Energy Storage Enhancements Issue Paper

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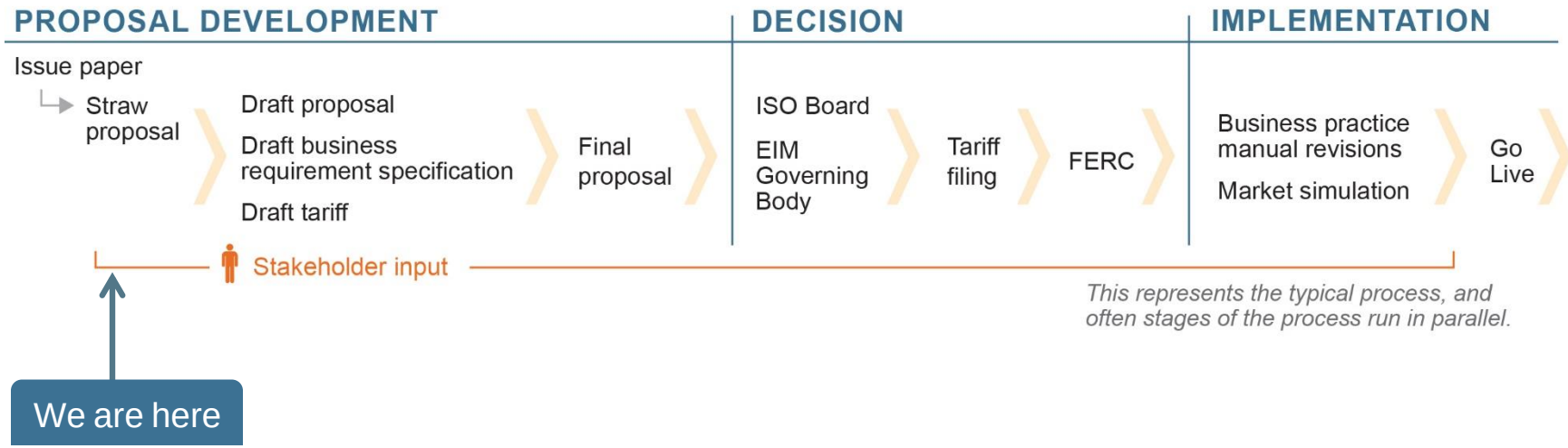
Agenda

Time	Item	Speaker
9:00-9:10	Introductions and Stakeholder Process	James Bishara
9:10-9:30	Background and Scope	Gabe Murtaugh
9:30-10:30	Real-time Enhancements	Bridget Sparks
10:30-11:30	Ensuring State of Charge	Gabe Murtaugh
11:30-11:40	Variable Charging Rates	Gabe Murtaugh
11:40-11:55	Exceptional Dispatch	Bridget Sparks
11:55-12:00	Next Steps	James Bishara

ISO Policy Initiative Stakeholder Process



BACKGROUND AND SCOPE

The ISO continues to explore ways to best integrate and model storage

- The current market construct was generally designed to best optimize and operate gas resources
  - Typically capable of generating 24x7 with few to no use-limitations
  - May have costs that change with output range
- Storage resources behave differently than gas resources and have different cost structures
  - Storage can charge energy for discharge at a later time
  - Storage resources have limited energy storage capability
    - Nearly all storage in the ISO market is 4-hour duration
- More fundamental market modifications or redesigns may be necessary to accommodate storage resources

Marginal Costs for storage were discussed in detail during the ESDER 4 stakeholder initiative

Three factors drive storage resource costs:

1. Energy Costs – Charging costs and losses
2. Marginal cost to charge and discharge
   - Cell augmentation costs
3. Opportunity Costs - Value of energy in the future

The ESDER 4 policy assumed some simplifications for storage resources, and there could be further expansions to the current storage model to better capture costs

REAL-TIME ENHANCEMENTS

Multi-Interval Optimization (MIO) and Spread Bidding

- Today, the market dispatches all resources based on future expectations of market conditions
  - The multi-interval optimization is effective at positioning system and increasing overall market efficiency reducing uplift payments
  - The optimization can issue startup, shutdown and dispatch instructions for future conditions
- The market minimizes costs during binding and advisory periods
  - Dispatch instructions for storage may be 'inconsistent' with bids in the binding interval
- If a storage resource has a self schedule or exceptional dispatch to discharge, the resource will be charged to meet that schedule

Multi-Interval Optimization (MIO) and Spread Bidding

- Feedback – Reduce or eliminate advisory intervals considered for storage resources

- Feedback – Real-time market should only consider specific dollar thresholds, rather than spread bids

End of Horizon Opportunity Costs

- The real-time market considers future intervals between 65 minutes and two hours
  - These horizons cannot ‘save’ state of charge for use later in the day when selling opportunities may be greater

➢ Feedback – Allow storage to include an end of horizon opportunity cost in submitted bids

Bid Cost Recovery

- Bid cost recovery provides compensation for net revenue shortfalls across the entire day
  - Day-ahead uplift is settled separately from the real-time market uplift
  - Storage resources only represent energy costs and do not have start costs, minimum load costs, or transition costs
- Bid cost recovery may be less necessary for storage if changes storage has better tools to represent costs

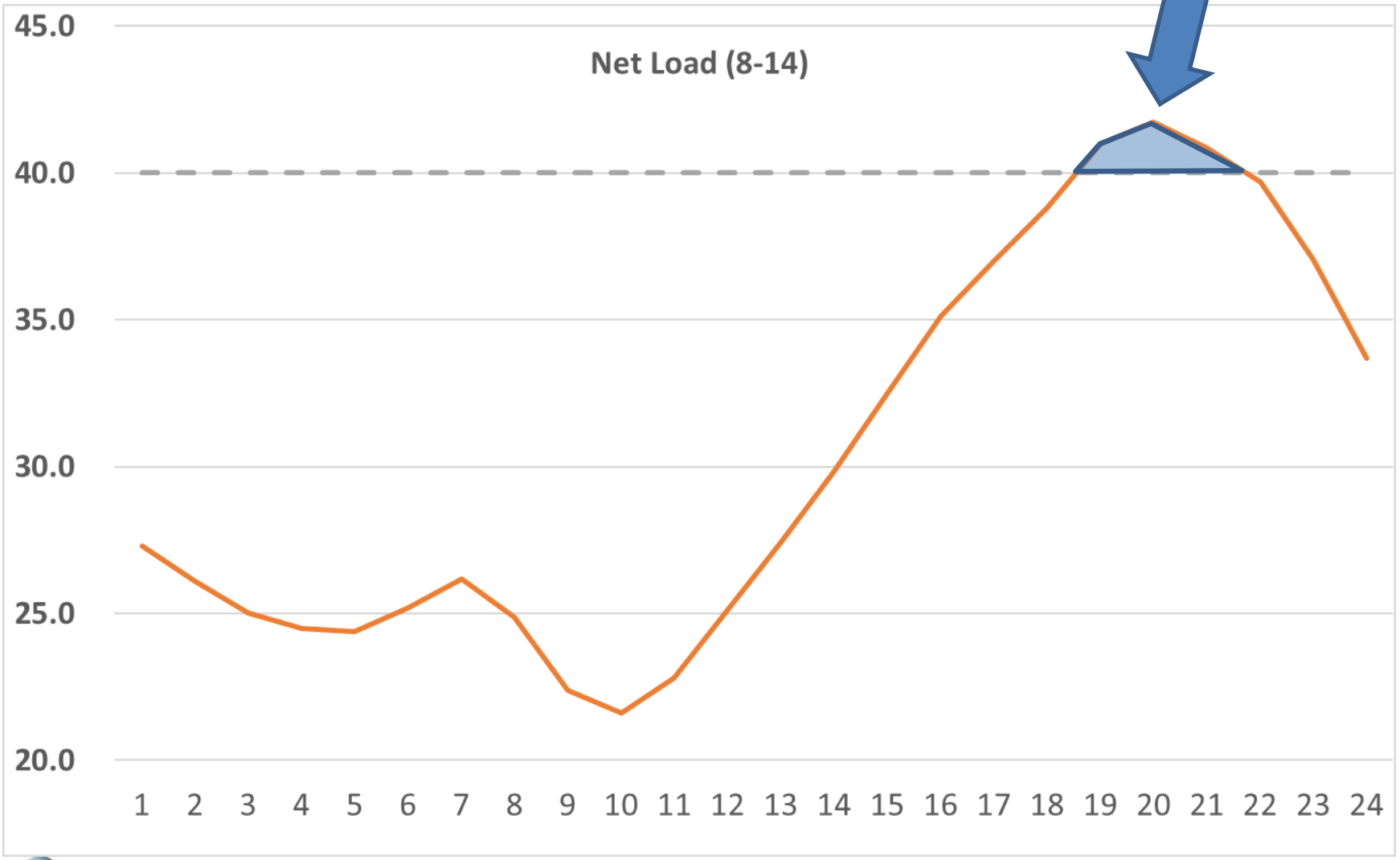
- ➢ Feedback – Net costs and revenues across charge/discharge cycle (8-9 hour period) instead of 24 hour period
- ➢ Feedback – Ensure that bid spread is met for charge and discharge energy

ENSURING STATE OF CHARGE

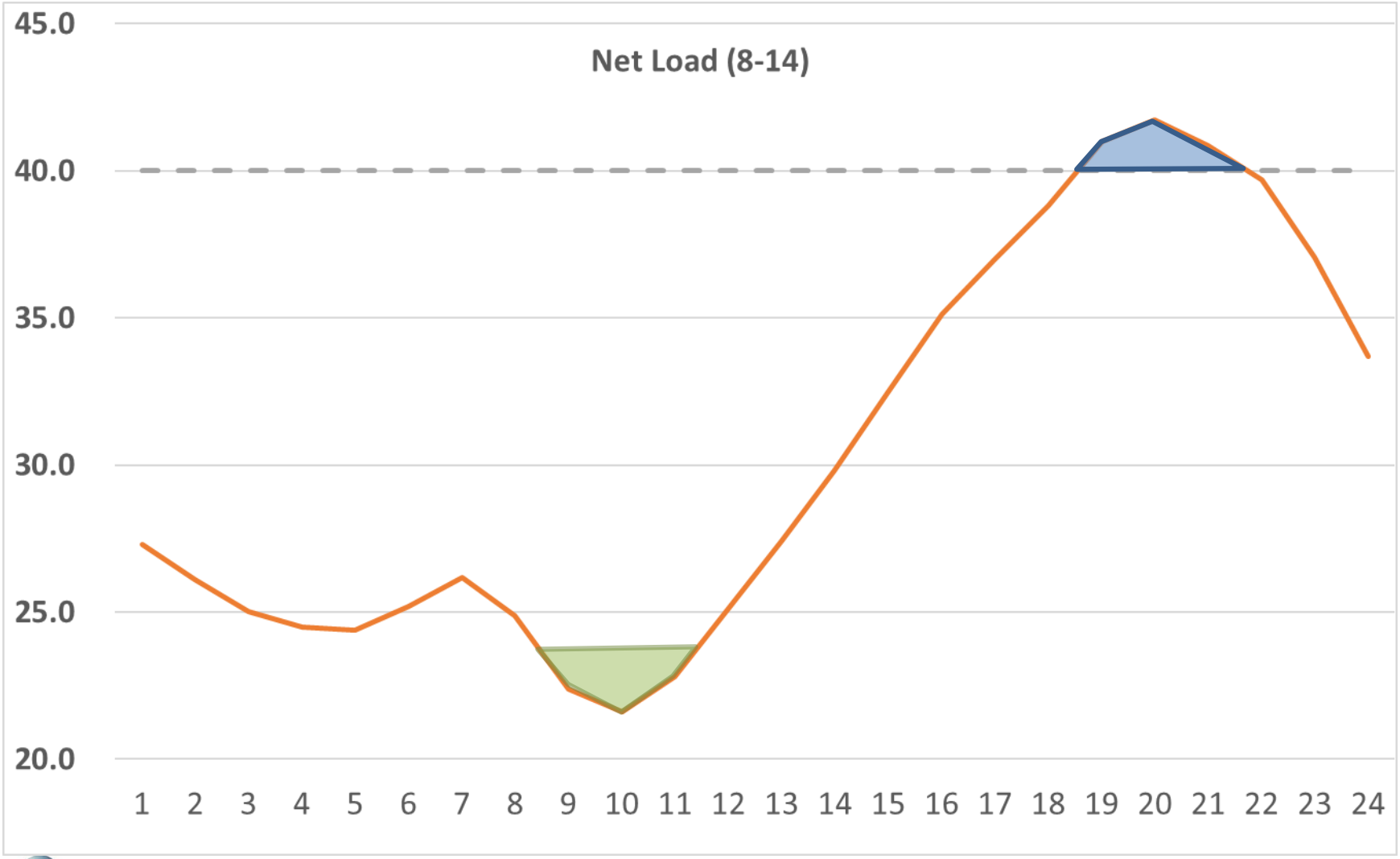
The ISO will rely on storage resources to deliver energy to the market during certain periods

- Forecasts show that the ISO will require energy from storage resources to meet peak loads
  - Last summer all resources were needed to meet load, including storage
  - Periods where storage is critical will become more frequent as storage penetration increases and traditional resources retire
- The day-ahead market optimally charges and discharges storage so that demand is satisfied during all hours
  - On-peak summer day's energy is typically needed in the evening
  - The DA market will charge/discharge storage even if the resources are very expensive
  - The market charges the storage resources at the lowest priced hours of the day
- The real-time market cannot make the same decisions as DA market because of the limited look-ahead horizon

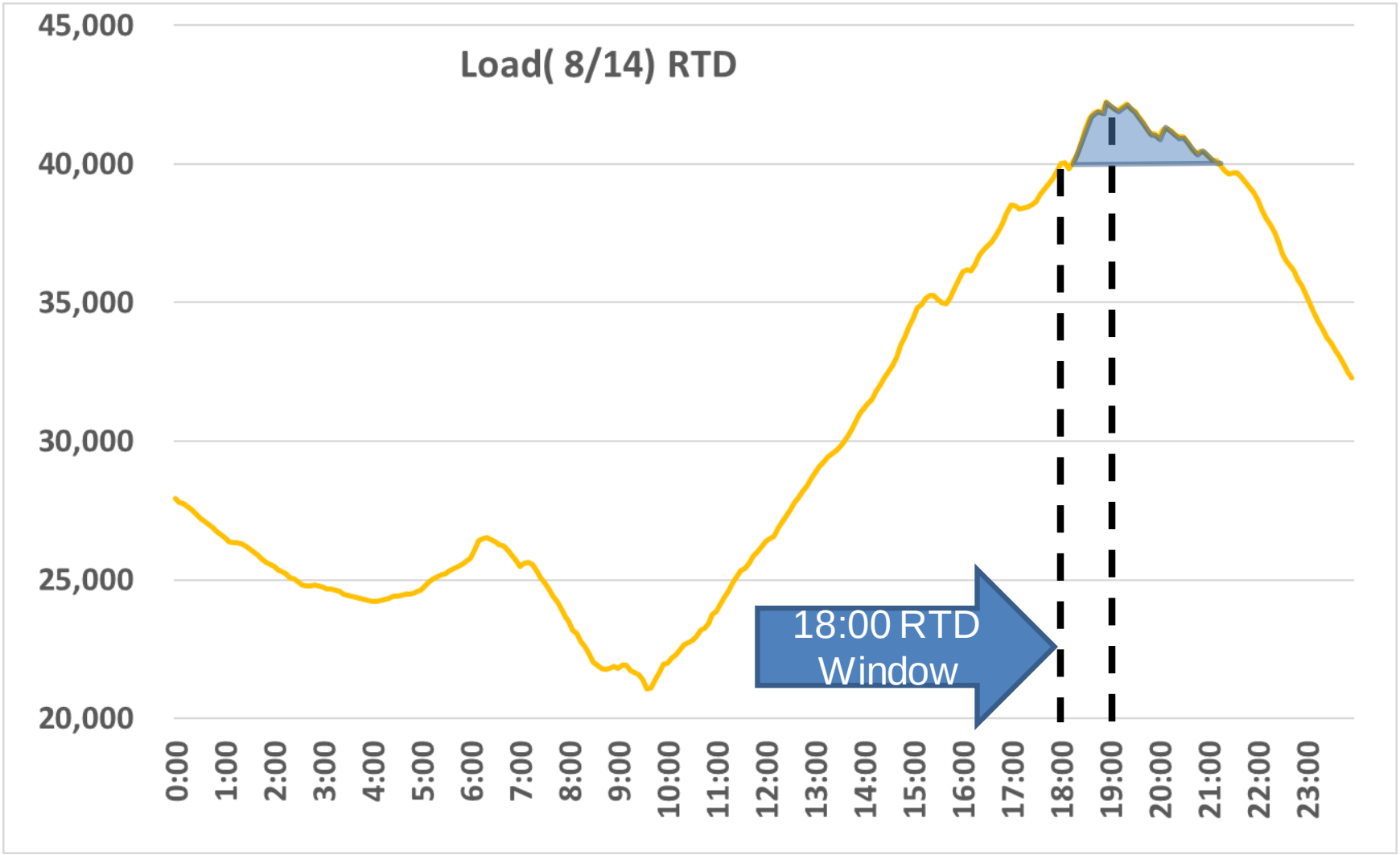
The day-ahead market understands that gas generation cannot meet evening peaks



The day-ahead market schedules the storage resource to charge and discharge efficiently



The real-time market only observes a fraction of the period where storage is critical



Several potential solutions were discussed to this issue

- Expanding the look-ahead for the real-time market
  - This solution is technologically infeasible
- Scarcity pricing
  - Current $2,000/MWh prices may be insufficient to deter all actions that could result in unavailability
- Apply prices to existing minimum sate of charge tool
  - Prices may be difficult to compute, and may require inaccurate ex-post calculations
- Energy shift product
  - Product would specify energy that would be bought (at a certain time) and sold (at a certain time) in a single transaction
  - Day-ahead results may not be updated the real-time market
- Biddable state of charge product

Any solution must address both ISO reliability concerns and storage compensation concerns

- Solution will be enhanced by real-time forecasts
  - Today, the minimum state of charge requirement is enforced day-ahead market results and is not updated in by real-time forecasts
  - As actual conditions change, requirements should be updated

- Any solution should be security constrained and result in reliable outcomes
  - Transmission congestion for storage should be accounted for
  - Solution should address local/zonal needs as well as system needs

VARIABLE CHARGING RATES

Variable Charging Rates

- Charging rates degrade as storage approaches full state of charge
  - Some storage resources are 'oversized' to avoid this problem
  - Current modeling only includes one Pmin (max charge rate)

- Is the current model sufficient?

➢ Feedback – Model storage resources so that Pmin can change based on state of charge

EXCEPTIONAL DISPATCH

Exceptional Dispatch

- Exceptional dispatch is an instruction to a resource to provide a target MW value
  - Compensation is at the higher of bid or market prices
- Operators may want to have a specific amount of state of charge to set up grid for later in the day
  - Charging instructions may have appropriate compensation, but issuing instructions to hold energy receive no (little) compensation

➢ Feedback – Offer an exceptional dispatch for storage to move to a target state of charge (MWh) and include compensation for lost opportunities

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 May 19, 2021, 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