Comments on Energy Storage Enhancements Straw Proposal

Department of Market Monitoring

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Summary

The Department of Market Monitoring (DMM) appreciates the opportunity to comment on the *Energy Storage Enhancements – Straw Proposal*.[1]

DMM supports the ISO's development of an energy storage model that reflects costs of energy storage resources dependent on state of charge. Although this model will make significant improvements in the ability of battery storage resources to accurately reflect costs in the market, the new model also introduces new considerations for monitoring and market power mitigation.

DMM also supports market enhancements that improve the availability of ancillary services awarded to energy storage resources, and the proposed enhancements to allow state of charge exceptional dispatch of energy storage resources. The ISO proposes to compensate resources receiving state of charge exceptional dispatch for opportunity cost of missed market opportunities. While this type of compensation may be appropriate, the ISO's proposed approach should be further developed to consider a wider range of applicable opportunity costs.

DMM supports enhanced tools to manage local area reliability needs. As an additional component of these enhancements, the ISO should consider ways to address the potential for unmitigated local market power that may result during charging of a storage resource needed for local reliability. Such enhancements will become increasingly important as reliance on storage resources within transmission constrained areas increases.

DMM does not oppose the proposed enhancements for co-located resources. However, co-located storage resources that are restricted to charging from the output of a co-located variable energy resources (VERs) are inherently less flexible and potentially less available in peak hours than storage resources that can charge from the grid at any amount. Therefore, it will be important that the CPUC's new slice-of-day resource adequacy framework and the ISO's UCAP policy appropriately differentiate between the capacity contributions of the two types of storage resources.

Finally, DMM notes that the ISO does not address the issue of bid cost recovery (BCR) that can result from differences in state of charge between the day-ahead and real-time markets. DMM

[1] *Energy Storage Enhancements – Straw Proposal*, California ISO, December 9, 2021: http://www.caiso.com/InitiativeDocuments/StrawProposal-EnergyStorageEnhancements.pdf

continues to recommend that the ISO consider mechanisms that could better align day-ahead and real-time state of charge levels, or that the ISO consider other restrictions on bid cost recovery eligibility, to prevent potential BCR gaming opportunities.

Comments

I. Energy Storage Resource Model

DMM supports the ISO's development of an energy storage model that reflects costs of energy storage dependent on state of charge

DMM supports the ISO's development of a new energy storage model that considers variation in cost by state of charge (SOC). It is important that all resources have the ability to accurately reflect costs in the ISO market, and DMM views this model as a significant improvement in the ability of battery storage resources to accurately reflect costs applicable to a particular market interval.

DMM understands that costs for battery storage resources can vary based on state of charge, so that that the cost of producing at a given megawatt output level can vary depending on SOC. This can be true for O&M and cycling costs, as well as for opportunity costs associated with expected market opportunities in future intervals.

Bids for energy storage resources under the existing NGR model may be expected to represent opportunity costs and other operating costs, based on an assumption of the resource's SOC in the operating hour and future operating hours. However, the last opportunity to update a real-time energy bid is T-75 before hour and bids must be held static through the hour, regardless of how the resource is dispatched between time of bid submission and end of hour. Because of these limitations, the actual state of charge on which realized costs depend could end up being significantly different in the dispatch interval from that reflected in the energy bid curve submitted at T-75.

By accepting an energy bid curve that corresponds with a unit's SOC rather than its operating level, the limitations imposed by a static energy bid curve are resolved. Because there is a direct translation between a state of charge bid and a typical energy bid curve for a given period of time, the market optimization can effectively convert costs submitted by SOC to an energy bid curve for use by the market that accurately reflects costs at the time of dispatch.

The ISO also proposes that the new energy storage model allows dynamic minimum output (PMIN), maximum output (PMAX), and ramp rate that vary by SOC, as well as costs and time to transition between charging and discharging. DMM supports these additional features to the extent they are used to allow energy storage resources to better reflect their operational characteristics in the market. However, these types of new features also introduce new considerations for monitoring and market power mitigation, as discussed in the following section.

The proposed energy storage model introduces new considerations for monitoring and market power mitigation

The ISO's proposed new energy storage model offers significant improvement in the ability for energy storage resources to accurately reflect costs in the ISO market. However, the new model also introduces new considerations for monitoring and market power mitigation.

One feature introduced in the new model is the ability to account for time and costs of transitioning between charging and discharging. Because a transition must occur after the resource is charged and before it can discharge, inflated transition costs could potentially be used to exercise market power or withhold energy.

If the ISO allows storage resources to reflect transition costs between charging and discharging, the ISO needs to develop clear guidelines for acceptable values of these costs. The ISO will also need to develop a process to review and confirm the reasonableness of any submitted transition costs.

In addition to developing guidelines for transition costs, the ISO will need to develop local market power mitigation (LMPM) procedures for energy storage bids submitted as state of charge. Default bids for resources using the newly proposed energy storage resource model could be developed and submitted in the same SOC format as market bids. Default SOC bids could consider default values of variable O&M and cycling costs that may vary with SOC.

Default SOC bids could also estimate expected opportunity cost at a given SOC, based on resource characteristics and expectations of future market prices. Conceptually, default SOC bids would translate to a range of typical default energy bid (DEB) curves for a specified period of time that vary depending upon SOC at the beginning of the interval. The default SOC bid approach would enhance the ISO's current energy storage DEB which does not consider state of charge in its reflection of O&M, cycling, or opportunity cost.

Finally, the ISO should consider how bids that vary by interval due to changes in SOC will impact broader LMPM processes. For instance, under current LMPM processes for the RTD market, an energy bid may be mitigated in an advisory interval, with the mitigated bid flowing through to the binding market run. The ISO would need to implement LMPM processes for bids submitted as SOC in a way that ensures that if a resource is mitigated to its default SOC bid in an RTD advisory interval, the binding interval can consider the mitigated SOC bid in the context of the SOC at the start of that interval, rather than the advisory interval, when determining a market clearing solution. This will ensure that the market clearing solution in the binding interval accurately reflects the cost of the mitigated energy storage resource at the SOC in that interval.

The ISO will need to carefully consider this and any other potential implications of the new energy storage model for LMPM.

II. Reliability Enhancements

DMM supports market enhancements that improve the availability of ancillary services awarded to energy storage resources

In earlier comments, DMM discussed some of the issues around availability of ancillary services procured from energy storage resources.[2] The ISO also notes in the straw proposal that a number of issues have been identified around the ability of storage resources to provide ancillary services to the market, and the feasibility of those awards between day-ahead and real-time. To address some of these issues, the ISO proposes to require all ancillary service awards for storage resources to be accompanied by bids for energy.

DMM supports the ISO's proposal to require energy bids for the full range of ancillary service awards. As the ISO notes, this requirement will ensure that resources with ancillary service awards can be charged or discharged by the market in order to ensure continued availability of the ancillary services capacity throughout the day.

While DMM supports the ISO's proposal, DMM suggests that the ISO could further enhance ancillary services functionality for energy storage resources by better aligning regulating limits used for these resources in the day-ahead and real-time markets. DMM has observed that some storage resources frequently 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, the real-time market may be forced – potentially uneconomically – to move a battery resource to an operating point at which day-ahead ancillary service awards remain feasible. If real-time regulation ranges cannot accommodate the full day-ahead regulation up and down awards, the real-time market may be forced to find regulation on other resources instead.

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.

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

[2] *Comments on Energy Storage Enhancements Working Group*, Department of Market Monitoring, August 10, 2021: http://www.caiso.com/Documents/DMM-Comments-on-Energy-Storage-Enhancements-Working-Group-Aug-10-2021.pdf

DMM supports enhancements to exceptional dispatch procedures for energy storage resources

The ISO proposes to expand exceptional dispatch (ED) functionality for energy storage resources. The proposed new functionality would allow ISO operators to issue exceptional dispatches (EDs) for energy storage resources on the basis of state of charge rather than megawatt instructions. DMM supports these proposed enhancements.

DMM has observed cases where batteries received ED instructions to charge significantly when the resources were 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 to create headroom so that the resource could meet the charge instruction.

DMM has also observed cases where EDs issued as fixed megawatt instructions have caused ancillary service awards to become infeasible in real-time. In these cases, 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 instructions that do not consider existing state of charge can also drive inefficient outcomes. For example, such EDs can impact prices in earlier intervals if resources are forced to discharge out of economic merit to meet the ED, or may add charging demand on the system when it is not needed.

Based on these observations, DMM believes that the proposal to allow ED instructions as state of charge values for batteries will be a significant improvement to existing processes. 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.

Compensating storage resources for opportunity cost when exceptionally dispatched to hold state of charge may be appropriate, but the proposed approach needs further enhancement to accurately represent opportunity costs

The ISO proposes to compensate energy storage resources for opportunity cost of missed market opportunities when exceptionally dispatched to hold state of charge. The concept of compensating this type of opportunity cost may be appropriate. However, the ISO's proposed approach may only be appropriate in limited circumstances, which may not be those most likely for a storage resource to receive an exceptional dispatch to hold state of charge. Further, the ISO's proposed approach does not appear to consider bids at the time of exceptional dispatch.

In general, in a given interval, an energy storage resource has three potential actions: charge, discharge, or do nothing (hold current SOC). The optimal action for the interval depends on current SOC and expectations of market conditions in upcoming intervals.

The ISO's proposal appears to assume that if prices in a future interval are lower, and discharge occurs in that interval following an exceptional dispatch to hold SOC, then it would have been optimal for the resource to discharge at a higher price during the interval(s) the resource was exceptionally dispatched. This may not necessarily be the case, as the ISO's proposal does not appear to consider the resource's bids for the hours of the exceptional dispatch.

If bids to discharge at the time of exceptional dispatch were not economic at prevailing prices, there is no opportunity cost of missed discharge opportunities during the exceptional dispatch. This holds even if prices during the exceptional dispatch period were higher than the "reference interval price" where the resource ultimately discharges.[3] Although the resource may have found it optimal after the fact to discharge during the time of the exceptional dispatch, there is no opportunity cost because market dispatch would not have occurred based on the bids in the market at the time of the exceptional dispatch.

For energy storage resources, actions in one interval can impact the ability to perform profit maximizing actions in future intervals. For example, it may be optimal for a storage resource to charge in one interval in order to be able to discharge in a future interval. If a resource is physically positioned to charge, but otherwise prevented from doing so because of an exceptional dispatch to maintain a certain SOC (e.g., an exceptional dispatch to hold 0 MWh SOC), the resource may have opportunity cost resulting from the inability to discharge in a future interval because it was unable to charge during the period of exceptional dispatch. The ISO's proposed approach to opportunity cost compensation would be enhanced by considering opportunity costs that may result when an exceptional dispatch changes the positioning of the resource in a manner that impacts the ability to profit in a future interval.

[3] The ISO defines the "reference interval price" as the price at which an exceptionally dispatched energy storage resource ultimately discharges following the period of exceptional dispatch. See Straw Proposal, pgs. 12-13: http://www.caiso.com/InitiativeDocuments/StrawProposal-EnergyStorageEnhancements.pdf

The ISO's proposed approach to opportunity cost compensation may be further enhanced by considering that a resource may have both charging and discharging opportunities within the period of the exceptional dispatch. Consider an exceptional dispatch period where a storage resource is positioned to discharge and would find it profitable to do so, and then also has a profitable opportunity to recharge also within the timeframe of the exceptional dispatch that would allow it to discharge again in the period of the reference interval. In this scenario, determining the opportunity cost may not be as straightforward as evaluating the LMPs between the time of exceptional dispatch and reference price interval discharge. Discharge in the reference price interval may have already been expected, in addition to discharge during the exceptional dispatch period. In this scenario opportunity cost would result from the foregone profit of the additional discharge and recharge opportunity within the time of the exceptional dispatch.

The ISO's current proposal to compensate opportunity costs associated with state of charge exceptional dispatch appears most likely to represent opportunity cost for a peak hour discharge, where prices are expected to decline over rest of day. However, these are likely the very hours for which SOC is being held and would be released to meet system needs. The exceptional dispatch to hold SOC is more likely to occur in the hours leading up to peak load hours, rather than during those hours.

The ISO's proposal would be improved by more accurately considering the types of opportunity costs most likely to be incurred at times when energy storage resources are most likely to receive an exceptional dispatch to maintain a specific SOC. At a minimum, the ISO should consider resource bids at the time of exceptional dispatch when making any determination of opportunity cost from missed market opportunities.

DMM supports enhanced tools to manage local area reliability needs and new forms of local market power

The ISO uses "second tier constraints," such as minimum online constraints (MOCs), to meet local reliability needs through day-ahead market processes. These constraints ensure commitment of resources for local needs, but are not priced in the market, and do not create energy schedules.

As the ISO notes, energy storage resources are always committed and therefore meet the criteria to satisfy second tier constraints. However, unlike traditional resources, storage resources cannot generate when needed unless they are charged.

The ISO proposes enhancements to the logic for second tier constraints to automatically secure state of charge (SOC) through day-ahead processes for energy storage resources needed for local reliability needs. As reliance on storage resources continues to grow, DMM supports these enhancements to ensure storage resources have sufficient SOC when needed to meet local reliability needs.

While DMM supports the proposed enhancement, the ISO would need to consider local market power implications of creating charging schedules for storage resources that are part of an MOC or are otherwise needed for local reliability.

For the case of a traditional generator that is part of an MOC, market power concerns are somewhat mitigated by caps on commitment costs. However, energy storage resources do not have traditional commitment costs. When energy storage resources are required to charge to meet the need of an MOC or otherwise provide local capacity, energy bids to charge effectively become the cost of providing that commitment.

Storage resources that are required to charge to meet an MOC or other local reliability need could potentially exercise local market power by submitting very low charging bids. Although existing market power mitigation measures do not allow for mitigation that would raise bids to a level higher than those submitted, the ISO should consider ways in which energy storage charging bids may be mitigated up to ensure competitive market outcomes when charging is required to meet local reliability needs.

III. Co-located Enhancements

Tax issues and enhanced co-located resource functionality

The ISO proposes enhancements that could limit the dispatch charging instructions of co-located storage resources to the VER forecast, and allow deviation of the storage resource when the VER is unable to produce the forecasted amount. The ISO proposes these changes to address stakeholder concerns that some co-located storage resources are limited in their ability to charge from the ISO grid in order to maintain preferential tax treatment. The ISO also states that a storage resource without sufficient SOC to discharge because the onsite VER was unable to produce enough to charge the storage resource should submit an outage card, which would be subject to RAAIM.

The investment tax credit (ITC) and property tax issues seem significant enough to discourage participation, and could even discourage investment in new storage resources, if the ISO does not acknowledge them as costs or constraints in its dispatch instructions. The straw proposal portrays the impact of charging from the grid on reducing the ITC as something that the co-located resource operator could incorporate into its SOC bids as an averaged incremental cost. The ISO may also be able to estimate the average cost of charging from the grid on a resource's ITC and incorporate it into default SOC bids. DMM continues to recommend that the ISO and stakeholders continue to develop a reasonable model for incorporating ITC reductions into bids. This could be significantly more efficient than most co-located resources resorting to constraining themselves to never charge from the grid.

If the ISO allows co-located resources to constrain themselves to never charge from the grid, it will be important that the CPUC's new slice-of-day resource adequacy framework and the ISO's UCAP policy appropriately differentiate between the capacity contributions of the two types of storage resources. Storage resources that can never charge from the grid will be less flexible

and less able to supply capacity at all critical hours than storage resources that can charge from the grid. Therefore, co-located resources that are constrained to not charge from the grid should receive a lower capacity payment than storage resources that can charge from the grid. If the slice-of-day framework being developed at the CPUC and the ISO's UCAP framework can appropriately discount the capacity values of co-located storage resources that will not charge from the grid, these resources will then be able to weigh the costs and benefits of choosing to limit their ability to charge from the grid.

Pseudo-tie resources functionality

The ISO proposes to relax the existing requirement that pseudo-tied co-located resources show firm transmission for the full generating capability of the resources from the generator interconnection to the ISO delivery point. The ISO then proposes to use the aggregate capability constraint (ACC) to ensure that the aggregate market dispatch of the pseudo-tied co-located resources does not exceed the interconnection limits and firm transmission associated with the project. DMM does not oppose this change, which appears to better align firm transmission requirements for co-located resources with generator interconnection limits.

IV. Additional changes

DMM continues to recommend that the ISO consider mechanisms that could better align day-ahead and real-time state of charge levels to prevent potential BCR gaming opportunities

In earlier comments, DMM expressed concern that significant deviations between day-ahead and real-time state of charge values can create opportunities for potential gaming of bid cost recovery payments.[4] The ISO does not address this issue in the straw proposal.

DMM continues to recommend 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.

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[4] *Comments on Energy Storage Enhancements Working Group*, Department of Market Monitoring, August 10, 2021: http://www.caiso.com/Documents/DMM-Comments-on-Energy-Storage-Enhancements-Working-Group-Aug-10-2021.pdf

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

In light of DMM's recent observations of bid cost recovery patterns for select energy storage resources, 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.