

Comments on Storage Design and Modeling Working Group Session 2 and 3

Department of Market Monitoring

March 7, 2025

Overview

The Department of Market Monitoring (DMM) appreciates the opportunity to comment on the *Storage Design and Modeling Working Group Session 2 and 3* held January 23 and February 20, 2025.^{1,2} In these comments, DMM adds to our previous comments from the ISO's Storage Design and Modeling Working Group 1.³ While DMM supports many items in the proposed scope of this initiative, DMM continues to strongly encourage the ISO to address the storage bid cost recovery (BCR) concerns as the top priority, before undertaking additional storage design enhancements that may considerably slow the pace of development for needed storage bid cost recovery enhancements.

In these comments, DMM addresses the following seven issues raised in the proposed storage design and modeling (SDM) initiative:

- **Storage bid cost recovery (BCR), and co-located resources and settlements enhancements.** DMM recommends the ISO complete a comprehensive review of BCR rules for batteries, and address the previously identified efficiency, gaming, and underlying bidding incentives issues. This should be the top priority in this initiative, and should be completed before undertaking other storage market design enhancements that may be complex and time consuming to develop and implement. DMM also recommends the ISO work to improve the settlement design for co-located resources in a timely manner, but not at the expense of first addressing the BCR design for storage resources.
- **Storage default energy bids (DEB).** Storage DEBs should be allowed to vary by hour, and change to reflect changing intraday opportunity costs. This may result in some hours with higher DEBs, and some hours with lower DEBs than would be produced under the current methodology. Additionally, the ISO should develop DEBs for storage resources in the Western Energy Imbalance Market (WEIM).
- **Hybrid resource DEBs.** Developing DEBs for hybrid resources should be a relatively high priority. Currently, hybrid resources are not subject to local market power mitigation (LMPM). These resources should be subject to LMPM, and the ISO should develop an expedited DEB to reflect the

¹ *Storage Design and Modeling Working Group Session 2*, California ISO, January 23, 2025: <https://stakeholdercenter.caiso.com/InitiativeDocuments/Presentation-Storage-design-and-modeling-Jan-23-2025.pdf>

² *Storage Design and Modeling Working Group Session 3*, California ISO, February 20, 2025: <https://stakeholdercenter.caiso.com/InitiativeDocuments/Presentation-Storage-Design-and-Modeling-Feb-20-2025.pdf>

³ *Comments on Storage Design and Modeling Working Group Session 1*, Department of Market Monitoring, January 8, 2025: <https://www.caiso.com/documents/dmm-comments-on-storage-design-and-modeling-working-group-session-dec-11-2024-jan-8-2025.pdf>

resources' marginal costs. The DEB for hybrid resources can then continue to be enhanced as needed in future initiatives.

- **Improved outage reporting and state-of-charge (SOC) limitations.** DMM supports development of market model improvements that incorporate nonlinearities of storage resource operations. The recommendations include Masterfile parameters that adjust ramp rates when the resource is operating near the minimum and maximum SOC, and allow storage to submit bids based on SOC.
- **Dynamic limits.** DMM does not support extending dynamic limit functionality to storage resources. DMM believes any potential need for dynamic limits for storage resources would be obviated by other enhancements proposed in this initiative. Using dynamic limits in lieu of such enhancements would be an opaque approach to modeling storage resources, and could potentially reduce the reliability of storage resources, and allow for strategic gaming.
- **SOC definition and calculation, and distribution-level storage constraints.** DMM recommends the ISO improve the definition of SOC to clearly reflect energy that a resource has available to the market. DMM also supports allowing distribution-level resources the ability to dynamically reflect their distribution system limits.

Comments

Storage BCR design should be the top priority in this initiative, followed by co-located resources and settlement enhancements

DMM and the Market Surveillance Committee (MSC) have identified efficiency, gaming, and bidding incentive issues with the current BCR design for batteries.^{4,5} While the ISO continues to indicate that the topic of battery BCR is in scope for this initiative, the previous two stakeholder meetings have not proposed BCR improvements, nor reviewed storage BCR issues. Instead, a multitude of additional scope items have been discussed, the introduction of which risks significantly slowing any further progress on the issue of battery BCR. DMM continues to strongly recommend that addressing the core efficiency issues of battery BCR should be a priority ahead of the rest of this initiative. DMM understands there is an interdependency with storage DEBs, and has indicated this is also a high-priority concern, but reiterates this is secondary to storage BCR improvements.⁶

In general, DMM recommends that through the SDM initiative, the ISO clearly identify where storage BCR is warranted, and where it is not, in both the real-time and day-ahead markets. The resulting BCR design should address the core efficiency issues created by the current BCR design.

⁴ *Opinion on Storage Bid Cost Recovery*, James Bushnell, Scott M. Harvey, Benjamin F. Hobbs; Members of the Market Surveillance Committee, November 1, 2024: <https://www.caiso.com/documents/market-surveillance-committee-final-opinion-storage-bid-cost-recovery-nov-01-2024.pdf>

⁵ *Comments of the Department of Market Monitoring of the California Independent System Operator Corporation*, Department of Market Monitoring, ER25-576-000, December 17, 2024: <https://www.caiso.com/documents/dmm-comments-on-er25-576-storage-bcr-dec-17-2024.pdf>

⁶ *Ibid.*

In addition to standalone batteries, co-located resources are becoming increasingly developed in the CAISO system. Due to some recently observed market outcomes involving co-located resources, DMM recommends the ISO work to improve the settlement design for co-located resources with urgency. However, DMM views this as a secondary priority to addressing the primary BCR design for storage resources.

Storage DEBs should vary hourly to incorporate changing intraday opportunity costs, and the ISO should develop a standard storage DEB for WEIM resources

DMM continues to recommend that the ISO improve storage default energy bids (DEBs) to vary across different hours of the day and better reflect real-time opportunity costs.⁷ Specifically, DMM recommends enhancing real-time DEBs to capture intraday opportunity costs associated with potentially higher real-time prices based on changing real-time conditions.

Real-time conditions may differ from day-ahead conditions, leading to price differences across markets. The ISO's real-time market software cannot estimate the opportunity costs of most storage resources with its current optimization horizon. Therefore, intraday opportunity costs estimated using day-ahead prices may be inaccurate, and may lead to inefficient dispatch when mitigation occurs. DMM continues to emphasize the importance of improving the opportunity cost component of the DEB calculation, and recommends estimating this opportunity cost beyond the current real-time optimization horizon, to provide a more realistic estimate of real-time opportunity cost.⁸

During the January 23 meeting discussion of developing a method to calculate real-time intraday opportunity costs, there was concern the estimates would not be of settlement quality, and thus should not be used. Currently, the opportunity cost component of the real-time storage DEB is calculated from day-ahead prices. Using day-ahead prices that are of settlement quality to estimate the real-time DEB only reflects the opportunity cost of a binding financial agreement from the day-ahead, but does not reflect the opportunity cost or value to system reliability needs in the real-time.

Given the significant differences that can materialize between day-ahead and real-time, even an opportunity cost component derived from a model with non-settlement quality real-time data would likely be superior to a static day-ahead price. Modeling opportunity costs in the real-time that reflect robust estimates of real-time intraday opportunity costs will be more precise than day-ahead estimates. This would be beneficial for both market efficiency and reliability.

DMM recommends the ISO work with stakeholders to develop a method to calculate a real-time intraday opportunity cost for storage that could be the foundation for an enhanced real-time storage DEB that varies hourly. Such an approach could result in DEBs that are higher in some hours—but lower in others—than the current storage DEB. This outcome supports more efficient mitigation that better aligns with real-time intraday opportunity costs that vary across the day.

Additionally, DMM notes that the current storage DEB is not available to storage resources in the WEIM. DMM recommends that in the near term, the ISO make the current storage DEB available to all WEIM

⁷ *Comments on Storage Bid Cost Recovery and Default Energy Bids July 8, 2024 Workshop*, Department of Market Monitoring, July 18, 2024: <https://stakeholdercenter.caiso.com/Common/DownloadFile/6a07fe60-f791-489c-8100-64e2f7b55118>

⁸ *Ibid.*

resources. DMM further recommends the ISO extend any enhanced real-time storage DEB developed in this initiative to WEIM storage resources, adapting the model as necessary to meet the specific needs of the WEIM.

The ISO should develop DEBs for hybrid resources, and subject these resources to local market power mitigation

DMM continues to suggest that hybrid resource DEB development should be a high priority for the ISO.⁹ Currently, hybrid resources are not subject to local market power mitigation, and do not have a functional DEB.

DMM recommends an initial approach to calculating a DEB for hybrid resources, using the maximum of the DEBs that apply to each of the generation components that make up the hybrid resource. In cases where the resource is paired with storage, the DEB would often be driven by the opportunity cost of the storage component. The storage component should follow the storage DEB enhancements proposed above, and be limited to the storage resource's stored energy duration. This initial approach should be easy to implement, and should achieve the goal of subjecting hybrid resources to local market power mitigation in the near-term. After a near-term solution for hybrid DEBs is completed, hybrid resource DEBs should continue to be enhanced to more accurately reflect the costs of hybrid resources as a full system, rather than piecewise by generation component.

During the February 20 workshop, it was suggested that a hybrid DEB for a resource with a storage component should vary depending on whether the resource has the ability to grid charge. DMM recognizes this is a worthwhile consideration, but recommends the ISO move forward expeditiously with hybrid DEB development, and return to this consideration in a later enhancements phase. As well, this consideration may need to be extended to co-located storage resources that are using the off-grid charging indicator that prevents the storage resource from grid charging.

DMM supports improved outage reporting and market model improvements for SOC limitations specific to storage resources

DMM continues to support enhancements to storage outage reporting, and the incorporation of nonlinearities of storage operation into the market model.¹⁰ Storage resources face limitations and outage types not currently covered in outage management system (OMS) that are unique to storage resources, such as negative Pmin and energy (SOC) limitations. DMM understands that one common limitation for storage resources are issues of *foldback*, or varying ramp rates at the upper and lower ends of a resource's SOC range.

⁹ *Comments on Storage Design and Modeling Working Group Session 1*, Department of Market Monitoring, January 8, 2025: <https://www.caiso.com/documents/dmm-comments-on-storage-design-and-modeling-working-group-session-dec-11-2024-jan-8-2025.pdf>

¹⁰ *Ibid.*

DMM recommends two non-mutually exclusive paths to address foldback:

1. Include foldback into resource characteristics through Master File as a variable ramp rate that differs at the extremes of SOC.
2. Allowing scheduling coordinators to bid based on their SOC, versus capacity.

With both of these improvements, the ISO could create an outage card option to represent foldback, which would further aid in an accurate representation of a storage resource to the market. Improved outage reporting will assist market operators and monitors in ensuring the system is operating reliably and efficiently. DMM continues to recommend ISO staff work together to coordinate the development of new storage outage types into resource adequacy policy developments.¹¹

Lastly, there was a suggestion that dynamic limits could be used to manage SOC limitations in place of OMS. DMM does not support this use of dynamic limits, as discussed below.

The ISO should not extend the use of dynamic limits to non-hybrid resources

Stakeholders have suggested implementing dynamic limits for all storage resources to allow scheduling coordinators to manage issues such as foldback. DMM has previously recommended against this use of dynamic limits.¹²

The market model does not incorporate all of the information of the individual generation components of a hybrid resource, and as a result, the ISO developed dynamic limits for hybrid resources.¹³ The dynamic limit is intended to allow hybrid resources to capture all constraints and operational objectives (e.g., reflect VER forecasts and manage SOC of storage components), and as a result have a feasible dispatch.

DMM does not recommend the ISO develop dynamic limits for storage resources, as the market model has visibility of storage resource operations that it lacks for hybrids. For example, SOC is modeled and managed in the market for storage resources. The ISO has visibility into a storage resource's SOC, which factors into the resource's market awards and dispatch. DMM understands that stakeholders may wish to use dynamic limits for storage resources to model different limitations, such as foldback or stranded energy. However, DMM believes these limitations would be better captured through other market enhancements proposed in this initiative. Such physical limitations of the resource could be more appropriately captured in Masterfile, and can be reflected in OMS when appropriate.

Furthermore, OMS is used for interdependent resource availability and performance policies, such as resource adequacy availability incentive mechanism (RAAIM) and forthcoming unforced capacity (UCAP). These policies are used to create incentives for resources' operational and planning availability to the market. The dynamic limit does not enter into these incentive calculations, and thus would undermine the incentives for resource availability at potential times of resource scarcity.

¹¹ *Ibid.*

¹² *Ibid.*

¹³ While the market model has no visibility of each generation component in a hybrid, the ISO and DMM have access to the data to monitor dynamic limit use for hybrids.

The use of a dynamic limit for storage resources would create an opaque constraint that offers little information to market operators and monitors, and would be difficult to monitor, allowing for potential physical withholding and gaming between day-ahead and real-time markets.¹⁴ Although the SOC and variable energy resource (VER) forecast components of hybrid resources are not used in market optimization, these data are available for monitoring purposes and provide a degree of insight into the use of dynamic limits for hybrid resources. However, for storage resources, data supporting the reasons dynamic limits may be used would not be available.

As a result of these concerns, DMM recommends the ISO not extend the dynamic limit functionality to storage resources. OMS and Masterfile enhancements provide a much greater degree of visibility for the ISO and DMM. This is important for monitoring purposes and overlapping policies, such as RAAIM and forthcoming UCAP. To address nonlinearities in storage resource operation and fallback, the ISO should extend market functionality as discussed above, and continue to require the use of OMS to manage physical limitations of storage resources, where not otherwise captured in the market model.

Instances of observed lack of availability highlight the need to improve SOC definition, and better reflect distribution-level storage constraints in the market model

DMM has raised concerns to the ISO about the definition and calculation of SOC, and distribution-level storage constraints. The concerns arise from instances of observed lack of availability of storage resources.

The ISO's tariff definition of SOC is not robust. While the definition specifies that SOC should reflect stored energy available to the CAISO markets, it does not provide a definition of availability, e.g., within what timeframe the stored energy must be available.¹⁵ DMM recommends the ISO clarify a definition of SOC availability in the tariff, and consider including a standardized approach to calculating SOC.

Clarifications to the definition and calculation of telemetered SOC need to more accurately reflect the true SOC availability of storage resources to the market, at the time of market dispatch. DMM has identified cases in which the SOC is greater than zero, but the stored energy is unavailable to the market, and as a result the market is solving under inaccurate conditions for these resources. This tariff improvement should be a predicate to a system SOC mechanism discussed in Working Group Session 1.¹⁶

Distribution-level resources that participate in the CAISO market are subject to both the ISO's tariff, and distribution system operator (DSO) tariffs. DSO tariffs can lead to operational limits that the ISO is unaware of, and thus limiting access to the resource. The ISO recently gave distribution-level storage

¹⁴ *Comments on Hybrid Resources Final Proposal*, Department of Market Monitoring, October 30, 2020: <https://www.caiso.com/documents/dmmcomments-hybridresourcesphase2finalproposal-oct302020.pdf>

¹⁵ *CAISO Tariff—Appendix A*, California ISO, February 5, 2025: <https://www.caiso.com/documents/appendix-a-master-definition-supplement-as-of-feb-5-2025.pdf>

¹⁶ *Storage Design and Modeling Working Group Session 1*, CAISO, December 11, 2024: <https://stakeholdercenter.caiso.com/InitiativeDocuments/Presentation-Storage-Design-and-Modeling-Dec-11-2024.pdf>

resources OMS functionality to report DSO limitations, but OMS does not possess near real-time adjustments to a resource that a DSO tariff requires.

DMM recommends the ISO develop a transparent approach to reflect changing limits imposed on distribution-level resources by DSO tariffs. This could potentially be achieved through the use of dynamic limits by distribution-level resources, but only if they are registered in Masterfile as distribution-level resources, and only if there is sufficient data available for monitoring the use of such limits. In the absence of such data, the use of dynamic limits by distribution-level resources would suffer the same opacity as discussed in the sections above, and DMM would not recommend this approach to modeling limits faced by distribution-level resources.