



CA Market Evolution – The People, Technology, and Markets Needed for High Renewable Energy Scenarios

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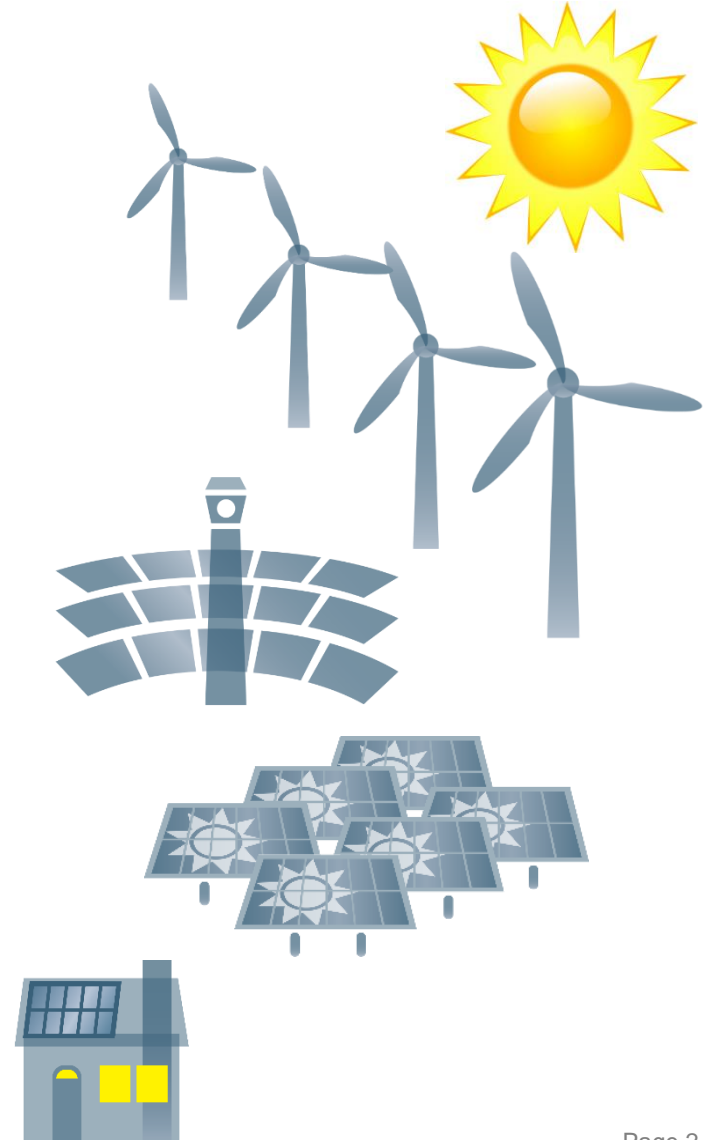
Manager, Short Term Forecasting

March 14th, 2018

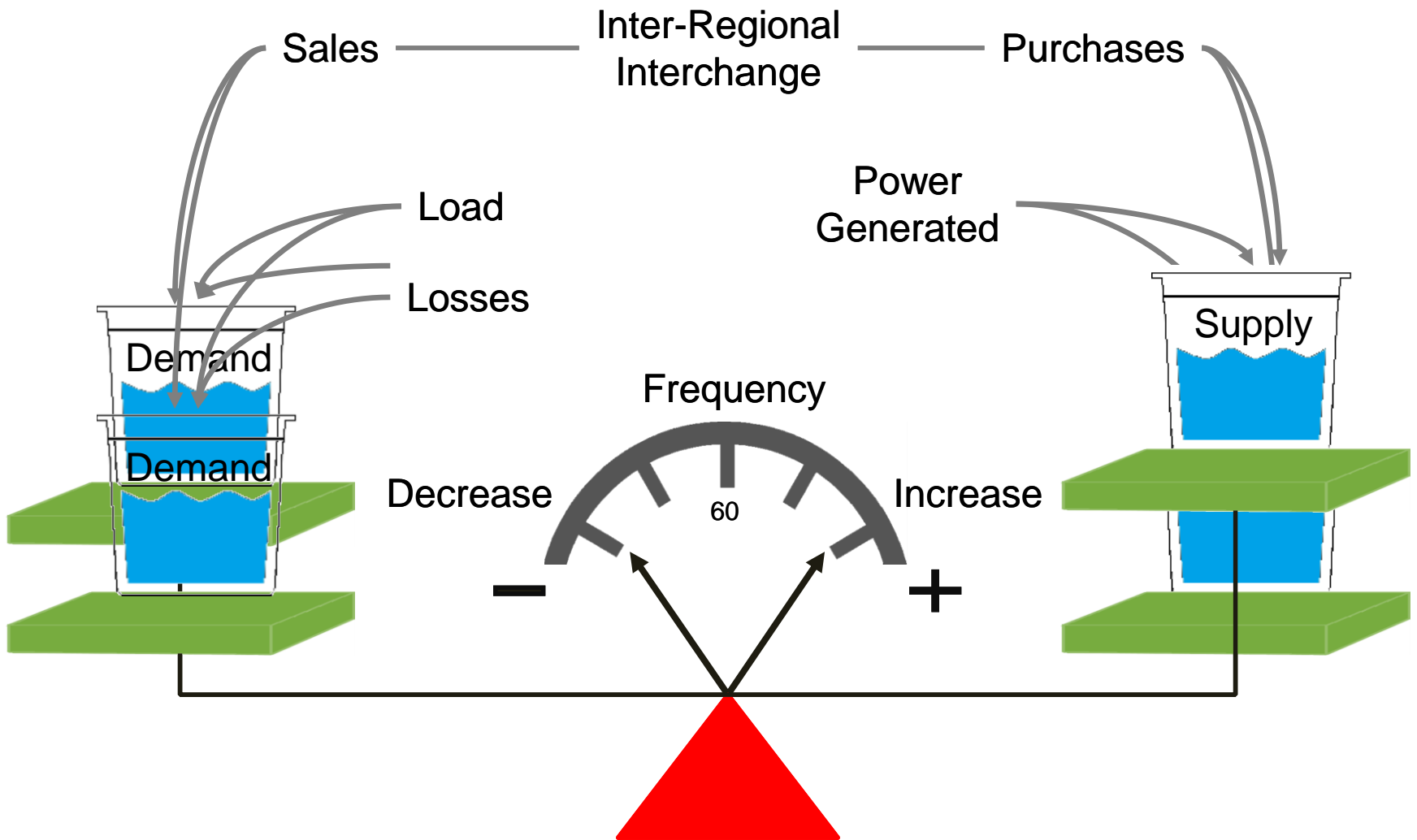
UVIG Spring Technical Conference

Major progress on meeting CA's renewable goals

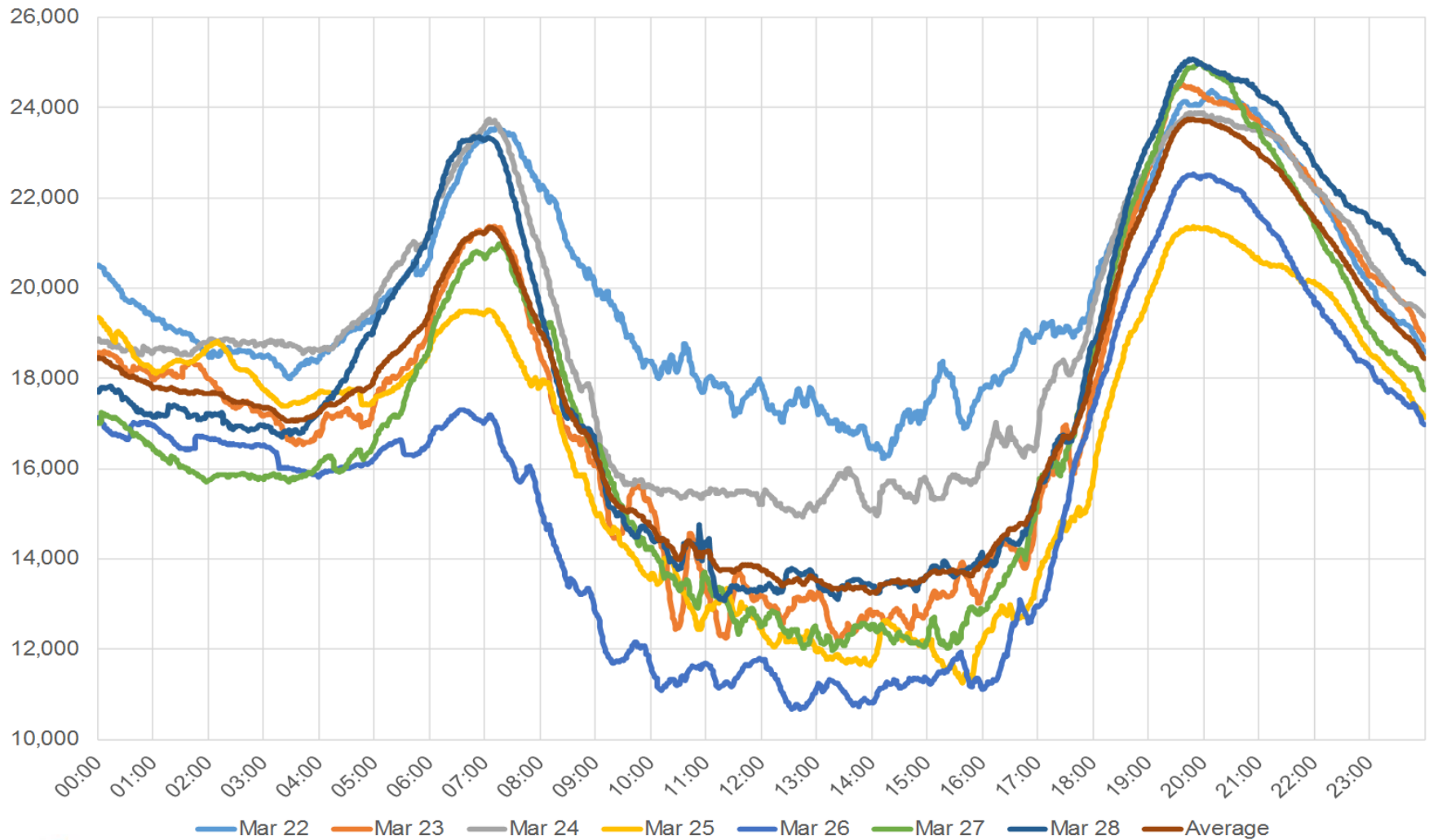
- Currently Installed:
 - 21,000 MW of utility-scale renewables
 - 6,000 MW of consumer rooftop solar
- Additional renewables:
 - 3,300 MW for 50% RPS by 2030 (2018 CPUC IRP)
 - 11,400 MW of consumer rooftop solar by 2030 (2017 CEC IEPR)



The balancing of supply and demand

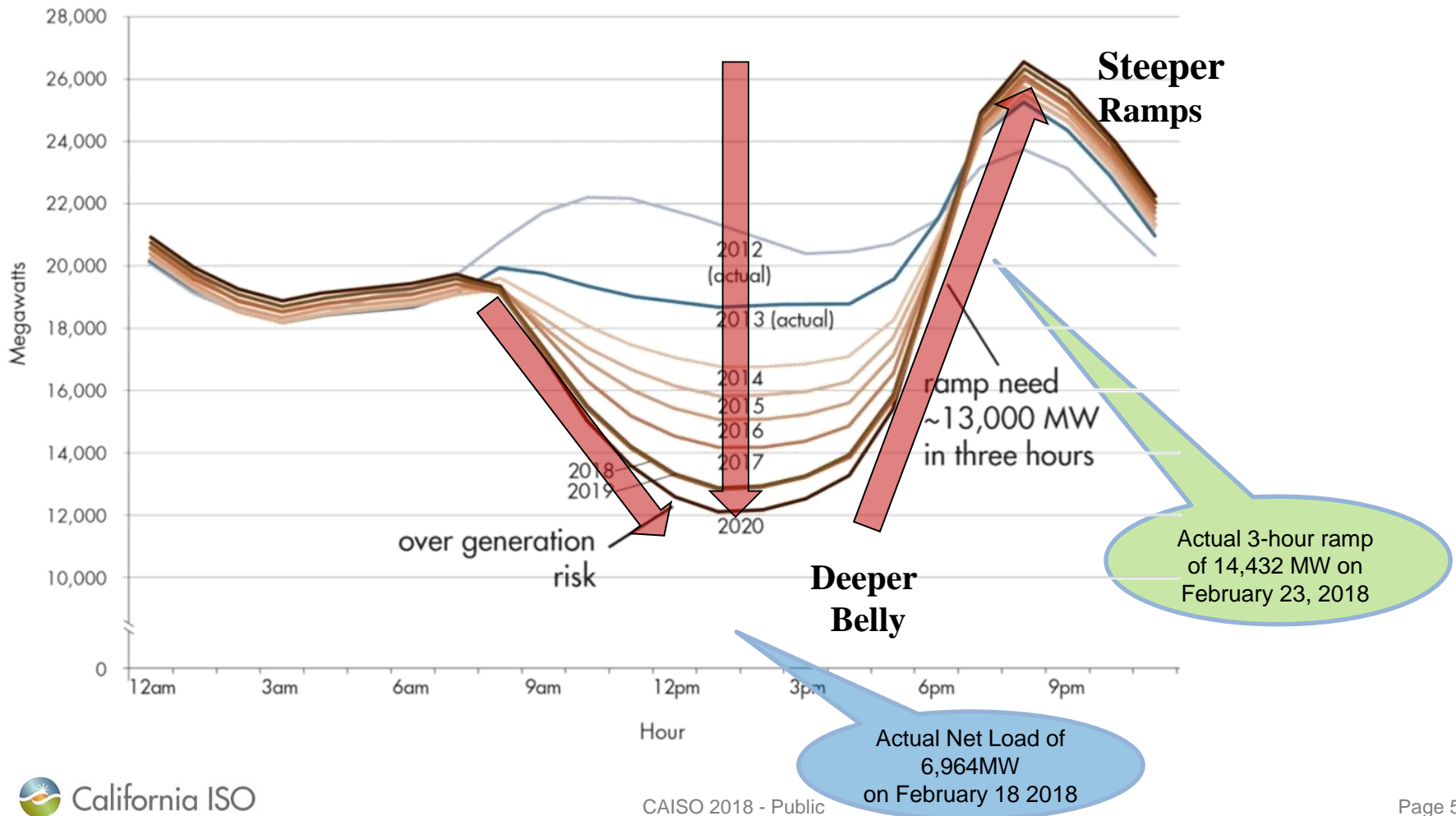


Net load varies significantly day-to-day and minute-to-minute



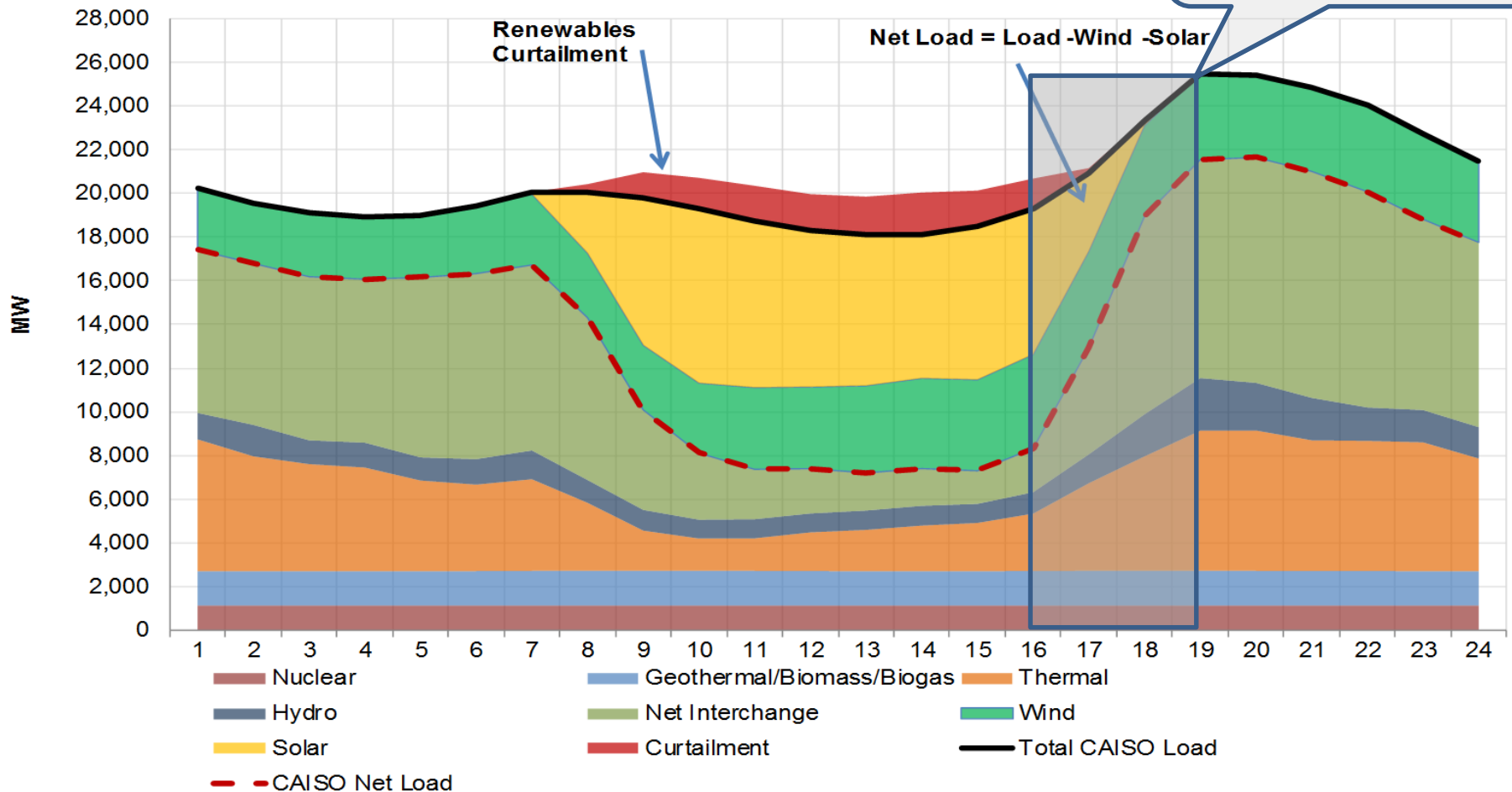
Actual net-load and 3-hour ramps are about four years ahead of ISO's original estimate

Typical Spring Day

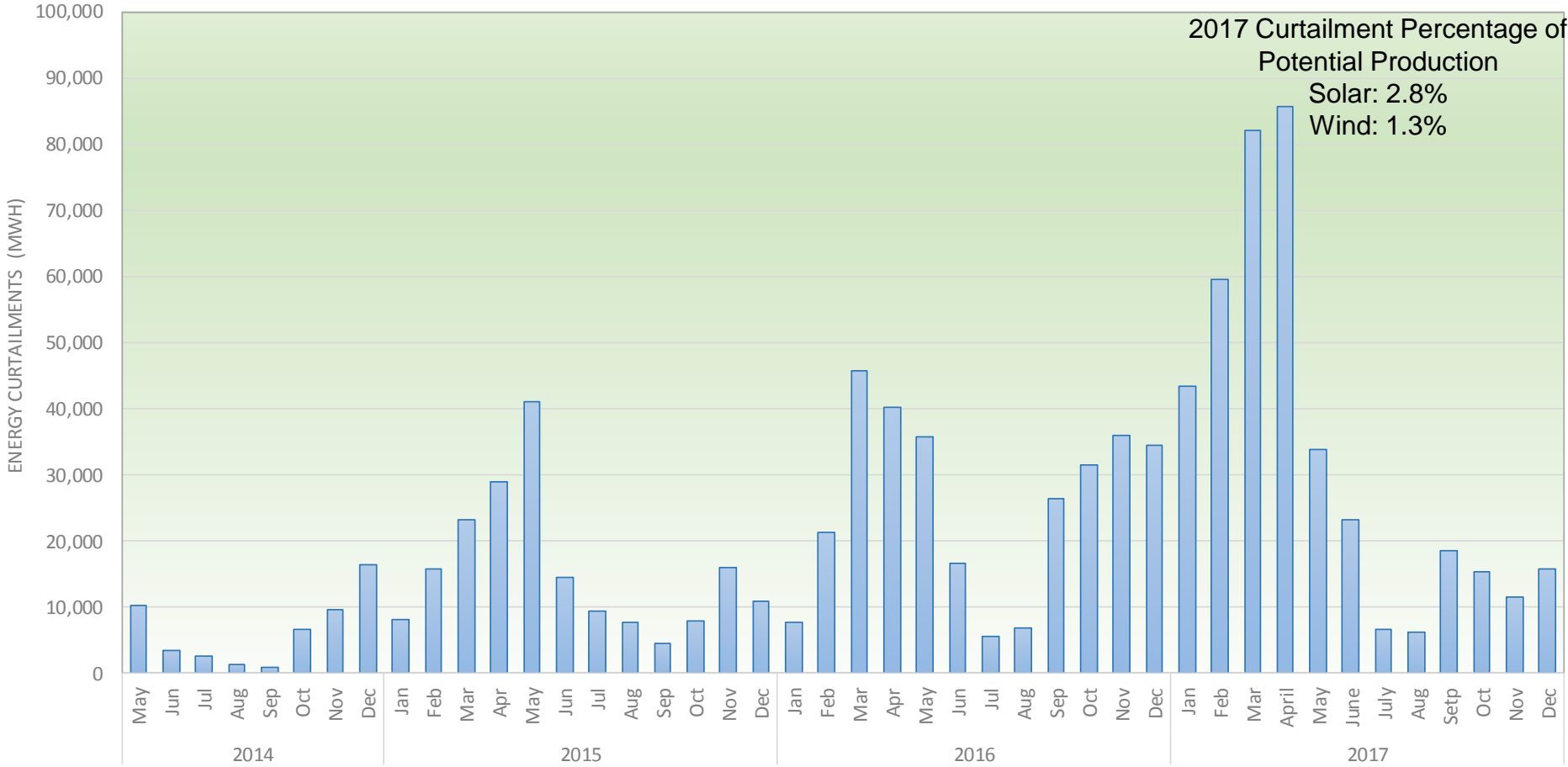


During February 18, 2018 renewables met 71% of load

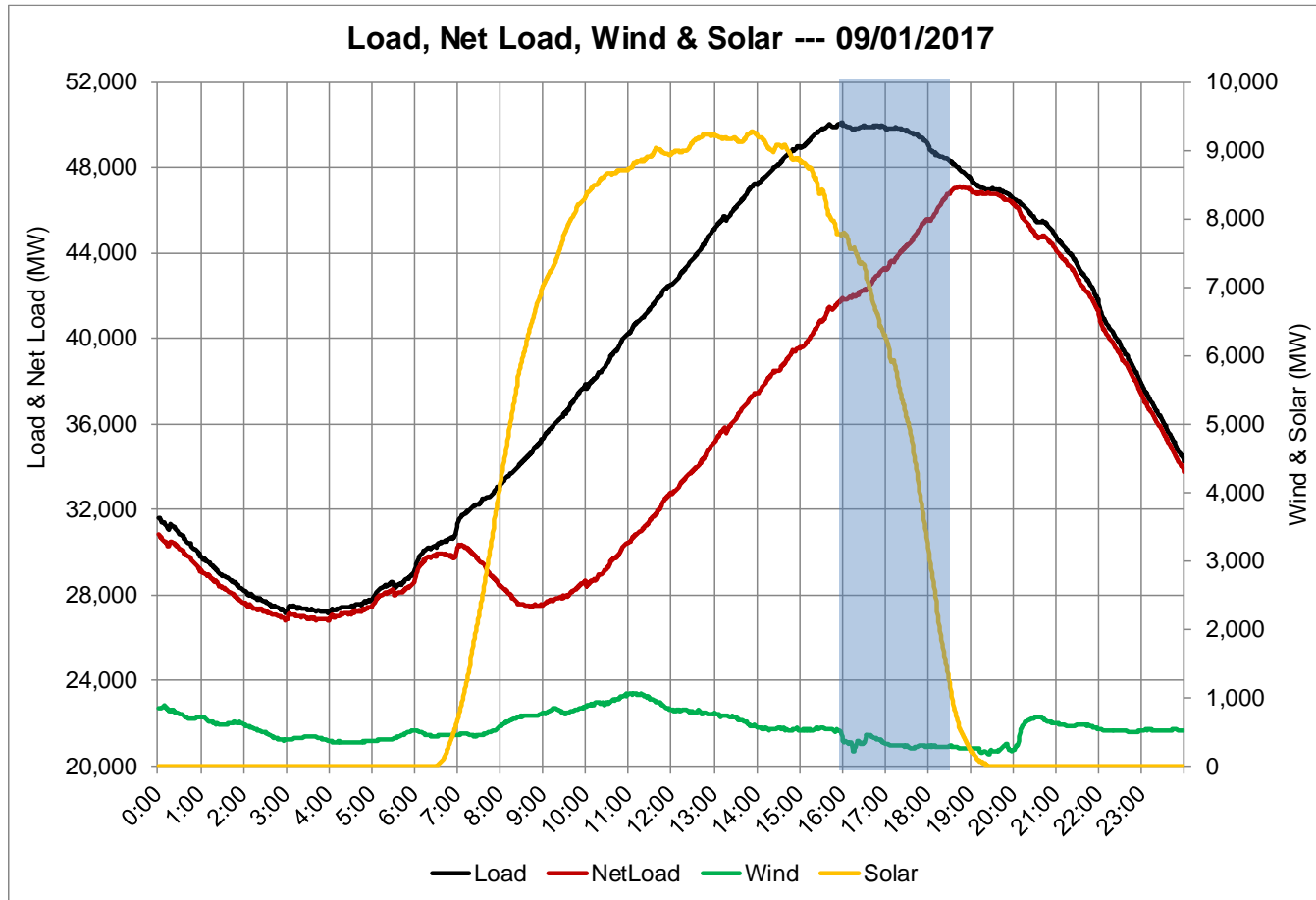
Generation Breakdown --- 02/18/2018



Increasing trend of renewable curtailment varies with seasonal and hydro conditions



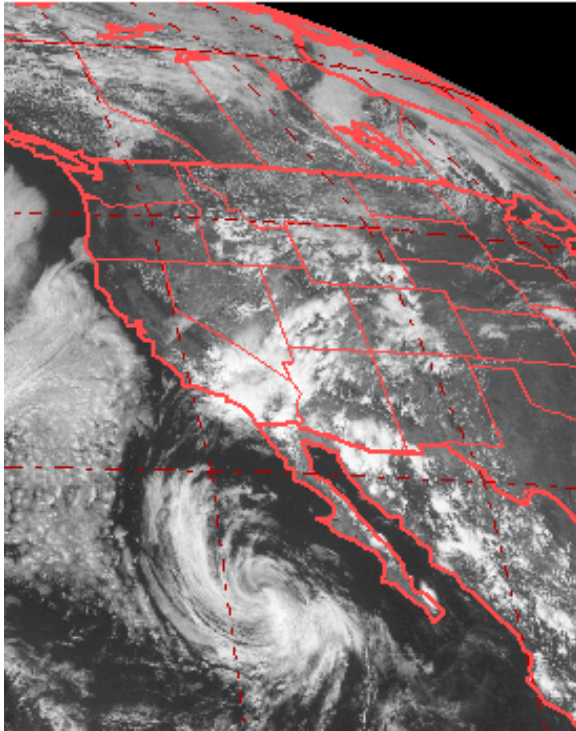
In 2017, the ISO peak load was 50,116 MW and occurred at 15:58:24 on September 1st



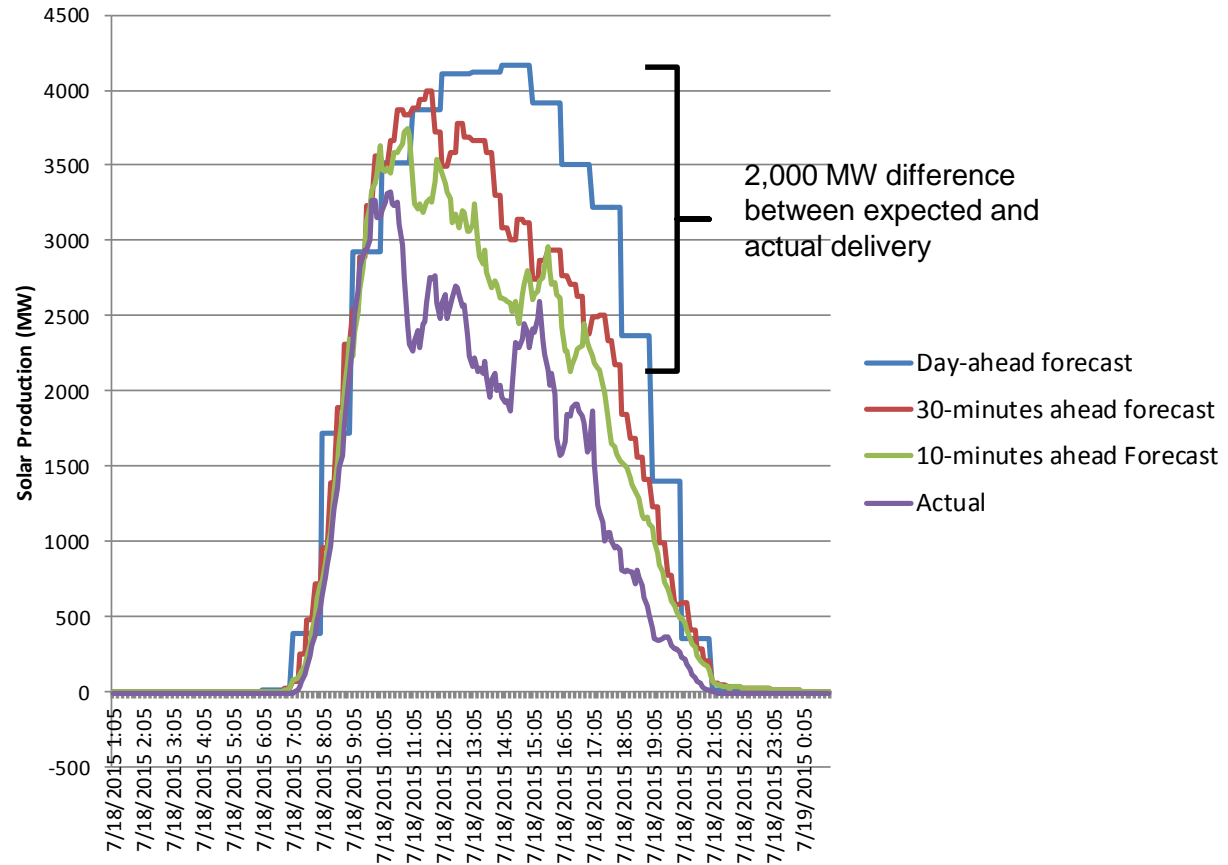
- 15:58 to 18:44**
- Net Load peaked 2 hours and 46 minutes after peak demand
 - Peak load decreased by 2,148 MW
 - Solar production decreased by 7,199 MW
 - Net Load increased by 5,258 MW

Enhance forecasting to manage supply uncertainty

Example day with monsoonal conditions

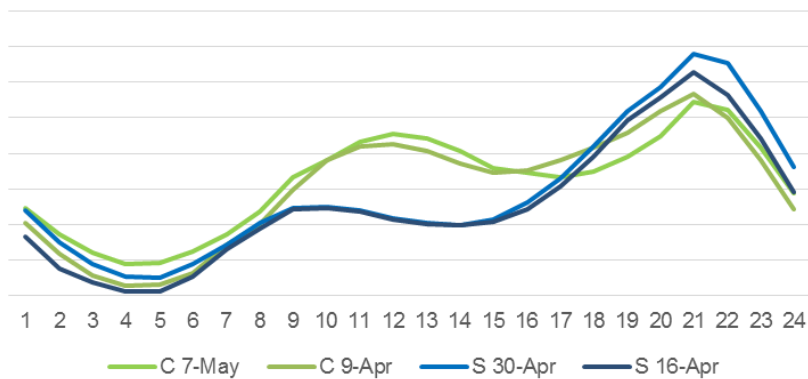


CAISO – Solar Forecast & Actual July 18, 2015



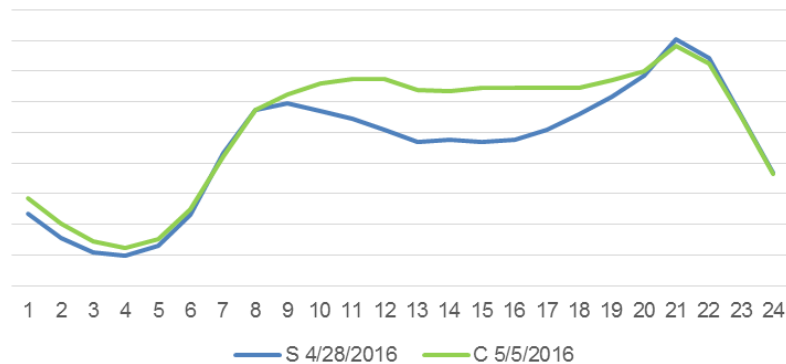
Enhance Load Forecasting to Manage Demand Uncertainty

Weekend Effect:
Sunny Vs. Cloudy



<u>Date</u>	<u>Day of Week</u>	<u>Temp</u>	<u>Sunny or Cloudy?</u>
7-May	Saturday	55/65	Cloudy
9-Apr	Saturday	58/64	Cloudy
30-Apr	Saturday	55/79	Sunny
16-Apr	Saturday	49/80	Sunny

Weekday Effect:
Sunny vs Cloudy



<u>Date</u>	<u>Day of Week</u>	<u>Temp</u>	<u>Sunny or Cloudy?</u>
28-Apr	Thursday	50/73	Sunny
5-May	Thursday	57/68	Cloudy

A suite of solutions are necessary



Storage – increase the effective participation by energy storage resources.



Western EIM expansion – expand the western Energy Imbalance Market.



Demand response – enable adjustments in consumer demand, both up and down, when warranted by grid conditions.



Regional coordination – offers more diversified set of clean energy resources through a cost effective and reliable regional market.



Time-of-use rates – implement time-of-use rates that match consumption with efficient use of clean energy supplies.



Electric vehicles – incorporate electric vehicle charging systems that are responsive to changing grid conditions.



Renewable portfolio diversity – explore procurement strategies to achieve a more diverse renewable portfolio.



Flexible resources – invest in fast-responding resources that can follow sudden increases and decreases in demand.

Thank you.

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