Comments on Storage Design and Modeling
Working Group Presentation on June 30, 2025

Department of Market Monitoring

July 16, 2025

Summary

The Department of Market Monitoring (DMM) appreciates the opportunity to comment on the *Storage Design and Modeling* working group presentation on June 30, 2025.[1] DMM continues to encourage the ISO to address the storage bid cost recovery (BCR) issues as a top priority, particularly real-time BCR resulting from uneconomic buyback of infeasible day-ahead schedules.[2] The battery BCR design changes developed by the ISO in fall 2024 mitigated some gaming opportunities, but do not address the issue of battery operators not being properly incentivized to bid their true real-time intraday opportunity costs.[3]

In these comments, DMM also provides recommendations on these other key issues:

- **Multi-interval optimization**. Before embarking on the development of any changes to uplift related to multi-interval optimization (MIO), DMM recommends the ISO conduct analysis of the losses and benefits that may accrue to storage resources as the result of MIO. DMM acknowledges that there may be instances when a resource incurs losses due to MIO. However, there are also instances when the same resource may earn more through MIO than it would if the optimization only considered the economics of the binding interval. Until both the losses and benefits due to MIO have been quantified in a systematic way, it is unclear that the MIO results in net losses for batteries in a manner that would warrant a new BCR paradigm.

- **Mitigation of hybrid resources.** DMM continues to place high priority on subjecting hybrid resources to local market power mitigation.[4] This first requires developing a default energy bid (DEB) for hybrid resources. DMM is not opposed to using the current storage DEB in the interim for hybrid resources with a storage component. While the current storage DEB will overstate costs of hybrid resources at times, it could be an easily implementable solution that would allow the current

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[1] *Working Group on Uplift & DEB, Mixed-Fuel & Distribution-Level Resources, and SOC Management* presentation, California ISO, June 30, 2025: https://stakeholdercenter.caiso.com/InitiativeDocuments/Presentation-StorageDesignandModeling-Jun30-2025.pdf

[2] *Comments on Storage Design and Modeling May 28, 2025 Presentation,* Department of Market Monitoring, June 11, 2025: https://www.caiso.com/documents/dmm-comments-on-storage-design-and-modeling-may-28-2025-presentation-jun-11-2025.pdf

[3] *Tariff Amendment to Prevent Unwarranted Bid Cost Recovery Payments to Storage Resources, and Request for Effective Date on Shortened Notice*, California ISO, November 26, 2024: https://www.caiso.com/documents/nov-26-2024-tariff-amendment-bid-cost-recovery-to-storage-resources-er25-576.pdf

[4] *Comments on Storage Design and Modeling Working Group Session 2 and 3,* Department of Market Monitoring, March 7, 2025: https://www.caiso.com/documents/dmm-comments-on-storage-design-and-modeling-working-group-sessions-2-and-3-mar-07-2025.pdf

fleet of hybrid resources to quickly become subject to local market power mitigation. Future work on a hybrid DEB would be appropriate to refine the estimate of marginal cost.

- **Hybrid dynamic limits.** DMM supports the ISO providing additional clarity on the appropriate usage of hybrid dynamic limits. DMM reiterates that resources using dynamic limits should be ineligible for real-time bid cost recovery for intervals in which the dynamic limit impacts the resource's dispatch.[5] DMM recommends the ISO clearly establish that hybrid resources are responsible for ensuring deliverability of awarded ancillary services as described in the tariff, and that dynamic limits may not be used to limit deliverability of awarded ancillary services for economic reasons.

- **Distribution-level charging constraints.** DMM supports flagging resources with distribution-level charging constraints in Master File, and clarifying the impact of distribution-level constraints on the ability of these resources to provide resource adequacy and ancillary services. Further, if regular use of outage cards is the preferred way to manage distribution-level constraints, DMM recommends that the ISO create a distribution constraint outage card type for storage resources that is not exempt from the resource adequacy availability incentive mechanism (RAAIM).

Comments

Storage BCR/uplift

DMM continues to encourage the ISO to address storage BCR design as the top priority of this initiative. The current BCR rules remove the exposure to real-time prices for storage resources with day-ahead schedules, which incentivize these resources to submit real-time bids that are inconsistent with their real-time intraday opportunity costs. While the ISO developed a tariff amendment to mitigate some gaming concerns, the underlying incentive issue will continue to result in inefficient dispatch of storage resources in the real-time market.

The policy change developed in fall 2024 lessens the potential benefit of buying back infeasible day-ahead schedules, such that resources may only be indifferent to buying back an infeasible day-ahead schedule. However, even if battery operators are merely indifferent between providing or buying back their day-ahead schedule, there remains no incentive to submit real-time bids that reflect expectations of future real-time prices during hours of day-ahead awards.

This indifference does not incentivize battery operators to develop more sophisticated bidding strategies that reflect how real-time opportunity costs vary within a day, which would lead to real-time schedules that align with real-time price and system conditions. Such bidding strategies would support preservation of day-ahead awards, assuming these hours remain the most valuable hours of the day and real-time system conditions do not suggest batteries should operate differently. DMM recognizes that estimating these costs is challenging. However, this is the most efficient way for the market to schedule batteries, and efficient market design should incentivize bids based on the most accurate possible estimates of marginal (or opportunity) costs.

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[5] *Comments on Storage Design and Modeling Issue Paper and Straw Proposal on Outage Management*, Nonlinearity, and SOC Clarification, Department of Market Monitoring, May 23, 2025: https://www.caiso.com/documents/dmm-comments-on-storage-design-and-modeling-issue-paper-and-straw-proposal-on-outage-management-nonlinearity-and-soc-clarification-may-23-2025.pdf

During the working group meeting, some stakeholders suggested that the elimination of BCR associated with buy-back of infeasible day-ahead schedules would create significant new risk, and questioned whether this risk could be appropriately mitigated by submitting $1,000/MWh bids for all hours of the day. DMM believes such extreme bids would often not be supported by realistic expectations of real-time prices. Therefore, in the majority of hours, this bidding strategy would likely be inconsistent with real-time costs and over-estimate any additional risk.

Further, the availability of additional charging or discharging opportunities over the course of the day will often not support an estimated opportunity cost of $1,000/MWh in all hours. In general, DMM notes that the best practice way for storage resources to participate is to estimate hourly opportunity cost throughout the day and bid accordingly. DMM believes such bidding would be better incentivized by eliminating real-time BCR associated with buy-backs of infeasible day-ahead schedules due to insufficient state-of-charge.

Current BCR rules were designed for conventional generation resources without consideration of energy storage resource characteristics. Therefore, DMM continues to recommend a default starting position of no BCR eligibility for batteries, and then only establishing eligibility for BCR under specific situations where deemed appropriate. While there may be some instances where BCR is appropriate for storage resources, these circumstances should be specifically carved out to avoid over-extending BCR to storage resources and distorting their bidding incentives. DMM believes addressing the distorted real-time bidding incentives due to BCR, and other BCR issues that have already been identified (e.g., day-ahead BCR resulting from unintended interactions between battery bid parameters and the optimization), should be the main focus of the changes to uplift design for storage resources.

Before determining any changes to uplift related to multi-interval optimization (MIO), DMM recommends the ISO conduct analysis of both losses and benefits that may accrue to storage resources as the result of MIO. While MIO may dispatch batteries in ways that may end up being uneconomic in some intervals, MIO is designed to dispatch batteries in ways that provide higher profits and more efficient market outcomes than would be achieved with a model that only considered the economics of the binding interval. DMM believes more thorough research needs to be conducted on the costs and benefits to battery resources being dispatched through a multi-interval optimization before determining whether this is a substantial concern that warrants additional uplift.

Further, DMM notes that there would be a number of potential challenges around designing appropriate uplift related to MIO. For example, while the MIO may drive an uneconomic dispatch, any uplift design needs to also consider and separate the impact of any actions taken by the battery scheduling coordinator that lead to the dispatch. The ISO's energy storage model currently provides battery operators with the ability to set and change a wide range of resource constraints dynamically in real-time, and the ISO is considering adding even more dynamically configurable constraints as part of this initiative.[6] These constraints provide battery operators with a very high degree of control over how

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[6] These constraints include minimum and maximum state-of-charge levels at the end of each hour, as well as minimum and maximum state-of-charge levels for operating day. Others include the initial day-ahead state-of-charge, and SOC and charging limitations imposed through use of outage cards. As part of the current initiative, the ISO is also considering the addition of even more operating constraints that can be dynamically set and changed by battery operators in real-time.

batteries are dispatched in the real-time market, and can also result in significant BCR in ways that can be very difficult to directly identify, especially due to the MIO incorporated in the real-time market software. DMM believes it is reasonable to err on the side of not paying BCR when these constraints are utilized. Any uplift design must be able to identify when use of these constraints impact the dispatch of batteries in real-time, and clearly exclude such instances from BCR eligibility.

Hybrid mitigation and default energy bid (DEB)

DMM continues to place a high priority on subjecting hybrid resources to local market power mitigation. This requires first developing a default energy bid (DEB) for hybrid resources. While DMM recommends developing a DEB specific to hybrid resources, DMM does not oppose using the storage DEB in the interim for hybrid resources that have a storage component. Although likely to overstate hybrid resource costs in some intervals, using the Nth highest priced hour in the day as an estimate for the intraday opportunity cost of the storage component of a hybrid resource with N hours of discharge capability seems a decent interim proxy. However, all limitations of the storage DEB would still apply. DMM continues to recommend improvements to the storage DEB, and similar recommendations would apply to a hybrid DEB. In particular, DMM has long stated that the storage DEB should vary throughout the day to reflect the varying intraday opportunity costs, and this logic should apply to a hybrid DEB as well. [7]

DMM acknowledges that the current storage DEB is an imperfect representation of the opportunity costs for hybrid resources. Hybrid resources operate differently than storage resources, and these characteristics should be reflected in DEB calculations more specific to hybrids. For instance, during the intervals where the storage component is fully charged and the non-storage component is providing the output, the current storage DEB would likely <u>overstate</u> the marginal cost of production—particularly the current storage DEB that is static throughout the day.

DMM supports using the storage DEB in the interim to subject hybrid resources to some degree of mitigation. However, DMM recommends stakeholders discuss potential issues with using the storage DEB for hybrid resources, and consider these issues in the ongoing refinements of a DEB for hybrid resources in the future.

Finally, for completeness in the development of mitigation rules for hybrid resources, DMM notes that the ISO would also need to establish a DEB for hybrid resources that do not contain a storage component. The storage DEB would not be an appropriate proxy in these cases. While DMM is not aware of any such resources currently, nothing precludes their future development, and a DEB would be required should hybrid resources become subject to mitigation.

Hybrid dynamic limit issues

The ISO describes that hybrid dynamic limits are to be used to reflect ambient or renewable generation unavailability, a lack of state-of-charge (SOC), or to manage onsite charging. Stakeholders are requesting further clarification of the use of the dynamic limit as it relates to the tariff, and whether the tool may

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[7] *Comments on Storage Bid Cost Recovery and Default Energy Bids July 8, 2024 Workshop*, Department of Market Monitoring, July 18, 2024: https://www.caiso.com/documents/dmm-comments-on-storage-bcr-and-default-energy-bids-july-8-2024-workshop-jul-18-2024.pdf

be used for more general management of SOC, e.g., to preserve stored energy for future intervals. DMM supports the ISO further clarifying the appropriate use of the dynamic limit, and cautions against too broad of a definition that could lead to increased opacity of the use of the dynamic limits, and further complicate monitoring through added complexity.

DMM recommends the ISO not allow use of dynamic limits for general SOC management (e.g., for economic reasons). All co-located and standalone storage resources must manage SOC through bids, and DMM believes this should be the same for hybrids with a storage component. Like storage resources, hybrid resource operators should be incentivized to bid in a manner that reflects the opportunity cost value of the storage component of the resource that would make the resource indifferent between dispatching at that bid price or holding their SOC to a later period.

DMM understands there is complexity to hybrid resources, such as the resource is comprised of multiple technology types, including storage. DMM further understands that the ISO does not model SOC constraints for hybrid resources as it does for storage resources. The dynamic limit tool is appropriate for reflecting physical limitations deriving from SOC constraints. However, DMM maintains the resource ought to be able to manage economic considerations of the asset through bids.

To manage the multiple hybrid components that constitute a hybrid resource, the ISO allows for incremental bidding up to ten bid segments. Resources can use these multiple bid segments to reflect costs of all components of the hybrid resource.

DMM continues to recommend that resources should be ineligible for real-time bid cost recovery for intervals in which the dynamic limit impacts the resource's dispatch. BCR for day-ahead buybacks due to usage of dynamic limits would be easily gameable and—similar to the storage day-ahead buyback issue—it would distort the bidding incentives of hybrid resource operators, as they would be indifferent between providing or buying back their day-ahead schedules. In general, dynamic limits reflect actions taken or limitations imposed by the resource operator and therefore dispatches driven by dynamic limits should not be eligible for bid cost recovery.

Dynamic limit and ancillary services

As discussed above, DMM believes that hybrid resources should generally manage their SOC through bids, and not dynamic limits. However, ancillary service awards impose additional deliverability requirements on resources such that a minimum or maximum SOC may be required to be maintained through the duration of the ancillary service award. This may not be possible to achieve with real-time economic bids that are required to be submitted 75 minutes before the operating hour, and an SOC that could be constantly impacted within the hour by ancillary services deployment. For standalone storage resources, the ISO observes SOC through telemetry and manages this issue through the ancillary services state-of-charge constraint (ASSOC). However, hybrid resources' SOC is not visible to the ISO for market operation purposes, and these resources do not have SOC managed by the ASSOC. Therefore, hybrid resources may need to manage SOC within the hour of an ancillary services award using dynamic limits to ensure sufficient SOC to meet ancillary service deliverability requirements under the tariff.

DMM recommends that the ISO clarify that dynamic limits may be used by hybrid resources to ensure deliverability of awarded ancillary services as required by the tariff. DMM further recommends the ISO clarify that uneconomic dispatches driven by dynamic limits and the need to manage SOC for ancillary services deliverability purposes would not be eligible for BCR. This would be consistent with BCR rules that do not allow BCR for batteries when the ASSOC is binding.

DMM further recommends the ISO clarify it is not acceptable to use the dynamic limit to restrict the deliverability of ancillary services for economic reasons when it is physically possible for a hybrid resource to deliver their ancillary services schedule.

Distribution-level charging constraints

DMM continues to recommend that the ISO include a flag in Master File to identify distribution-level storage resources. Further, DMM recommends the ISO develop a transparent approach to reflect charging limits imposed on distribution-level resources by distribution system operator (DSO) tariffs. This could potentially be achieved through the use of dynamic limits by distribution-level resources, but only if they are registered in Master File as distribution-level resources, and only if there is sufficient data available for monitoring the use of such limits. [8]

Further, if dynamic limits were to be used for this purpose, the ISO would need to ensure that RAAIM penalties would apply when use of the dynamic limit prevents full deliverability of resource adequacy (RA) capacity, since these limitations would be known when the RA capacity was sold. The interaction of dynamic limits with RAAIM is currently unknown since hybrid resources are not subject to RAAIM. The ISO should further clarify how RAAIM might apply for all types of RA when the ability of an RA resource to charge is impacted. To the extent that limitations in charging capability result in undeliverability of RA, these circumstances should be subject to RAAIM.

The limits on distribution-connected resources may impede a resource's ability to provide their resource adequacy capacity, and their full operating range for ancillary services. The general limitation on resources will be known by the scheduling coordinator ahead of time, and DMM asks the ISO to clarify the rules for distribution-level resources for the sale of RA and the certification to provide ancillary services. DMM recommends the ISO clarify the ability for these resources to provide RA and certify to provide ancillary services under conditions that may limit their ability to provide these services behind the distribution system.

Lastly, the limitations imposed by the distribution system upon distribution-level resources are currently incorporated into the market software through the outage management system (OMS). While the ISO is developing new outages for storage resources, DMM suggests the ISO consider developing an outage type related to distribution-level resources. [9] Since limitations are generally known at the point of interconnection, the ISO should not make the outage type exempt from the RA availability incentive mechanism. Doing so should incentivize these resources to only provide RA capacity that is likely to be deliverable and not impacted by distribution constraints.

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[8] *Comments on Storage Design and Modeling Working Group Session 2 and 3*, Department of Market Monitoring, March 7, 2025: https://www.caiso.com/documents/dmm-comments-on-storage-design-and-modeling-working-group-sessions-2-and-3-mar-07-2025.pdf

[9] *Storage Design and Modeling Issue Paper & Straw Proposal on Outage Management, Nonlinearity, and SOC, California ISO, March 27, 2025:* *https://stakeholdercenter.caiso.com/InitiativeDocuments/2025-03-27-SDM-Outage-Management-Nonlinearity-SOC-Definition-Issue-Paper-Straw-Proposal-FINAL.pdf*