

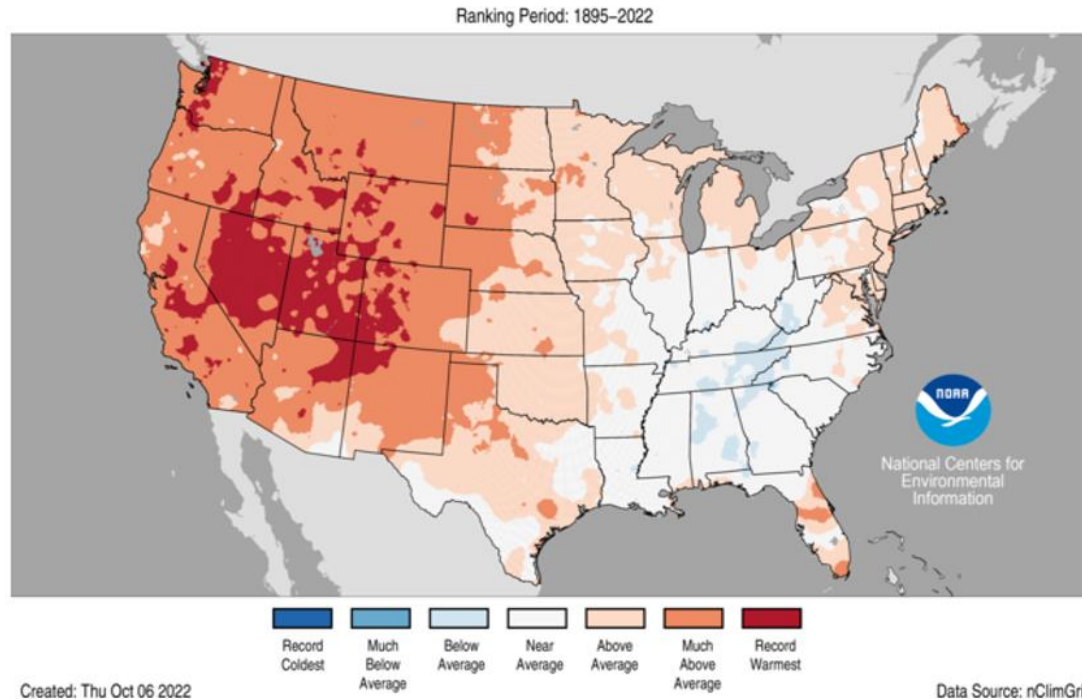


Performance of Batteries in CAISO During the 2022 Heat Wave

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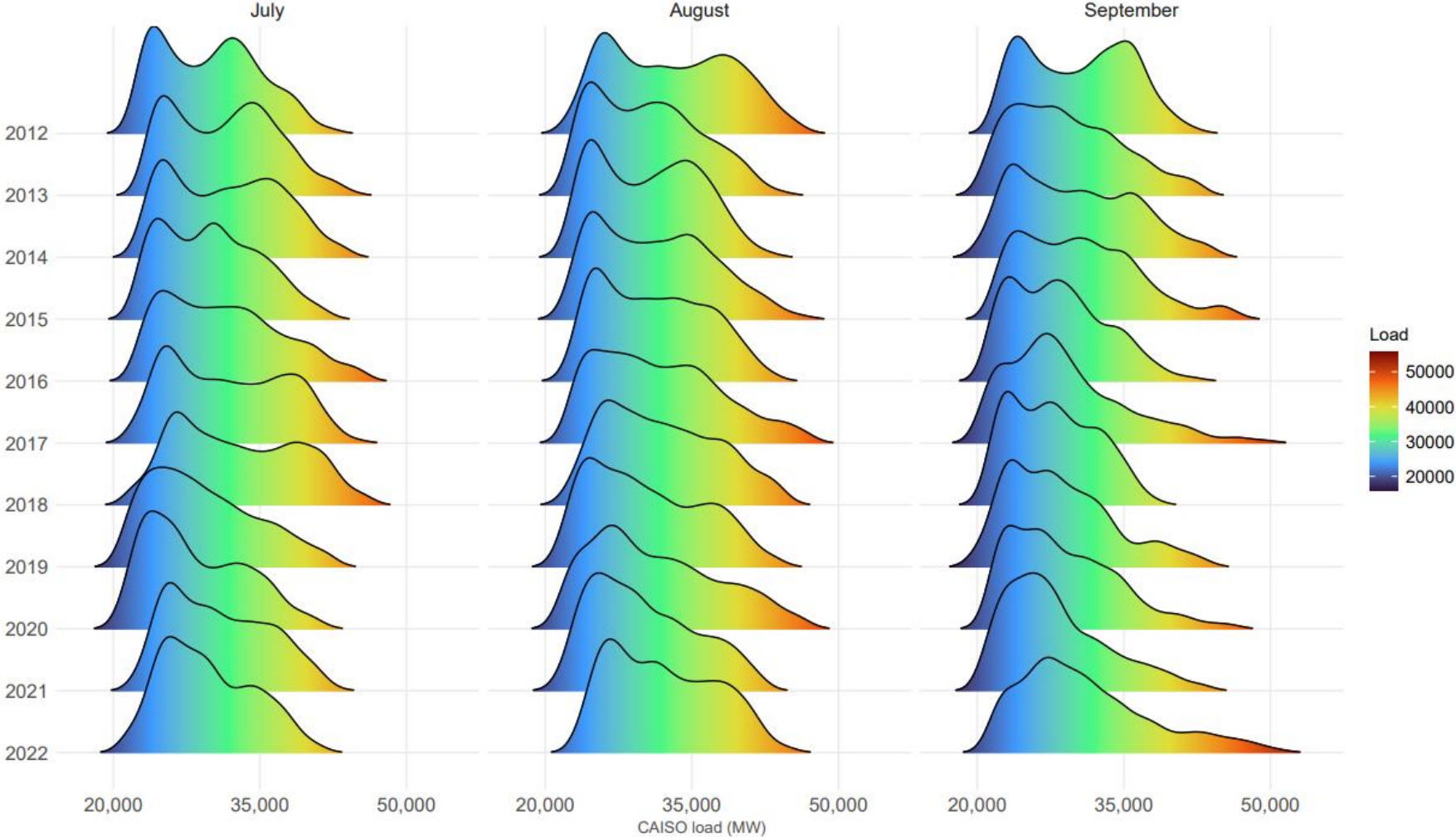
ESIG Meteorology and Market Design for Grid Services Workshop
June 2023

A 10-day shattering heatwave drove record demands

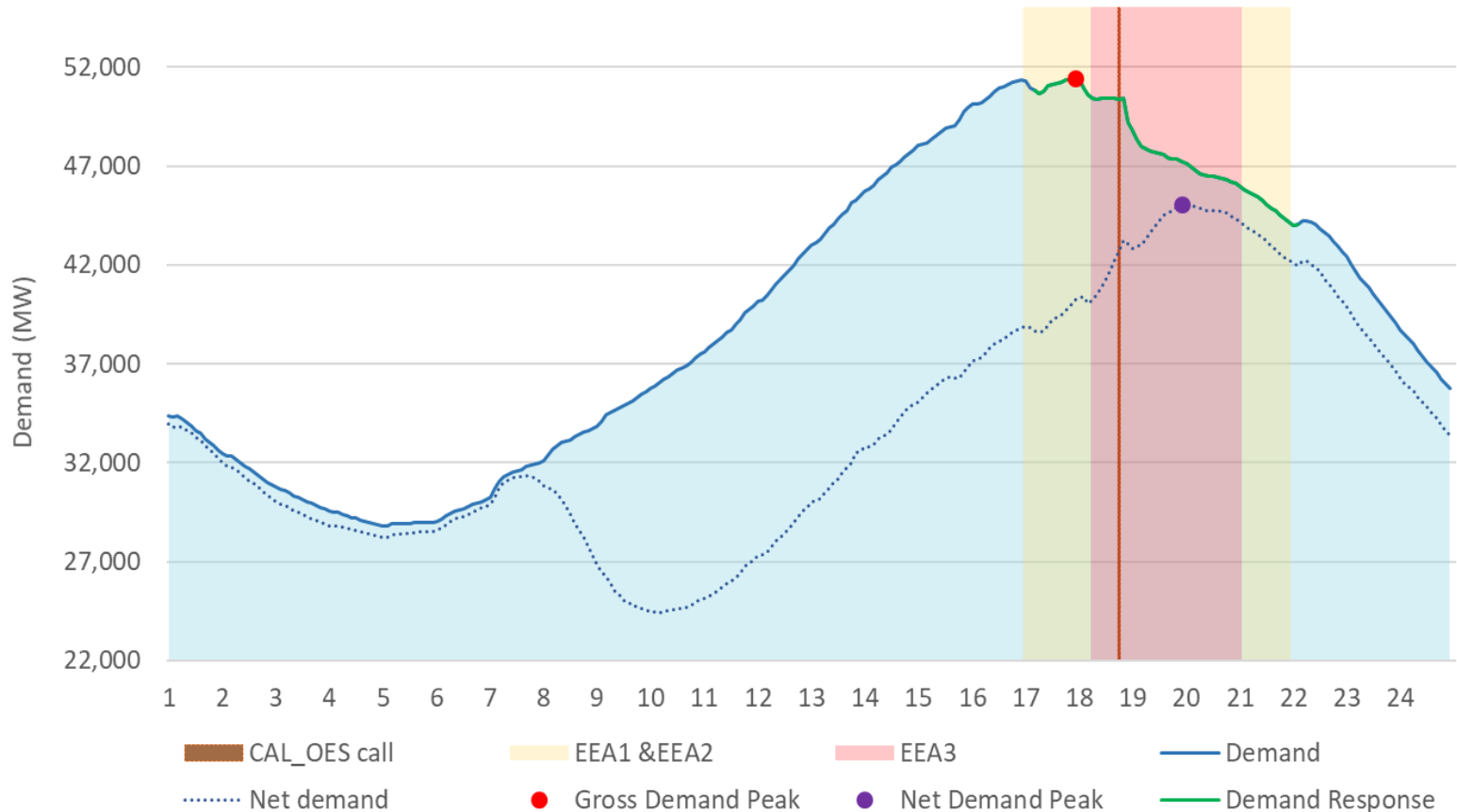


- Multiple cities in California broken 100-year old records for maximum and minimum temperatures
- Using 28 years' worth of weather data, the ISO weighted 3-day temperature through September 6 was a 1-25 year event

On September 6, the most critical day of the heatwave, CAISO set a record load of 52,061 MW



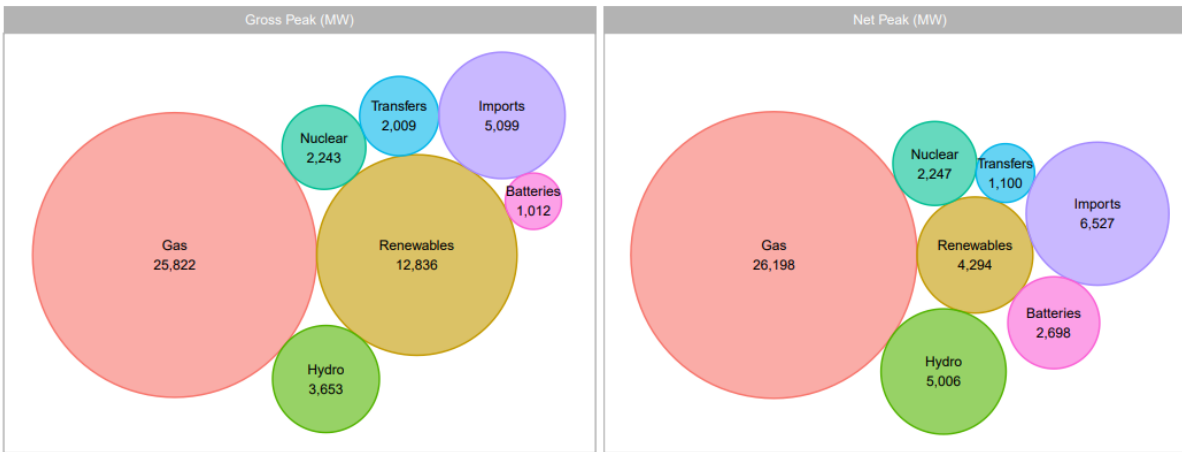
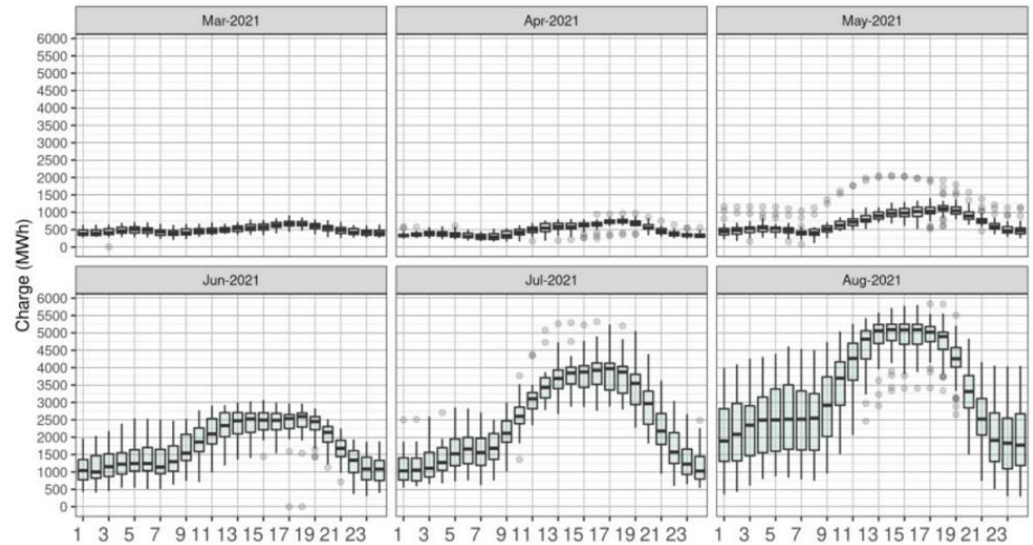
Many factors helped prevent the CAISO from ordering rotating outages, including supply from storage resources



Demand Response and conservation efforts may have reduced demand by up to 1,500 MW

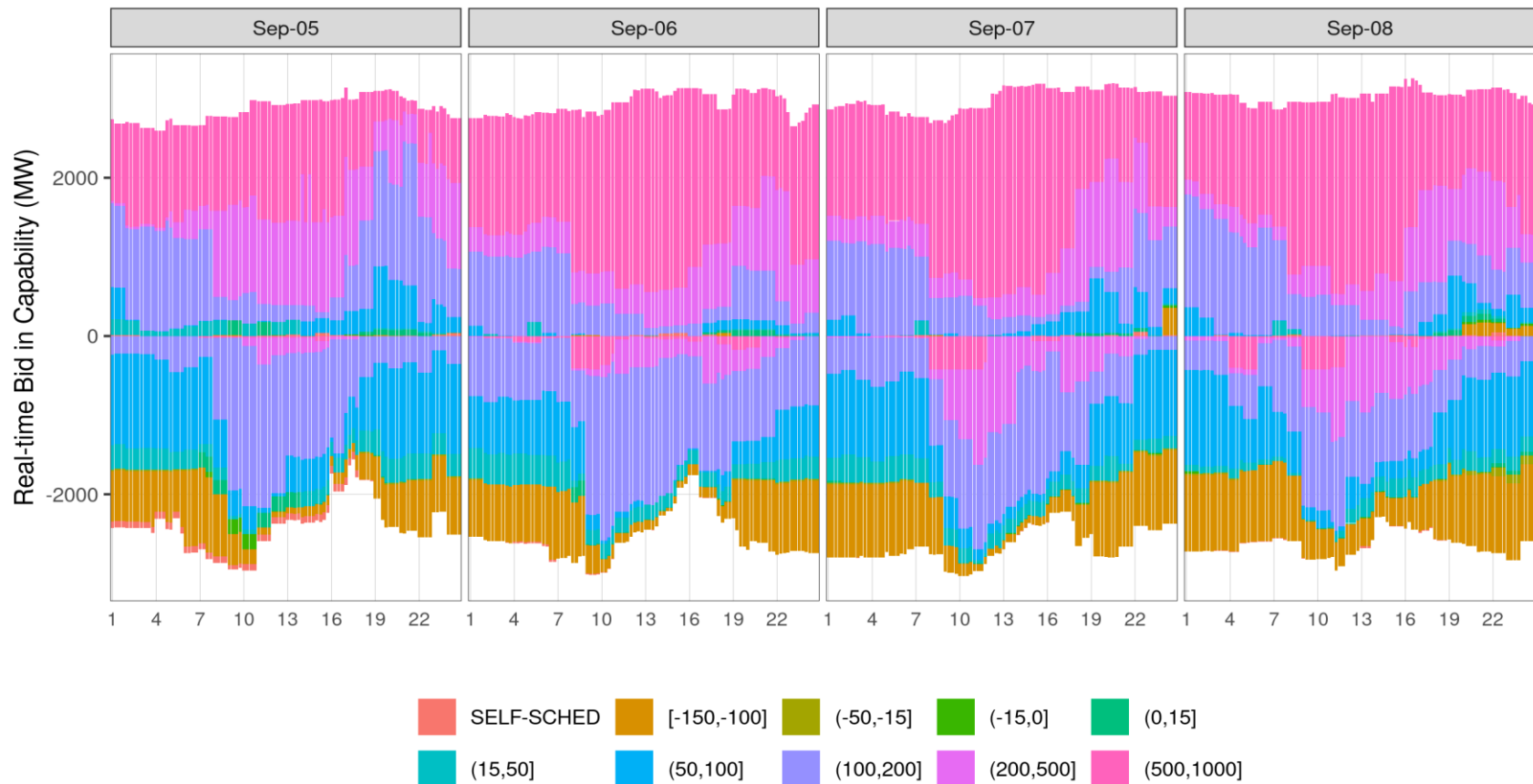
CAISO has seen an explosive growth of storage resources

Regulation requirements are largely procured from storage resources

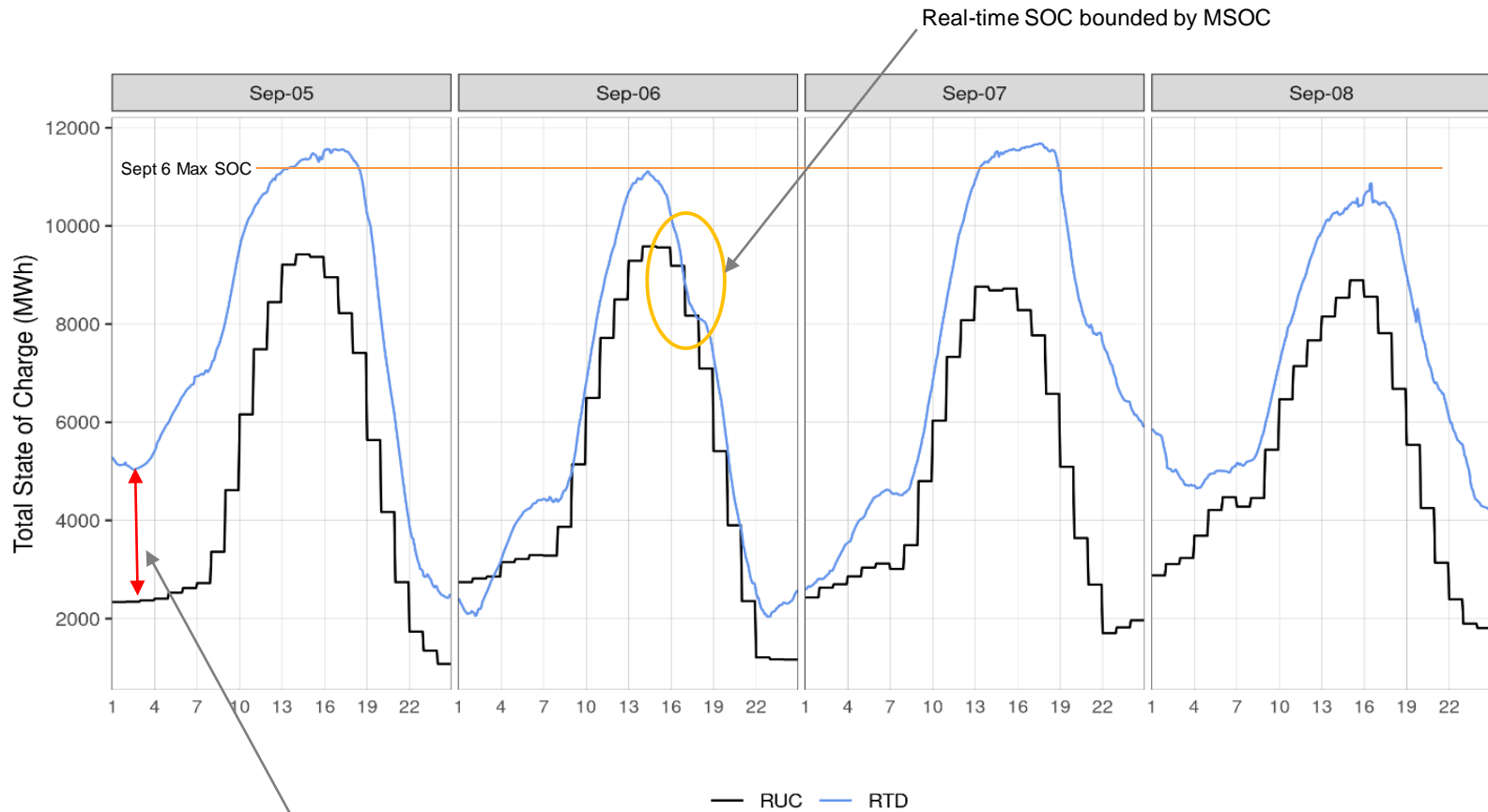


Storage resources contributed to meet demand peaks on Sept 6

Real-time energy bids of storage resources adjusted through the heatwave and were bounded at the bid cap of \$1,000MWh



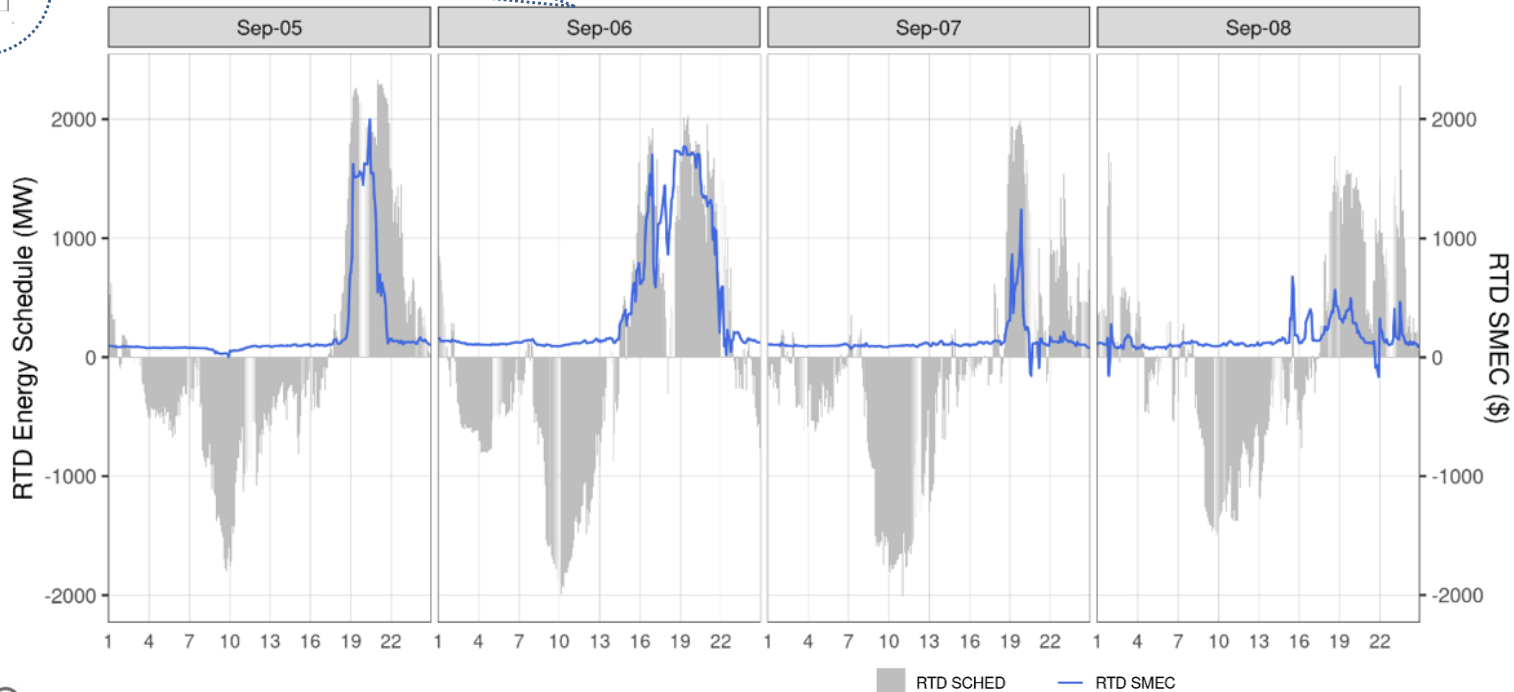
September 6 observed a lower maximum SOC relative to adjacent days due to premature discharge



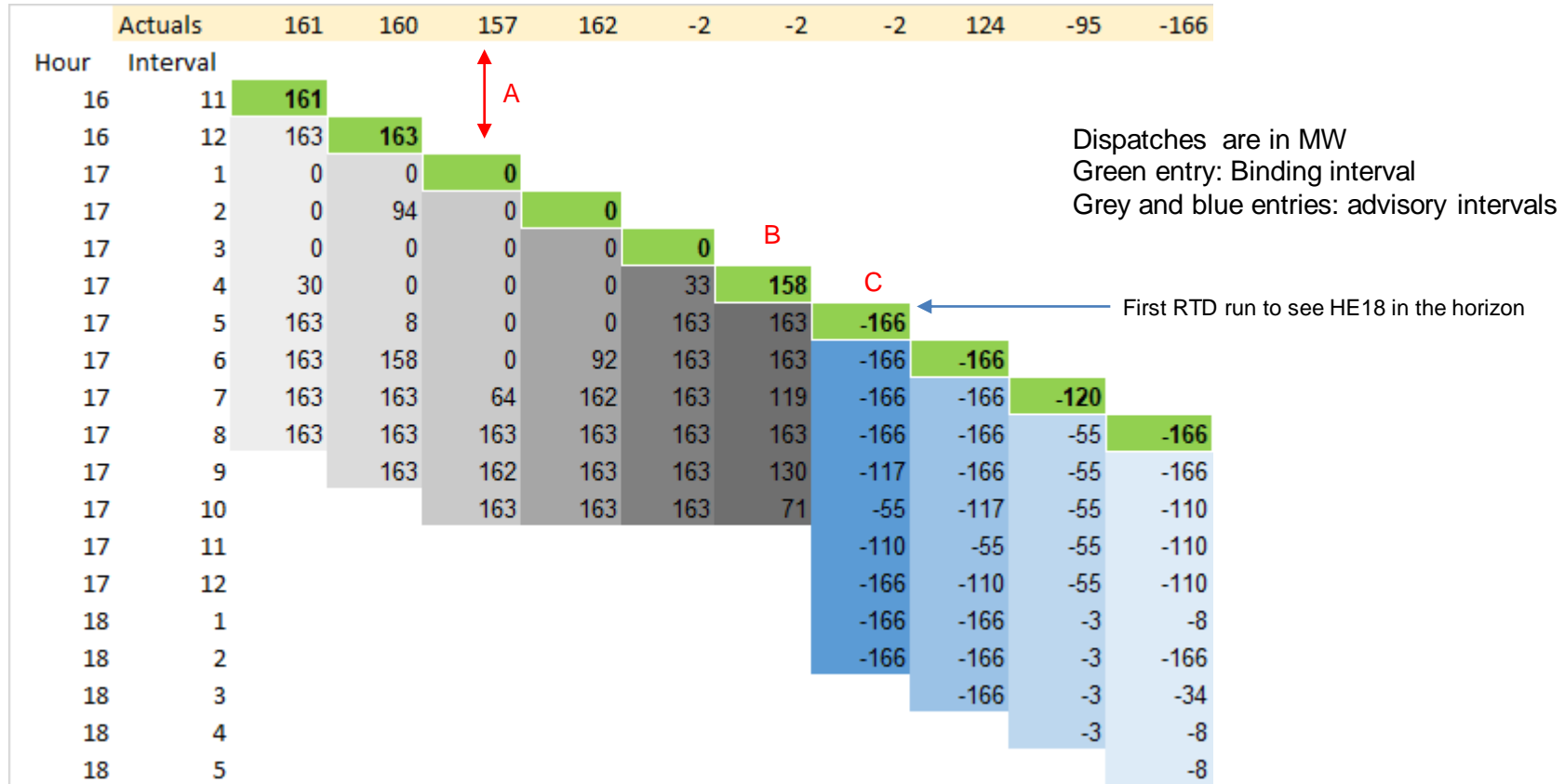
The initial day-ahead state of charge can be very different to what realizes in real-time. It will influence what MSOC is imposed in real-time

Storage resources started to discharge prematurely on Sept 6 as prices quickly increased making resources economical

RTD dispatches can only look ahead for next 50 minutes.
RTD multi-interval optimization can only optimize through that horizon

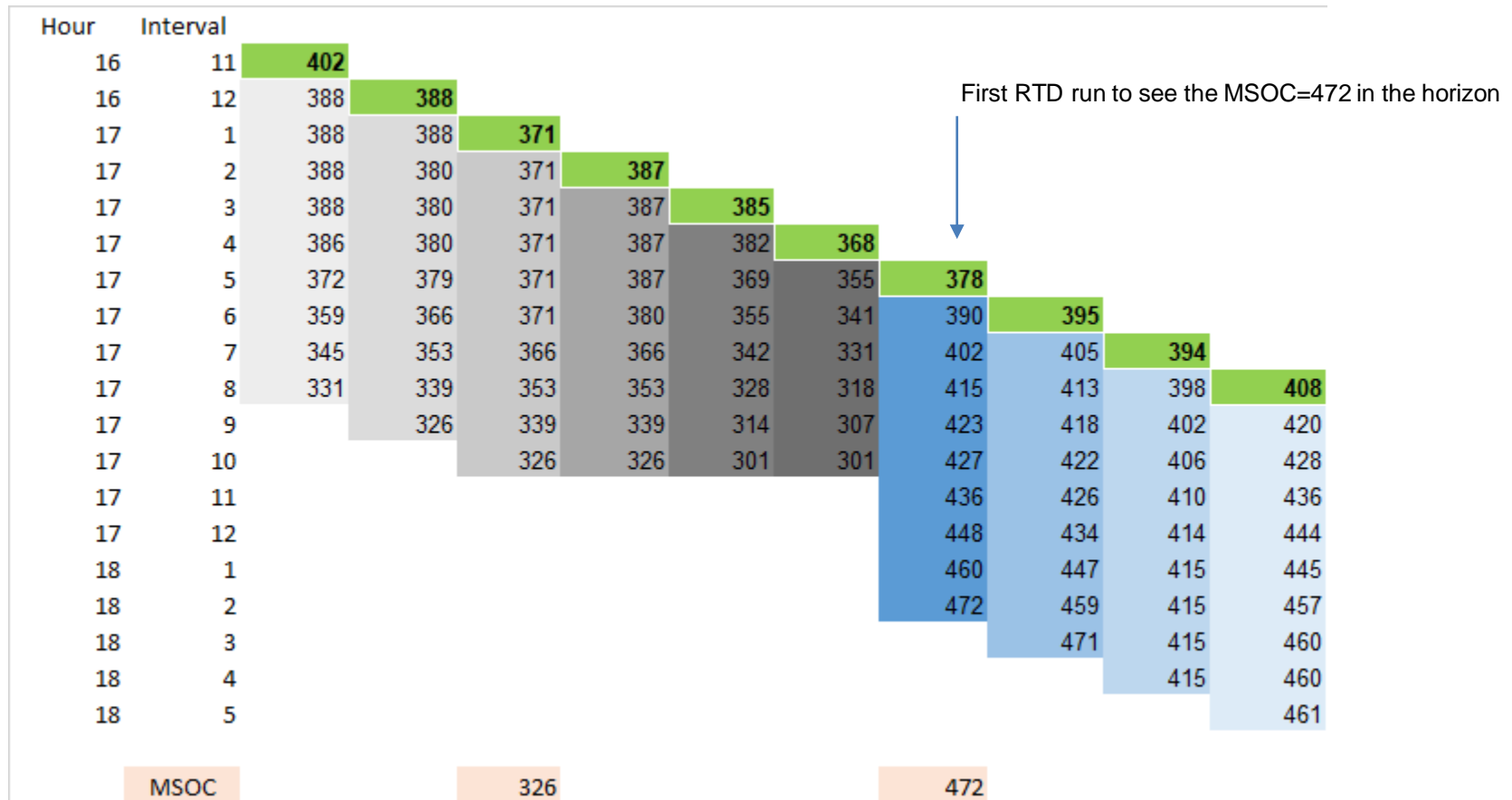


Premature discharges were driven by economics when resources were in merit across the optimized horizon

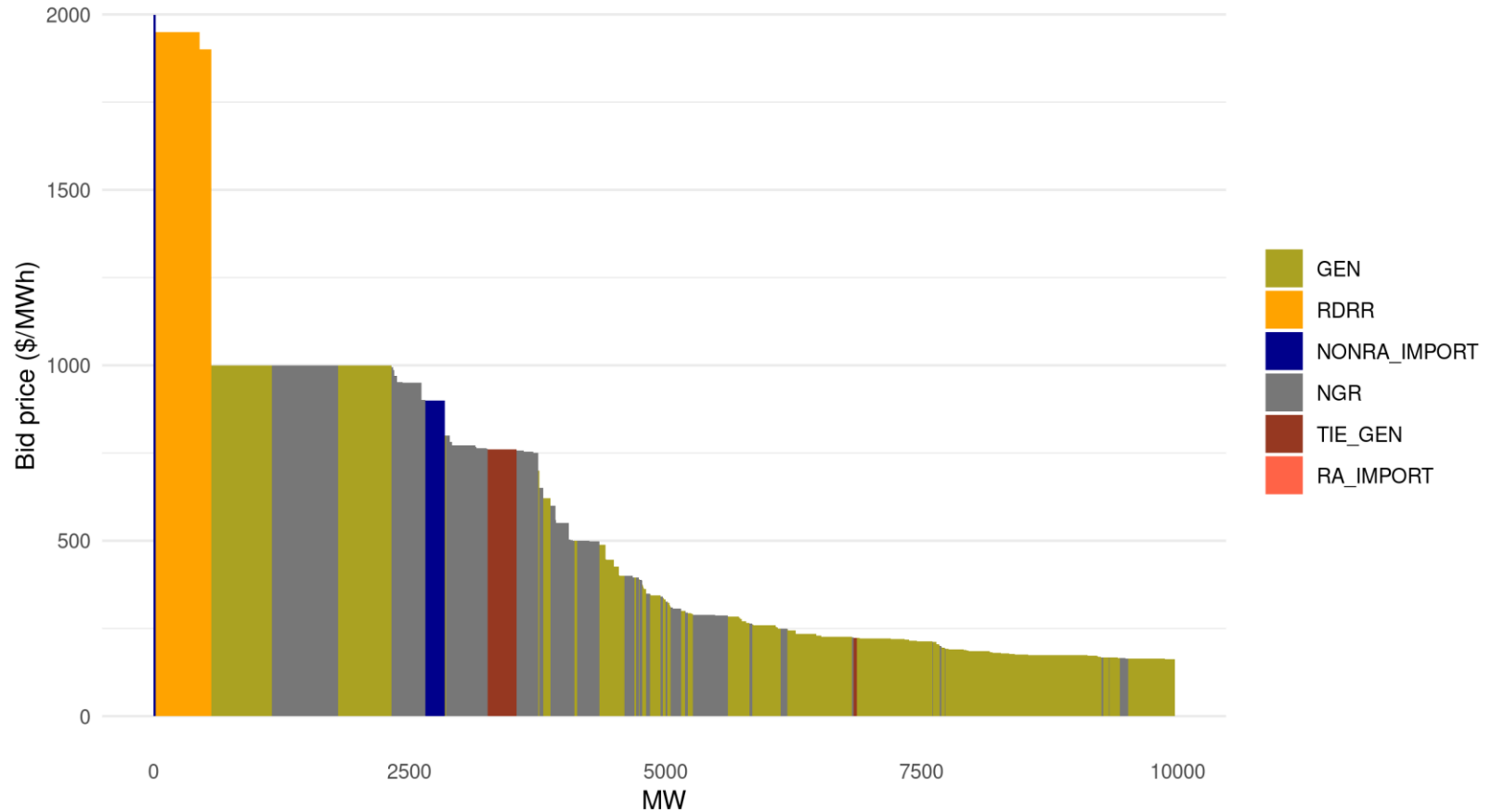


The multi-interval horizon was too short to foresee and position resources more in advance

Dispatches were driven to meet SOC constraints and regulation procurement

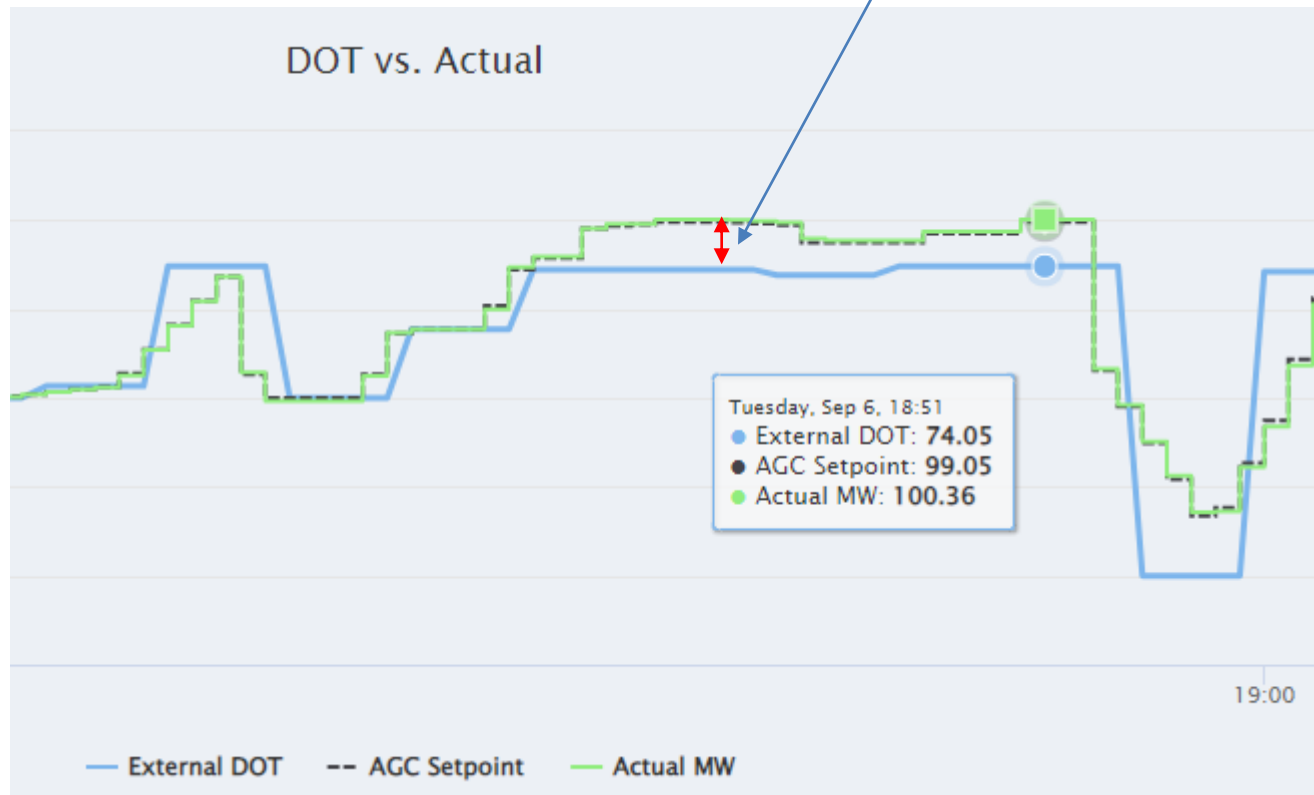


Storage bids capped at \$1,000 even when bid caps increased to \$2,000 and clearing prices were above \$1,000



Resources on regulation depleted SOC faster than originally projected by RTD

Following AGC signal uses up more SOC and changes RTD projections



Areas of challenges and improvements

- Multi-interval optimization is critically useful but with horizon not long enough
- Better consideration of Ancillary services interplays, like SOC depletion from regulation use, (enhancement going live on July 1)
- Utilization of minimum state of charge (use last year and extended for this year)
- Operator tools to instruct resources to target operating points and pay for opportunity costs (going live in Q3)
- Consider opportunity costs above the \$1000 bid cap