Energy Storage Enhancements Workshop

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Gridwell Consulting

- Gridwell Consulting is an energy consulting firm located in Sacramento, CA
  - ✓ Educate – Model – Optimize – Advise
  - ✓ Interconnection, Resource Adequacy, Energy Markets,
  - ✓ Storage modeling, contract negotiations, stakeholder representation

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About Western Power Trading Forum

- Western Power Trading Forum is a non-profit, trade forum dedicated to competitive markets and transparency at the California ISO and across the West
- CAISO Committee- paid monthly service for WPTF members that covers CAISO policy and important happenings

This presentation does not necessarily represent all WPTF members' views

Overview

1. Long-duration storage technologies should be considered within this initiative
2. Prioritize refinements, evaluate need for new products and redesigns, take interim steps
3. Rational real-time market prices will maximize the benefits of storage

Long-duration storage technologies require additional bidding parameters

- The CAISO and CPUC have identified the need for long-duration storage in local areas and as part of the system resource mix
- Many of these technologies have a lower round-trip efficiency and require additional bidding parameters (transition times, start-up times, multiple ramp rates)
- Storage technologies in market right now:

Hydrogen	Second-life EV
Compressed Air	Liquid Air
Iron Redox (chemical flow)	Gravity

Prioritize refinements, evaluate need for new products and redesigns

1. Prioritize known needed refinements to the NGR model and energy market
   - Real-time multi-interval optimization challenges
   - Publish advisory price data
   - Regulation parameters and award infeasibilities
2. Evaluate need for redesigns and move forward incrementally with suspected issues
   - Evaluate and demonstrate the value of new products and redesigns with market data
   - Publish advisory price data*

* Not a mistake to put in twice, transparency solves a lot of issues

Refine real-time optimization

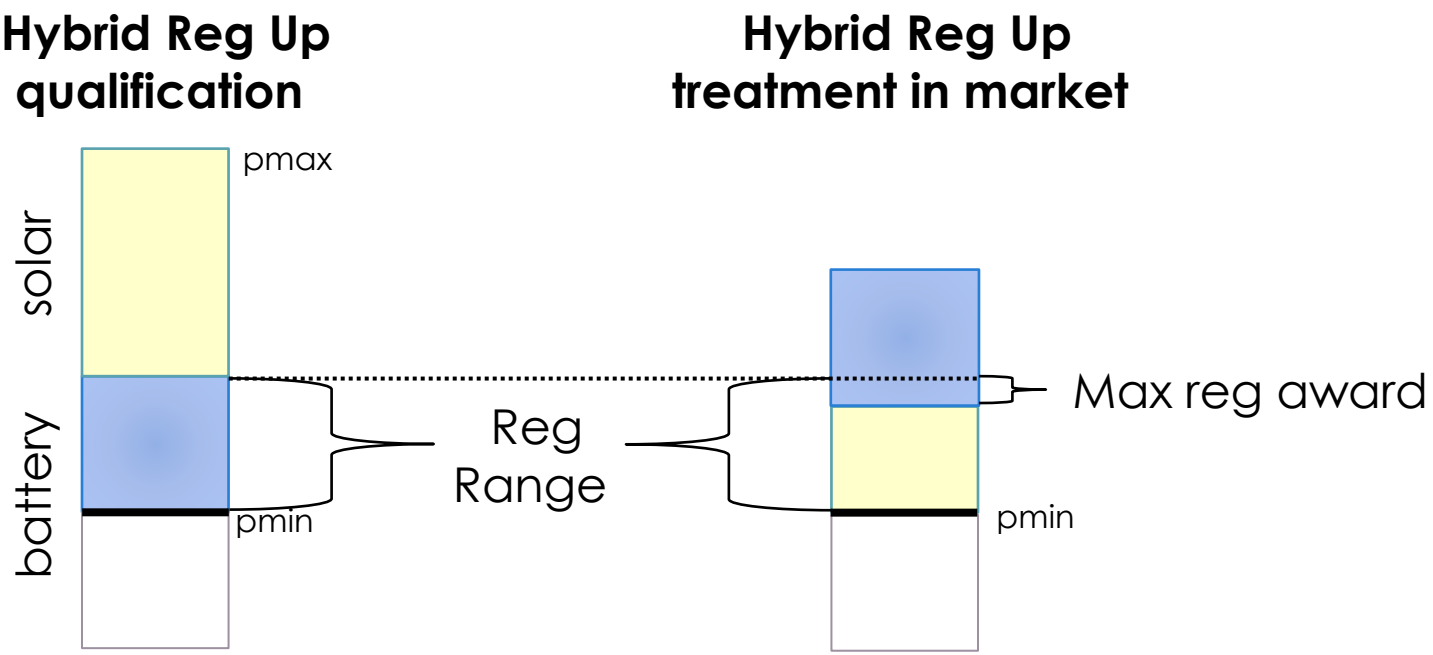
- Prioritize implementation of the end-of-hour state of charge bidding parameter
- Interim step: release advisory prices for SCs to have more information when structuring offers
- Focus on market signals for efficient storage participation
- Evaluate whether market prices plus new exceptional dispatch tool is sufficient compared to the minimum state-of-charge parameter

Refine regulation program for stand-alone storage

- Infeasible day-ahead regulation awards
  - The DA market does not assume any deployment of regulation when awarding energy storage resources reg up and/or down
  - Actual deployment of regulation in RT directly impacts the resources state-of-charge in that moment and going forward
  - Without DA adjusting state-of-charge used in DA market for some assumed level of reg deployment, sets up energy storage such that they cannot provide awarded regulation in RT

Refine regulation for hybrid resources

- Regulation range for hybrid resources
  - Currently market limits the ability for hybrid resources to provide regulation because the regulating range is based only on the battery component



Rational real-time market prices maximize benefits of storage

- Storage is a pure arbitrage product – it has every incentive to charge during lowest prices and discharge during highest
- Real-time prices reflect grid reliability needs
  - More real-time prices are rational across the day (indicate grid needs) the better storage will be at providing energy when needed
- CAISO has not demonstrated that storage will not show up when prices are highest
  - If storage is not showing up when prices are highest, the cause must be identified and resolved through the market

Appendix

Regulation from Energy Storage

- Infeasible Day-ahead regulation awards
  - 100 MW/400 MWh battery certified to provide 200 MWs of reg up and down
  - Assume it has a 0% SOC beginning HE 9

	HE 9	HE 10	HE 11	HE 12	HE 13	HE 14	HE 15	HE 16
Energy Schedule	-100	-100	0	0	0	0	100	100
Regulation up	0	0	100	100	100	100	0	0
Regulation down	0	0	0	0	0	0	50	100
SOC	25%	50%	50%	50%	50%	50%	25%	0%

Regulation from Energy Storage

	HE 9	HE 10	HE 11	HE 12	HE 13	HE 14	HE 15	HE 16
Energy Schedule	-100	-100	0	0	0	0	100	100
Regulation up	0	0	100	100	100	100	0	0
Regulation down	0	0	0	0	0	0	50	100
SOC	25%	50%	50%	50%	50%	50%	25%	0%

- Assume RT the resource is deployed approx. 40% of its awarded regulation capacity