California ISO

Market and Operational Challenges of an Evolving Power System

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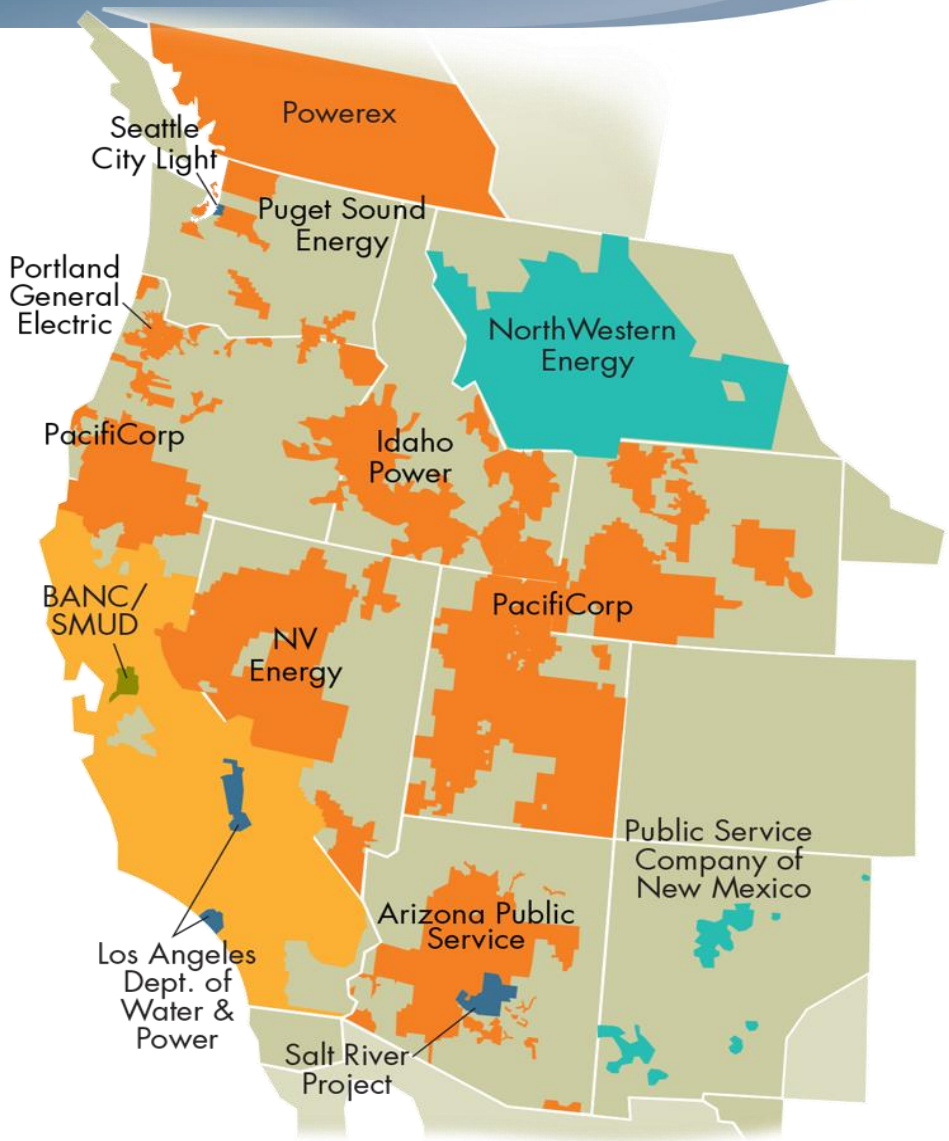
DynPOWER Conference 2021
September 2021

California ISO

- **Nonprofit** public benefit corporation
- Part of Western Electricity Coordinating Council
- Energy Imbalance Market covers 10 Western States abd British Columbia
- **75,747** MW of power plant capacity
- **50,270** MW record peak demand (July 24, 2006)
- **>1,100** power plants
- **26,014** circuit-miles of transmission lines



CAISO Markets

Transmission-Right Markets

Day Ahead Market

Real-Time (EIM) Market

CRR allocation → CRR auction → Market Power Mitigation → Integrated Forward Market → Reliability Unit Commitment → Fifteen Minute Market → Real-Time Dispatch

Monthly, seasonal and TOU intervals

Congestion Revenue Rights
(Obligations)

Hourly intervals

Energy
- a) physical
- b) virtual

Mileage

Capacity
- a) Reliability
- b) Ancillary services
  - -Spinning
  - -Non Spinning
  - -Regulation

15- and 5-minute intervals

Energy

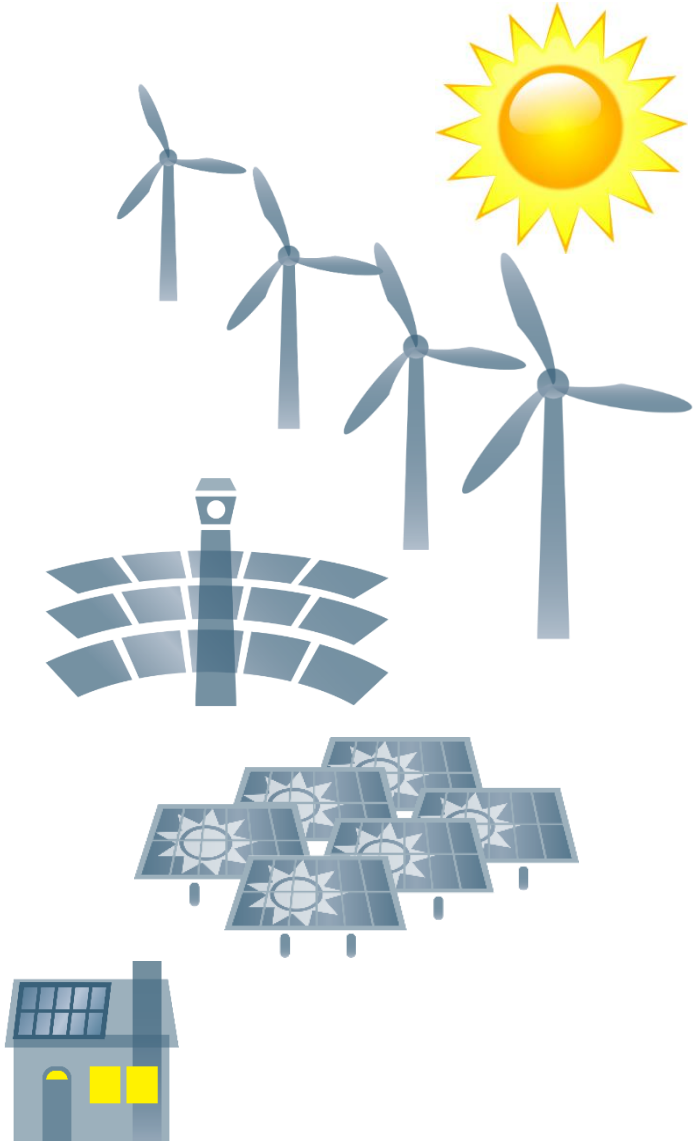
Flex Ramp

Mileage

Capacity
- -Spinning
- -Non Spinning
- -Regulation

Major progress on meeting CA's renewable goals

- Currently Installed:
  - 21,000 MW of utility-scale renewables
  - ~11,000 MW of consumer rooftop solar
- Additional renewables:
  - 4,000+ MW additional utility-scale renewables by 2026
  - ~16,750 MW of consumer rooftop solar by 2026
- Projected 5000+ MW of storage and hybrid resources

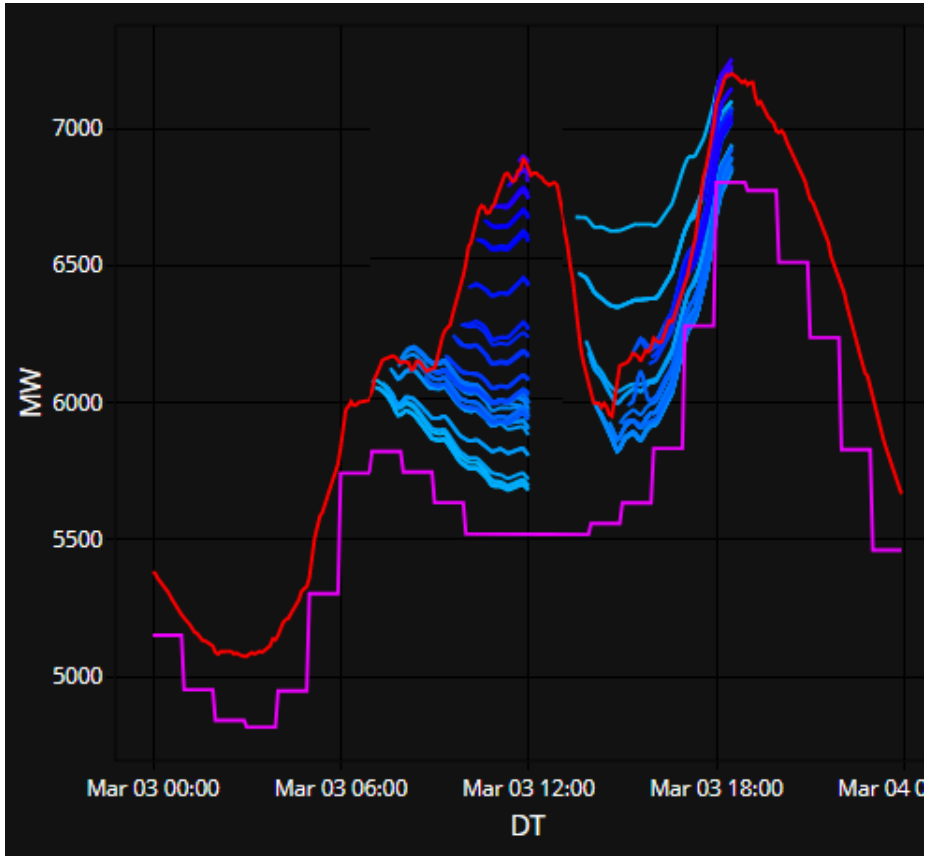


System and markets are evolving towards a non-deterministic environment

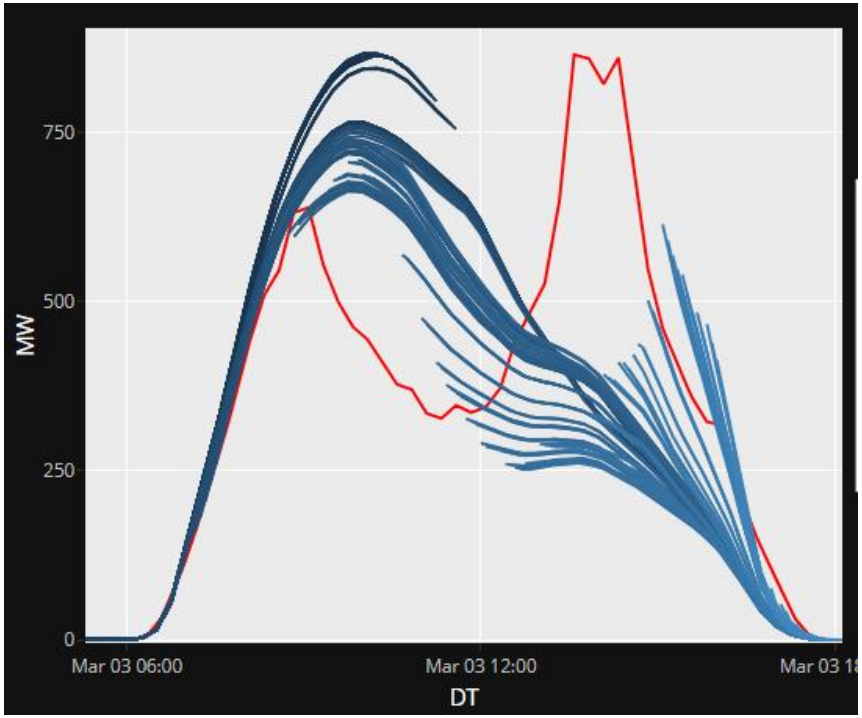
- Weather variables, such as temperatures, introduce uncertainty components to multiple variables in the power system, including
  - Load forecast
  - Behind the meter generation
  - Utility-based wind and solar production
  - Regulation requirements
- CAISO still uses a deterministic market clearing process with deterministic inputs
- Different products and procedures are developed to then “factor in” uncertainty

Demand Forecast Movement due to Behind the Meter Solar

Load Forecast Movement due to BTM Solar



BTM Solar Forecast Updates vs. Actual



Comparing conventional to variable generation

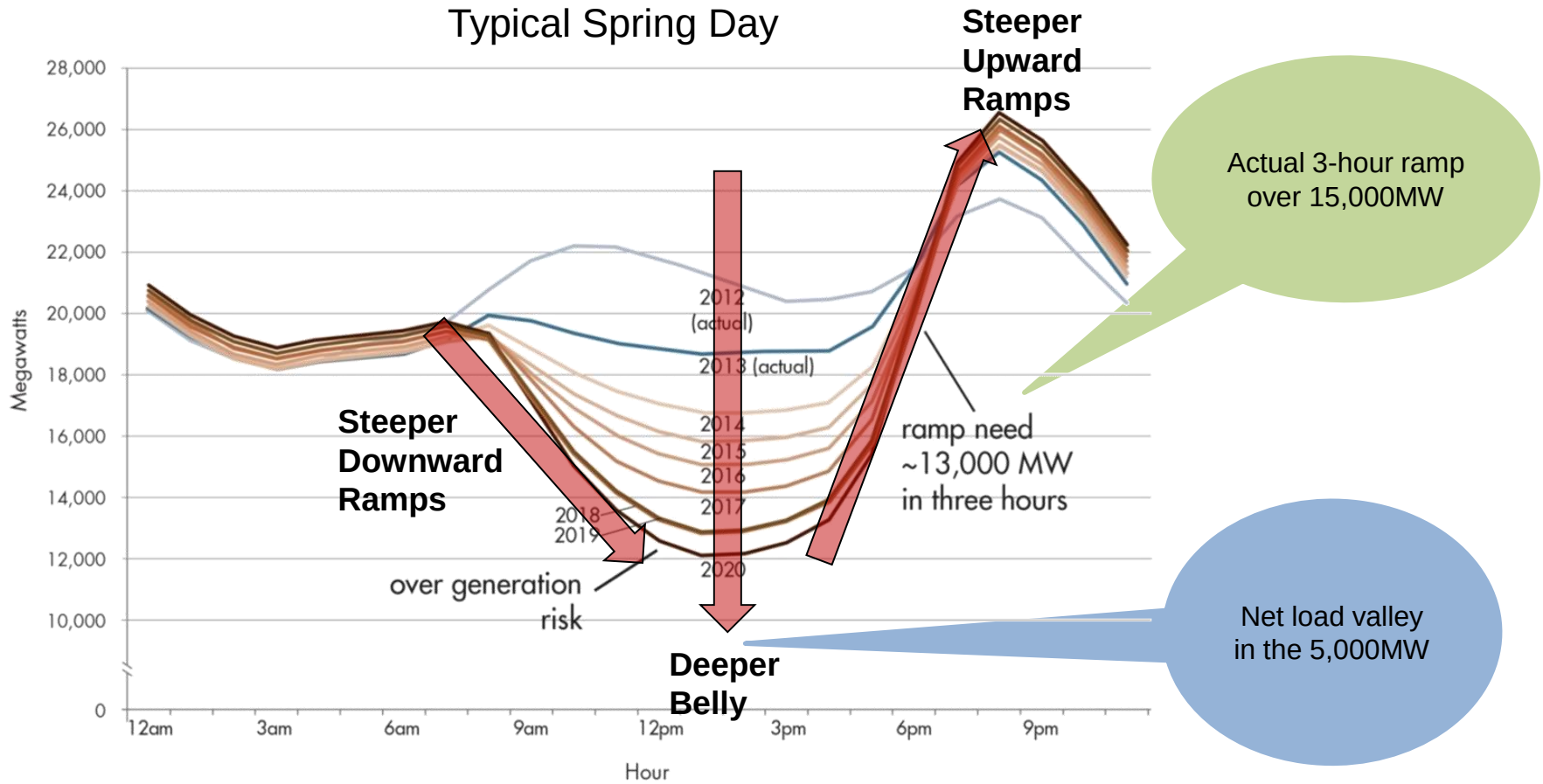
Conventional Generation

- Predictability
- No surprises
- Dependable energy schedules
- Accurate forecasts
- Contingency reserves available
- Generators that follow dispatch commands
- Excellent tools for visibility of system status
- High quality data
- De-rate information on units is timely and accurate

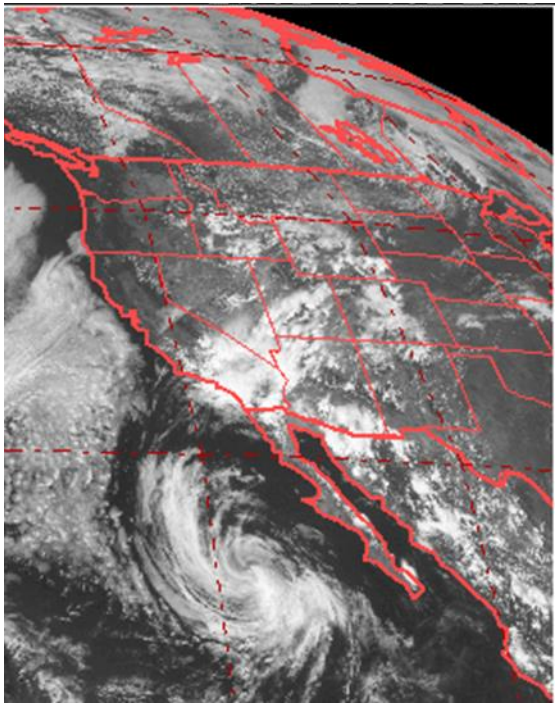
Variable Generation

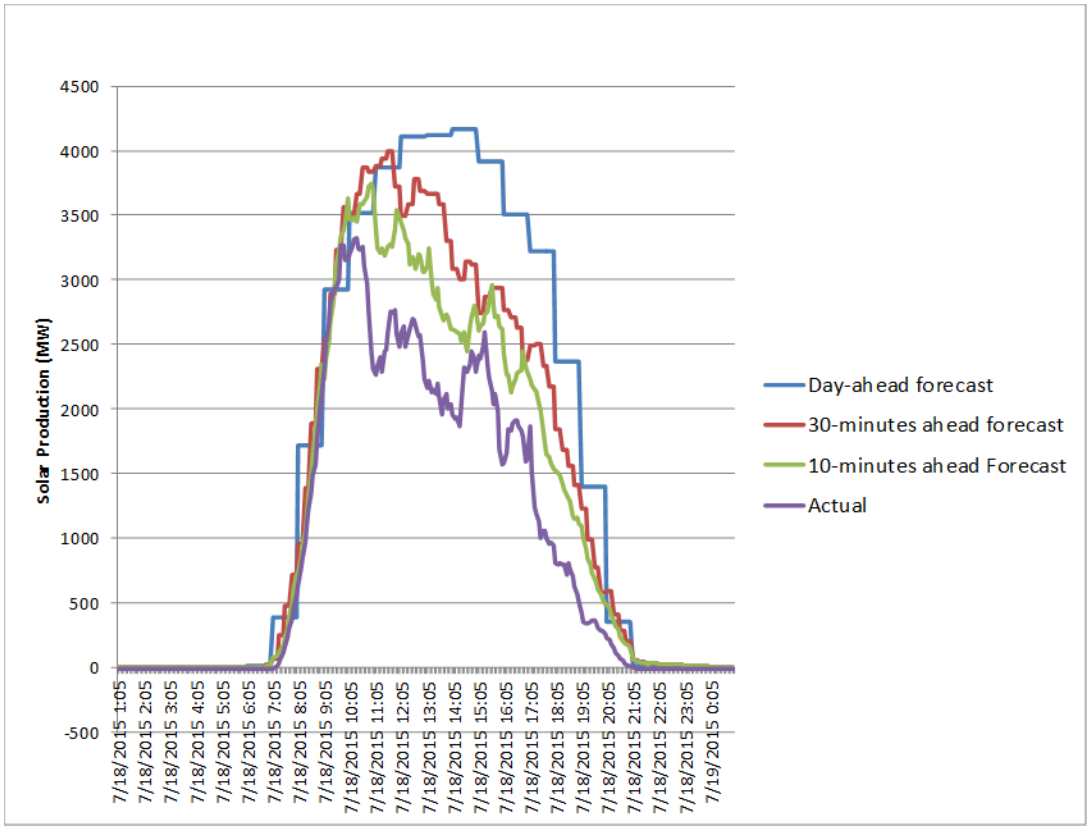
- Hard to predict
- Forecast inaccuracy is high
- Maximum generation at night when loads are low and there is no place for the energy – 70 % of the wind produced during a 24 hour period is at nights and 30 % of the Solar produced in a week is on weekends
- Large ramp demands both up and down
- Lack of visibility of anticipated generation production changes
- May not follow dispatch commands --- treated as “Must Take” generation

The duck turns 10 years old: Actual net-load and 3-hour ramps are approximately four years ahead of the CAISO's original estimate



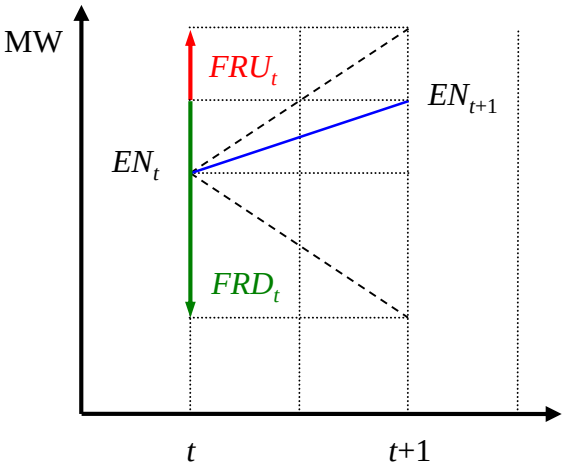
Variability poses a great forecasting challenge which results in uncertainty in market and systems operations



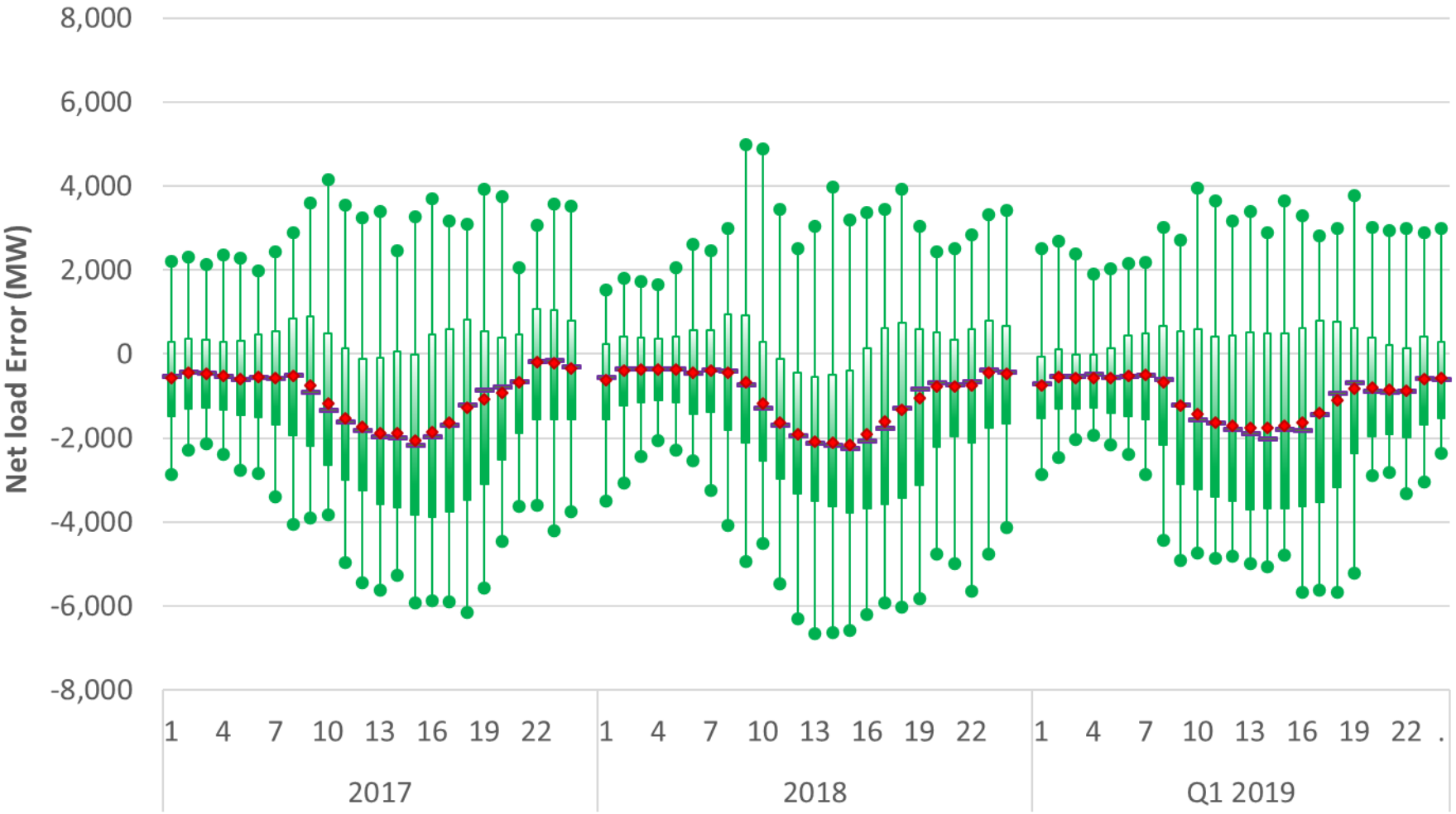


Flexible ramping product implemented in 2016 makes important changes to the real-time market

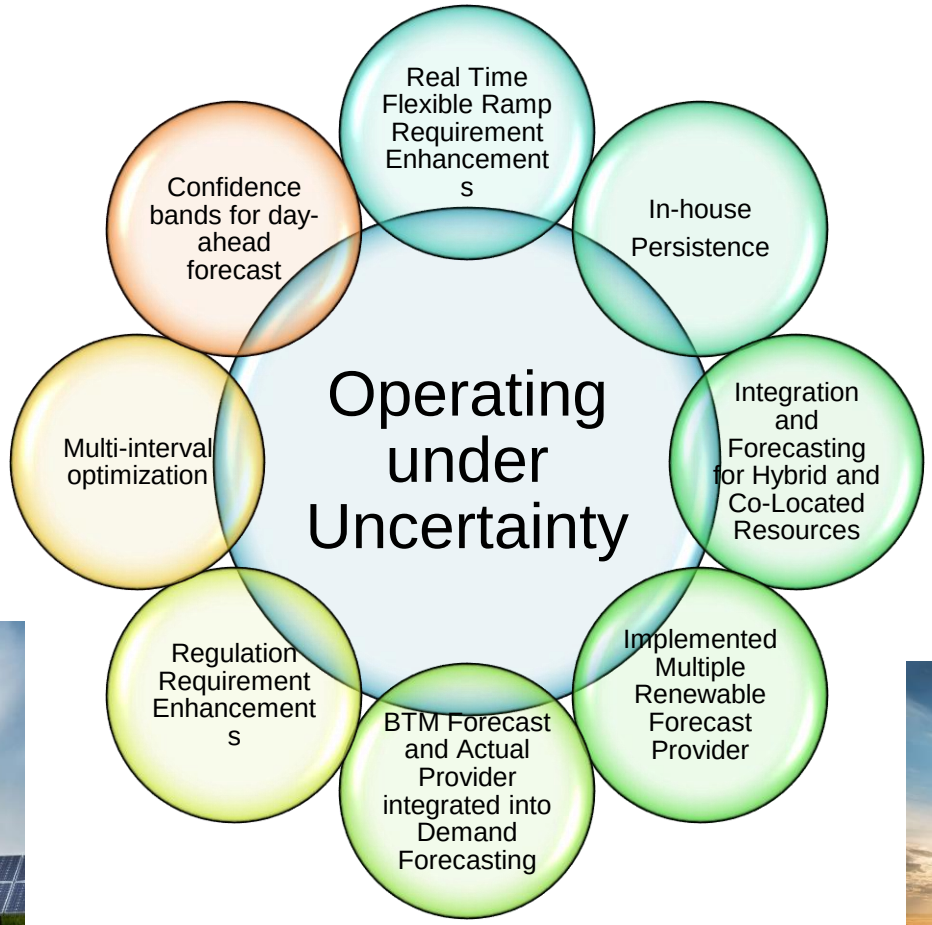
- Secures ramping capability in the fifteen-minute market and real-time dispatch
- Accounts for upward and downward ramping needs
- Compensates resources who provide ramping and charges those that consume ramping capability
- Procures ramping capability for uncertainty when expected value greater than cost
- Aligns cost allocation with those who benefit from additional ramping capability to meet net load uncertainty



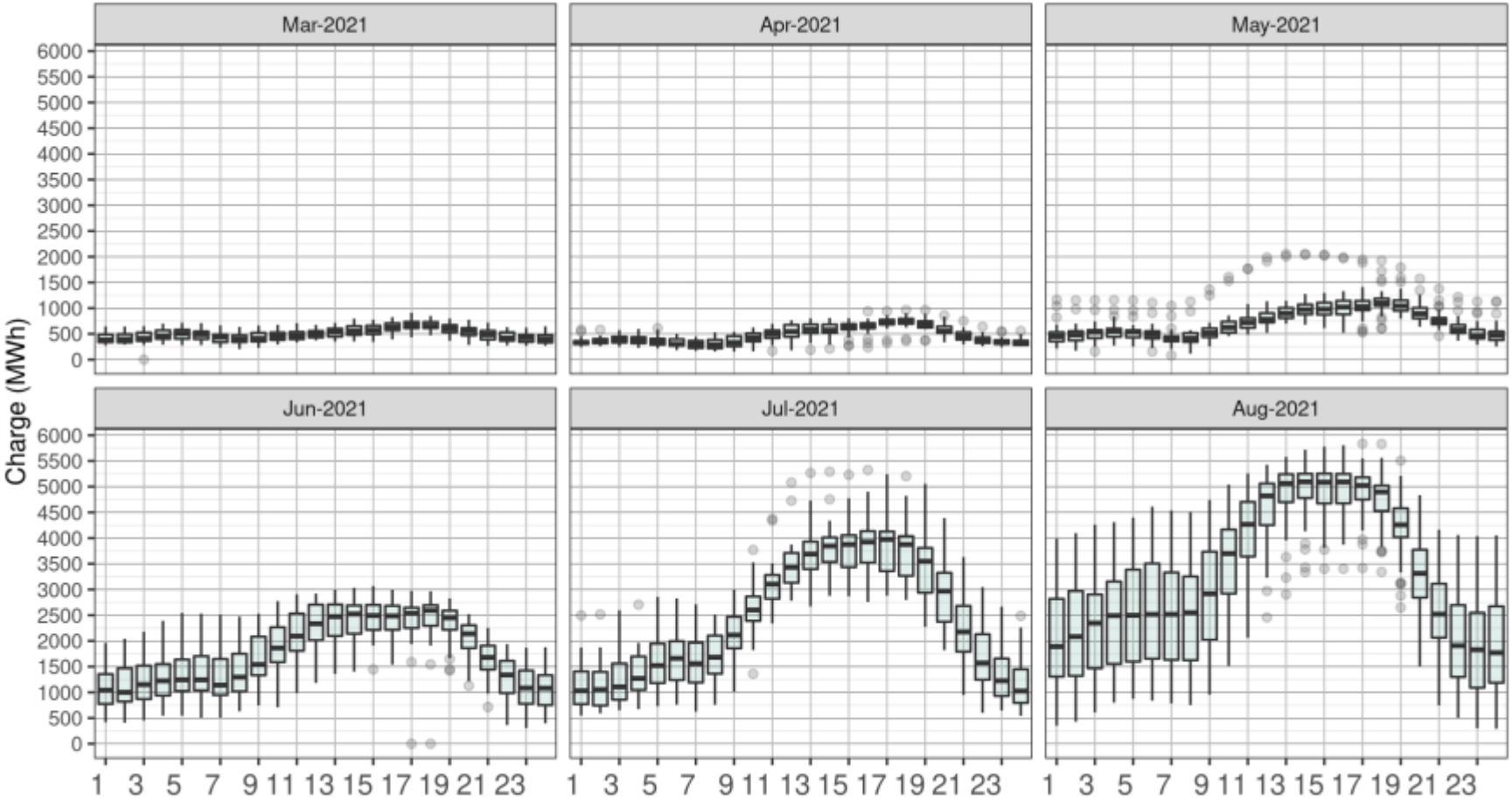
Day-Ahead imbalance in CAISO market will factors in uncertainty in load and renewable resource



Advancements to handle uncertainty in CAISO's market and system

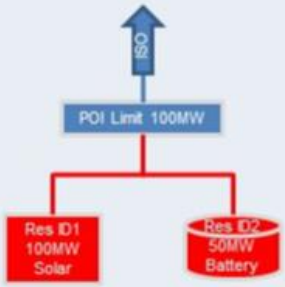


California is seeing an explosive growth of storage resources



Rapid growth in storage technologies will require new forecasting techniques and market design to support market participation

- Hybrid Resource Initiative Phase 2 go-live Fall 2021
  - Phase 1 go-live was Dec 2020
- Expected to have 5,000 MW of renewable + storage by 2024
  - Based on LSE survey
- CAISO will provide wind and solar forecasting services:
  - Optional for hybrid renewables
  - Required for co-located

Hybrid vs. Co-located	Definition	Forecasting / Dispatch
Hybrid 	A Generating Unit, with a unique Resource ID at a single Point of Interconnection, with components that use different fuel sources or technologies.	• No aggregate forecast for hybrid • Hybrid expected to follow dispatch
Co-located 	A Generating Unit with a unique Resource ID that is part of a Generating Facility with other Generating	• VER component will be forecast • VER dispatched rules • Battery will dispatched and state of charge managed