# Colombia Wholesale Market Forum

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# California ISO

Within its balancing authority area, the California ISO:

- Maintains reliability on the grid
- Manages the flow of energy
- Oversees the transmission planning process
- Operates the wholesale electric market (Day-Ahead and Real-Time)

For much of the western U.S., the ISO:

- Operates the Western Energy Imbalance Market (EIM)
- Serves as Reliability Coordinator (RC West)

# California ISO facts

As a federally regulated nonprofit organization, the ISO manages the high-voltage electric grid in California and a portion of Nevada

**50,270** MW record peak demand (July 24, 2006)

**224.8** million megawatt-hours of electricity delivered (2020)

**75,747** MW power plant capacity

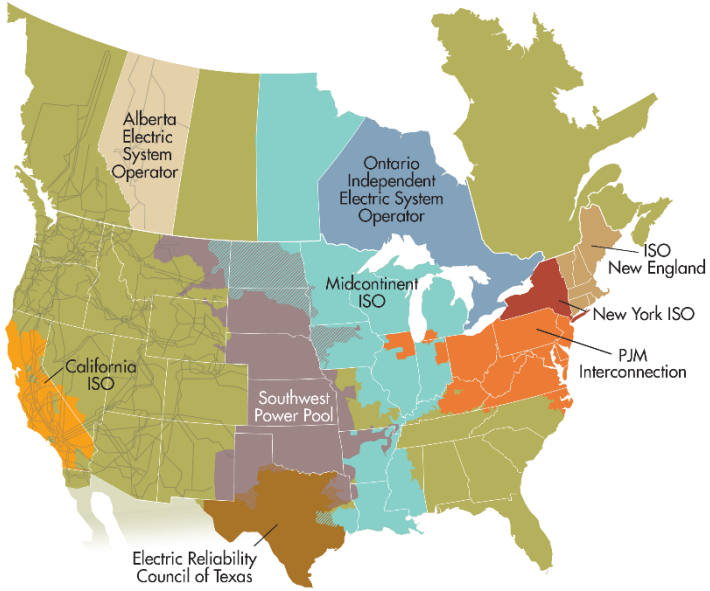
*Source: California Energy Commission*

**1,119** power plants

*Source: California Energy Commission*

**32** million people served

One of **9** ISO/RTOs in North America



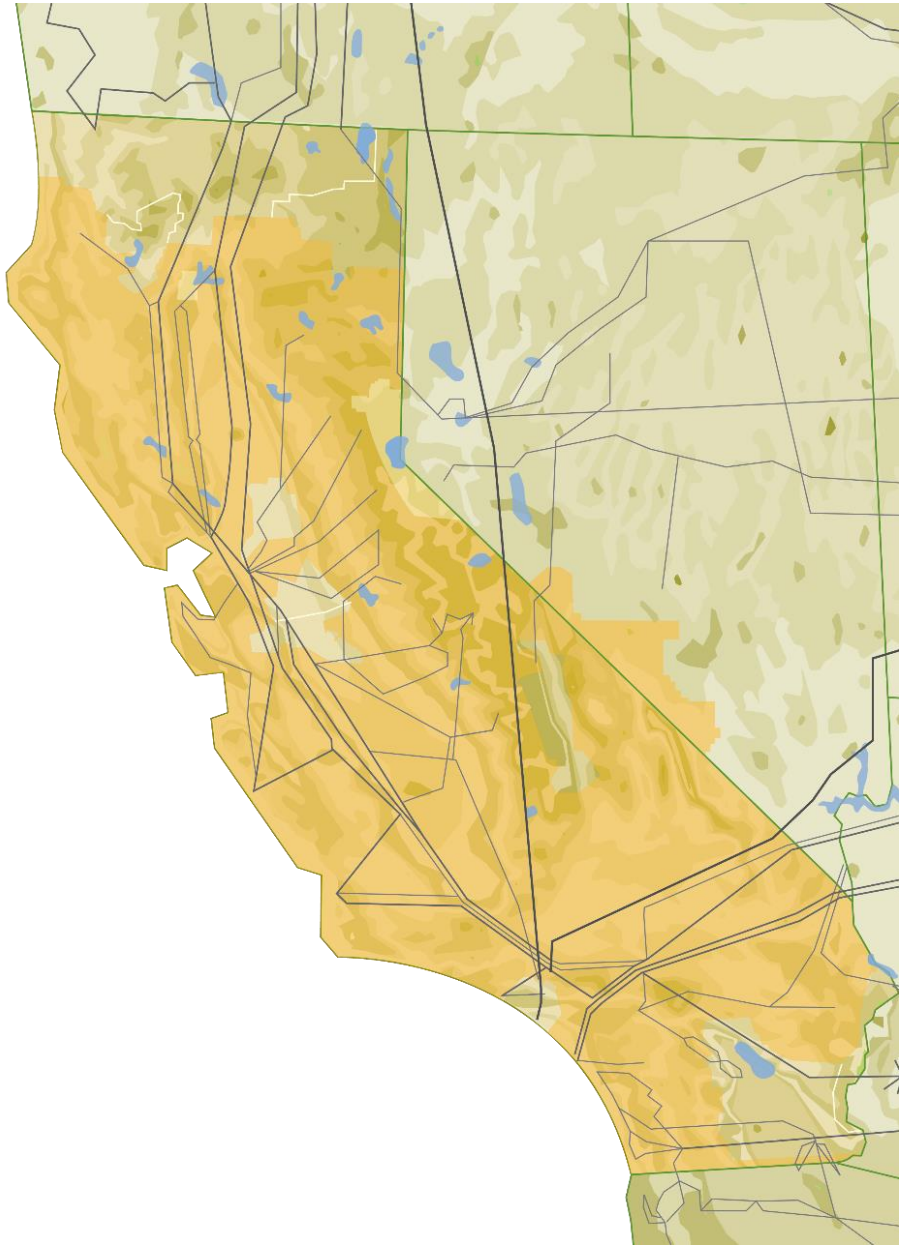
# California ISO facts

**26,000** circuit-miles of transmission lines

**$10.8** billion annual market (2018)

**78¢** per MWh grid management charge (June 1, 2020)

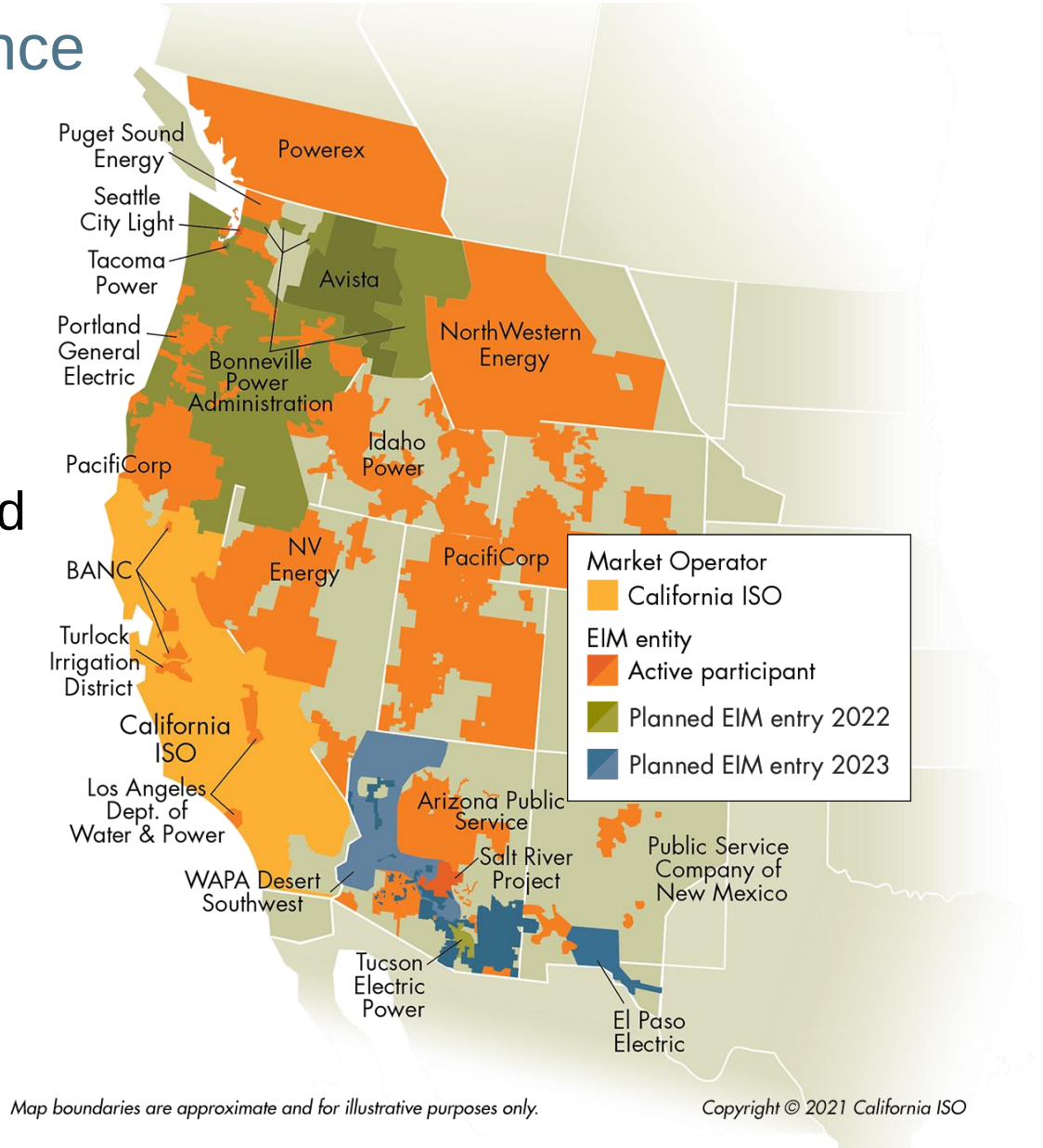
**33,617** market transactions per day (2020)



# Western Energy Imbalance Market (EIM)

Since its launch in 2014, the Western EIM has enhanced grid reliability, generated millions of dollars in benefits for participants, and improved the integration of renewable energy resources.

- Gross benefits exceeding $1.4 billion
- Reduced over half a million metric tons of $CO_2$

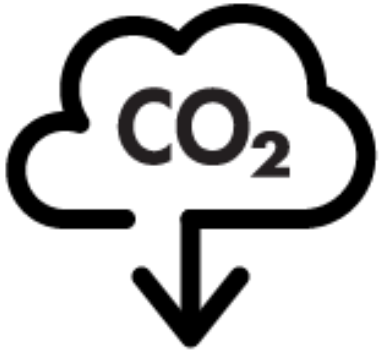


# Renewable Portfolio Standard (RPS) goals

California requires all utilities to purchase energy that meets the state's aggressive renewable energy goal mandate

- In 2030, the state's RPS requires 60 percent of the energy provided by utilities to be from a qualified renewable source
- By 2045, 100 percent of all energy provided to consumers must be from zero carbon resources

# Emissions




The ISO supports the integration of low and zero carbon energy resources, like wind, geothermal, hydro, storage and solar to meet California greenhouse gas emission policies

**40%**
Below 1990 levels by 2030

**80%**
Below 1990 levels by 2050

Lowering emissions is now a regional effort, because many neighboring states also have similar mandates

# Reliance on Imports

The ISO imports nearly 25 percent of its annual electricity supply to help meet the upward ramp that occurs when the sun sets and solar generation diminishes

Transmission limitations and changes to the resource mix in neighboring states are reducing the amount of available imports

# Solar

By 2030, utility-scale solar power plants will supply an estimated 21,000 MW each day to the ISO electric grid

Rooftop solar is not connected to the high-voltage transmission system, but they affect the ISO's markets and grid operation. Rooftop solar is expected to produce up to 16,000 MW by 2030

Grid operators must find other resources in the late afternoon to meet demand when solar production drops and energy demand begins to rise

# Wind

Wind is fast becoming one of the West's most dynamic renewable resources, with brisk industry growth, and future development of offshore wind farms. While wind conditions can be highly variable, generators typically take advantage of night winds

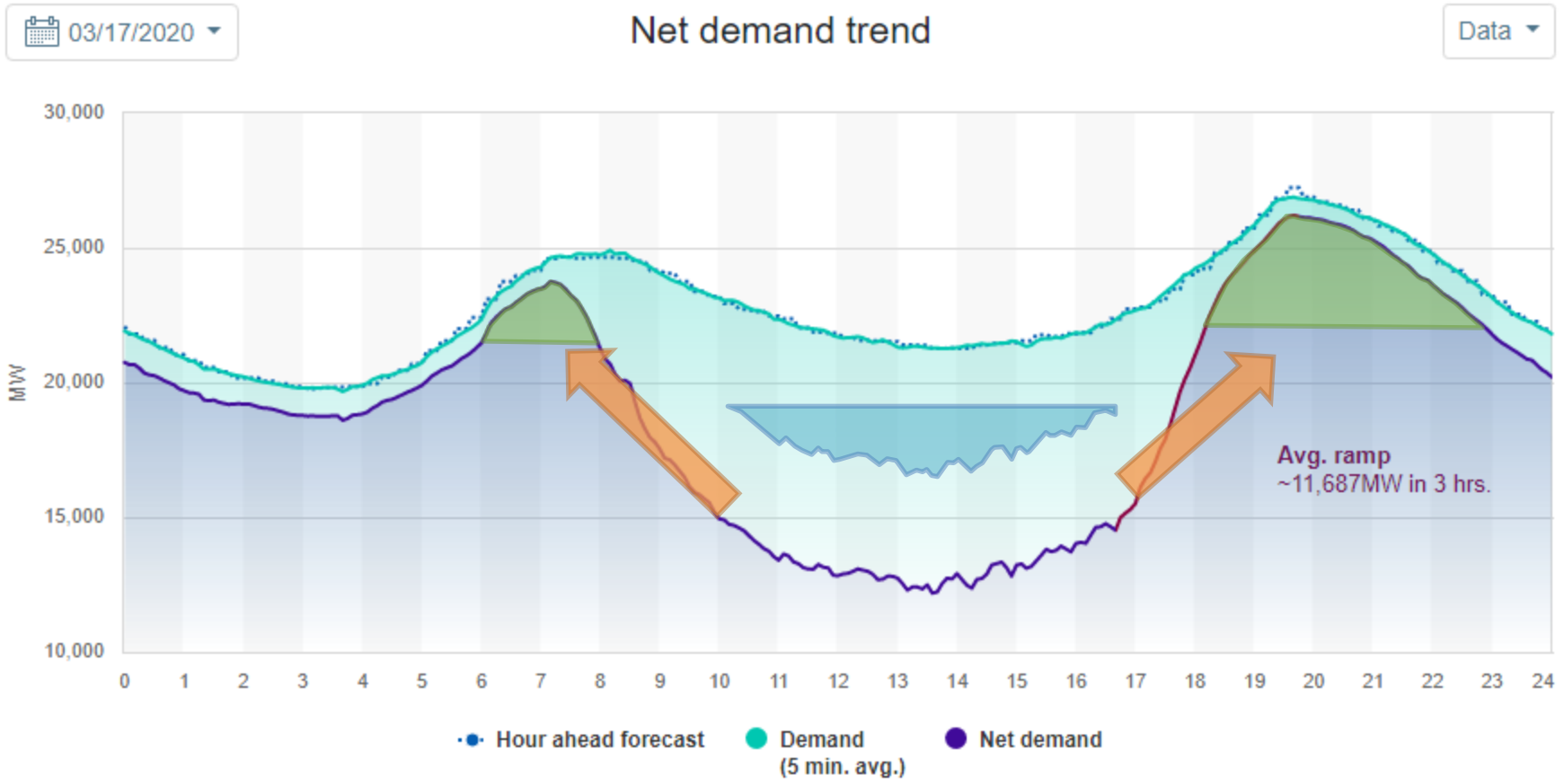
Recent ground-breaking tests conducted by the ISO show that wind resources can supply ancillary and reliability services to the grid, which can lead to increased wind resources in the future

# Net demand

Represents current power system needs, **excluding wind and solar**, and compares it to current energy demand and forecasted energy demand in five-minute intervals

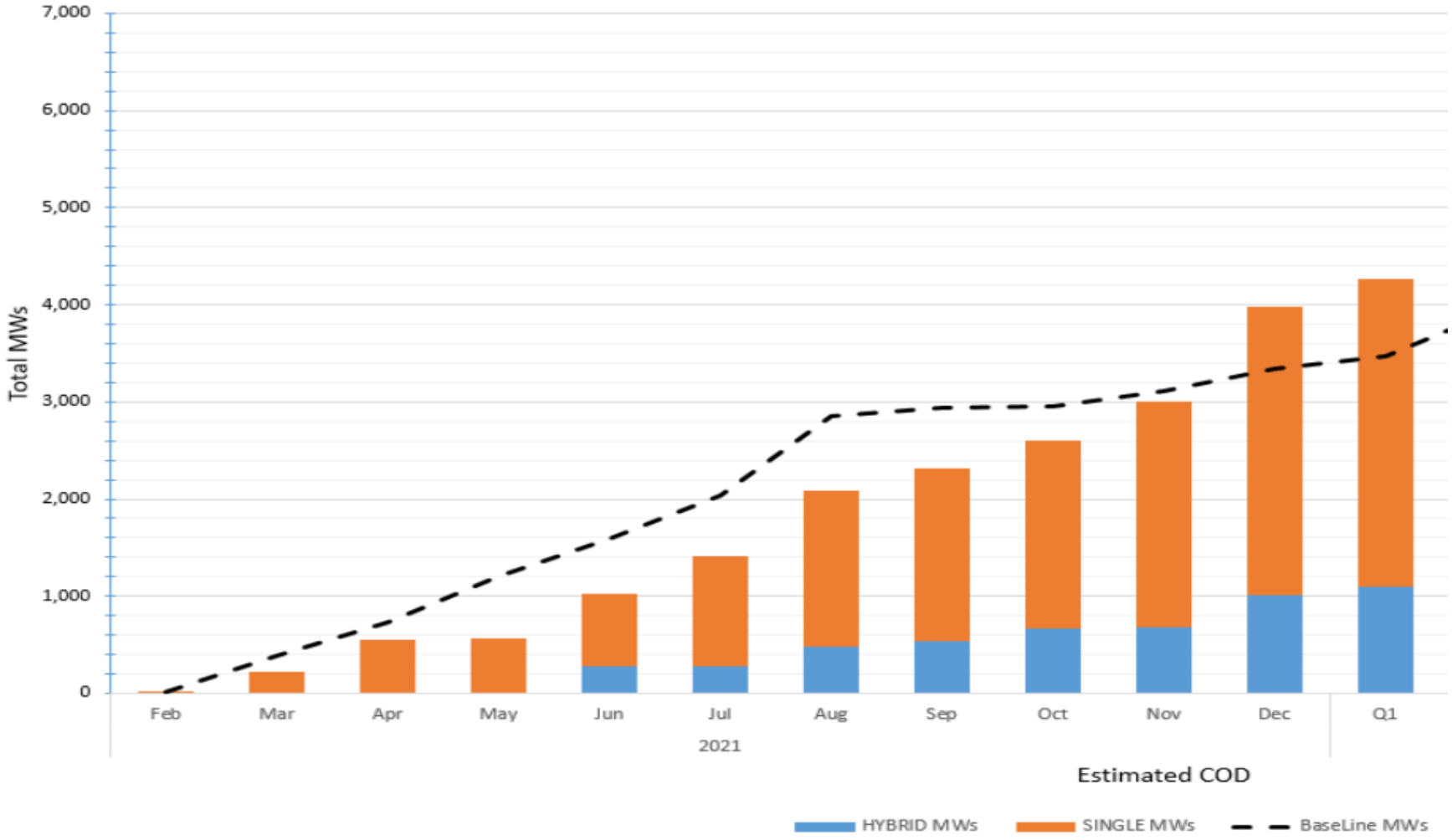
Net demand illustrates how the ISO meets the demand for electricity while managing ever-changing ramp rates of variable energy resources, such as solar and wind

# Solar and wind resources driving significant differences between gross and net demand. Storage resources critical to smoothing net demand curve

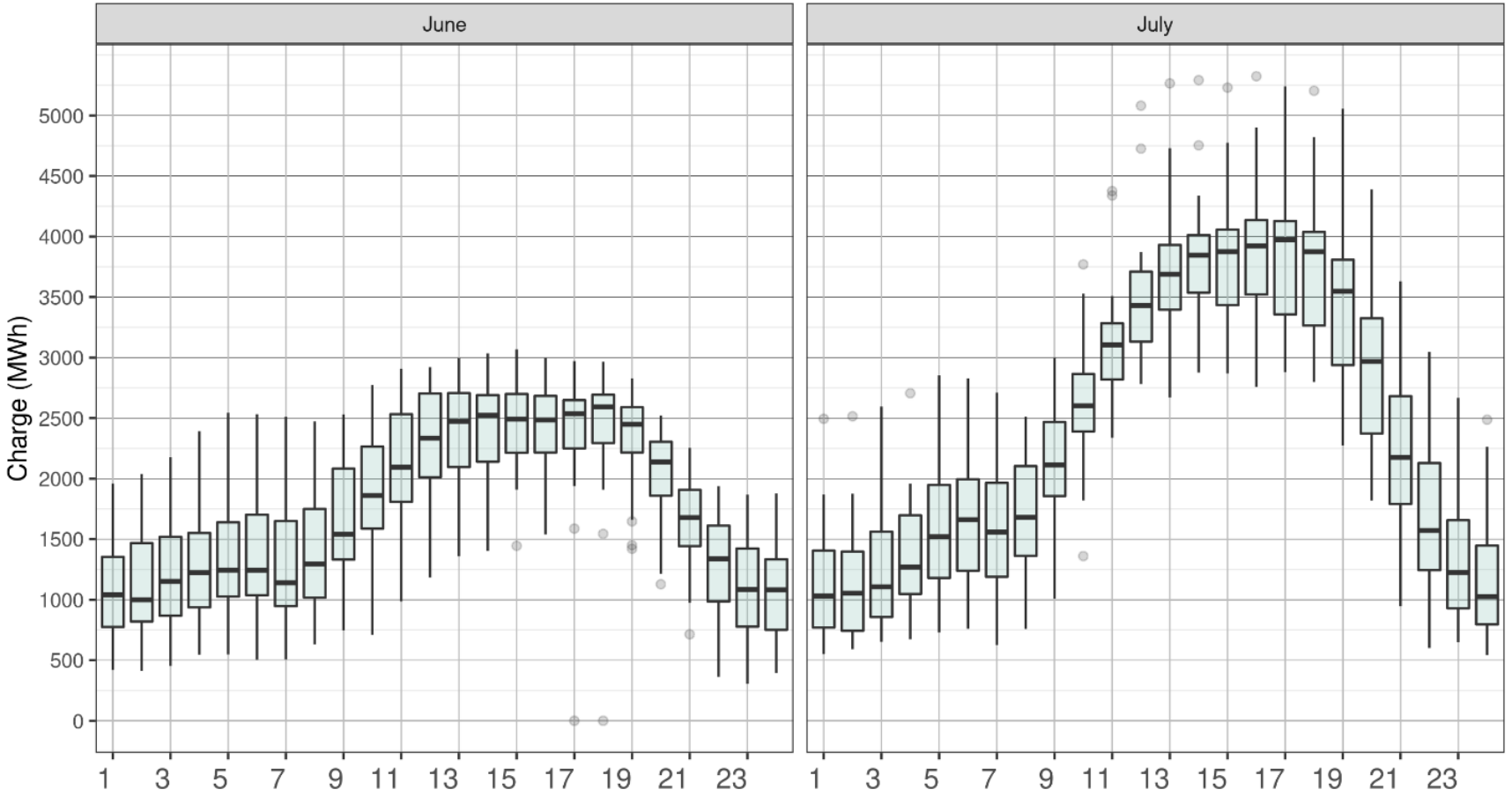


# Storage Policy and Resource Adequacy

# Storage resources are on pace for extreme growth during the next few years



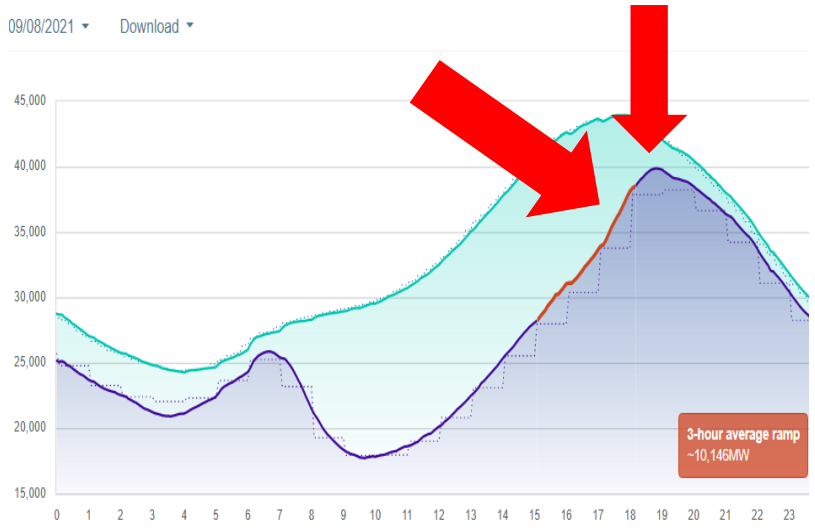
# Storage resources are providing charging and discharging energy to the grid during key times



# Operators have difficulty managing ramps up to the evening peak and meeting net load peak periods

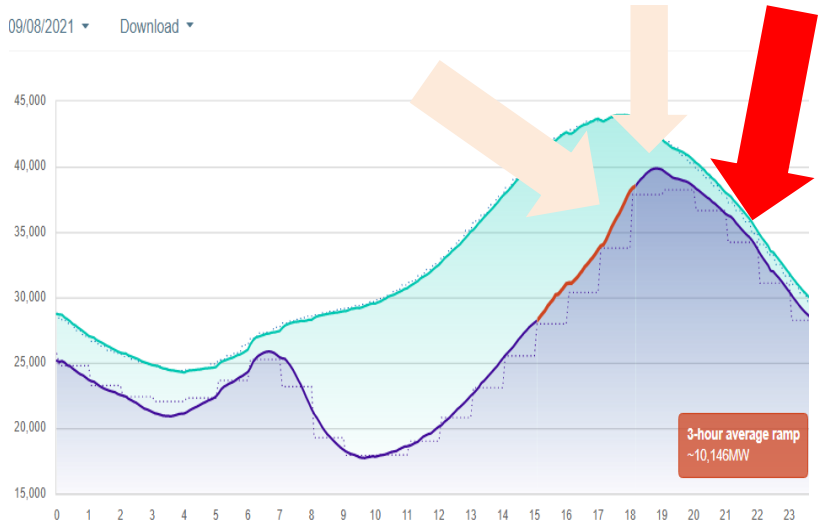
- ISO struggles to meet ramps leading to the peak periods
- ISO struggles to meet net load peak demand

- Storage resources are helping and are critical to meeting these peaks
  - Operations notes improvements in evening ramping capability of the fleet with the recent addition of storage
- The system can afford very few gas retirements



# As the grid changes over the next 2 to 3 years, the issues that operations face will change

- Less trouble meeting net load ramps, but more difficulty maintaining reliability after the evening peak
  - *How do we ensure batteries are charged?*
- If gas is retired ISO may struggle at night
- May propel into morning ramp
- Additional solar increases need for ramping resources



# CAISO has tools to model and track state of charge for storage resources

- Dispatch for storage can be to charge or discharge
- Model includes state of charge
  - Model understands that charging increases state of charge and discharging decreases state of charge
  - Includes round trip efficiency for charging
  - Storage resources can specify upper and lower bounds for state of charge
  - Market optimization prevents resources from operating outside of these ranges
- Day-ahead model charges storage during low priced hours and discharges resources at high priced hours
- Real-time dispatches are based on LMPs and bids

# Resource adequacy requirements need to evolve to meet operational needs

- Net load peak requirements are needed
  - Must ensure all operational needs (24x7) are met
- Advanced capacity counting methodologies needed for variable output resources
  - Wind and solar, demand response, hydro
- Capacity counting rules for storage are insufficient
  - 1 MW of storage can help hit system peaks, but reliability **is not** equivalent to any generator
  - Chance that storage is not charged during periods of critical need
- Resource adequacy must account for capacity and energy needs

# CAISO is introducing a number of new tools into the market

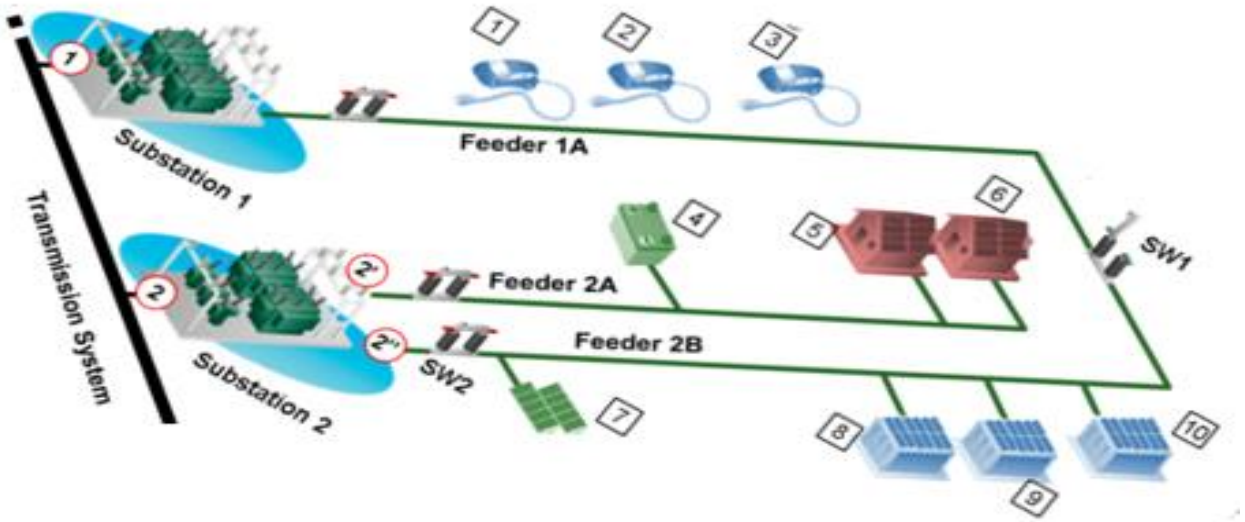
Fall 2021

- Biddable real-time parameters to specify max and min SOC
- Market power mitigation for storage resources
  - DEBs include energy costs, cell degradation and opportunity costs
- Parameters to prevent generation from exceeding interconnection limits
  - Model includes contractual parameters for multiple off-takers

Spring 2022

- Allow hybrid resources to specify operating limits on a 5-minute basis

# Distributed Energy Resources



# CAISO DER Participation Models Successes

1. Stand-alone DER
   - 500+ new DERs (2.2 GW) since 2005
   - Same requirements as transmission-connected resources

2. Demand Response (2010)
   - Distribution interconnection requirements, ISO registration process
   - 2.0 GW in CAISO markets
   - PDR and RDRR (emergency) models
   - 7 settlement methodologies (Electric Vehicles, behind-the-meter solar/storage, weather-matching, 10 in 10, etc.)

# CAISO DER Participation Models Successes

## 3. Distribution Energy Resource Aggregations (2016)

- Allows small DERs to participate as a DERA
- Created when California regulator had a 1 MW cap for NEM resources, which was later removed.
- DERAs cannot participate in net energy metering program or demand response program
- Distribution companies get 30 days to review DERA to ensure DERs are not also demand response participants, NEM, in other DERAs, conflict with their tariffs, or create risk
- No participants to date

# DERA Challenges

- Retail programs are more attractive
  - The DERs that could be in DERAs generally are eligible to participate in net energy metering programs
  - No capacity limit under CA net energy metering
- Current CAISO stand-alone resource requirements are low
  - 500 kw for generators and 100 kW for storage
- In California, regulators have yet to establish a resource adequacy capacity value for DERAs
- Distribution companies are wary of complexity DERAs could represent

# Where to evolve? Distribution System Operator will be needed

| Total TSO | Hybrid DSO | Total DSO |
|---|---|---|
| TSO optimizes entire power system (T&D) | TSO optimizes bulk power system – dispatches wholesale DER services | TSO optimizes bulk power system – see "virtual" resource at T&D interface |
| DSO reliably operates D network providing full visibility to TSO | DSO optimizes distribution system – dispatches DER for distribution services coordinated with TSO | DSO coordinates aggregated response of all DER services at T&D interface & wholesale market |
| DER customer/aggregator coordinate with TSO | DER customer/aggregator coordinate with both | DER customer/aggregator coordinate with DSO |

- Currently positioned to effectuate a Hybrid DSO model
- Total DSO framework desired
- DSO evolution needed to fully capture DER value in system operations

# Market Enhancements to address increased ramping and uncertainty needs

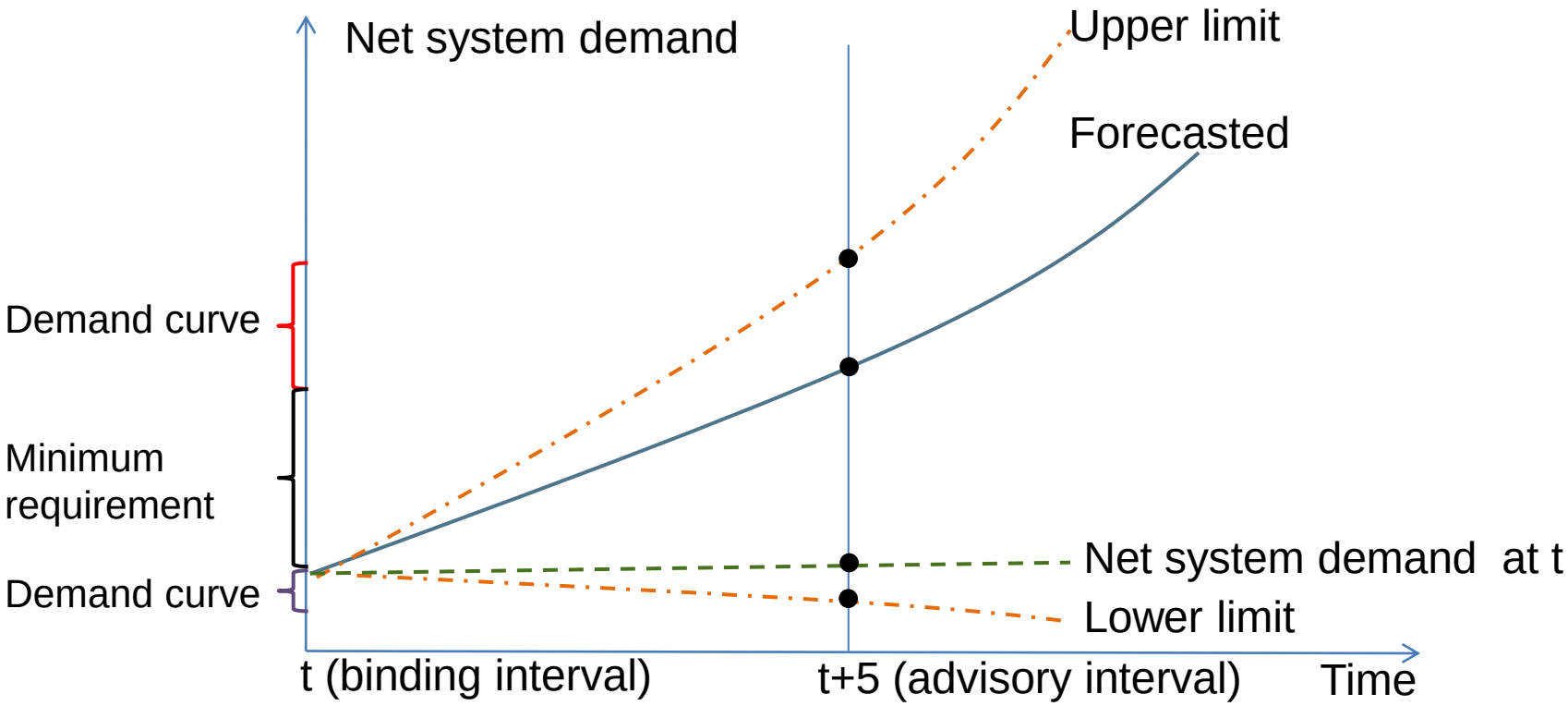
# Traditional ancillary services are inefficient at meeting operational needs for flexibility

- Regulation can address uncertainty, but should only be used for uncertainty that materializes after real-time market five-minute dispatch
  - Uncertainty before real-time dispatch should be reflected in energy price
  - Regulation is not available for real-time market dispatch

- Spinning reserves are dispatched to meet contingency events, flexible ramping routinely dispatched

# Real-time market flexible ramping product to meet ramping needs (2014)

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



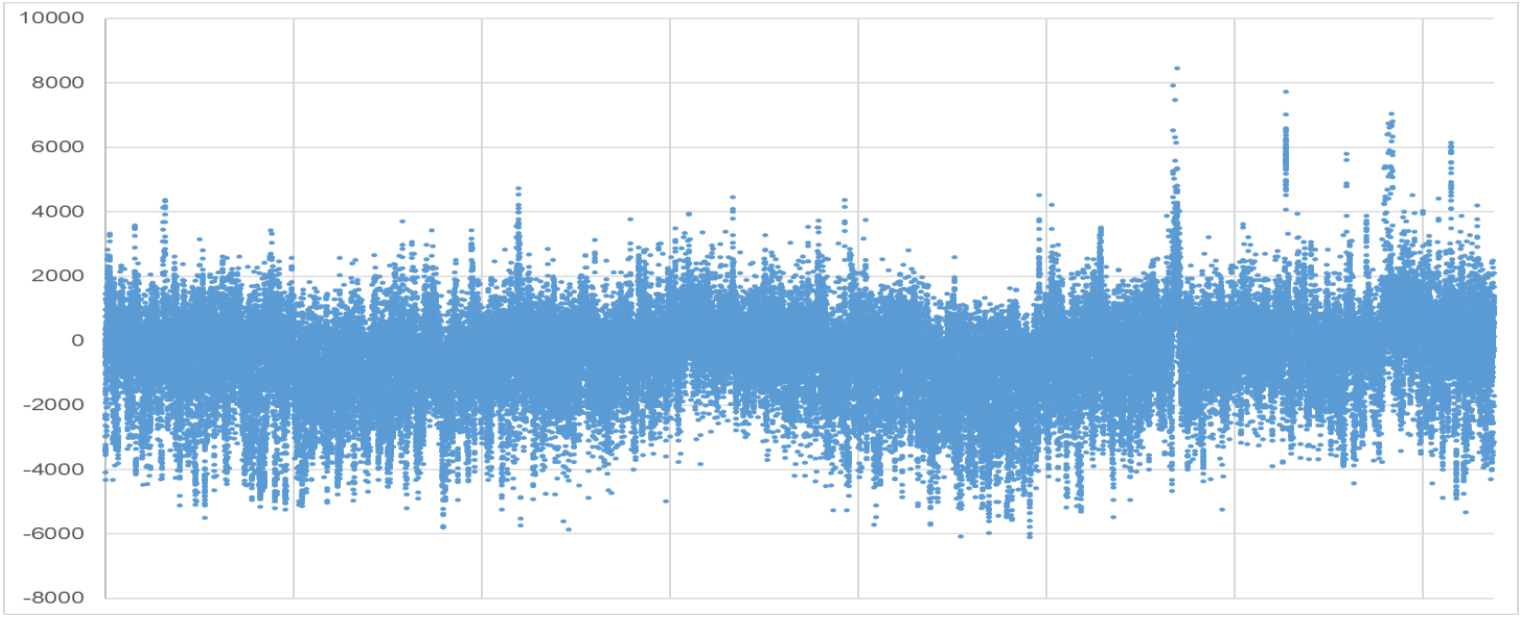

**Real ramping need:**

Potential net load change from interval t to interval t+5

(net system demand t+5 – net system demand t)

# Net load imbalance varies greatly and is increasing as due to supply and demand uncertainty

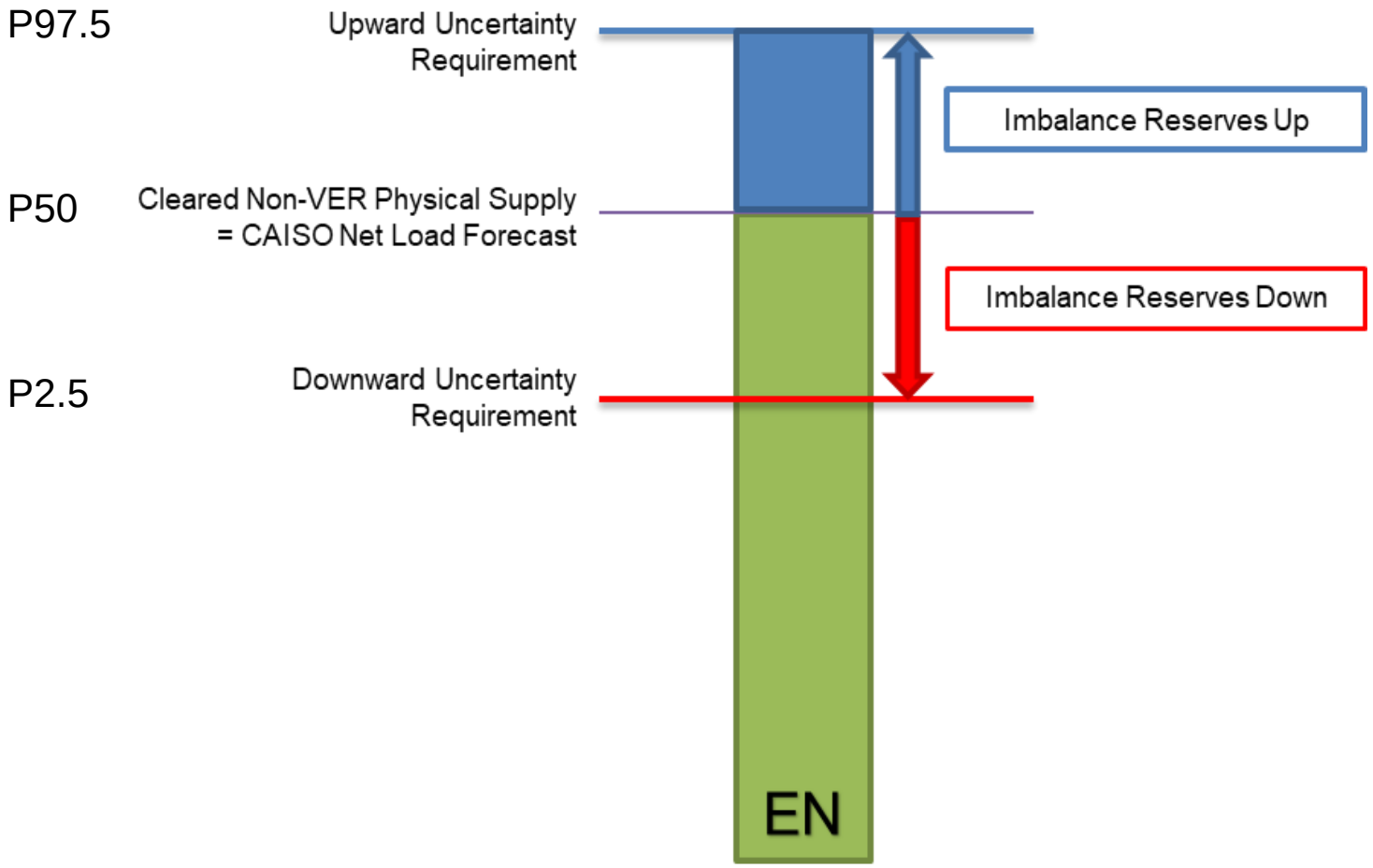
Net load imbalance from Jan 2017 – Mar 2019




Each data point is the quantity of imbalance (between FMM and IFM) for each FMM interval of Jan 2017 – Mar 2019

Proposing to meet this need with
new day-ahead market imbalance reserve product

# Day-ahead imbalance reserve product ensures sufficient resources are committed and scheduled to meet real-time net demand uncertainty



California ISO

# Questions?