Storage design and modeling Working Group Session 1 Vistra Corp. Storage Scoping

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Vistra's view of urgent Track 1 issues and potential solutions

- Default energy bid (DEB) reform so storage default energy bid reflects accurate real-time opportunity costs of operations.
- Bid Cost Recovery (BCR) reform to replace existing framework with durable framework that aligns with storage's unique characteristics
- Reflecting physical availability:
  - Modeling improvements to reflect physical availability of Pmin, Pmax, Min SOC, or Max SOC availability due to known technical characteristics or approved outages
  - Outage reporting improvements for safety, equipment, electrical, or mechanical failures or imminent failures

Storage DEB reform

Storage DEB not reflecting opportunity costs

- Charging bids mitigated DOWN so may not be able to charge to have sufficient SOC
- Current RT DEB fails to capture real-time opportunity costs and does not:
  - account for change in market conditions in RT market from the DA clearing prices,
  - account for differences expected when real-time footprint expands into WEIM,
  - provide storage owners the ability to effectively manage SOC,
  - allow frequently mitigated resources to recover their costs including risk adders,
  - allow CAISO to utilize storage resources most efficiently, or
  - provide proper price formation to the market.
- Storage not allowed to submit reference level change requests and should be allowed to fully comply with FERC Order 831.

Storage Default Energy Offer (DEB) Proposed Reform

- Storage DEB proposed reform starting point:
  - Storage DEB to align it with an opportunity cost methodology similar to hydro DEB (with storage) by using the short-term opportunity pricing component
- Key principles of DEB reform:
  - Storage must be able to charge where it would be overly punitive to mitigate charging bids down as no other demand bids are mitigated down in CAISO's market
  - Storage must be able to have reasonable assurance that they can reflect discharge bids even when mitigated that allows the storage to preserve SOC needed to meet a reasonable amount of their schedules later in the day
  - Storage must have ability to reflect charge spread between its discharge and charge mitigated bids that is at least components for its registered VOM where the value of moving from charge into discharge should be at least registered VOM.

BCR reform

Holistic BCR Reform

- Key principles of BCR reform should:
  - Leverage hold State of Charge exceptional dispatch formulation
  - Account for "input" and "output" costs being outputs of market optimization itself unless adjusted via outages or bids
  - Result in making storage whole to charge spread for its throughput (cycling) across the day instead of being made whole to specific bids/offers
  - Result in making storage whole when net losses due to market mitigation
- Additional discussions needed on:
  - Integrating biddable State of Charge product into settlements including uplift
  - Whether uplift should be adjusted or if a no-pay/deviation penalty should be assessed when real-time initial SOC is meaningfully different from IFM bid-in initial SOC

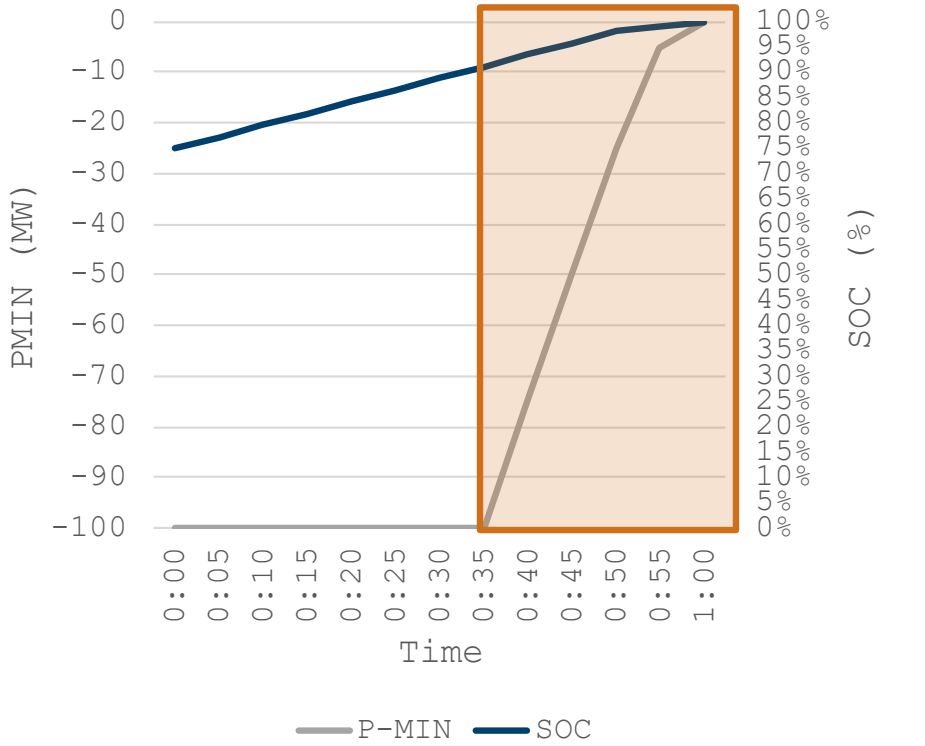
Modeling improvements to better reflect physical availability

Modeling improvements: Market model should capture known technical limitations from foldback impacts

- Reflect foldback impacts to Pmin and Pmax when battery at low or high end of State of Charge capability.
- Durable solution should be resource-specific and apply new Master File registered rates below:
  - **Charge current rate curve** to Pmin as f(SOC)
  - **Discharge current rate curve** to Pmax as f(SOC)
- If durable solution cannot be implemented by 2025, then interim solution for 2025:

Apply single rate of change to all LESR at SOC %

- E.G. Example on right shows no change to Pmin until 90% SOC where it takes 20 minutes to reach 0 MW Pmin as it approaches 100%.
- Single rate of change assumption should be temporary solution until resource-specific can be implemented.
- CAISO should propose rate curve based on historical data in collaboration with stakeholders.



- Illustrative example
- Similar impacts to Pmax occur when nearing 0% SOC
- The amount of reduced Pmax capability is largely inverted to the shape above
- Reduction to Pmin capability is more severe than reduction to Pmax capability
- Recommend dynamic modelling both reductions to improve operations

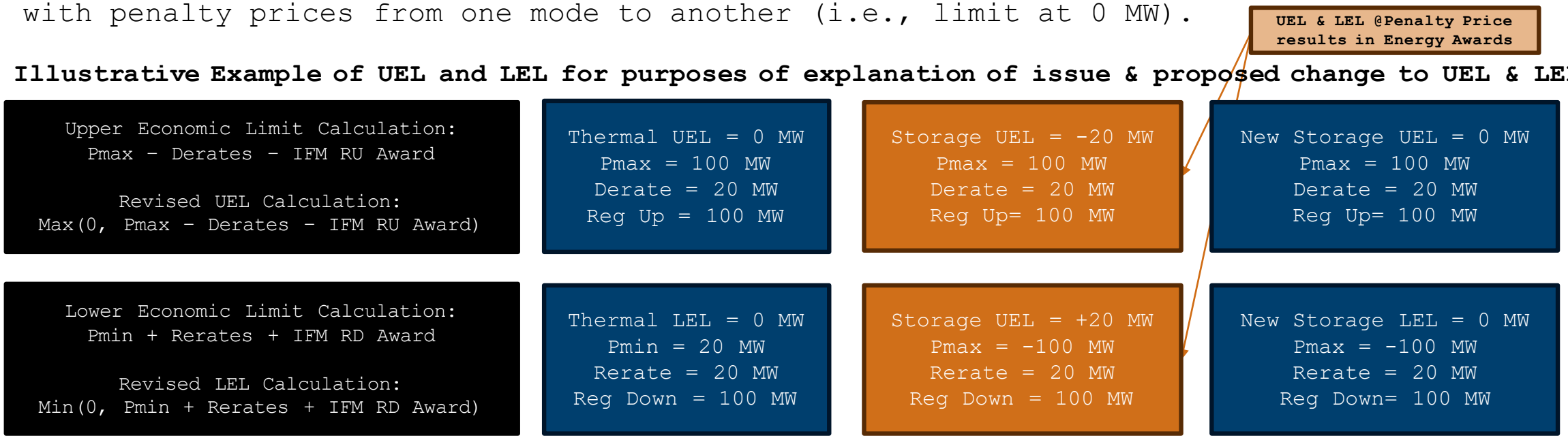
Modeling improvements: Alternative to foldback modeling could be to extend use of dynamic limit tool

- Alternatively, CAISO could consider extending its dynamic limit functionality to all storage whether stand-alone storage, co-located storage, or hybrids to allow fix in 2025.
- CAISO has dynamic limits to mitigate for timing granularity risk between bid submission and dispatch that can be submitted up to 10 minutes prior to RTD run.
- This functionality is not meant to manage equipment or mechanical outages, but could be used to manage availability changes due to foldback.
- Stakeholder discussions needed on:
  - Dynamic limits should ensure impact both energy availability and AS availability.
  - Adequate guidance for the appropriate use of outage cards through the Outage Management System versus the utilization of the Dynamic Limits concept for real-time participation for all types of storage.
  - Other non-outage reasons for adjusting Pmax or Pmin via dynamic limit tool.

Modeling improvements: Upper Economic Limit and Lower Economic Limit when derates or rerates occur solutions

- When outages occur for storage units, Upper Economic Limits and Lower Economic Limits are allowed to cross-over from a discharge to charge mode and vice versa resulting in "forcing" energy awards
- No other asset type is forced into an energy position in the Fifteen Minute Market to be exposed to a new risk that it did not bid due to being on outage.
- Propose changes to limit UEL and LEL calculation from moving the UEL or LEL protected with penalty prices from one mode to another (i.e., limit at 0 MW).

Illustrative Example of UEL and LEL for purposes of explanation of issue & proposed change to UEL & LEL



Modeling improvements: Make available better tools to reflect AS deployment rates to align with the AS bids

- Continued challenges from limited tools for rate of AS deployment making available within the AS bid to ensure sufficient SOC preserved to meet those signals
  - Concerns AGC sending regulation signals at disproportionate rate to storage over non-storage resources with more tools (e.g., OR Ramp Rate, Regulation Ramp Rate)
  - Concerns existing attenuation factors not good estimates of likely deployment rates
- CAISO should explore potential improvements such as:
  - Better mileage design could be enhanced to maintain a certain rate of SOC usage
  - Biddable attenuation factors so that AS provision is better understood
  - Improved AGC logic factoring in telemetered SOC to better manage signal across regulation resources so AGC does not send signals disproportionately to storage as it nears SOC when deployment exceeds expectations

Outage reporting improvements to better reflect physical availability

Outage reporting: Clarify Pmax, Pmin, and Max or Min SOC outages must be reported if exceed relevant thresholds

CAISO Tariff Section 9.3.10.3(a) and 9.3.10.3.1 contains reporting requirement for max MW output of Generating Unit

"Required to notify the CAISO within sixty (60) minutes after discovering any change in the maximum output capability of *at least ten (10) MW* or five percent (5%) of the value registered in the Master File, whichever is greater, from the value registered in the CAISO's outage management system pursuant to Section 9 that lasts for fifteen (15) minutes or longer."

CAISO filed to amend Generating Unit definition in FERC Order 2023 compliance filing on May 16, 2024 under ER24-2042 (pending redlines below)[1]

- Generating Facility Capacity

The net capacity of the Generating Facility ~~and~~ or the aggregate net capacity of the Generating Facility where it includes more than one Generating Unit for the production and/or storage for later injection of electricity.

- Generating Unit

An individual electric generator, or storage for later injection of electricity, and its associated plant and apparatus whose electrical output is capable of being separately identified and metered or a Physical Scheduling Plant that, in either case, is: (a) located within the CAISO Balancing Authority Area (which includes a Pseudo-Tie of a generating unit to the CAISO Balancing Authority Area) or, for purposes of scheduling and operating the Real-Time Market only, an EIM Entity Balancing Authority Area; (b) connected to the CAISO Controlled Grid, either directly or via interconnected

Clarifications on State of Charge thresholds needed

Tariff Section 9.3.10.3(a):

"…Or reducing the maximum output or minimum output by ten (10) MW or more or the maximum continuous energy limit or minimum continuous energy limit by 40 MWh from the value most recently recorded in the CAISO's outage management system pursuant to Section 9"

Tariff Section 9.3.10.3.1:

"Required to notify the CAISO within sixty (60) minutes after discovering any change in the maximum output or minimum output ~~capability~~ of at least ten (10) MW or five percent (5%) of the maximum or minimum output values registered in the Master File, whichever is greater, or the maximum continuous energy limit or minimum continuous energy limit of at least forty (40) MWh or five percent (5%) of the maximum or minimum continuous energy limits registered in the Master File, whichever is greater, from the value registered in the CAISO's outage management system pursuant to Section 9 that lasts for fifteen (15) minutes or longer

1 https://www.caiso.com/documents/may16-2024-compliancefiling-ferc-orderno-2023-er24-2042.pdf

Outage reporting: Add outage types as reasons for applicable Nature of Works especially allowing Technical Limitations not Modeled for Foldback

Outage Type	Description	*Best Nature of Work (NoW) Category*	NOW Definition
Foldback design characteristic	Not equipment or mechanical failure but rate change at outer edges of state of charge range. This should be captured in the market model, but until modeling solution can be implemented need immediate solution to use Technical Limitations not Modeled.	***Technical Limitations not in Market Model*** ***(CAISO action needed to allow this card use. CAISO has not approved this use, so it is being reported as plant trouble)***	Provide notification that resource is unavailable due to technical limitations not captured in the CAISO market model and that result in infeasible dispatches because they are inconsistent with the resource's design capabilities.
Inverter outage	Inverters go out of and back into service at an unknown point in time.	***Plant Trouble***	
Rack outage	Racks (or cells) disconnect from rest of operating bank, which can be caused by racks being out of balance with other racks within bank, where outage needed to restore bank to similar SOC level to allow for them to reconnect to bank and return to operation.	***Plant Trouble***	
Safety management outage	Manage safety at resource or neighboring sites in response to failures or credible risks of imminent failure due to safety concerns.	***Plant Trouble***	Plant equipment fails or is in danger of imminent failure resulting in a curtailment of dispatchable capacity.
Control system failures	Control system failures/disruptions need to be repaired.	***Plant Trouble***	
Electrical component or Transformer failures	Breakers, cables, or transformer failures or imminent failures necessitate outage.	***Plant Trouble***	

Delays to immediate action to allow reporting technical limitations of foldback under this card will prolong data issues with outages that both CAISO and CPUC are hoping to use to begin evaluate forced outage rates, which will delay any feasible UCAP dates beyond 2028.

Outage reporting: OMS limitations should be addressed to improve operator and market visibility into capability

- System must automatically accept updates to existing forced outage card.
- System must allow existing or new overlapping outage cards that can adjust Availability, Load Max, Max Energy and Min Energy values on one card and allow non-NULL values in addition to NULL for other card(s).
- System must allow existing or new overlapping outage cards with adjustments to Availability, where system will allow different values on two or more cards and system will transfer most restrictive (highest curtailment MW or MWh) for each parameter
- System should add single Out-of-Service checkbox for NGRs to allow a single check to reflect full unavailability across Maximum Output to Minimum Output for NGR.
- System should retain outage card values when existing outage card's end date extended.
- System should allow Load Max (Pmin) rerates on the Test Energy card when going through New Resource Implementation process.

Thank you for your time!

For questions or further discussion, please reach out after the holidays:

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