

Comments on Energy Storage Enhancements Revised Straw Proposal

Department of Market Monitoring

April 7, 2022

Summary

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

DMM supports the CAISO's development of an energy storage model that reflects costs of energy storage resources dependent on state of charge. DMM also supports the application of local market power mitigation to resources using the energy storage resource model. However, extension of current energy storage default energy bids to the energy storage resource model may have mixed implications for accuracy of marginal cost estimates. The new model also introduces additional 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 CAISO proposes that resources receiving an exceptional dispatch for state of charge be compensated for the opportunity cost of missed market opportunities. While this type of compensation may be appropriate, the CAISO's proposed approach should be further developed to consider resource energy bids in counterfactual analysis in order to avoid overestimating applicable opportunity costs.

DMM supports enhanced tools to manage local area reliability needs. As an additional component of these enhancements, the CAISO 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, DMM believes it would be far more efficient to reflect tax implication of grid charging in energy bids rather than by limiting the ability charge from the grid. Further, co-located storage resources that are restricted to charging from the output of 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 CAISO's UCAP policy appropriately differentiate between the capacity contributions of the two types of storage resources.

¹ *Energy Storage Enhancements – Revised Straw Proposal*, California ISO, March 21, 2022:
<https://www.caiso.com/InitiativeDocuments/RevisedStrawProposal-EnergyStorageEnhancements.docx>

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

Comments

I. Energy Storage Resource Model

DMM continues to support the CAISO's development of an energy storage model that reflects costs of energy storage dependent on state of charge

DMM continues to support the CAISO's development of a new energy storage model that considers variation in cost by state of charge (SOC). 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 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 minutes 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.

DMM supports additional features that would better reflect physical characteristics of storage resources

The CAISO further proposes that the new energy storage model allow time to transition between charging and discharging, while also mentioning the issue of variable charging and discharging rates that could necessitate the use of a dynamic minimum output (P_{MIN}) and maximum output (P_{MAX}). While it is unclear from the revised straw proposal if the CAISO is

actually proposing to include dynamic PMIN and PMAX as a feature of the new energy storage model, DMM supports each of these additional features to the extent they allow energy storage resources to better reflect their operational characteristics in the market. If the CAISO also allows storage resources to reflect transition costs between charging and discharging, the CAISO needs to develop clear guidelines for acceptable values of these costs. The CAISO will also need to develop a process to review and confirm the reasonableness of any submitted transition costs.

DMM requests CAISO define its proposal for how the optimization will use state of charge bid curves to determine optimal dispatch and locational marginal prices

In the revised straw proposal, CAISO discusses a scenario where the dispatch to discharge an energy storage resource using the newly proposed model crosses two segments of the state-of-charge bid curve.² In this example, the CAISO presents a calculation which concludes that the LMP which could lead to such a dispatch would be a state-of-charge weighted average of the applicable SOC bid curve segments, rather than the marginal cost at the SOC required to produce the dispatch in the example.

The SOC bid curves described in the revised straw proposal for resources electing the new energy storage model translate directly to power output (megawatt) bid curves for a given period of time. As such, it is unclear why resources using this model would be dispatched or contribute to price formation differently than other resources using traditional bid curves.

DMM requests the CAISO review whether or not the example on page 12 of the revised straw proposal accurately reflects how the CAISO plans to use SOC bid curves to determine optimal dispatch and locational marginal prices. If it does, DMM recommends that CAISO revise the approach to use marginal cost dispatch and pricing processes analogous to other resources.

The details of how the optimization will use state of charge bid curves to determine optimal dispatch and locational marginal prices are a critical aspect of energy storage market design. The example in the revised straw proposal indicates that the CAISO may be planning to use average costs of resources using the energy storage resource model to determine dispatch and prices. This would lead to prices that are incompatible with the proper incentive for storage resources, and more traditional resources, to follow CAISO's dispatch.

DMM requests that in the next proposal CAISO define the changes to the day-ahead and real-time market objective functions, decision variables, and constraints that it proposes for incorporating SOC bid curves. DMM also requests that CAISO illustrate how it proposes to incorporate these changes into locational marginal pricing so that market prices will continue to be incentive compatible with market awards.

² Revised Straw Proposal, pg. 12

II. Market Power Mitigation

DMM supports the application of local market power mitigation to the energy storage resource model, but use of current default energy bids may have mixed implications for accuracy of marginal cost estimates.

DMM supports the application of local market power mitigation to resources using the energy storage resources model. In addition to potential issues with the existing energy storage default energy bid (DEB) discussed in earlier DMM comments, the extension of the existing storage DEB to the energy storage resource model as proposed may have mixed implications on the ability for the storage DEB to accurately reflect marginal costs.

The revised straw proposal appears to make no changes to the existing energy storage DEB when applied to the day-ahead market. Opportunity costs will vary based on state of charge. However, because the day-ahead market optimization considers a full 24 hour time frame, the existing energy storage DEB for the day-ahead market does not consider opportunity cost associated with charging and discharging opportunities later in the operating day. Therefore, the energy storage resource model using bids based on state of charge would also not be expected to reflect opportunity cost within the operating day of the day-ahead market.

DMM understands that some operating and maintenance or cycling costs may be higher at extreme states of charge (e.g., a fully depleted battery with 0 MWh SOC). Therefore, one potential enhancement may be to allow a DEB that better reflects this cost dependent on SOC. However, DMM notes that the existing storage DEB already incorporates a very conservative static estimate of cycling costs, reflecting a high cost as would be incurred from multiple cycles per day. This existing estimate is less precise, but will likely cover – and possibly even overestimate – any additional cycling costs from operating at extreme states of charge.

In earlier comments, DMM has noted that opportunity costs for energy storage resources are dynamic and subject to change over the course of a day.³ However, the existing energy storage DEB is a static value for all hours of the day. Therefore, because the proposed approach will increase the real-time storage DEB to reflect higher opportunity cost as the SOC falls, adapting the current energy storage DEB methodology to the energy storage resource model as proposed may improve accuracy of the real-time DEB when the storage resource has no opportunity to recharge before reaching the highest priced discharge intervals.

For intervals where an energy storage resource has sufficient opportunity to recharge before reaching the highest prices of the day, at lower states of charge, the proposed sloped DEB approach could exacerbate what may already be an overestimate of opportunity cost.

³ Pg. 4-5 of *Comments on Energy Storage and Distributed Energy Resources – Storage Default Energy Bid – Draft Final Proposal*, Department of Market Monitoring, October 9, 2020: <http://www.caiso.com/Documents/DMMComments-ESDER4StorageDefaultEnergyBidDraftFinalProposal-Oct92020.pdf>

DMM understands that the current energy storage DEB will form the lower bound of the real-time DEB curve based on state of charge under the energy storage resource model. The current storage DEB approach assumes the resource could discharge for the number of hours per day specified in the CAISO Master File, and has no ability to recharge before reaching the highest priced intervals of the day.

As DMM understands, applying the slope adjustment described in the revised straw proposal will adjust the real-time storage DEB to result in higher values at lower states of charge. At very low state of charge, this could lead to a DEB reflecting an opportunity cost of the highest priced hours of the day. When this occurs earlier in the operating day when ample recharging opportunities remain before reaching the highest priced hours, this may significantly overstate the actual opportunity cost at that time.

CAISO should extend market power mitigation to the charging range of resources using the energy storage resource model

The revised straw proposal does not address the potential for mitigation on the charging bid range of resources using the energy storage resource model. DMM notes that forgoing mitigation on the charging bid range of an energy storage resource using the proposed model is inconsistent with the treatment of storage resources using the NGR model, and may allow additional exercise of local market power.

Energy storage resources are modeled as generators with a negative operating range. Mitigating the negative operating range would still result in decreased bids, and would be done to prevent uneconomic charging of the resource which may be done to raise prices in constrained areas with local market power. The intent of such mitigation would not be to raise bids in order to cause charging: this would be a new type of mitigation that does not currently exist and is not contemplated here.

Charging of storage resources is done at times which optimize the operation of the resource over a period of time. Therefore, forgoing charging at a time when it may be optimal to charge has a direct associated opportunity cost that should be reflected in the charging bid. A resource with local market power that is also positioned to benefit from elevated prices may exercise market power by submitting charging bids that significantly exceed the opportunity cost of forgoing charging at a given time, leading to uneconomic charging awards. Such market power would be mitigated by extending local market power mitigation to the charging range of storage resources using the energy storage resource model, as is done for storage resources using the NGR model today.

Application of mitigation to the full operating range of an energy storage resource may also be appropriate to ensure that the monotonic non-decreasing nature of energy bid curves is preserved such that mitigation on the discharge range cannot result in lower bids than those on the charging range.

CAISO should consider how bids that vary by interval due to changes in SOC will impact broader LMPM processes

Under current local market power mitigation (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 CAISO 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 CAISO will need to carefully consider this and any other potential implications of the new energy storage model for LMPM.

III. 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.⁴ The CAISO 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 CAISO proposes to require all ancillary service awards for storage resources to be accompanied by bids for energy.

DMM supports the CAISO's proposal to require energy bids for the full range of ancillary service awards. As the CAISO 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 CAISO's proposal, DMM suggests that the CAISO 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 the values registered in the CAISO 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

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>

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 CAISO 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 CAISO must procure these reserves off other resources in real-time on short notice.

DMM supports enhancements to exceptional dispatch procedures for energy storage resources

The CAISO proposes to expand exceptional dispatch (ED) functionality for energy storage resources. The proposed new functionality would allow CAISO operators to issue exceptional dispatches (EDs) for energy storage resources on the basis of state of charge rather than megawatt instructions. DMM continues to support 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 CAISO 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 CAISO needs to consider resource energy bids in the proposed counterfactual analysis to avoid overestimation of opportunity costs

The CAISO 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, and the CAISO's approach presented in the revised straw proposal appears to be an improvement over that presented in the earlier straw proposal. However, additional enhancements are needed to ensure that opportunity costs of holding state of charge are not significantly overestimated.

As DMM understands, the CAISO is proposing to optimize the charge and discharge of a storage resource exceptionally dispatched to hold state of charge over the period of the exceptional dispatch, plus a window of time following the exceptional dispatch. The proposed approach will use realized prices to produce two counterfactual examples with and without the exceptional dispatch. The CAISO then proposes to compensate the exceptionally dispatched resource for any profit foregone as a result of the exceptional dispatch, as indicated by the difference in counterfactuals.

CAISO is not proposing to consider energy bids of the exceptionally dispatched resource as part of the counterfactual analysis. The energy bids of the resource in the context of market prices are the basis of any valid counterfactual analysis. Failure to consider the bids of the resource for which the counterfactual analysis is conducted may significantly overestimate calculated opportunity cost of the exceptional dispatch when the counterfactual optimal dispatch is not supported by the bids.

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

The CAISO 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 CAISO 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 CAISO 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 CAISO 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 CAISO 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.

IV. Co-located Enhancements

Tax issues and enhanced co-located resource functionality

The CAISO proposes enhancements that would limit the dispatch charging instructions of co-located storage resources to the forecast of one or more co-located VERs, and allow deviation of the storage resource when the VERs are unable to produce the forecasted amount. The proposed changes would not be available by default, would only be available to resources that have contractual investment tax credit or property tax implications existing at the time of this policy's implementation, and would not be available to resources that have been on the grid for 5 years or more.

The CAISO proposes these changes to address stakeholder concerns that some co-located storage resources are limited in their ability to charge from the CAISO grid in order to maintain preferential tax treatment. The CAISO 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 CAISO does not acknowledge them as costs or constraints in its dispatch instructions. Therefore, DMM does not oppose the "grandfathered" type of provisions CAISO is proposing to promote

resource development and allow some co-located storage resources to avoid charging from the grid, while disincentivizing future contractual arrangements that prohibit or discourage grid charging.

The revised 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 CAISO 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 CAISO and stakeholders 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, and could represent a long-term solution available to all resources with such limitations now or in the future.

Given CAISO's proposal to allow some co-located resources to constrain themselves to never charge from the grid for up to 5 years from the policy implementation, it will be important that the CPUC's new slice-of-day resource adequacy framework and the CAISO's UCAP policy appropriately differentiate between the capacity contributions of the two types of storage resources.⁵ 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 is being developed at the CPUC and the CAISO'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 CAISO 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 CAISO delivery point. The CAISO 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.

⁵ CAISO estimates in the revised straw proposal that the provisions to prevent grid charging would go into place in 2023. DMM understands that proposed functionality would be in place for at most 5 years from that time, as the functionality is only available for resources online by that time, and would not be available to resources that have been online for more than 5 years. This timeframe could extend into new resource adequacy structures that are currently under development.

V. Additional changes

DMM continues to recommend that the CAISO 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.⁶ The CAISO does not address this issue in the revised straw proposal.

DMM continues to recommend that the CAISO 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 CAISO consider the implications of a day-ahead submitted state of charge as a new and unique intertemporal constraint between markets.⁷ DMM recommended that the CAISO revisit this topic in future initiatives to address potential settlement implications.

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 CAISO market, DMM recommends that the CAISO 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.

⁶ *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>

⁷ *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>