Energy Storage Enhancements
Draft Final Proposal

Gabe Murtaugh
Storage Sector Manager, Market and Infrastructure Policy
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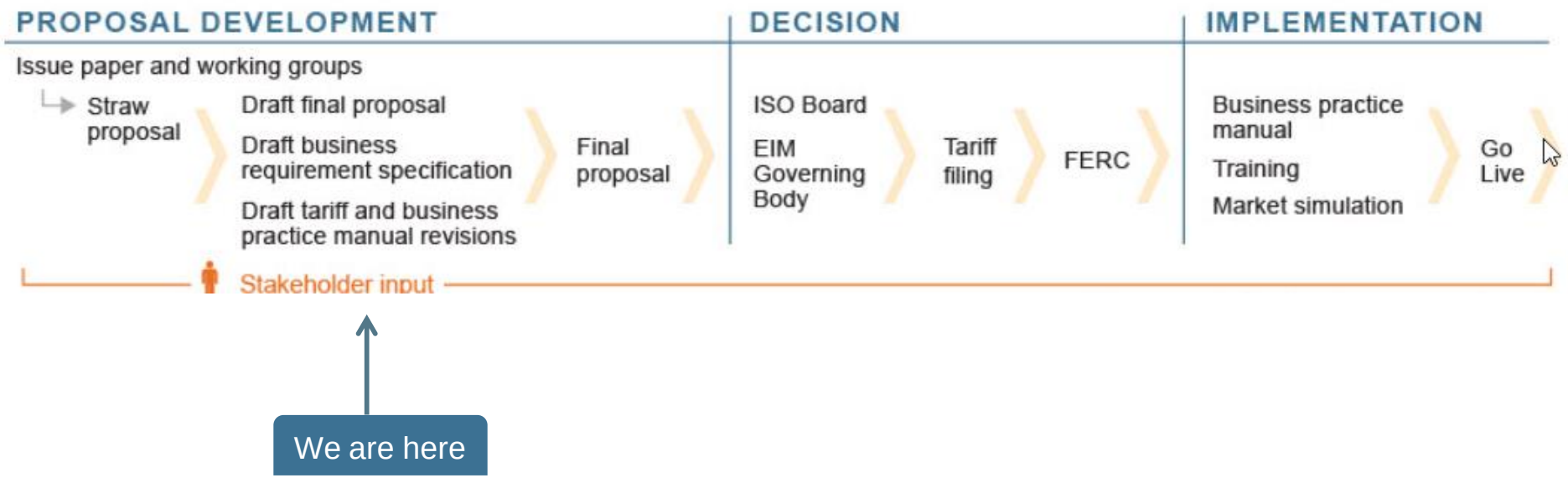
Agenda

Time	Item	Speaker
9:00-9:10	Introductions and Stakeholder Process	Brenda Corona
9:10-9:15	Policy Summary	Gabe Murtaugh
9:15-10:40	Storage Day-Ahead Default Energy Bid	Gabe Murtaugh
10:40-11:15	Remaining Draft Final Proposal Details	Gabe Murtaugh
10:00-11:55	Additional Q&A	Gabe Murtaugh
11:10-12:00	Next Steps	Brenda Corona

ISO Policy Initiative Stakeholder Process



Meeting Overview

- ISO plans to walk through high level overview of topics covered in the draft final proposal
  - ISO will not present the details of each topic
  - Will provide details of the proposal to change the default energy bid
  - Will respond to all questions related to the topic
- Proposal on local issues has been moved to the storage modeling enhancements initiative
  - Allow additional time to develop and vet proposal
- ISO will draft and post a Final Proposal
  - These will be accompanied by draft business requirements and draft tariff language
- ISO plans to take this policy for approval at the October 2022 Board of Governors Meeting

The draft final proposal continues to include changes to ensure reliable storage operation and modeling

Enhancements for reliability:

1. Improved accounting for state of charge while providing regulation
2. Enhanced bidding requirements for resources providing ancillary services
3. Exceptional dispatch tools for storage resources to hold state of charge and opportunity cost compensation

Enhancements to co-located model:

4. Electable mechanism to prevent ‘grid charging’
5. Extension of the co-located model to pseudo-tie resources

Improvements to the storage default energy bid:

6. Add an opportunity cost component into the day-ahead default energy bid

STORAGE DAY-AHEAD DEFAULT ENERGY BID

The ISO uses a default energy bid for storage resources in the day-ahead market

$$DA\ Storage\ DEB = \left(MAX\left(En_{\delta/\eta}, 0\right) + \rho\right) * 1.1$$

En: Estimated cost for resource to buy energy
δ: Energy duration
η: Round-trip efficiency
ρ: Variable cost

This default energy bids includes three components:

- Energy: Expected cost to charge the storage resource considering duration (Max SOC/Pmax) and round-trip efficiency of the resource
- Variable: Wear and tear the resource incurs from charging and discharging
  - This component is not included in the discharge portion of the resource
- Multiplier: Accommodates some differences between expectations and actual outcomes

The ISO proposes to expand the day-ahead default energy bid to include an opportunity cost term

$$DA\ Storage\ DEB = MAX\left[\left(MAX\left(En_{\delta/\eta}, 0\right) + \rho\right), \boldsymbol{OC_{\delta}}\right] * 1.1$$

En: Estimated cost for resource to buy energy
δ: Energy duration
η: Round-trip efficiency
ρ: Variable cost
OC: Opportunity Cost

- Opportunity costs are a function of the duration of the storage resource
  - A four hour resource will receive an opportunity cost equal to the fourth highest priced hour of the day
- This proposed formulation aligns with the RT DEB
- The opportunity cost will ensure that storage resources are not dispatched prematurely

The ISO default energy bids already include prices from the market power mitigation run

- The ISO uses prices from the market power mitigation run to determine expected costs to buy energy
  - The ISO proposes to use the same series of prices – from the market power mitigation run – to generate the opportunity cost term

- Some market participants raised concerns that market power mitigation run values might be inflated
  - Prices from the market power mitigation run inherently could be inflated because market power mitigation has not yet been applied
  - The ISO is considering how this could be accounted for and the potential for using the day-ahead market results from the previous day

DRAFT FINAL PROPOSAL POLICY

The ISO proposes policy to help ensure storage resource availability while providing ancillary service

The ISO has two proposals to address service availability:

1. Update the state of charge equation so that it reflects regulation awards
   - Make the estimated state of charge more accurate
   - Use a formula that includes different hourly multipliers
2. Require bids alongside ancillary service awards
   - Ensure that storage resources can always provide ancillary service
   - This rule will apply in the day-ahead and real-time markets
   - The ISO may consider tailoring requirements to specific hours

- ISO proposes both tools, because they provide different functions, which will help address independent concerns

The ISO proposes new exceptional dispatch tools for storage resources to hold state of charge

- The ISO is proposing a new form of exceptional dispatch to hold state of charge
  - Today the exceptionally dispatch tool only specifies a certain power (MW) output form resources
  - Operators can require storage resources to hold state of charge
  - This tool will only apply in the real-time market

- The ISO developed an opportunity cost methodology to compensate storage resources
  - The ISO compares two counterfactual energy schedules, based on bids, one with the dispatch and one without, to determine lost opportunity

The ISO proposes an operation mode to allow co-located storage the ability to avoid grid charging

- Resources will only charge when generation is scheduled from on-site resources
  - ISO will insert a constraint ensuring that storage charging schedules do not exceed co-located renewable output schedules
  - Functionality will apply in the day-ahead and real-time market
  - Functionality would not preclude self-schedules in the day-ahead market
  - ISO plans to develop this with functionality to be toggled on or off for specific hours

- Offer the ability for storage to “back down” when energy from renewables does not meet schedule

The ISO will extend additional co-located features to pseudo-tie resources

- Pseudo-tie resources will be allowed to participate in the market similar to co-located resources today
  - ISO will allow co-located resources outside of the ISO balancing area to utilize “undersized” transmission and interconnection when modeled as a pseudo-tie resource
  - These pseudo-tie resources will have access to newly proposed features as well as existing features
  - Resources are required to receive approval from balancing area they are located in for this treatment

NEXT STEPS

Next Steps

- All related information for the Energy Storage Enhancements initiative is available at: https://stakeholdercenter.caiso.com/StakeholderInitiatives/Energy-storage-enhancements
- Please submit stakeholder written comments on today's discussion and the storage enhancements issue paper by Sep 09, 2022, through the ISO's commenting tool
  - The commenting tool is located on the Stakeholder Initiatives landing page (click on the "commenting tool" icon): https://stakeholdercenter.caiso.com/StakeholderInitiatives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APPENDIX

Appendix: Ancillary Service Proposal

- Today the formula that governs state of charge is:

$$SOC_{i,t} = SOC_{i,t-1} - \left(P_{i,t}^{(+)} + \eta_i P_{i,t}^{(-)}\right)$$

- The ISO proposes to update the formula as follows:

$$SOC_{i,t} = SOC_{i,t-1} - \left(P_{i,t}^{(+)} + \eta_i P_{i,t}^{(-)} + \mu_1 RU_{i,t} - \mu_2 \eta_i RD_{i,t}\right)$$

$SOC_{i,t}$	State of charge for resource *i* at time *t*
$P_{i,t}^{()}$	Dis/Charge (+/-) instruction for resource *i* at time *t*
η_i	Round trip efficiency for resource *i*
$RU_{i,t}$	Regulation up awarded to resource *i* at time *t*
$RD_{i,t}$	Regulation down awarded to resource *i* at time *t*
μ	Multiplier

- Analysis shows μ_1=.08 and μ_2=.19 across all hours

Appendix: Ancillary Service Proposal

- Operators noted storage resources can run out of SOC, resulting in an inability to provide ancillary services
  - Storage schedules with ancillary services may become infeasible
- ISO proposes that upward/downward ancillary services awards have accompanying energy bids
  - Storage resources are required to have energy bids in the opposite direction of ancillary service awards, at 50% of the award

EXAMPLE: A ±12 MW storage resource

- Award: 12 MW regulation up (i.e., regulation will discharge the resource)
  - Must bid a 6 MW (0 MW to -6 MW) range of charging energy
- Award: 12 MW regulation down (i.e., regulation will charge the resource)
  - Must bid a 6 MW (0 MW to +6 MW) of discharging energy
- Award: 8 MW of regulation up and 8 MW of regulation down
  - Must bid 4 MW of charging and discharging energy (-12 MW to 12 MW)

Appendix: Exceptional Dispatch

- The ISO proposes to run two very simple counterfactuals to determine payment to storage resources:
  1. Profit maximizing energy schedule without ED
  2. Profit maximizing energy schedule with ED

- Counterfactuals will be based on actual prices realized at the location of the resource
  - Stakeholders requested that there should be no counterfactual dispatch if bids are not economic

- The timeframe used to construct counterfactuals will run through the end of the operating day

Appendix: Co-Located Proposal

- Co-located resources may elect to use an optional tool that will prevent on-site storage from receiving dispatch instructions in excess of co-located renewable schedules
- Any storage resource may elect this option
- There is no time limit for participation with this option
- Resources are still required to follow exceptional dispatch and operator instructions

Appendix: Co-Located Proposal

- Storage resources may deviate down when dispatch instructions are above actual renewable output
  - ISO is not responsible for ensuring that actual output levels between co-located storage and solar are aligned, this likely must be done through facility level controls
  - Storage cannot deviate beyond the difference between actual and forecast renewable output
  - Storage resources that deviate will not receive unique settlement treatment and will still be subject to uninstructed deviation charges
  - There will be no additional ISO settlement measures between the co-located resources