

CAISO energy storage enhancements



April 13, 2022

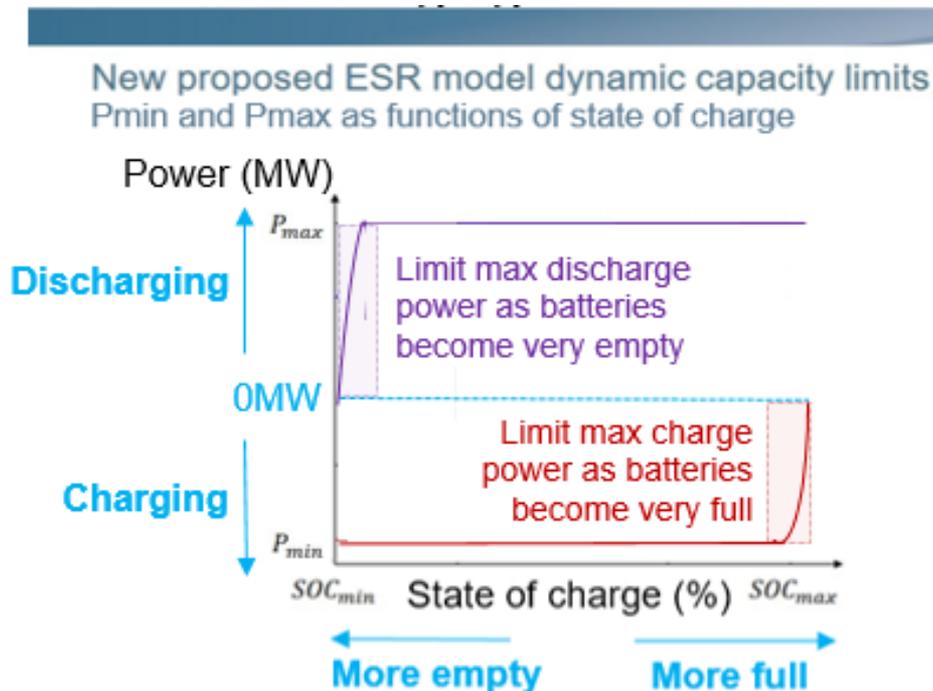
REV
RENEWABLES

REV energy storage enhancement priorities

- CAISO's revised straw proposal improves some areas, such as on compensation for exceptional dispatch.
- CAISO should prioritize fixing observed problems of storage resources in the operational NGR model.
- Much more detail is needed to explore how proposed ESR features will work.
 - How does this model function in the day-ahead market?
 - How is energy co-optimized with ancillaries in a model that doesn't allow resources to bid power (MW) only energy (state of charge)?
 - How would resources match day-ahead MW output schedules in real-time with no ability to discharge at any power other than P_{max} or charge at any power other than P_{min} ?
- Dynamic capacity limits are good, and should be also applied to NGR; dynamic ramp rates are not necessary.
- ESR energy bids should allow MW tiers, just like NGR bids, for each state of charge point.

Dynamic capacity limits can solve the variable charging rate problem

- **Problem:** Batteries cannot charge at max power when full. Batteries can not discharge at max power when empty.
- **Solution:** Limit max power as a function of state of charge.



- Variable charging rates are a function of *power (MW)* not *ramp rates (MW/min)*
- This would be an important improvement to the NGR model (which supports operating resources today!)

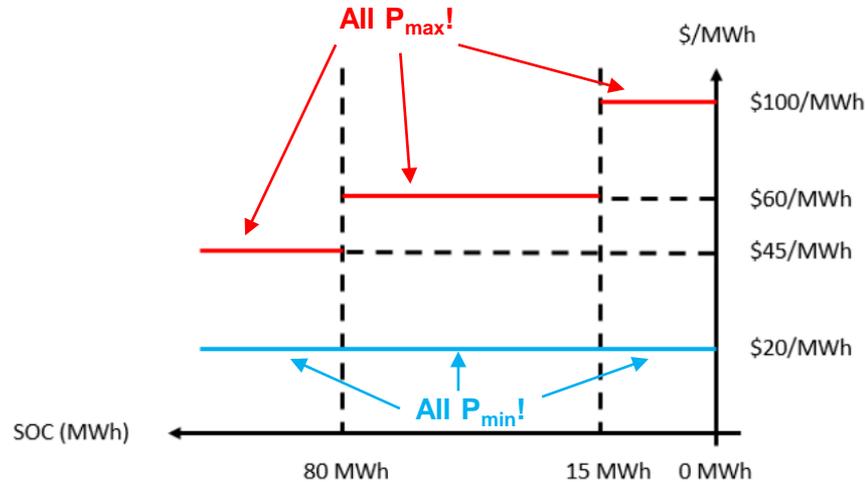
Source: original graphic from CAISO, with REV annotations

Energy storage resource bids should be a function of both state of charge and power

- **Problem:** Battery opportunity costs go down as the resource gets full, and up as the resource gets empty. Real-time bid curves reflecting these costs must be entered more than 75-minutes prior to the start of the trading hour.
- **Solution:** Allow resources to submit different MW bid curves for different states of charge
 - CAISO's proposed solution is one step forward, one step back. Resources would only allowed to ever charge or discharge at maximum power.
- Resources would be able to reflect costs as state of charge but lose the ability to reflect costs in terms of power.
- ESR, as proposed, only allows bidding in terms of state of charge.
- This removes basic abilities to reflect costs of operating at different power and to match day-ahead awards in real-time operations.
- CAISO should also allow ESR resources to bid in MW tiers, just like under the NGR model.
- NGR only allows bidding in MW tiers.

Use the same units as NGRs today, no need to reframe bids as only a function of state of charge

The example resource bids a step function to discharge energy



Source:
original graphic
from CAISO,
with REV
annotations

California ISO

Bid curve at 90% SOC		Bid curve at 10% SOC	
MW	\$/MWh	MW	\$/MWh
-100	-10	-100	50
-50	0	-50	70
0	60	0	120
50	70	50	140
100	70	100	140

- A better model would allow bidding MW tiers for different SOC.

Questions?

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