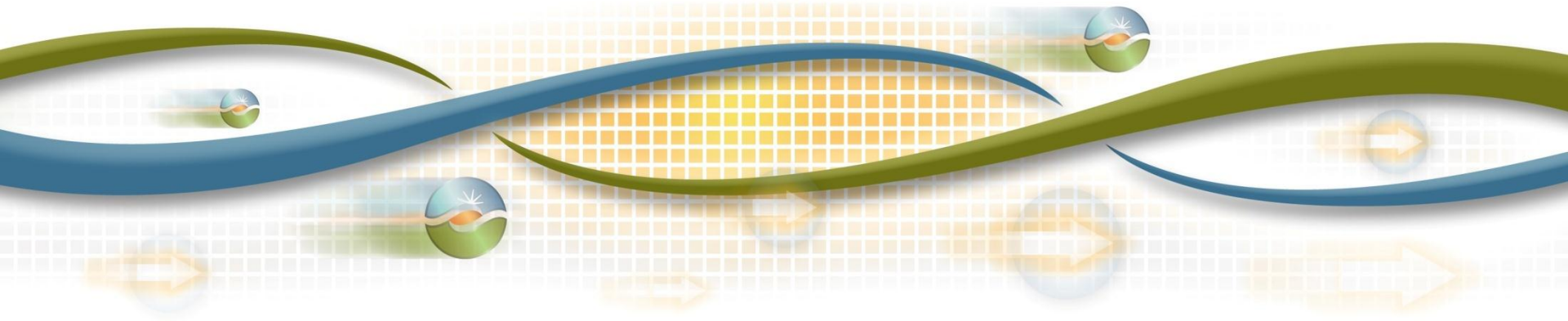


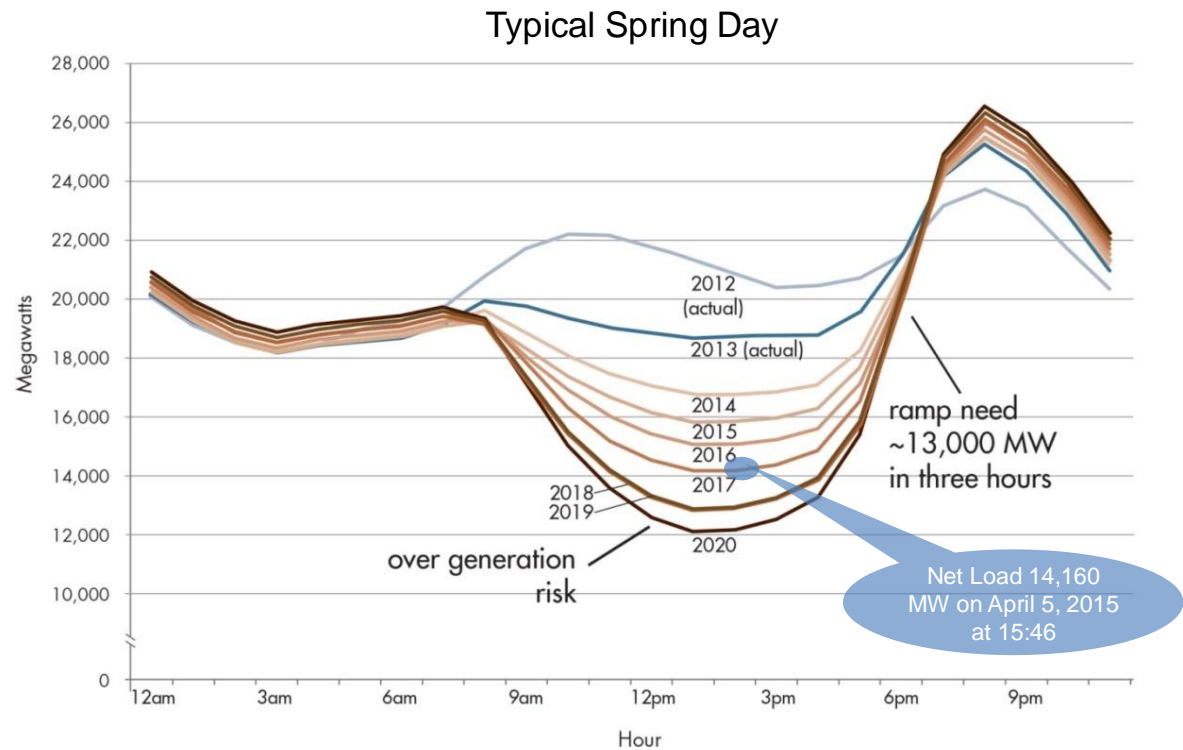
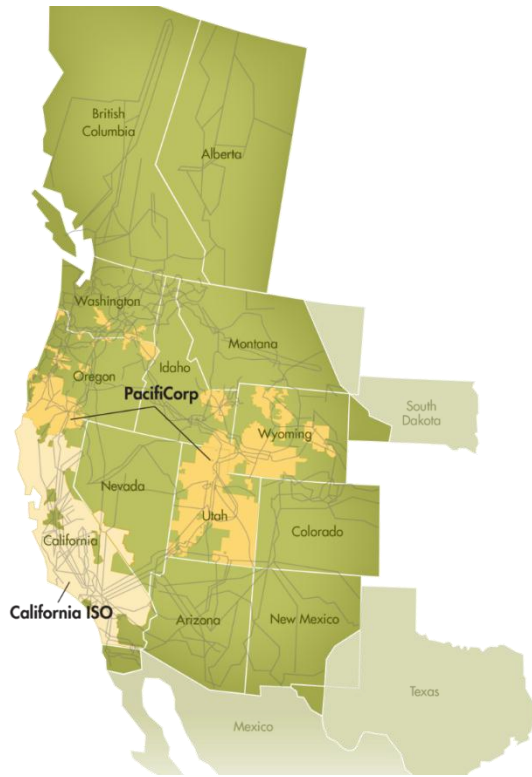


Iowa State University Wind Energy Industry Symposium

Clyde Loutan, Sr. Advisor
Renewable Energy Integration
September 29, 2015

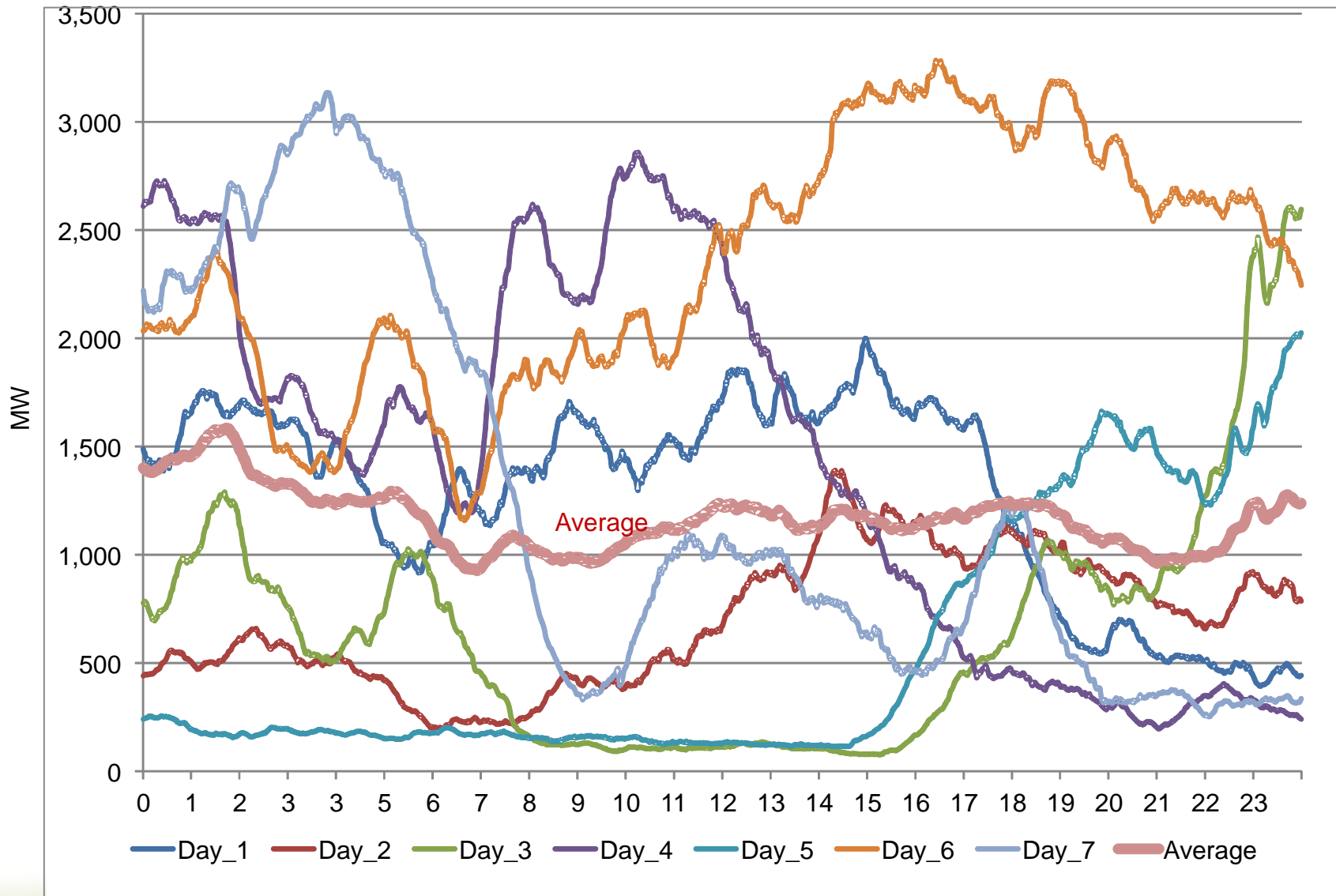


California ISO is the largest of ten BAs in California and now operates in seven western states

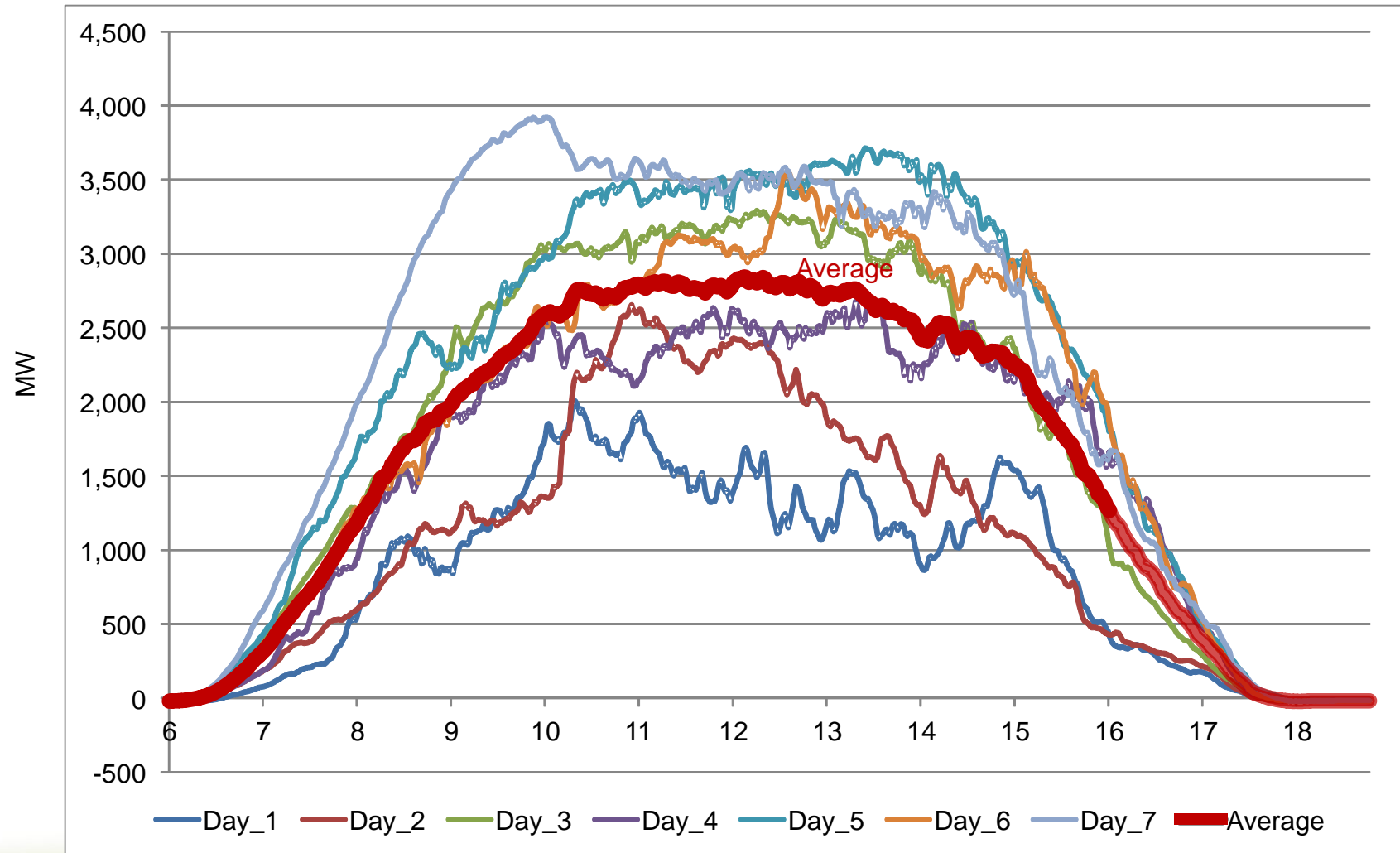


- **65,226 MW** of power plant capacity (net dependable capacity)
- **50,270 MW** record peak demand (July 24, 2006)
- **30 million** people served
- **\$10 billion** annual market
- **80%** of the load served in California

Wind production varies from one day to the next --- first week of March 2014



Solar production varies from one day to the next --- first week of March 2014

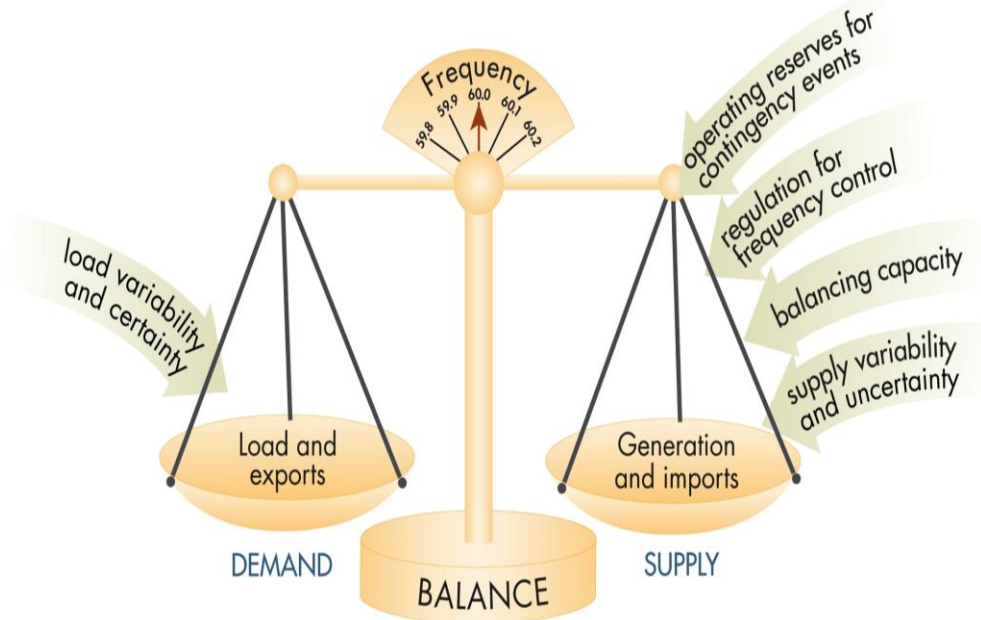


A Balancing Authority (BA) is responsible for operating a transmission control area

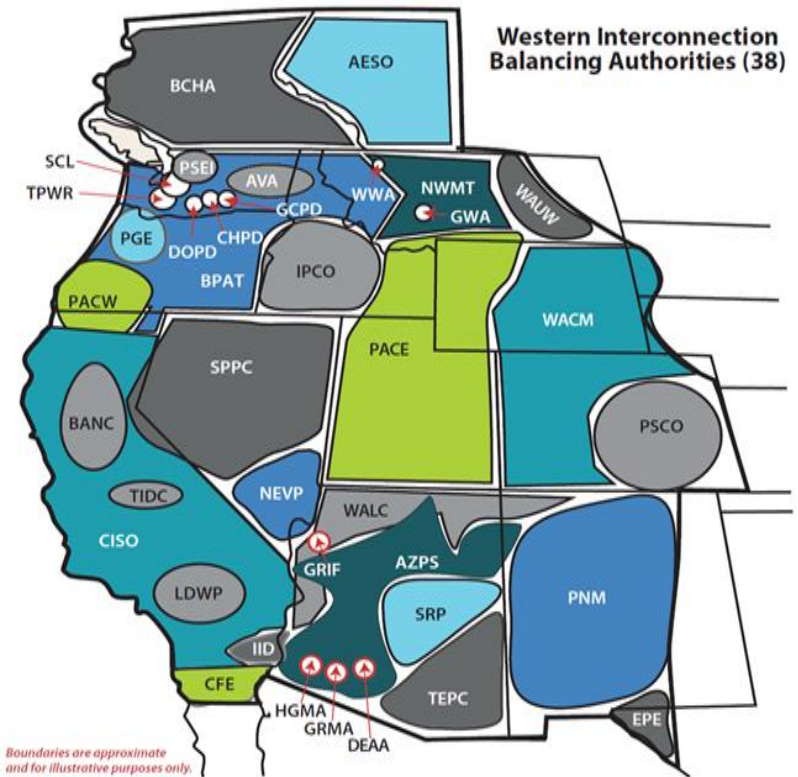
Electricity is produced, delivered, and consumed at the speed of light.

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



The assessment of a Balancing Authority control performance is based on three components

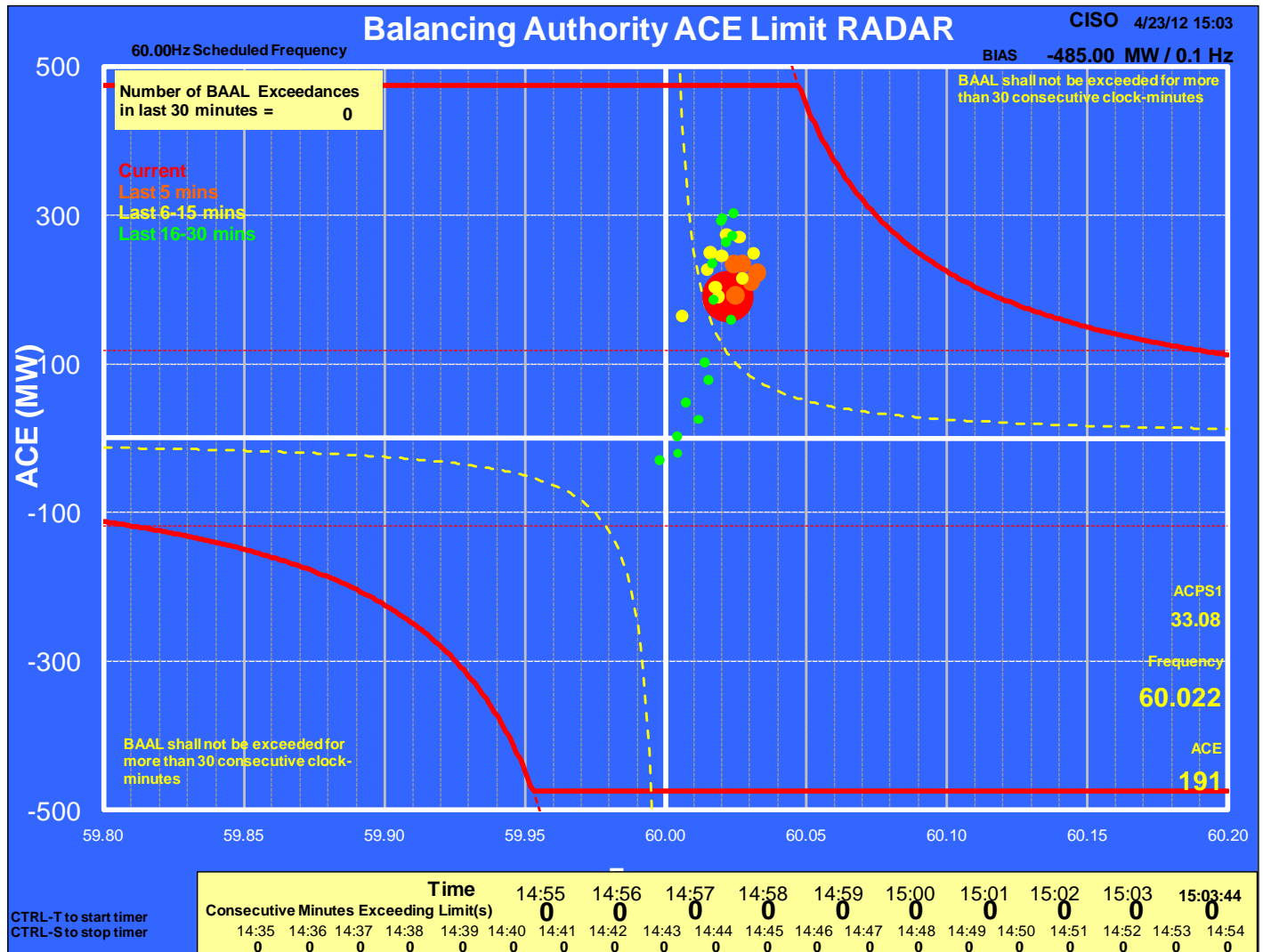
- **Control Performance Standard (CPS1)** - measures how well a BA's ACE performs in conjunction with the frequency error of the Interconnection measured as a 12 month rolling average
- **Balancing Authority Ace Limit (BAAL)** - is a real-time measure of area control error and system frequency which cannot exceed predefined limits for more than 30-minutes
- **Disturbance Control Standard (DCS)** - is the responsibility of a BA to recover its ACE to zero if its ACE just prior to the disturbance was greater than zero or to its pre-disturbance level if ACE was less than zero within 15 minutes
- ***New NERC operating standard (BAL-003-1 to be implemented in 2017)***
 - All BAs to support the interconnection frequency within 30 seconds following a disturbance greater than 500 MW anywhere in the interconnection

Control Performance Assessment

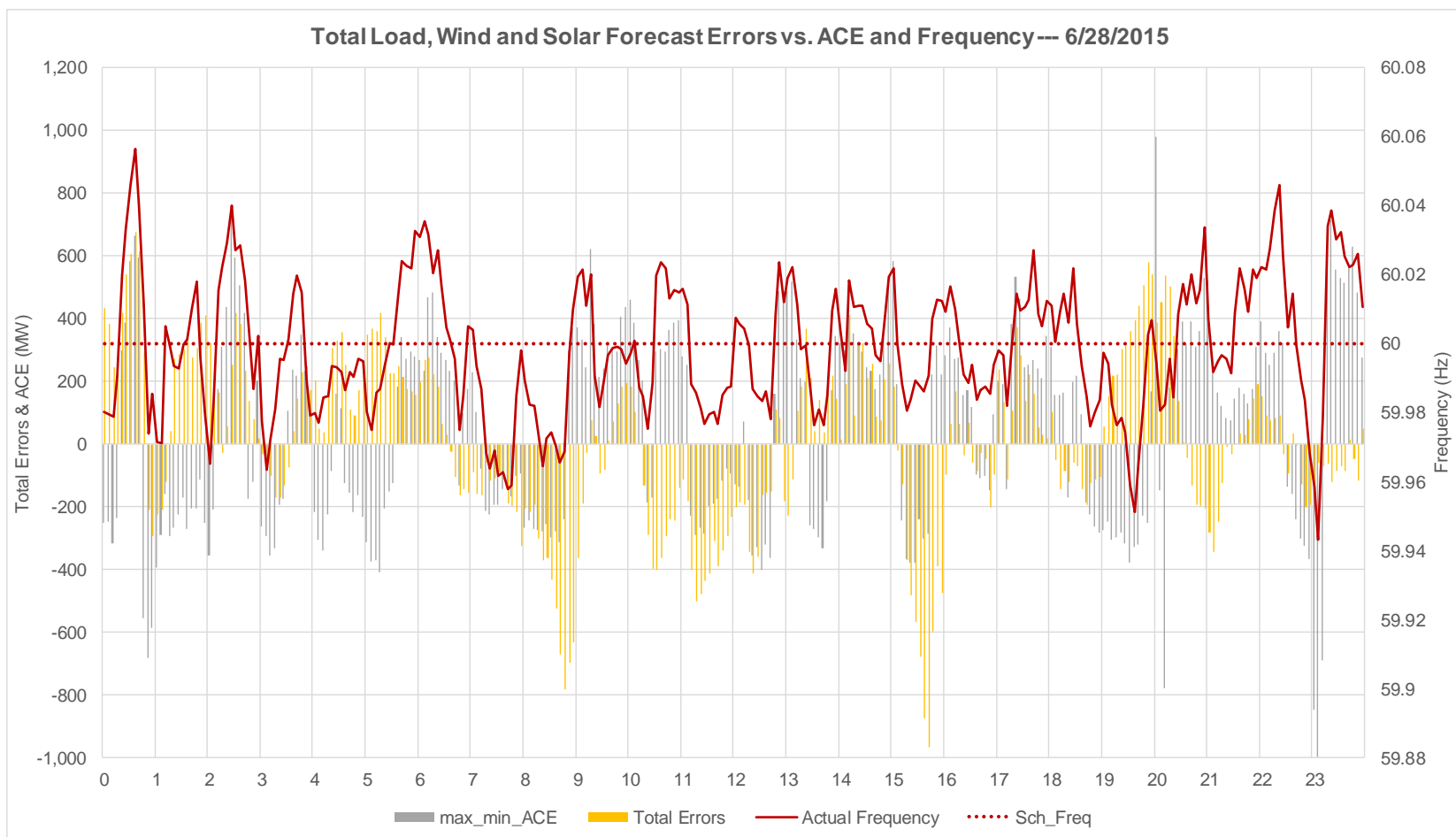
Pass is when $CPS1 \geq 100\%$; $BAAL_{Limit} \leq 30$ minutes & $DCS = 100\%$

Balancing Authority ACE Limit (BAAL)

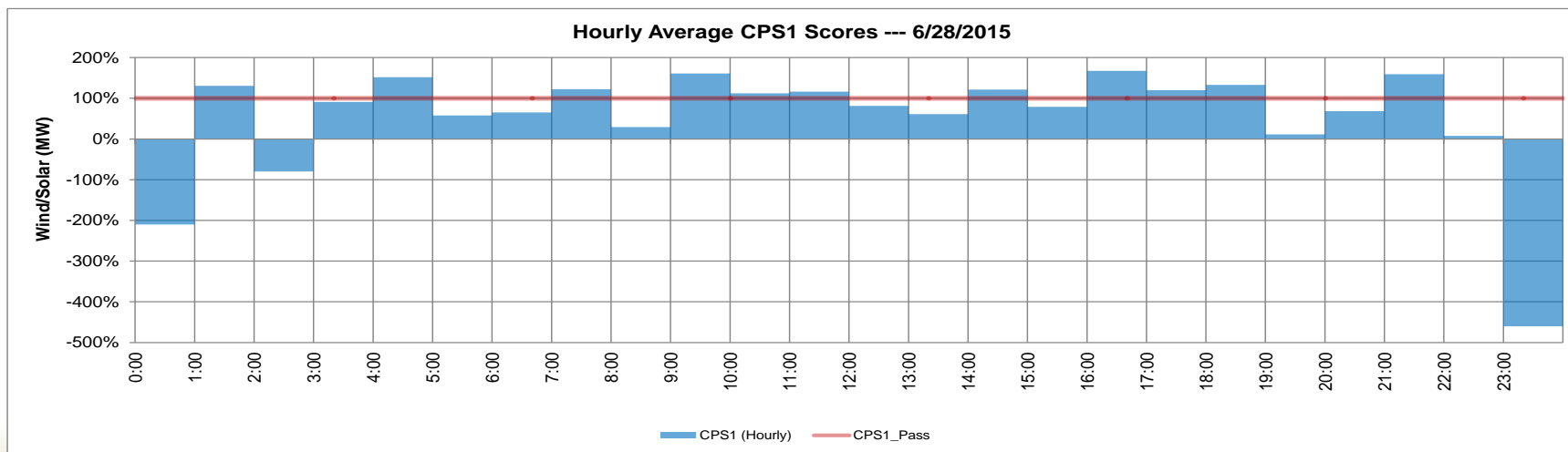
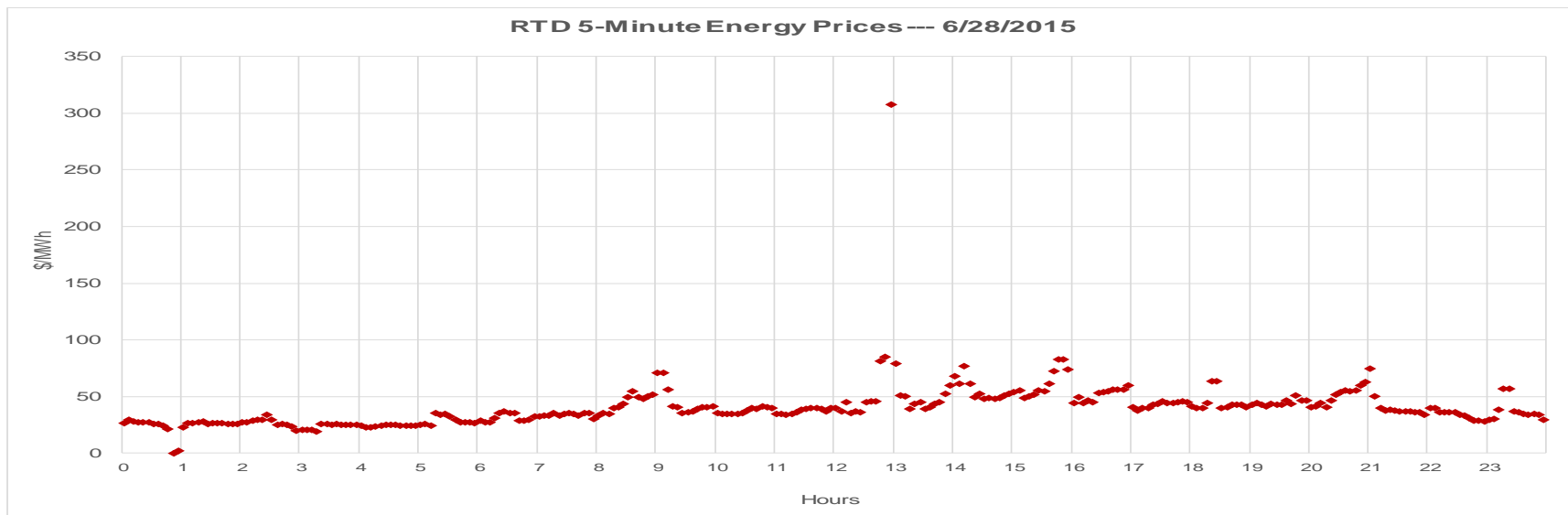
- BAAL is designed to replace CPS2
- Control opposes frequency deviation
- BAAL relaxes area regulation needs
- ACE is allowed to be outside BAAL for up to 30 minutes



Generally when the total wind, solar and wind forecast errors are in the same direction as frequency deviations, affects on control performance are not reflected in 5-minute energy prices



Magnitude of 5-minute energy prices may not reflect ramping deficiencies on the system but can impact CPS1 performance





Questions!