

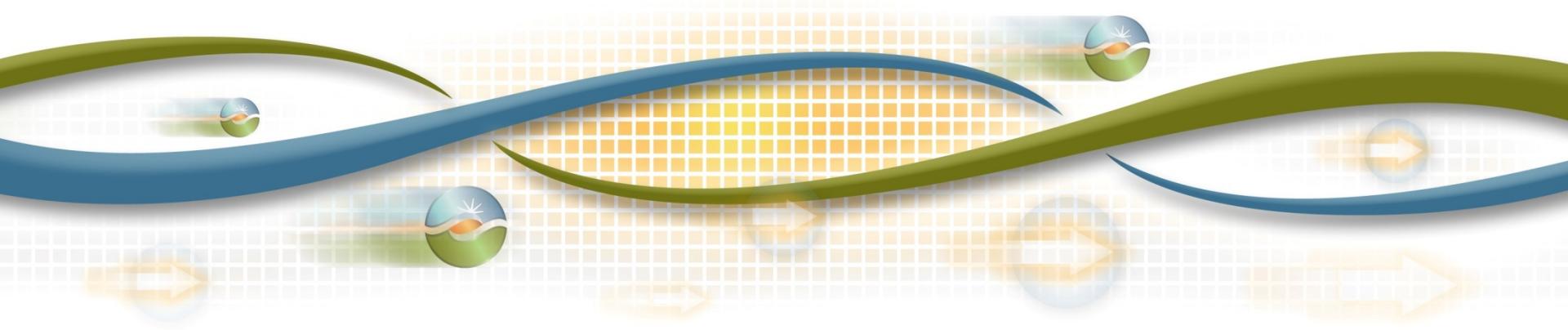


California ISO

Information Technology and Energy Industry

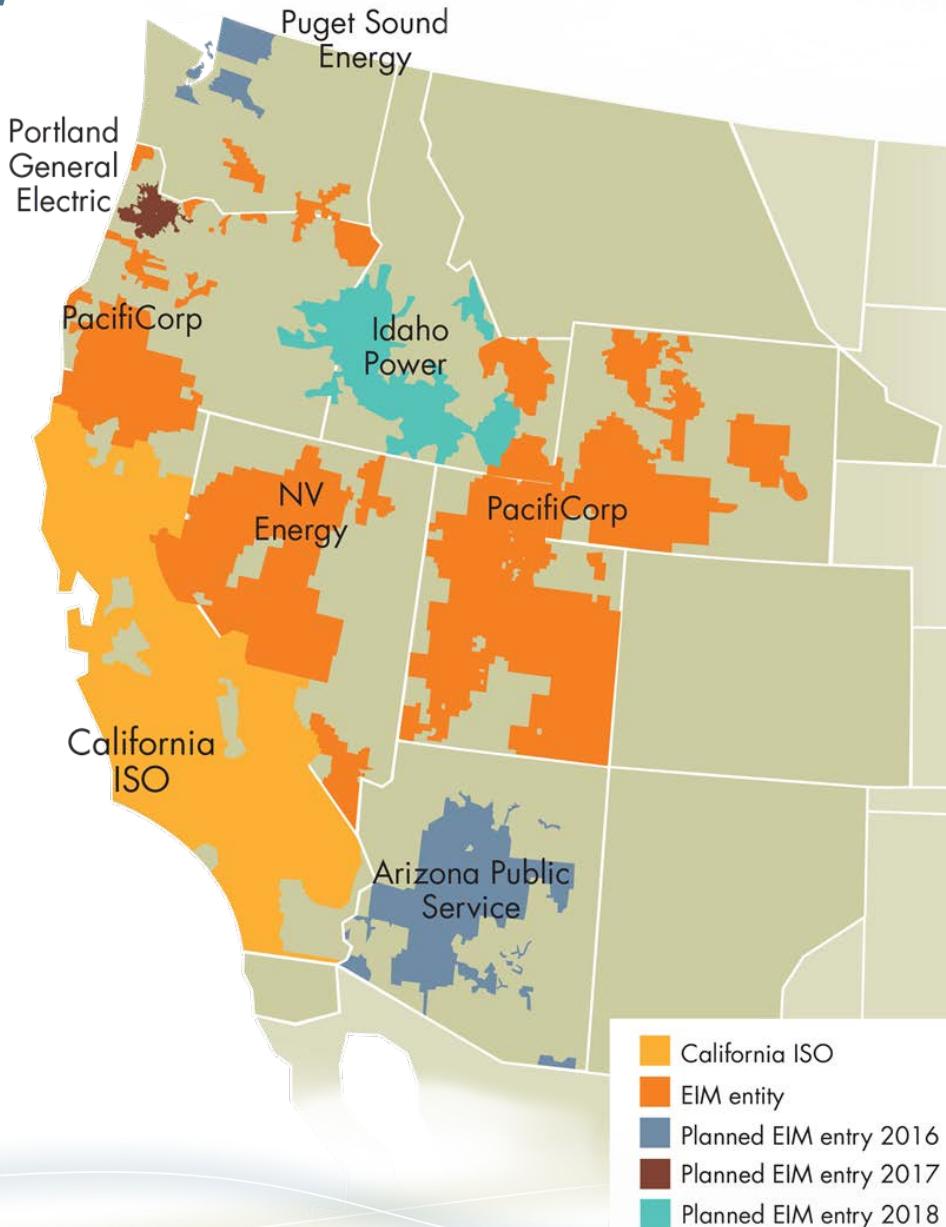
July 12, 2016

Mark Rothleder
VP Market Quality and Renewable Integration



California ISO Overview

- Nonprofit public benefit corporation
- Part of Western Electricity Coordinating Council: 14 states, British Columbia, Alberta and parts of Mexico
- 71,000 MW of power plant capacity
- 50,270 MW record peak demand (July 24, 2006)
- 26,014 circuit-miles of transmission lines
- ISO is governed by the Federal Energy Regulatory Commission, which has jurisdiction over transmission lines that cross state borders.



California energy and environmental policies drive renewable integration

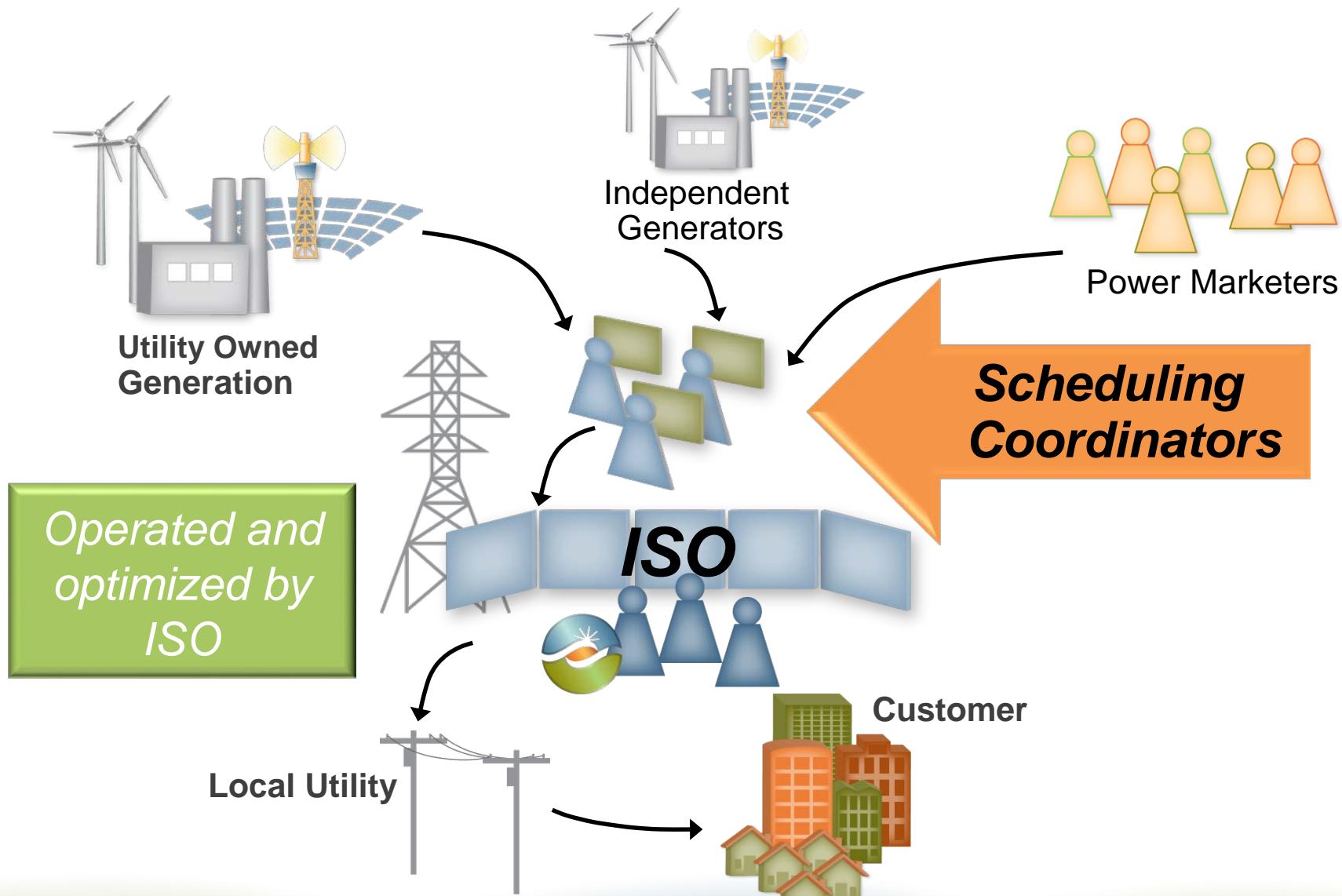
- Greenhouse gas reductions to 1990 levels by 2020
- 33% of load served by renewable generation by 2020
- 12,000 MW of distributed generation by 2020
- Ban on use of once-through cooling in coastal power plants
- Less predictable load patterns – rooftop solar, electric vehicles, and smart grid
- SB 350 2030 goals
 - 50% renewables
 - 50% reduction petroleum use – cars & trucks
 - Double energy efficiency of existing buildings
 - Greenhouse gas reductions to 40% below 1990 levels

What does the ISO do?

- Uses advanced technology to efficiently and effectively operate the grid in day-ahead and in real-time.
- Deployment of advanced technologies enable the ISO to provide real-time 5 minute resource optimization to CA and five additional states in the West.
- Plans for transmission, generation interconnection and operates the grid in compliance with Federal reliability requirements for 80% of CA and part of Nevada.



How the ISO fits in...

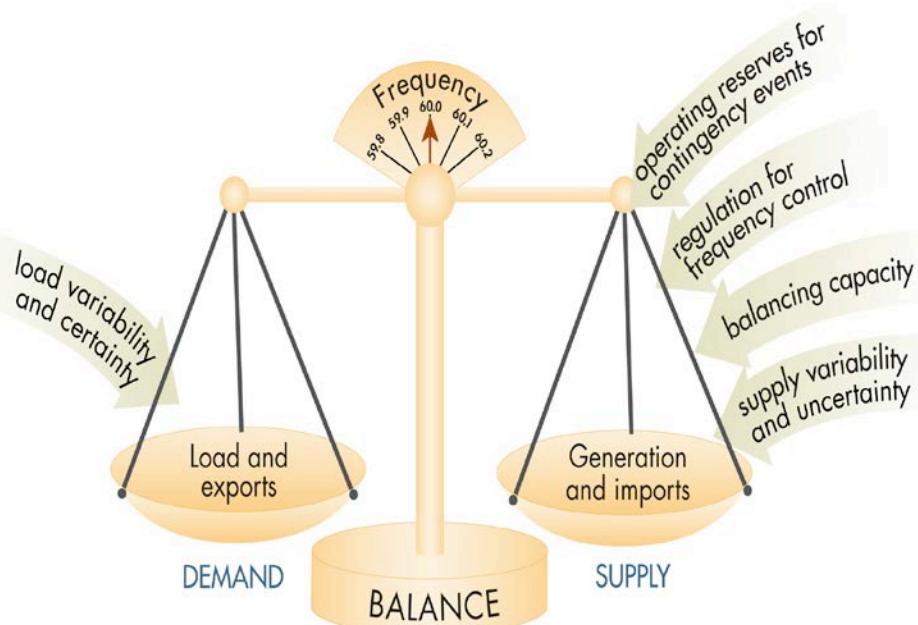


A Balancing Authority (BA) is responsible for operating a transmission control area

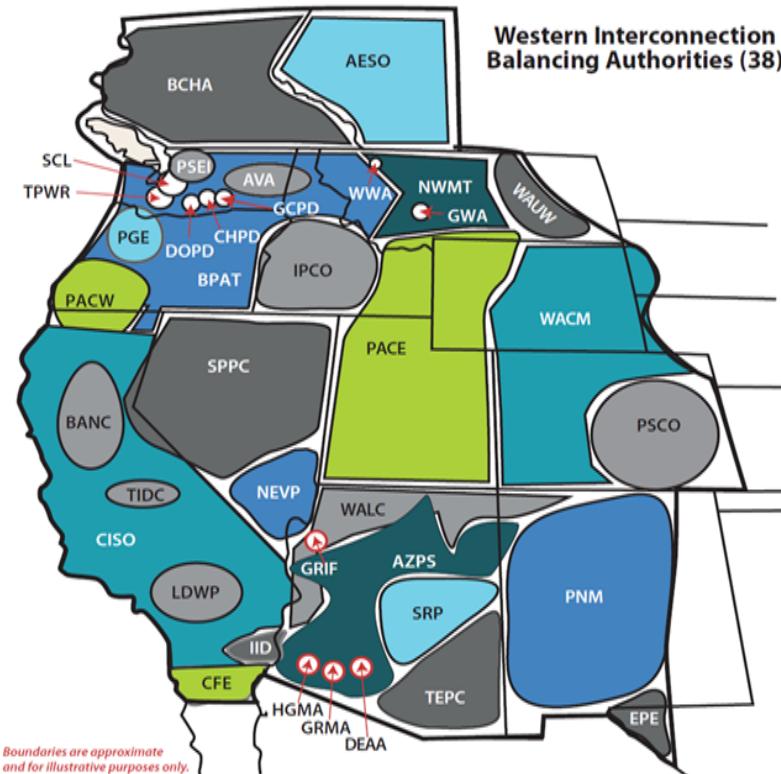
Electricity is produced, delivered, and consumed at the speed of light.

The ISO balances the system in two timeframes:

- Market down to 5-minute resolution
- AGC on a 4-second basis



WECC is the regional entity for the provinces of Alberta and British Columbia, the northern portion of Baja California, Mexico, and all or portions of the 14 Western states between



Emerging operational areas where information technology will be leveraged

- System reliability and situation awareness
- Renewable Integration
- Increased system coordination
 - Transmission / Distribution System operational coordination
 - Regional coordination and optimization
 - Gas / Electric Coordination
- Demand and supply forecasting
- GHG emission tracking and control
- Information security

Power industry transformation



Wind

- Unpredictable Output
- 4768 MW Peak – April 12, 2014
- 6087 MW Installed Capacity



Solar Thermal / Photo Voltaic

- Semi – Predictable Output
- 7755 MW Peak – May 11, 2016*
- 8000 MW Installed Capacity

*April 24, 2016 simultaneous wind and solar exceeded 10,000MW



Roof Top Solar

- Semi – Predictable Output
- Behind the meter – Residential
- 4000 MW Estimated Capacity

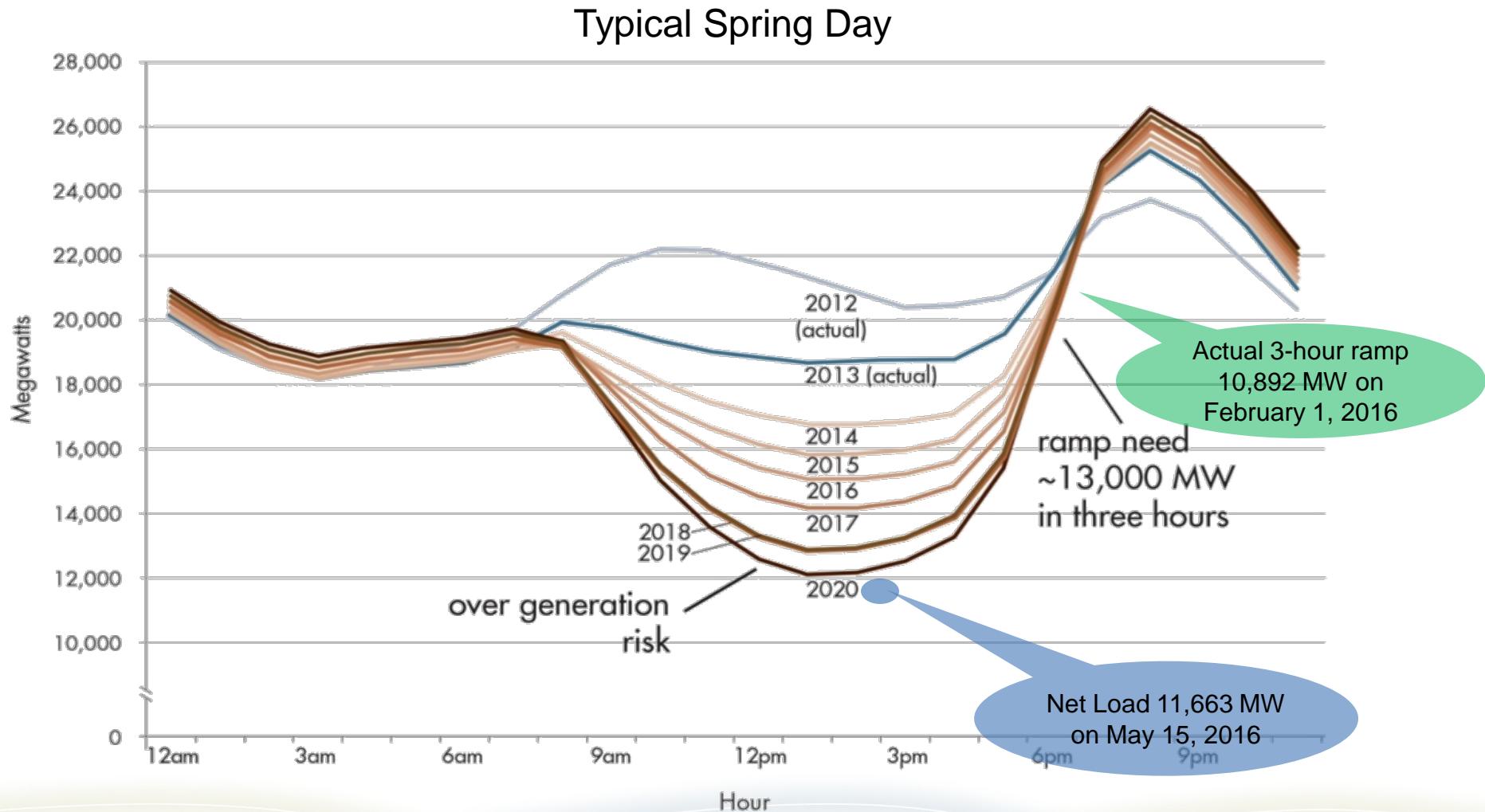
Main Drivers:

- ✓ California RPS
- ✓ GHG reduction
- ✓ Once-through-Cooled plants retirement

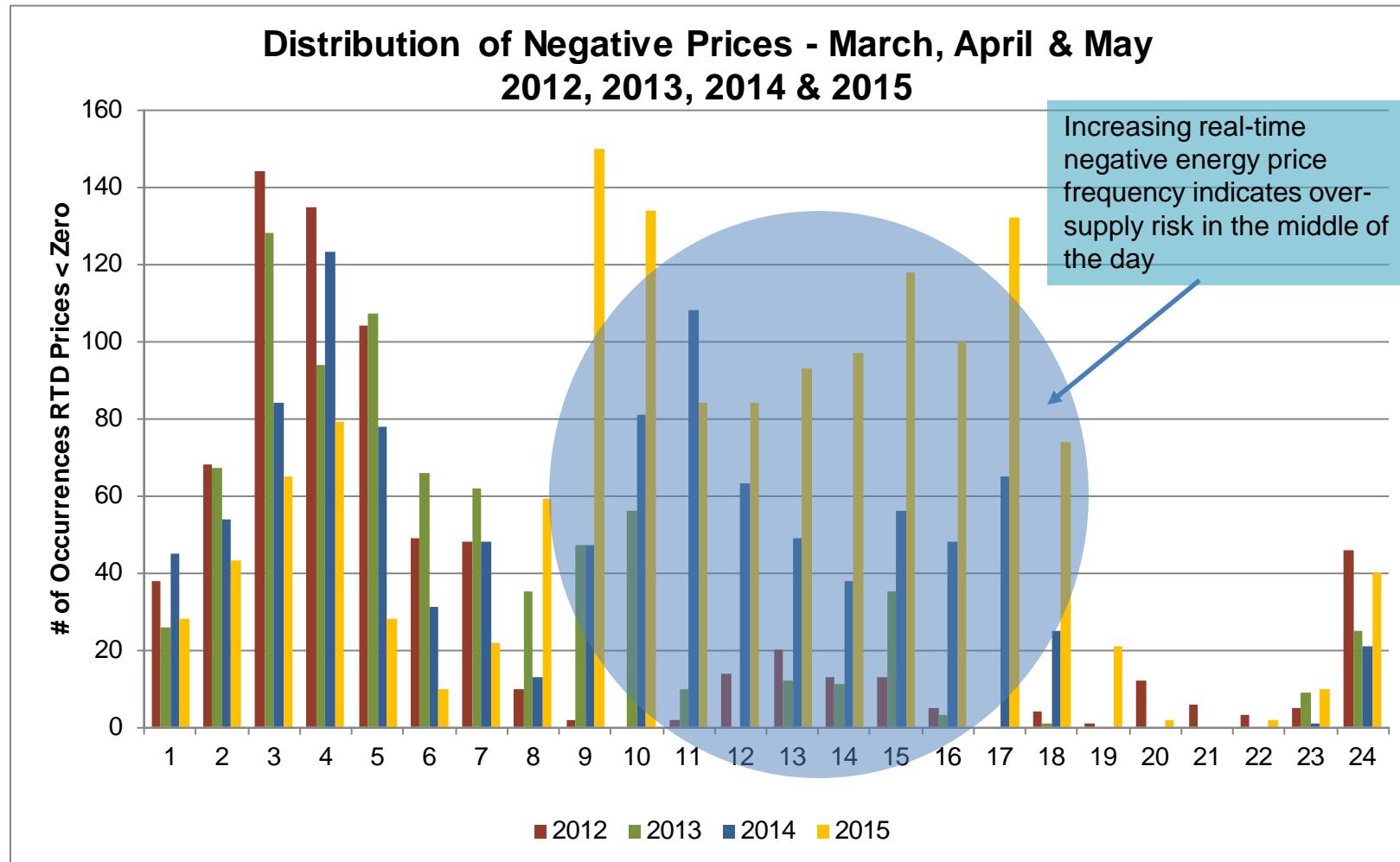
Goals:

- ✓ Higher expectation of reliability
- ✓ Higher expectation of security
- ✓ Smart Grid
- ✓ Situational awareness through Visualization

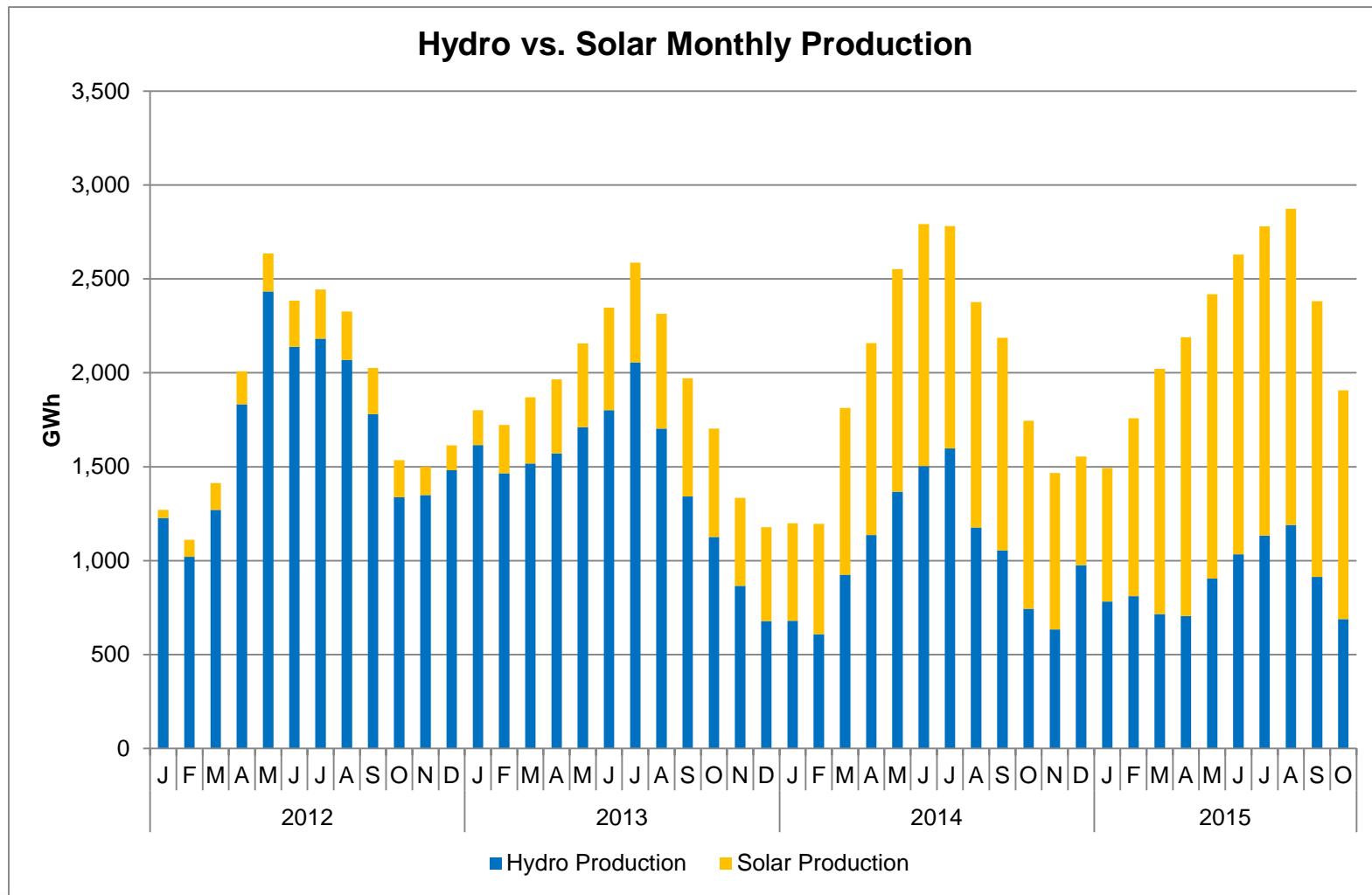
Original estimate of net-load as more renewables are integrated into the grid



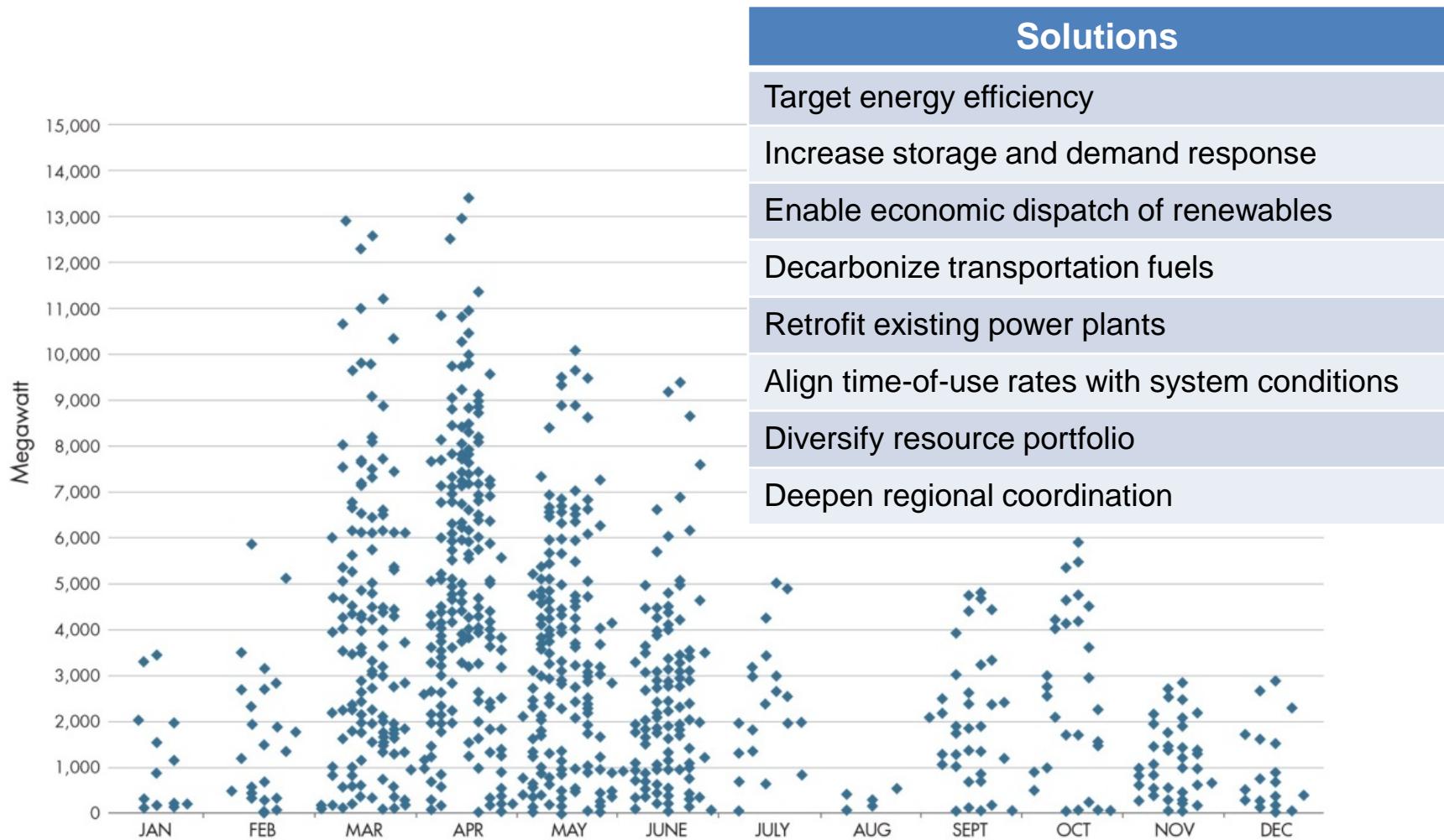
Negative energy prices indicating over-supply risk start to appear in the middle of the day



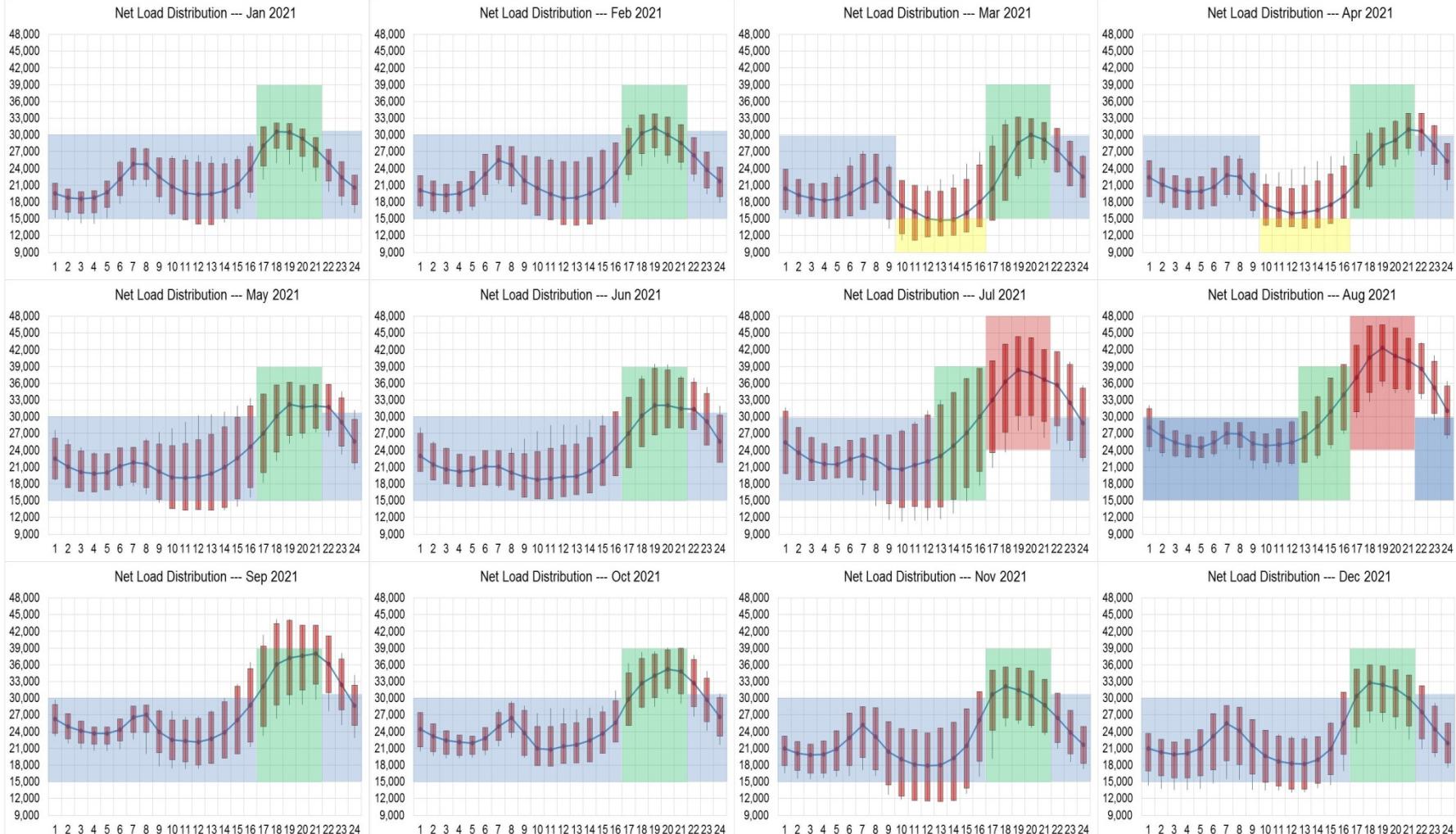
Solar supported energy needs lost due to drought conditions- 2012 through October 2015



Renewable curtailment in 2024 at 40% RPS is significant



2021 Monthly Net Load Distribution --- Weekdays



Off-Peak



Peak

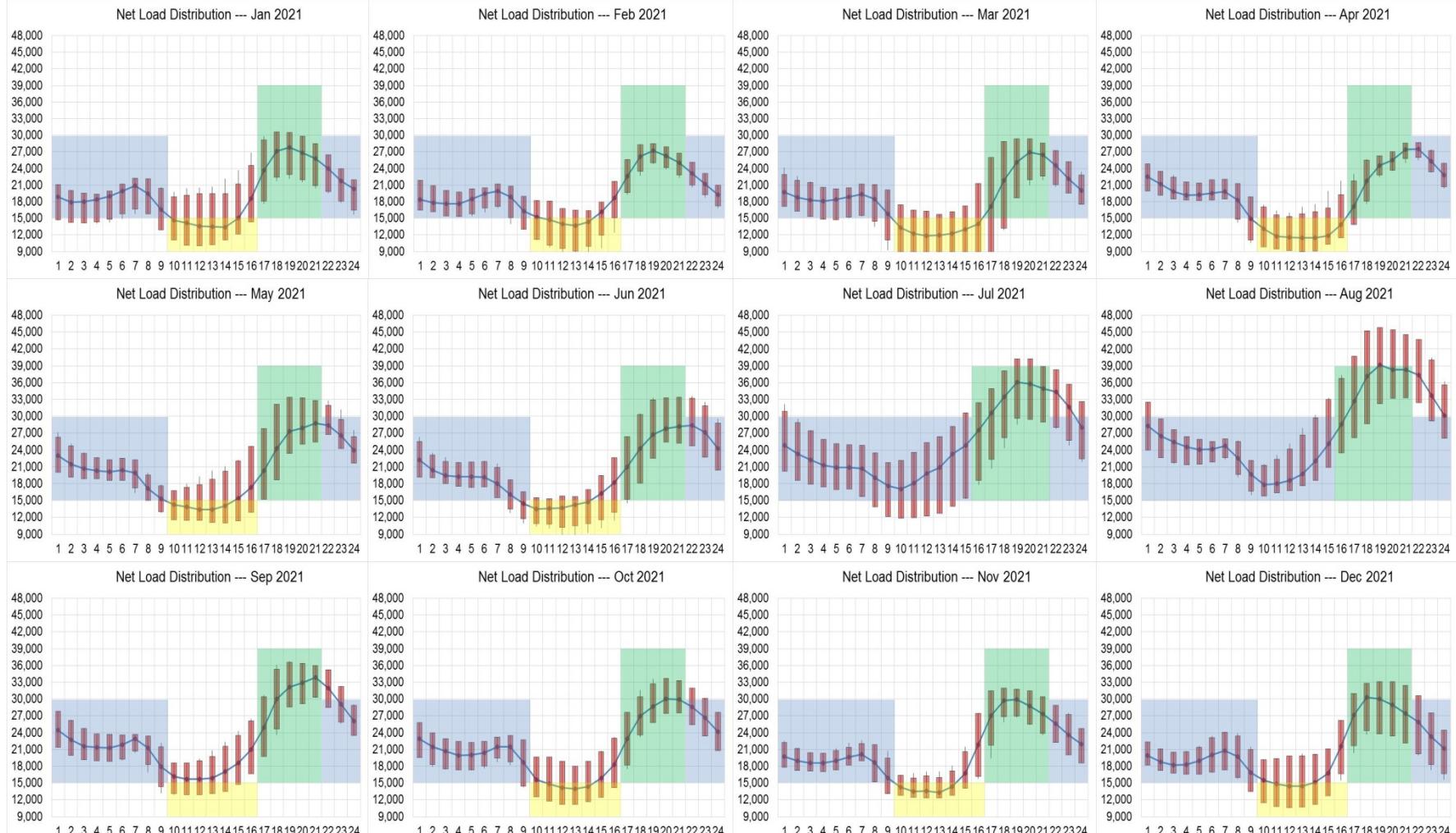


Super Off-Peak



Super Peak

2021 Monthly Net Load Distribution --- Weekends



Off-Peak

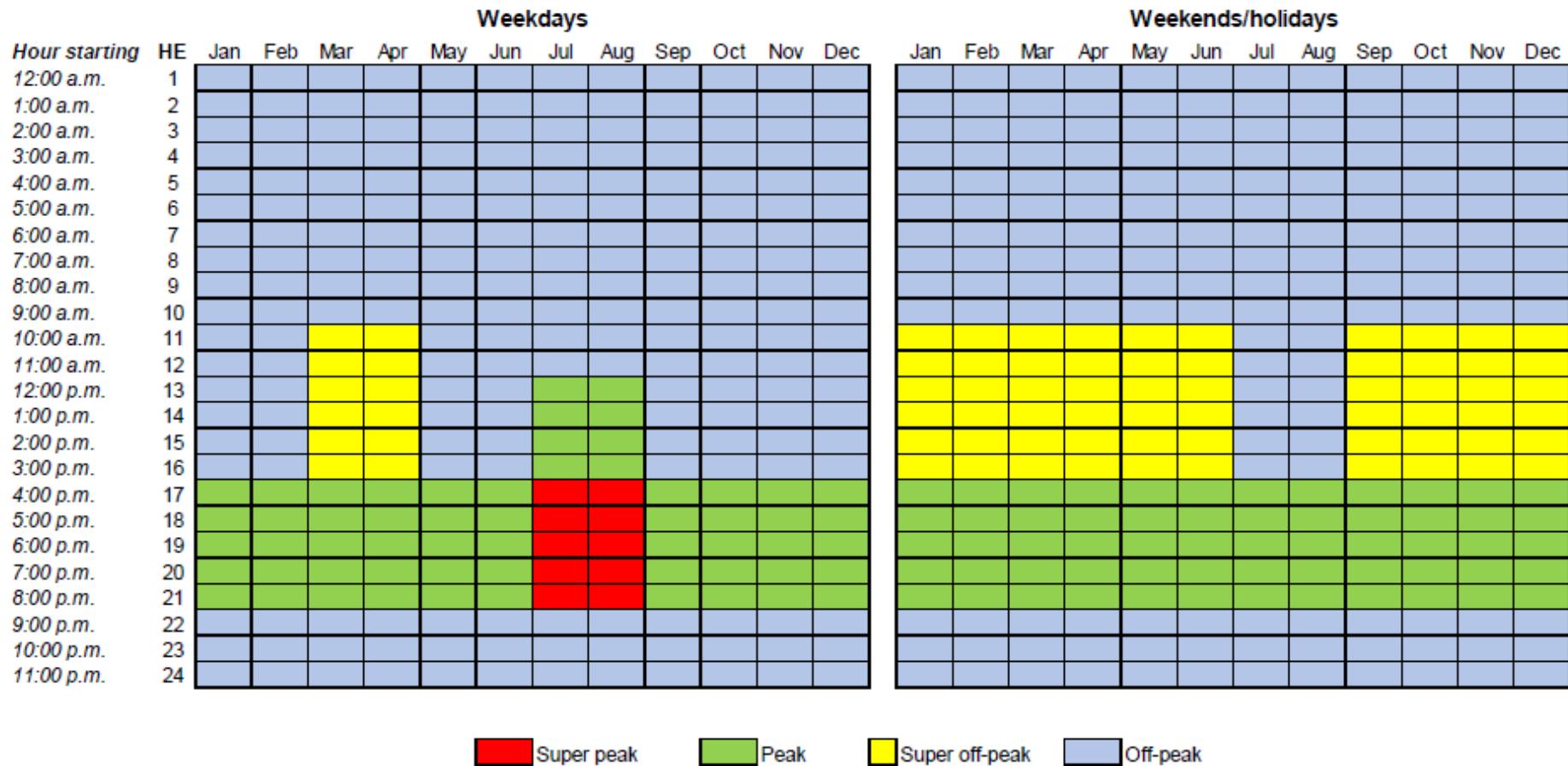


Peak



Super Off-Peak

Proposed Weekday and Weekend TOU Periods

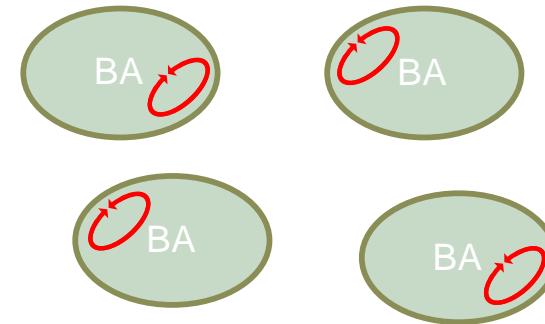


Periods were simplified to provide a CAISO system-wide uniform approach and limit variation in peak and off-peak periods.

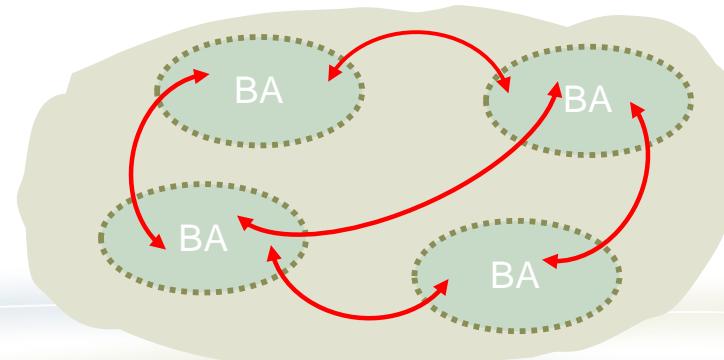
Energy Imbalance Market is an important tool for effective use of resources around the west

- Builds on existing market
- Automated dispatch resolves imbalance & avoids congestion
- Increase flexibility & decreases flexible reserve
- Provides situational awareness, enhances reliability
- Voluntary and no exit fees
- Preserves autonomy, including compliance, balancing, and reserve obligations
- Decreases integration cost

Prior to EIM:
Each BA must balance loads and resources w/in its borders.

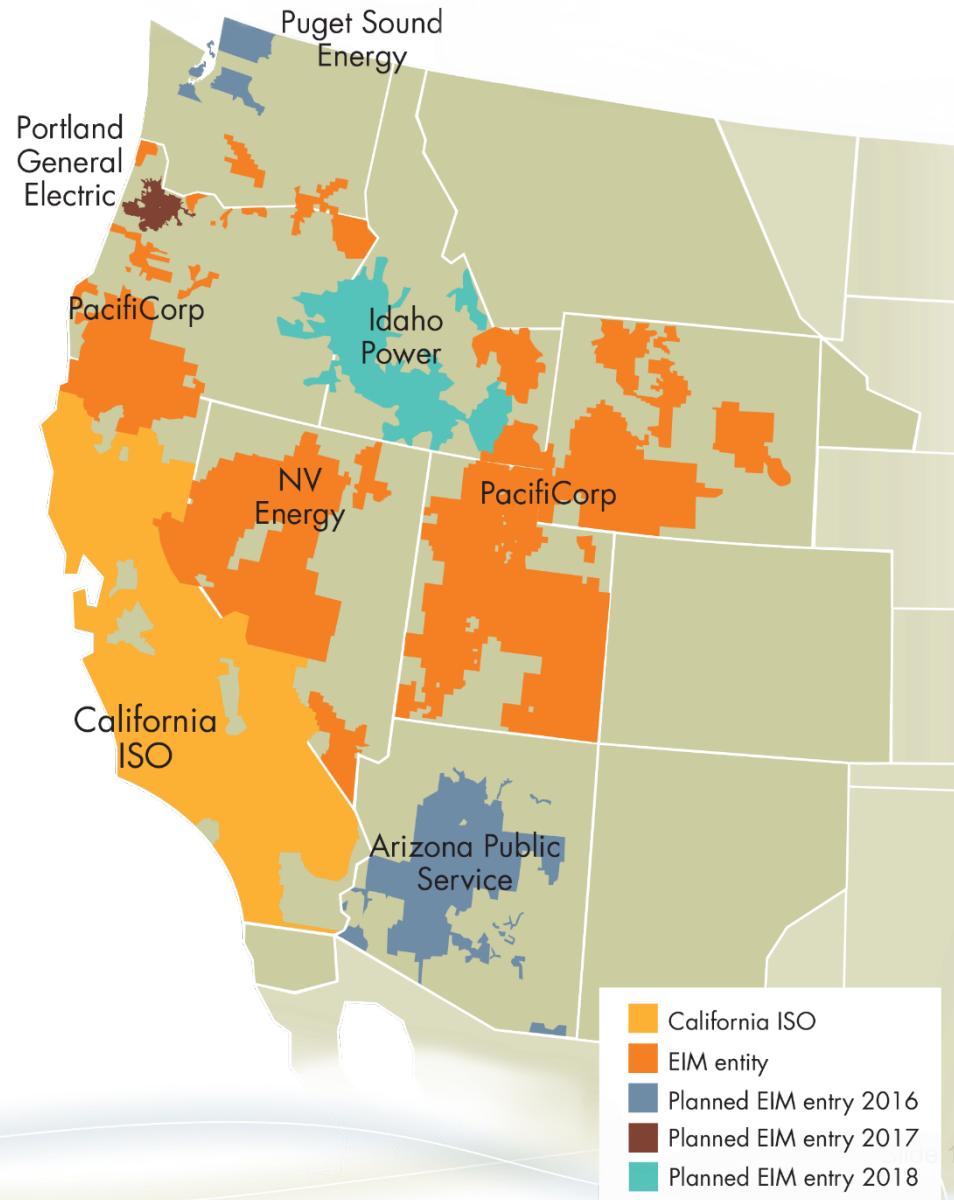


In an EIM:
The market dispatches resources across BAs to balance energy



EIM benefits \$64M since October 2014

- Arizona and Puget continue their respective implementation progress:
 - August 1st begins parallel operations, teams begin preparing Readiness Criteria for FERC filing
 - October 1st Go-Live
 - Idaho Power will join EIM in spring of 2018.
 - LADWP has announced its intent to explore EIM participation.



18 large power plants representing ~9,800 MW of capacity are supported by Aliso Storage



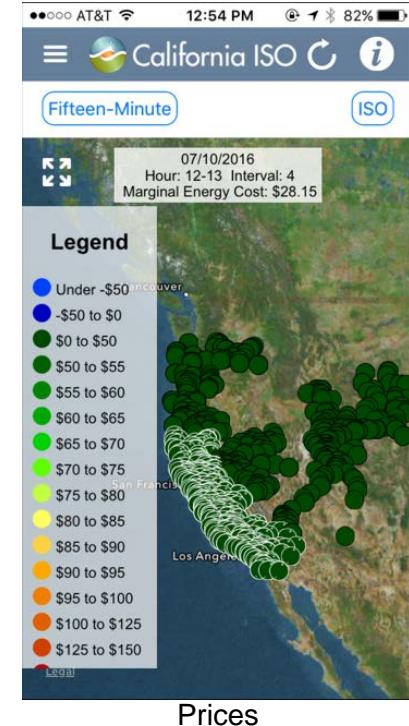
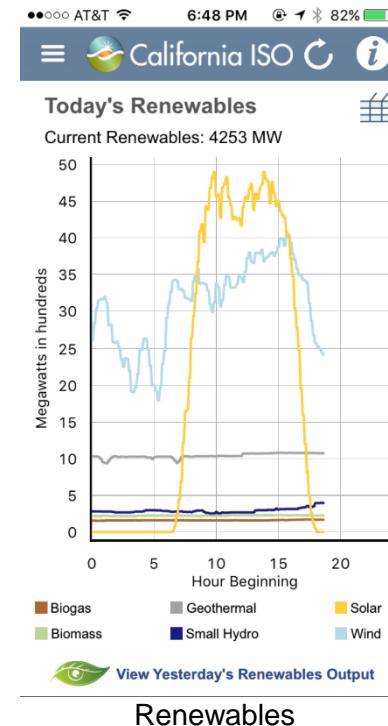
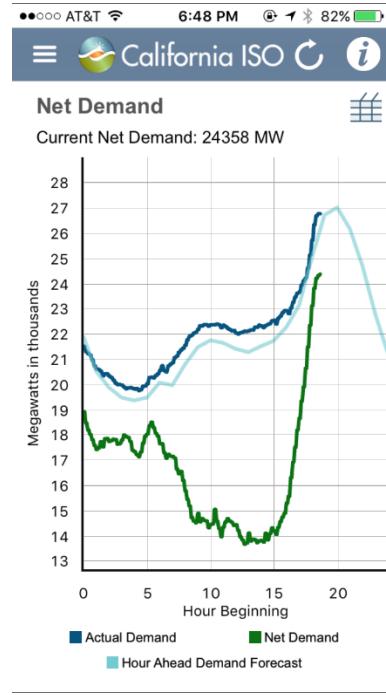
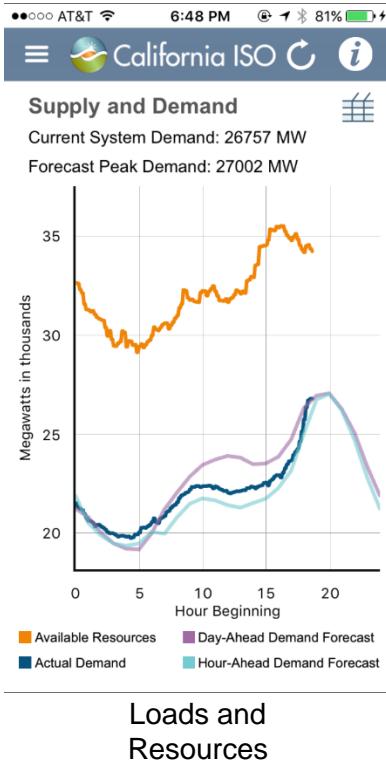
T:\Projects\Special Requests 2\Roger Johnson\AlisoCanyon\AlisoCanyon_AffectedCities_SelectPowerPlantsV2.mxd

Mitigation Measures

- Power Flow Analysis – Joint ISO and LADWP
 - Identified minimum generation required to maintain reliability
 - Areas at risk for transmission constraints
 - Generation and Transmission available outside the LA Basin for energy and operating reserves
- Gas curtailment methodology and walkthrough May 16
 - Joint effort – ISO, LADWP, Peak RC, SoCalGas
- ISO Tariff Changes – Approved June 1
 - Market Constraint / Nomogram
 - Broader authority to reserve transmission on ISO internal paths – Path 26
- Coordination with Peak RC to increase SOL in emergency
- EIM energy Transfers

EXAMPLES OF VISUALIZATION & SITUATION AWARENESS

Information available by phone app

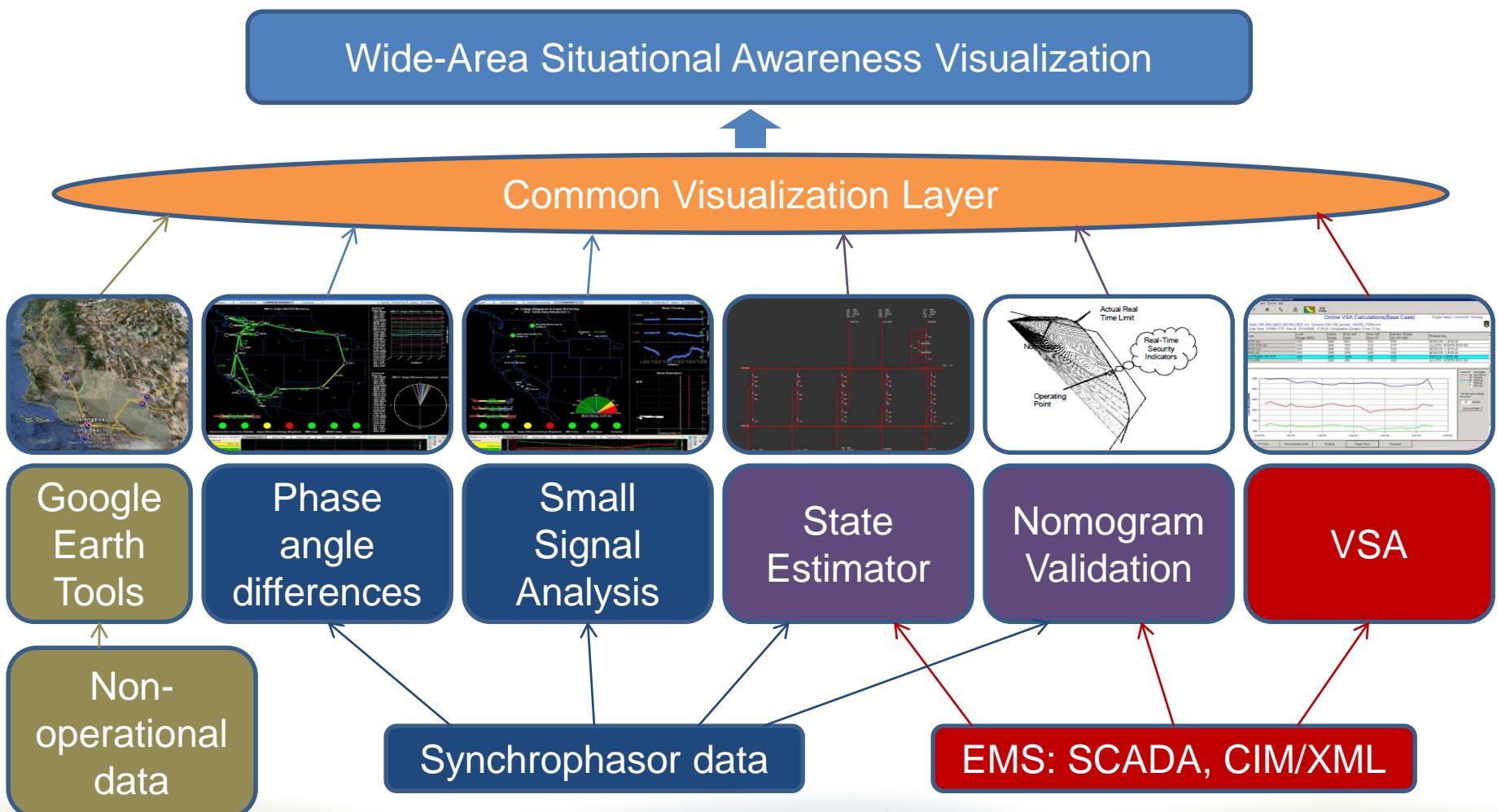


ISO Today: Free Smart Phone App:

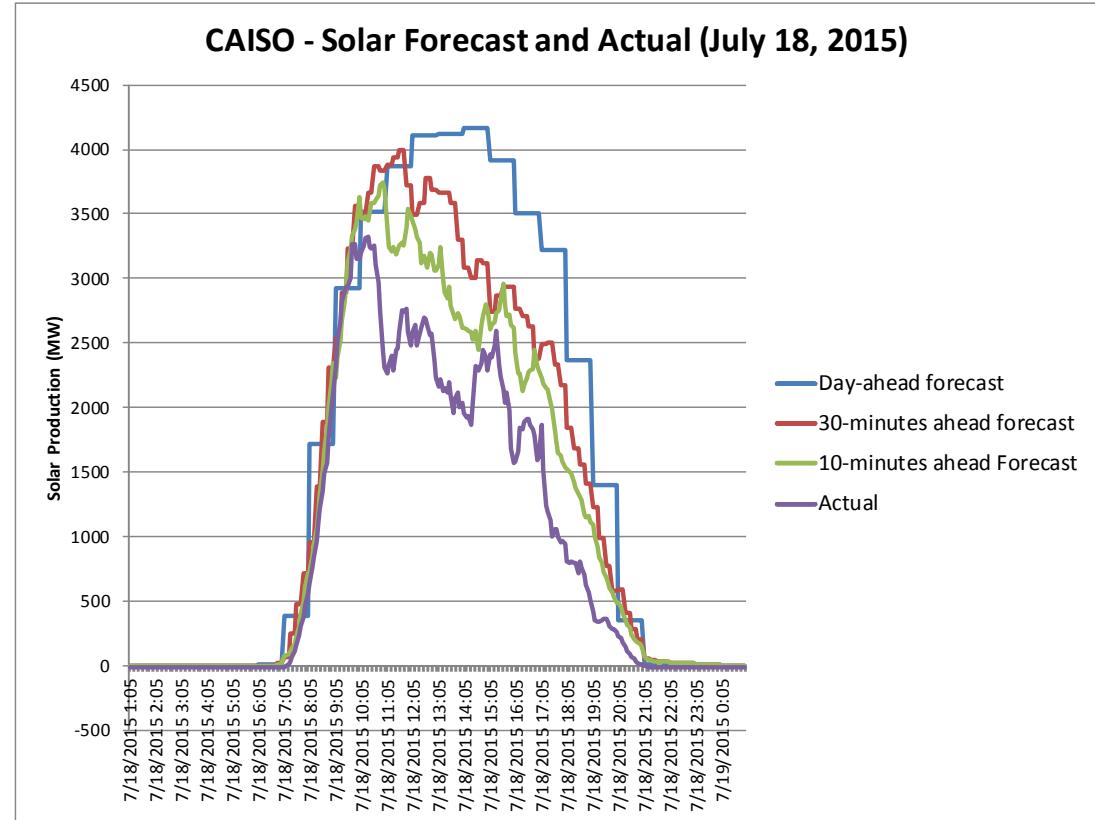
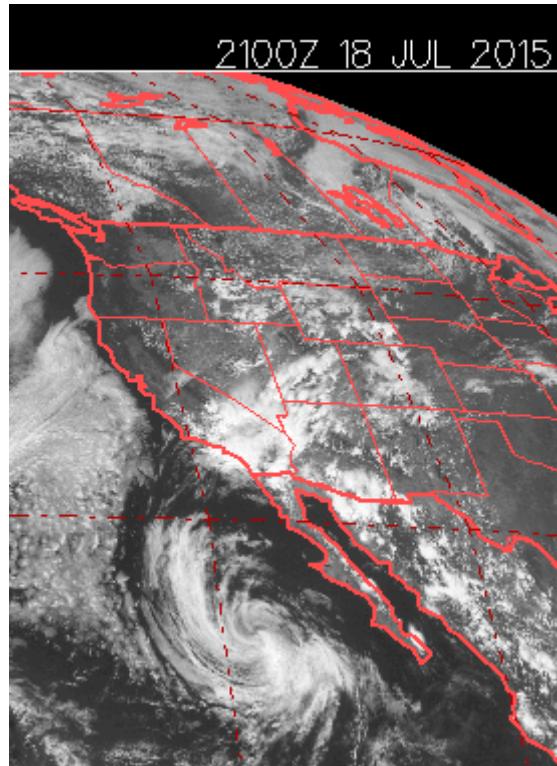
<http://www.caiso.com/Pages/ISOToday.aspx>

Real time view of supply and demand, renewable energy production, emergency notifications and requests for energy conservation.

A common visualization layer integrates the results of multiple applications to provide Wide-Area Situational Awareness



July 18, 2015 illustrates the need to integrate satellite information to forecast supply variability

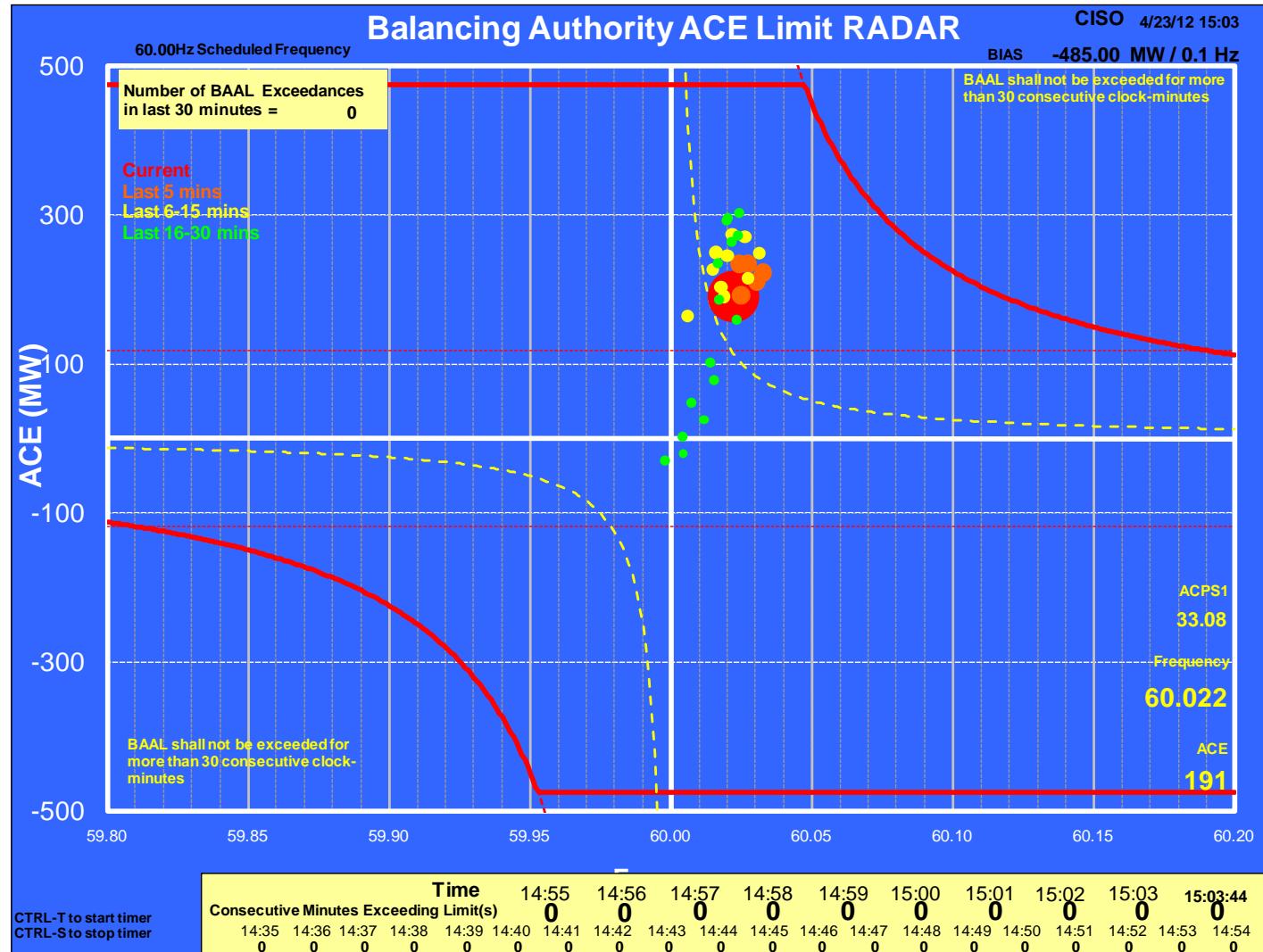


Renewable Profiles

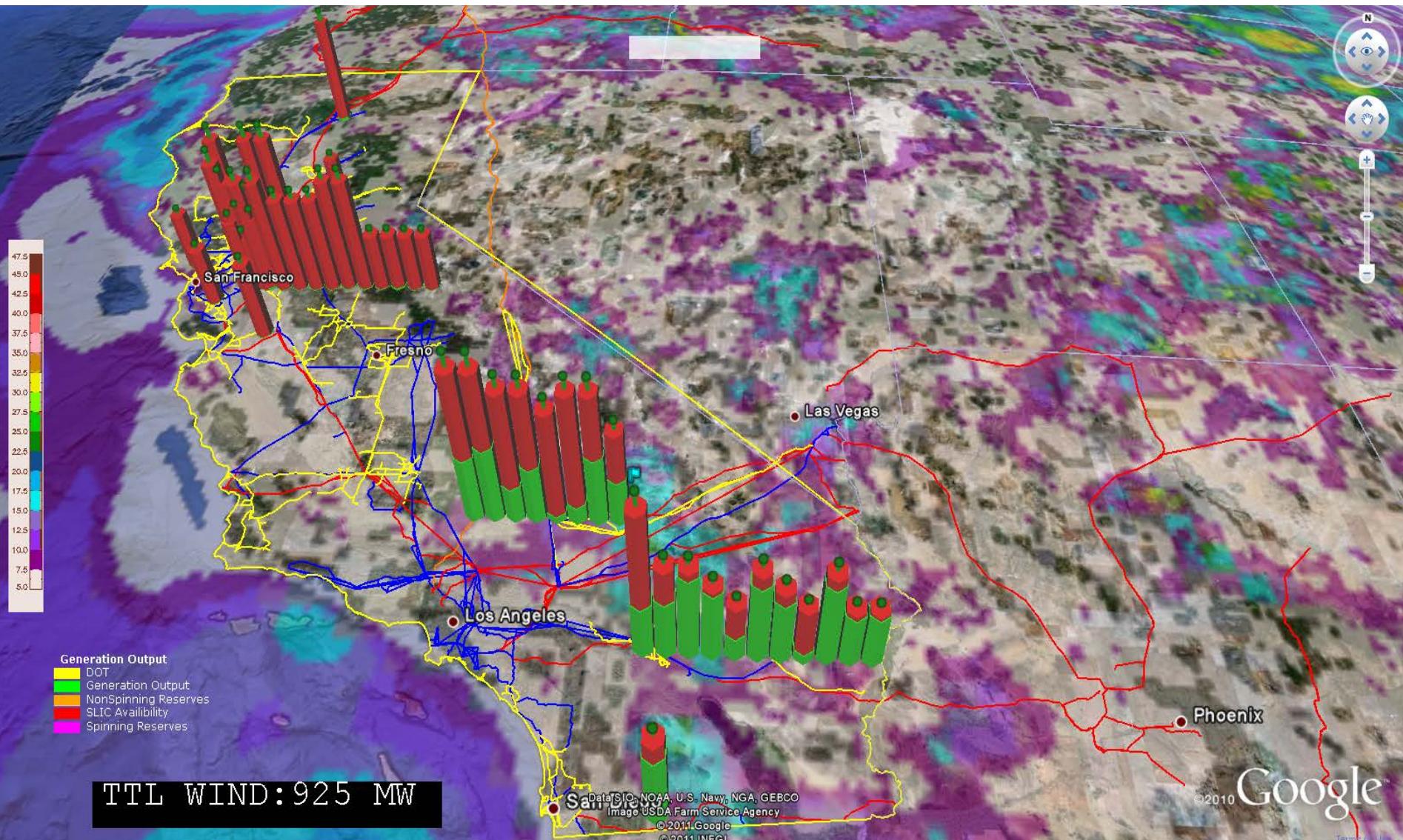


Balancing Authority ACE limit (BAAL)

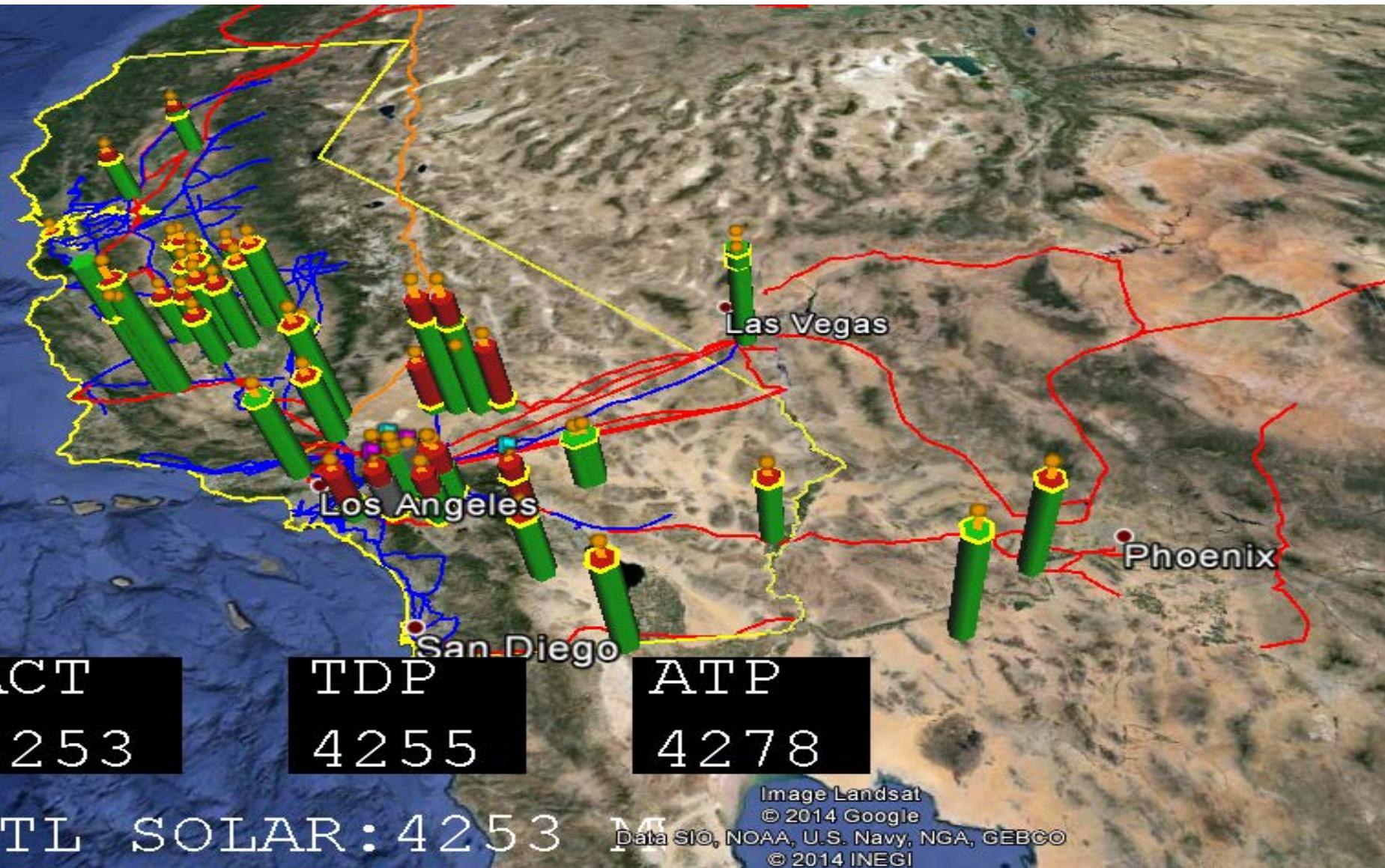
- BAAL is designed to replace CPS2
- Control opposes frequency deviation
- BAAL relaxes area regulation needs
- ACE is allowed to be outside BAAL for up to 30 minutes



Wind Summary Visualization

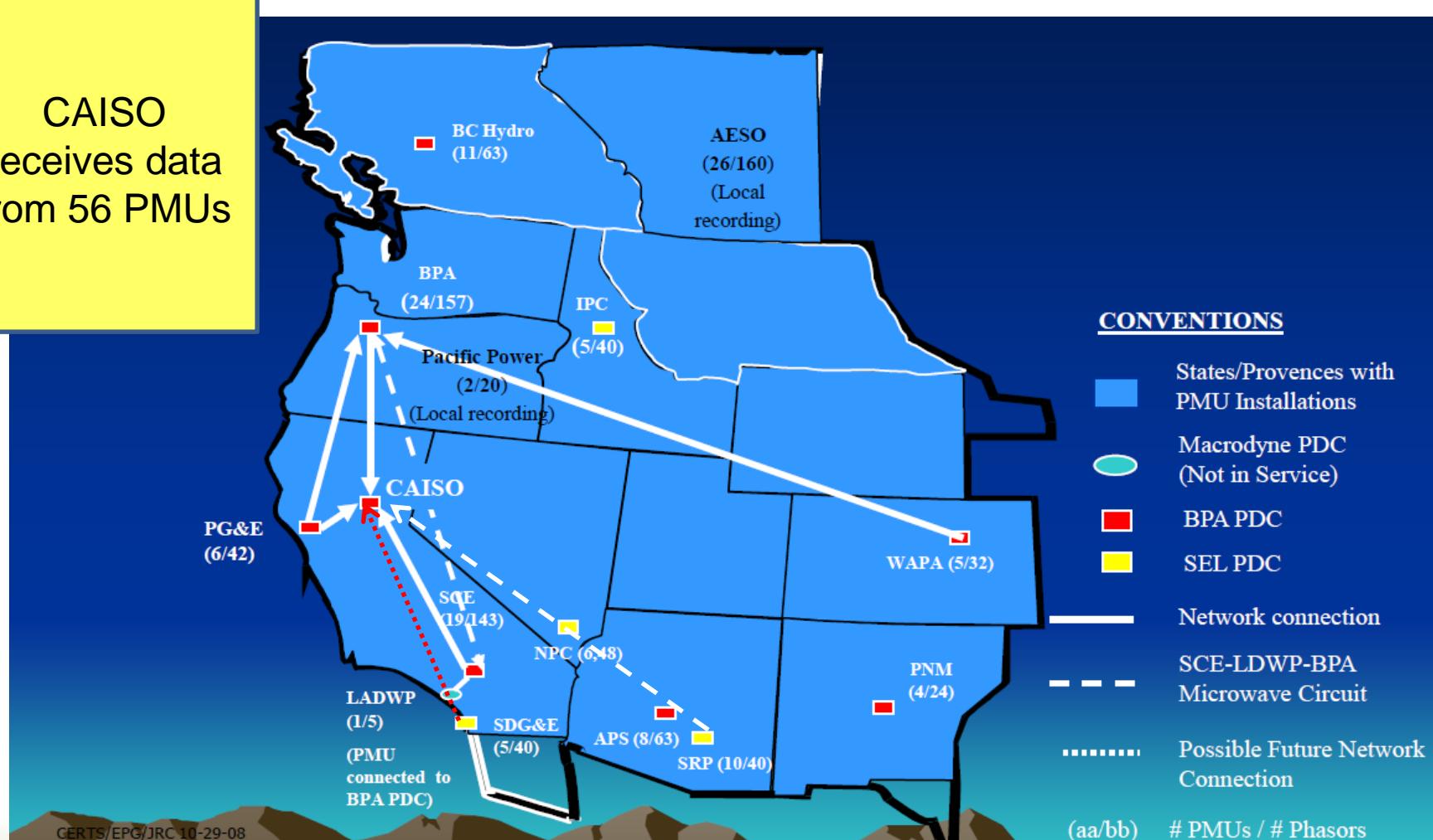


Solar

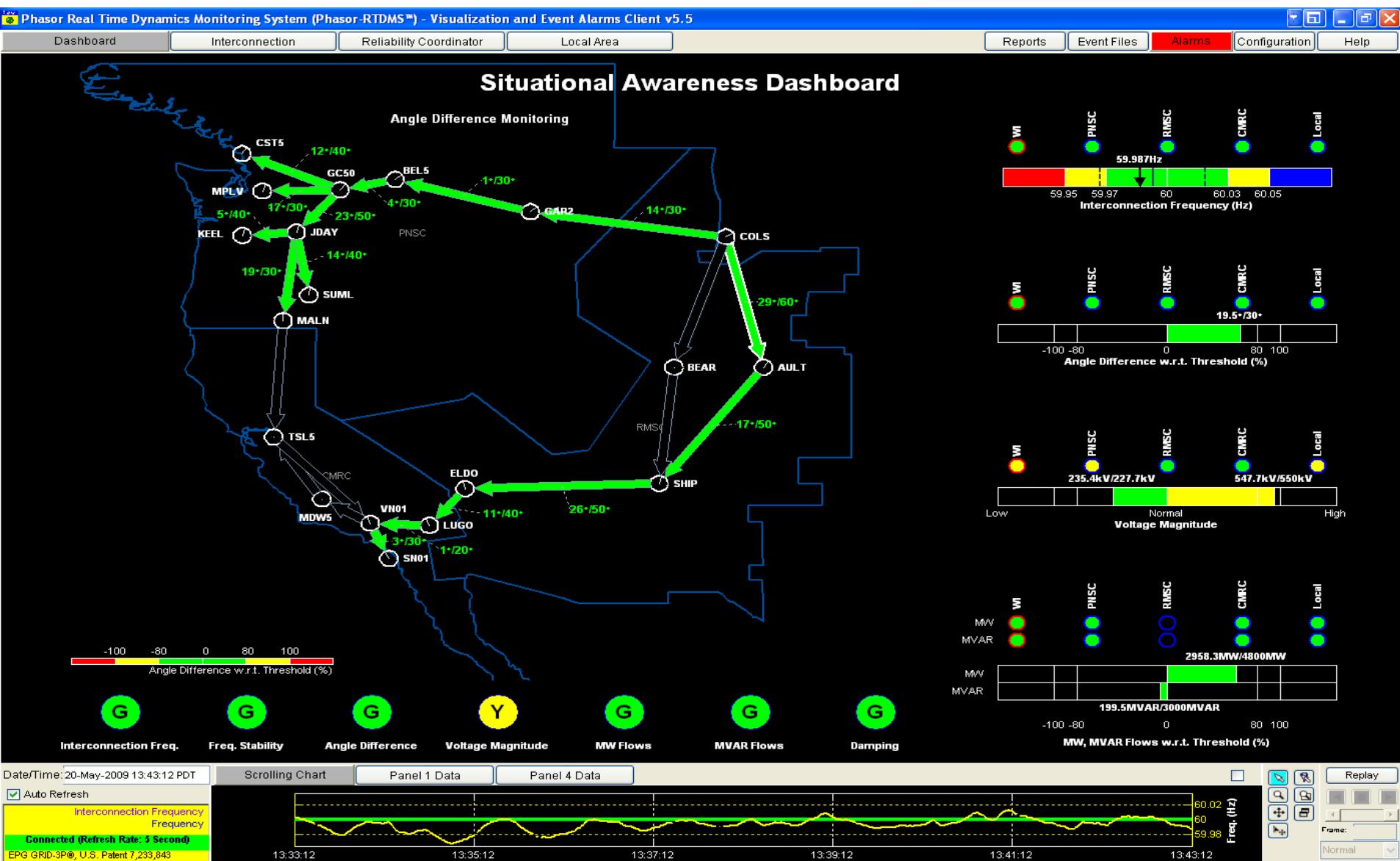


Synchrophasor data exchange between utilities and California ISO

CAISO receives data from 56 PMUs



RTDMS Application – Visualization Tool



QUESTIONS