

DOCKETED

Docket Number:	23-ERDD-01
Project Title:	Electric Program Investment Charge (EPIC)
TN #:	251428
Document Title:	Presentation - EPIC 4 Grid Modernization Research Scoping Workshop
Description:	N/A
Filer:	Elyse Kedzie
Organization:	California ISO
Submitter Role:	Public
Submission Date:	8/1/2023 10:47:45 AM
Docketed Date:	8/1/2023



California ISO

EPIC 4 Grid Modernization Research Scoping Workshop

July 21, 2023

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California ISO

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

52,061 MW record peak demand
Sept. 6, 2022)

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

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

32 million people served



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

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

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



Managing power through new technologies and consumer programs



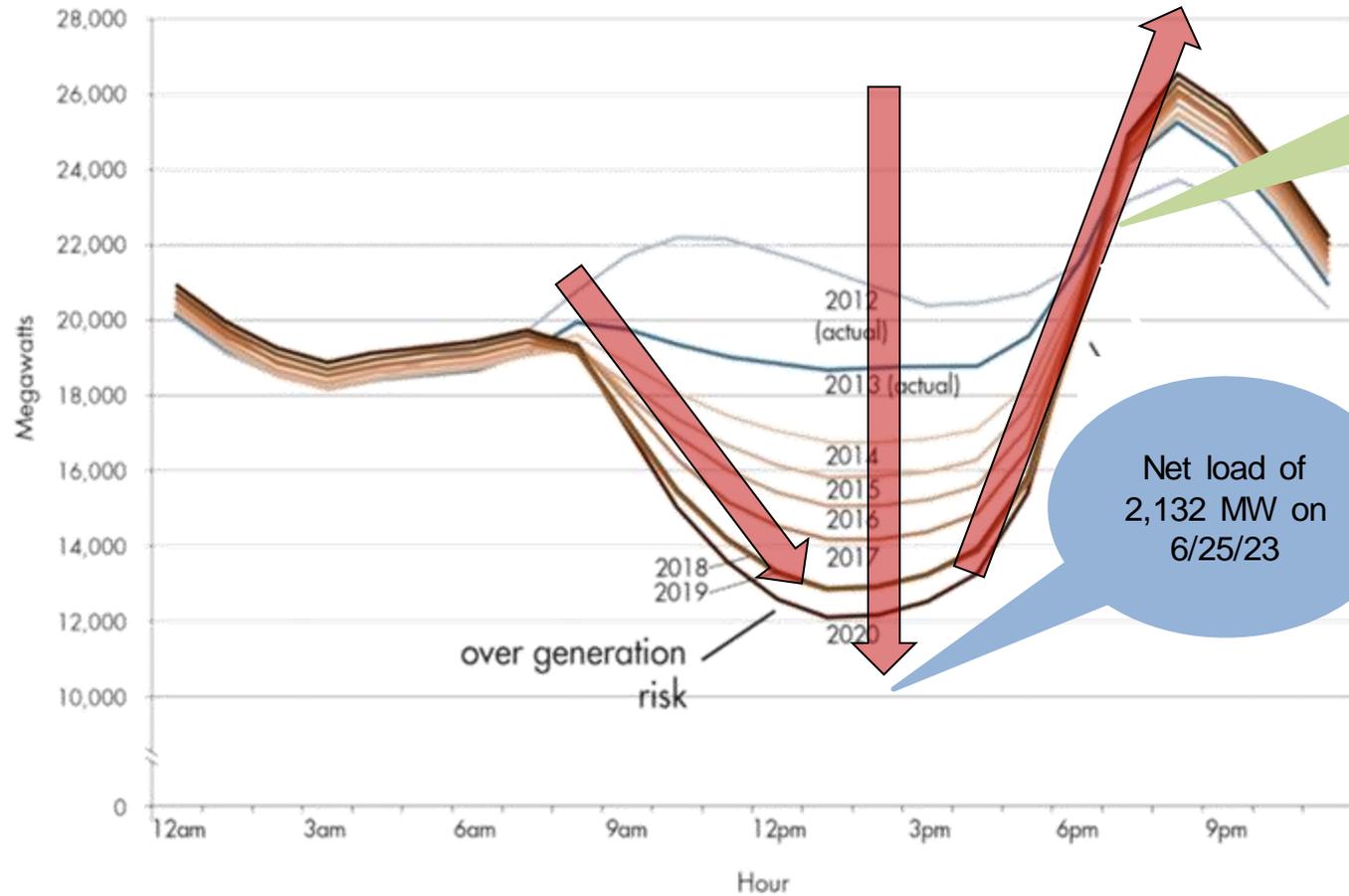
- As more renewable energy is integrated on the electric system, over-supply conditions often occur during the middle of the day
- To minimize curtailment, excess renewable energy must be stored
- Several new technologies and consumer programs have been developing including:
 - Storage/batteries (ISO is agnostic to resource technology)
 - Demand response
 - Time-of-use rates
 - Hydrogen fuel
 - Offshore wind and wave technology
 - Underground compressed air
 - Electric vehicles
 - DER

CAISO's current real-time operational challenges

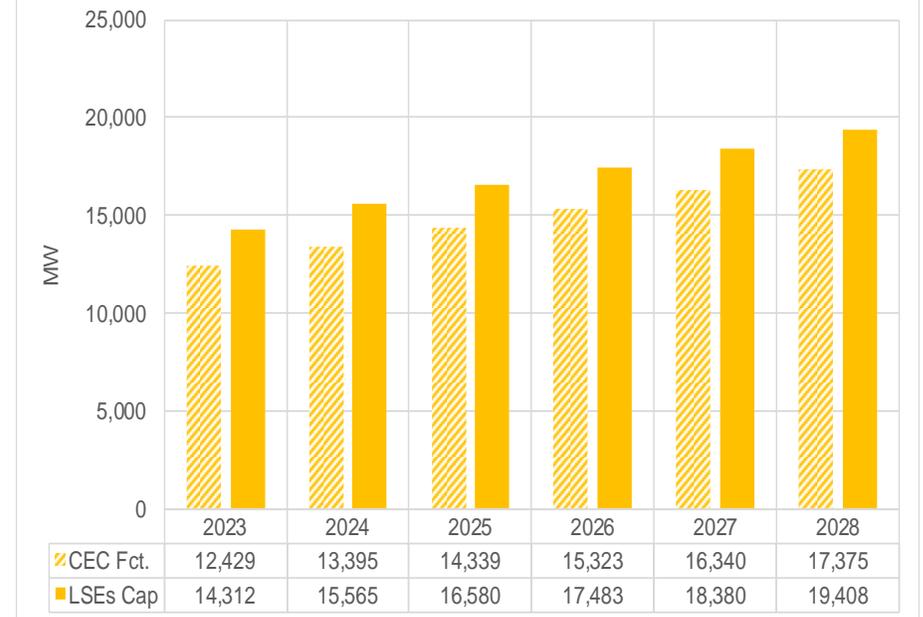
- Intra-hour variability can be greater than $\pm 8,000$ MW in some hours
- Maximum 3-hour net load ramps greater than 18,000 MW during sunset and is expected to continue increasing
- 10-minute variability between $\pm 1,000$ MW and $\pm 2,000$ MW
 - Minimize supply/demand imbalances in the RTD timeframe
- Depleting procured regulation used in some hours
- Over-supply conditions during the middle of the day continues to increase
- Experiencing control performance challenges on weekends during sunrise, sunset and the middle of the day
- During spring, cannot commit enough gas units on governor control to meet primary frequency response obligation
- Better utilization of storage and IBR resources to provide essential grid services including PFR

Actual net-load and 3-hour ramps are more than five years ahead of ISO's original estimate

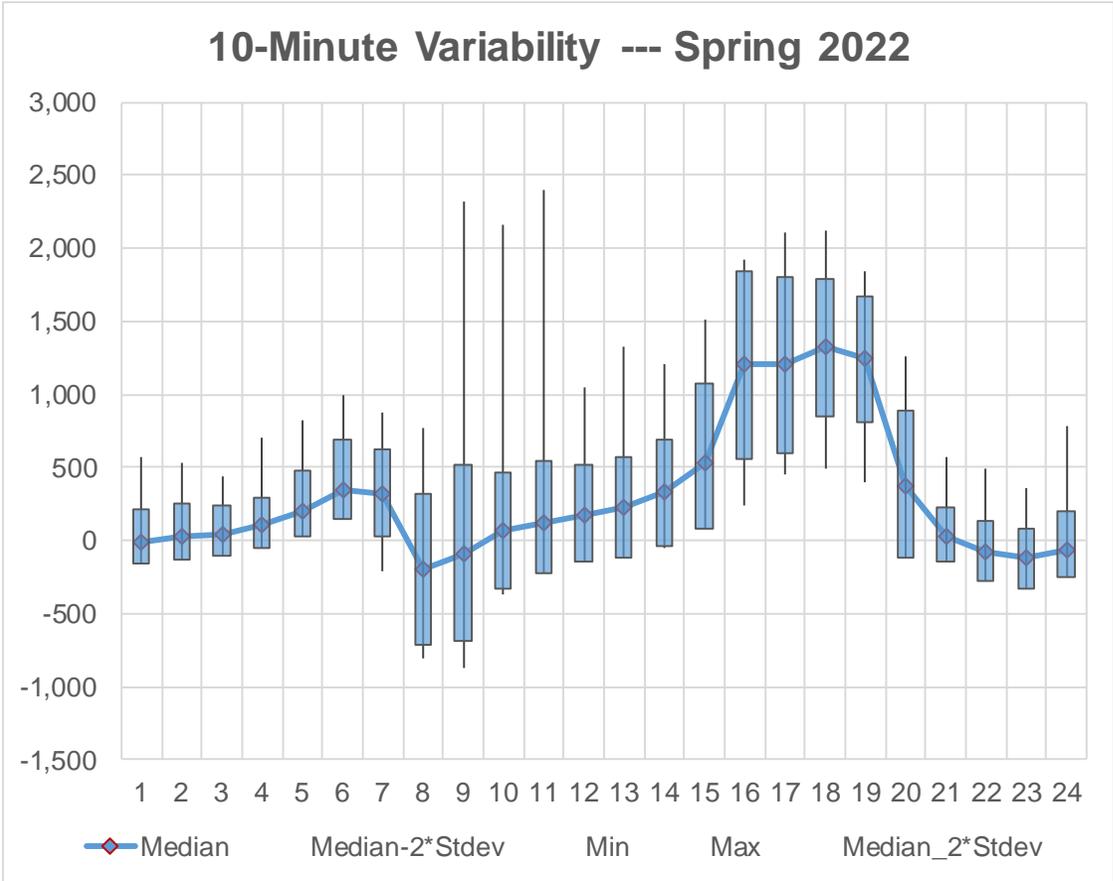
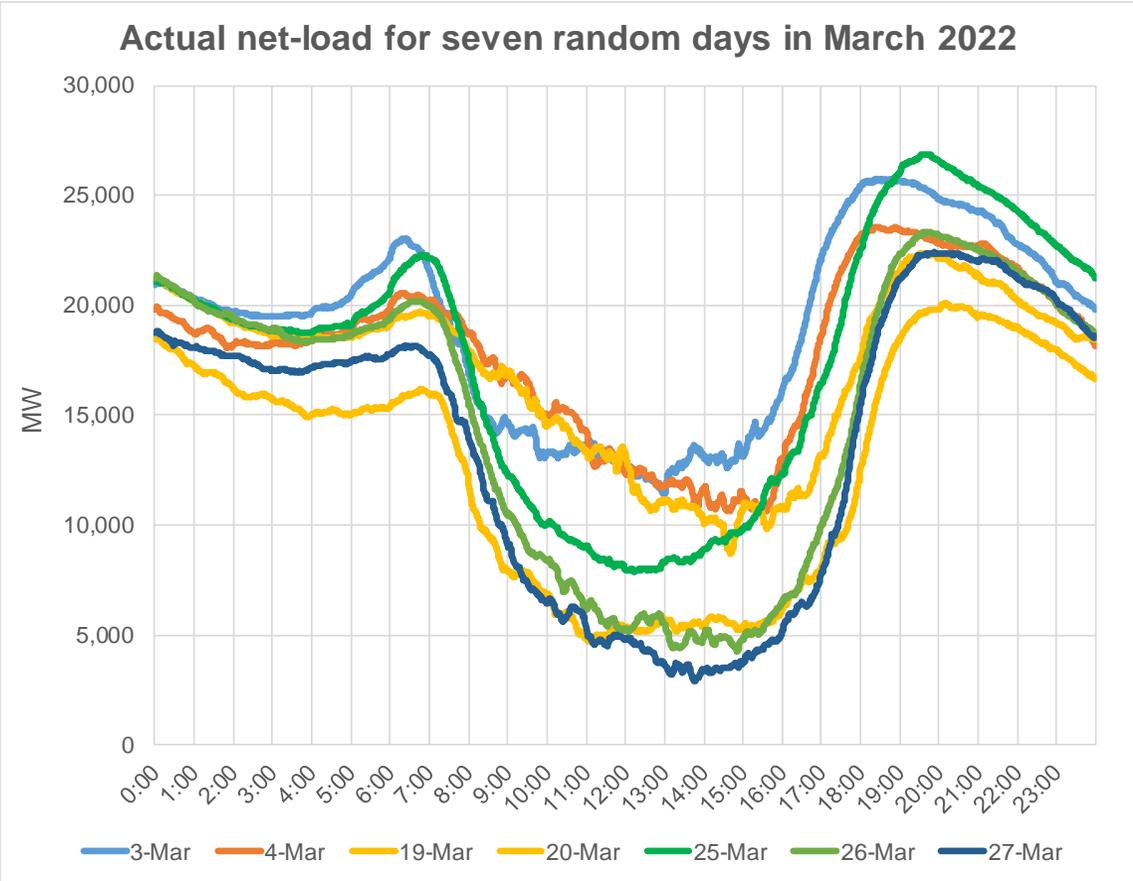
Typical Spring Day



LSEs Expected Capacity vs. CEC's Forecast Production



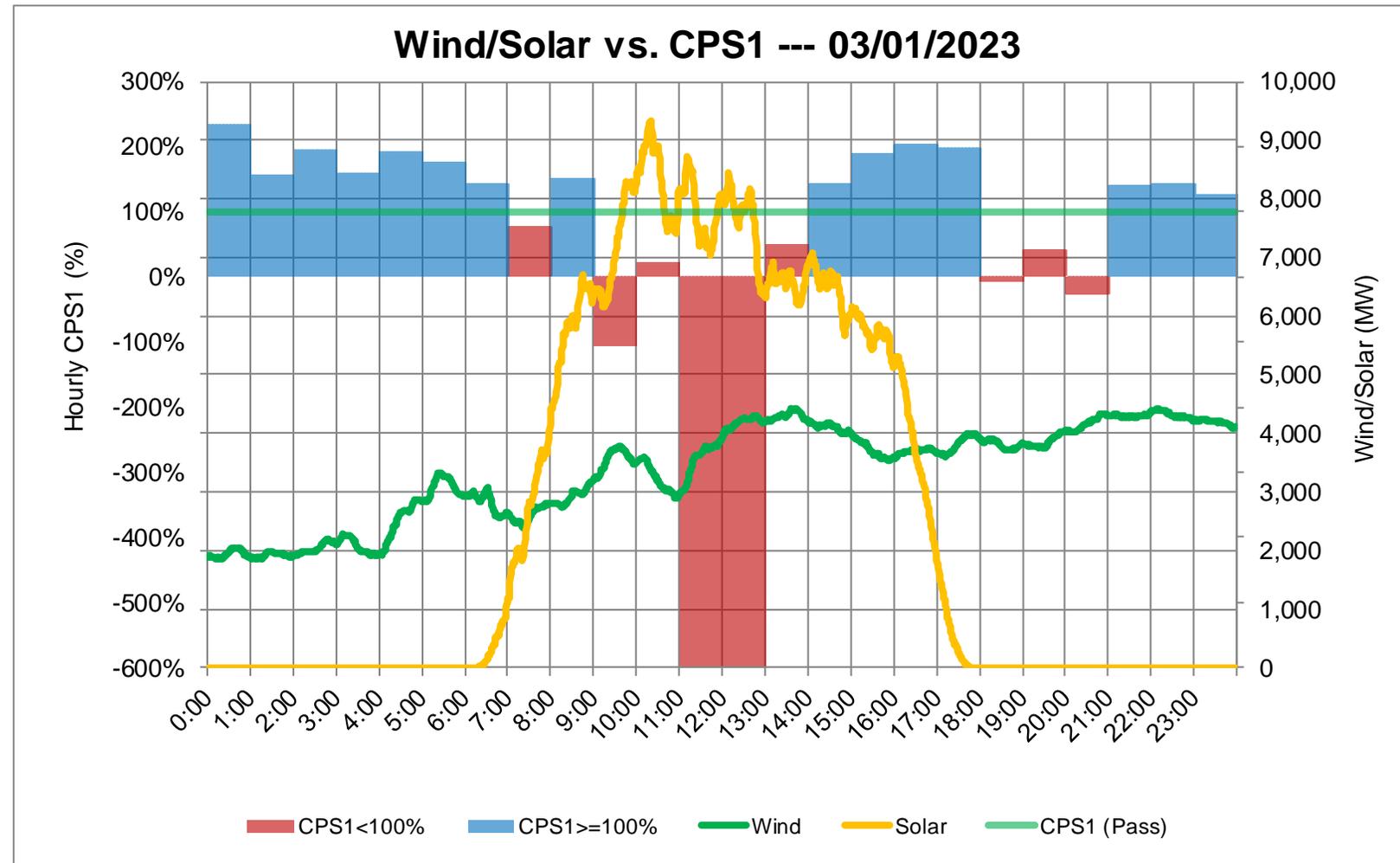
Example of net-load variability for seven random days in March 2022 ... and distribution of 10-minute variability during spring 2022



Variability is one of our biggest concerns under N-0 operating conditions

Need to enhance operational performance during periods of increased supply variability

- On rainy cloudy days it's a challenge forecasting solar and wind in the near-term
- Forecast could lag actual production
- Market prices could be stable and supply/demand imbalances in RTD would be shifted to AGC

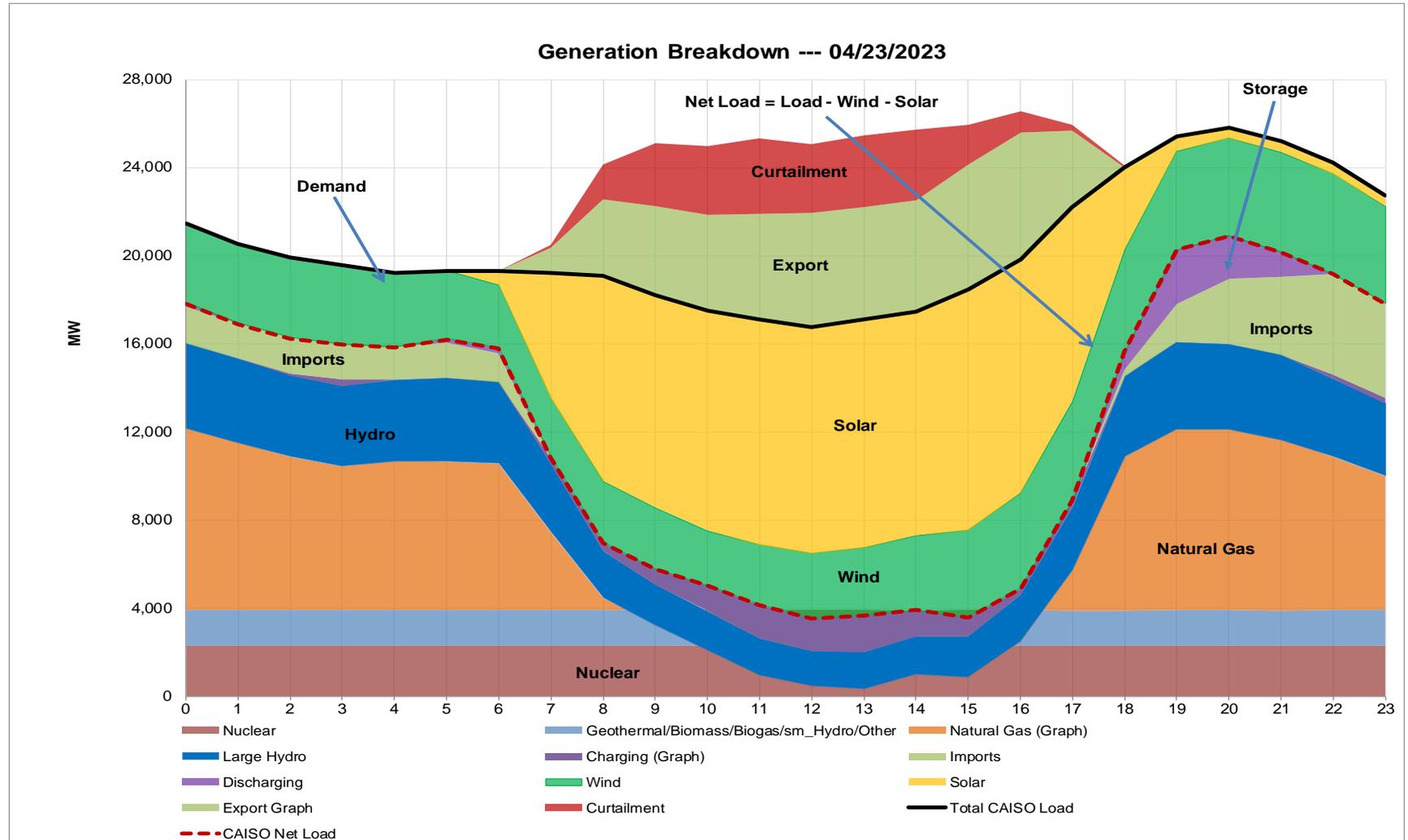


CPS1 is a NERC Control Performance Standard which is calculated each minute and evaluated on a rolling 12-month average.

Maximum load plus export served by non-carbon resources on Sunday, April 23, 2023 was 108%

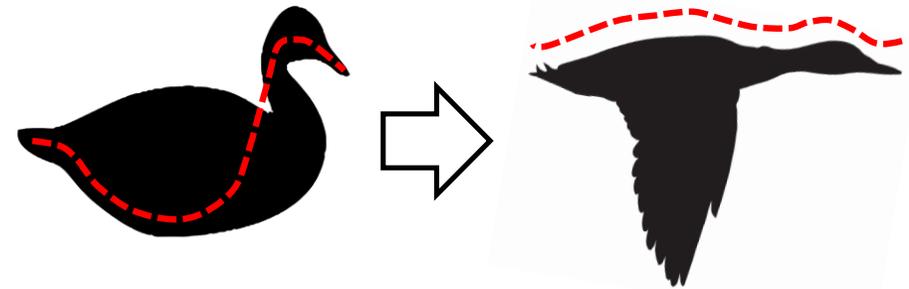
Operational Challenges

- Lack of downward dispatchability during middle of the day
- Relies on imports/exports and DEC bids to balance the system
- Lack of adequate frequency response capability during the middle of the day
- Potential control performance issues due to lack of flexibility
- **Need IBRs including storage to provide essential grid services such as:**
 - Voltage Control
 - Frequency response/control
 - Active Power Management



What is the “Duck” telling us?

- Integrating higher levels of renewables is making significant impact on how we meet mid-day demand
- Management of increased over-supply requires economic bids from all resources, including renewables
- Increasing challenges to simultaneously meet evening ramp and most severe contingency
- Need additional solutions such as storage, time of use (TOU) rates, regional collaboration, and flexibility from all resources to shift and shape demand
- Need to maintain sufficient capacity during multiple days of low wind/solar production
- Volume and speed of solar morning ramp is greater than demand and needs to be managed
- Renewable resources need to follow dispatch instructions similar to other resources



We must make the duck fly!

A healthy grid must counter-act the ill-effects of the sitting “duck curve”

Potential Research Interests

- Improve prediction of short term net-load variability to enhance control performance
- Predict required headroom to allow IBR resources to provide ancillary services
- Develop criteria to allow IBR resources to provide voltage control when wind/solar are not available
- Develop criteria on how EV and other behind the meter DER can shape and shift load and provide ancillary services
- Identify the need and application for grid-forming inverters
- How do we incentivize IBRs to provide essential grid services to meet the State's clean energy goals?
- Identify areas with respect to reduced short circuit strength and find applicable solutions



Questions