Electric Advisory Committee Meeting Optimizing Bulk Power Operating Reserves

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Arlington, Virginia
June 19-20, 2019

Current NERC and WECC standards on contingency reserves

NERC: BAL-002-3 – Disturbance Control Standard – Contingency Reserve for Recovery from a Balancing Contingency Event

- No requirement for a BA to carry Spinning Reserve

WECC: Standard BAL-002-WECC-2a — Contingency Reserve

- The greater of either:
  - The amount of Contingency Reserve equal to the loss of the most severe single contingency;
  - The amount of Contingency Reserve equal to the sum of three percent of hourly integrated Load plus three percent of hourly integrated generation

    (Shall maintain at least half of its Contingency Reserve as Operating Reserve – Spinning)
- WECC is considering eliminating the Spinning Reserve requirement

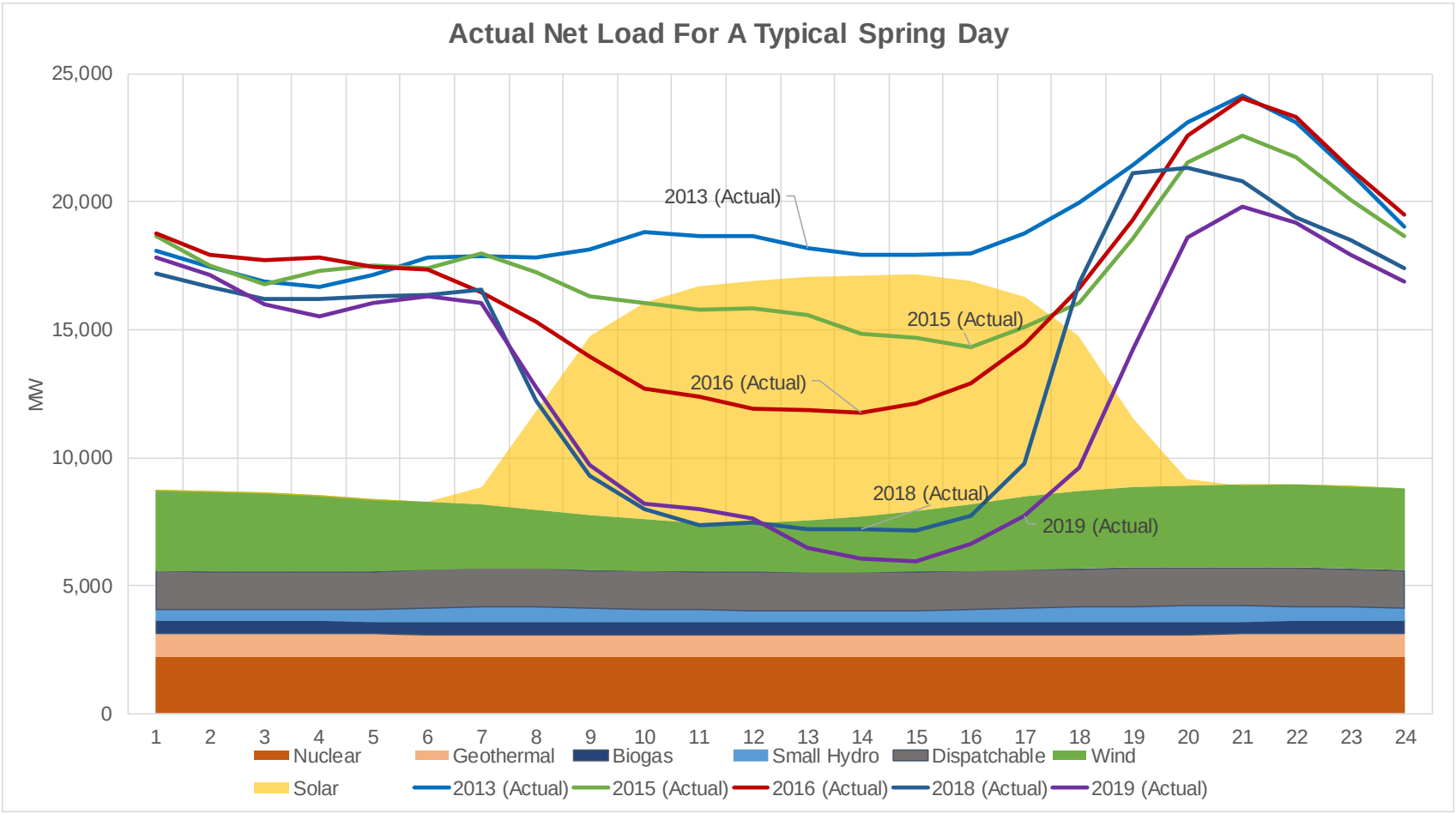
NERC: Standard BAL-003-1.1 — Frequency Response and Frequency Bias Setting

NERC: Standard BAL-001-2 – Real Power Balancing Control Performance

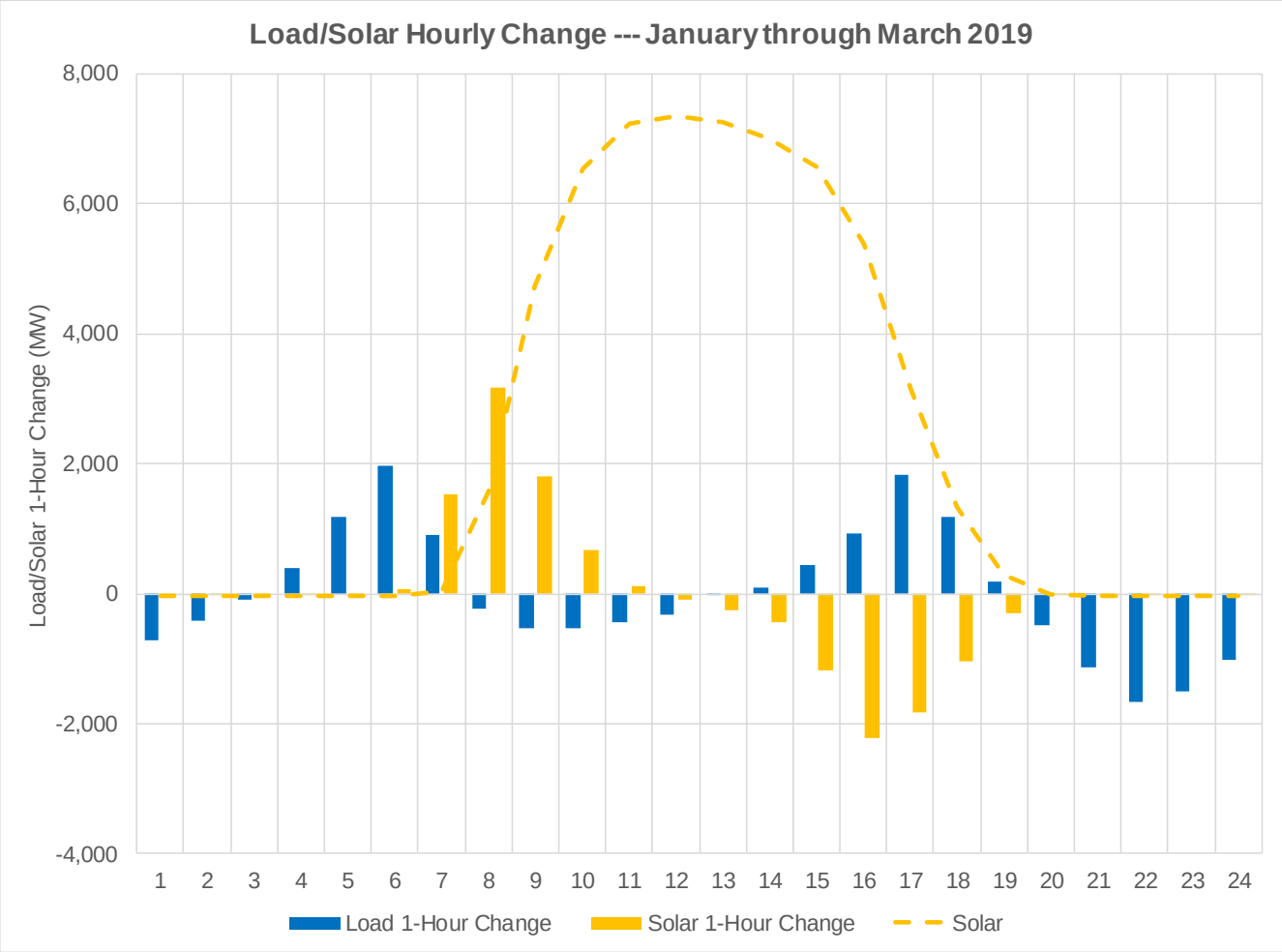
CAISO's current real time operational challenges

- Intra-hour ramps can be greater than ± 6,000 MW in some hours
- Maximum 3-hour ramps greater than 15,000 MW during sunset
- 10-minute variability between ±1,000 MW and ± 1,500 MW
  - Dispatch decisions for the binding 5-minute interval could be off by ± 1,500 MW
- Depleting regulation procured in some hours
- Oversupply conditions continue to increase
- Experiencing control performance challenges during sunrise and sunset and the middle of the day on weekends
- The CAISO faces risk of violating primary frequency response obligation --- especially under hydro spill conditions

Net load (load less solar than wind) continues to drop

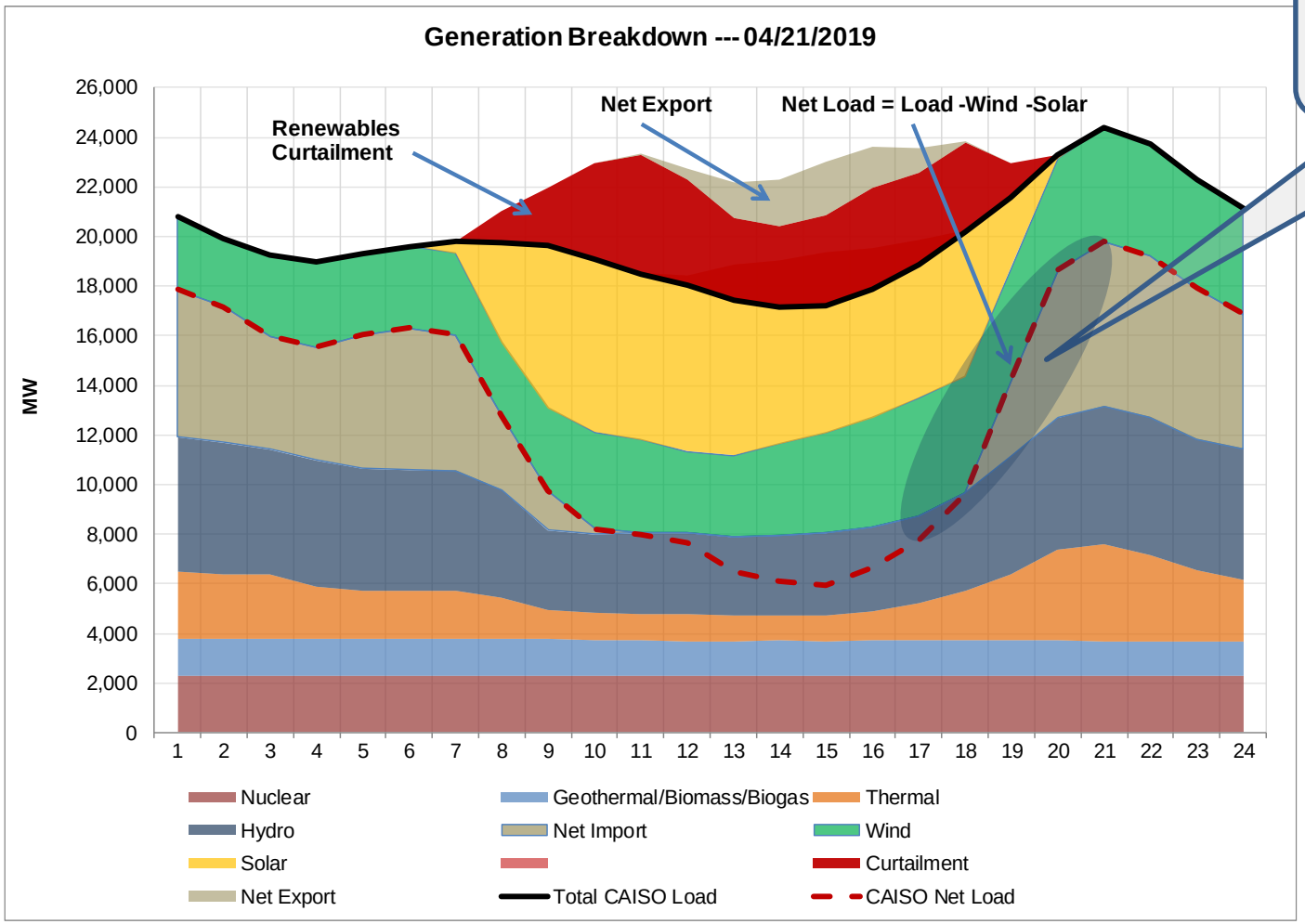


Hourly load and solar change for January through March 2019



- During sunrise, while solar is ramping up, load is still dropping off partly due to roof-top solar PV
- May have to impose a MW/hour limit on aggregated solar production during sunrise due to high ACE and frequency
- During sunset, load is increasing while solar production is decreasing, which drives the 3-hour upward ramping needs

On Sunday April 21, 2019 the CAISO experienced a minimum net of 5,667 MW @ 14:37

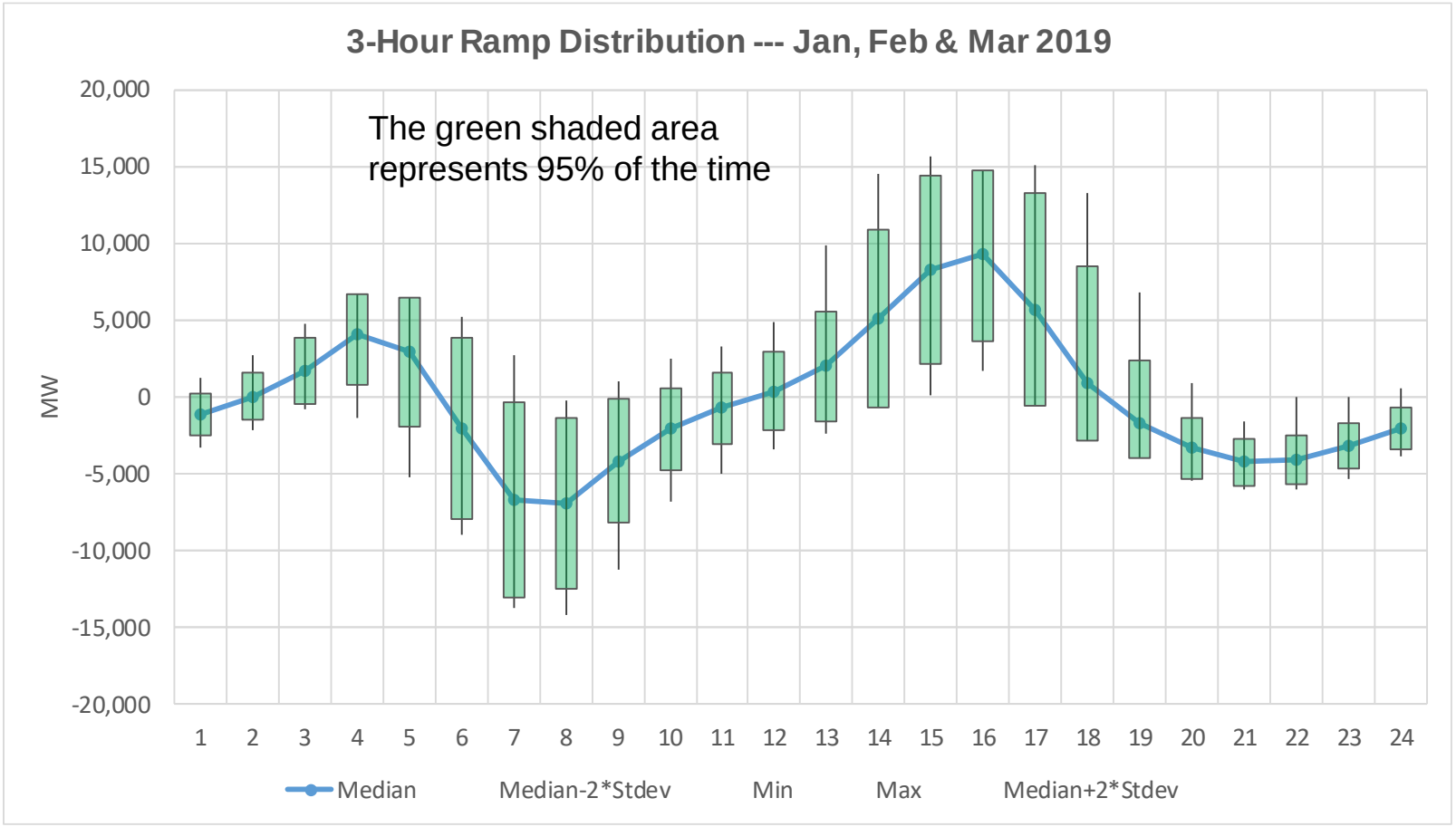


3-hr, 11,355 MW ramp met by:
- Import ~ 64.4%
- Hydro – 15.6%
- Thermal – 20.0%

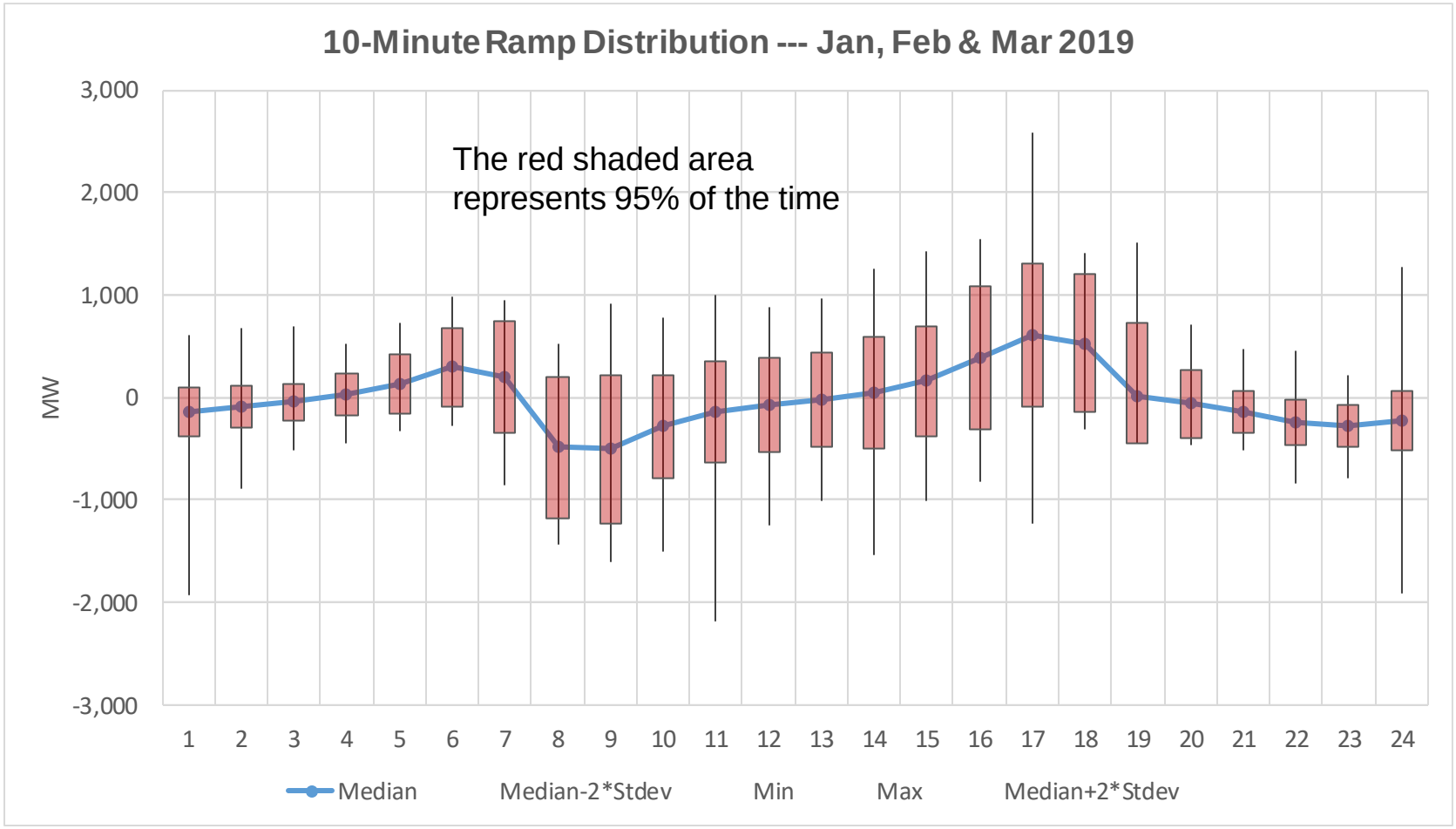
- Maximum renewable curtailment was 4,789 MW
- Total curtailment of renewables was 31,989 MWh
- Maximum net export was 2,359 MW
- Max EIM export was 4,150 MW
- The CAISO continued to curtail solar during sunset, which helped in reducing the 3-hour upward ramp
- Max simultaneous wind & solar production was 11,598 MW at 14:36

What is the Optimum Level of Operating Reserves?

The 3-Hour ramp distribution for January through March 2019 can exceed +15,000 MW during sunset

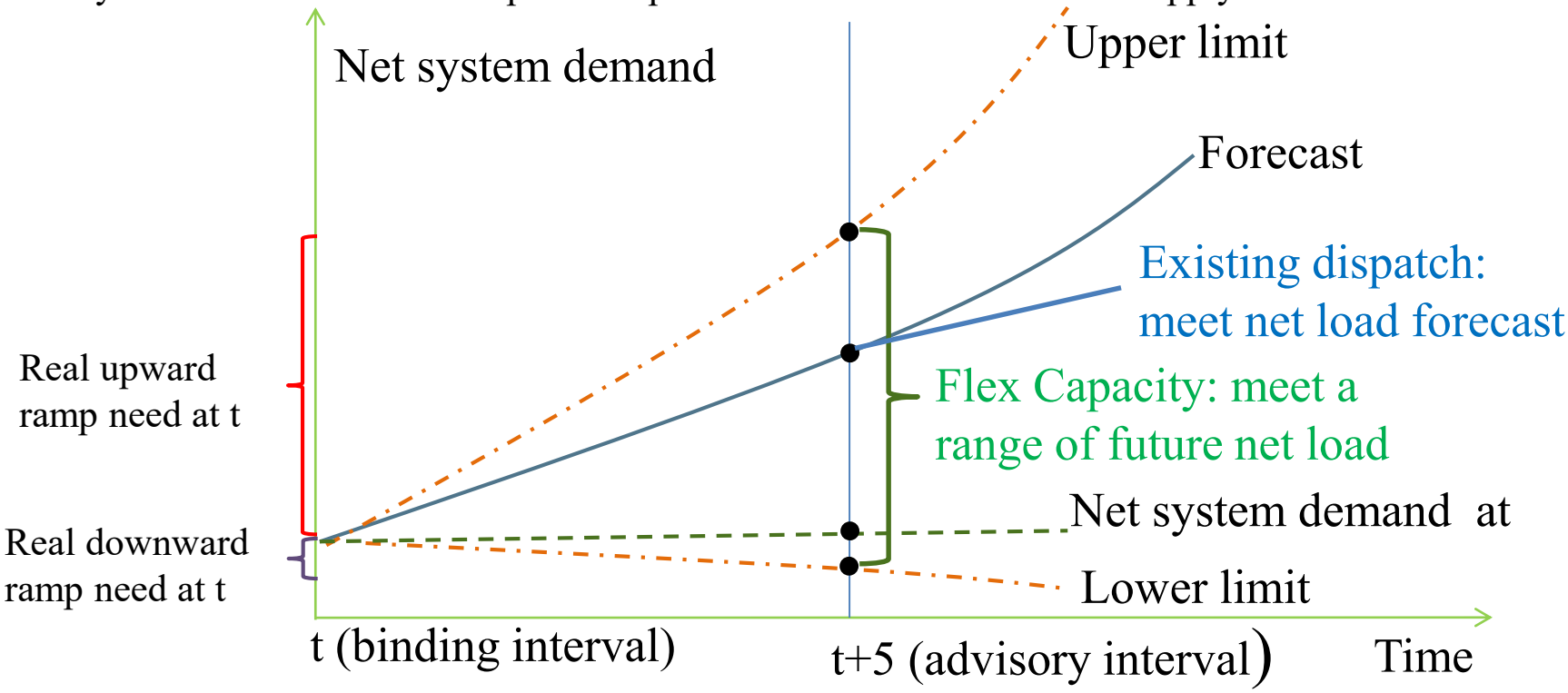


The 10-minute net load variability for January through March 2019 can exceed 2,000 MW during sunset



Flexible ramping needs

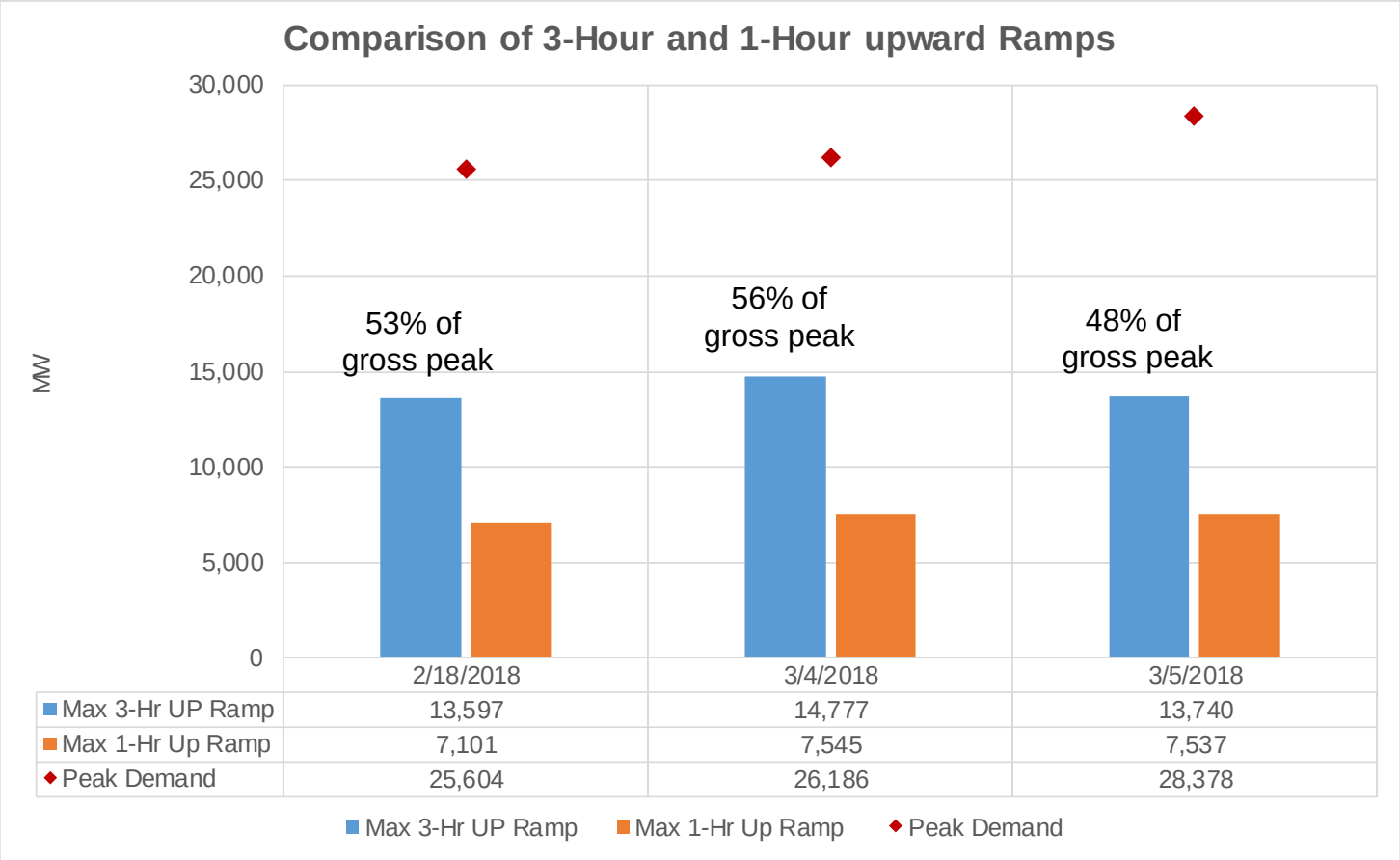
Net system demand = load + export – import – internal self-schedules - supply deviations



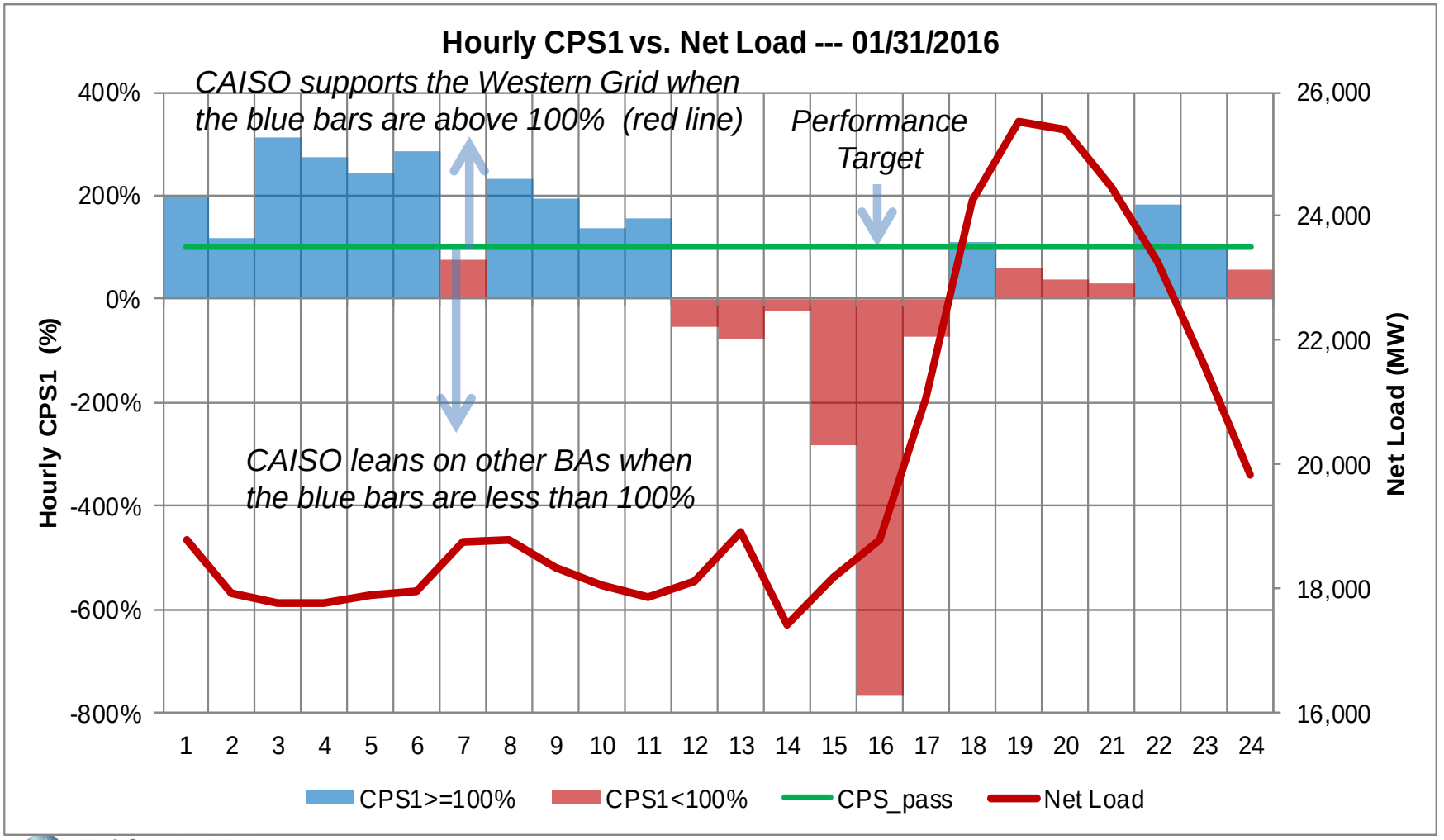
Ramping need:

Potential net load change from interval t to interval t+5
(net system demand t+5 – net system demand t)

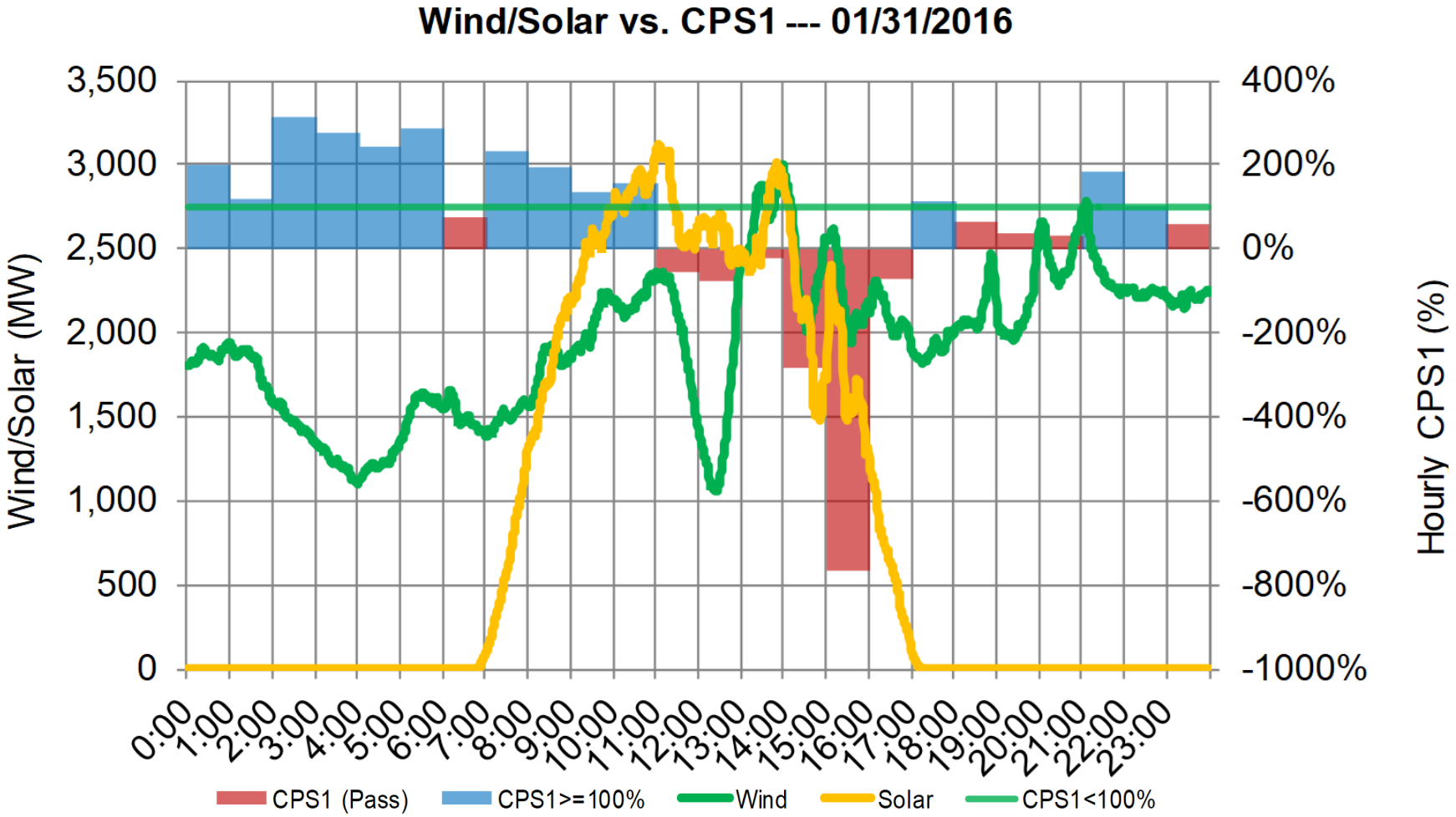
The 3-Hour upward ramps are more than 50% of the daily peak demand, which indicates the need for faster ramping resources



CAISO tracks real-time supply and demand balance as a measure of operational effectiveness



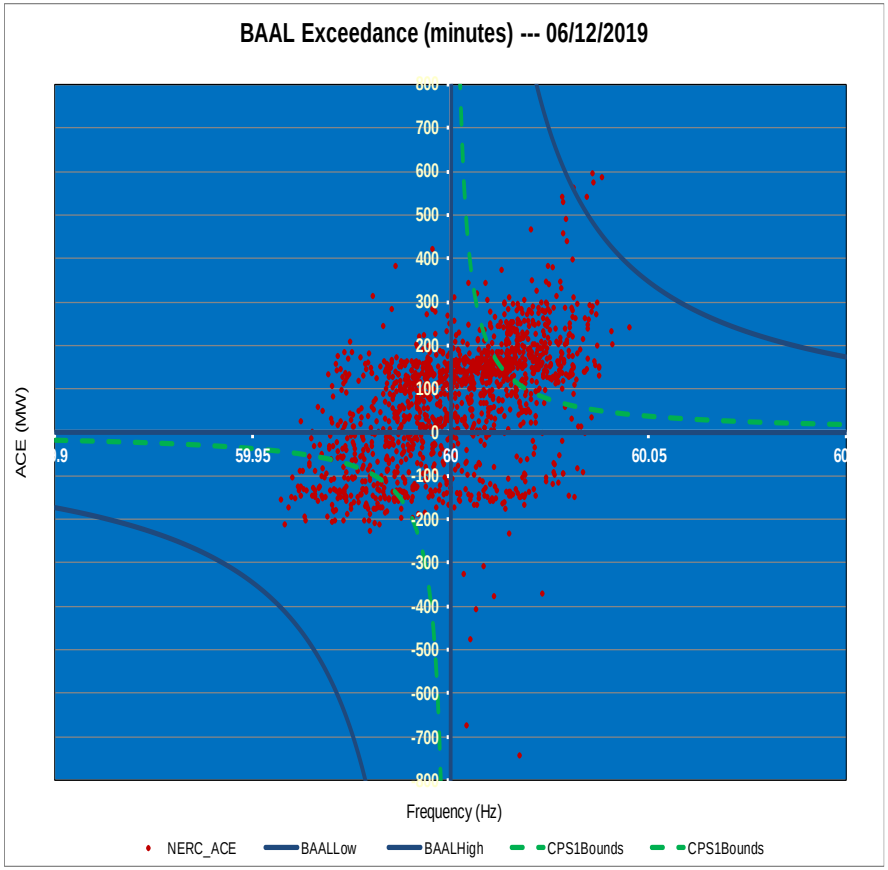
Operational performance during periods of increased supply variability



CPS1 is NERC Control Performance Standard which is evaluated on a rolling 12-month average. Over the past few years, the rolling average has been declining as a result of some poor daily performances.
Thus, the CAISO need to take measures to enhance daily performance on days with higher variability.

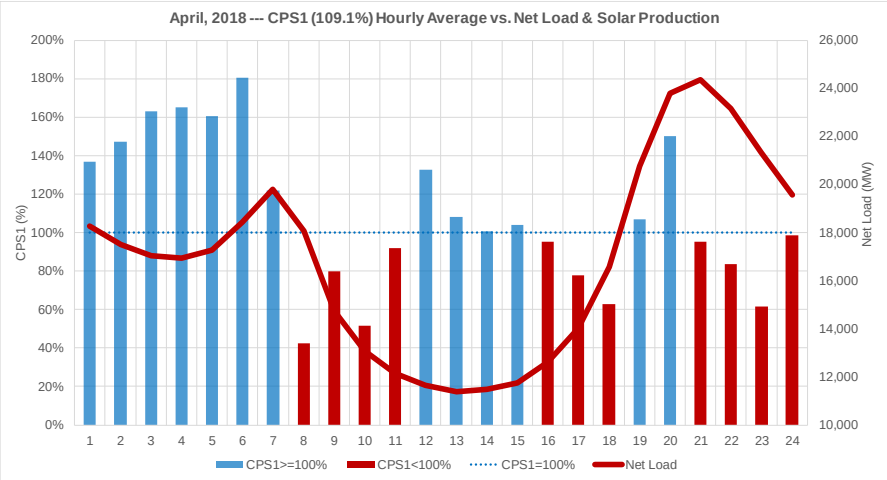
Are there any standards/policy changes that could help integrate higher levels of renewables?

- NERC has several operating standards to address abnormal and emergency operating conditions
- Most operational challenges today occurs under N-0 conditions
  - Natural variability/uncertainty (wind/grid connected and roof-top solar PV)
  - CAISO has no visibility of approximately 8,000 MW of BTM solar (~12,000 MW by 2022)
- CPS1 (green curves) are within the BAAL limits (blue curves)
- NERC should consider:
  - Instead of calculating CPS1 every minute, could this calculation be done every 5-minutes or 10-minutes etc.?
  - Relaxing Epsilon 1 (next slide)

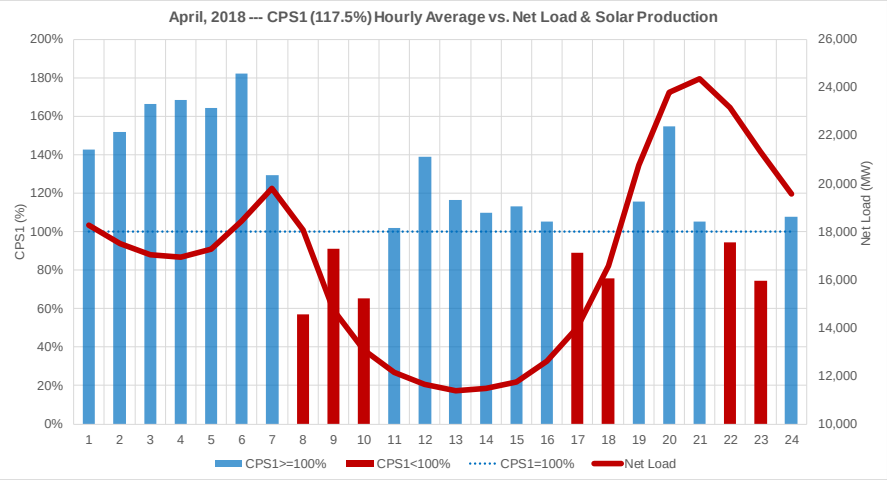


Increasing epsilon 1 (22.8 mHz) by 5% or 10% results in significant improvements in monthly CPS1 scores

Current Standard: CPS1 109%

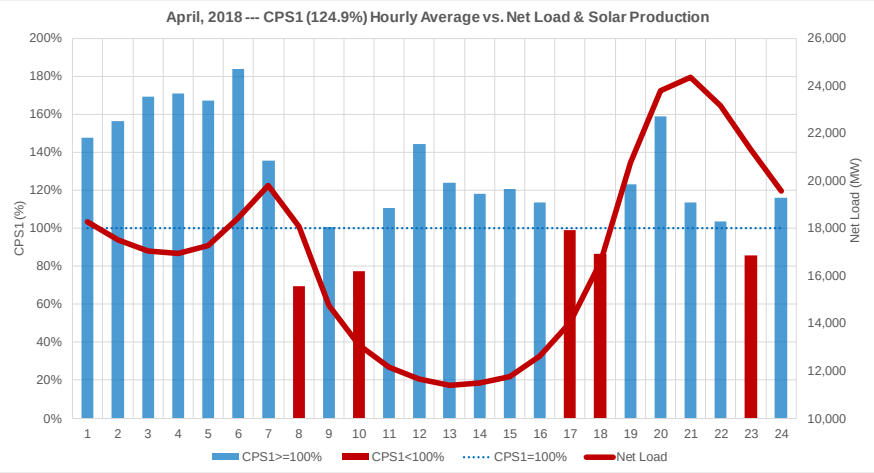


Increase Epsilon 1 by 5% --- CPS1 117%



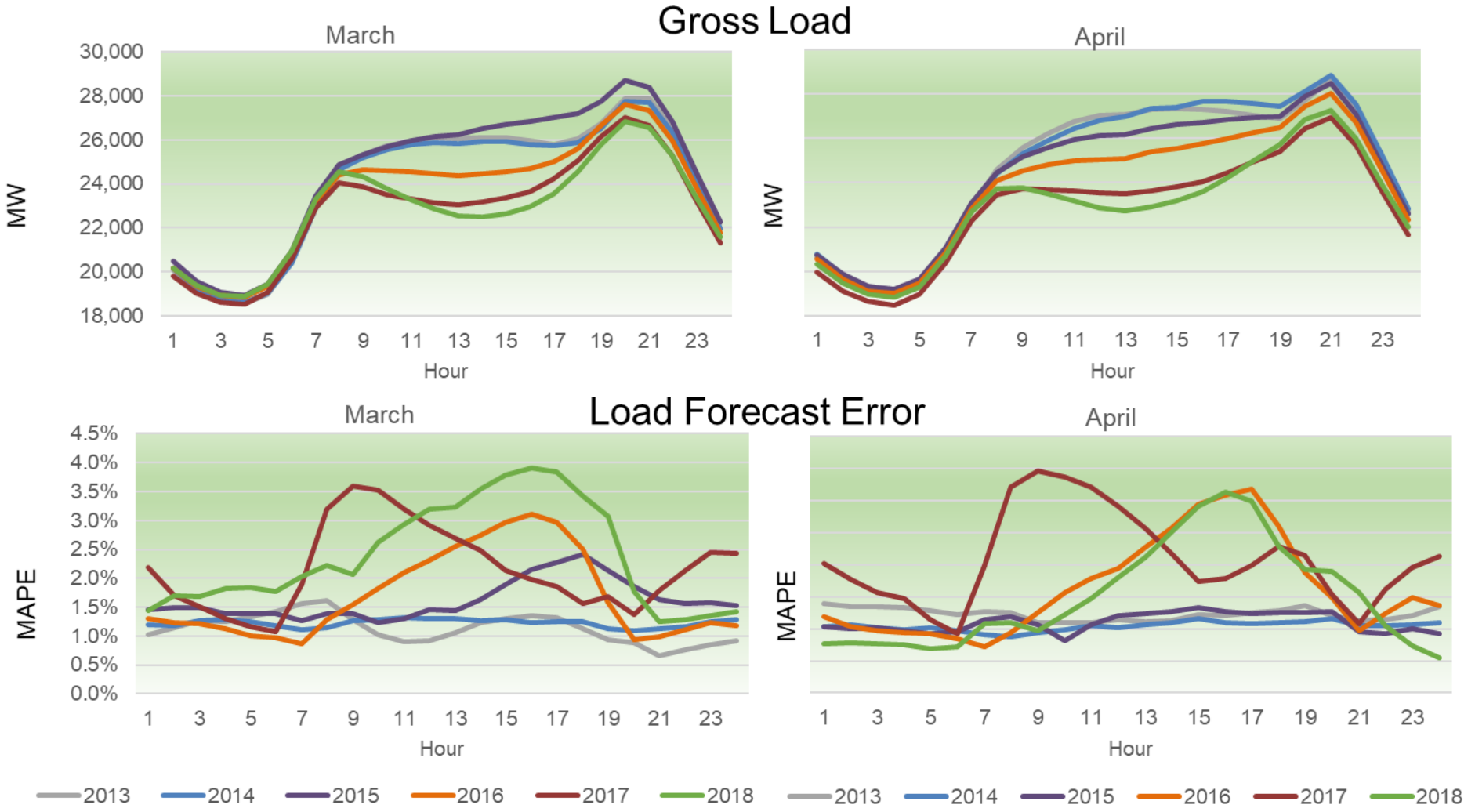
Epsilon 1 is the root mean square (RMS) targeted frequency error for each Interconnection

Increase Epsilon 1 by 10% 125% --- CPS1



California ISO

Hourly error increases in middle of day due to effects of increasing behind the meter production on mid-day load



What is the “Duck” telling us?

- Integrating renewables create a significant impact on how supply meets mid-day demand
- Management of increased oversupply requires economic bids from all resources, including renewables
- Increasing evening ramp requires flexible capacity to balance supply and demand
- Need additional solutions such as storage, TOU rates, regional collaboration, and using all resources flexibly to help manage increasing oversupply and ramping needs
- Need to maintain sufficient production capacity during periods of low renewable production due to multiple days of cloud cover and low winds
- The volume and speed at which solar resources ramp up is faster than demand is increasing and needs to be managed
- Renewable resources need to follow dispatch instructions similar to other resources

Potential recommendations for inverter-based resources

- Renewable resources including storage devices must provide essential reliability services
  - Voltage Control
  - Frequency control
  - Ramping Capability
- Impose a steady state ramp rate of 10% of P_{max} to help manage variability in real-time,
- Reduce dead bands on renewable resources and storage devices from 0.036 Hz to 0.016 Hz,
- Propose governor-like droop settings on renewable resources and storage devices from 5% to 4% during normal operating conditions,