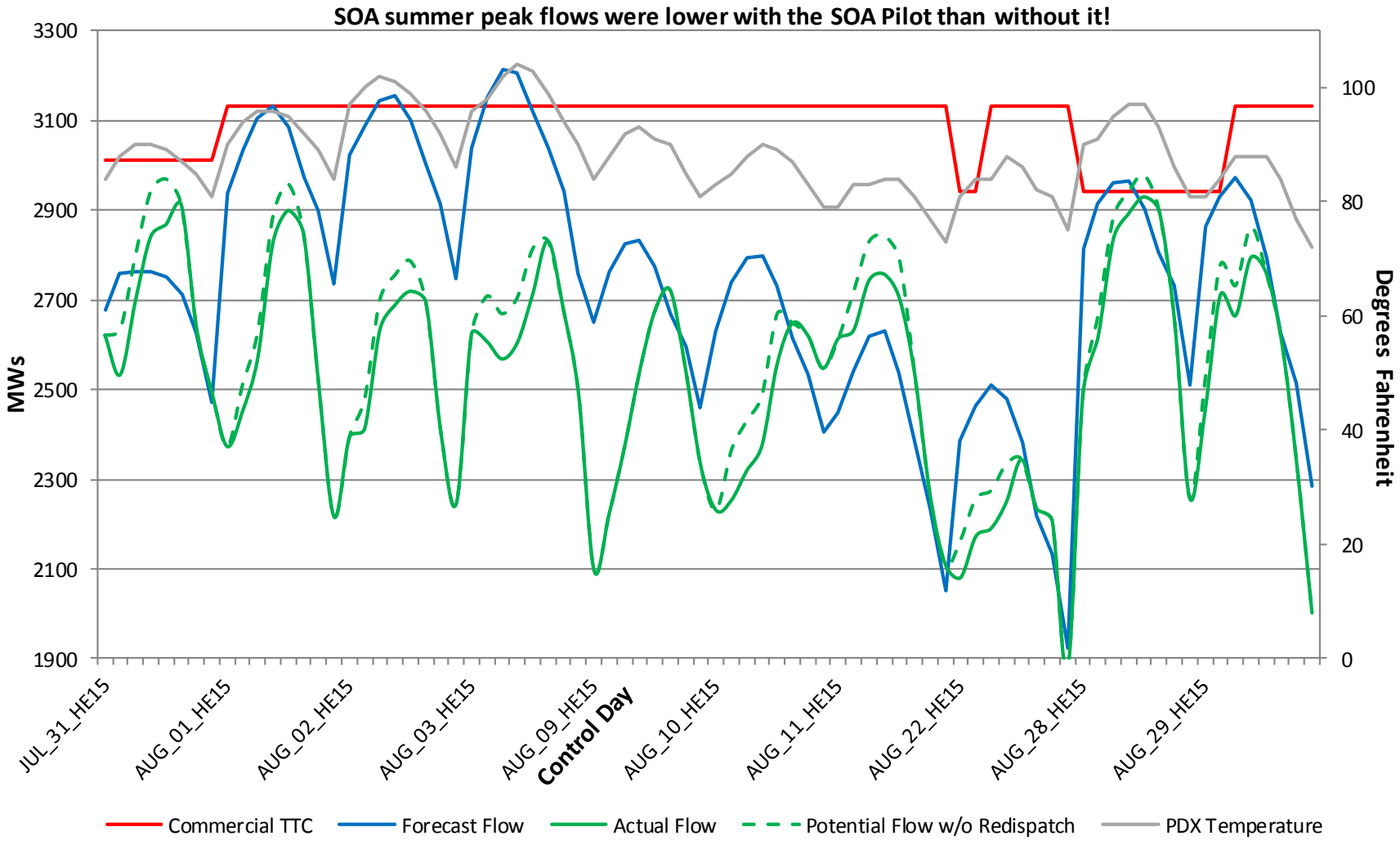
SOA Pilot Comparative Results

- Analysis shows similarities in performance from both summers:
  - flow reduction goals were met under different operating conditions
  - performance results were repeatable from summer to summer
  - results are reliable, flow reduction results were validated by multiple analysts
  - the average flow relief slightly increased in Summer 2018 compared to Summer 2017

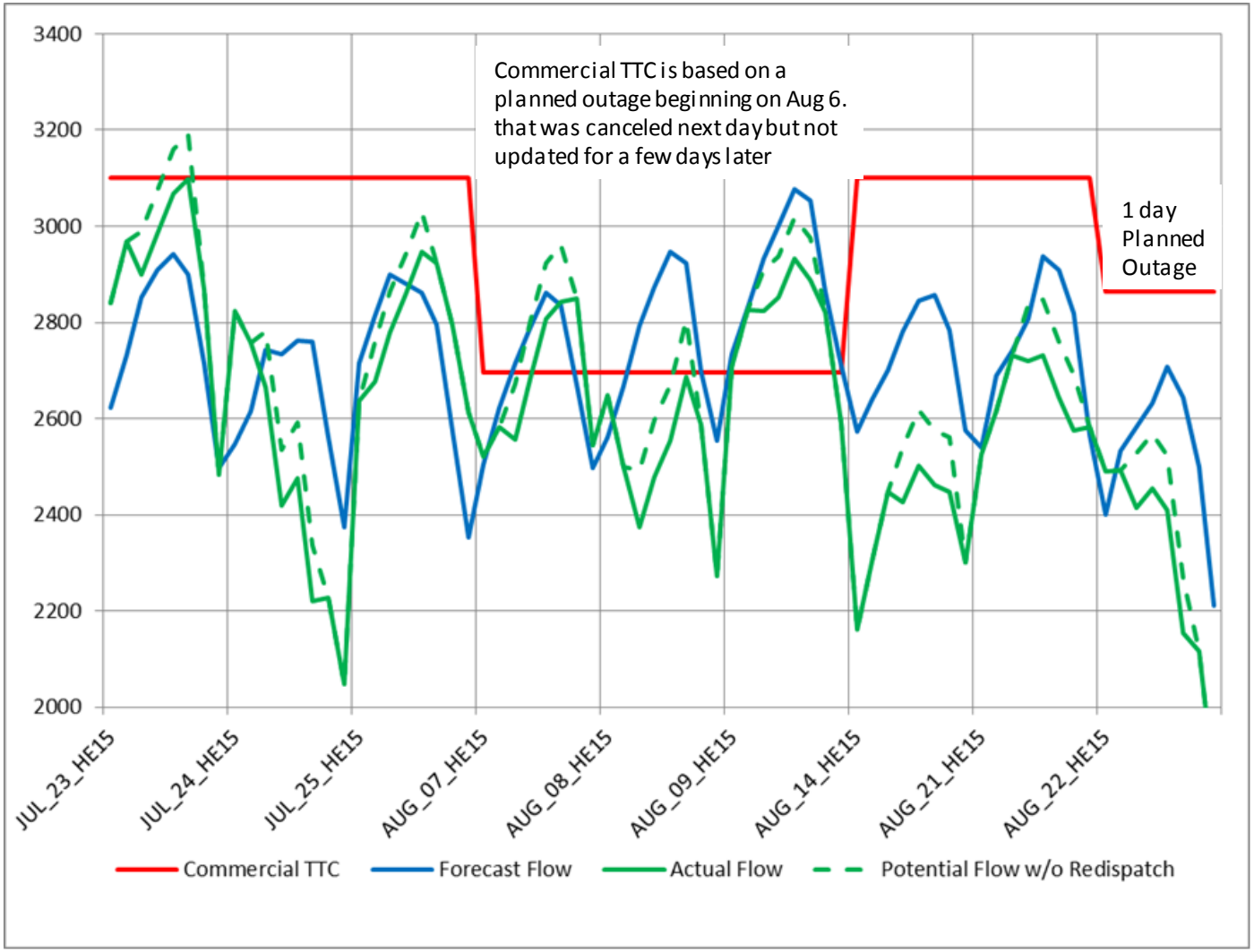
	Summer 2017 Relief			Summer 2018 Relief		
	Max	Avg	Min	Max	Avg	Min
Full Portfolio	-112	**-105**	-101	-117	**-107**	-83
Partial Portfolio	-82	**-75**	-71	-87	**-77**	-53

Note: relief is "schedule informed" where impacts are calculated based on schedules before and during SOA Pilot events, including resupply schedules

2017 SOA Pilot Reduced Flows Chart

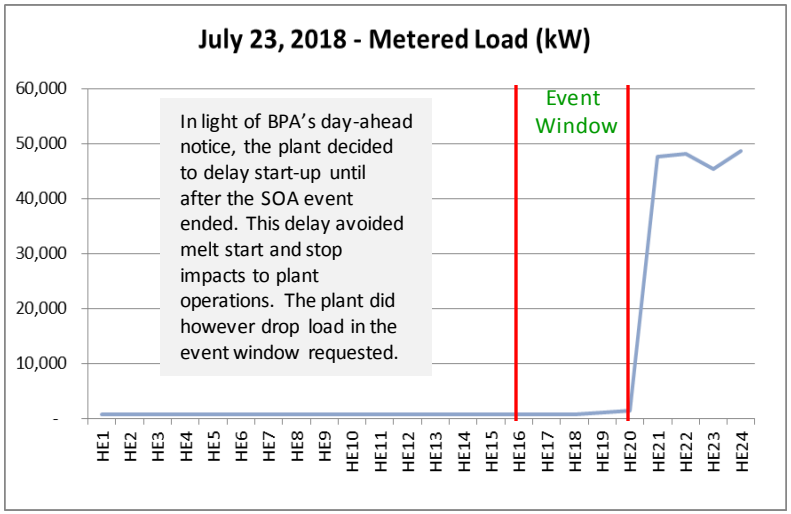


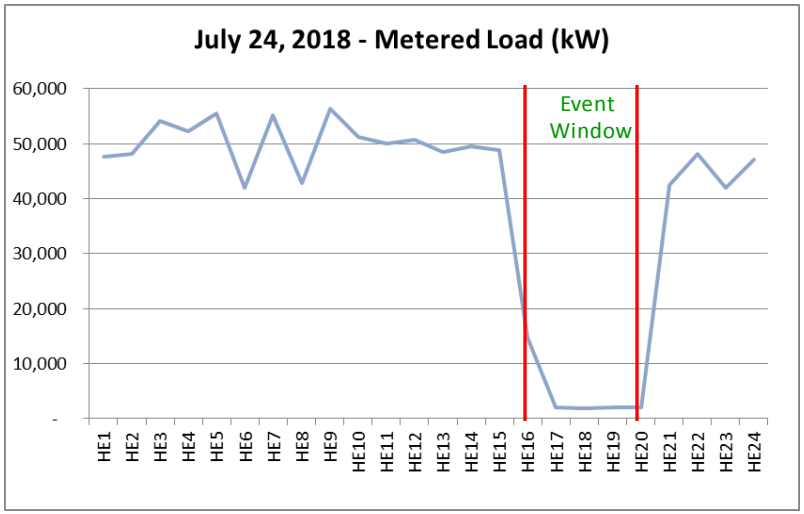
2018 SOA Pilot Reduced Flows Chart

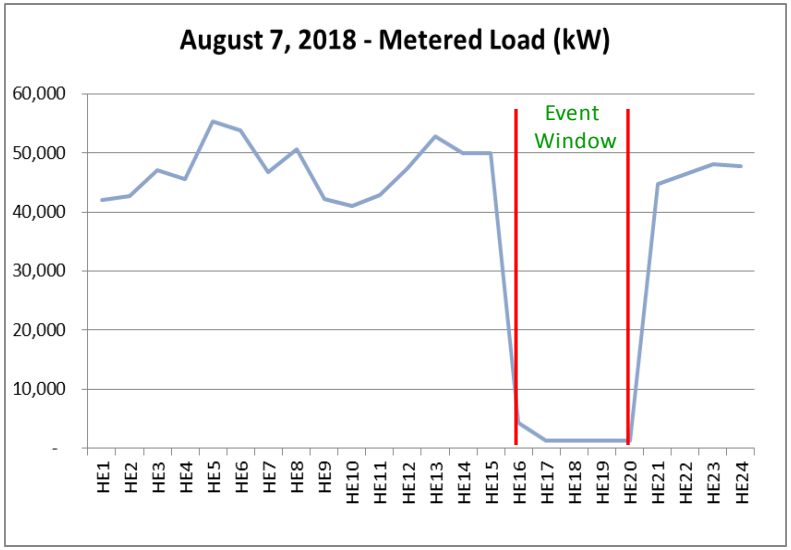


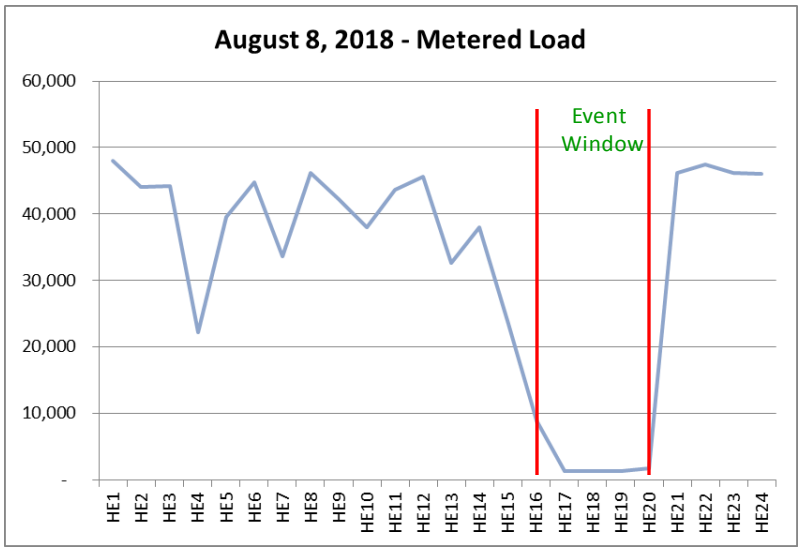
Repeatable results, again SOA summer peak flows were lower with the SOA Pilot than without it!

Load Reduction



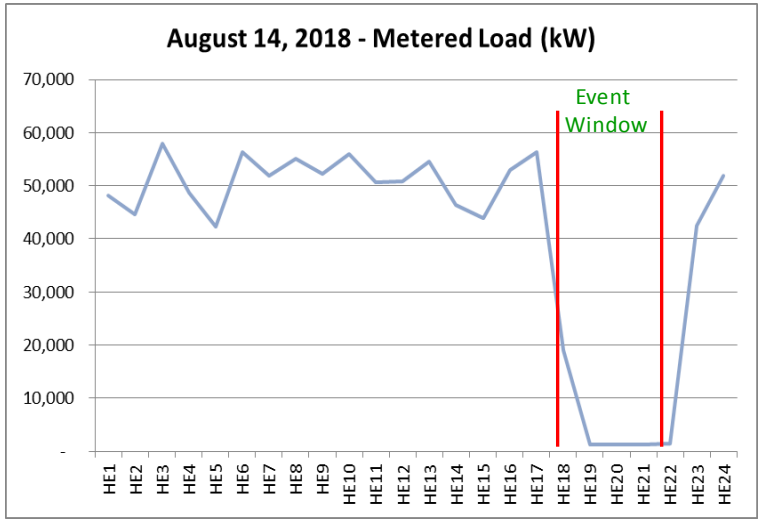


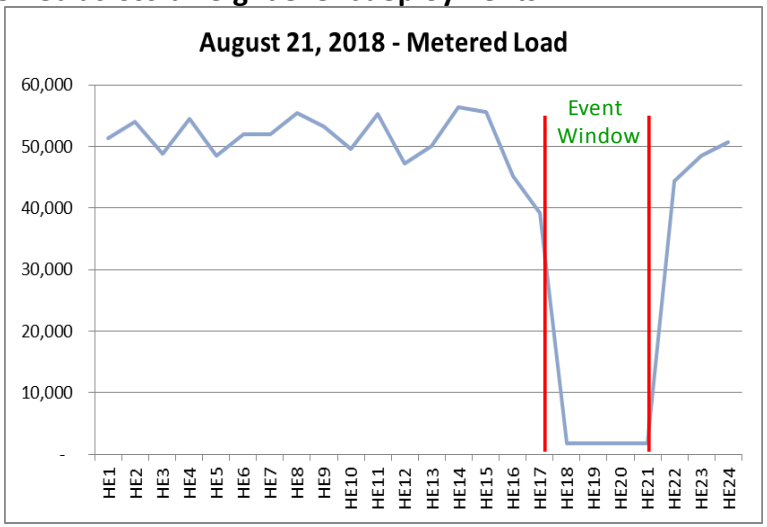


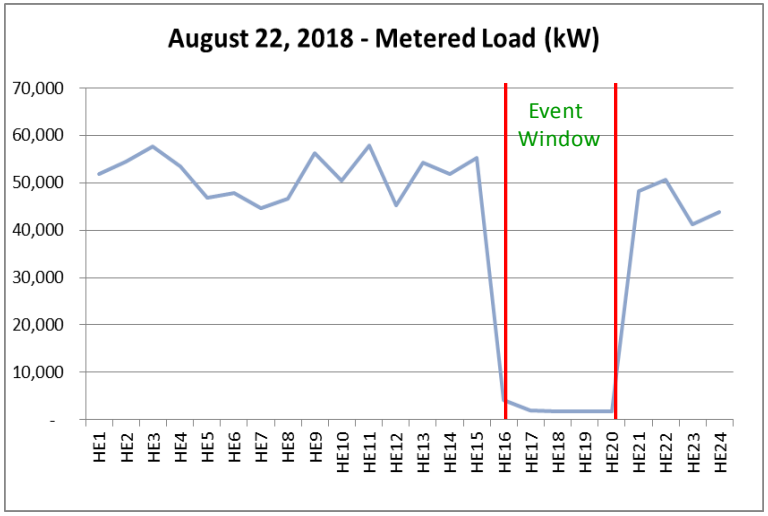


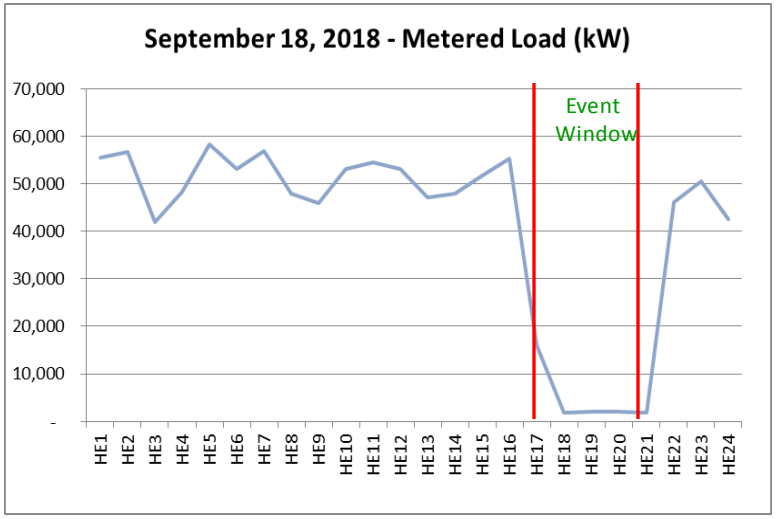
More Load Reduction

Consistent load reduction is observed across all eight event deployments



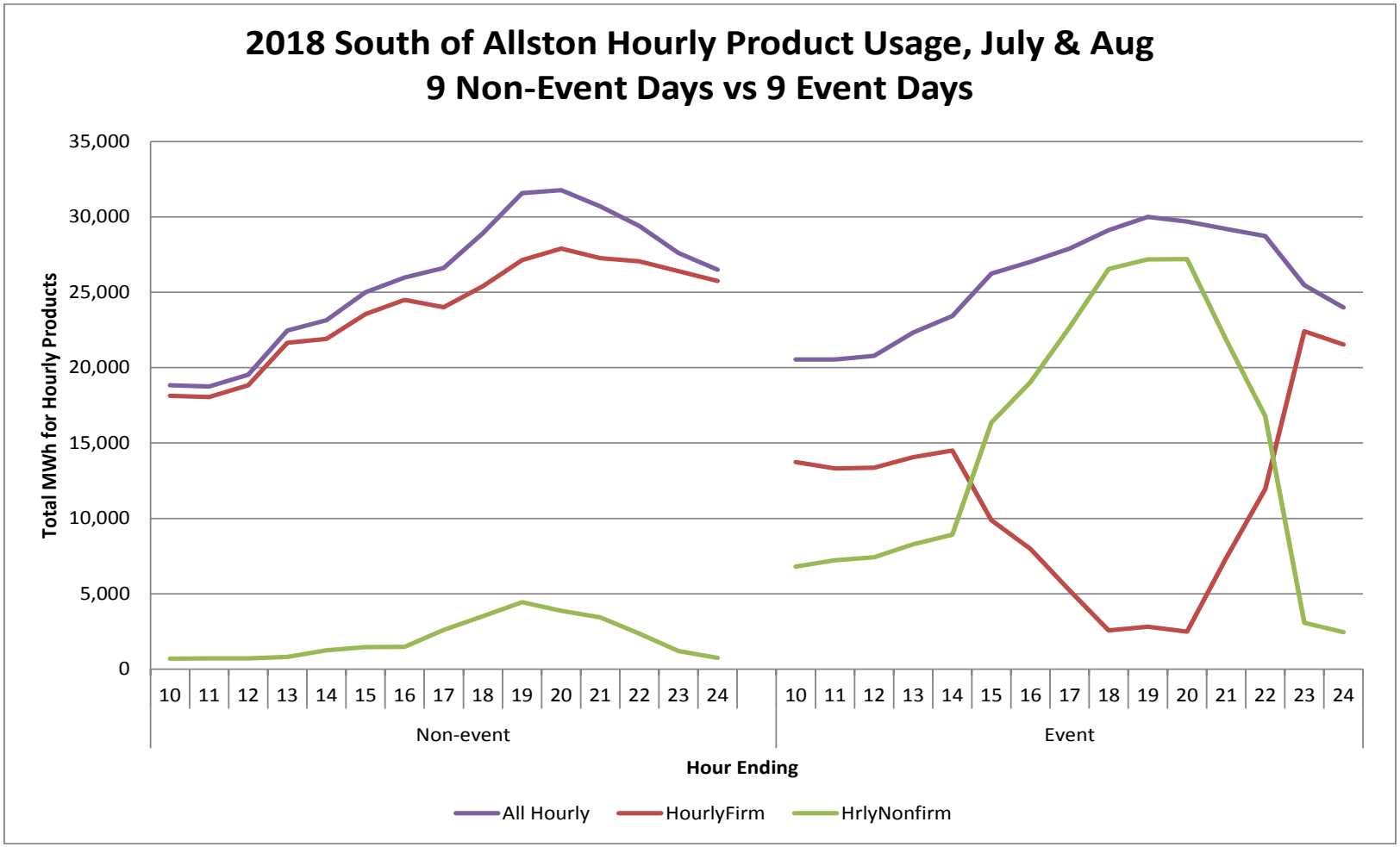






Hourly Product Usage

Similar to Summer 2017, hourly non-firm transactions replaced hourly firm transmission during SOA Pilot events

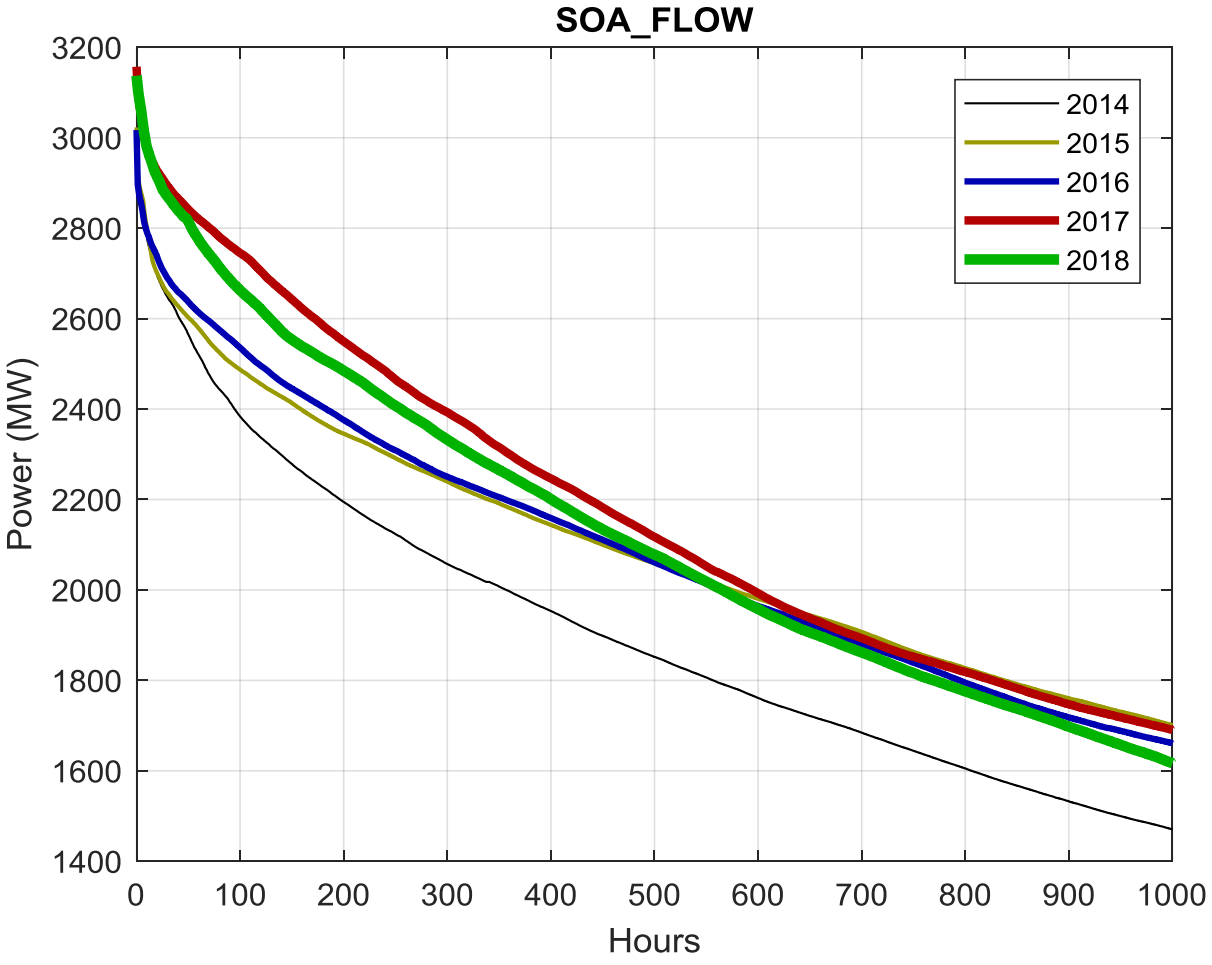


Key Findings

Overall, the SOA Pilot advanced BPA's understanding of how to translate technical requirements into commercial term sheets, how to establish new performance evaluation criteria, and how to develop a new flow prediction model to decide when to deploy a limited hour flow relief non-wires program:

- The all sources Request for Offers (RFO) took far more time and effort to stand up than expected (e.g., contract negotiations)
- Build in more response time for bidders to price multiple offers and for buyer to evaluate multiple offers
- Understand billing system capabilities and options before you sign contracts that you lock you in to the term of the contract
- Plan and budget for internal tool development and system integration
- Relying on a single demand response resource can present a challenge
- Establish data requirements before project starts and data is lost
- Take a year-round holistic view to planning and budgeting (e.g., battery storage)
- Understand the market and response to congestion
- Be prepared to revisit and renegotiate contract terms and conditions (e.g., misused transmission)

South of Allston Flow Persistence Curve

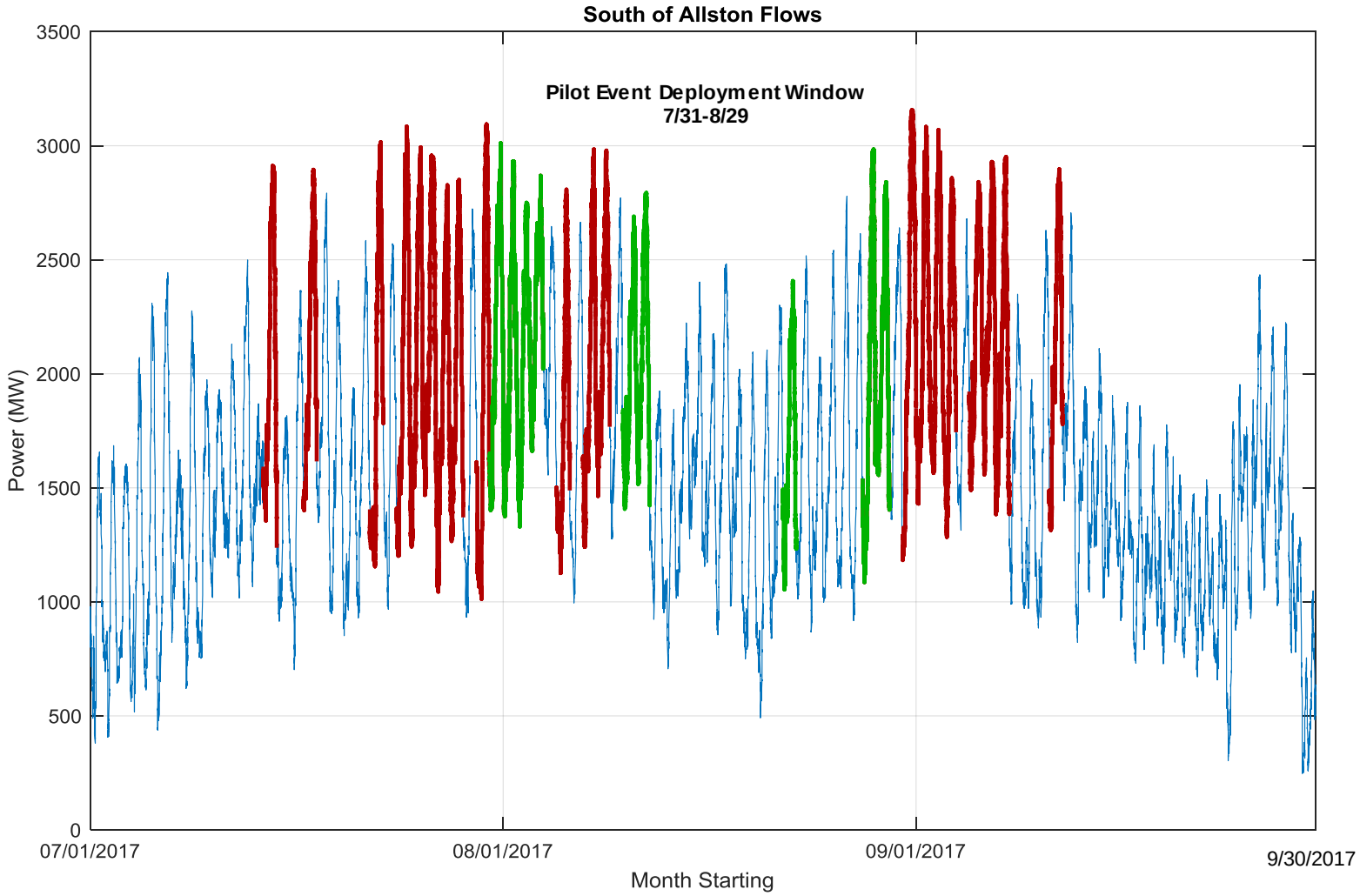


9/30/2017

Flow persistence chart shows more hours of higher SOA flows in 2017 and 2018

SOA Pilot High Flow Days

Red = SOA pilot not deployed (actual flows over 2800MW)
Green = SOA pilot deployed



Summer 2017 highlights the need for more hours of relief needed, should high SOA flows persist in out years

Next Steps

- Determine how non-wire options can be developed in BPA's cluster study and commercial assessment efforts

- Subject to budget and commercial need, the team is planning to stand up a new non-wires program designed to create new transmission inventory options for our customers

- You can find more SOA Pilot information at: https://www.bpa.gov/transmission/CustomerInvolvement/Non-Wire-SOA/Pages/default.aspx

RC Services Transition Overview

Pam Sporborg
Portland General Electric
Transmission Services

Agenda

- Review NDA and discussion parameters
- Key Players: Decoding the Acronym Soup
- Which RC? Reviewing the Results from WECC declarations
- Timeline and Next Steps
- Key Questions:
  - Onboarding
  - Outstanding Issues

Disclaimer

- PGE is a signatory to the CAISO Non-Disclosure agreement for RC Services.
- PGE is not participating in the SPP RC stakeholder working group.
- This presentation will focus on publicly-available information.
- Detailed information, including draft procedures, is available to NDA signatories on CAISO's secure participant portal.
- Information will become publicly available once it has been approved by the RC Project Steering Committee. This includes draft Business Practice Manuals and Procedures.
- This information is expected to become available in late November.

Key Players: The RCs

Key Players: Regulators

WECC WESTERN ELECTRICITY COORDINATING COUNCIL

FERC Federal Energy Regulatory Commission

Western Interstate Energy Board

Key Players: RC Customers

Peak MAC

- Five Customer Classes
- Class 1 and 2 are “funding” classes
- Representatives: **Class 1:** Kristie Cocco (APS); Sarah Edmonds (PGE); Jim Shetler (BANC). **Class 2:** Linda Jacobson-Quinn (Farmington Electric); Chris McDarment (Chelan); Phillip Shafeei (Colorado Springs)

Peak Funding Parties

- Formed to facilitate dialogue among Class 1 and Class 2 Peak funders outside of the Peak governance structure.
- Co-Chairs: Sarah Edmonds (PGE); Jim Shetler (BANC)

RC Customers’ User Group

- Enables discussion independently from any potential RC provider
- Coordinators: Chris McDarment; Kristie Cocco

Reliability Coordinator Project Steering Committee

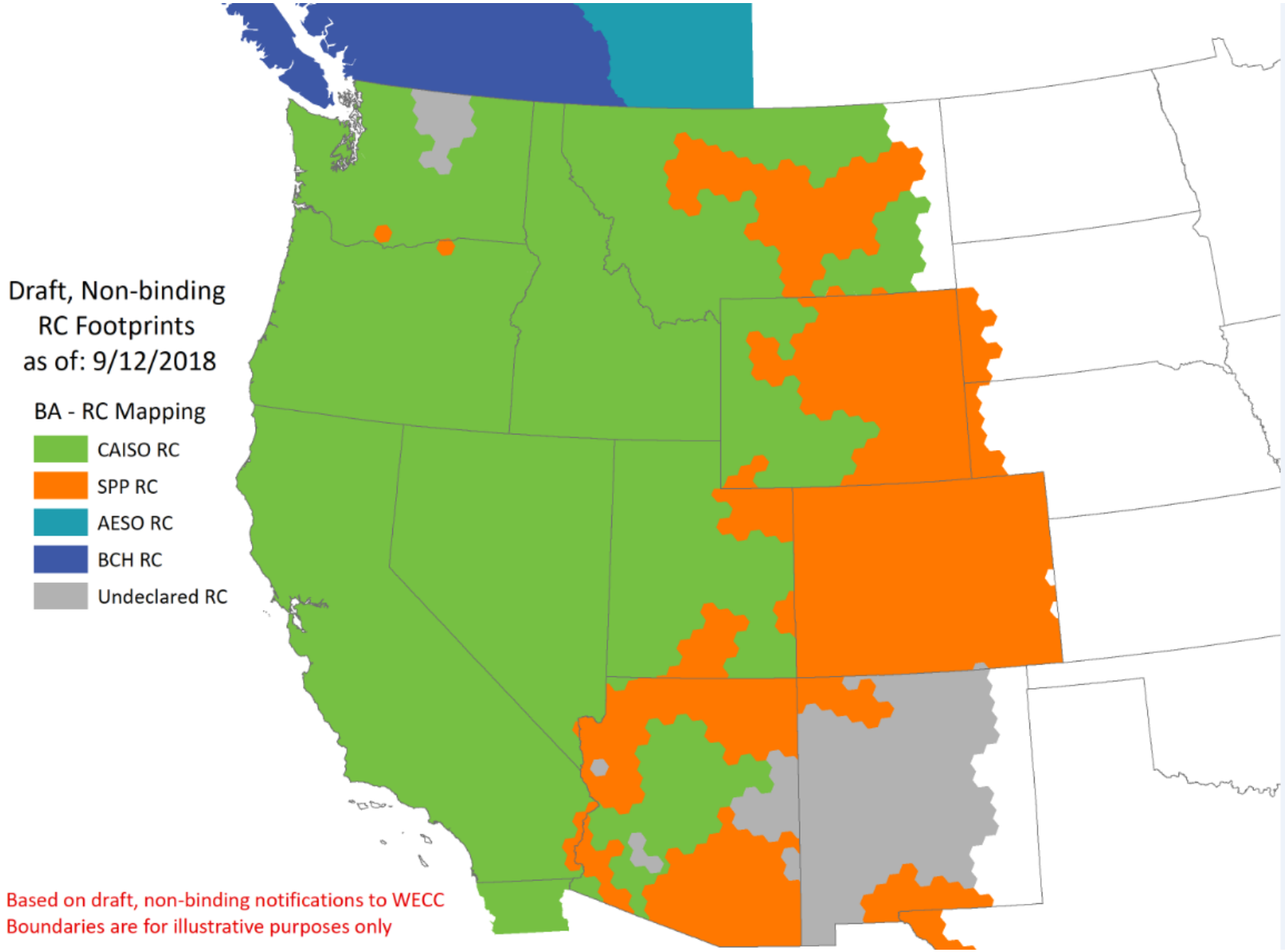
- Provides oversight for the CAISO NDA signatories’ Working Groups in order ensure sufficient guidance and resources have been provided to support critical activities.
- Co-Chairs: Michelle Cathcart (BPA); Steve Cobb (SRP)

Western Reliability Working Group

- SPP forum for RC Customers and other stakeholders

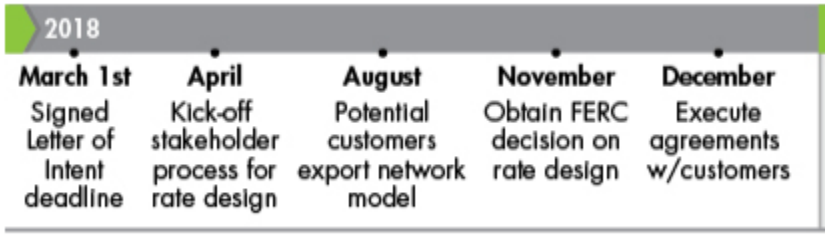
RC Transition Coordination Group

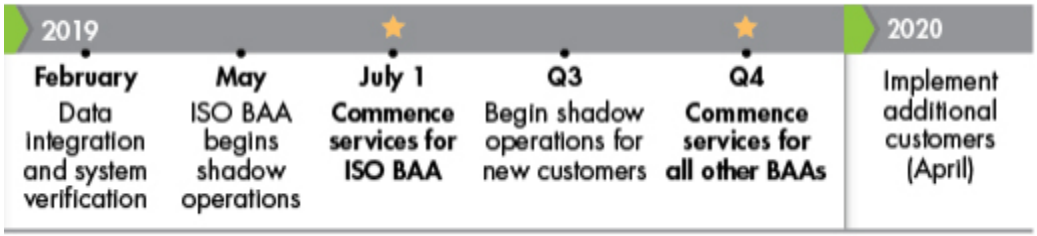
- Created at the recommendation of WEIL to represent the interests of BA/TOPs during the RC transition period.
- Coordinate with the RC to RC coordinating group.
- Representatives from existing RC Customer coordinating groups


Draft, Non-binding
RC Footprints
as of: 9/12/2018
BA - RC Mapping
CAISO RC
SPP RC
AESO RC
BCH RC
Undeclared RC
Based on draft, non-binding notifications to WECC
Boundaries are for illustrative purposes only

Timeline for CAISO RC Transition

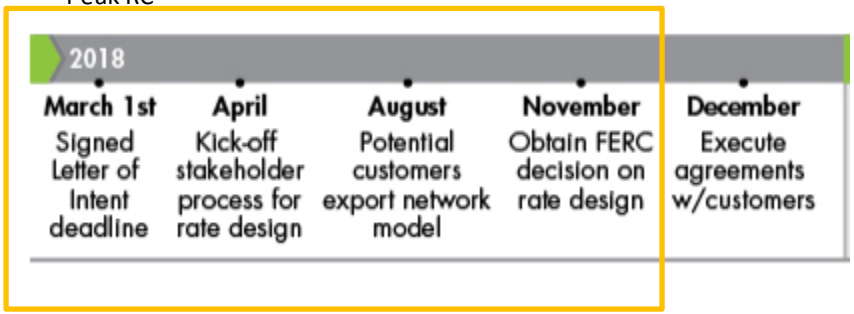
2017		2018		
November	**December**	**January**	**March**	**July**
SPP and MWTG indicate withdrawl from Peak RC beginning Deceber, 2019	Peak and PJM announce partnership for market and reliability services	CAISO Announces Plans to become an RC	Majority of BA/TOPs submit non-binding notice of withdrawl to Peak RC	Peak announces decision on wind-down

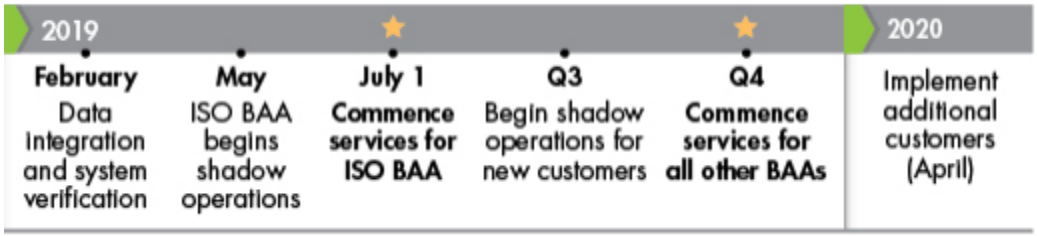




Timeline for CAISO RC Transition

2017		2018		
November	**December**	**January**	**March**	**July**
SPP and MWTG indicate withdrawl from Peak RC beginning Deceber, 2019	Peak and PJM announce partnership for market and reliability services	CAISO Announces Plans to become an RC	Majority of BA/TOPs submit non-binding notice of withdrawl to Peak RC	Peak announces decision on wind-down





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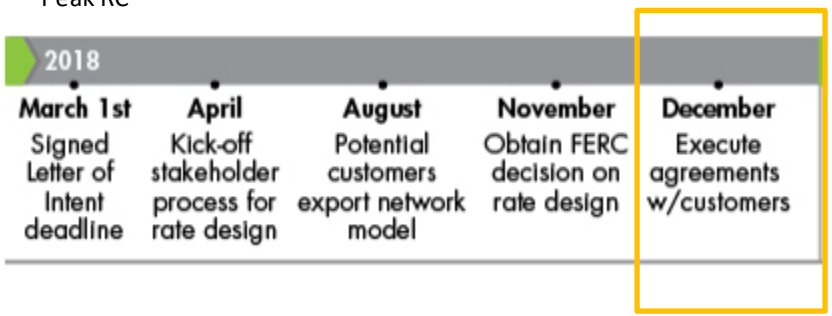
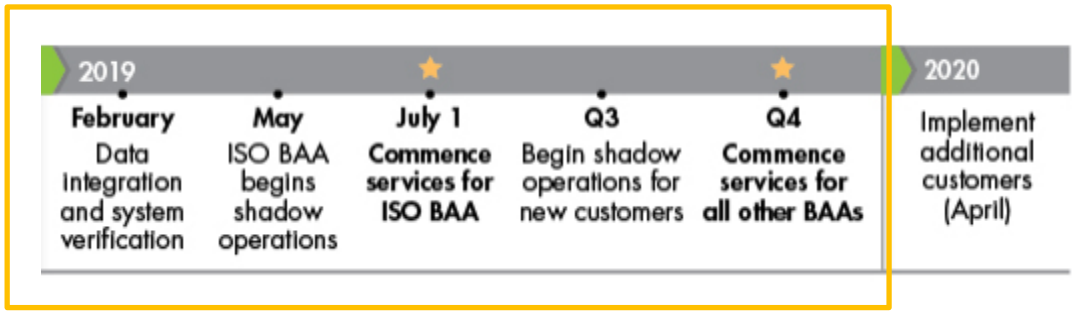




CAISO RC Customer Onboarding

- Data Sharing
- Outage Management
- Full Network Model
- Training

Outstanding Questions

- RC Governance/Oversight
- Seams Coordination
- Universal Data Sharing Agreement
- RC Cost Allocation
- WECC RC Footprint Certification
- Peak Wind-Down

Krish Reed
Real-Time Trader
October 24, 2019

Balancing Authority Implementation

Evolution of the Avangrid Balancing Authority (BA)

- Avangrid has a **1,300 MW** wind fleet located in the Bonneville Power Administration (BPA) service territory as well as **10** MW's of solar with more on the way.

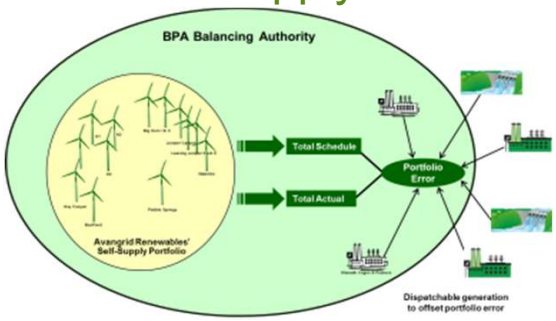
- *In 2008 BPA implemented a Wind Integration Charge (WIC) in response to rapid wind development*
- *Iberdrola negotiated with BPA the "self-supply" option to take responsibility for balancing wind*
- *The existing Self Supply program will no longer be viable and may be discontinued by Bonneville Power Administration*

- October 2010, the Self-Supply program was launched
- Self Supply has provided considerable benefits
- July 31st, 2018 Avangrid 's BA went live
  - Independent, Renewable, Generation-Only BA

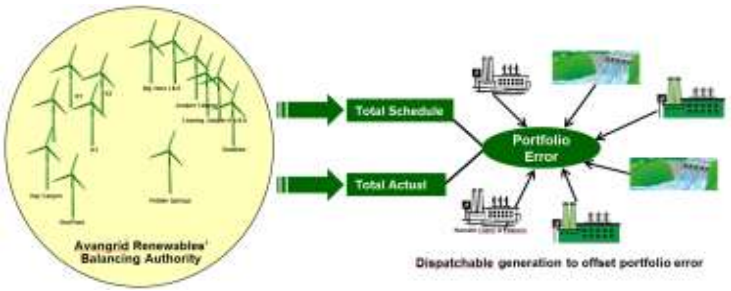
Why a Balancing Authority

- Eliminate long term uncertainty of integration costs
  - No longer subject to questions concerning the Self-Supply program
- Improved operational flexibility
  - No longer subject to OCBR, OMP, or decreased magnitude of curtailments due to transmission
- Cost savings
  - No longer subject to cost of VERBS, Intentional Deviation, Imbalance, OCBR or OMP
- Greater access to a number of market structures available only to a BA
  - Including capacity, reserve sharing and ADI
- Increased opportunity for growth

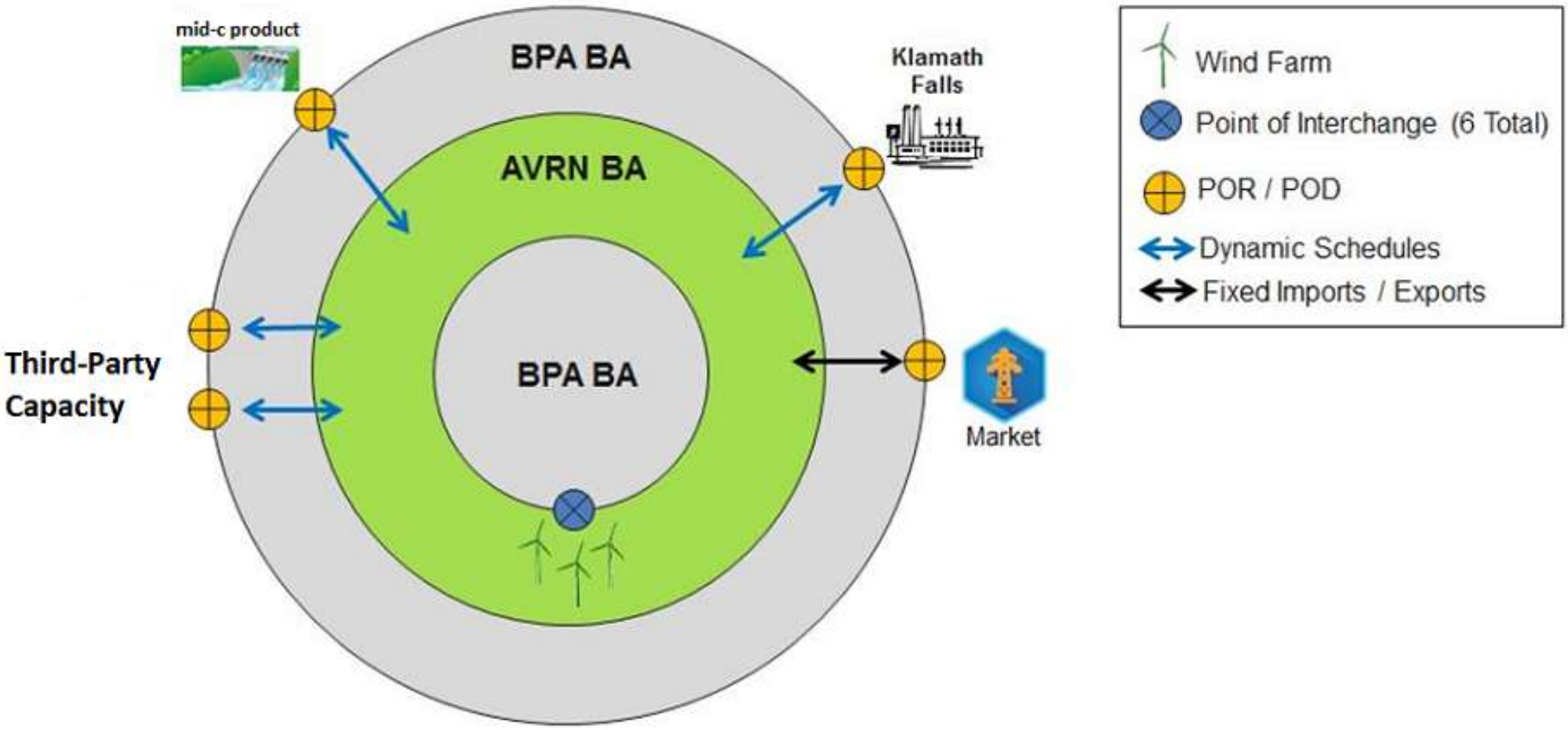
Self-Supply



AVRN BA



Avangrid: A BA with in a BA



Implementation Basics

- Managing Schedule Control Error (SCE) vs. Managing Area Control Error (ACE)
- Managing Contingency Reserves
- Operational Changes in the Nation Control Center
- Effects on Balancing the Wind Portfolio/ Asset Optimization
- Forecasting
- Scope of Implementation

Managing Area Control Error (ACE) vs. Scheduling Control Error (SCE)

- For both, we are basically managing the difference between generation and exports (demand)
  - In Self-Supply, when managing the SCE, we had access to BPA Reserves
    - Paid for Regulating and Following
    - This gave us some amount of flexibility when managing our error
  - As a BA managing an ACE, we no longer have access to BPA Reserves
    - Gained access to ACE Diversity Interchange (ADI) and NWPP Reserve Sharing Group
    - Gained access to varied balancing options
  - Greater Coordination between the National Control Center (responsible for reliability) and the Avangrid Merchant side

Managing ACE vs. SCE cont.

- When managing ACE we are now subject to BAL-001-2
  - Requires incremental and decremental capacity to keep frequency near or at 60 Hz
  - States that BAA ACE cannot fall outside of the Balancing Authority ACE Limit (BAAL) for more than 30 Consecutive minutes
    - Occurs when ACE and frequency remain on the ‘same side’ and ACE is outside of the BAAL.

Managing ACE vs. SCE cont.

- Meant to insure that BA does not have a significant negative impact on system frequency for an extended period of time.
- Under BAL-001-2 we're also subject to Control Performance Standard 1 (CPS1)
  - A rolling yearly standard that measures the impact on frequency error with a 100% minimum allowable score
  - CPS1 assigns each control area a share of the responsibility for control of interconnection frequency
    - Insures the BAA is generally helping frequency over time

Managing Contingency Reserves (CR)

- As a BA we are subject to BAL-002 (Disturbance Control Standard)
  - We are now required to carry a percentage of our generating capacity on spin or non-spin reserves
  - CRs must be carried on a resource that is capable or responding to disturbance within 10 minutes
  - Since wind generation is variable, we must closely monitor generation vs. tagged CRs
    - As on-line generation within the BA increases so does the amount of tagged CRs necessary to satisfy our Reserve Sharing obligation

Operation Changes – National Control Center (NCC)

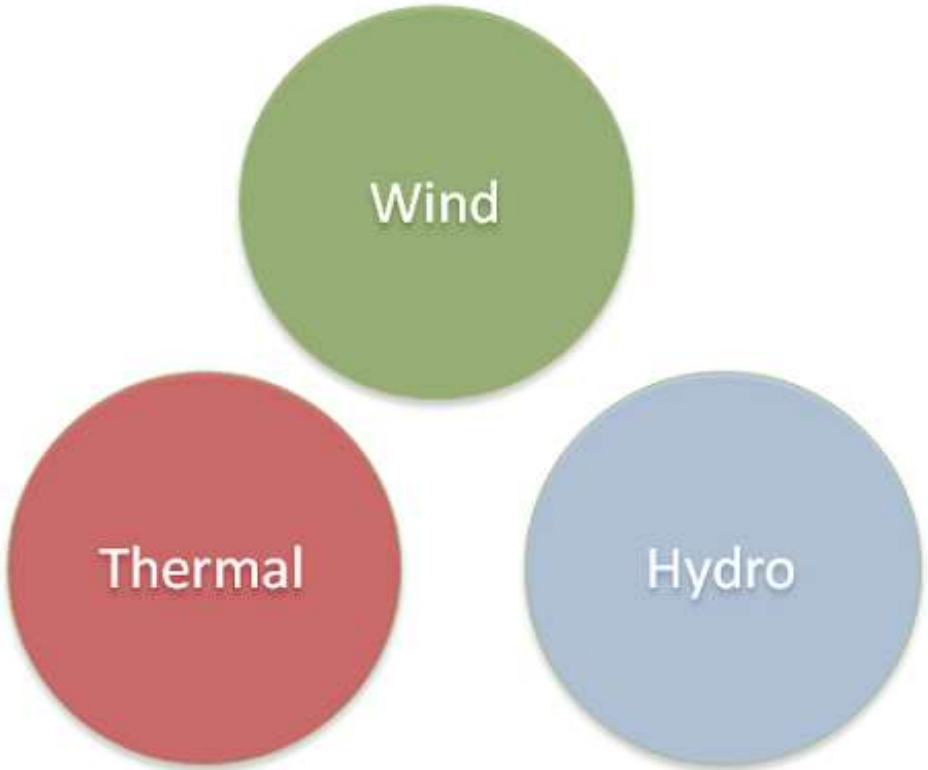
- The NCC is now a reliability authority with new NERC standards it must comply with
  - Increased security requirements and access restrictions
  - Tag authority approver and issue curtailments for reliability
  - Issue directives if necessary to maintain reliability
  - NERC defines 34 separate functions that a BA operator is required to perform
- The Self-Supply desk was converted into the Avangrid BA desk, staffed with NERC certified dispatchers
  - Primary job functions include:
    - Comply with all applicable NERC standards and take whatever actions necessary to achieve compliance
    - Maintain acceptable ACE
    - Coordinate with the Reliability Coordinator (Peak RC)
    - Approve tags and issue curtailments
    - Dispatch Avangrid generation
    - Deploy and call on contingency reserves from the NWPP
    - Maintain sufficient regulating, frequency responsive, and contingency reserve levels

Effects on Balancing the Wind Portfolio / Asset Optimization DA

Day ahead decision based on …

- Wind forecasted volatility
- Hydro opportunity cost
- KF gas and power prices

… to decide how much Wind, Thermal and Hydro to schedule and how much INC/DEC reserves to leave for real time



Effects on Balancing the Wind Portfolio / Asset Optimization DA

- TOP-002 R4: Each Balancing Authority shall have an Operating Plan(s) for the next-day that addresses:
  - Expected generation resource commitment and dispatch
  - Interchange Scheduling
  - Capacity and Energy reserve requirements, including deliverability capability

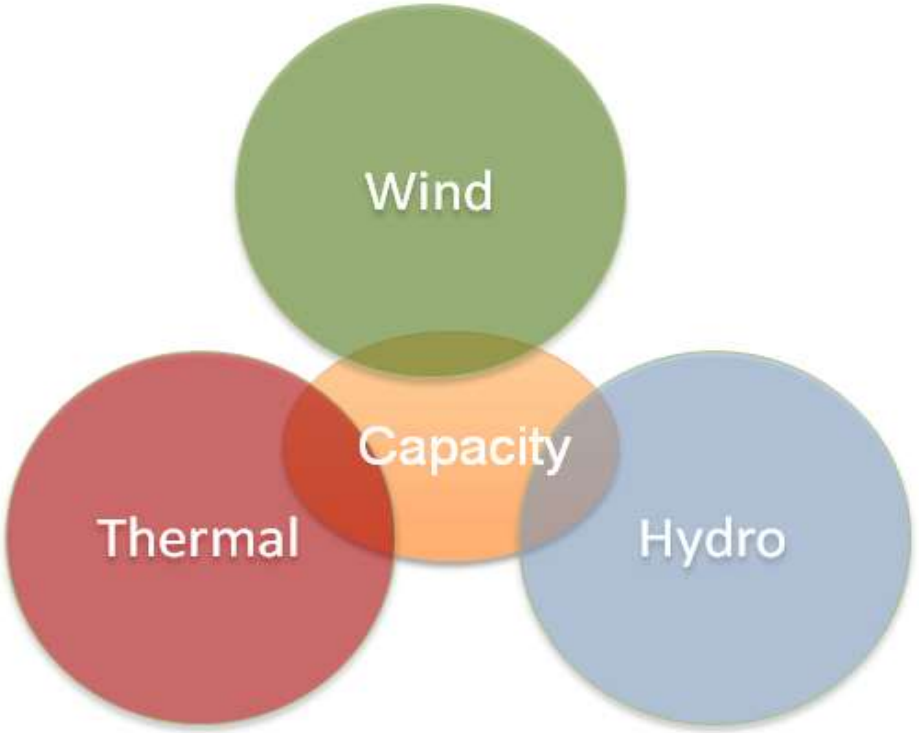
- EOP-011-1 R2: Each Balancing Authority shall develop, maintain, and implement one or more Reliability Coordinator-reviewed Operating Plan(s) to mitigate Capacity Emergencies and Energy Emergencies within its Balancing Authority Area

Effects on Balancing the Wind Portfolio / Asset Optimization DA

Day ahead decision based on …

- Wind forecasted volatility
- Hydro opportunity cost
- KF gas and power prices
- Capacity needed to cover forecasted wind min and max
- Communication with NCC

… *to decide* how much Wind, Thermal and Hydro to schedule and how much INC/DEC reserves to leave for real time

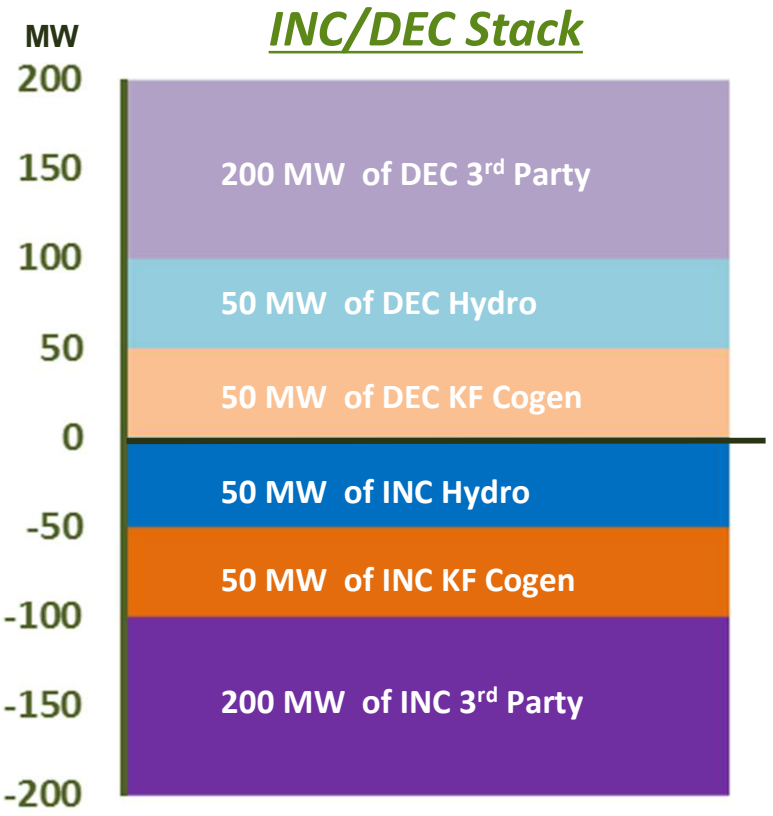


Effects on Balancing the Wind Portfolio / Asset Optimization RT

Real time decision based on…

- Higher certainty around forecast
- Adjustments to wind, hydro and Klamath schedules
- 3rd party INC/DEC reserves
- Pricing components

… to set a stack of INC/DEC resources for the NCC to adjust position



Effects on Balancing the Wind Portfolio / Asset Optimization RT

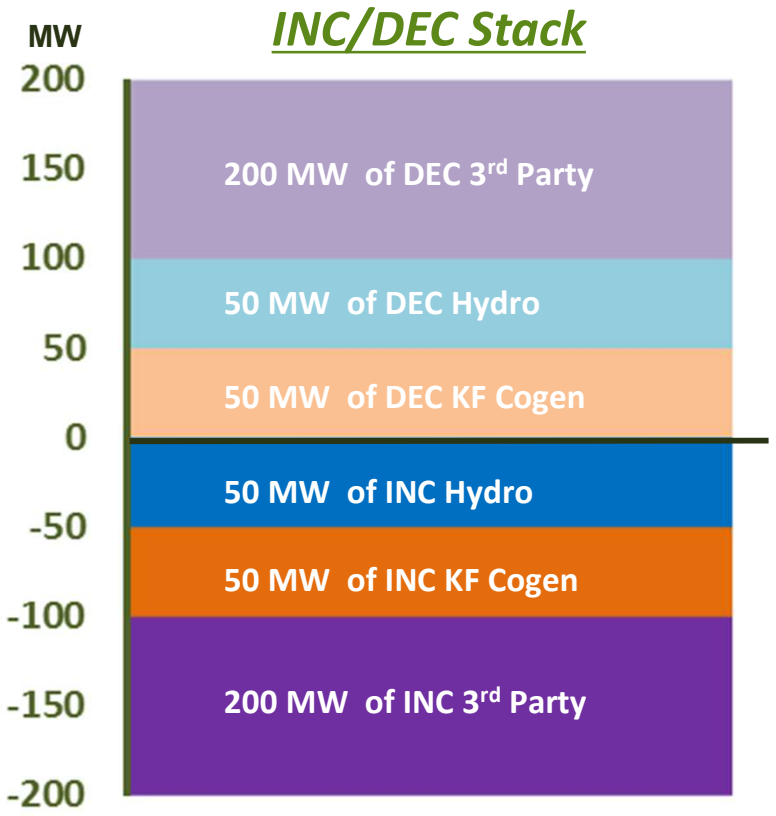
- The NCC must have operational awareness and capability on a RT basis in order to ensure operational reliability and to mitigate Capacity Emergencies and Energy Emergencies within the Balancing Authority Area
- Increased coordination between the NCC and RT
- Three-way communication

Effects on Balancing the Wind Portfolio / Asset Optimization RT

Real time decision based on…

- Wind Volatility
- Inra-hour market
- Higher certainty around forecast
- Adjustments to wind, hydro and Klamath schedules
- **3rd party INC/DEC reserves**
- Pricing Components

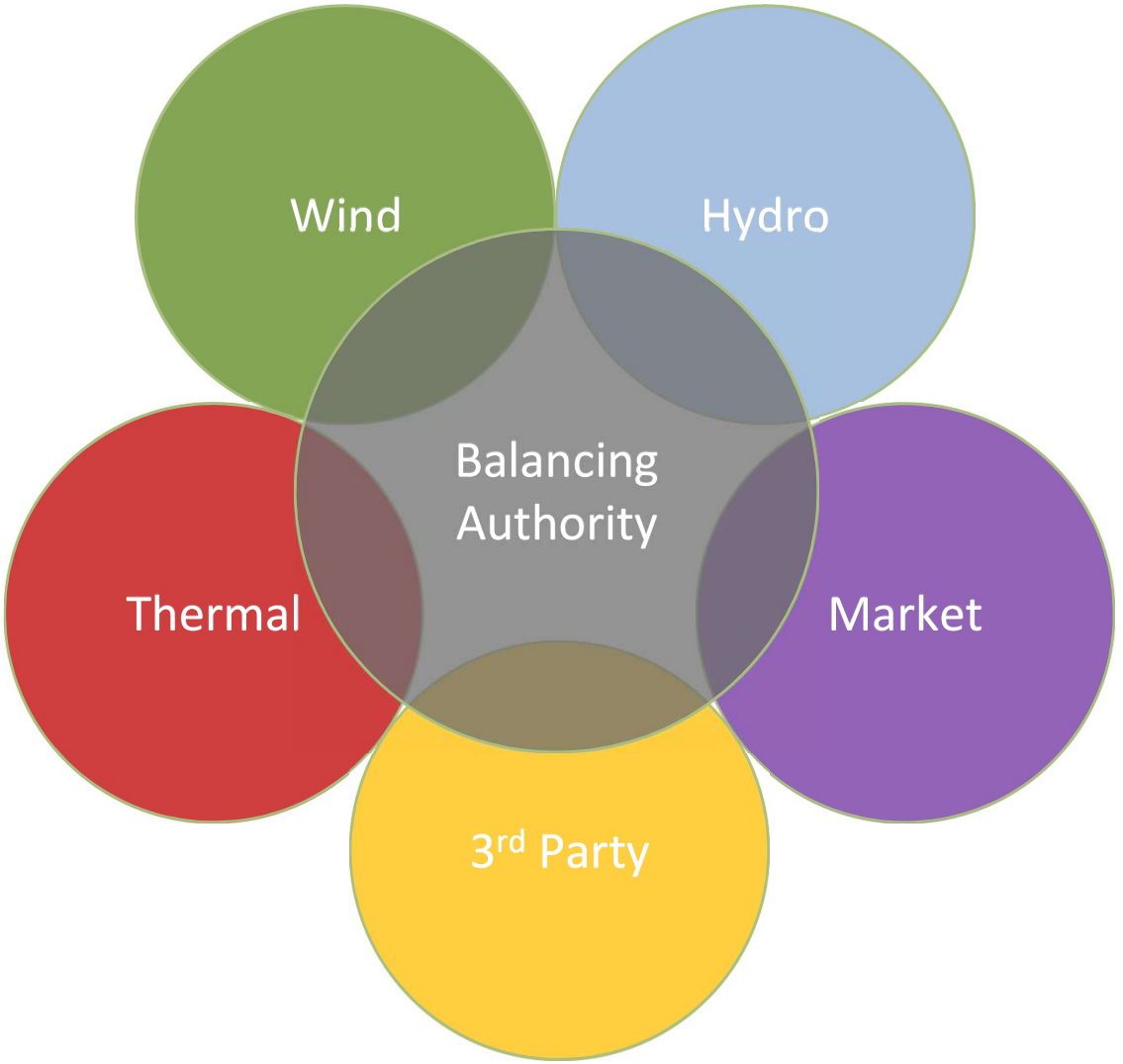
… to set a stack of INC/DEC resources for the NCC to adjust position



Effects on Balancing the Wind Portfolio / Asset Optimization RT

Tools for RT

- VER Imports
- Improved access to 3rd party counterparties
- Reduced restrictions for on-demand capacity
- Sinking to the BA
- Sub hour sales/purchases



Forecasting

- Avangrid has a round the clock forecasting desk
- Provide hourly and sub-hourly evaluation of assets
  - Confidence in forecast
  - Volatility information
- Use publicly available information as well as a number of proprietary met stations in key locations

Scope of Implementation

- Internally
  - Around 20 different departments within Avangrid
    - From the CEO to Operations to compliance to networking
  - Added communications system
  - Expansion to EMS system
  - Several new interchange sites added, new meters and integration with satellite backup and frequency measurement
  - Addition of new OATI products
  - Expansion of Pi and other measurement programs
  - Addition of new POR/POD's
  - Improved CORE SCADA
- Externally
  - BPA
    - Avangrid coordinated with several different departments
  - GridForce
    - Close coordination with around 6 departments
  - Counterparties

Anticipated Benefits

- Improved operational flexibility in how we schedule, manage and balance the wind
- Access to a greater number of market structures that can only be utilized as a BA
- Long term integration cost certainty, enabling the company to provide improved service
- Decreased exposer to cost causing policies
- A platform for growth through services to customers, 3rd parties and load serving entities
- No tag replacement within the BA!

Peak Reliability Update

NWPP After the Fact and System Schedulers Meeting

PEAKRELIABILITY
assuring the wide area view

Topics

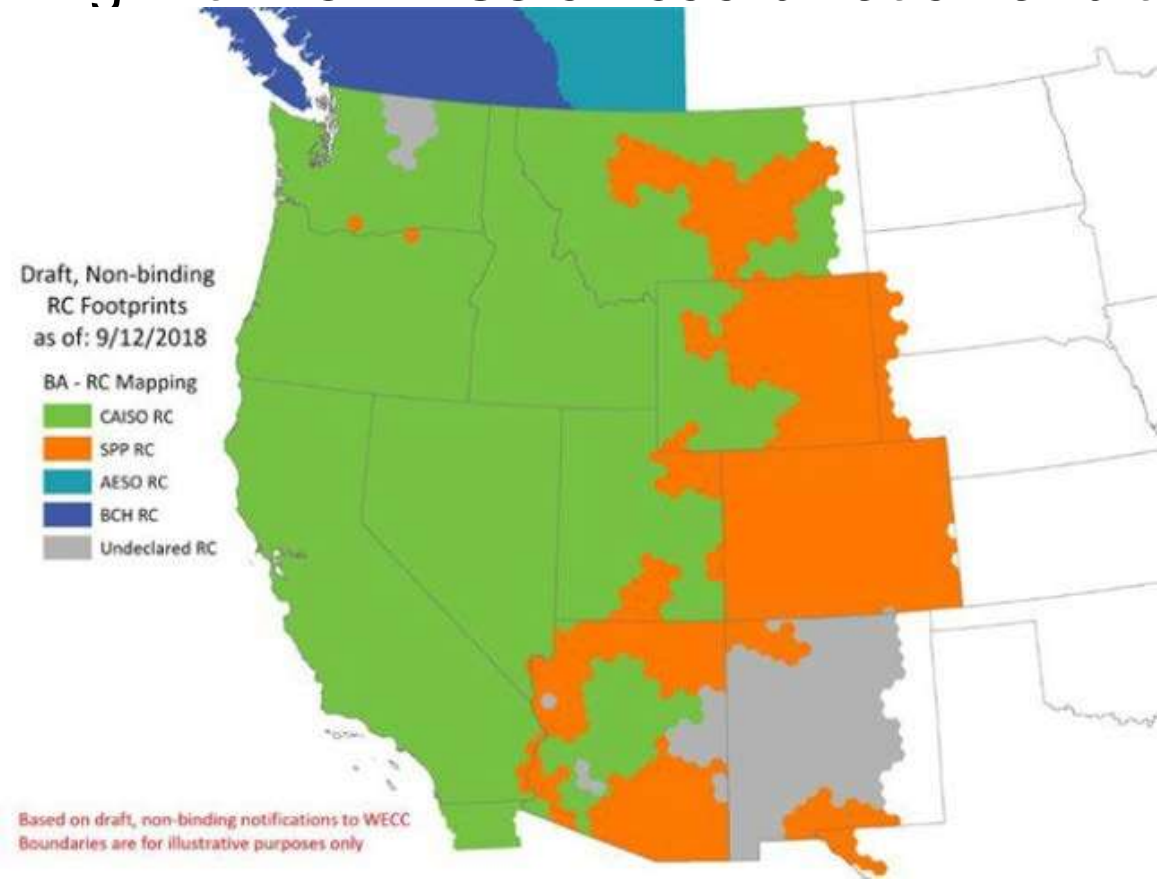
- Peak Wind Down
- ECC Update
- WIT Update
  - BAL-004-WECC-3
  - WIT Dispute Resolution

Peak Wind Down

- Peak will cease operations as Reliability Coordinator in late 2019
- Decision based on feedback from Peak funders
  - Cost
  - Governance

Peak Wind Down

- Peak working with new RCs on coordination and transfer



PEAKRELIABILITY

RC Startup Schedule (tentative)

- July 1, 2019 - CAISO RC (including CAISO, CENACE, LADWP, BANC and TID BAs)
- September 2, 2019 – BC Hydro RC
- November 1, 2019 – CAISO expanded footprint
- December 1, 2019 – SPP

ECC Update

- Peak currently holds contract for Enhanced Curtailment Calculator (ECC)
  - Product known as OATI webIntegrity
- Tool provides:
  - Unscheduled Flow Mitigation Plan
  - Pre- and post-contingency situational awareness

ECC Update

Transition Plan:

1. Peak will continue to hold contract and provide ECC inputs through 2019
2. Working with OATI to change ECC to support multiple RCs prior to CAISO transition 7/1/19
   - Supports UFMP with CAISO as RC for Path 66
3. ECC will change to be integrated with CAISO EMS inputs Q4 2019

WIT Update

- Peak current holds contract to WECC Interchange Tool (WIT) and serves as administrator

- Tool provides:
  - Schedule and Actual Checkout
  - Inadvertent Interchange Accounting
  - Automatic Time Error Calculation

WIT Update

Transition Plan:

1. Peak will continue to hold contract and provide administration through 2019
2. Peak working with RCs to determine future contract holder(s)
   - Options: One RC, Multiple RCs, BAs
3. RCs looking for feedback from BAs

BAL-004 WECC-3

Effective date: October 1, 2018

B. Requirements and Measures

R1. Each Balancing Authority shall operate its system such that, following the conclusion of each month, the month-end absolute value of its On-Peak and Off-Peak, Accumulated Primary Inadvertent Interchange (PII_{accum}), as calculated by the WECC Interchange Tool (WIT) or its successor electronic confirmation tool, are each individually less than or equal to: *[Violation Risk Factor Medium:] [Time Horizon: Operations Assessment]*

PEAKRELIABILITY

WIT Dispute Resolution

- Peak works with WECC After the Fact Working Group (under WECC ISAS) on checkout dispute resolution
- Required to balance Interchange prior to Inadvertent Interchange submittal to NERC CERTS

Please remember to send all WIT Change Request Forms to the disputereports@peakrc.com

Questions

April Freeman
afreeman@peakrc.com
360-448-2668

Tamela Keith
tkeith@peakrc.com
360-213-2334

Fuel Supply Resiliency: A Hydro System Perspective

Tony Klement
Scott Winner

Bonneville Power Administration
10/24/18

Overview

- Background on “Resiliency”
- Overview of the FCRPS
- Fuel (Water) Management of the FCRPS

DOE Proposed Rule, Sep 2017

- Secretary Perry submitted a Proposed Rule directing FERC to consider requiring RTOs and ISOs to update tariffs that would require the purchase and cost recovery from “resilient resources”
  - i.e. resources with a 90 day on site fuel supply
    - Coal and Nuclear, specifically

DOE Proposal states:

- The resiliency of the nation's electric grid is threatened by the premature retirements of power plants that can withstand major fuel supply disruptions caused by natural or man-made disasters and, in those critical times, continue to provide electric energy, capacity, and essential grid reliability services.

FERC response, RM18-1-000

- Jan 2018, the Commission responded by siting Orders 888 and 2000 that paved the way for the formation of RTOs, ISOs and open markets.
- Also sited were Orders 890 and 719 that provide detail in the benefits to consumers of competitive wholesale energy market.
- Basically, no: FERC can not go against existing Orders and force consumer to buy higher priced energy. Docket closed.
  - However, FERC acknowledged that “Resilience” is a concept worth further exploration

FERC's own words

- The North American electric power system is undergoing a rapid and significant transformation with ongoing retirements of fossil-fired and nuclear capacity, as well as growth in natural gas, wind, and solar resources. This shift is caused by several drivers, such as federal, state, and provincial policies, low natural gas prices, electricity market forces, and integration of both distributed and utility scale renewable resources. The changing resource mix is altering the operating characteristics of the bulk power system (BPS). These changing characteristics must be well understood and properly managed in order to assure continued reliability and ensure resiliency. [16]

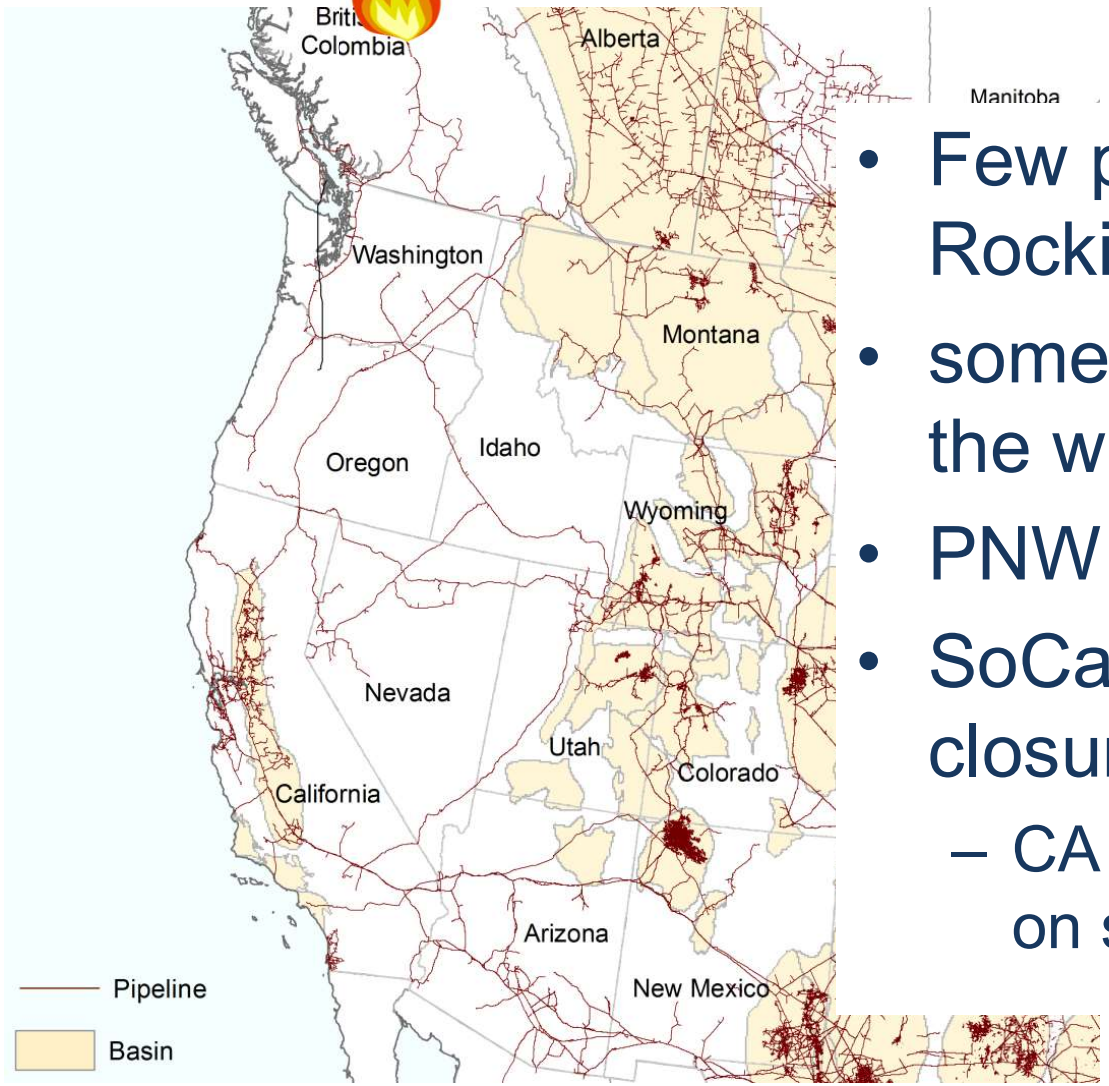
FERC, AD18-7-000

- With the closure of RM18, FERC opened a new Docket (AD18) to further investigate the concept of "Resilience"
- RTOs and ISOs we instructed to answer a number of question, due in Mar 2018
- Interested Parties were also invited to submit comments, due May 2018.
  - NERC responded by providing a list of Standard already in existence that address "resilience"
- FERC has not yet responded.

What have we learn

- You can't undo 20 years of market development with a single memo
  - Rick Perry does not have the political clout to make this happen
- A suite of Standards are already in place that address resiliency of the grid and load service
- But, there is a new focus on the link between fuel supply and power generation and is the fuel supply chain resilient?

Natural Gas Pipeline System: WECC report



- Few pipes cross the Rockies, 75%
- some vulnerabilities in the west
- PNW is in good shape
- SoCal is in a N-1 with the closure of Aliso Canyon
  - CA regulators are working on solutions

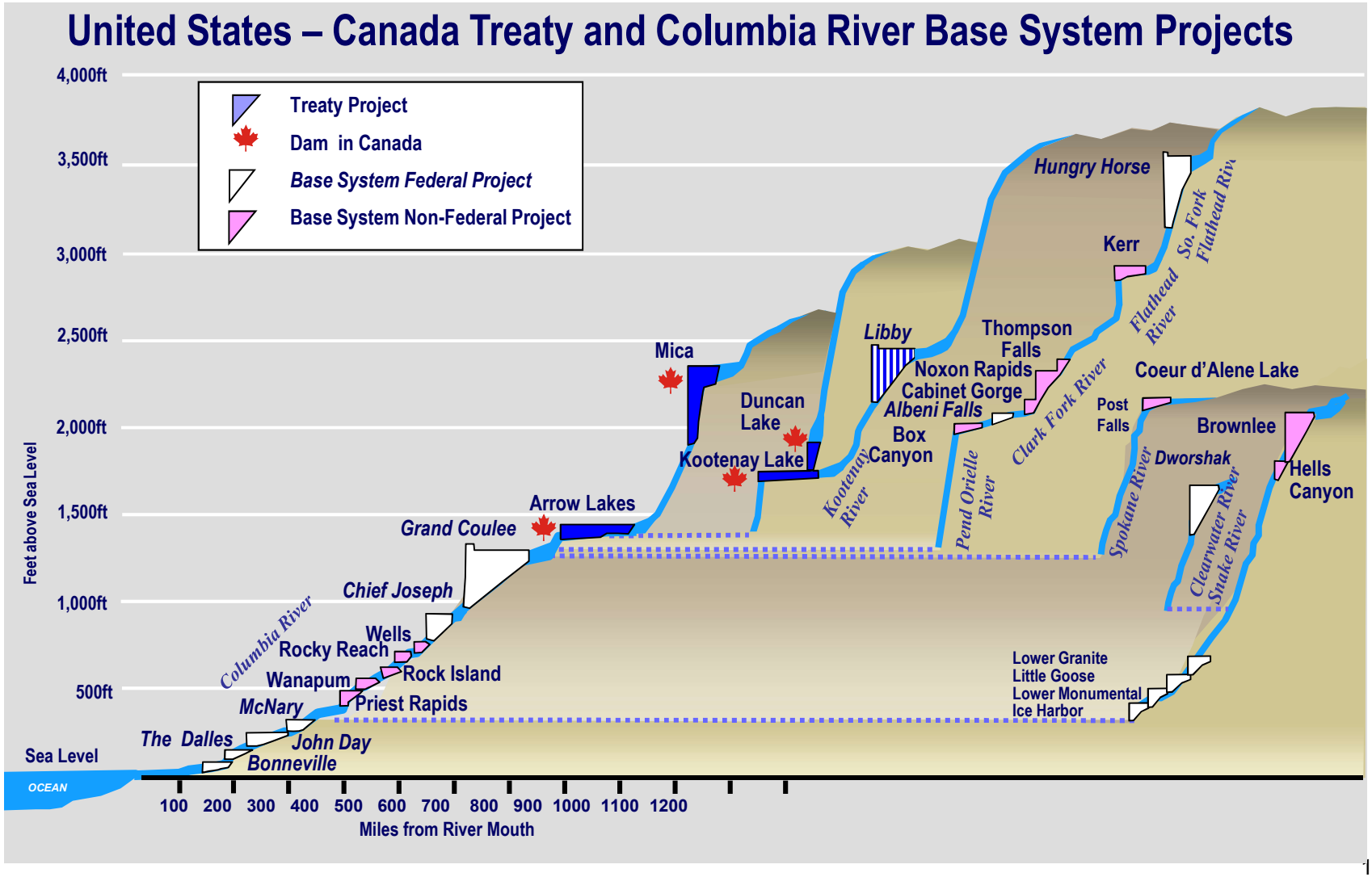
Topology of the PNW

- 260K sq. mile drainage basin
- 100 MAF per year
  - 33 trillion gal
- Temperate rain forest and high desert

Federal Columbia River Power System FCRPS

- 31 federal hydro project, 1 nuclear plant, handful of renewable projects; biomass and wind
  - Federal projects are operated by the USACE & BOR and dispatched by BPA
- Capacity over 22,000 MW
  - 6,480 MW at GCL
  - 1,500 KW at Boise Diversion
- Hydro represents 50% of the PNW power supply
- FCRTS
  - 15,000 miles, 300 substations, 160 customers, 75% of the PNW transmission system

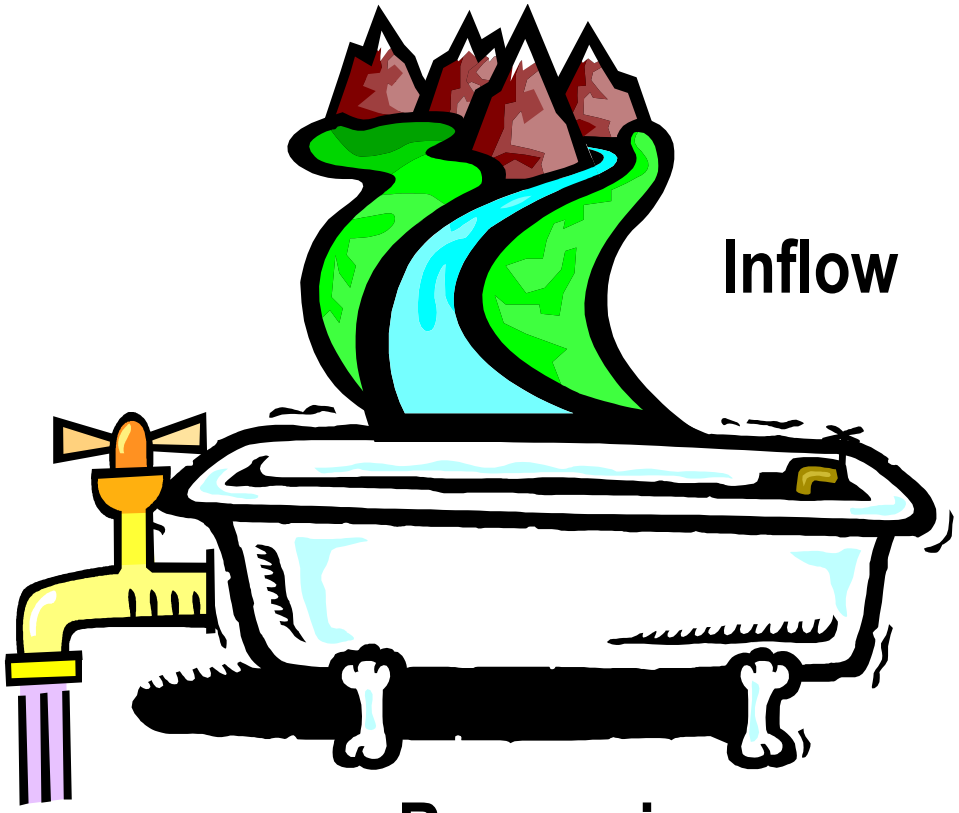
Interconnected hydro system



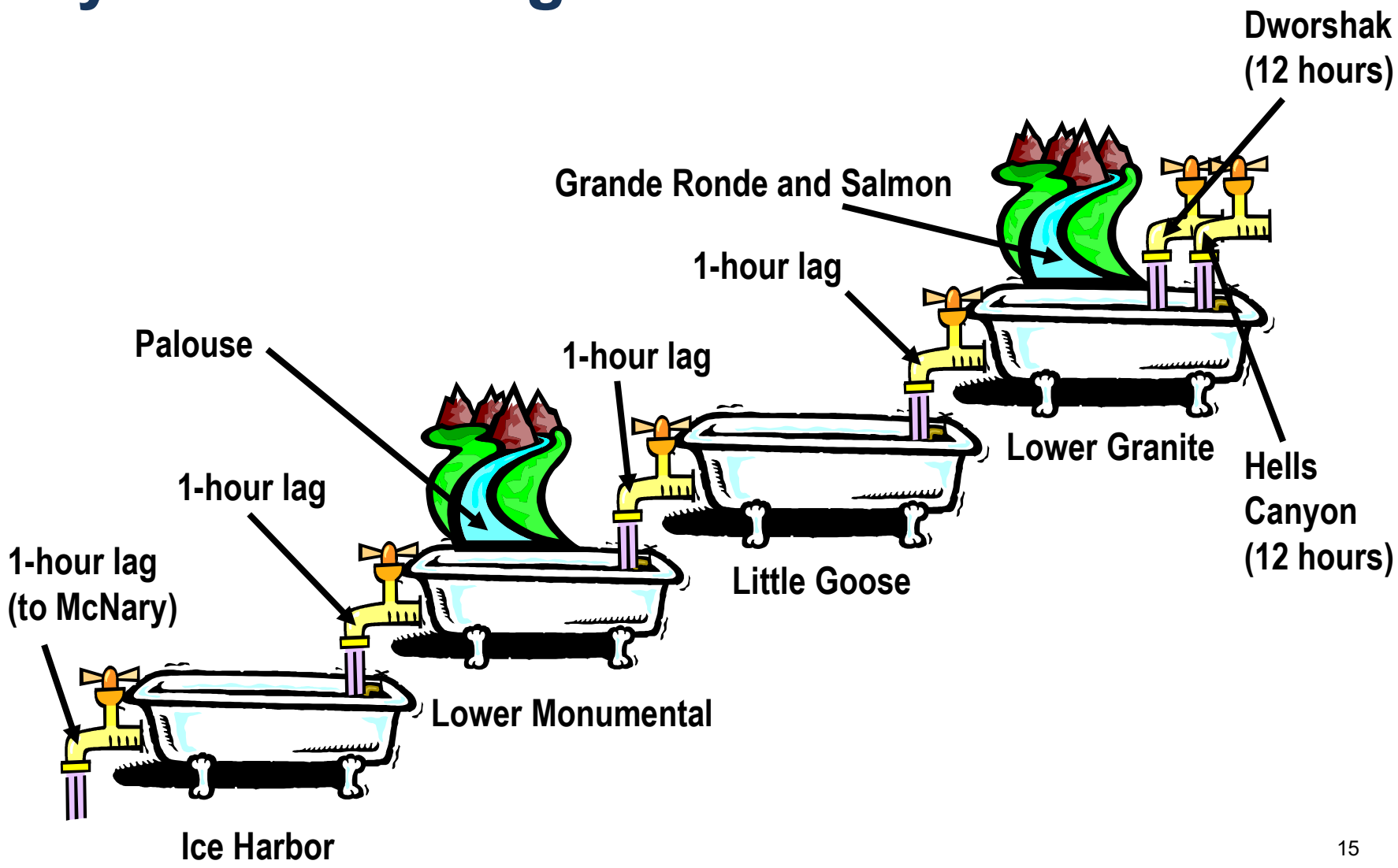
Non Power System Demands

- Flood Control (USACE first priority)
- Irrigation (BOR first priority)
- Fish spawning and migration
- Tribal fishing rights
- Migratory bird habitat
- Recreation (GCL & MCN)
- River Commerce (navigation, sea ports)
- Special operation

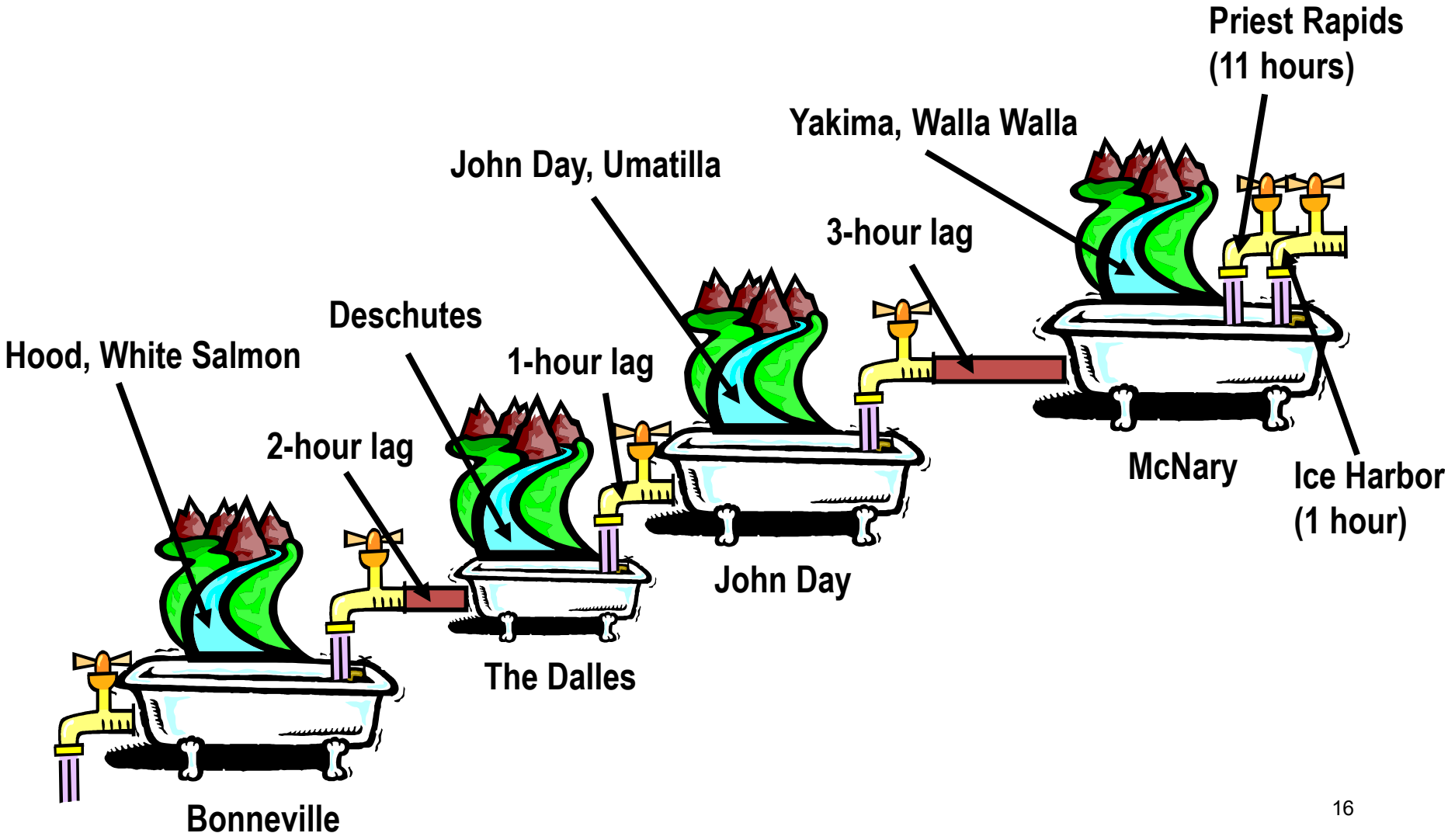
Hydraulic Management: the reservoir



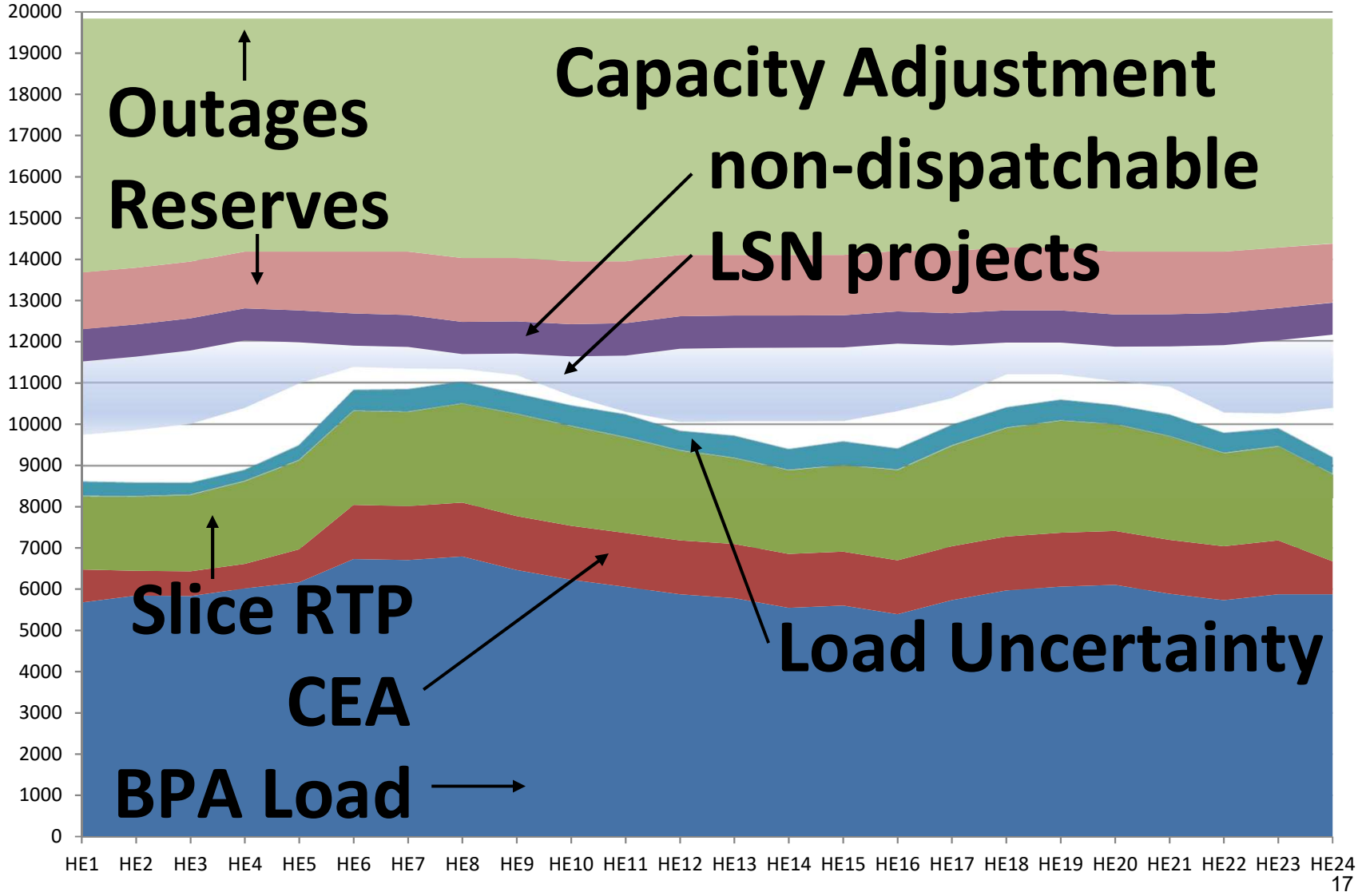
Hydraulic Management: Lower Snake



Hydraulic Management: Lower Columbia



FCRPS Flexibility



- BPA's ability to flex generation on the FCRPS is governed by many factors; fish constraints, flood control, water supply, project limitations. Of these, water supply is the only one we have some control over, but for appreciable change it's hours away or even a day or more.