



California ISO

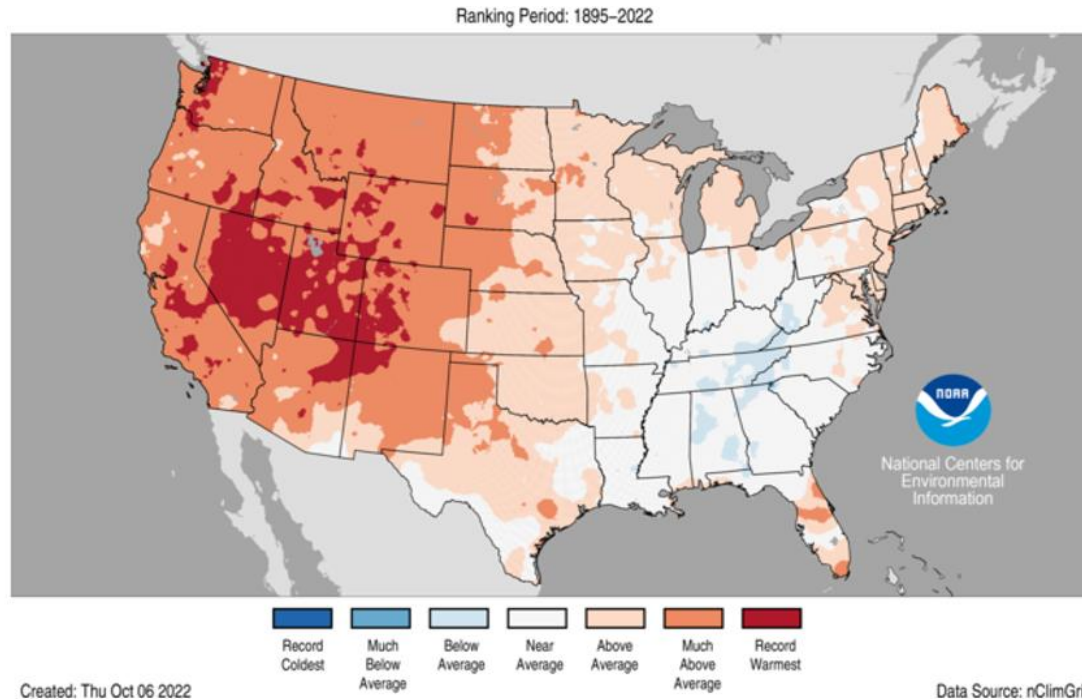
Performance of Batteries in CAISO During the 2022 Heat Wave

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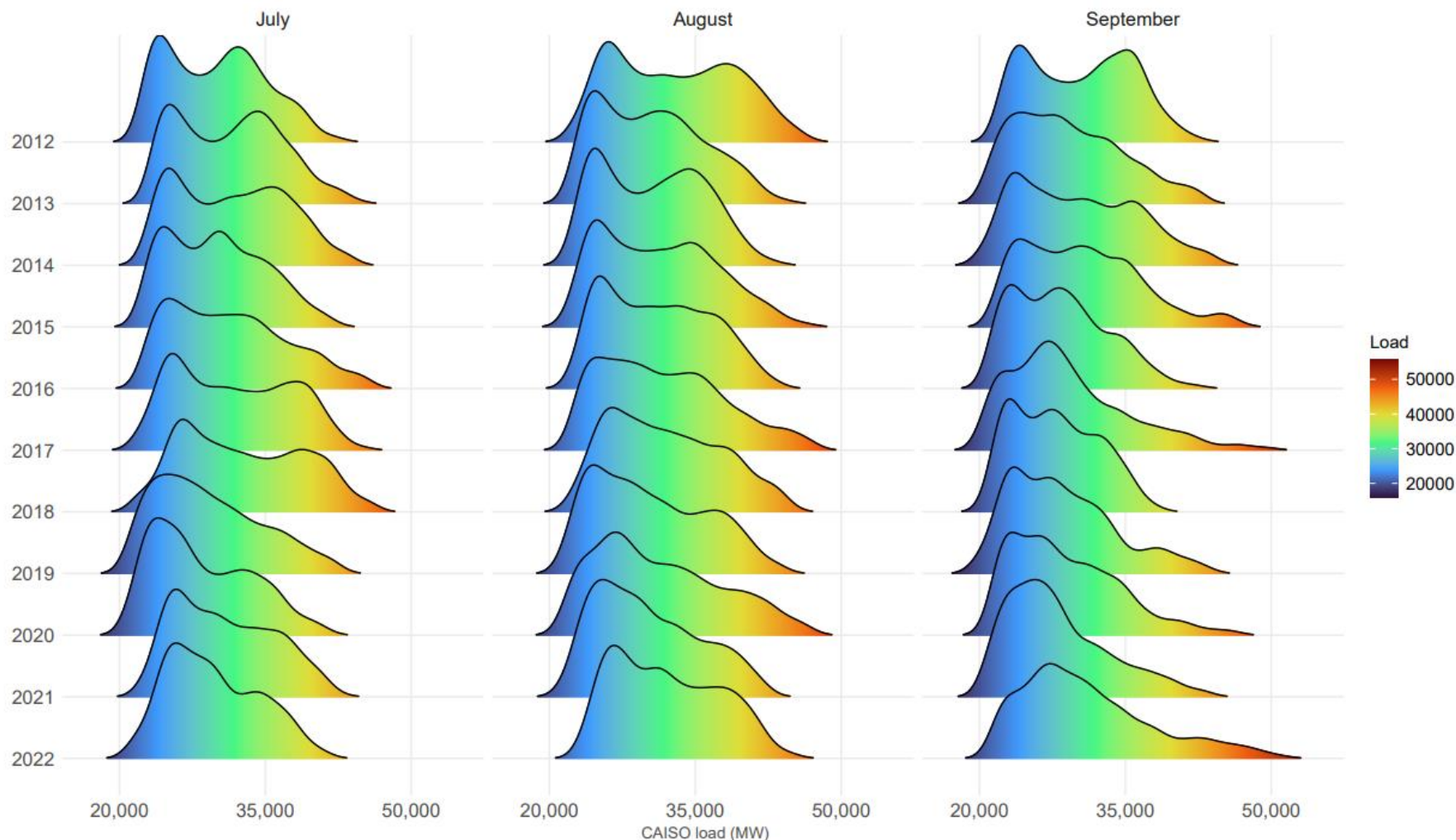
ESIG Meteorology and Market Design for Grid Services Workshop
June 2023

A 10-day shattering heatwave drove record demands

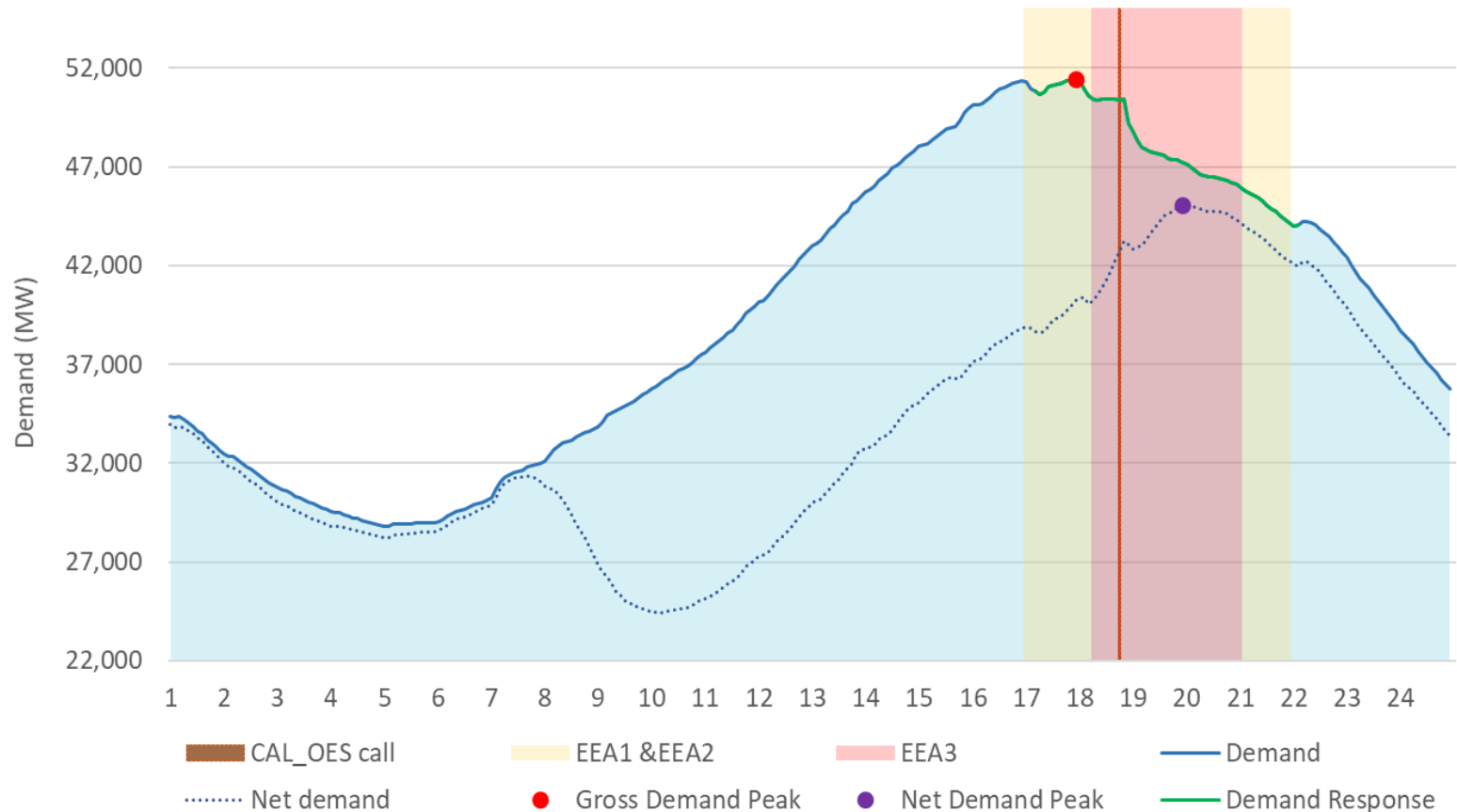


- Multiple cities in California broken 100-year old records for maximum and minimum temperatures
- Using 28 years' worth of weather data, the ISO weighted 3-day temperature through September 6 was a 1-25 year event

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



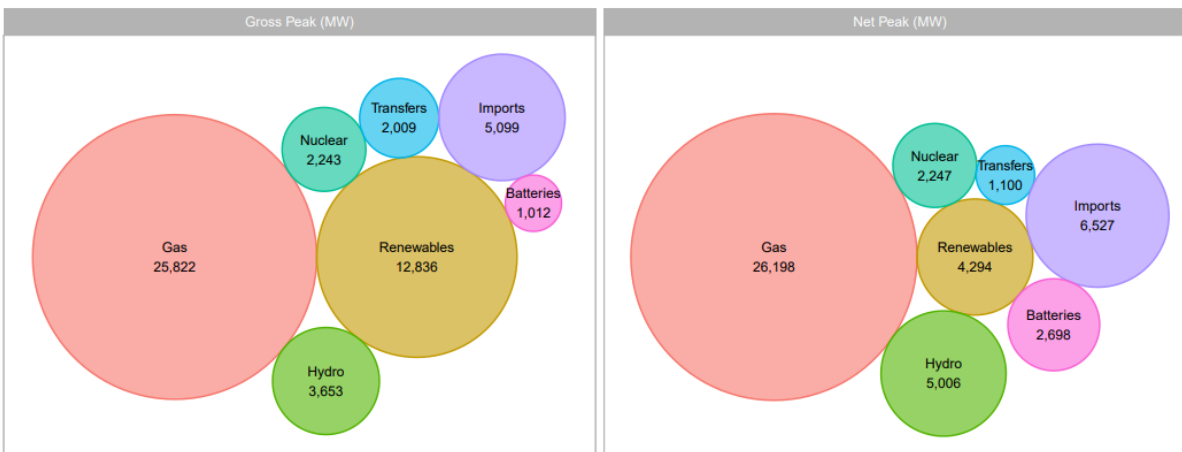
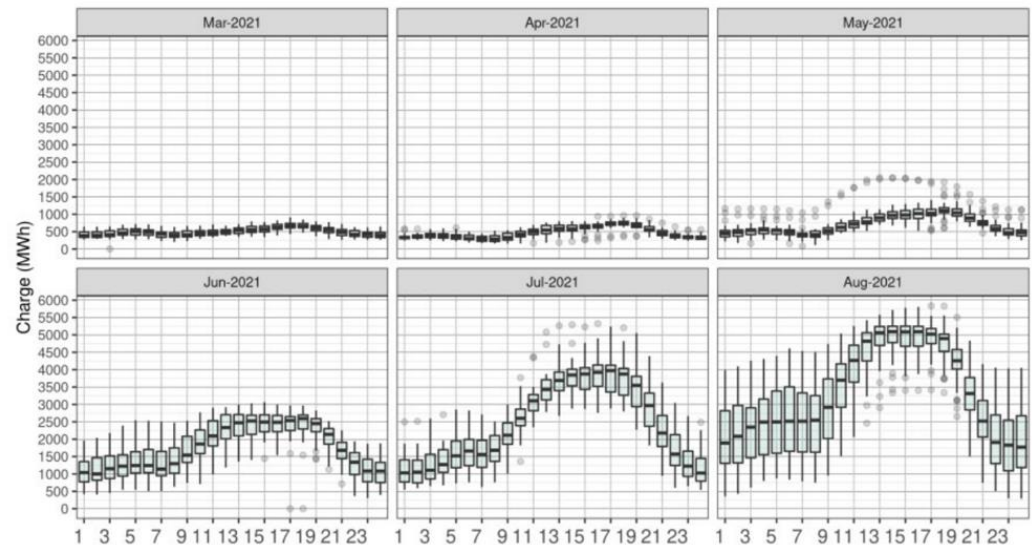
Many factors helped prevent the CAISO from ordering rotating outages, including supply from storage resources



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

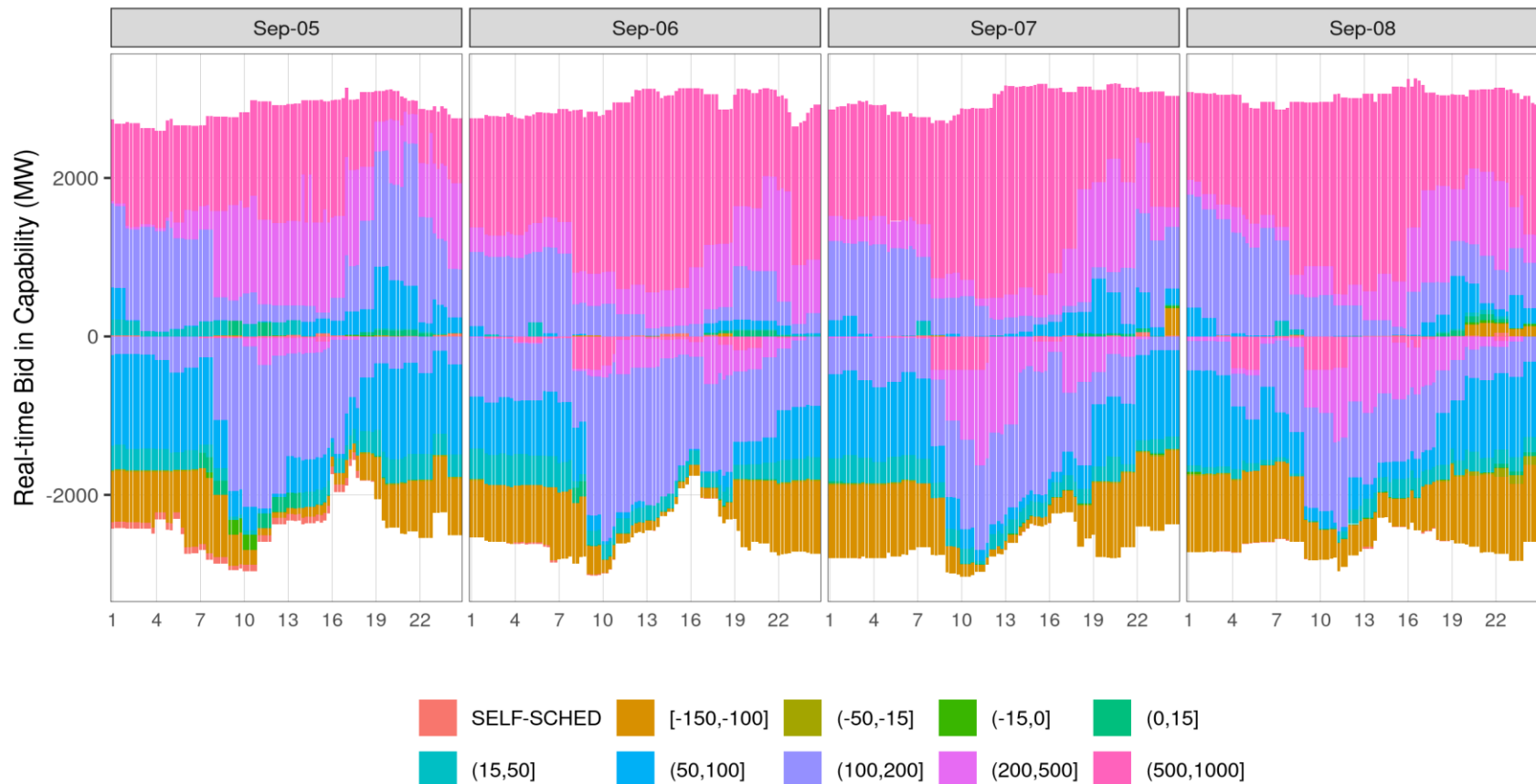
CAISO has seen an explosive growth of storage resources

Regulation requirements are largely procured from storage resources

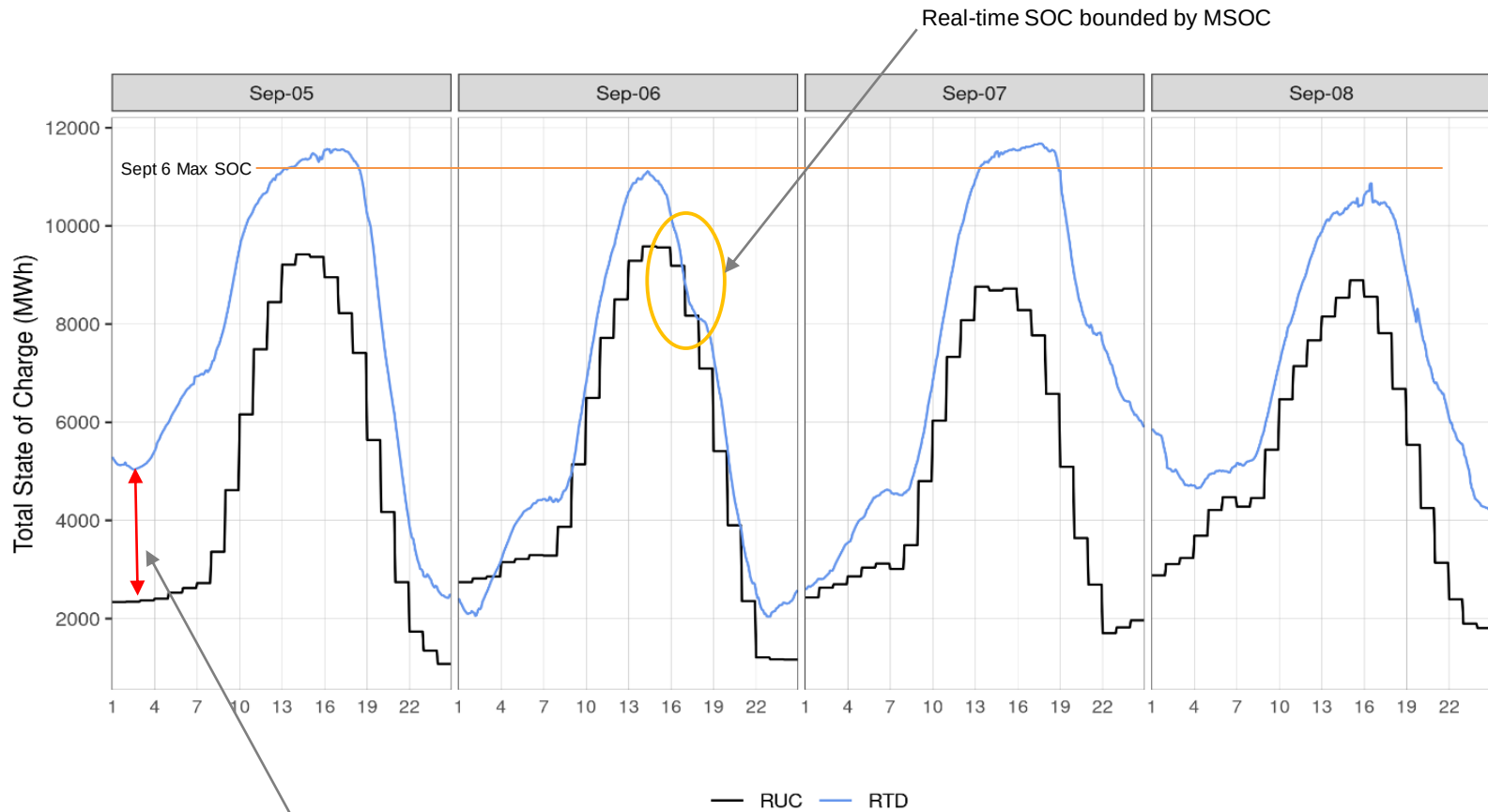


Storage resources contributed to meet demand peaks on Sept 6

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



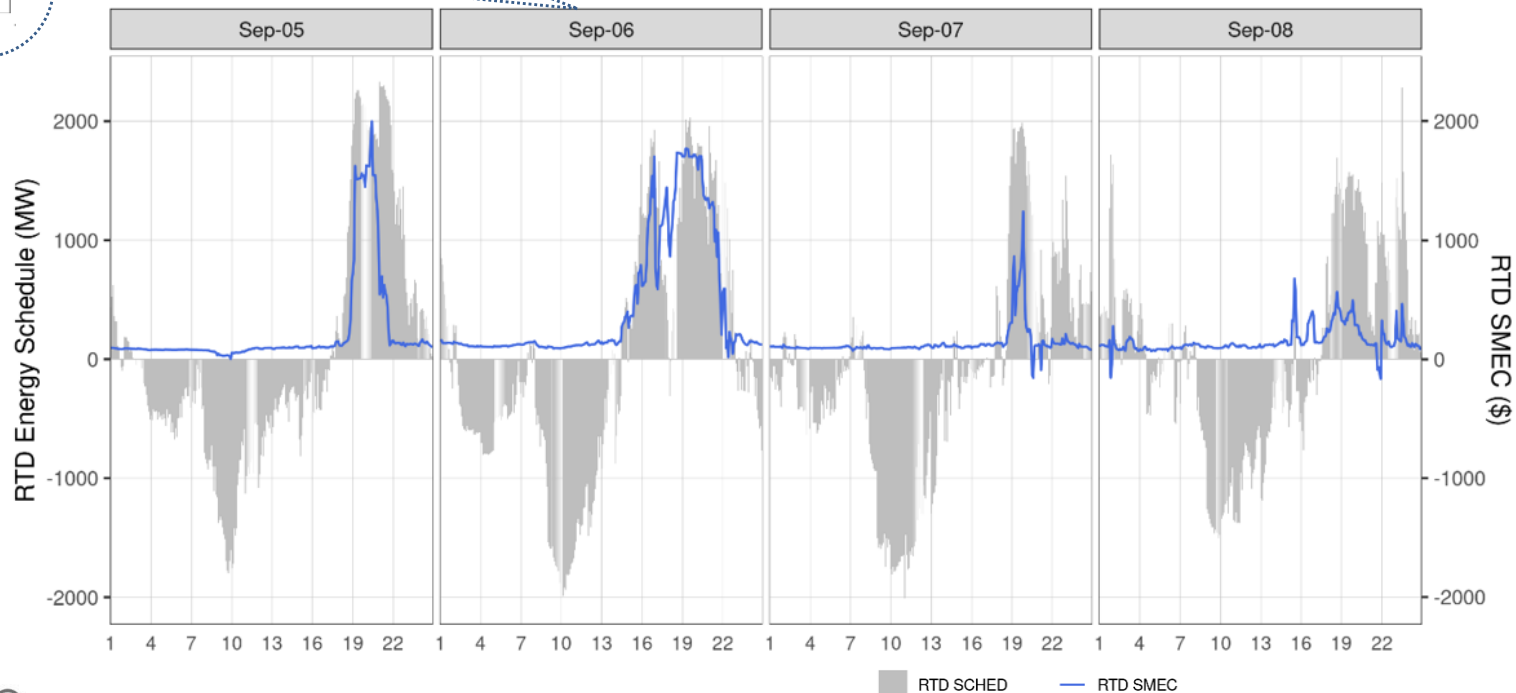
September 6 observed a lower maximum SOC relative to adjacent days due to premature discharge



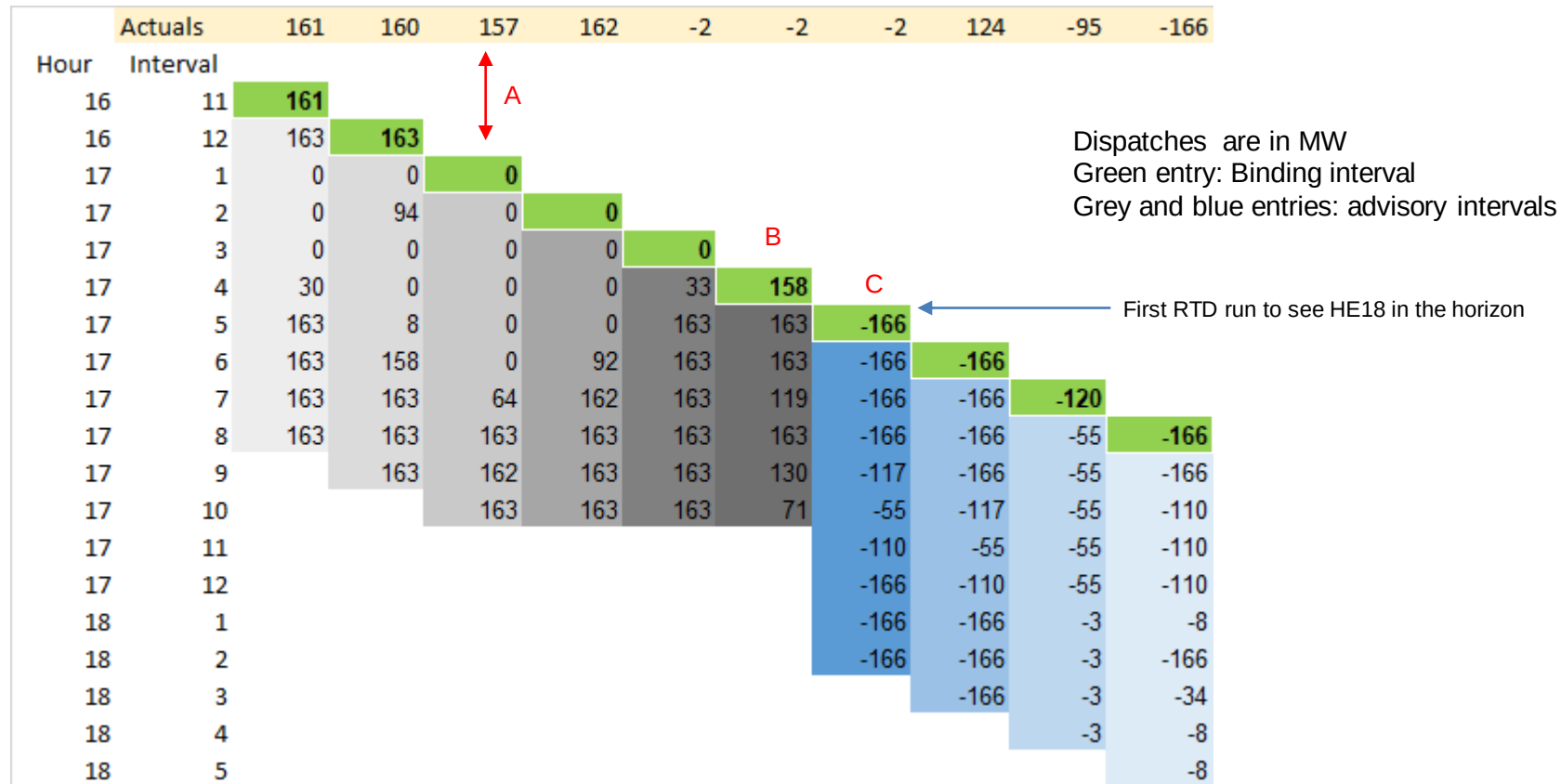
The initial day-ahead state of charge can be very different to what realizes in real-time. It will influence what MSOC is imposed in real-time

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

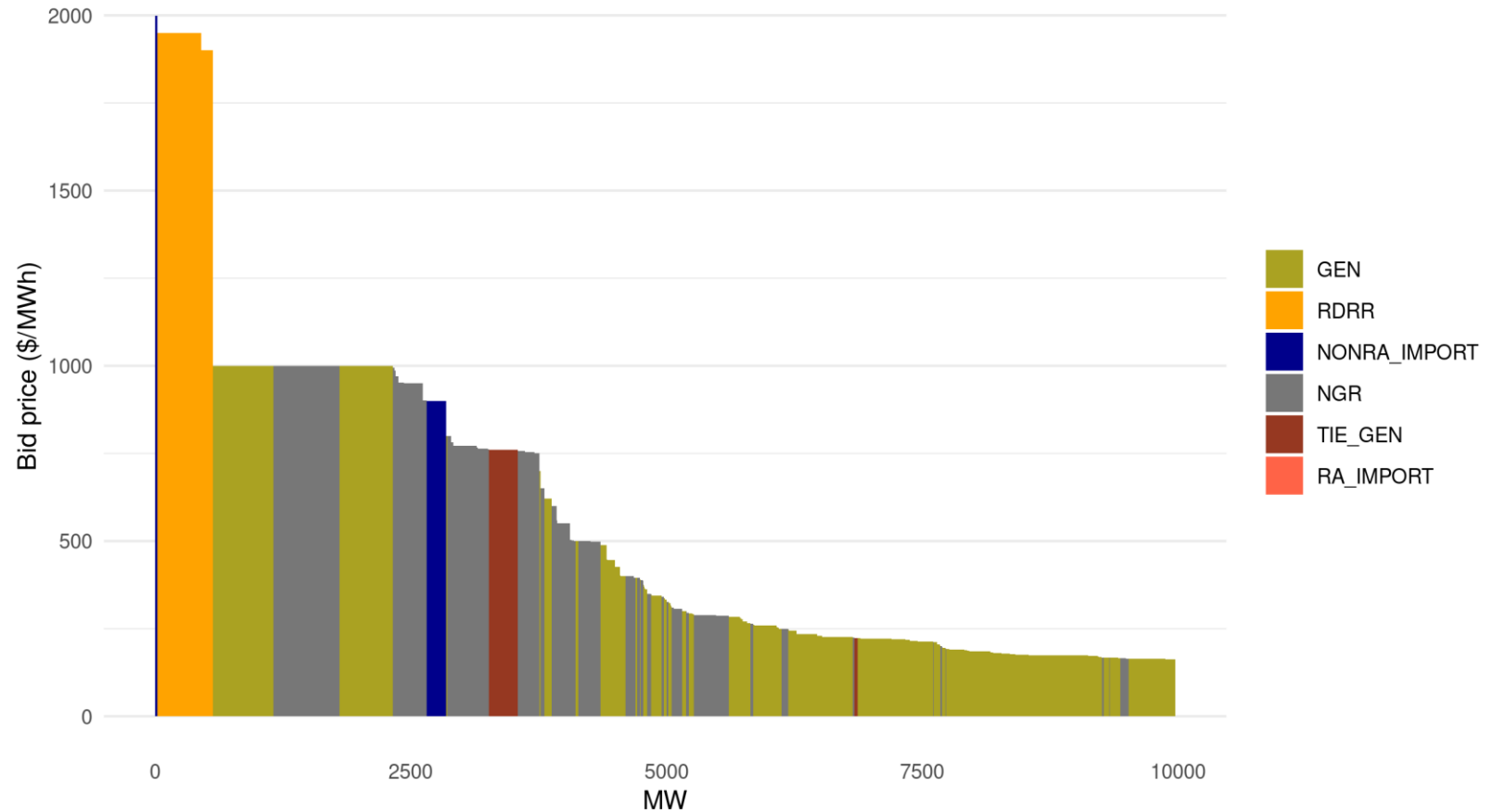
Dispatches were driven to meet SOC constraints and regulation procurement

Hour	Interval	MSOC											
16	11	402											
16	12	388	388										
17	1	388	388	371									
17	2	388	380	371	387								
17	3	388	380	371	387	385							
17	4	386	380	371	387	382	368						
17	5	372	379	371	387	369	355	378					
17	6	359	366	371	380	355	341	390	395				
17	7	345	353	366	366	342	331	402	405	394			
17	8	331	339	353	353	328	318	415	413	398	408		
17	9		326	339	339	314	307	423	418	402	420		
17	10			326	326	301	301	427	422	406	428		
17	11							436	426	410	436		
17	12							448	434	414	444		
18	1							460	447	415	445		
18	2							472	459	415	457		
18	3								471	415	460		
18	4									415	460		
18	5										461		

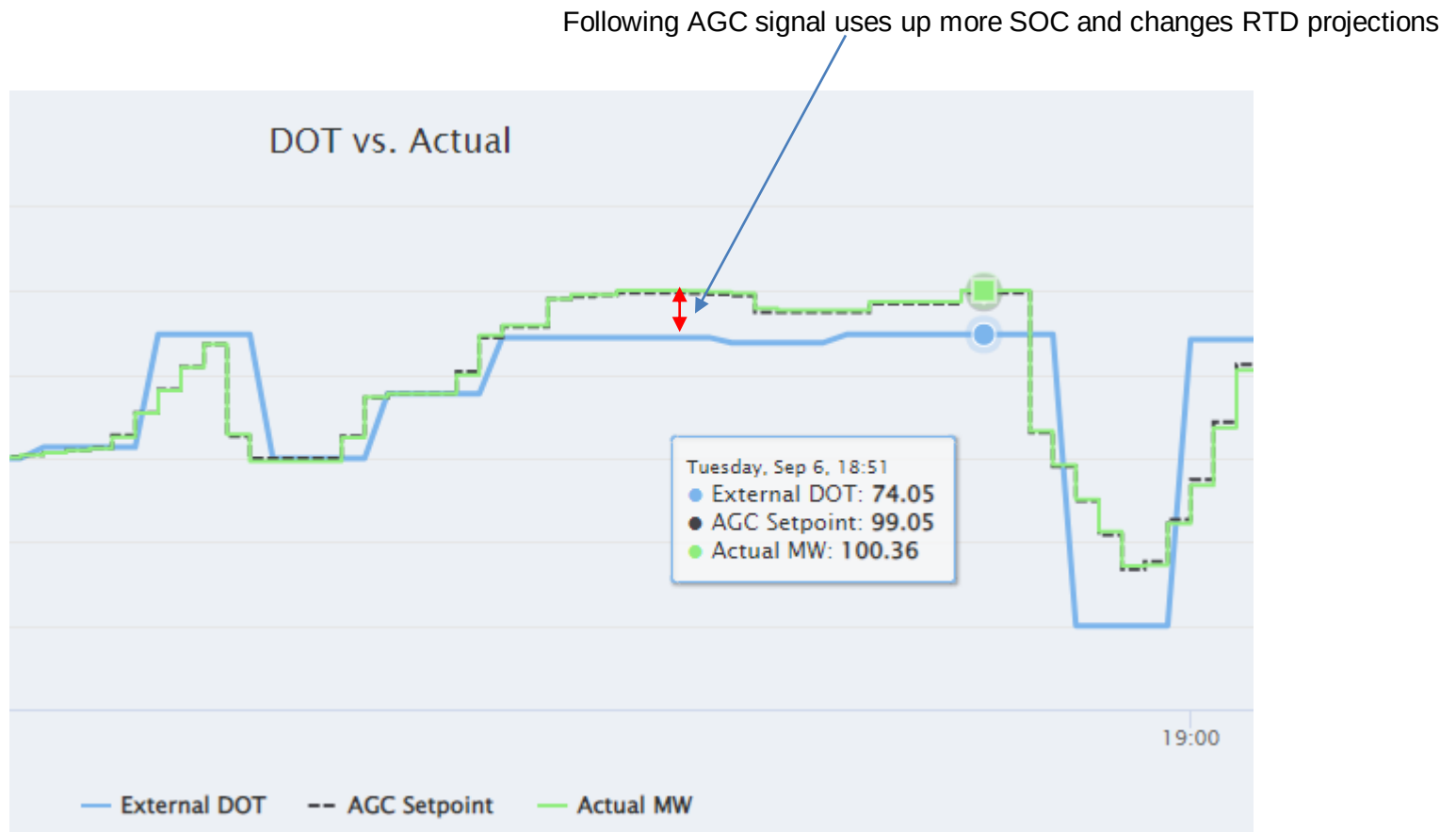
First RTD run to see the MSOC=472 in the horizon

MSOC 326 472

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



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