



California ISO

WESTERN ENERGY IMBALANCE MARKET (WEIM)

Battery storage issues

Eric Hildebrandt

Executive Director, Department of Market Monitoring

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Overview

- Role of Department of Market Monitoring
- Growing role of batteries in CAISO and WEIM
- Key market design and performance issues/challenges
 - Operational availability of batteries
 - Bid cost recovery
 - Local market power mitigation
- Questions and comments

Mission of independent market monitors

“Each independent system operator ... must include a mission statement ... that identifies the Market Monitoring Unit’s goals, including the protection of consumers and market participants by the identification and reporting of market design flaws and market power abuses.”

FERC Order 719

To provide independent oversight and analysis of the CAISO Markets for the protection of consumers and Market Participants by the identification and reporting of market design flaws, potential market rule violations, and market power abuses.

Department of Market Monitoring Mission Statement
CAISO Tariff, Appendix P

Core functions of independent market monitors (FERC Order 719)

1. Review and report on the performance of wholesale markets, including quarterly and annual reports.
2. Evaluate existing and proposed market rules, and provide recommendations.
3. Notify FERC Office of Enforcement when a market participant or the ISO has engaged in conduct that may require investigation.
4. Market monitors may also perform functions related to inputs for market power mitigation.
 - Bids used in mitigation, cost review, etc.

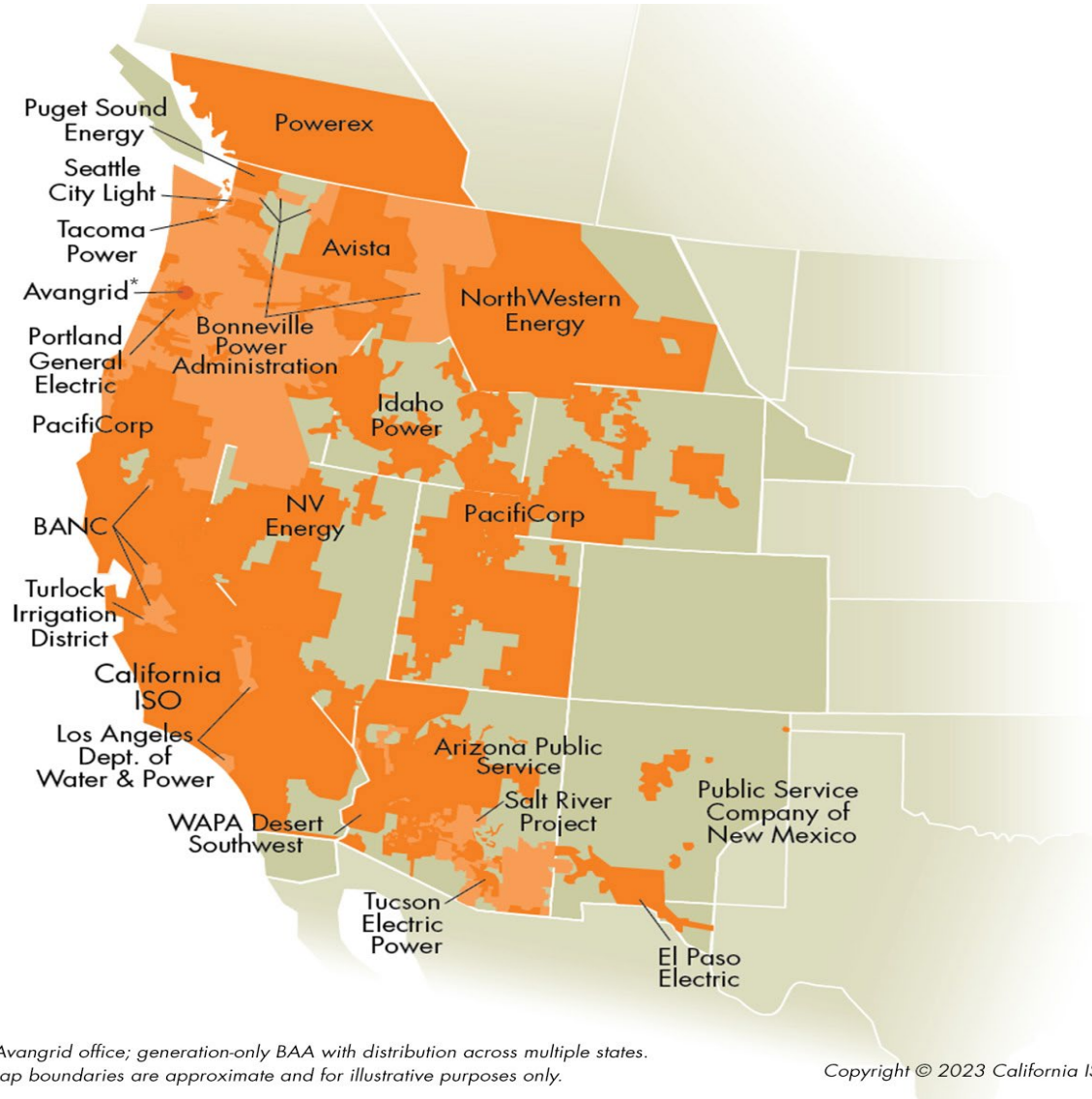
CAISO Department of Market Monitoring

- Independent from CAISO management, as required by FERC Order 719
 - DMM Oversight Committee consists of two CAISO Board members and Governing Body member as an observer
- Internal business unit of the CAISO
 - 18 staff (economics, data analysis, engineering)
 - Access to all CAISO/WEIM market and operational data
 - Work closely with CAISO staff on market design and ongoing monitoring
- Communicate frequently with FERC, state PUCs, WEIM Governing Body, and interested stakeholders

California ISO and Western Energy Imbalance Market (WEIM)

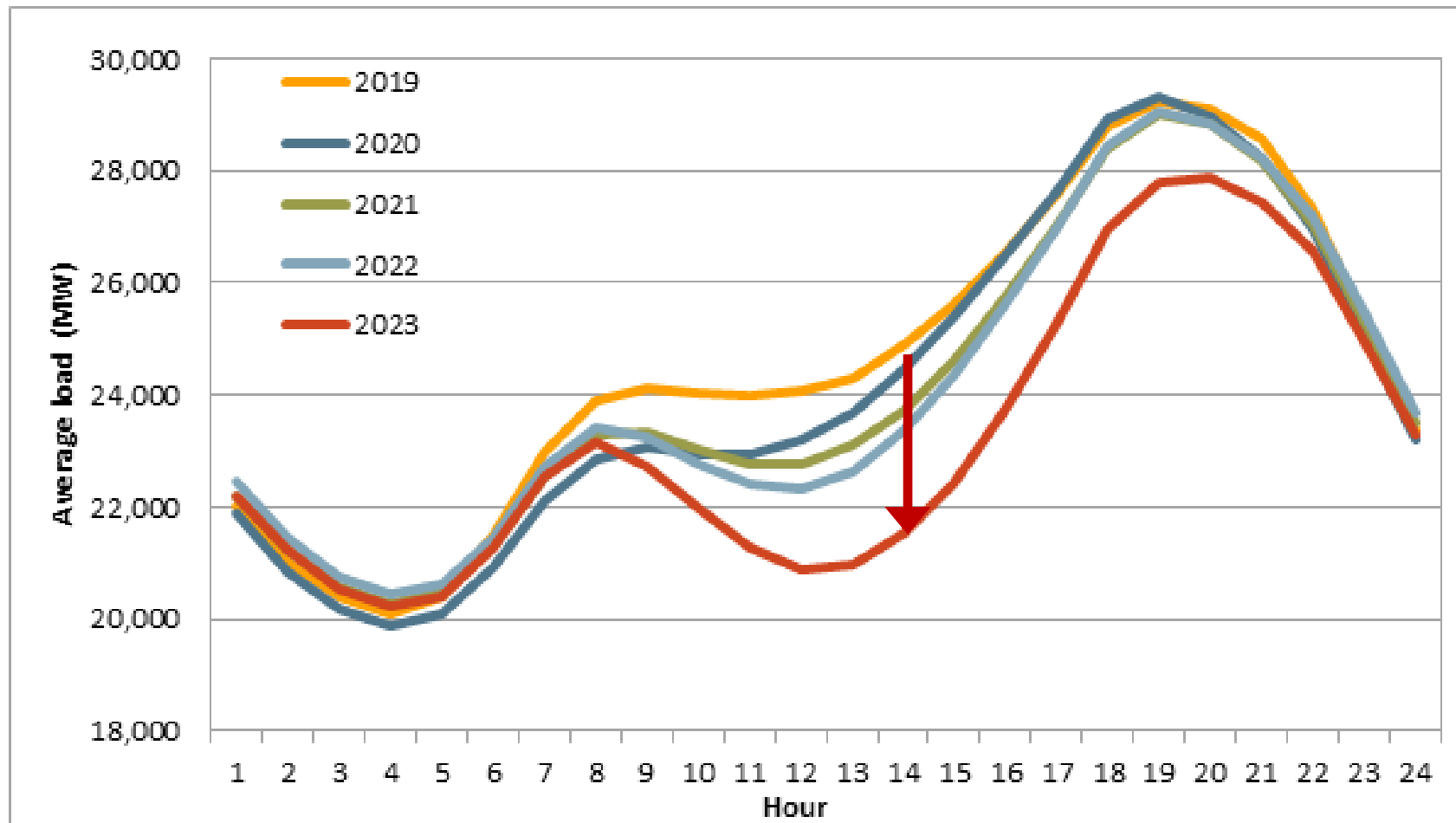
Key trends

- Continuing growth of solar
- Battery storage increasing rapidly
- Increased regional transfers
- Excess solar during mid-day hours being used to support battery charging and net exports from California

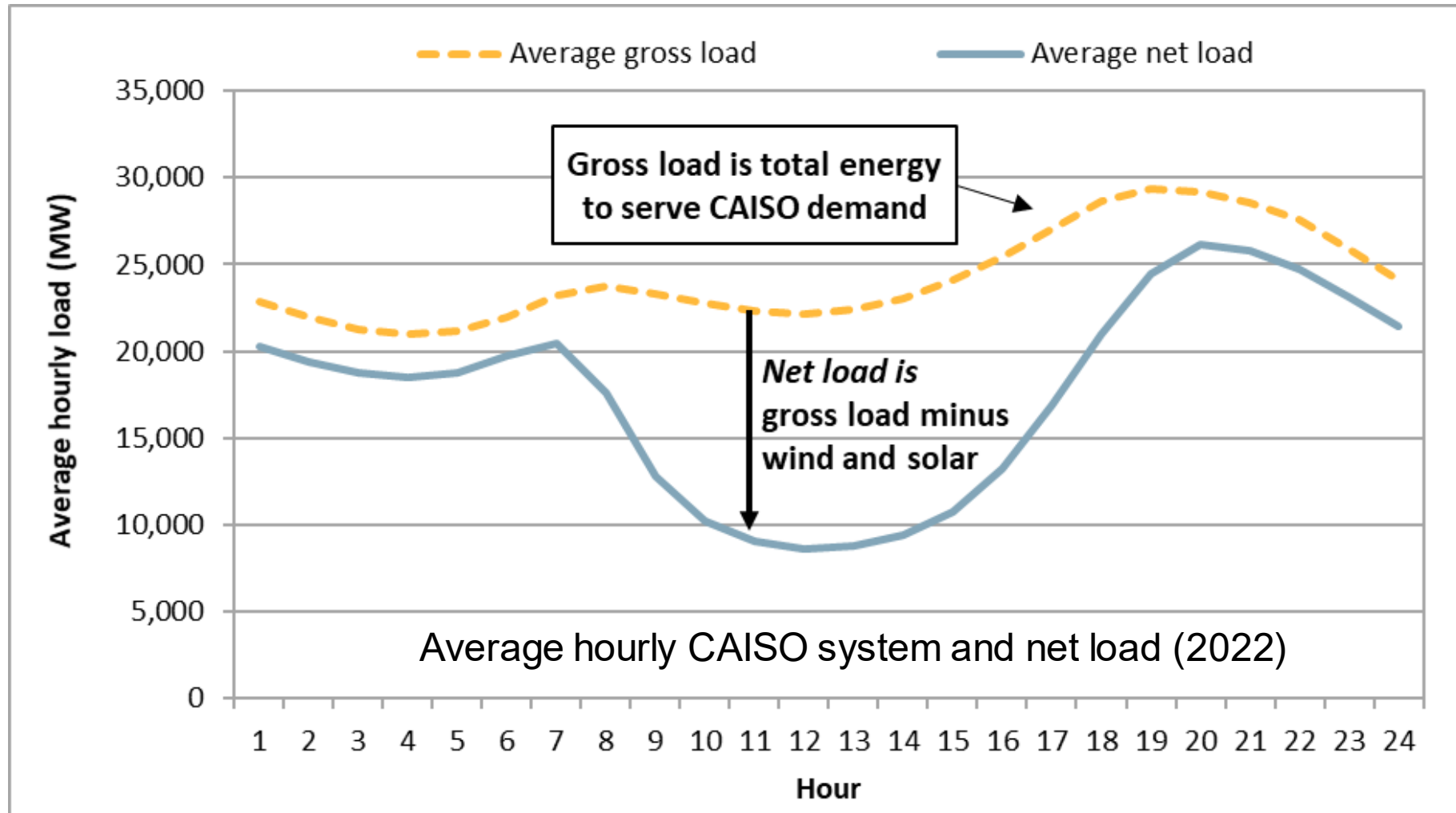


Behind-the-meter solar continues to drive down system loads during daytime hours

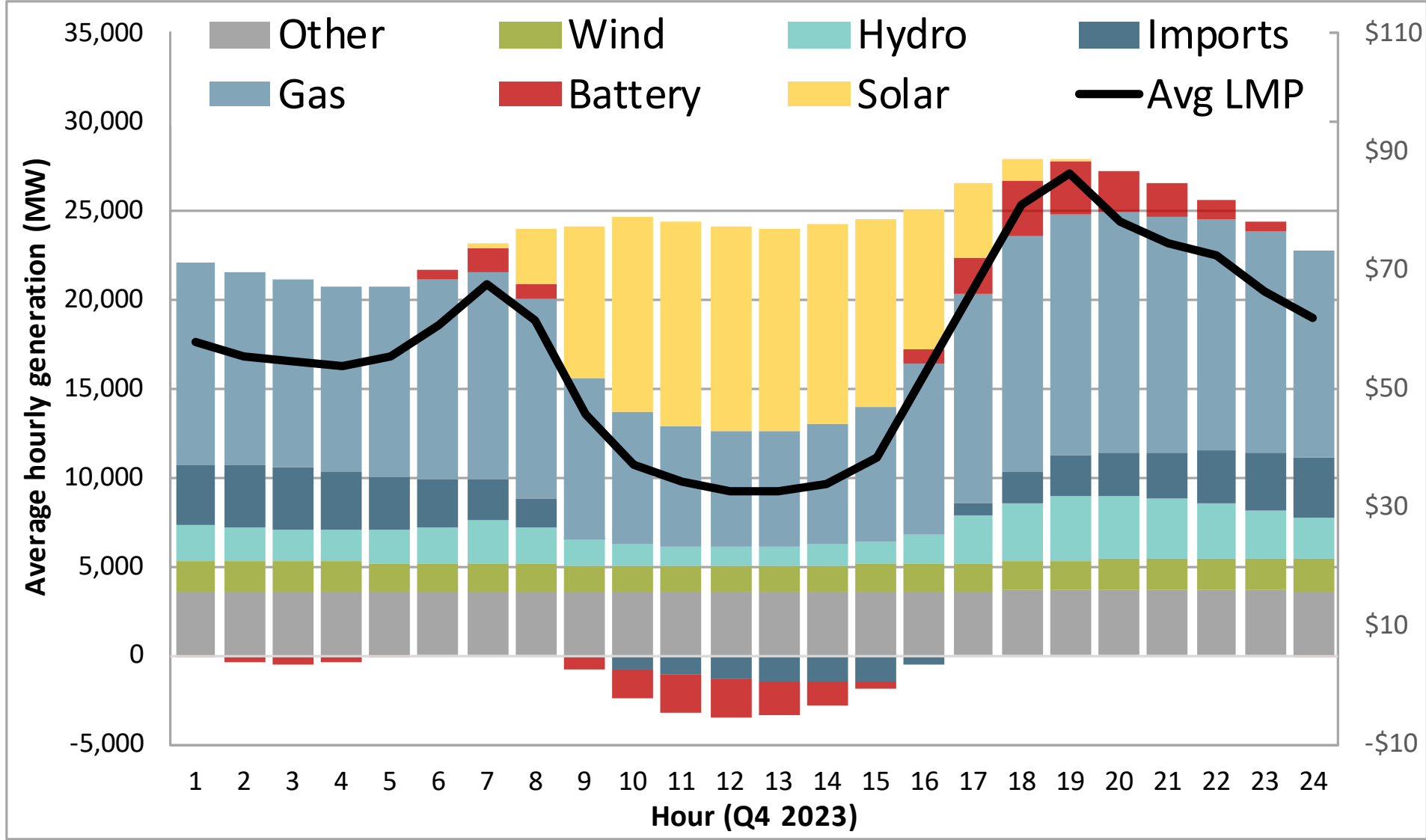
Average hourly CAISO area load (2019–2023)



Western area operations and prices driven by net load (net load = total load – (wind + solar))

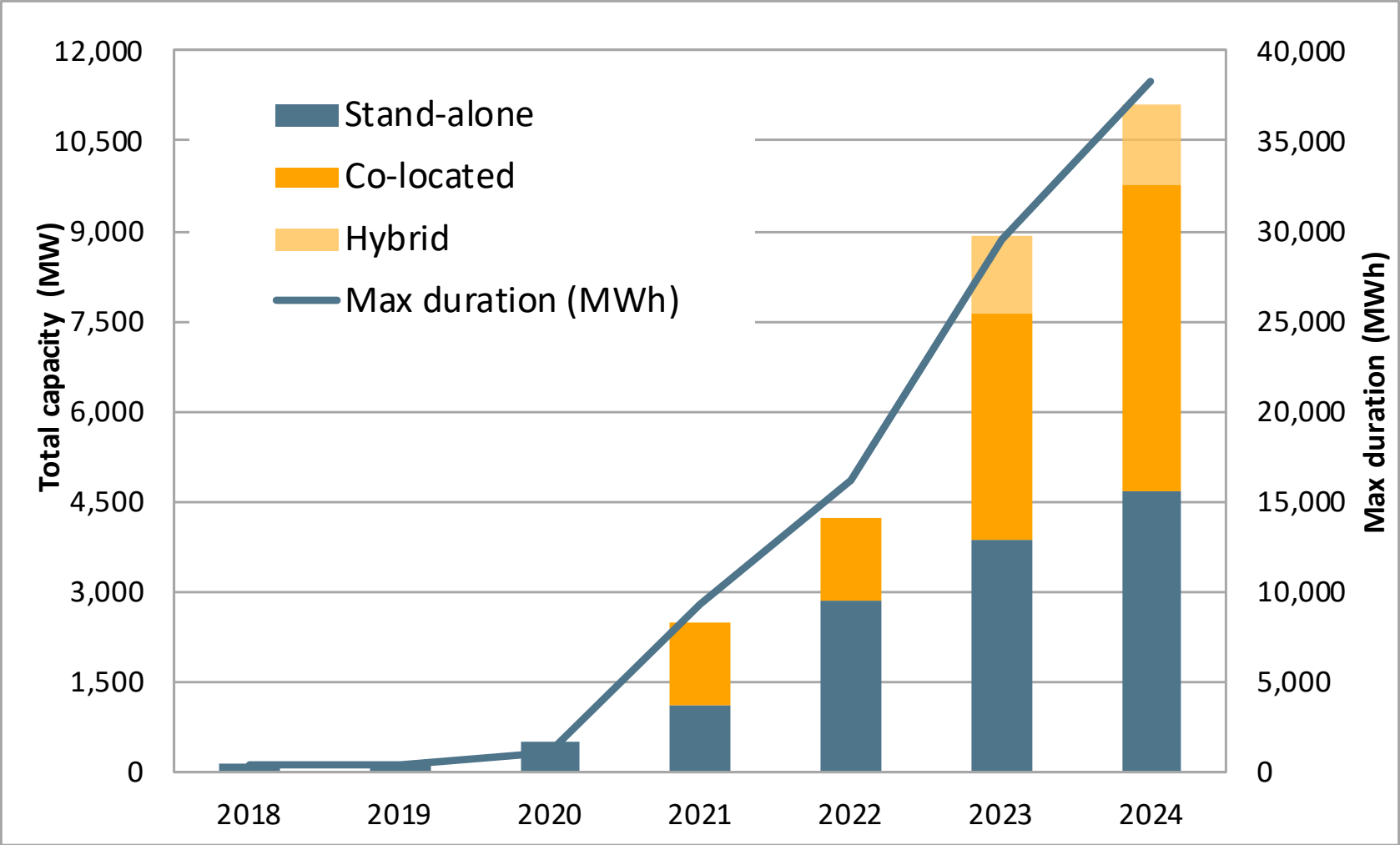


Market prices are now lowest during peak solar mid-day hours

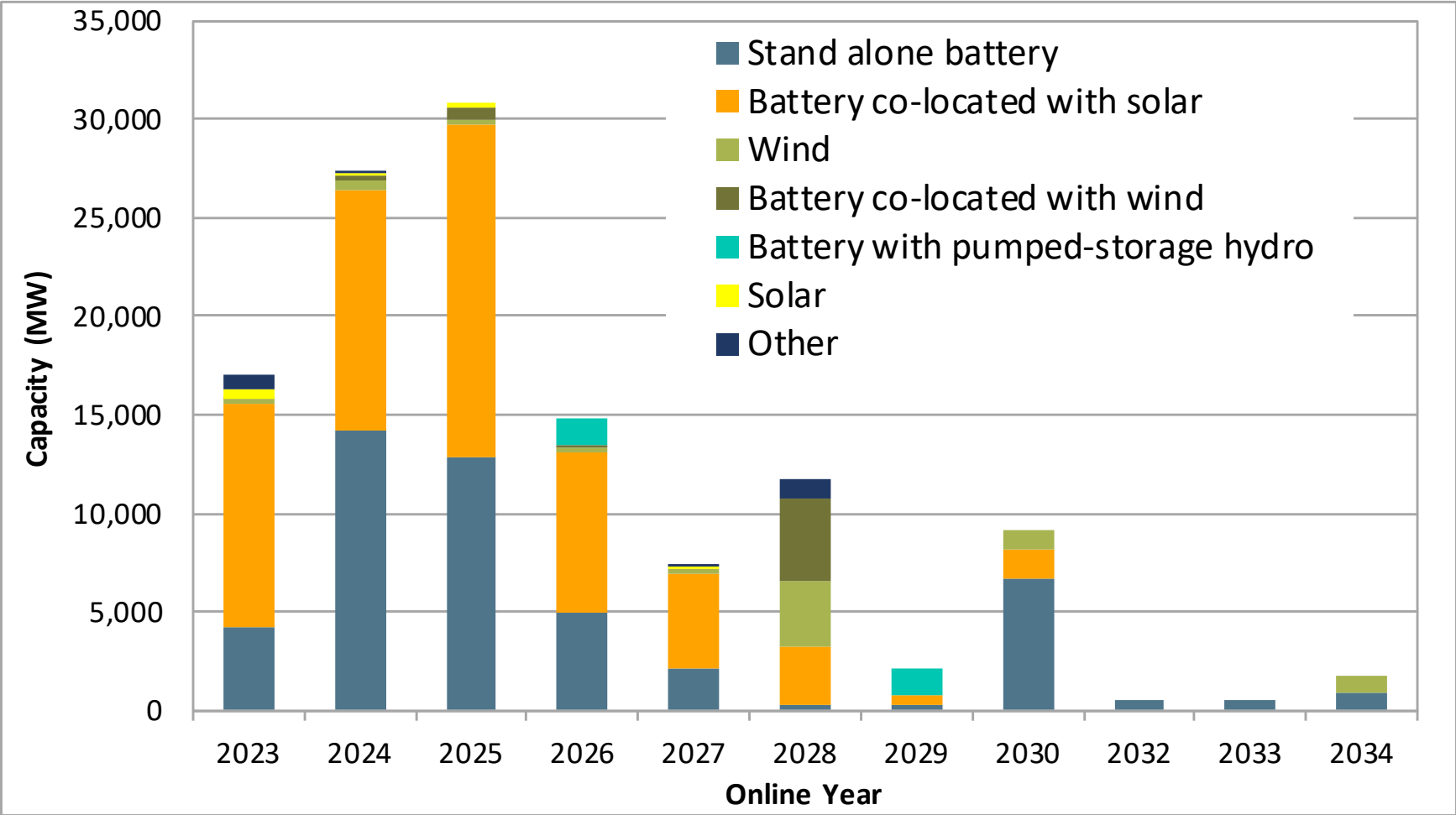


➤ Batteries charge during low priced daytime hours, and discharge during morning and evening ramping hours.

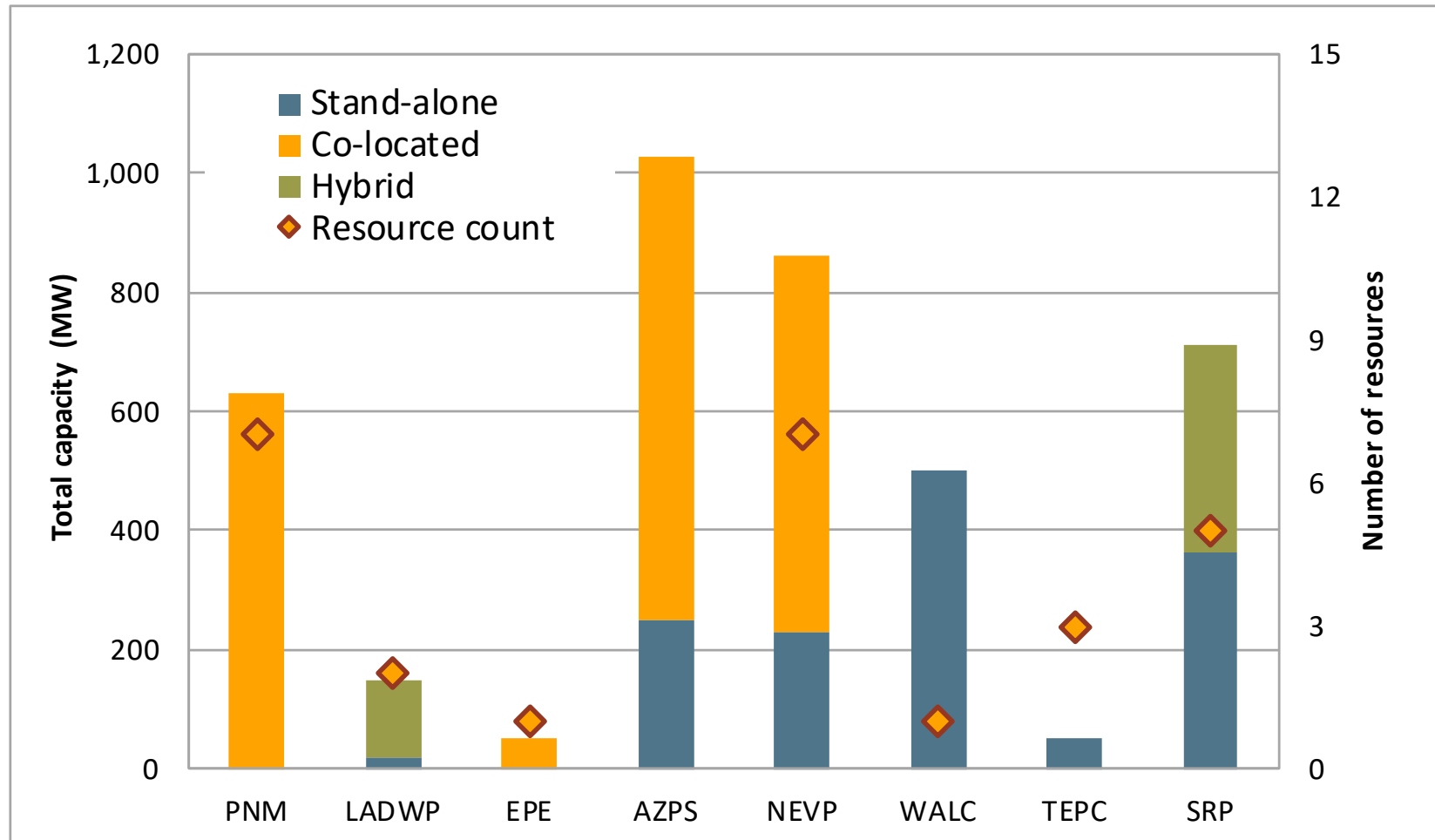
Most battery capacity measured based on maximum discharge capacity for 4 hours (California resource adequacy requirement)



Battery storage and combined solar/battery facilities will continue to be the main source of new capacity in CAISO

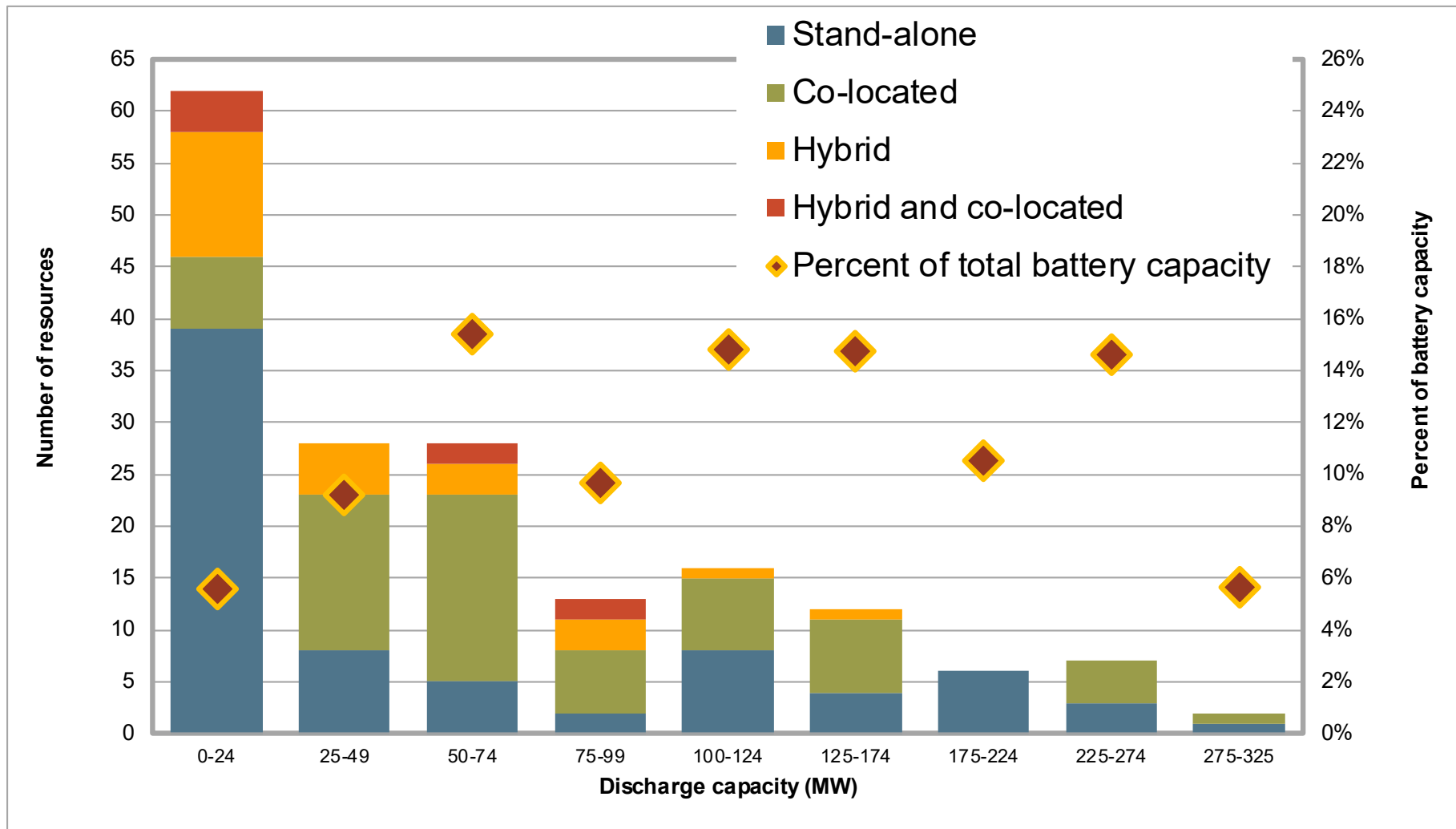


Battery capacity in other WEIM balancing areas now exceeds 4,000 MW – or about 4 times the capacity in 2023.

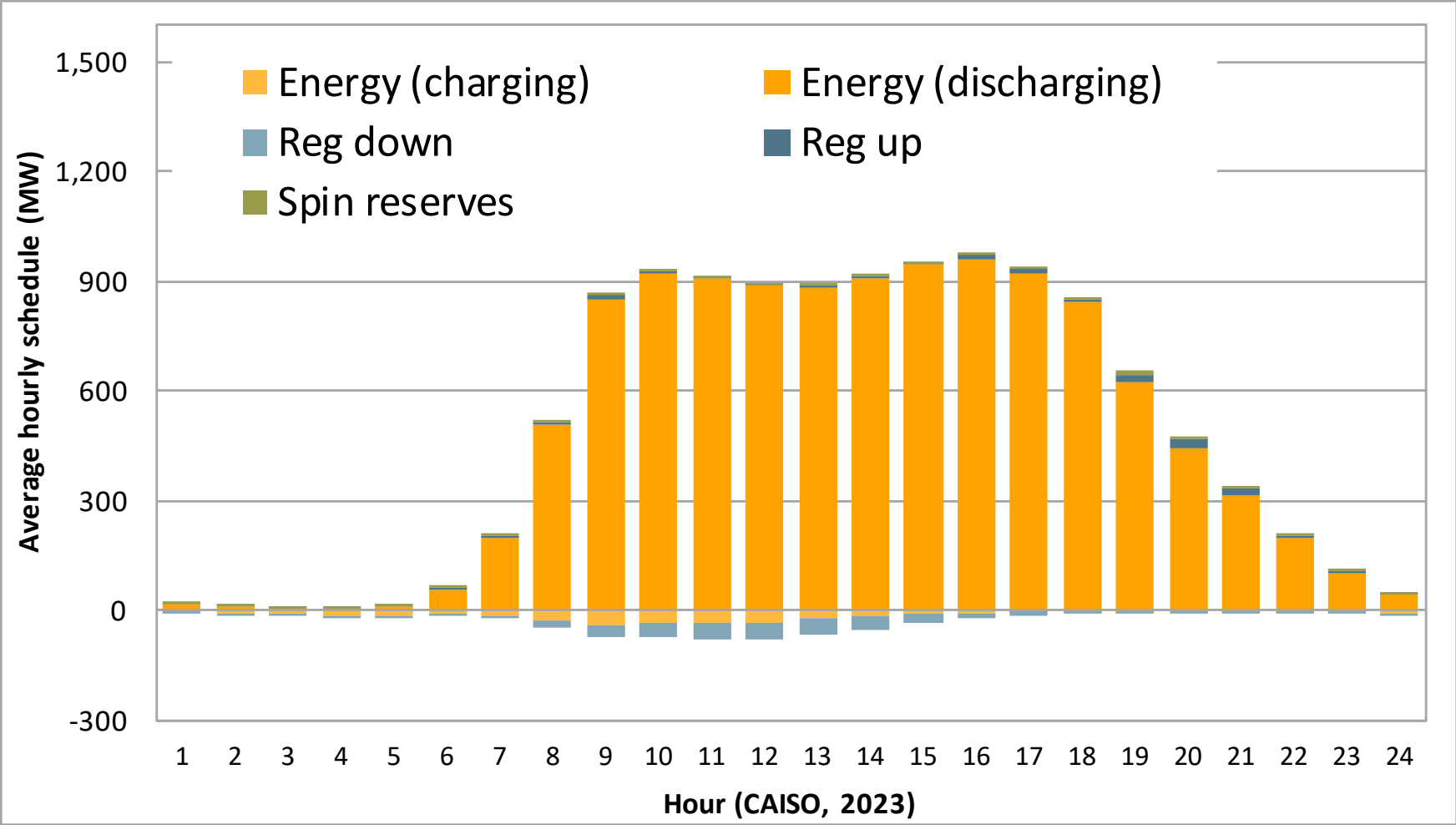


- Batteries now account for about >3% of installed capacity in the WEIM outside of the California ISO balancing area
- About 1,500 MW of stand-alone and about 2,500 MW of co-located batteries
- Most battery capacity located in Desert Southwest balancing areas

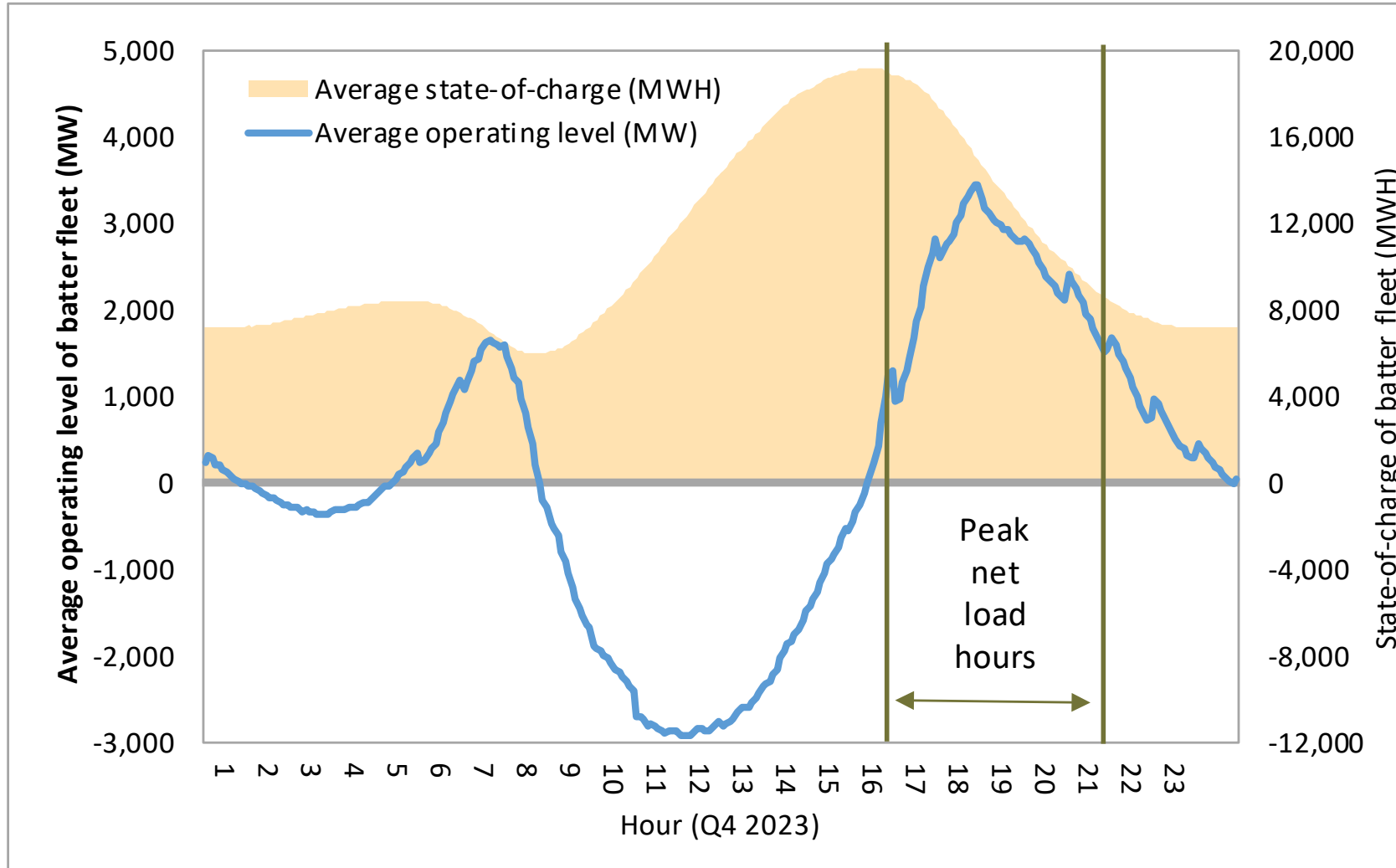
Batteries in CAISO include wide range of sizes and types



Hybrid resources primarily provide energy to the grid, and “self-charge” mainly using co-located renewable resource.

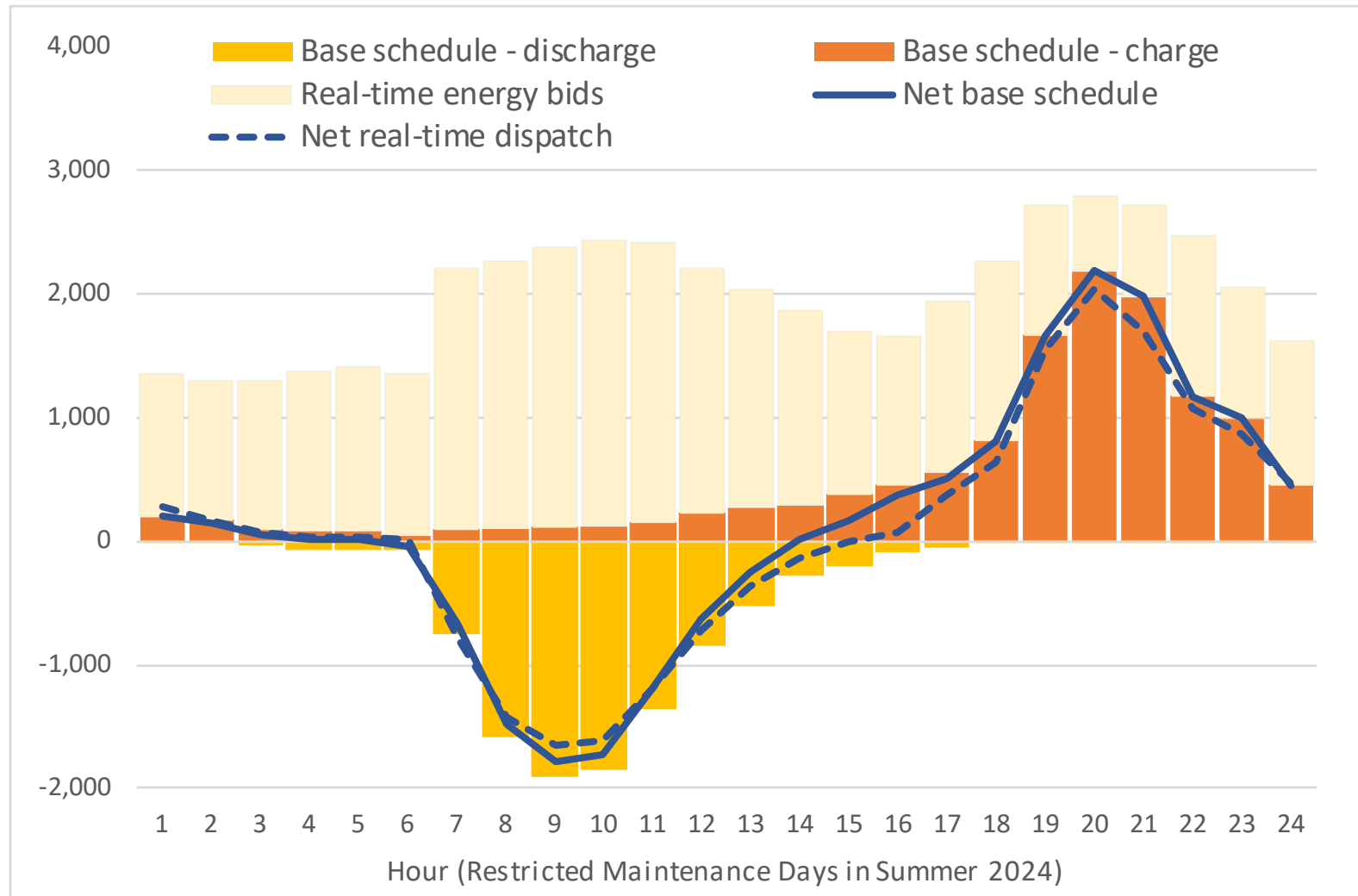


Batteries usually scheduled to store up energy during day and discharge during peak net load hours (~18 to 22)



- State-of-charge refers to total energy stored in battery (MWh).
- 400 MWh state-of-charge = 100 MW for 4 hours.
- California resource adequacy program rates battery capacity based on 4 hour energy potential of battery storage capacity.
- This standard assumes batteries will be fully charged at the beginning of the 4 hours with highest net load.

Batteries in WEIM outside of CAISO are mainly self-scheduled just prior to real-time market.

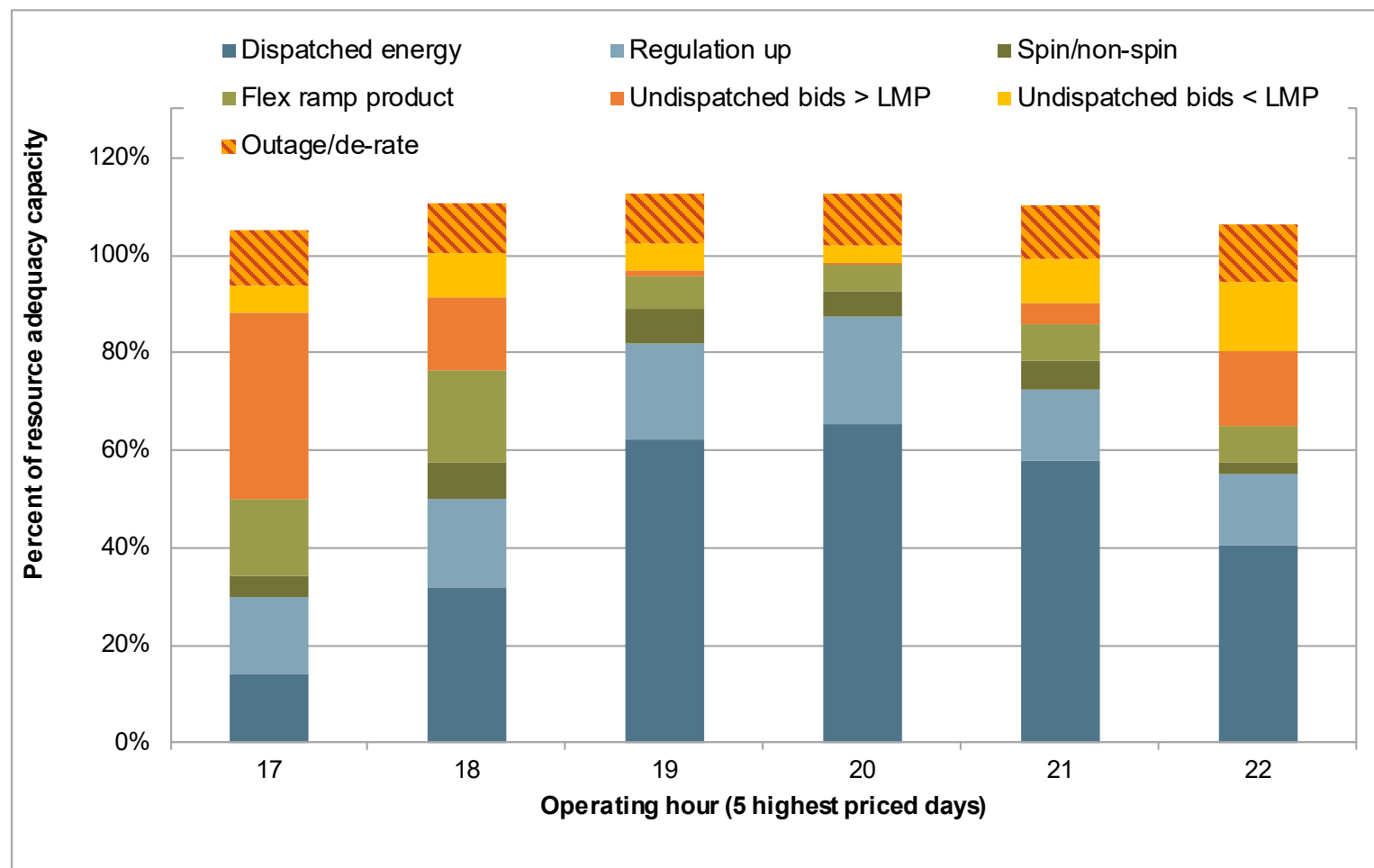


- All WEIM resources submit base schedules just prior to real-time market.
- Base battery schedules are determined by owners, rather than day-ahead market optimization.
- Batteries in WEIM usually get dispatched at or near base schedules in real-time market.

Operational availability of batteries

- CAISO day-ahead market 24 hour optimizes the scheduling batteries to charge in lower cost hours and discharge during highest priced hours
- In real-time, batteries are re-dispatched by market software with more limited look ahead timeframe (~ 2 hours) and uncertainty about prices in later hours
 - Batteries can get dispatched during the day (based on bids and market prices) in ways that prevent batteries from being charged up and available during most critical evening hours.
- Current bid cost recovery rules provide financial incentive to bid in a way that causes batteries to be dispatched differently from day-ahead schedules
 - This contributes to batteries sometimes needing to be charged up during higher priced hours and/or not being fully charged prior to most critical net load hours (~18-22)
- In addition, outage rates for batteries in CAISO and WEIM averaging over 10%
- Battery operators can set numerous resource constraints that can limit their availability to be dispatched when needed (e.g., state-of-charge at beginning and end of hour, etc.)

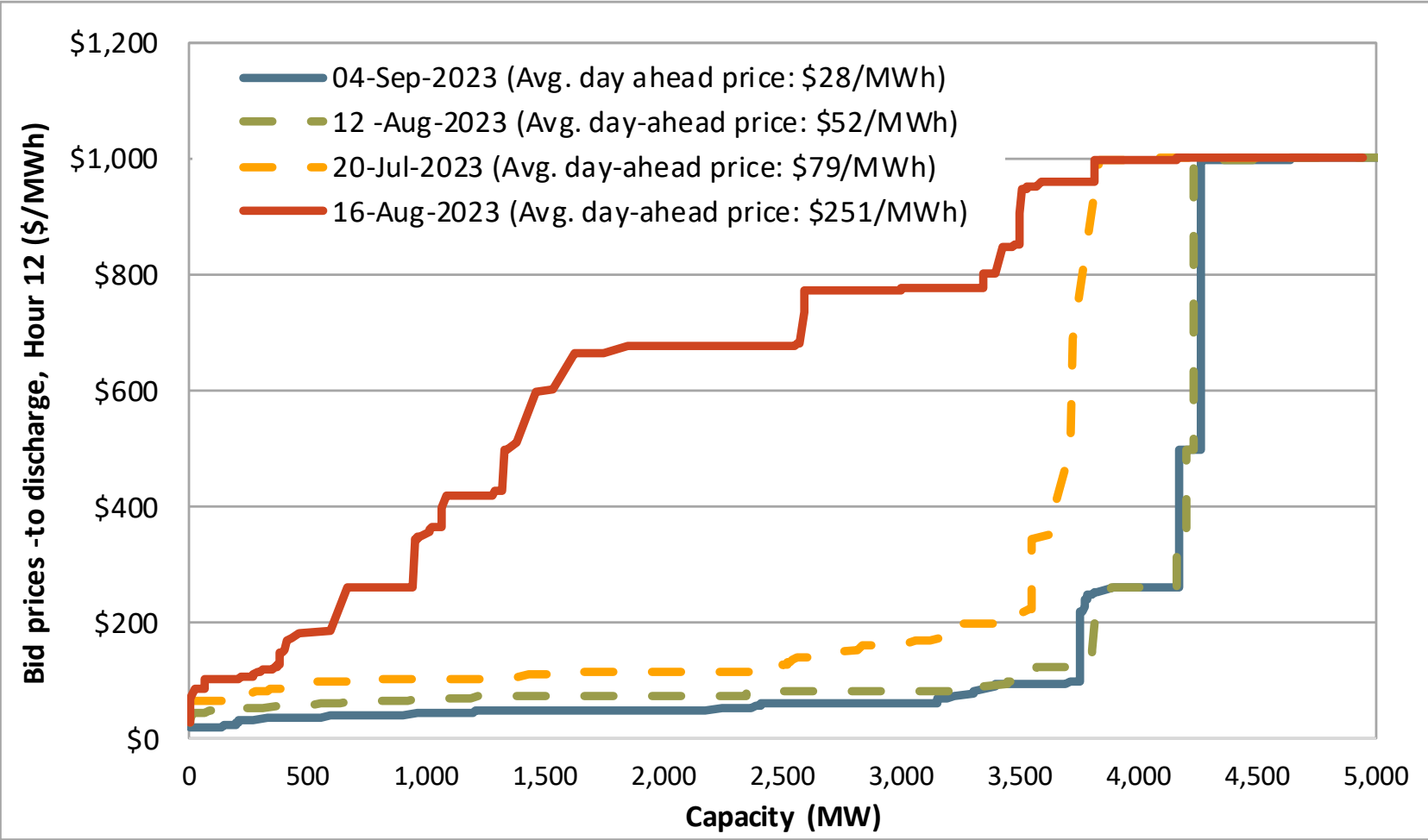
Average battery capacity during 5 highest priced days in summer 2023



- Capacity in yellow represents bids < market clearing price that were not dispatched
- This is likely due to various resource conditions and constraints (e.g., state-of-charge, etc.)

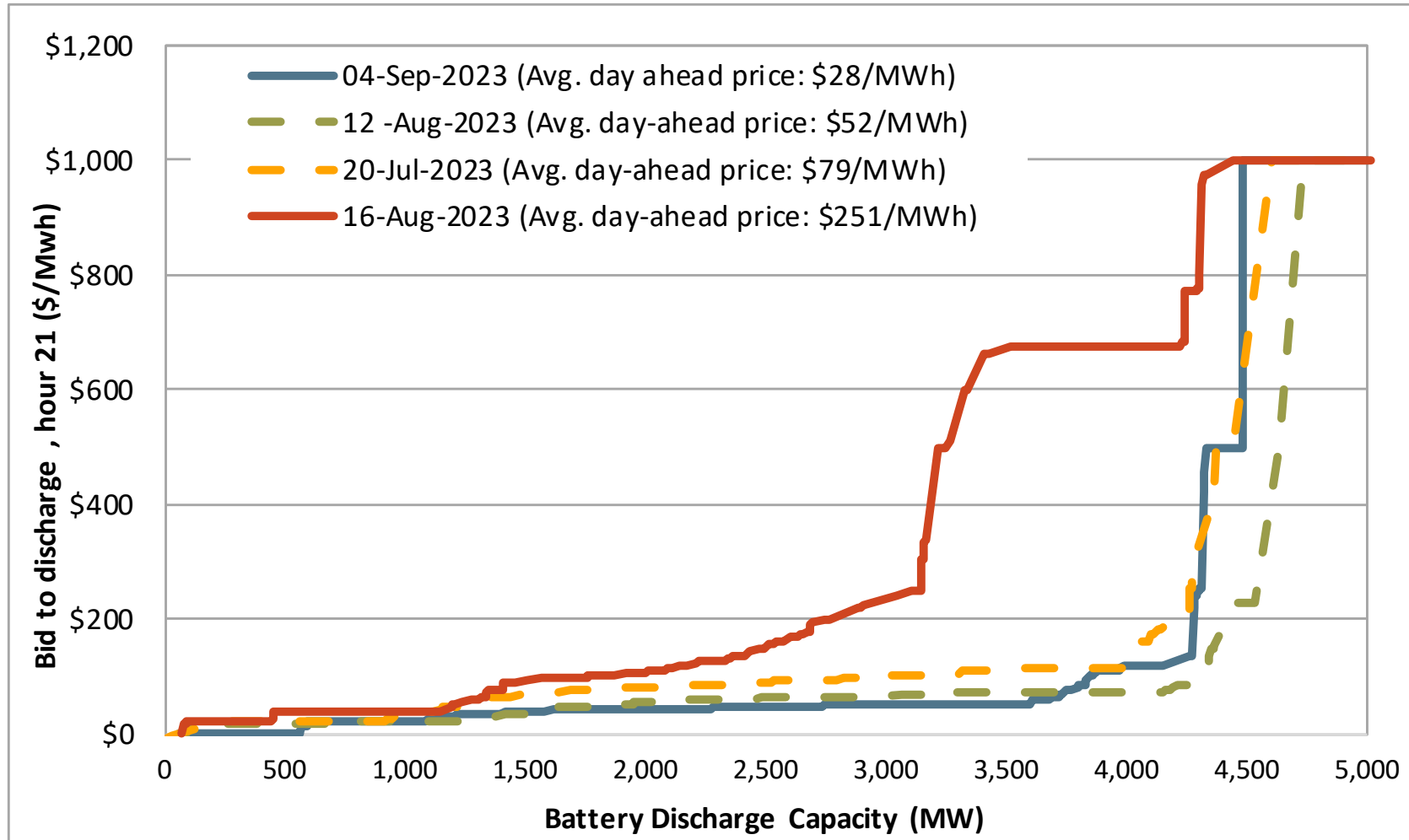
Bid prices to discharge during mid-day hours are high, but can still be dispatched if prices are relatively high.

Bid prices to discharge, hour 12



Bid prices during peak net load hours are lower, but some are still very high.

Bid prices to discharge, hour 21

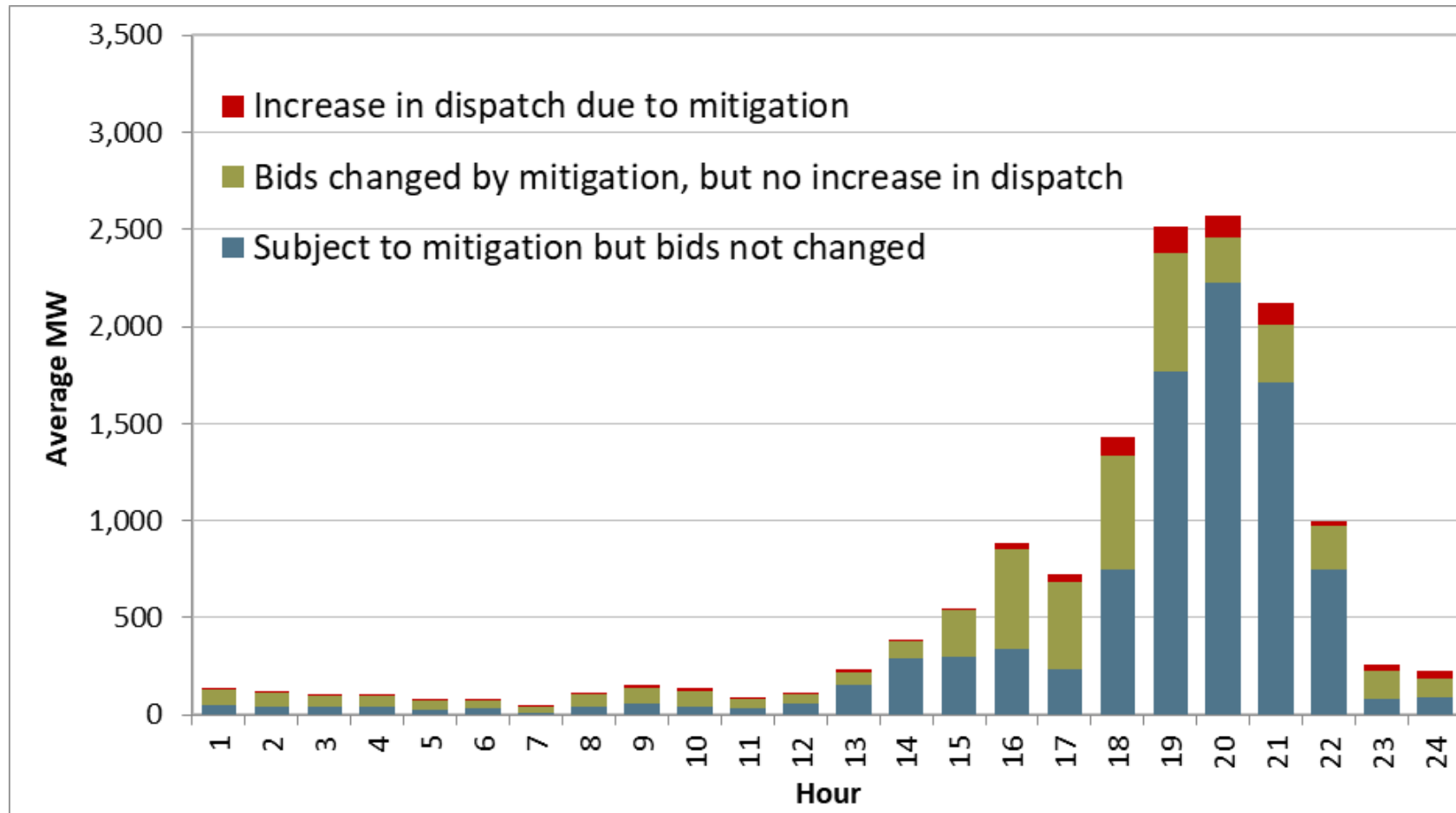


Local market power bid mitigation

- In practice, mitigation has minimal impact on dispatch:
 - Default Energy Bid (DEB) for batteries based on 4th highest price in day-ahead market (plus > 10% adder)
 - Units subject to mitigation usually don't have bids lowered since bid > DEB
 - When bids are lowered, mitigated bid is usually higher than market clearing price
- Recommended improvements in default energy bids:
 - Develop daily opportunity cost DEB for WEIM areas based on hourly price forecast for WEIM areas
 - Enhance DEBs to allow updates based on real-time prices
 - Allow DEBs to vary by hour (e.g., mid-day vs. hours 18-22)
 - Develop DEB for hybrid resources (currently not subject to mitigation)

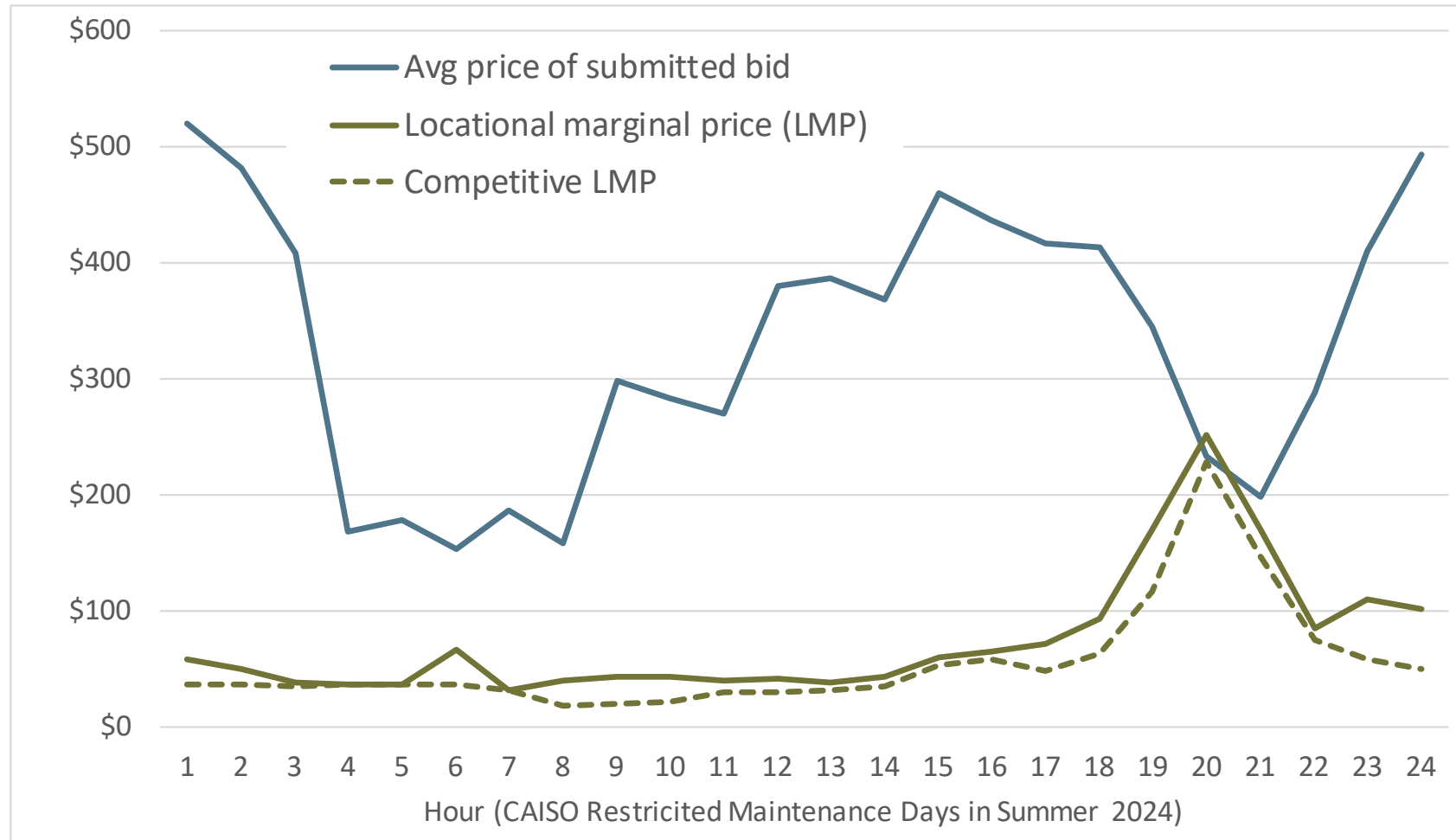
Impact of bid mitigation on dispatch of batteries is very limited

Hourly averages for all 9 Restricted Maintenance Days in summer 2023 (real-time)



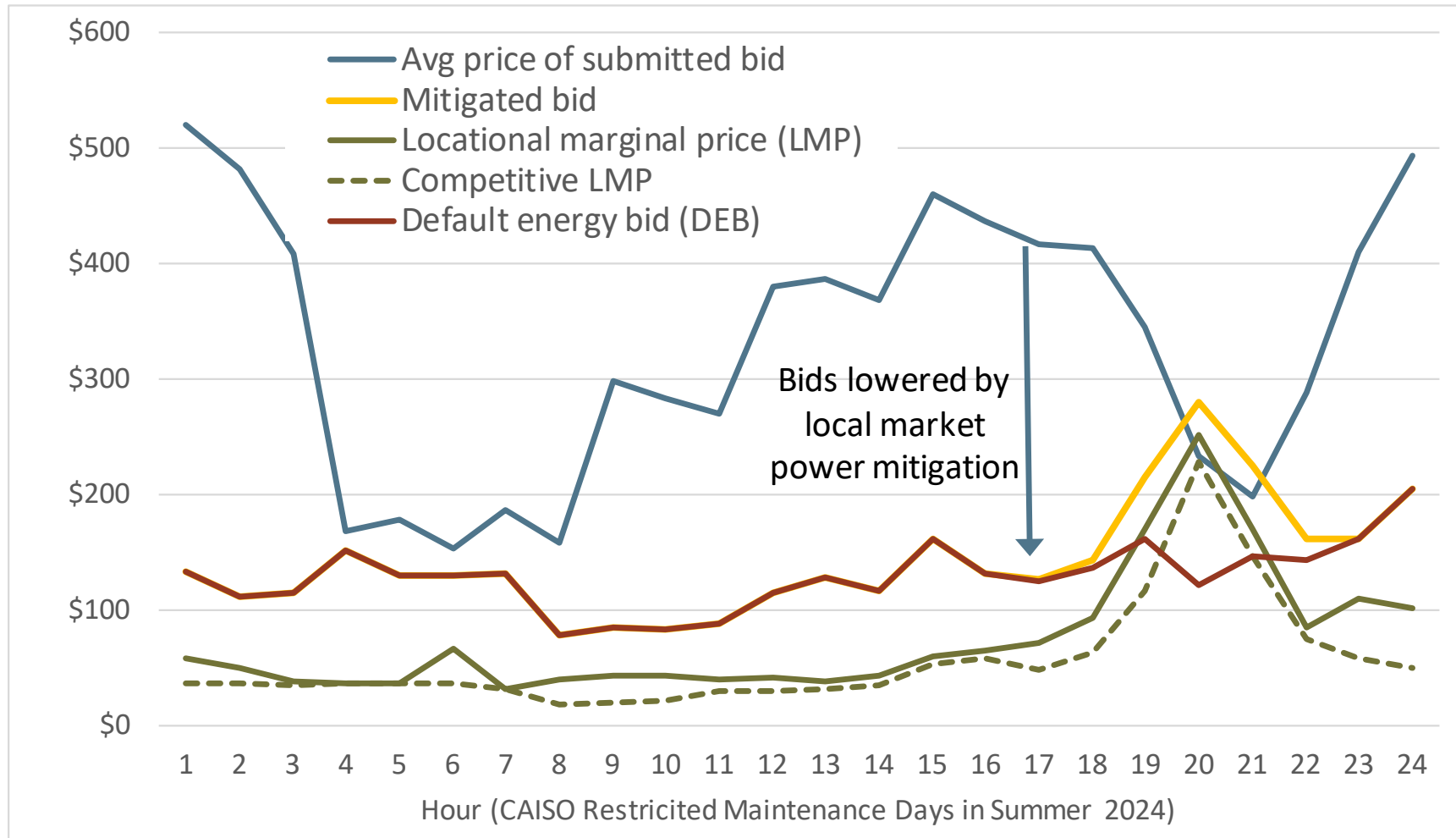
- Red bars show the potential increase in capacity dispatched due to bid mitigation.
- Most of the impact of bid mitigation occurs in peak net load hours, when batteries should usually be discharging.

Battery bid prices to discharge are usually quite high in the mid-day hours, and much lower in the peak net peak hours.



➤ Chart based on average bids and prices for batteries in CAISO area during restricted maintenance day in summer 2024.

Bid mitigation procedures protect against local market power, but have minimal impact on the dispatch of batteries.



- Default energy bids (DEBs) used to mitigate bids are usually well above market prices, except in the peak net load hours when prices are highest.

Local market power mitigation procedures

- Bid mitigation triggered when congested constraints are found to be structurally non-competitive
 - 3 pivotal supplier test used to determine structural competitiveness of constraints
 - Can the transmission constraint be met without the supply of three largest suppliers?
- All units that can help relieve congestion on structurally uncompetitive constraint are subject to potential bid mitigation
- When subject to mitigation, bids are capped to the maximum of:
 - Default energy bid for unit (DEB)
 - Competitive locational marginal price (competitive LMP)

For more information

- Department of Market Monitoring webpage
 - <http://www.caiso.com/market/Pages/MarketMonitoring/Default.aspx>
- CAISO Tariff, Appendix P
 - http://www.caiso.com/Documents/AppendixP_CAIsoDepartmentOfMarketMonitoring_as_of_Apr1_2017.pdf
- Eric Hildebrandt, Executive Director, ehildebrandt@caiso.com
- Ryan Kurlinski, Senior Manager, rkurlinski@caiso.com
- Adam Swadley, Manager, aswadley@caiso.com
- DMM@caiso.com