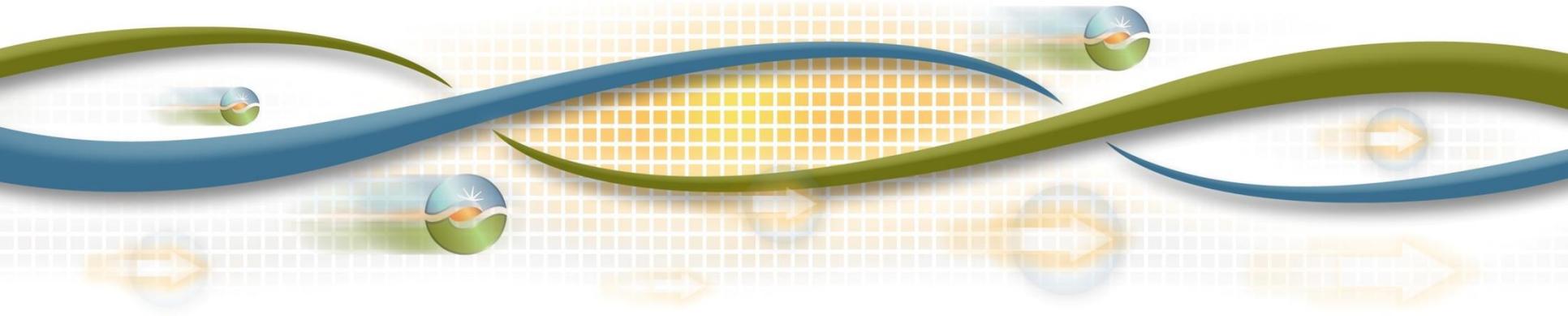




August 21, 2017 Solar Eclipse Review

Nancy Traweek
Executive Director, System Operations



CAISO solar eclipse overview

- Installed solar capacity at BES level ~ **10,000 MW**
 - Peak solar output of 9,914 MW on June 17, 2017
- Installed wind capacity of ~ 6,500 MW
 - Peak wind output of 4,985 MW on May 16, 2017
- Rooftop solar ~ **5,800 MW**
 - Approximately 31% or 1855 MW are commercial or industrial installations with the remainder being residential
- Expected obscuration
 - 76% at the higher latitudes of Northern California to approximately 62% in the lower latitudes of Southern California
- ISO all-time peak load of 50,270 MW July 24, 2006
 - Forecast peak load for August 21 - 36,339 MW
 - Actual load on August 21 - 36,046 MW

CAISO preparation for the solar eclipse

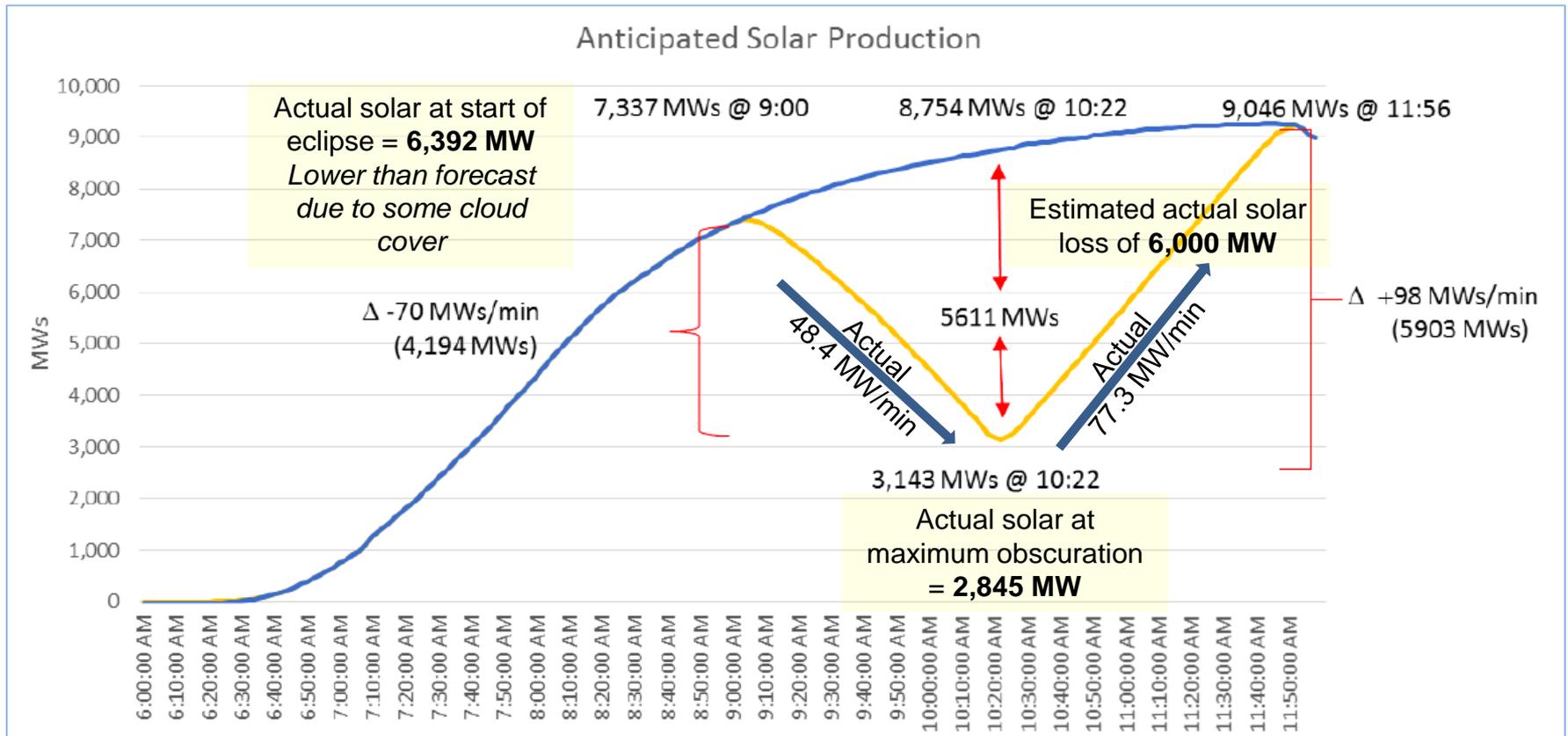
- Performed studies using high, medium, and low load level days
- Adjusted load forecast in studies and day ahead market to compensate for reduction in behind-the-meter solar
- Adjust solar ramp as follows for both the studies and day ahead market*
 - HE10 max solar, HE 11 min solar, HE12 max solar
- Increased regulation up & down procurement for the eclipse period
- Tightened AGC bands (close to L_{10}) for the eclipse period
- Restricted Maintenance Operations (no TTC derate)
 - Actual RMO was set 2 weeks in advance
- Solar resources
 - Requested to follow Dispatch Operating Target (DOT) during return from eclipse
- Hydro generation
 - Requested hydro resources be ready for rapid response during loss and return of solar
- ISO RT Ops staff
 - Crew training – used simulator and table top
 - Created guide for on-shift crew

** The CAISO Day Ahead Market normally uses hourly averages for load and resource values. This would have dampened the impact of the eclipse.*

Coordination in preparation for the solar eclipse

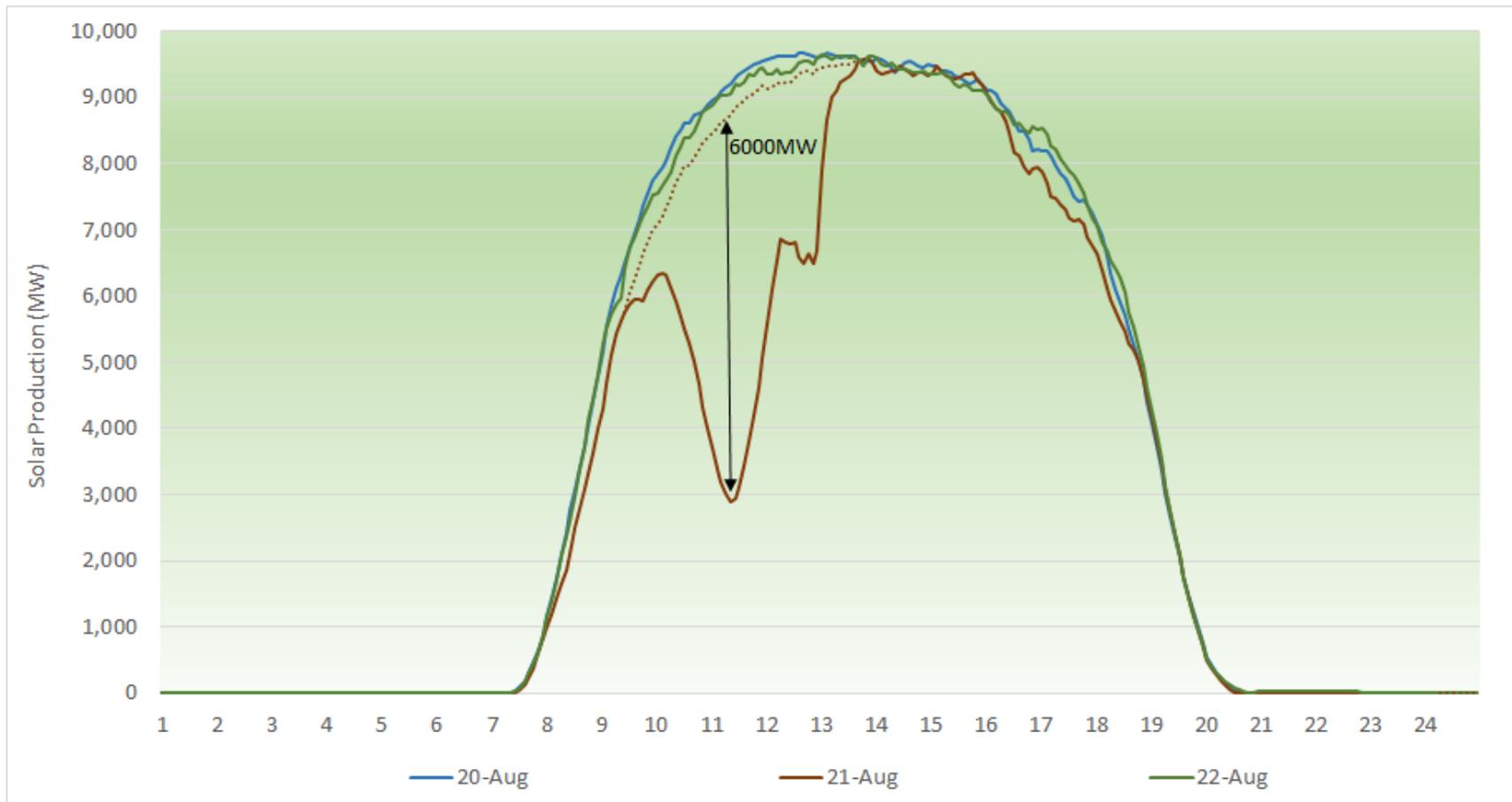
Entity	Items
Peak RC	<ul style="list-style-type: none">• Shared Operational Plan• Discussed eclipse impact on BES & rooftop resources• Shared market simulation results• Peak RC solar eclipse readiness call
Adjacent BA's	<ul style="list-style-type: none">• Reviewed anticipated eclipse impact & Operational Plans
EIM Participants	<ul style="list-style-type: none">• Discussed consistent policy for ETSR's during eclipse• Accounted for eclipse in energy schedule submittals
Gas companies	<ul style="list-style-type: none">• Shared gas burn calculations from market simulations• Discussed any planned gas line work
CAISO TO's	<ul style="list-style-type: none">• Anticipated eclipse impact & Operational plan• Sent "Peak Day" messaging before and during the eclipse
Market Participants	<ul style="list-style-type: none">• Shared anticipated eclipse impact & Operational Plan• Verified resources had adequate fuel• Requested bids to keep resources flexible• Requested they follow their DOT (dispatch target)

Anticipated and actual impact on CAISO solar resources



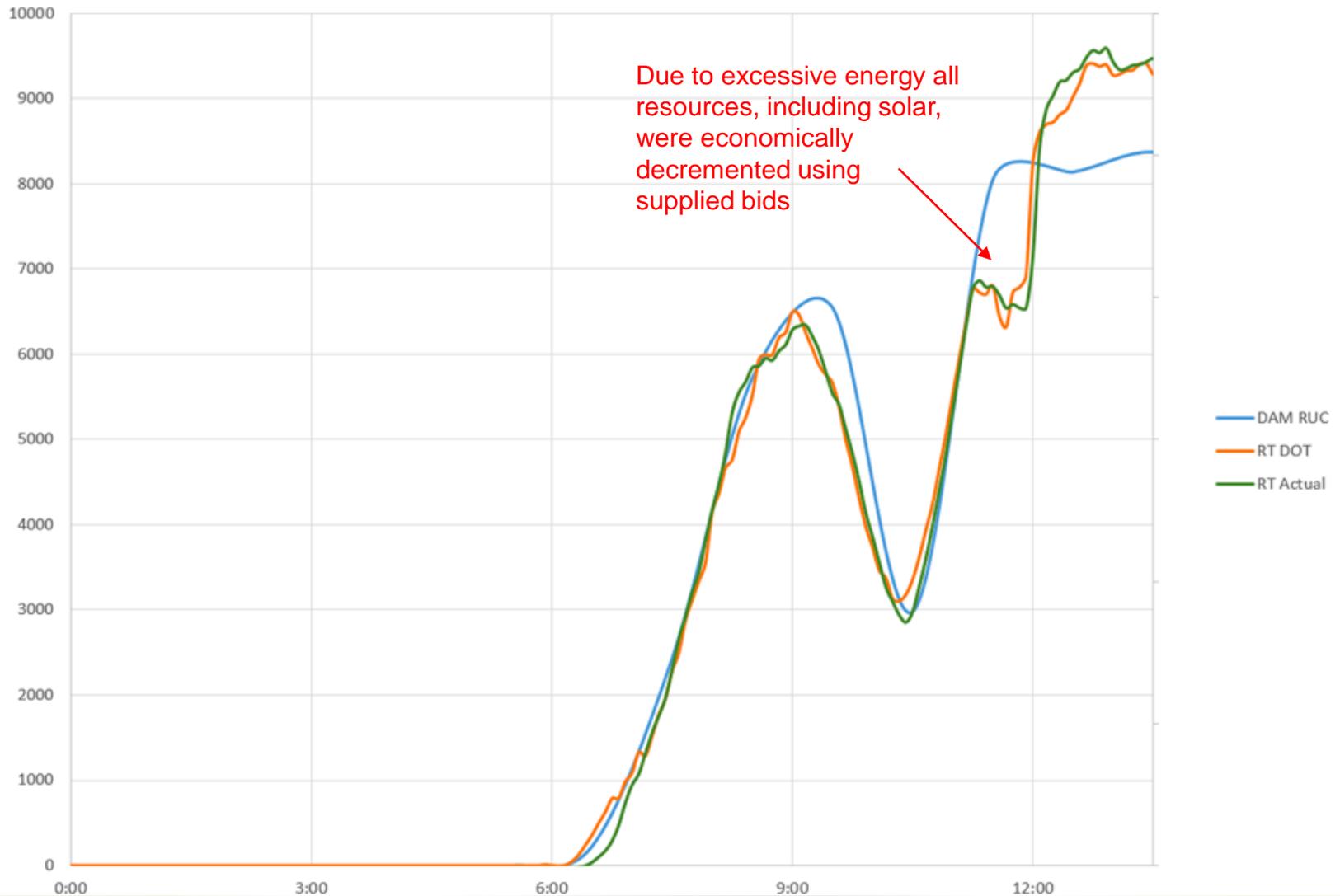
Blue line is similar day solar output. Yellow is forecast of the solar eclipse impact on solar production.

Solar production during the eclipse compared to adjacent days

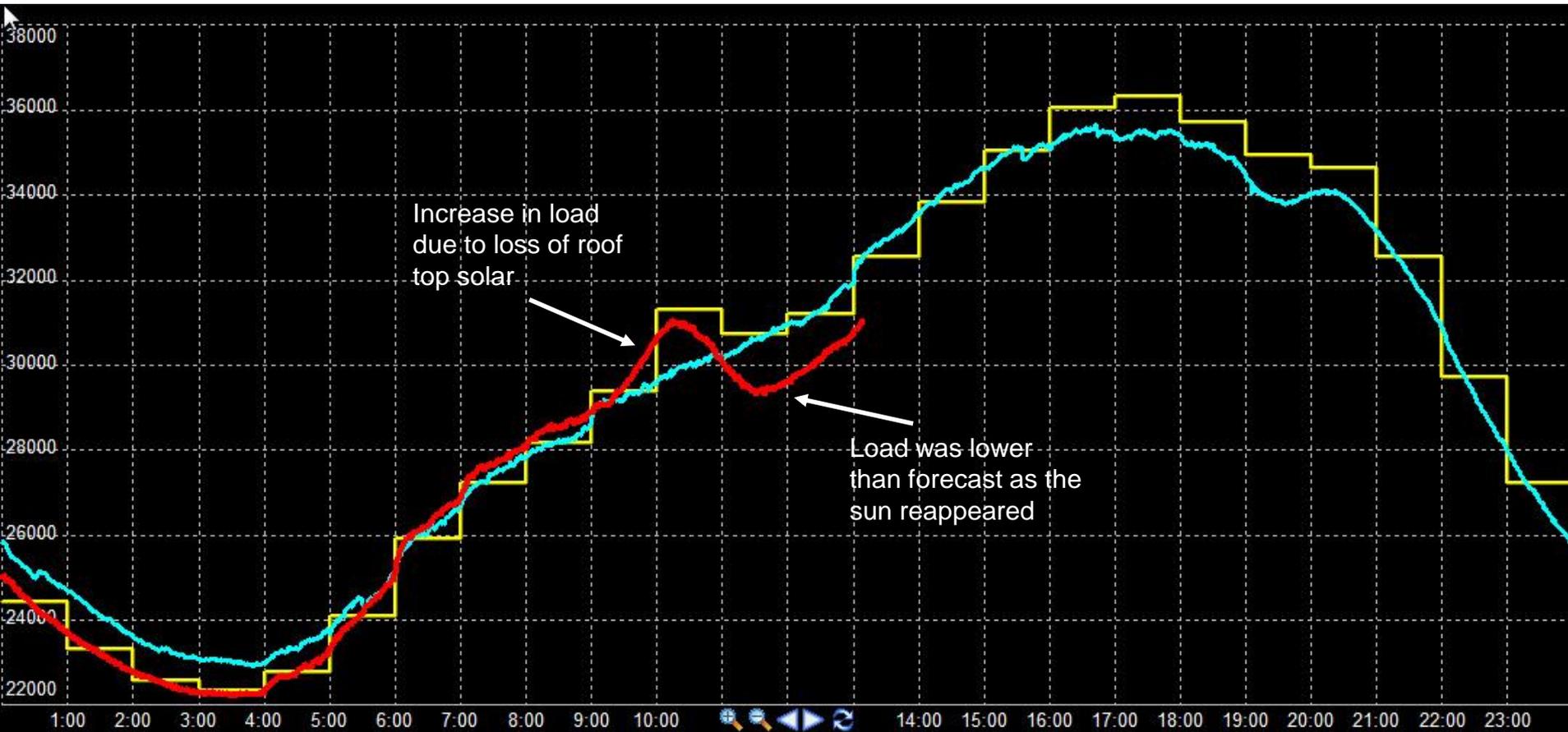


Comparison of solar forecast and actual generation

Aug 21, 2017

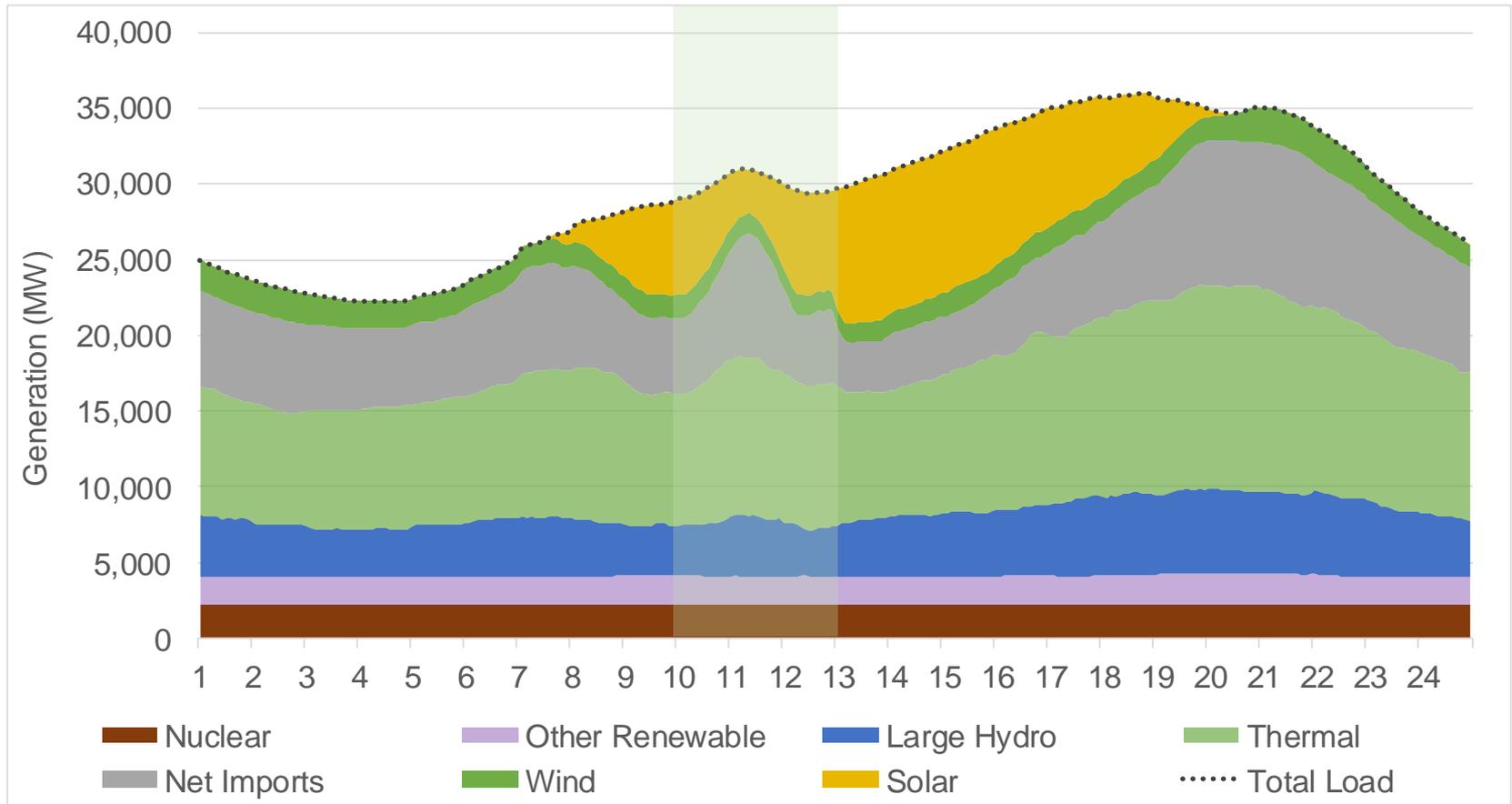


CAISO load and solar eclipse impact on behind the meter solar

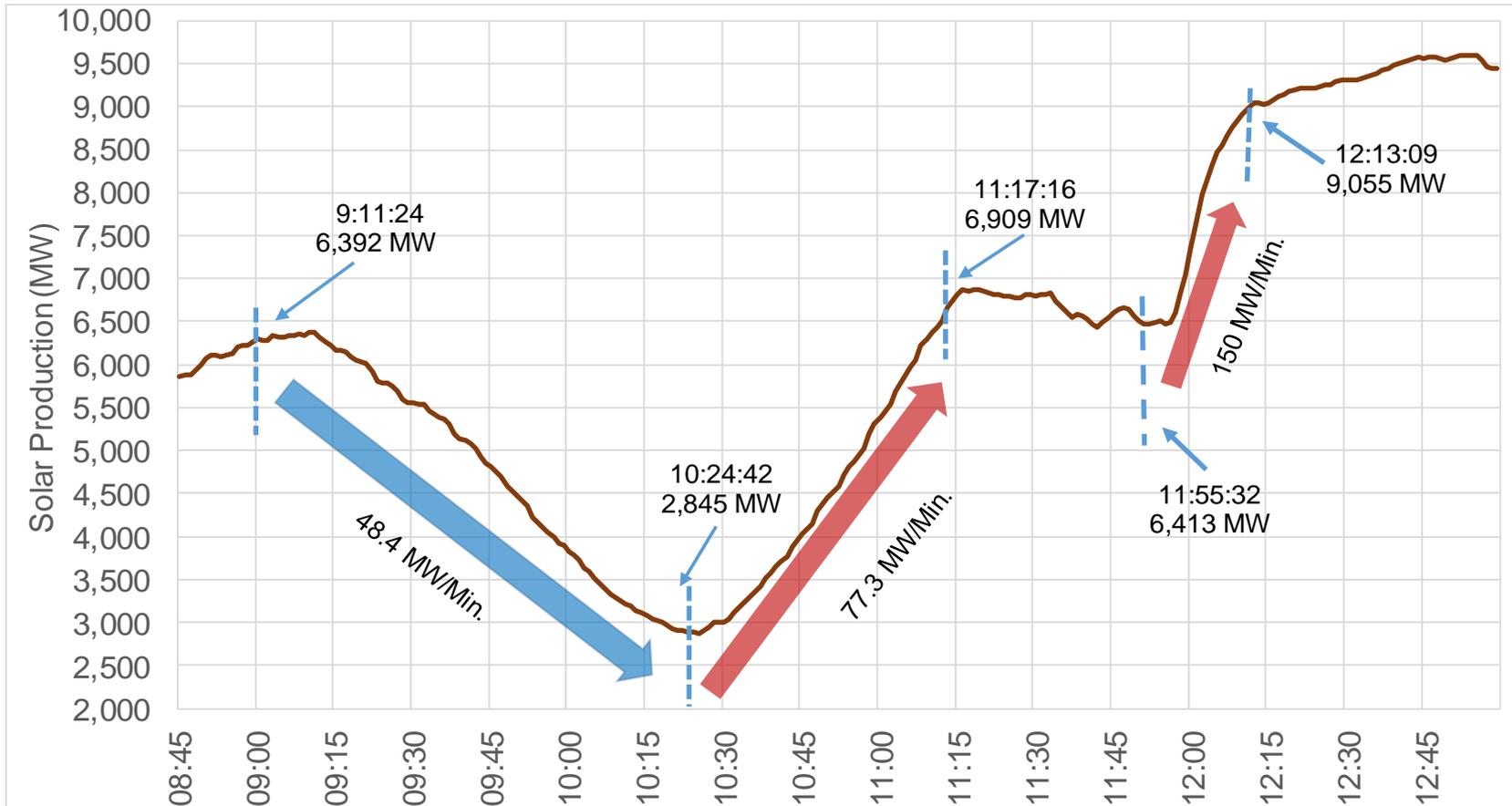


Red is actual load, yellow is day ahead forecast, blue is Monday August 14, 2017

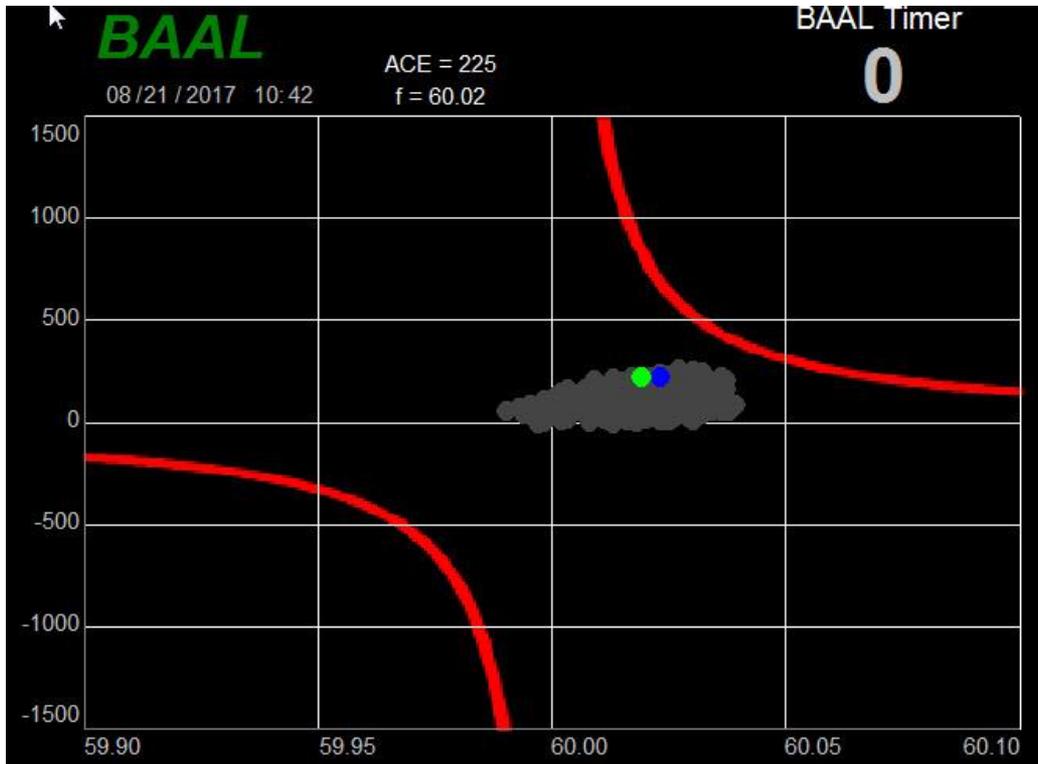
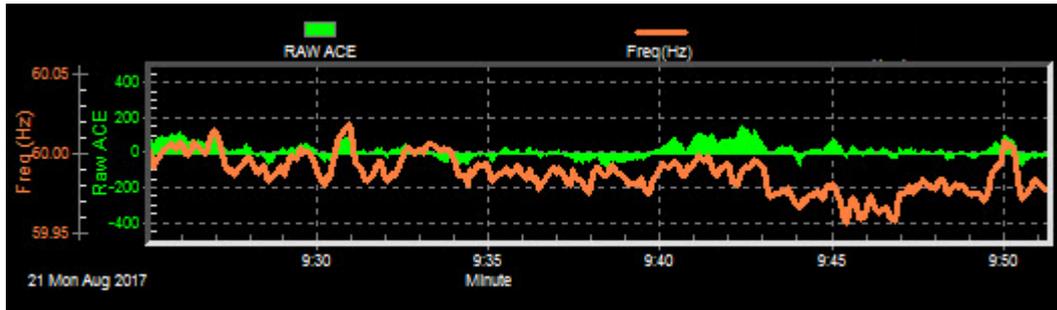
CAISO resource mix for August 21, 2017



Downward and Upward ramps during the eclipse were about 50MW/min and 150MW/min



CAISO performance indices



- Current
- 10 sec ago
- Last 30 minutes

Wrap-up

- Replacement energy came from the following
 - Interties (~3,200 MW)
 - Hydro (~800 MW)
 - Thermal (~1,600 MW)
 - EIM transfers (~350 MW)
- No manual intervention was required during the eclipse
 - No manual curtailment of solar resources
 - No manual/verbal dispatch of resources

Key points

- Extensive preparation by all teams was key to making this a success
- Accurate forecasts for load and variable resources are crucial
- A flexible resource fleet is important
 - Incremental bid on solar was very useful during return from eclipse
 - Variability of resources types helped manage the ramp up and down due to limitations on configuration transitions.
 - Giving hydro resources enough heads up to adjust water for maximum flexibility