Comments on Energy Storage Enhancements Working Group

Department of Market Monitoring

August 10, 2021

I. Summary

The Department of Market Monitoring (DMM) appreciates the opportunity to comment on the Energy Storage Enhancements Working Group held on July 26, 2021. DMM provides the following comments:

- DMM continues to recommend that the ISO prioritize enhancing processes for issuing exceptional dispatch instructions to battery resources in the near-term. Enhanced processes may have improved some inefficient outcomes associated with manual dispatches that DMM observed last year and already this summer. Since exceptional dispatch functionality will continue to be used by ISO operators, enhancements to these processes for managing storage resources will be important as the storage fleet continues to grow significantly.
- DMM has reviewed several cases where batteries have been operated uneconomically in real-time. Many of these cases involve the market moving battery resources to maintain ancillary service awards in real-time. For example, when battery regulation limits change between the day-ahead and real-time markets, then the real-time market may be forced to move a battery resource to an operating point at which day-ahead ancillary service awards remain feasible. DMM has also observed that more restrictive state of charge constraints enforced in the 5-minute market under certain conditions have sometimes forced the 5-minute market to dispatch resources uneconomically, also causing ancillary service awards to become infeasible in the 5-minute market. DMM continues to suggest that the ISO consider smaller-scale enhancements in the near term that could mitigate these occurrences and help address potential operational issues.
- DMM is concerned that significant deviations between day-ahead and real-time state of charge values can create opportunities for potential gaming of bid cost recovery payments. DMM recommends that the ISO consider ways to better align day-ahead and real-time state of charge levels.
- As the ISO increases its reliance on energy and availability-limited resources, it will become increasingly important to ensure that the ISO has sufficient energy and ramping capacity to meet demand across all hours of the day, particularly across the net peak and through the night. DMM has suggested several enhancements could help address this issue by positioning resources, including storage, to meet ramping and energy needs across the day

and allowing the ISO to reserve and compensate additional ramping capacity and energy.[1] These include (1) an extended real-time market look ahead, and (2) extending the time horizon for which the flexible ramping product procures ramp to address uncertainty. The ISO has indicated that it is not planning on pursuing these enhancements. Therefore, DMM recommends that the ISO at least consider developing more simplified new constraints for reserving both energy and ramping capacity to address uncertainty beyond the real-time look ahead-horizon (e.g, 6 to 8 hours forward). DMM envisions that any type of resource, not just storage resources, could compete to provide these new services.

- DMM suggests that the ISO enhance resource adequacy availability incentives for storage resources by considering storage resources' use of parameters to limit state of charge and charge availability in RAAIM or UCAP calculations

DMM provides additional detail on these issues below.

II. Exceptional dispatch enhancements

DMM has observed that exceptional dispatch (ED) instructions sent to battery resources have sometimes resulted in inefficient outcomes on days where system conditions have been very tight. DMM recommends that the ISO prioritize enhancements to these processes for managing storage resources in the near-term. ISO operators continue to issue exceptional dispatches to batteries, and DMM agrees with other stakeholders that there is significant room to improve these processes.

DMM has observed cases where batteries have been sent ED instructions to charge significantly when resources are already at or near a full state of charge. In some of these cases, resources could not feasibly meet ED instructions to charge. In other cases, these ED instructions caused batteries to discharge uneconomically prior to the ED to charge, in order to reduce the resource's state of charge and create headroom so that the resource could meet the charge instruction. DMM provided a stylized example of exceptional dispatch actions that operators have taken and associated market impacts in comments on the Issue Paper.[2]

Because EDs are often issued as fixed megawatt instructions today, when operators have issued EDs to batteries with existing ancillary service awards, ancillary service awards have become infeasible in real-time. Ancillary services must then be procured from other resources in real-time on short notice when the system may already be very constrained. Exceptional dispatch

[1] See *Enhancing the flexible ramping product to better address net load uncertainty*, Department of Market Monitoring presentation to Western EIM Body of State Regulators, June 12, 2020: http://www.caiso.com/Documents/Presentation-Real-TimeFlexRampProductEnhancements-WesternEIMBodyofStateRegulators-June122020.pdf

[2] *Comments on storage enhancements issue paper*, DMM, May 20, 2021, pp. 2-3: http://www.caiso.com/Documents/DMM-Comments-on-Storage-Enhancements-Issue-Paper-May-20-2021.pdf

instructions that do not consider existing state of charge can also drive inefficient outcomes such as impacting prices in earlier intervals if resources are forced to discharge out of economic merit to meet the ED, and adding charging demand on the system when it is not needed.

DMM believes that processes for issuing EDs to batteries could be significantly improved if EDs were issued as state of charge values instead of megawatt values. First, issuing EDs to batteries as state of charge values could help prevent ED instructions from being infeasible and could mitigate instances of resources being forced to either discharge or charge uneconomically to meet ED instructions. Issuing EDs as state of charge values could also allow batteries more flexibility to maintain existing ancillary service awards and could provide resources more flexibility to capture additional revenue opportunities before the time at which the ISO determines it needs the resource to be at a specific level of charge.

III. Near-term enhancements to address uneconomic dispatch of storage resources in real-time related to ancillary services

DMM has reviewed several cases where batteries have been moved uneconomically in real-time. Many of these cases involve the real-time market moving battery resources to maintain ancillary service awards. DMM continues to suggest that the ISO consider smaller-scale enhancements in the near term that could mitigate many of these occurrences and could help address potential operational issues.

Regulation limits in real-time

DMM has observed that some storage resources often have more limited regulating ranges in real-time than values registered in the ISO master file which are used in the day-ahead market. When battery regulation limits change between the day-ahead and real-time markets, then the real-time market may be forced to move a battery resource to an operating point at which day-ahead ancillary service awards remain feasible. Often, these dispatches are uneconomic. If real-time regulation ranges cannot accommodate the full day-ahead regulation up and down awards, then the real-time market may be forced to find regulation on other resources instead. DMM provided a stylized example of this issue in comments on the Issue Paper.[3]

DMM is concerned that the as the battery fleet continues to grow, these issues may become more prevalent. Forcing charge or discharge on a resource in real-time to maintain ancillary service awards when regulating limits are more restrictive in real-time presents bid cost recovery gaming concerns and potential operational issues when resources must be backed off

[3] *Comments on storage enhancements issue paper*, DMM, May 20, 2021, pp. 5-6: http://www.caiso.com/Documents/DMM-Comments-on-Storage-Enhancements-Issue-Paper-May-20-2021.pdf

of day-ahead ancillary services and the ISO must procure these reserves off other resources in real-time on short notice.

DMM suggests that if storage resource regulating ranges change frequently and if updated values are known in the day-ahead timeframe, then the ISO could allow storage resources to update regulating ranges on a timelier basis and potentially at the hourly level. These updated values could be reflected in the day-ahead market, potentially aligning day-ahead regulating ranges better with real-time values.

5-minute market state of charge constraints

DMM has also observed that more restrictive state of charge constraints enforced in the 5-minute market under certain conditions have sometimes forced the 5-minute market to dispatch resources uneconomically, also causing ancillary service awards to become infeasible in the 5-minute market.

When a battery resource's discharge energy bid range is less than upward ancillary service awards, or when a resource's charge energy bid range is less than downward ancillary service awards, then the following RTD constraints specified in the Market Operations BPM Section 7.8.2.5 are enforced.[4]:

$$SOC_{i,te} \geq \underline{SOC}_{i,te} + \max\left(0, SSEn_{i,te}, \underline{P}_{i,te} + SSRd_{i,te}\right)\frac{RM}{T}$$

$$SOC_{i,te} \leq \overline{SOC}_{i,te} + \eta_i \min\left(0, SSEn_{i,te}, \overline{P}_{i,te} - SSRu_{i,te} - SSSr_{i,te} - SSNr_{i,te}\right)\frac{RM}{T}$$

These constraints result in minimum state of charge and maximum state of charge constraints becoming more limiting than observed in the 15-minute market. While DMM understands that the intent of these constraints are to ensure that a battery has sufficient charge or headroom to charge to ensure that ancillary service awards or self-schedules are feasible for the rest of the hour in RTD, in practice these constraints have appeared to impact battery resource schedules in a way that is counter to their intent. DMM recommends that the ISO consider removing these constraints.

For example, when a lower maximum state of charge is enforced in RTD to ensure that the resource maintains enough state of charge headroom to maintain feasible ancillary service awards or maintain charging self-schedules while operating at a charging state for the rest of the hour, the lower maximum state of charge constraint in RTD could result in the resource approaching its maximum state of charge sooner and more frequently. RTD will try to move the resource to its self-scheduled charging operating points, but the battery approaches the lower maximum state of charge constraint in doing so. The result is that RTD will eventually discharge

[4] Market Operations BPM, Section 7.8.2.5.

the battery (often uneconomically) to create additional charging headroom in order for the resource to be moved back to a charging operating point in future intervals.

Counter to the intent of the constraint, the resource is discharged and backed off its charging operating point more frequently being subject to the lower maximum state of charge, and therefore its ancillary service awards or self-scheduled charging becomes infeasible more frequently. Because ancillary services are not procured in RTD, there is also no capacity procured to replace the reserves which become infeasible in RTD, which could pose potential reliability issues.

IV. Day-ahead and real-time state of charge alignment issues

DMM has concerns that significant deviations between day-ahead and real-time state of charge values can create opportunities for potential gaming of bid cost recovery payments. DMM recommends that the ISO consider mechanisms that could better align day-ahead and real-time state of charge levels, or add additional restrictions on bid cost recovery that could be related to differences between real-time state of charge and day-ahead market initial state of charge. Early in the ESDER stakeholder processes, DMM recommended the ISO consider the implications of a day-ahead submitted state of charge as a new and unique intertemporal constraint between markets.[5] DMM recommended that the ISO revisit this topic in future initiatives to address potential settlement implications. In light of DMM's recent observations and the significant and growing volume of battery resources in the ISO market, DMM recommends that the ISO consider enhancements to mitigate potential gaming opportunities when entities submit initial day-ahead state of charge values that deviate significantly from actual state of charge values in real-time.

In the day-ahead market, battery resources submit an initial state of charge value which the day-ahead interprets as the level of charge that a battery has at the start of a market day. However, in real-time, a battery's actual state of charge may be different from the initial state of charge value submitted in the day-ahead market. DMM has observed that day-ahead initial state of charge and actual state of charge values at the start of a day sometimes diverge significantly for certain battery resources. When these values diverge significantly, the real-time market may schedule a battery much differently than was predicted in the day-ahead market. Battery resources are largely protected from any financial losses resulting from real-time schedules that deviate from day-ahead awards through real-time bid cost recovery, which limits the incentives that suppliers may have to accurately estimate initial state of charge in the day-ahead market.

[5] *Stakeholder Comments: Energy Storage and Distributed Energy Resources (ESDER) – Revised Draft Final Proposal*, DMM, February 2, 2016. http://www.caiso.com/InitiativeDocuments/DMMComments-EnergyStorageDistributedEnergyResources-RevisedDraftFinalProposal.pdf

DMM has observed instances where resources reflect a much higher state of charge in the day-ahead market than what materializes in real-time, which requires resources to be backed down from day-ahead discharge awards. DMM has also observed cases where resources reflect a much lower state of charge in the day-ahead market than what materializes in real-time, which requires resources to be backed down from day-ahead charging awards. In many of these cases, resources receive significant real-time bid cost recovery when they must either buy back day-ahead discharge awards or must sell back day-ahead charge awards.

The ISO also enforces minimum and maximum state of charge constraints on battery resources to ensure that ancillary service awards are feasible. When ancillary services are awarded in the day-ahead market based on much different state of charge assumptions than what actually materializes in real-time, the real-time market may be forced to charge or discharge a battery resource to ensure the ancillary service awards remain feasible. DMM has observed, for example, cases were resources with significant regulation down awards from the day-ahead market reflect a much lower initial state of charge in the day-ahead market than actual state of charge in real-time. Given resources must have charging headroom to maintain regulation down awards, the real-time market is forced to discharge resources uneconomically (sometimes in the middle of the day) to create charging headroom to maintain the regulation down.

DMM recommends that the ISO consider enhancements to mitigate potential gaming opportunities when entities submit initial day-ahead state of charge values that deviate significantly from actual state of charge values in real-time. The ISO could consider, for example, moving batteries to day-ahead initial SOC values in real-time and removing bid cost recovery eligibility for any movement required to get a resource to day-ahead initial state of charge by the start of the day. However, this approach could result in significant movement on battery resources in the last couple hours of the day. The ISO could also consider fully re-optimizing the procurement of ancillary services in real-time. Instead of forcing batteries to operate in a certain way (often uneconomically) in real-time to maintain reserves, the real-time market could determine whether scheduling reserves on a battery would remain optimal given actual state of charge levels. This approach could allow battery resources to operate more flexibly in real-time as state of charge constraints in real-time to maintain day-ahead reserves would be largely removed.

V. Ensuring sufficient energy and ramp across the day

As the ISO increases its reliance on energy and availability-limited resources, it will become increasingly important to ensure that the ISO has sufficient energy and ramping capacity to meet demand across all hours of the day, particularly across the net peak and through the night. DMM has suggested several enhancements could help address this issue by positioning resources, including storage, to meet ramping and energy needs across the day and allowing

the ISO to reserve and compensate additional ramping capacity and energy.[6] These include (1) an extended real-time market look ahead, and (2) extending the time horizon for which the flexible ramping product procures ramp to address uncertainty. The ISO has indicated that it is not planning on pursuing these enhancements. Therefore, DMM recommends that the ISO at least consider developing more simplified new constraints for reserving both energy and ramping capacity to address uncertainty beyond the real-time look ahead-horizon.

To help ensure that storage resources have sufficient state of charge to meet net peak demand, the ISO and PG&E have discussed designs that would compensate storage resources for reserving and holding state of charge to meet ramping and energy needs later in the day. While these types of constraints could help ensure storage resources specifically are available across the net load peak and through the night, other resource types are also capable of providing these energy and ramping services and should be allowed to compete with storage to provide and be compensated for such services.

If in the near term the ISO cannot feasibly extend the real-time market horizon and procure flexible ramping product to address the actual uncertainty in ramping and energy needs several hours out, then DMM suggests that the ISO consider developing new, more simplified constraints for reserving both energy and ramp to address uncertainty beyond the real-time look ahead-horizon. For example the ISO could consider developing constraints to hold ramp and energy on resources for 6 to 8 hours out. DMM envisions that any type of resource (not just storage resources) could compete to provide these new services.

VI. Resource adequacy availability incentives for storage resources

While a longer real-time look ahead horizon or new, long-term energy and ramp products could help position resources to be able to meet demand in peak net load hours, resources should also be adequately incentivized to be available when the ISO will rely on this capacity the most.

DMM suggests that the ISO consider resource adequacy batteries' use of the following parameters in RAAIM or UCAP calculations. The ISO previously considered these types of parameters in its UCAP proposal in the RA Enhancements initiative. DMM has observed that use of some of these parameters have limited resources' ability to reach a state of charge to be able to provide 4-hour RA values across net peak load hours. Today, storage resources can avoid exposure to RAAIM if discharge bids are in place up to resource adequacy values in

[6] See *Enhancing the flexible ramping product to better address net load uncertainty*, Department of Market Monitoring presentation to Western EIM Body of State Regulators, June 12, 2020: http://www.caiso.com/Documents/Presentation-Real-TimeFlexRampProductEnhancements-WesternEIMBodyofStateRegulators-June122020.pdf

RAAIM hours. However, there are other means by which storage resources may limit availability in peak net load hours:

- De-rates to maximum SOC in Masterfile, SIBR, or OMS below a resource's 4 hour resource adequacy value
- De-rates to minimum SOC such that (maximum SOC – minimum SOC) is less than a resource's 4 hour resource adequacy value
- De-rates to Pmin or not offering charging bid range such that resources are unable to charge sufficiently for later hours.
- De-rates to Pmin or limiting charging bid range may require that a resource be economic to charge across a longer period of time in order to reach an SOC needed to provide 4 hours of resource adequacy. This scenario may not be an issue if a resource starts the day with a high level of charge. However, DMM has observed cases where resources start the day with a low state of charge and limit charging bid ranges such that it would take 8 or more hours charging at Pmin for a resource to be fully charged by hour ending 17.