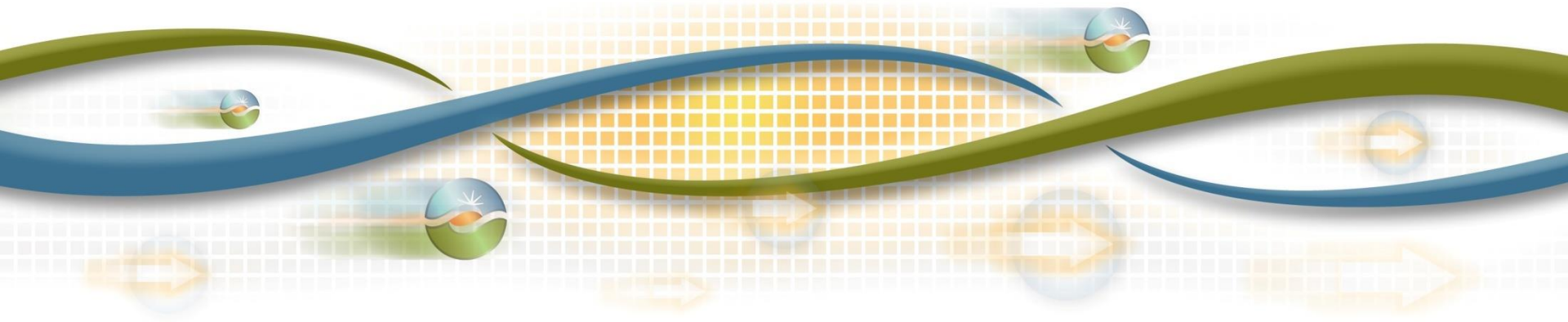


Western Energy Imbalance Market

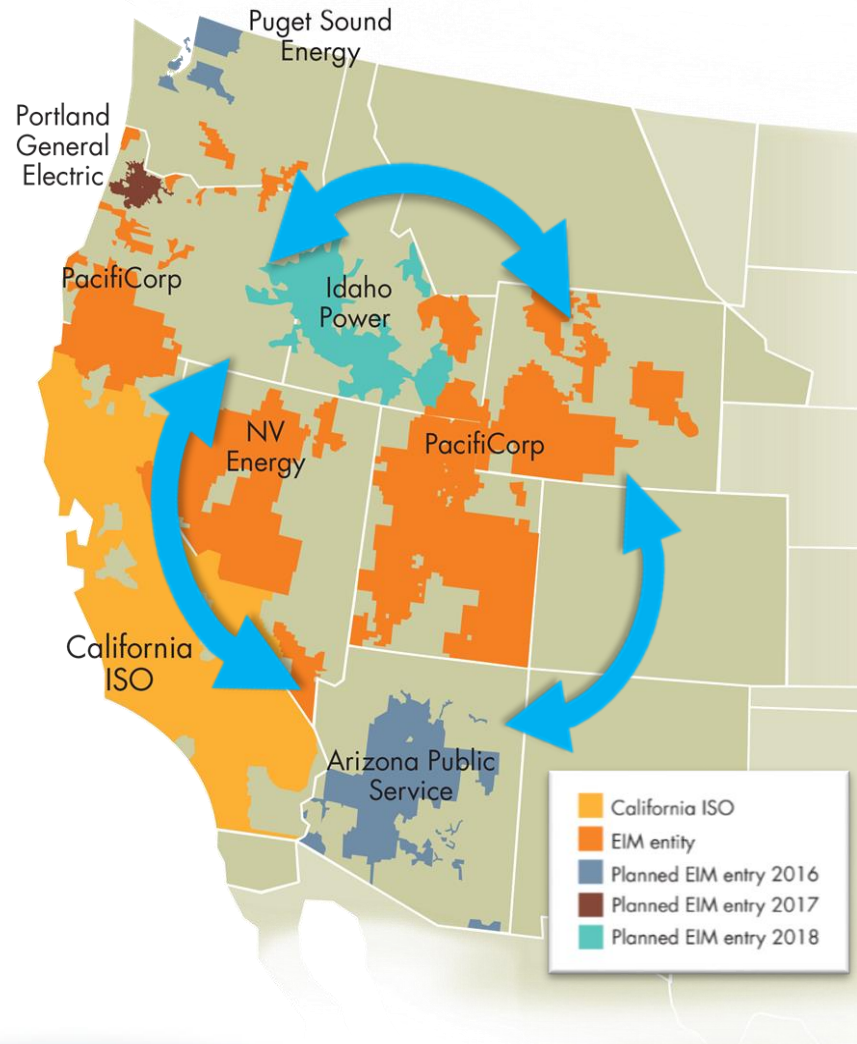
Monday, May 23, 2016

Peter Colussy, External Affairs Manager - Regional



Energy Imbalance Market is an easily-scalable extension of real-time market to broader region

- Situational awareness enhances reliability
- No critical mass required. No exit fees
- Easily scalable, low-cost, low risk, voluntary option for new participants
- Preserves BAA autonomy, including compliance, balancing, and reserve obligations
- Benefits increase with more transfer volume between BAAs



EIM provides significant net benefits and will operate in eight western states

EIM Entities

	PacifiCorp	NV Energy	Puget Sound Energy	Arizona Public Service
Go Live	November 2014	October 2015	Fall 2016	Fall 2016
Peak Demand (MW)	9,500	8,148	4,912	7,000
~ Annual benefits (in millions)	\$21-\$129	\$9-\$18 (2017)	\$18-\$30	\$7-\$18
		\$15-\$29 (2022)		
~ Start-up costs (in millions)	\$20	\$11.2	\$14.2	\$13.5
~ Annual on-going costs (in millions)	\$3	\$2.6	\$3.5	\$4

Benefits are consistent with earlier analysis, over \$64 million for first 16 months

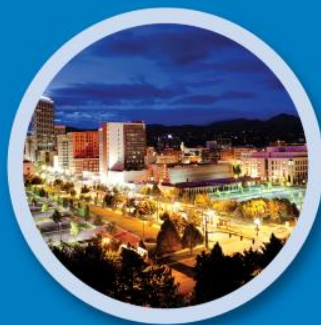
BAA	Nov-Dec 2014	Jan-Mar 2015	April-June 2015	July-Sept 2015	Oct-Dec 2015*	Jan-Mar 2016	Total
ISO	\$1.24 M	\$1.45 M	\$2.46 M	\$3.48 M	\$5.28 M	\$6.35 M	\$20.26 M
PacifiCorp	\$4.73 M	\$3.81 M	\$7.72 M	\$8.52 M	\$6.17 M	\$10.85 M	\$41.8 M
NV Energy	N/A	N/A	N/A	N/A	0.84 M	\$1.70 M	\$2.54 M
Total	\$5.97 M	\$5.26 M	\$10.18 M	\$12.00	\$12.29 M	\$18.90 M	\$64.6 M

* NV Energy EIM go-live on December 1

PacifiCorp EIM Lessons Learned

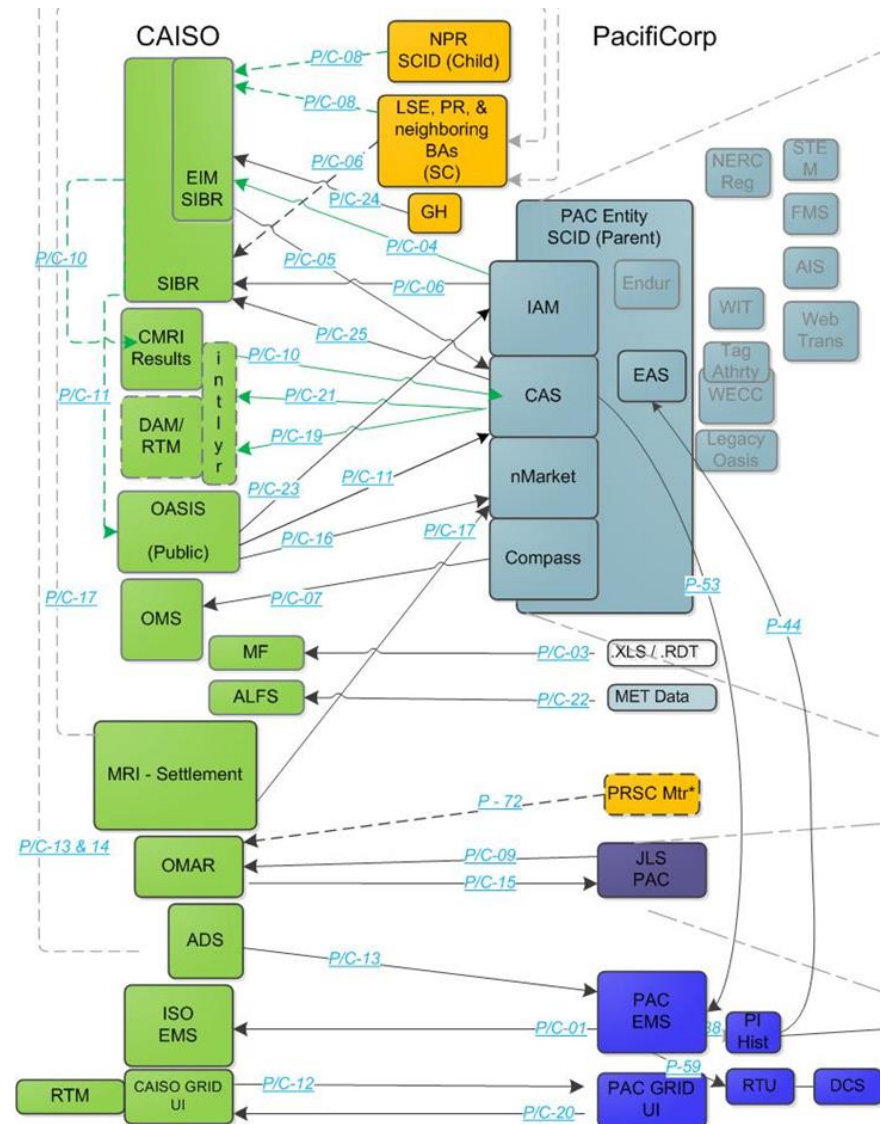
Western Conference

May 23, 2016



EIM Interfaces

- 8 PacifiCorp system changes were identified
- 40 new or modified interfaces
 - 24 PacifiCorp/ISO interfaces
 - 16 PacifiCorp internal interfaces
- Additional 31 PacifiCorp internal interfaces impacted by regression testing



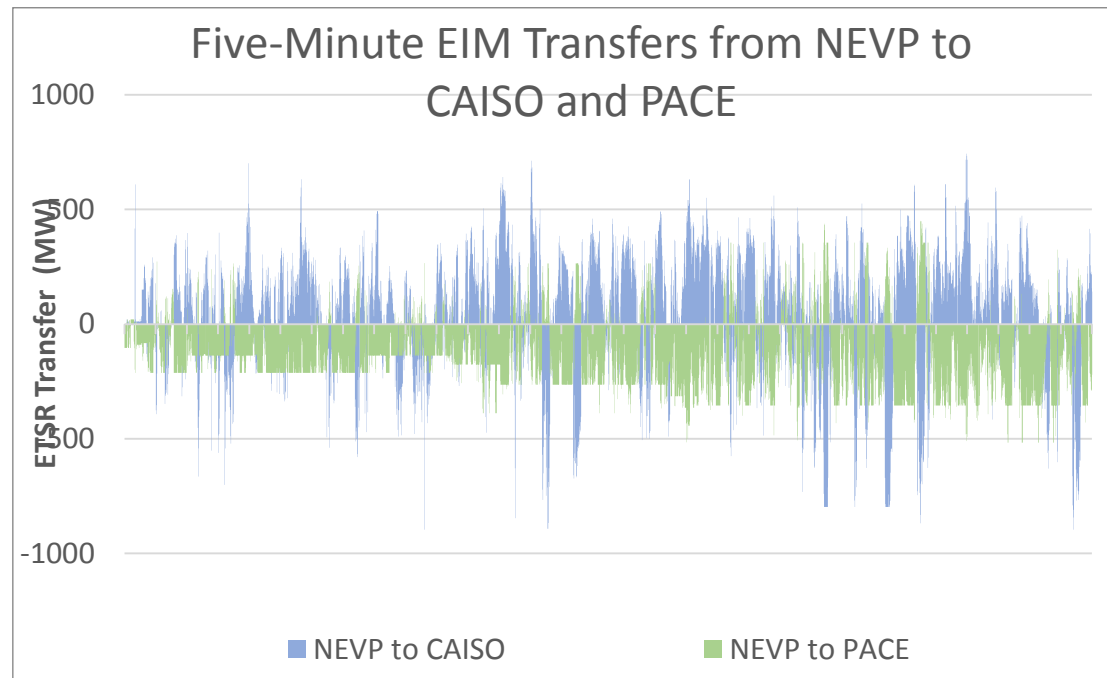
EIM Operations



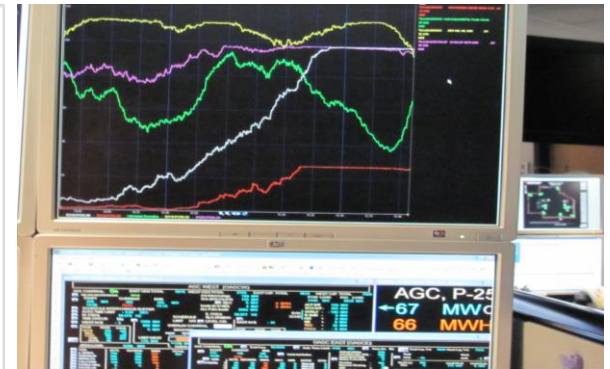
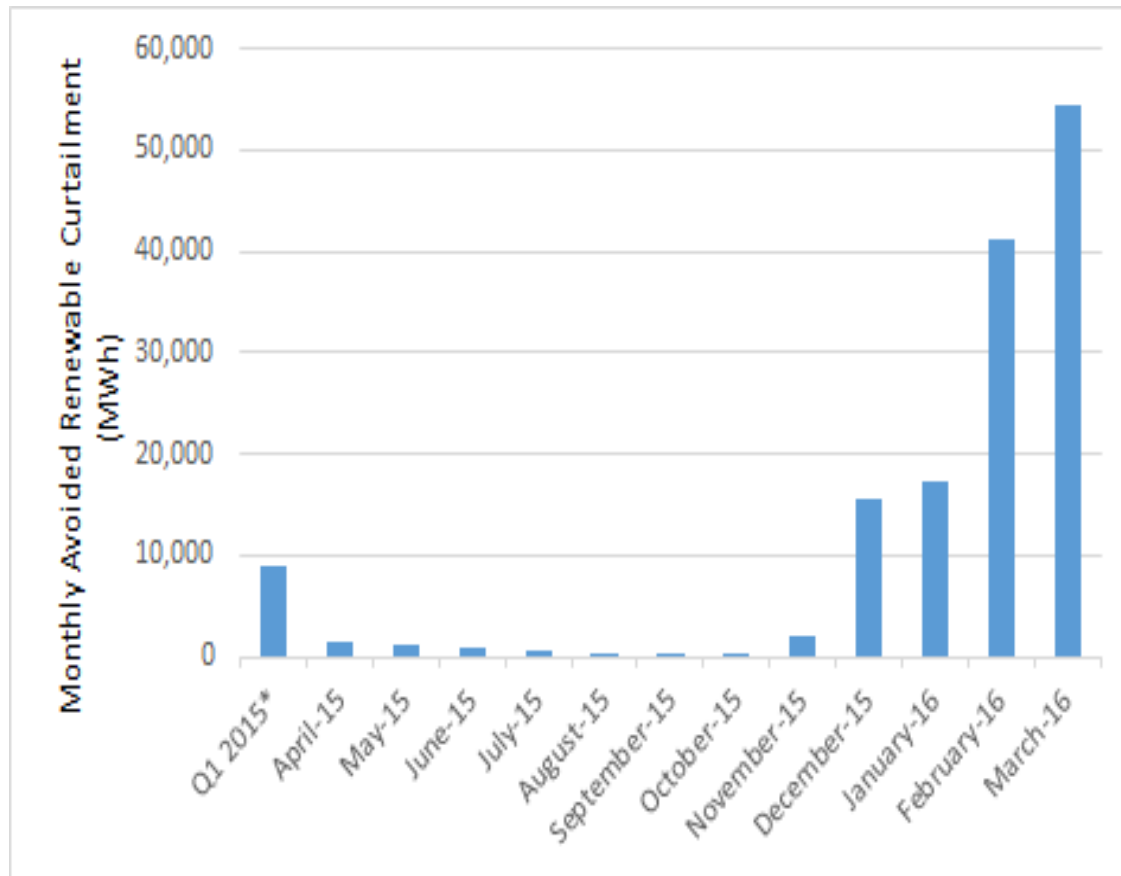
- Operator training
- Market simulation
- Parallel operations



- Market model
- Manual dispatch
- Outage reporting
- Available balancing capacity



Variable Energy Operation

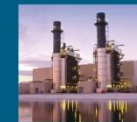




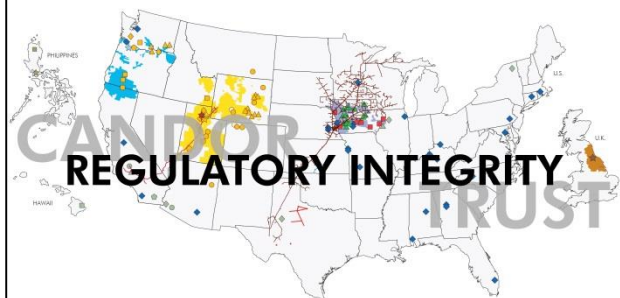
EMPLOYEE COMMITMENT



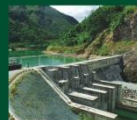
CUSTOMER SERVICE



OPERATIONAL EXCELLENCE



REGULATORY INTEGRITY



ENVIRONMENTAL RESPECT



BERKSHIRE FINANCIAL STRENGTH OWNERSHIP

Energy Imbalance Market Update

Walter Spansel, Vice President, Transmission Officer

May 23, 2016



Operational Experience

NV Energy began participating in EIM starting December 1, 2015

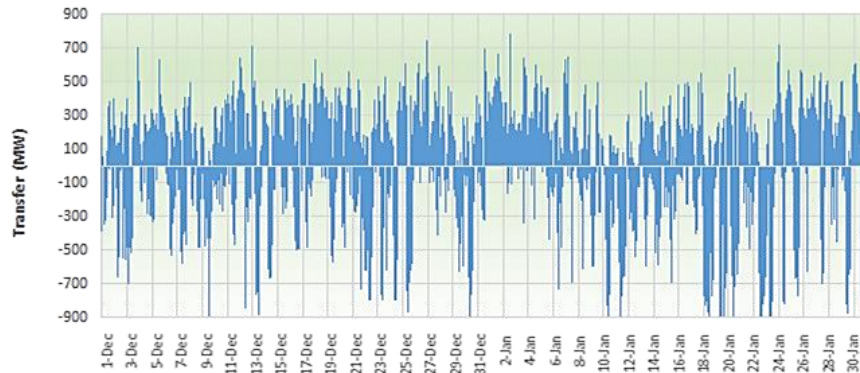
- Balancing test passed 96.67 percent of the hours
- Flex ramp sufficiency test passed 98.9 percent of the intervals
- Solutions have been feasible using available bids:
 - 99.7 percent of fifteen-minute market intervals
 - 99.6 percent of five-minute market intervals
 - Enabling active market participation
 - Avoiding market infeasibilities

Systems operated as expected at launch and very smoothly due to extensive testing, simulation and parallel operations beforehand

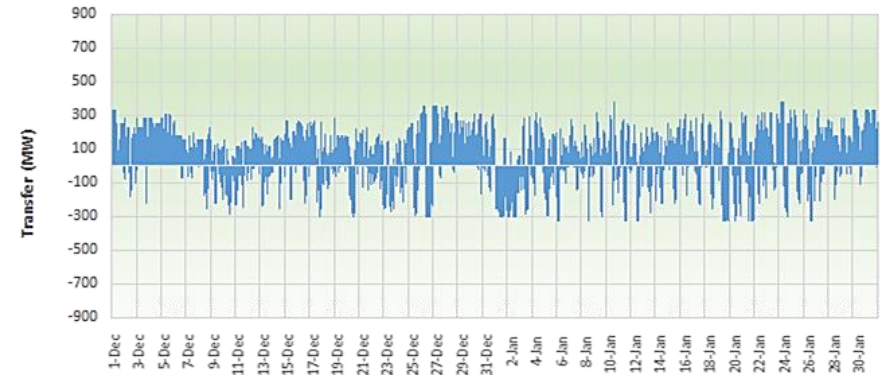
Operational Experience

Robust bi-directional transfers observed with NV Energy

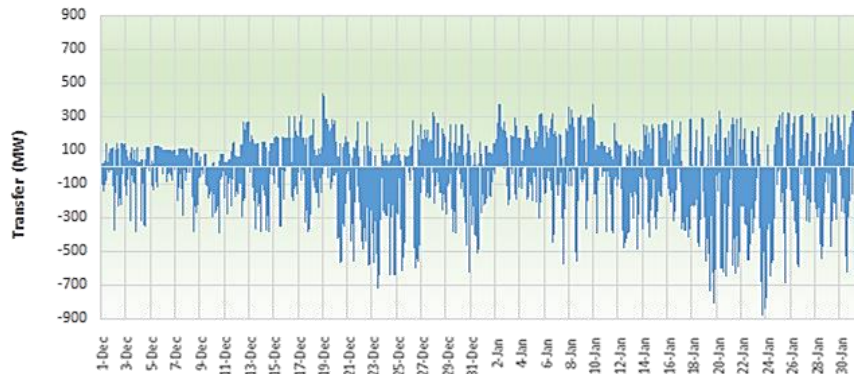
Transfers from Nevada to CAISO



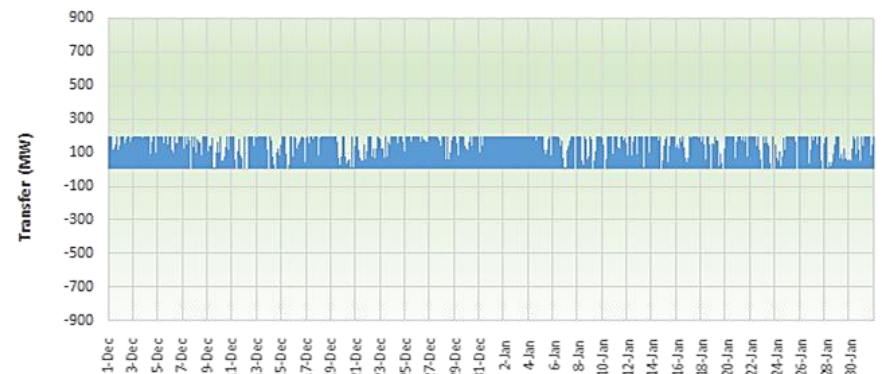
Transfers from PAC West to CAISO



Transfers from PAC East to Nevada



Transfers from PAC East to PAC West



Benefits

- **More efficient dispatch**, both inter- and intra-regional, in the Fifteen-Minute Market and Real-Time Dispatch
- **Reduced renewable energy curtailment**, by allowing balancing authority areas to export or reduce imports of renewable generation when they would otherwise need to be economically curtailed,
 - Avoided curtailments displaced an estimated 48,342 metric tons of CO2 for Q1 2016
- **Reduced flexibility reserves needed in all balancing authority areas**, which saves cost by aggregating the load, wind, and solar variability and forecast errors of the combined EIM footprint.
- The EIM continued to show significant benefits during the first quarter of 2016. The **total benefits for the quarter of \$18.90 million** are consistent with pre-launch studies, and reflect the transfer benefits of a more robust EIM footprint, that includes both PacifiCorp and NV Energy.



APS EIM Update

Brad Albert
GM – Resource Management

May 23, 2016



APS - EIM BACKGROUND

- **APS decided to participate in Spring 2015**
 - Targeted October, 2016 go-live
- **Context for our decision**
 - Dispatch efficiency was the primary driver
 - Estimated net customer savings of \$7M per year
- **Renewable integration challenges are growing**
 - Significant “duck curve” in non-summer months
 - Approximately 500 MWs of rooftop solar
 - 250 MWs of grid-scale solar PV
 - 290 MWs of wind
 - 250 MWs of solar CSP (with energy storage)

APS - IMPLEMENTATION STATUS

- **On-track for October 1st go-live**
 - System testing underway since early March
 - Training operating staff
- **Strong project team**
 - Internal staff from all operating areas
 - Consulting support (Utilicast)
 - Technology provider (PCI)
- **Lessons learned**
 - Good assistance/support from other utilities
 - Complexity of joint participant facilities
 - “Tolled” generating units dynamically signaled into our BAA

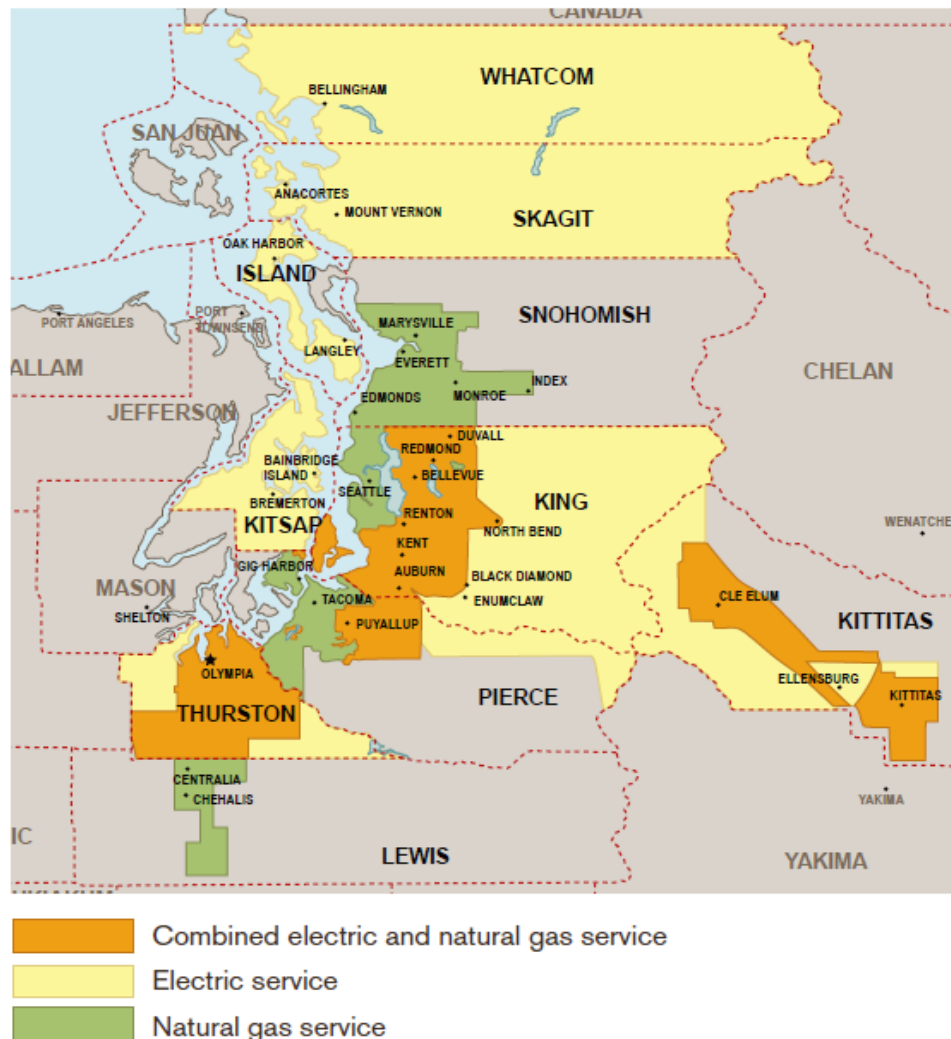
EnergyImbalanceMarket



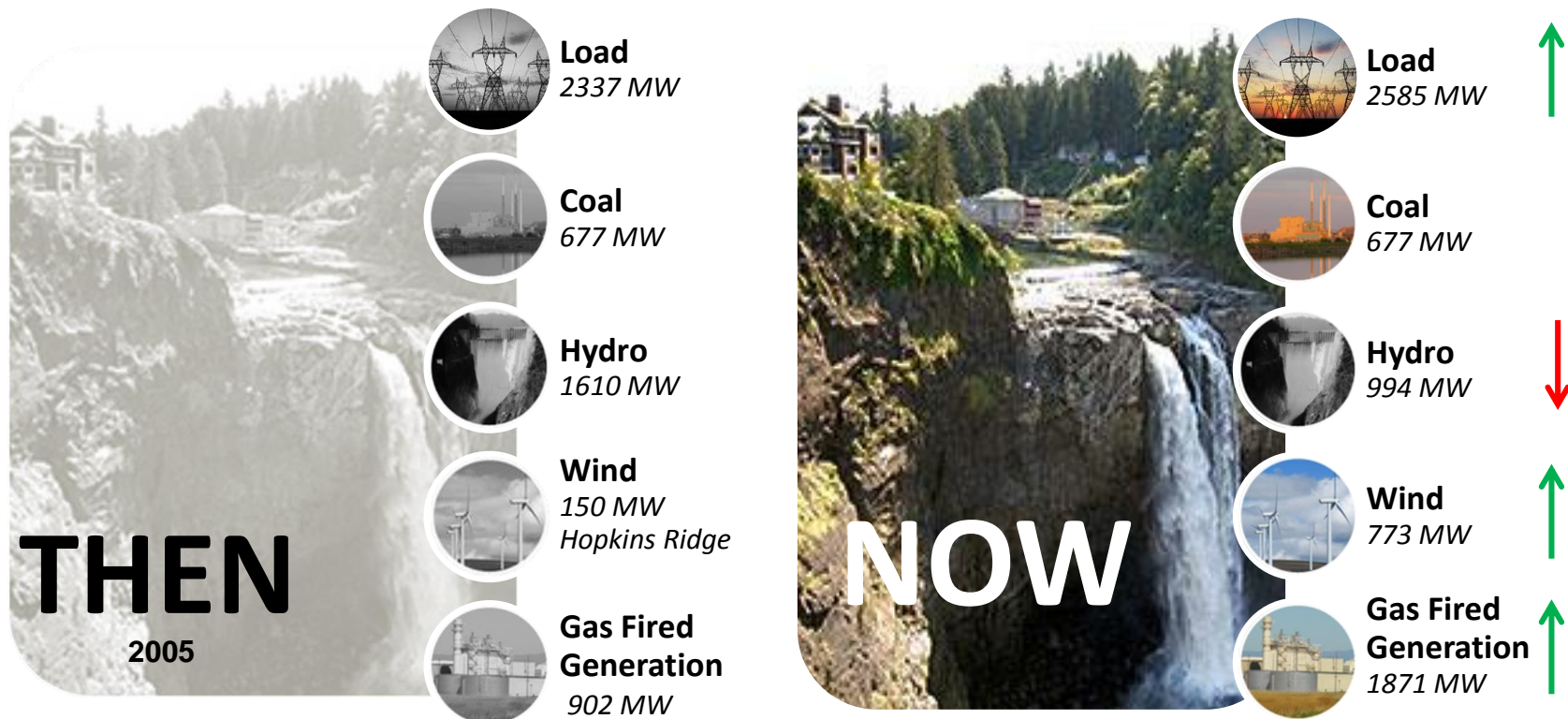
Mariah Kennedy
Puget Sound Energy
May 23, 2016

Who is PSE?

- Headquarters: Bellevue, Wash.
- Customers:
 - More than 1 million electric
 - More than 770,000 natural gas



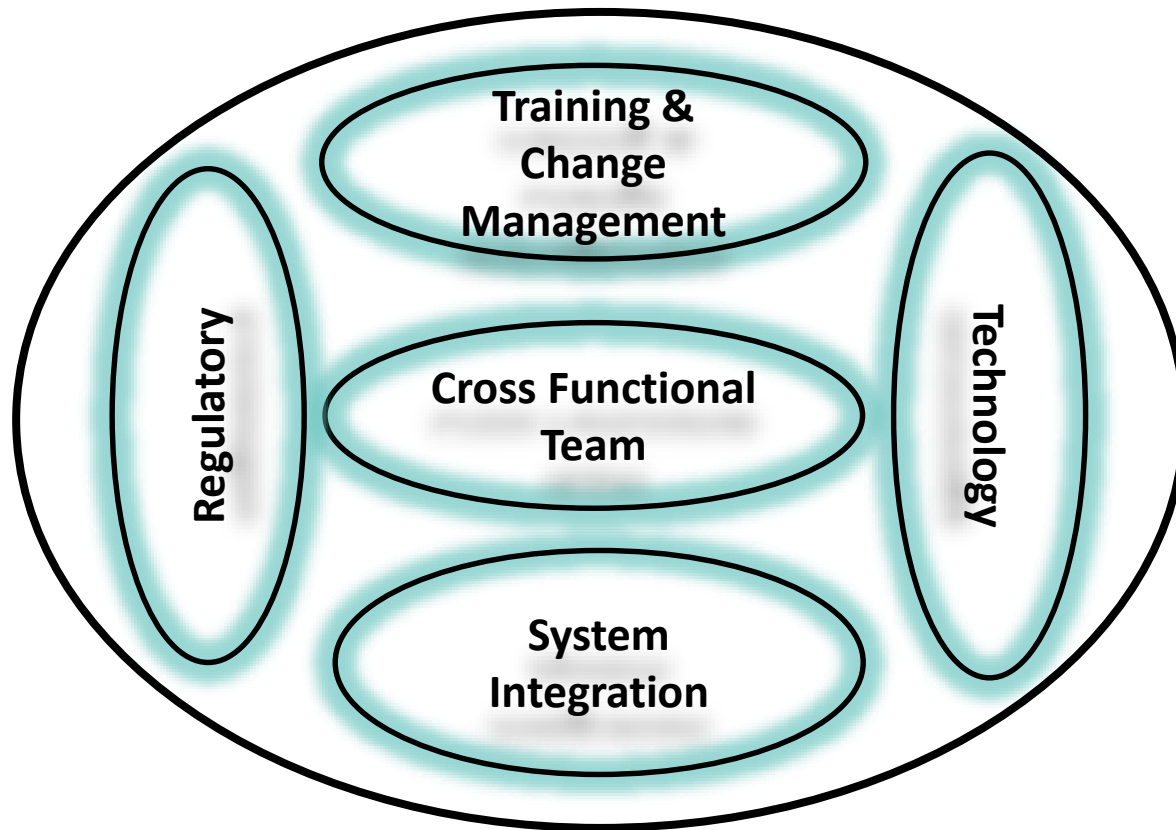
Why EIM?



Energy Imbalance Market = Economic and Reliability Benefits

Estimated PSE Benefits
\$18.3 Million

What are the challenges and lessons learned?



Go Live! – October 1, 2016



PGE EIM Lessons Learned

May 23, 2016

Western Conference



- Engaging five vendors at the same time is a challenge (OSI, PCI, OATI, Utilcast, and ABB)
 - Have technical staff ready to engage early
 - Upgrade systems as early as possible
 - Major internal IT support required.
 - Vendor delivery of applications according to timeline
 - Historical experience indicates that the project vendors will exceed timelines.
 - Delays could result in difficulties for personnel to adjust to multiple new applications/processes at once.

- Network Model
 - Network model requires substantial validation and correction to be operational
 - CAISO will not start integrating PGE's model until all validation has been completed
- Develop an internal Project team with clear process and development responsibilities
- Proper timing for introduction of change management.
- For those in the Northwest, proper coordination with BPA

- Complete the CAISO Resource Data Template training
- Submit EIM Entity and PRSC Applications to CAISO
- Phase 2: Design and Build
 - Lower-level CAISO training for project resources
 - Determine business process and application changes due to CAISO EIM operations
 - Identify and document gap analysis to map out strategy for transitioning from current business processes to CAISO EIM operations business processes
 - Design and develop applications and interfaces to function within the CAISO EIM operations business processes