



California ISO

Evolution of storage within CAISO

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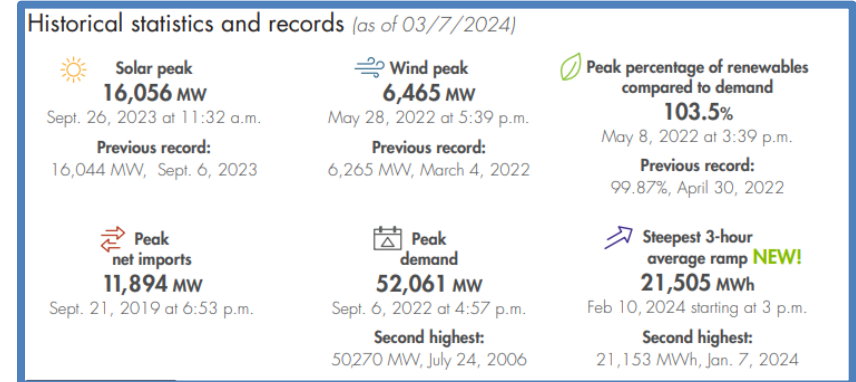
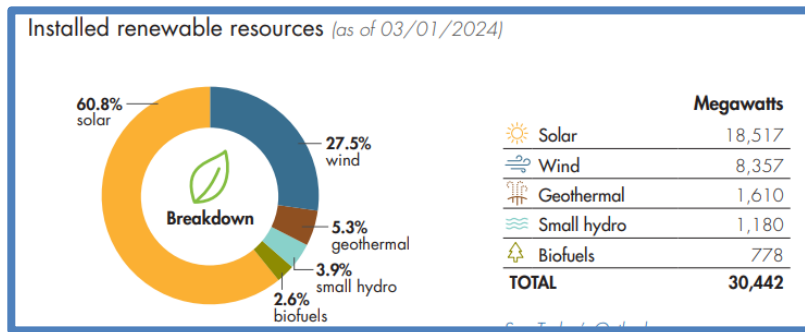
Vice President, System Operations

November 17, 2021

Agenda

- Introduction
- Evolution of energy storage in California ISO
- Observation of energy storage usage and behavior

California ISO - Introduction

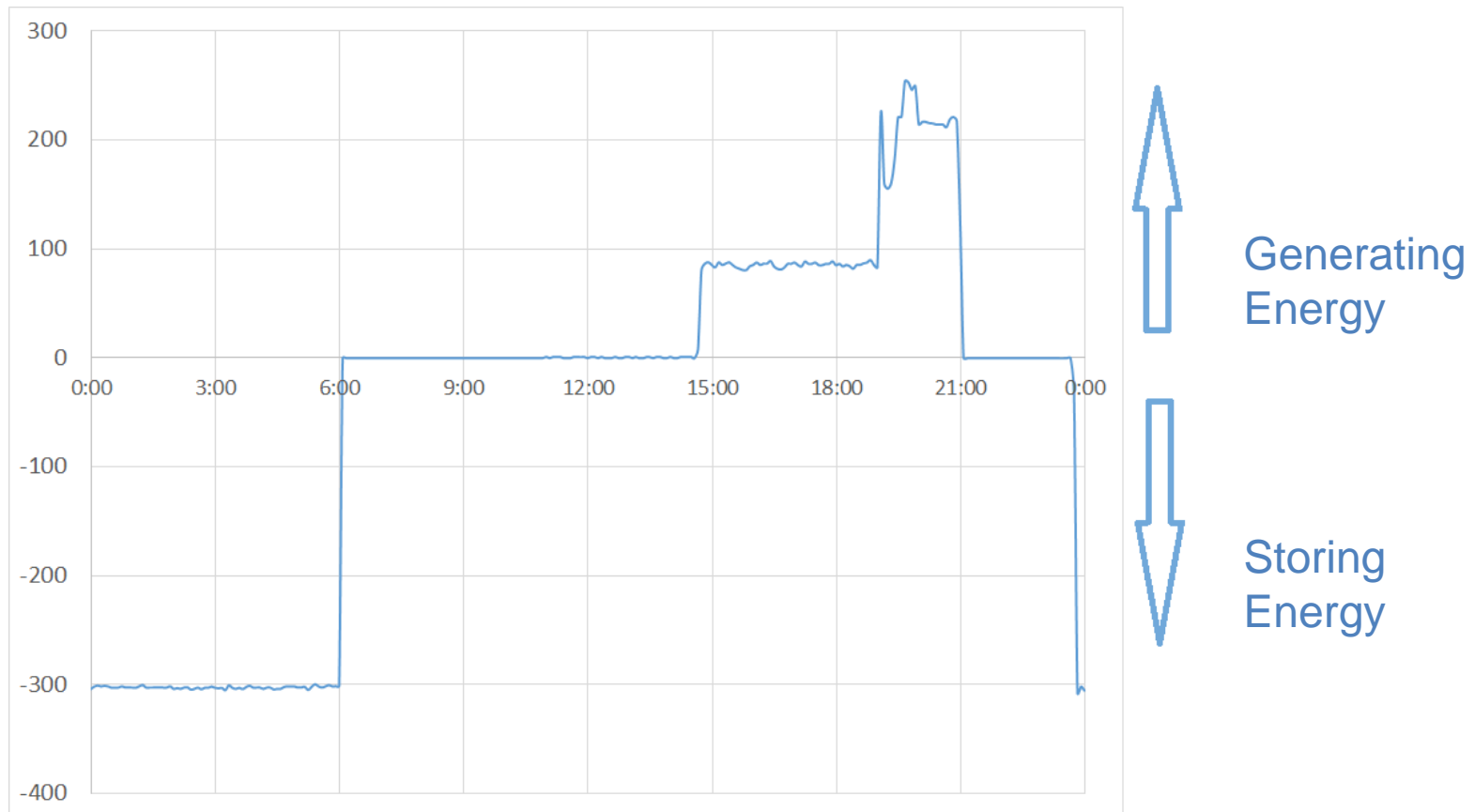


Evolution of energy storage in California ISO

- Prior to 2010:
 - In CAISO, primary energy storage was pump-hydro
- By end of 2020: ~ 100 MW BESS
- By end of 2021: ~ 2,000 MW BESS
- By end of 2022: ~ 4,300 MW BESS
- By end of 2023: ~ 7,000 MW BESS

Observation of Energy Storage usage and behavior

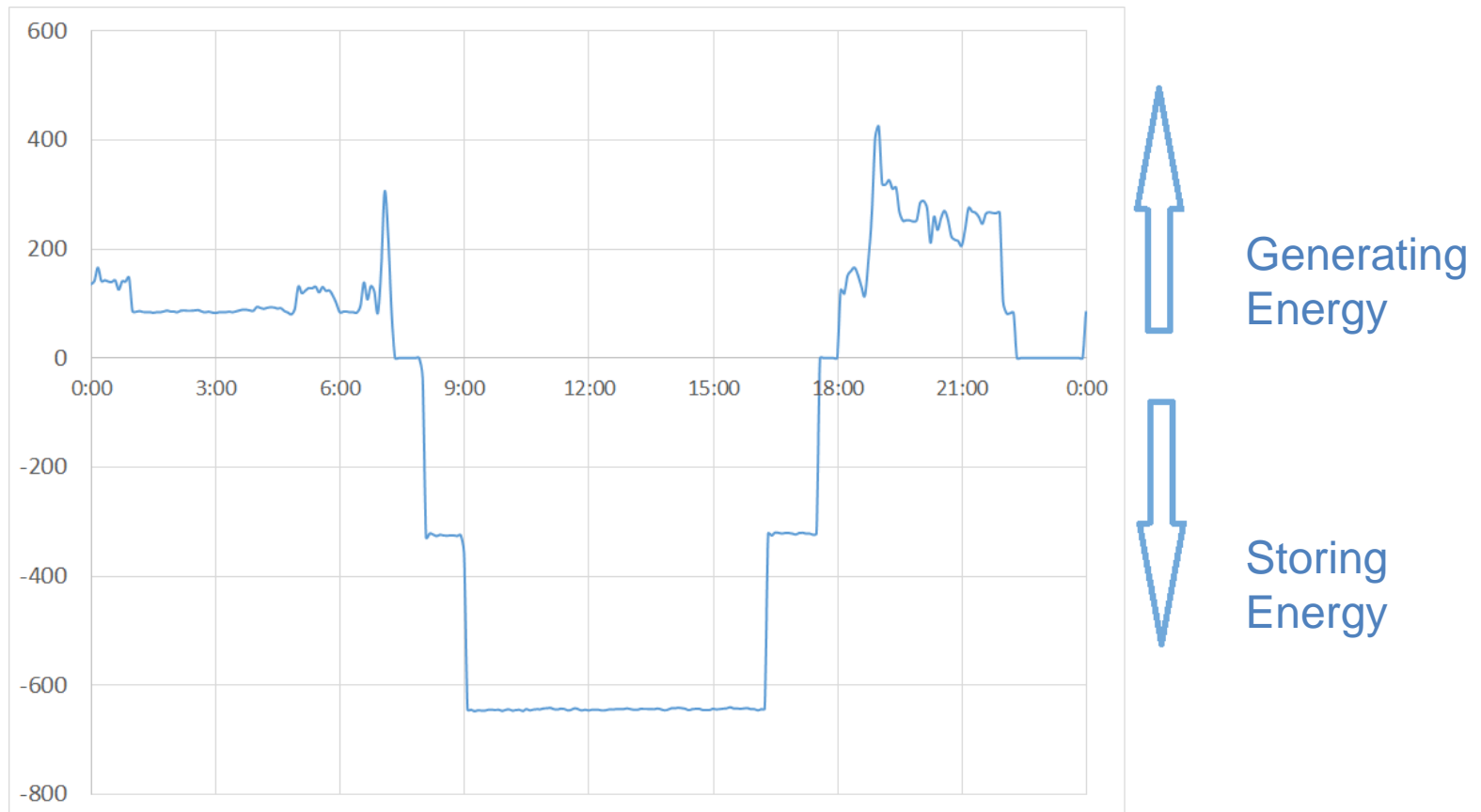
Prior to 2010: Energy is stored during the night and used during the day



Example of Pump Storage Behavior

Observation of Energy Storage usage and behavior

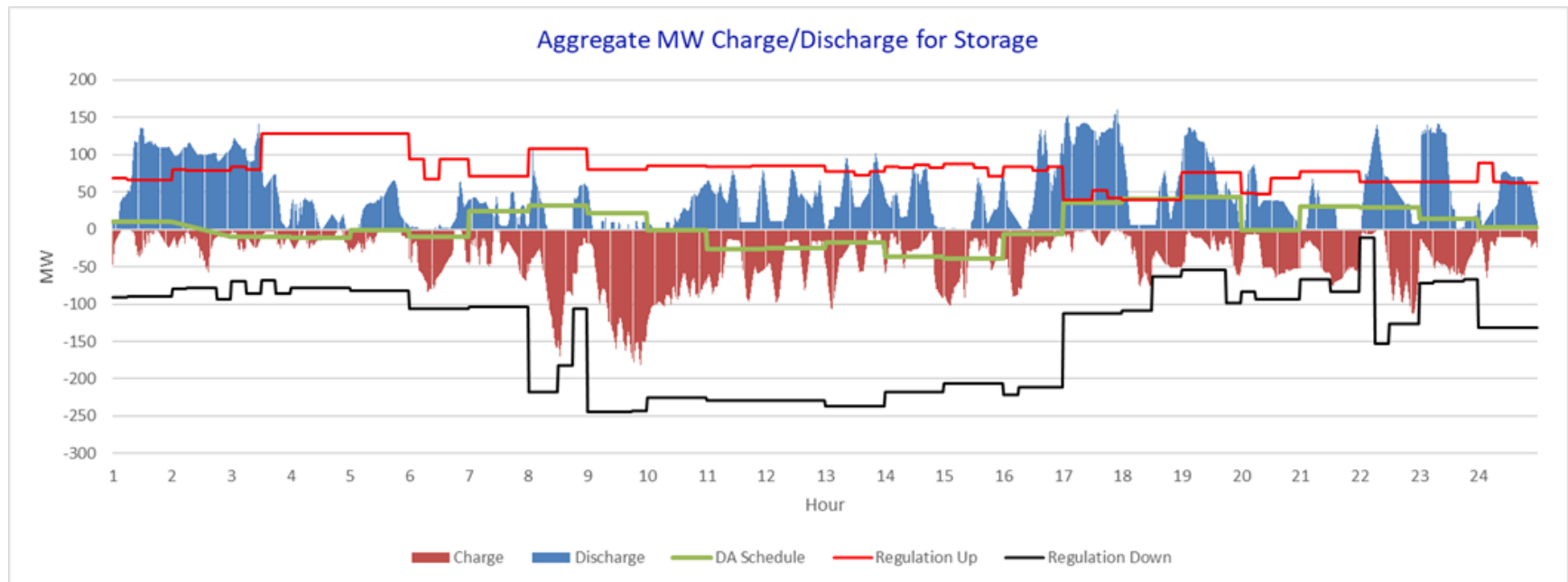
High penetration of solar has changed the utilization of energy storage



Example of Pump Storage Behavior

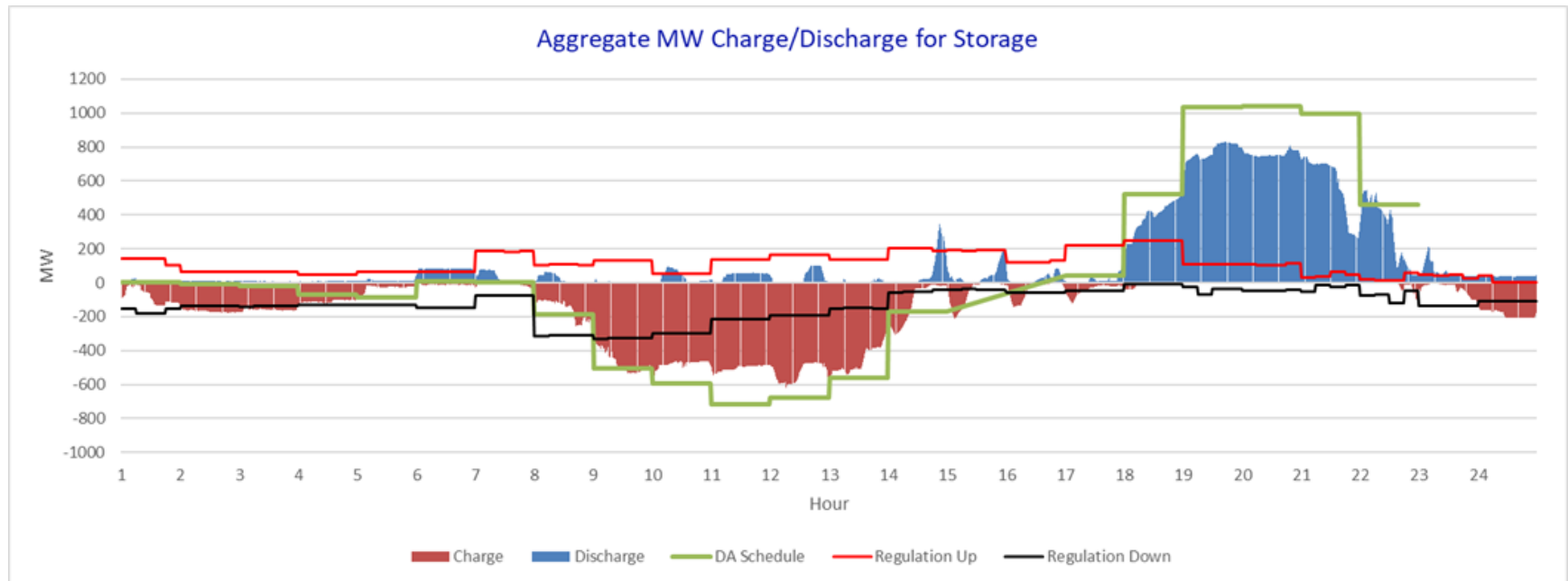
BESS usage and behavior in the beginning 2021

Typical behavior observed when storage penetration was lower at the beginning of 2021 (BESS ~ 500MW)



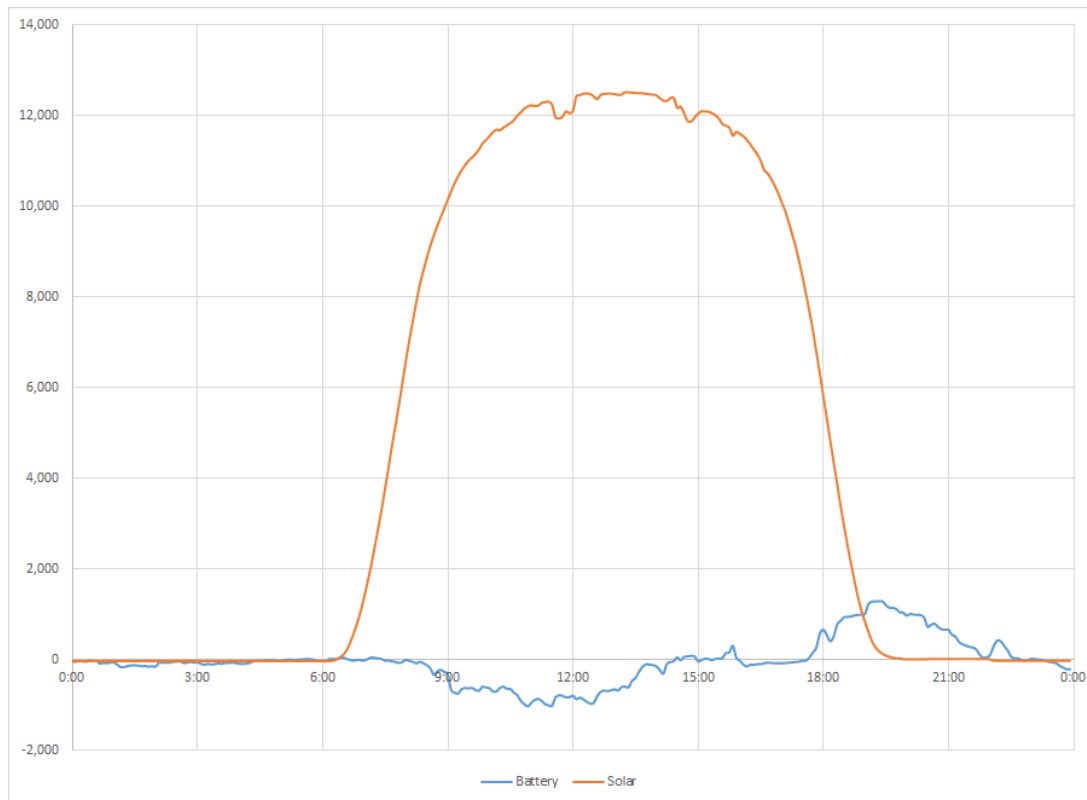
BESS usage and behavior in Summer 2021

Typical behavior observed when storage penetration was higher in the summer of 2021 (BESS ~ 1500MW)



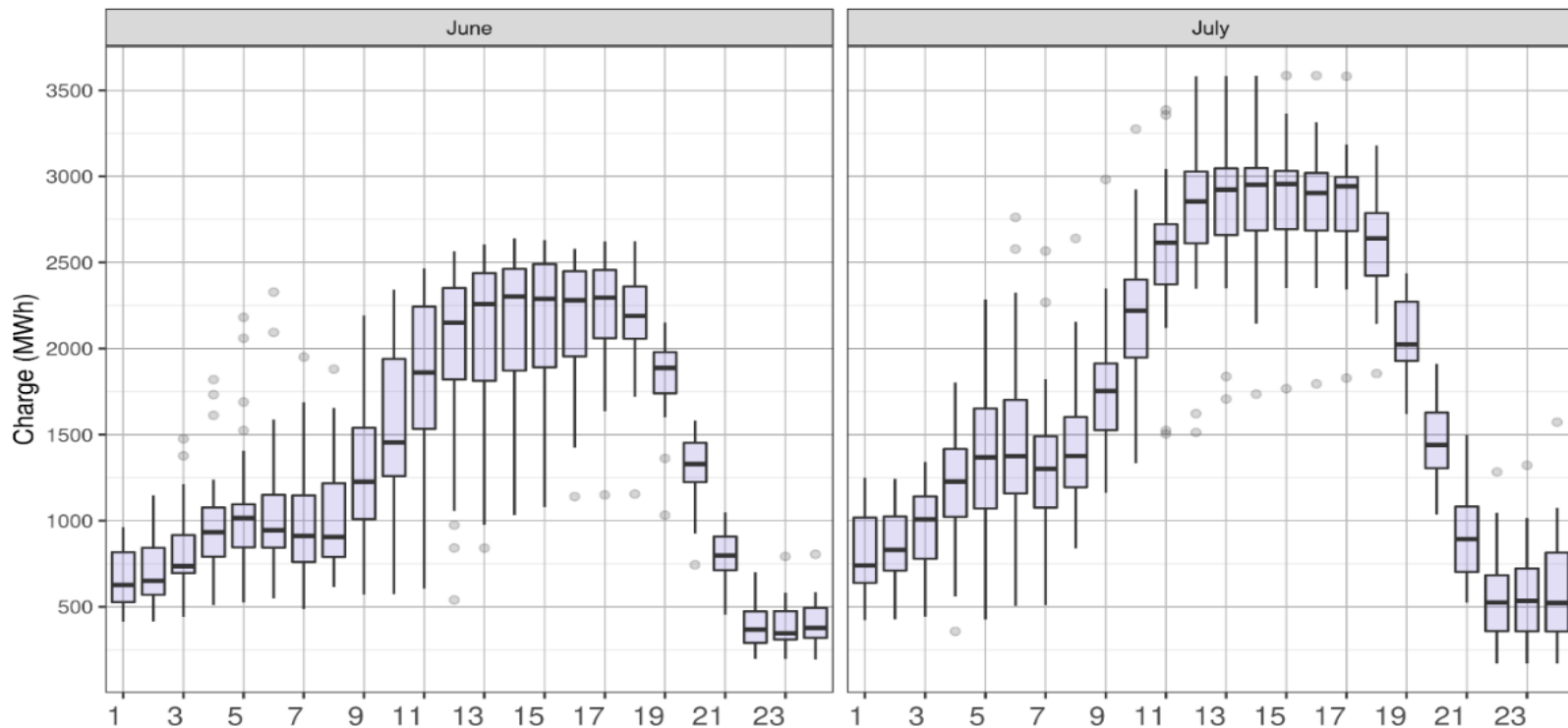
BESS usage and behavior in Summer 2021

Typical interaction between solar and battery in a summer day in CAISO reflect both utilization for regulation and energy need



Storage resources shifted energy from low priced periods to the evening peak

- Observation of “State of Charge (SOC)” for BESS in CAISO
- BESS need to be optimized and positioned to have the correct SOC to meet the need of the grid.



Other observations

- It is important for market optimization to account for and model battery charging and State of Charge to meet energy and ancillary service needs
- Frequency response setting in the BESS inverter has helped CAISO's Frequency Response
- Continued coordination and collaboration between CAISO, Scheduling Coordinators, and Plant Operators are keys to success in both pre-commercial and post-commercial operations of energy storage



Questions/Comments

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