Rules for bidding above the soft offer cap

Final Proposal

May 17, 2024

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1. Executive Summary

Through the *Price Formation Enhancements (PFE) stakeholder working group, market participants* have requested the ISO consider and prioritize policy enhancements for summer 2024 that would allow resources with intra-day opportunity costs to reflect those costs in their energy bids. Market participants have posited that allowing these costs to be accurately reflected will ensure the market can effectively and efficiently manage the dispatch of these resources.

FERC Order 831 establishes that resource market bids are subject to a soft offer cap of $1000/MW, primarily to address concerns about the exercise of market power. Bids can be submitted above $1000/MWh but must be cost verified by the market operator or market monitor.

On stressed days with high prices that can exceed the soft offer cap, the soft offer bid cap can create challenges for energy-limited resources that do not have sufficient headroom to reflect their opportunity costs in their bids without hitting the cap, and cannot incorporate intra-day opportunity costs into their bids. Bids from these resources can appear lower cost and "economic" to dispatch early in the day resulting in the premature dispatch and exhaustion of these energy limited resources prior to the critical net load peak evening hours. For these reasons, market participants have stressed the importance of the ISO timely addressing intra-day opportunity costs in relation to the soft offer cap for energy limited resources such as battery storage, hydroelectric resources, and demand response resources.

Solutions to these issues depend on 1) the ISO's ability to make timely technology enhancements for implementation for summer 2024, and 2) the policy and regulatory risks and associated tradeoffs discussed with stakeholders during the PFE working groups. Considering stakeholder recommendations and input — and the various regulatory, policy and technology feasibility risks — the ISO recommends the following:

1. Remove the $1000/MWh cap on Default Energy Bids (DEBs). Removing the cap on DEBs will allow hydro resources to reflect costs within their DEB and to be compensated up to that value, even if it is above $1000/MWh.
2. Modify the bid cap for energy storage resources to provide bidding flexibility using a proxy opportunity cost value. This will allow energy storage resources to submit bids that are higher than the current $1000/MWh soft offer cap in the real-time market. It will also allow the resources to indicate to the market their intra-day opportunity costs that support their availability for discharge during more stressed grid conditions, when prices might exceed the current soft offer cap.

The ISO believes that this proposal represents a balanced, reasonable and equitable approach for addressing the near-term market needs by allowing market participants to better reflect opportunity costs in their energy offers within the existing regulatory framework. The ISO is actively evaluating the feasibility of implementing these changes in summer 2024.

2. Background

FERC Order No. 831 requires market operators to verify the costs of incremental energy offers above $1,000/MWh (the "soft offer cap") before using these bids in the market. Its intent is to manage and mitigate concerns about market power. To comply with this order, the ISO uses its "reference level change request" (RLCR) process to verify costs above the soft offer cap. A reference level change request enables suppliers to update their "Default Energy Bids" (DEBs), which serve as a cost-based reference price used for mitigating market power. If approved, this request updates their DEB and enables them to bid up to their adjusted DEB if it exceeds the soft offer cap.

The RLCR process allows suppliers to adjust for energy cost changes not captured by their DEB in the ISO's market processes. When initially designed, the RLCR process was tailored toward gas resources that faced discrepancies between their actual fuel costs and the costs that CAISO's market systems used to calculate their DEB. The RLCR process was designed to validate requested DEB adjustments, using a reference based on fuel costs, in response to changing fuel costs. However, it lacks similar functionality for processing changes to the opportunity costs associated with storage, hydro, and demand response resources.

Through the *Price Formation Enhancements (PFE)* stakeholder working groups, stakeholders identified two primary issues that CAISO should promptly evaluate and address to manage resource availability during high price conditions, which generally correlate with stressed grid conditions across the market footprint:

1. Resources with intra-day opportunity costs may be unable to bid in a way to preserve their limited energy for the highest priced hours.
2. These resources may not be able to bid a way to maintain their day-ahead market schedules when real-time prices exceed the soft offer cap.

Intra-day opportunity costs refer to the potential revenues foregone when the market dispatches a resource with limited energy (i.e., battery storage, hydro generation) during a lower-priced period of the day instead of waiting for a higher-priced period, generally coinciding with periods when supply is most limited. If resources' DEBs do not accurately reflect these opportunity costs, these resources may be dispatched sub-optimally or otherwise not be available during higher-priced hours. This can cause inefficiencies and potential revenue losses. Additionally, if these energy limited resources have depleted their energy earlier in the day, they may be unable to meet their day-ahead market awarded schedules. Consequently, they would need to buy back their day-ahead schedules at high real-time prices to cover their positions. The inability to bid above the soft offer cap in the real-time market due to RLCR limitations exacerbates this issue. It prevents a resource from reflecting its opportunity costs and conserving its limited energy for the higher-priced hours that it had been scheduled for in the day-ahead market.

2.1. Default Energy Bids represent resource specific verified costs

FERC Order No. 831 requires that each resource's incremental energy offer is capped at the higher of $1,000/MWh or that resource's verified cost-based incremental energy offer.[1] FERC contemplated that cost verification requirements could work in conjunction with market power procedures; however, FERC does not prescribe the manner in which costs are verified.[2] Each ISO/RTO was empowered to propose how it would verify costs above $1,000/MWh in its compliance filing. FERC also requires verified cost-based incremental energy offers be capped at $2,000/MWh.

The default energy bid (DEB) mirrors a resource's competitive marginal costs in the market in conditions when market participants might have market power. These values are intended to be resource specific, and calculated pre-market based on information available at that time. Today, all DEBs are capped at $1,000/MWh when they are initially calculated. However, DEBs can be adjusted to above $1,000/MWh and up to $2,000/MWh through the reference level change request described below.

Absent perfect information, the DEB serves as a reasonable benchmark for a resource's specific short run marginal costs using predefined resource-specific operating parameters, and considering specific intra-day opportunity costs like nodal specific LMPs used in storage DEBs and bilateral prices used in hydro DEBs.[3] Most DEB calculations include a scalar[4] to account for some margin of error between the value defined by the DEB, calculated based on information known to the ISO, and a resource's actual costs.

For cost variability beyond what can be accounted for pre-market, market participants can use reference level change request process. The ISO's reference level change request (RLCR) process allows market participants to update the costs reflected through their DEB.[5] Two options are available: the manual and automated RLCR process. These options can be leveraged whenever a generator wishes to request that the ISO use a different fuel or fuel-equivalent cost in its reference level calculations, whether bidding above the soft offer cap or not.

Today, resources use the RLCR process to request DEB adjustments beyond the value of their DEB by providing the ISO with the necessary information to inform that adjustment. However, a resource's DEB might otherwise be calculated to be above $1,000/MWh if not for the cap on the DEB. In this case, though the ISO already has sufficient information to verify the resource's costs, the current process requires the resource's scheduling coordinator to take action through the RLCR process to reflect those costs in the market.

[1] Order No. 831 at P 1.
[2] If the cost verification standard cannot be accommodated through the cost-verification process, resources are eligible for make-whole payments.
[3] More on DEB options can be found in Appendix A.
[4] More on Scalars can be found in Appendix B.
[5] The RLCR process also enables updates to commitment cost bids, i.e. minimum load cost and startup cost bids.

The RLCR process does not yet accommodate requested changes in response to intra-day opportunity costs.

Energy storage and hydro resources are effectively not able to use the RLCR process today to adjust their DEBs in response to intra-day opportunity costs, because the ISO does not have rules to determine a reasonable cost expectation upon which to base an intra-day opportunity cost adjustment request. Without the ability to use the automated RLCR process, hydro and storage resources cannot request DEB adjustments *or* bid above the soft offer cap when opportunity costs materialize in real-time.

Through the stakeholder working group discussions, stakeholders have expressed support for enhancements to the RLCR process, but enhancements will be technology and policy resource intensive and beyond scope of what is feasible for a summer 2024 implementation. The ISO is committed to evaluating enhancements as part of a longer term evaluation of the design and these potential enhancements are highlighted in Section 6 of this paper.

For implementation for summer 2024, the ISO recommends proposals described in Section 4 of this paper.

3. Proposal Development Process

3.1. Stakeholder Recommendations for Policy Design

Stakeholders in the PFE working groups made recommendations and held discussions about changes to ISO rules for bidding above the soft offer cap, which primarily drove the development of this proposal.[6]

Stakeholders support finding a solution that can be in place for Summer 2024 to support energy limited resources', particularly battery storage and hydro generation, ability to hold their positions in the supply stack and maintain their DA schedules in real-time during higher priced periods that generally coincide with more challenging operating conditions.

Stakeholders understand that a summer 2024 timeline is highly constrained and may not support a holistic, durable, policy solution or novel technology development. Most stakeholders acknowledge an interim solution may not be optimal, but agree it would improve the status quo during the summer period where stressed operating conditions are likely. Meanwhile, some stakeholders advocate caution when revising policy and implementing new technology solutions on an expedited basis. Ultimately, stakeholders agree that resources with opportunity costs should be able to reflect those costs accurately in the market.

In addition to the short-term changes, stakeholders support a more robust initiative to serve the broader problem statement of improving resources' ability to adjust their costs in response to changing

[6] PFE Rules for bidding above the soft offer cap Issue Paper P. 10 IssuePaper-StakeholderRecommendations-PriceFormationEnhancements-Rules-BiddingAboveSoftOfferCap.pdf (caiso.com)

market conditions. A future initiative would support developing a definition of, and calculation for, intra-day opportunity costs for use in DEBs and the real-time optimization.

Objective: improve resource's ability to hold their positions in the supply stack during high priced periods

Stakeholder recommendations intend to provide resources with sufficient energy bidding flexibility to ensure the market appropriately values these resources and efficiently utilizes a resource's limited energy. Stakeholders recommended a range of values to serve as proxies for intra-day opportunity costs, summarized in Table 1.

The Maximum Import Bid Price (MIBP) is currently used by the ISO in other processes to estimate prevailing bilateral prices, and some stakeholders support it as an appropriate proxy for both storage and hydro opportunity costs. Some stakeholders expressed concerns regarding the liquidity of bilateral indices on which this proxy price is based, as well as the accuracy of the resultant proxy price once a methodology to decompose the 16-hour block into an hourly value is applied. Stakeholders also have expressed mixed opinions on the appropriateness of using a single, peak, or hourly MIBP value to represent an opportunity cost for energy limited resources.

In response to stakeholder concerns around the MIBP, the ISO proposed using prices calculated in its day-ahead market as the forecast for real-time opportunity costs. Stakeholders also submitted for consideration the hard bid cap of $2,000 MWh as a reference price.

Table 1: Proxy values under consideration

Proxy Value	Purpose
Highest cost-verified bid, MIBP	This stakeholder proposal reflects the same logic used today to screen non-resource-specific RA import bids above $1000/MWh
Highest value of the MIBP	Stakeholders propose this solution as an improvement over the MIBP hourly curve, as the real-time market does not optimize over the full horizon.
4th highest Value of the MIBP	This solution considers that limited energy resources are able to derive an opportunity cost based on prevailing bilateral prices, but mimics the use of the 4th highest hour in the storage DEB to represent the flexibility needed for a typical 4-hour battery storage resource.
$2,000/MWh	This value represents the hard cap for resource bids to set LMPs under Order No. 831.
Highest DA Price	This value was proposed by the ISO for stakeholder consideration. The opportunity cost estimate would based on a more liquid market result, but may not capture real time conditions or conditions outside of the CAISO BA.

Stakeholders put forth several interim measures that aim to enhance the bidding flexibility of energy-limited resources to represent their opportunity costs under tight system conditions. Below is a summary of these stakeholder recommendations for policy development. Stakeholders prefer a solution that would modify the DEB to ensure that market power mitigation would not reduce bids below a value that captures the agreed upon opportunity costs.

Summary of stakeholder recommendations for policy development

Approach 1 **Directly modify the cap applied to bids and default energy bids**. These proposals would allow certain resources to bid up to a specified cap whose value is a proxy for opportunity costs.

- Remove the $1,000/MWh cap on default energy bids
- Apply the same logic used today for non-resource specific RA imports
- Allow resources to bid up to a static value—4th highest MIBP, highest MIBP, $2,000/MWh
- Make these bid cap modifications conditional, or limited to only hours of the day in which issues have been observed

Approach 2 **Leverage existing tools to ensure resources can retain their day-ahead schedules in real-time.** These options provide a backstop for reliability. Importantly, these options would not require any immediate policy or implementation changes.

- End-of-Hour State of Charge constraint
- Self-Schedule the day-ahead schedule in real-time
- Base Schedule for WEIM entities
- Exceptional dispatch

Approach 3 **Enhance resources' ability to accurately identify and reflect costs through the reference level change request process.** These proposals are focused on modifications to DEB and/or the reference level change request process.

- Modify the reasonableness threshold to allow hydro and storage resources to request adjusted DEBs based on the highest (or 4th highest) MIBP value

3.2. Analysis: Proxies for intra-day opportunity costs on historical high priced days

None of the stakeholder recommended values, summarized in Table 1 above, are a perfect proxy for intra-day opportunity costs. Intra-day opportunity costs are the foregone profits of producing now rather than being able to produce later, so any proxy will necessarily be based on a forecast or assumption. The goal in identifying a sufficient energy offer cap is to find a proxy value that demonstrates a correlation with a resource's intra-day opportunity costs. For example, a proxy value for a four-hour duration battery storage resource would correlate with the four net peak load hours.

The options discussed in this paper intend to balance a reasonable representation of intra-day opportunity costs with the risk of overstating them. Over- or under-estimating costs can lead to undesirable outcomes.

The ISO performed analysis on historical high-priced days to investigate how the proposed offer cap proxies may have performed on a counterfactual basis when compared to real-time prices, specifically

the hourly average system marginal energy cost (SMEC) from the fifteen minute (RTPD) market. The purpose of comparing to the RTPD SMEC is to show how closely each proxy might have correlated to realized, historical real-time prices, however this does not provide a perfect comparison.

Figure 1, Figure 2, and Figure 3 below plot the hourly average RTPD SMEC against three different proxies: the highest uncapped DEB value, the highest IFM SMEC value multiplied by a scaling factor of 1.1, and the hourly real-time maximum import bid price (MIBP). For the purposes of this analysis, the highest uncapped DEB value is assumed to be analogous to the highest cost-verified bid, however a high-priced DEB alone would not serve as a cost-verified bid. The plots are shown for three reference days that experienced tight system conditions: September 6, 2022, August 16, 2023, and January 14, 2024.

For the two summer days in 2022 and 2023, the real-time MIBP tracks the general shape of realized RTPD SMEC but does not provide a perfect correlation under all conditions. For example, the hourly real-time MIBP understates RTPD SMEC during the evening ramp of September 6, 2022 and subsequently overstates RTPD SMEC during evening peak hours of August 16, 2023. Further divergence is observed on January 14, 2024, when the MIBP was driven high due to high bilateral prices in the Pacific Northwest while system-wide SMEC stayed lower.

Static parameters like the highest cost-verified bid (as proxied by the highest counterfactual DEB) or highest IFM SMEC multiplied by 1.1 will inherently eliminate intra-day fluctuations and may also over- or under-state prices depending on the time of day. For example, the two static parameters undershoot the RTPD SMEC in peak hours on September 6, 2022 but overshoot the RTPD SMEC for other hours of the day. Static parameters may not sufficiently capture intra-day price variations; in particular, IFM SMEC may not capture regional price variations well enough to serve as a proxy for opportunity costs outside the CAISO area.

Figure 1. Price trend comparisons on September 6, 2022

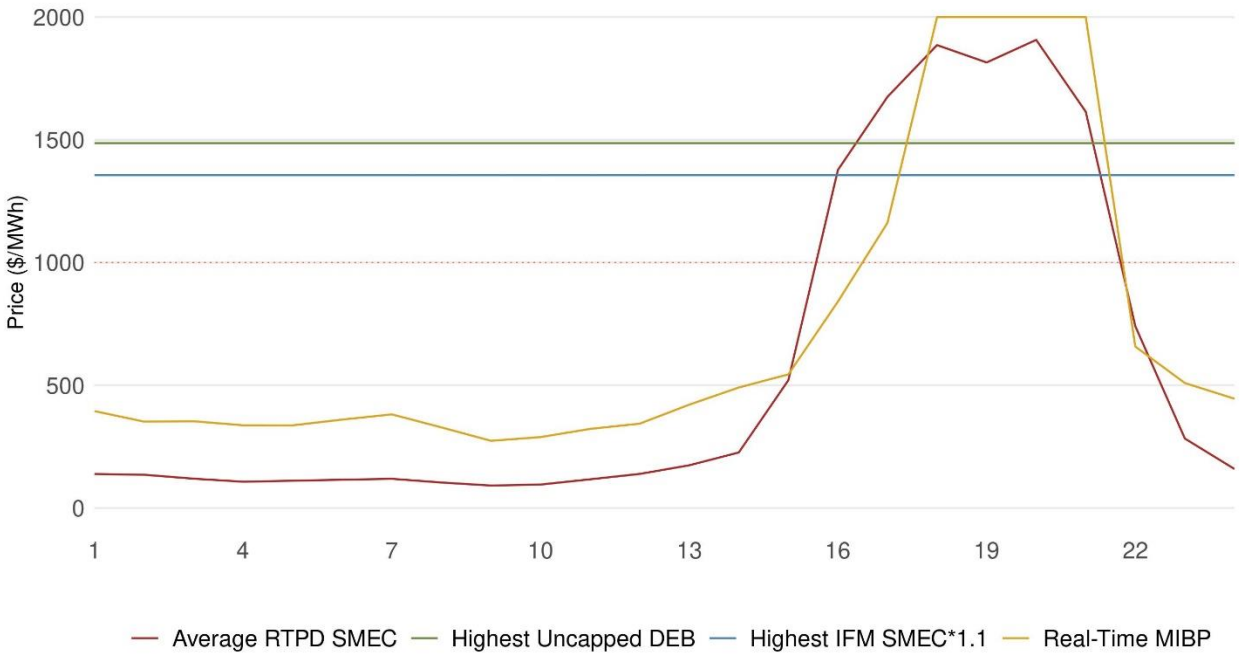


Figure 2. Price trend comparisons on August 16, 2023

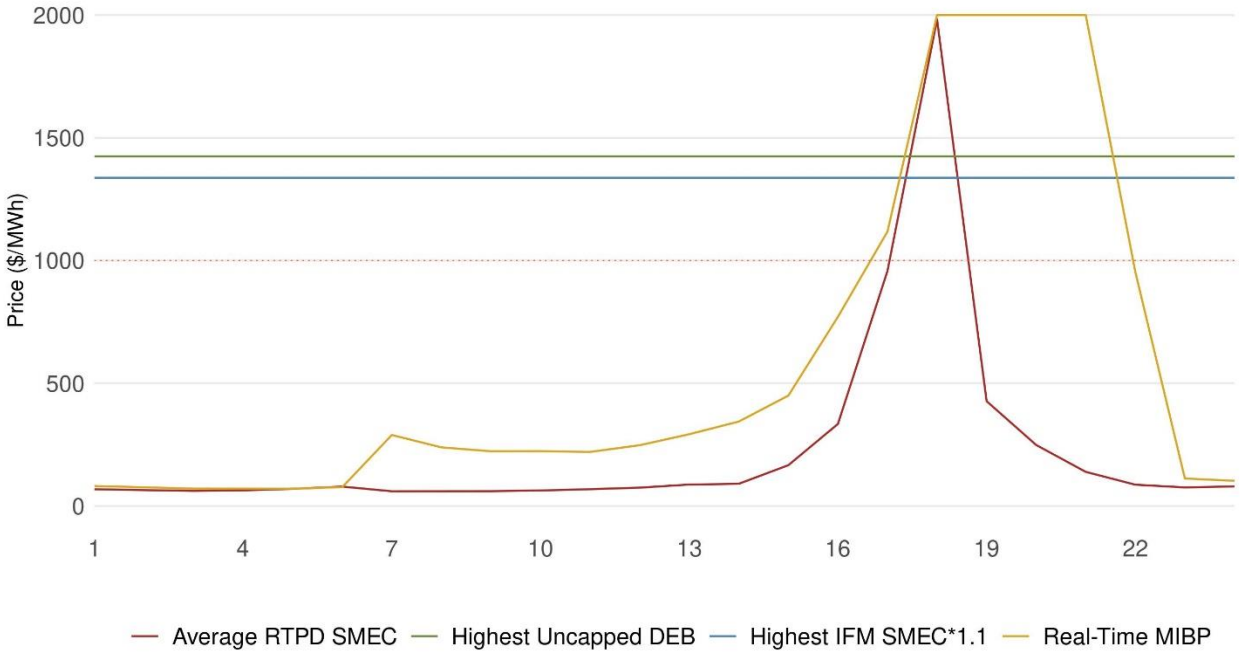
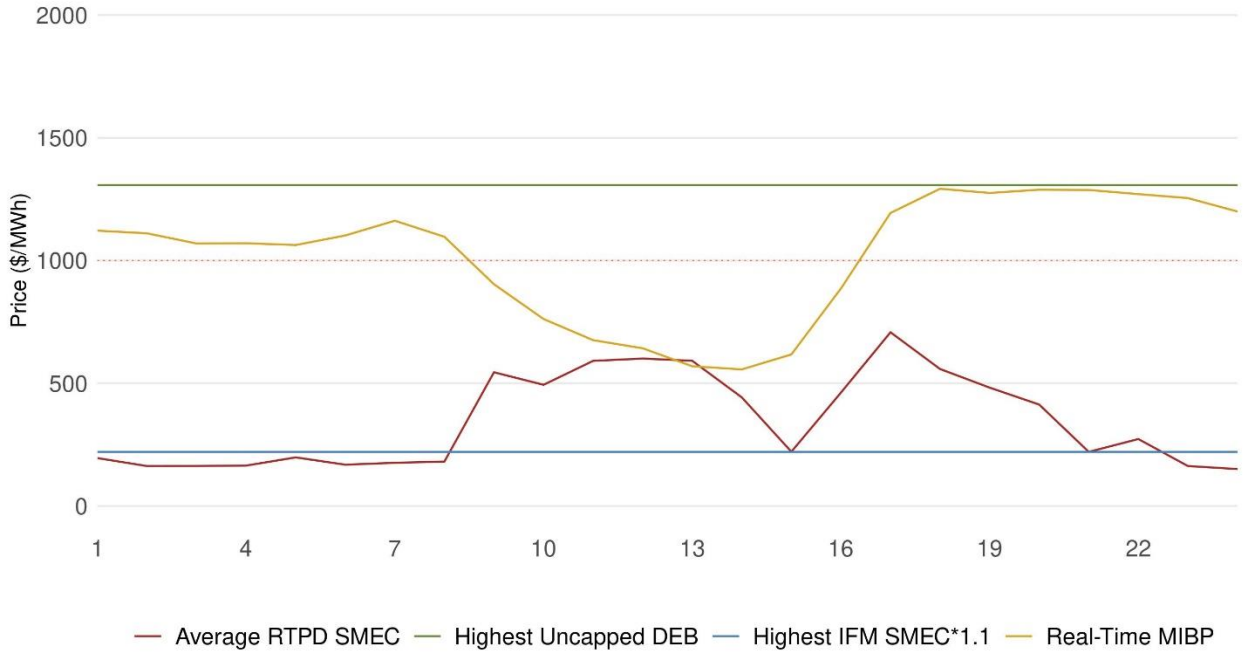


Figure 3. Price trend comparisons on January 14, 2024



4. Proposed Policy Changes for summer 2024

Considering the stakeholder recommendations and input, the ISO has identified proposals that may be feasible for summer implementation, pending further refinement and stakeholder input. These proposals (1) remove the cap on DEBs for all resources and (2) modify the bid cap for energy storage resources in the real-time market.

The proposals in this section address the identified issues for hydro and battery storage resources separately. The ISO considers this to be an appropriate outcome given the differences between how energy storage and hydro resources define opportunity costs today.

The ISO proposes the following:

- **(Section 4.1) Revise the cap on all Default Energy Bids from $1,000/MWh to $2,000/MWh.** This proposal would "uncap the DEB" for all resources. In particular, this would allow hydro resources to bid up to a value that reflects the opportunity costs already defined in their DEBs, even when those costs exceed $1,000/MWh.

- **(Section 4.2) Modify the bid cap for energy storage resources.** The additional modification of this proposal offers bidding flexibility to storage resources to maintain their relative position in the supply stack in the real-time market.

4.1. Proposal: **Revise the cap on all Default Energy Bids from $1,000/MWh to $2,000/MWh**

This proposal would revise the cap on DEBs from $1,000/MWh to $2,000/MWh. This change would apply to all DEBs[7] in both the day-ahead and real-time markets. As the DEB was designed to represent a resource's verifiable cost-based offer, this proposal is consistent with FERC Order No. 831 rules that require verified cost-based incremental energy offers to be capped at $2,000/MWh.

This proposal represents a process change, not a value change. Removing the $1,000/MWh cap from DEB calculations does not change the basis for calculating marginal reference costs accepted as default energy bid as described in the ISO's tariff. This proposal would not change the resource-specific parameters defined by any resource's DEB calculation, but offers value to resources for whom the automated RLCR process is cumbersome or unusable for validating costs above $1,000/MWh. The ISO has observed that DEB values today may, at times, rise above $1,000/MWh if not for the existing cap, based on the analysis in this section.

Today, gas resources can verify costs above $1,000/MWh through the RLCR process. This proposal does not give gas resources any additional headroom to make adjustments, but instead simplifies the adjustment process by removing the requirement to confirm existing cost information captured in the DEB. Gas resources would still rely on the RLCR process to make DEB adjustments in response to gas price volatility, in cases where the ISO-calculated DEB did not sufficiently capture that gas price volatility. Additional supporting information would still be required to support those types of DEB adjustment requests.

This proposal represents the foundational step for all further enhancements. A durable change, this proposal will simplify and support future enhancements to the RLCR process as well as additional interim rules.

In the near term, this change would have important impacts to bidding rules and market power mitigation.

Bidding Rules when the uncapped DEB is above $1,000/MWh: each resource's DEB becomes its bid cap

The offer cap for each resource would be set by that resource's DEB, should the value of the DEB rise above $1,000/MWh. In effect, a resource's energy offer above $1,000/MWh would be considered cost-verified because it is assessed against the DEB value, which is accepted today as a reasonable measure of resource-specific, verifiable costs.

[7] Through the PFE working group effort, stakeholders identified proxy demand response (PDR) for consideration within the scope of an interim approach. These resources do not currently have a DEB option, but are discussed in Section 6.2 of this paper. Other resources without DEBs, including hybrid resources, are out of scope for the interim.

This proposal to remove the cap from the DEB does not obviate the need for the RLCR process generally. In the event of fuel price spikes, gas-fired resources may still need to use the RLCR process to adjust their DEB if the ISO-calculated DEB does not capture the fuel price spike. A gas resource's DEB ("uncapped DEB") is calculated pre-market, but the SC can use the automated RLCR process to validate an adjusted DEB in excess of the uncapped DEB value in response to changing gas prices[8].

This proposal would cap bids above $1,000/MWh by the higher of $1,000/MWh, the uncapped DEB, or the adjusted DEB. This logic ensures that future enhancements to the RLCR process recommended by stakeholders to allow storage and hydro resources to adjust their DEBs in response to intra-day opportunity costs will be consistent with existing rules.

When the uncapped DEB is above $1,000/MWh, the uncapped DEB becomes the resource's specific bid cap. A resource's ability to bid up to its uncapped DEB would not be conditional on any other factors. The conditions must be met for other unspecified resources (e.g. RA imports, virtual bids) to bid above $1,000/MWh—a cost-verified bid above $1,000/MWh or a MIBP value above $1,000/MWh—do not impact the bid cap for resources with an uncapped DEB.

- ➔ **The bidding rules in this proposal cannot be applied to resources using the storage DEB option in the timeframe prescribed by stakeholders**. Uncapping the DEB could still confer the benefits of improved outcomes post-mitigation to storage resources under certain conditions.[9] Storage resources (and all resources) also are still eligible for after-market cost recovery under the CAISO's tariff. To ensure the problem statement posed by stakeholders can be resolved, the proposal in Section 4.2 provides an incremental, interim solution narrowly targeted for battery storage resources.

Market Power Mitigation when the DEB is above $1,000/MWh

Revising the DEB calculation cap to $2,000/MWh may improve outcomes for resources subject to local market power mitigation procedures. Stakeholders emphasized the importance of DEB modifications to prevent resources from being mitigated to a DEB that is capped at $1,000/MWh. This proposal offers some relief to mitigated resources without substantially changing existing market power policy.

Stakeholders emphasized the need to modify DEBs to prevent mitigating resource bids to $1,000/MWh or lower. Many stakeholders support re-evaluating DEB calculations to better capture opportunity costs. Stakeholders also support leveraging the RLCR process to facilitate DEB adjustments in response to intra-day opportunity costs. While most stakeholders agree with these approaches, many stakeholders are concerned about changing existing DEB calculations through an expedited policy process. This proposal offers some relief to mitigated resources, in so far as the uncapped DEB rises above $1,000/MWh, without changing existing market power mitigation policy or procedure.

[8] The Issue Paper for Rules for Bidding Above the Soft Offer Cap explains the automated RLCR process in more detail: IssuePaper-StakeholderRecommendations-PriceFormationEnhancements-Rules-BiddingAboveSoftOfferCap.pdf (caiso.com)

[9] See Appendix D for examples

Uncapped storage DEB calculations may not be sufficient to allow bidding above the soft offer cap

This proposal is an important first step and makes an incremental improvement, but may not solve in its entirety the problem presented by stakeholders. Stakeholders support uncapping the DEB as an initial step but note that it may not achieve the objective for summer.

Of immediate concern, if implemented in isolation, this proposal may exacerbate the ability for battery storage resources to maintain state of charge should limited energy hydro resources be able to systemically position themselves higher in the offer stack. Stakeholders have expressed concern that the ISO calculated DEBs do not accurately reflect expected costs, and do not explicitly consider potential opportunity costs informed by other technology types or prevailing regional conditions illustrated by the counterfactual analysis in Figures 5 and 6 below, the existing calculation of the storage DEB might be calculated to be less than $1,000/MWh and less than hydro DEBs even uncapped.

The opportunity cost defined by the storage DEB option is based on the 4th highest day-ahead LMP, which has not been observed to regularly be above $1,000/MWh during conditions when prices rise above $1,000/MWh in real-time. Figure 4 below shows a counterfactual calculation of hydro DEBs and storage DEBs, had the $1,000/MWh cap in the existing calculation not been applied. The values of these counterfactual DEBs are represented in a box-whisker plot[10] where hydro DEBs are plotted in blue, storage DEBs are plotted in red, and a horizontal dashed line is shown at $1,000/MWh for reference. The data is plotted for a broader set of high-priced days from 2022 to 2024.

High nodal LMPs on September 6, 2022 drove counterfactual storage DEBs to exceed the $1,000/MWh threshold but only for a few, resource-specific outliers, primarily due to congestion, while counterfactual hydro DEBs all remained below $1,000/MWh. However, on both August 16, 2023, and January 14, 2024, more counterfactual hydro DEBs were above the $1,000/MWh threshold due to high bilateral market prices while fewer counterfactual storage DEBs were above the threshold.

An uncapped DEB alone may not be sufficient for storage resources to submit energy offers at or above $1,000/MWh.

[10] A box-whisker plot represents data where the box covers the interquartile range (25th to 75th percentile), the line in the middle of the box represents the median (50th percentile), and dots represent outliers.

Figure 4. Counterfactual uncapped default energy bid values, high-priced days in 2022

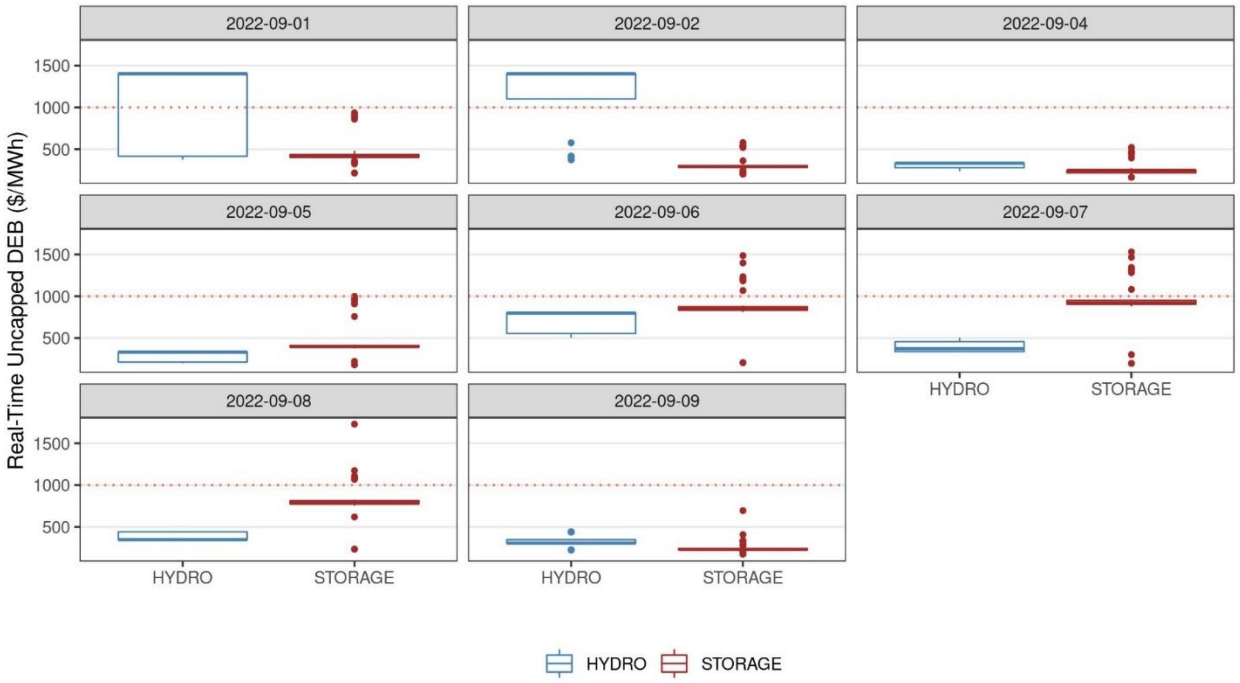
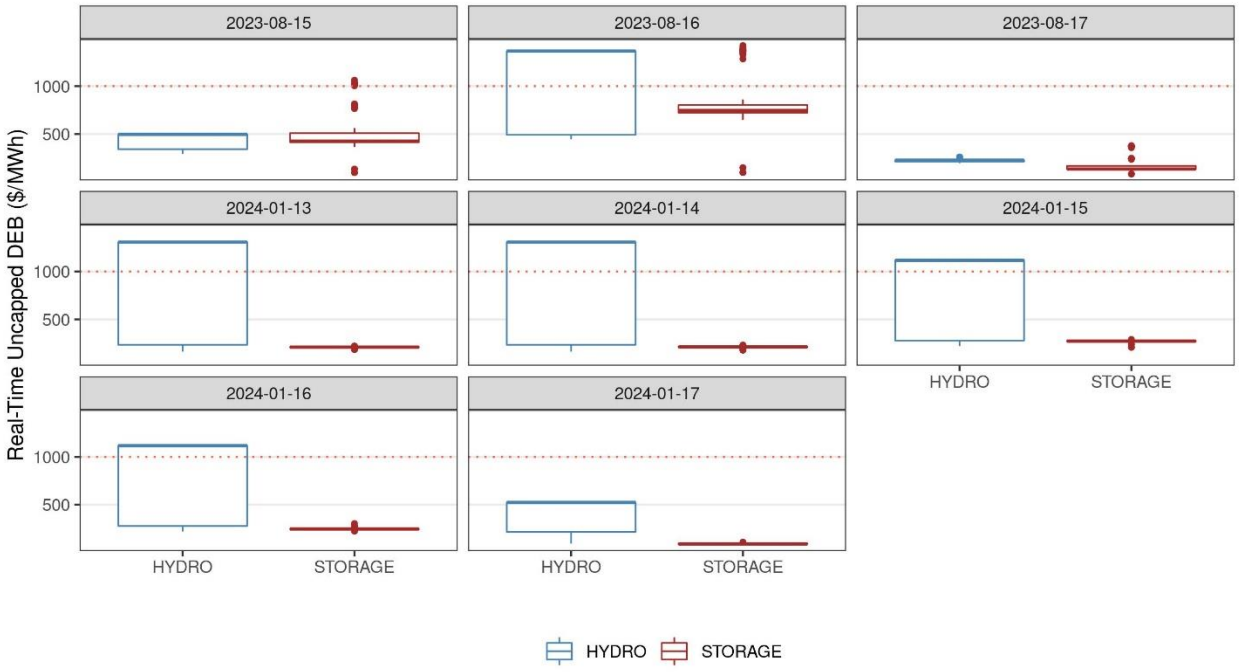


Figure 5. Counterfactual uncapped default energy bid values, high-priced days in 2023 and 2024



4.2. Proposal: **Modify the bid cap for energy storage resources using a proxy cost based on bilateral indices**

The technology implementation required to use the storage DEB option as a resource's bid cap is not feasible for implementation by stakeholders' desired implementation date. Some storage resources use different DEB options, e.g. a negotiated DEB (NDEB) option, for which implementation may be feasible for summer 2024. Regardless of implementation timelines, storage DEBs are not expected to be calculated at a sufficiently high value under the previous proposal alone to address stakeholder concerns. This proposal is incremental to the previous proposal, and extends equally to all storage resources[11].

This proposal provides storage resources with additional bidding flexibility in the real-time market to reflect intra-day opportunity costs not fully captured by existing storage DEBs. It allows storage resources to benefit from the uncapped DEB value if market power mitigation occurs. This proposal is intended to ensure, to the extent practicable, that storage resources can *at least* reflect the value currently represented by their DEB.

Today, storage resource bids are capped at $1000/MWh, without consideration of the DEB, going into the day-ahead market (DAM). Most stakeholders have not considered problem statements specific to the DAM because the market run can fully account for opportunity costs by optimizing over the time horizon of the full trade-day. Some stakeholders want solutions to address DA and RT to minimize differences, but did not identify modifications to the DAM as a high priority. This element of the proposal will only apply in the real-time market.[12] The ISO recognizes the immediate problem statement stakeholders asked for resolution on applies to the real-time market, which is where the risk arises for premature depletion of state of charge. While the ISO continues to believe that it is generally preferable to have rules aligned in the day-ahead and real-time markets, given the significant feedback and the existing ability of the day-ahead market to optimize storage over the twenty-four hour horizon, the ISO proposes to make this change only for the real-time market at this time. Future stakeholder conversations can provide additional time to consider any changes for the day-ahead market.

Today, storage resources can only bid above $1,000/MWh in real-time if they receive a successfully adjusted DEB through the RLCR process, a function not available to storage resources today. Stakeholder proposals that would allow storage resources to successfully adjust their DEBs are not feasible for summer.

[11] These resources will be identified by technology type instead of DEB type.
[12] This change is reflected in the memorandum provided to the ISO Board of Governors and Western Energy Imbalance Market Governing Body.

This proposal would apply to all battery storage resources, CAISO and WEIM, in ~~both day-ahead and~~ the real-time market.

Bidding Rules above $1,000/MWh for storage resources

The ISO proposes to allow storage resources to bid up to the maximum value of two additional proxies in the real-time market: the fourth-highest hourly MIBP value and the highest cost-verified bid[13].

For battery storage resource's whose DEBs cannot be used to inform the bid cap by stakeholders' targeted implementation date, the ISO proposes to allow these storage resources to bid up to the maximum of the MIBP's fourth-highest calculated hourly value and the highest cost-verified bid when either of those values rise above $1,000/MWh.

For battery storage resource's whose DEBs can be used to inform the bid cap by stakeholders' targeted implementation date, the ISO proposes to allow these storage resources to bid up to the maximum of the resource's DEB, MIBP's fourth-highest calculated hourly value, and the highest cost-verified bid when any of those values rise above $1,000/MWh. If none of those values rise above $1,000/MWh, these resources' bids would be capped at $1,000/MWh.

The ISO's proposal to utilize the fourth-highest hourly MIBP value would enable storage resources to manage their SOC in the real-time market through economic participation. Functionally, this proposal ensures four hours of SOC, which correlates to the typical sizing of the existing battery fleet, is available for use across net-peak hours, aligns with the day ahead schedules, and accurately values the storage resources' opportunity costs.

MIBP: Stakeholder feedback, and supporting analysis

Stakeholder approaches using the MIBP as a proxy for storage opportunity costs received the most stakeholder support as an interim solution. However, stakeholder proposals vary in terms of how to apply the hourly MIBP values. Some stakeholders urge the ISO to carefully consider the risks and benefits of each approach to provide sufficient time for stakeholder input and analysis.

The ISO performed analysis to compare historical real-time storage locational marginal prices (LMPs) from the fifteen minute market (RTPD) to both the hourly MIBP and fourth-highest MIBP on three days of interest, September 6, 2022, August 16, 2023, and January 14, 2024. A snapshot of peak hours, hours-ending 14 through 22, are shown. The purpose of this analysis is to compare the MIBP to realized real-time prices to evaluate how an MIBP-derived bid cap may have performed during tight system days. Note that while the effective storage bid cap was $1,000/MWh for the days below, the energy component or SMEC was still able to rise above $1,000/MWh, and nodal components like congestion also contributed to high LMPs during some hours. RTPD LMPs for all storage resources are shown using

[13] With the exception of the DA Storage DEB option, most DEB calculations are known prior to the applicable market and with sufficient time to allow SCs to make adjustments to bids or request an adjusted DEB through the RLCR process. However, the values informing the battery storage bid cap may not be known at the time that SCs submit bids for the relevant trade-day or hour. For example, resources can submit 'cost-verified bids' up until 75 minutes prior to the relevant RTM. Battery storage resource SCs would not have visibility into how this information effects the bid cap prior to submitting bids.

a box-whisker plot, while the hourly and fourth-highest MIBP values are plotted in green and blue respectively.

On September 6, 2022, the hourly MIBP values track the interquartile range of storage RTPD LMPs fairly closely, with the exception of some outliers that are driven higher or lower based on other non-energy LMP components. The fourth highest MIBP maxes out at the $2,000/MWh cap, so a bid cap based on the fourth-highest MIBP would have been set at a static $2,000/MWh value for the entire day. Conversely, on August 16, 2023, the hourly MIBP tracks higher than the interquartile range of storage LMPs during the evening hours whereas the fourth-highest MIBP also maxes out at $2,000/MWh. On January 14, 2024, the MIBP is far higher than RTPD storage LMPs, primarily driven by price separation between the high bilateral prices in the Pacific Northwest that set the MIBP and the relatively lower resource-specific LMPs.

Figure 6. Comparison of real-time storage LMPs and MIBP values, September 6, 2022

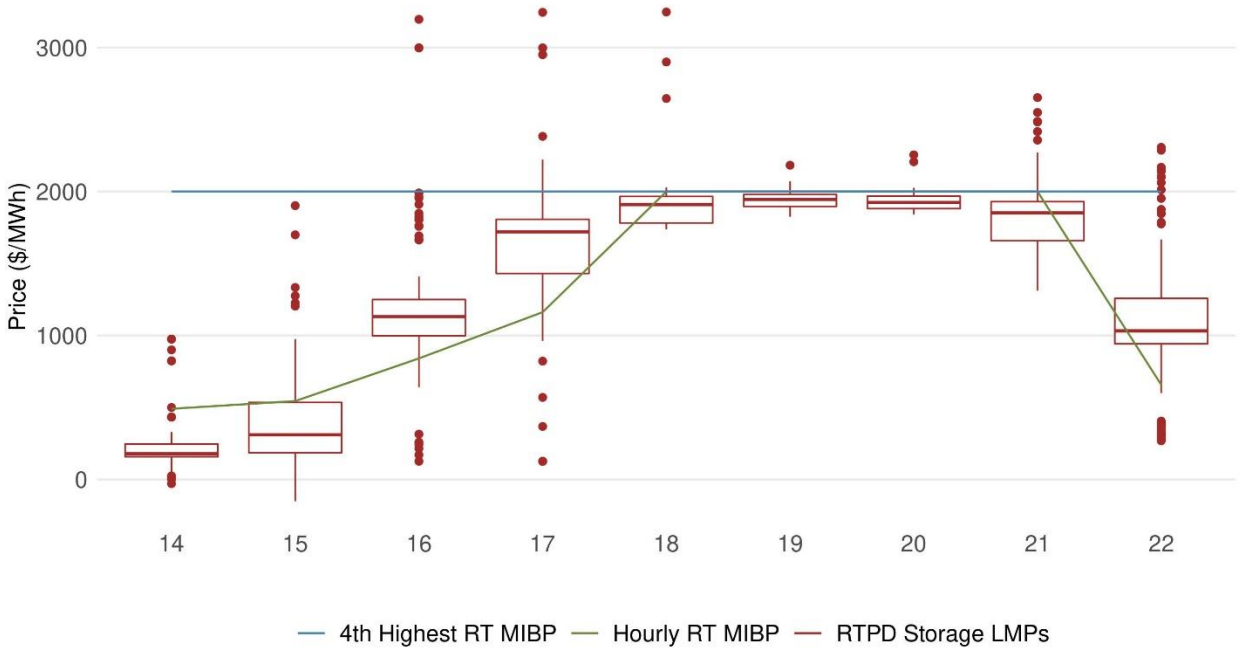


Figure 7. Comparison of real-time storage LMPs and MIBP values, August 16, 2023

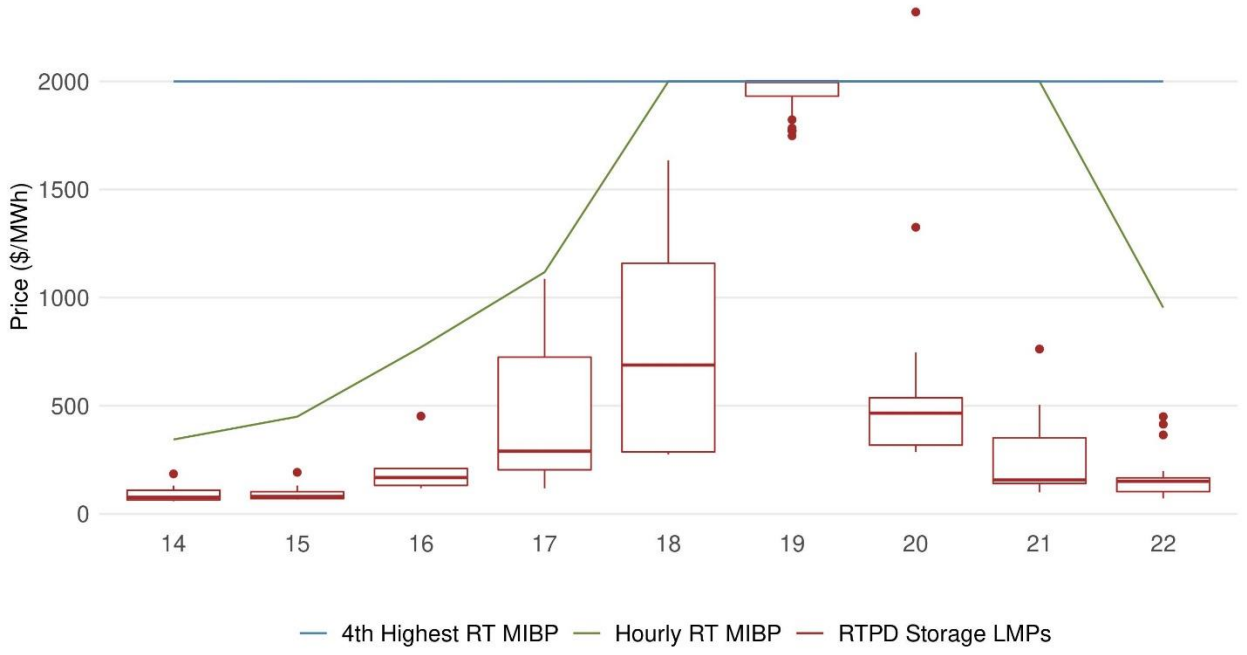
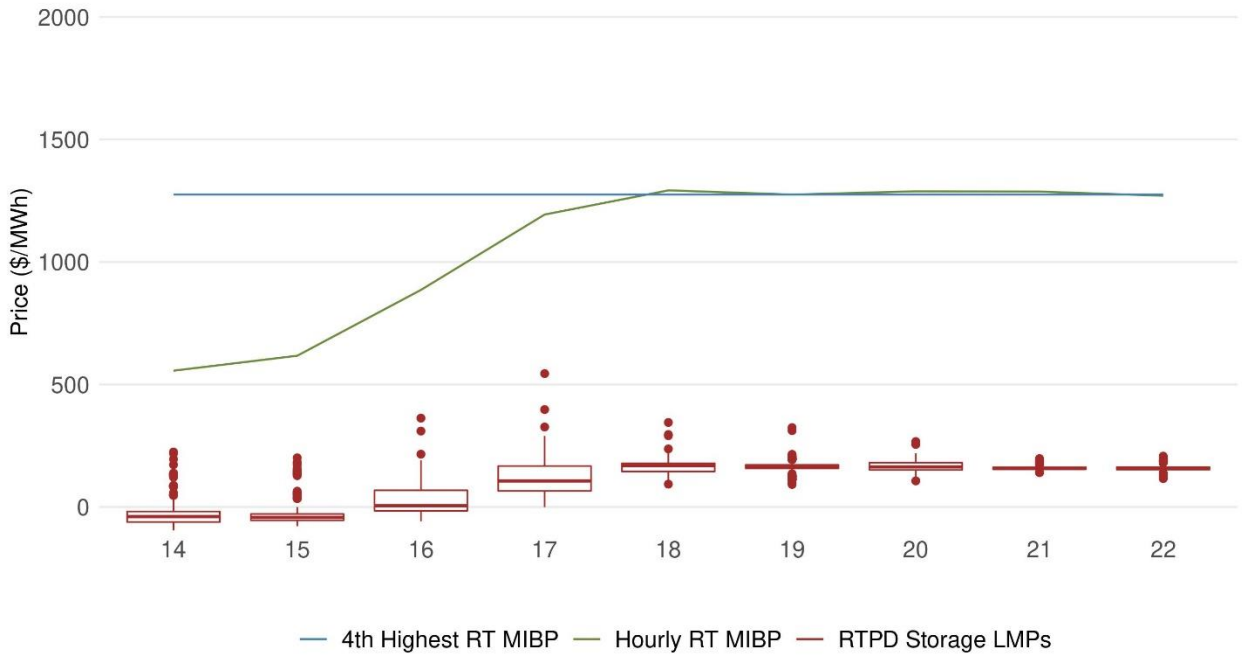


Figure 8. Comparison of real-time storage LMPs and MIBP values, January 14, 2024



Market Power Mitigation when the storage DEB is above $1,000/MWh

Market power mitigation may partially reduce the intended benefits of providing this additional bidding flexibility to storage resources if the bid cap does not consider the storage resource's DEB. Market power mitigation may also partially reduce the intended benefits of uncapping the DEB if the bid cap does not consider the storage resource's DEB.

This proposal is a necessary incremental step to unlock the benefit of uncapping the storage DEB for post-mitigation market outcomes. Even if a storage DEB uncapped is calculated to be above $1,000/MWh, that DEB value will not be used in MPM if the resource cannot submit a bid above $1,000/MWh. Storage resources will only have potential mitigation to a DEB calculated above $1,000/MWh during the conditions identified in Section 4.2 that result in an increase in the storage resources separately determined offer cap.

Some stakeholders do not consider a bid above $1,000/MWh and above the DEB to be "cost-verified", while others acknowledge the logic of the proxies represented in this proposal and the necessity of these considerations in the near-term. This proposal is intended to provide additional bidding flexibility in the near-term without superseding DEB calculations determined and approved by stakeholder processes.

4.3. Monitoring and Evaluation

The automated RLCR process allows the ISO to audit any submitted requests and requires scheduling coordinators to retain documentation that justifies their request. The penalty for audit failure may include a temporary suspension from using the automated RLCR process. While the ISO would already have the relevant supporting information for bids above $1,000/MWh that are capped by the DEB, some stakeholders expressed concerns with divorcing the ability to bid above $1,000/MWh from similarly standardizing controls.

The ISO proposes to monitor the use of the new bidding flexibility enabled through this proposal and consider associated market results in any evaluation of future market reforms.

5. Long term enhancements for future consideration

5.1. RLCR process

Stakeholders support enhancements to the RLCR process that would enable non-gas resources to verify and reflect changes to their resource specific opportunity costs in the market. Some stakeholder recommendations include:

- facilitating DEB adjustments in response to intra-day opportunity costs that vary hourly, and beyond the value calculated by the DEB
- informing real-time opportunity costs using a forward looking real-time market time horizon

5.2. Proxy Demand Response (PDR)

The ISO understands PDR opportunity costs to be different then the temporal opportunity costs due to energy limitations. The opportunity costs for PDR might include, for example, the forgone usage of energy for residential or commercial activity. The ISO lacks visibility into the underlying assets, and therefore has a limited ability to verify PDR specific costs. Engagement with the PDR community, significant policy discussion and stakeholder consideration is warranted to properly define the costs associated with those resources.

6. Stakeholder Engagement

Stakeholder input is critical for developing market design policy. The schedule proposed below allows opportunity to for stakeholder involvement and feedback.

6.1. Schedule

Table 2 lists the proposed schedule for the stakeholder process.

Table 2: Schedule for Stakeholder Process

Item	Date
Draft Final Proposal	May 1, 2024
Stakeholder call	May 2, 2024
Stakeholder comments due	May 8, 2024
Market Surveillance Committee Opinion	May 13, 2024
MSC Opinion Call	May 15, 2024
Joint EIM Governing Body and CAISO Board of Governors	*May 21-23, 2024*
Target Implementation	*Summer 2024*

The CAISO proposes to present its proposal to the EIM Governing Body and CAISO Board of Governors on May 21-23, 2024. The CAISO is committed to providing ample opportunity for stakeholder input into its market design, policy development, and implementation activities. Stakeholders should submit written comments to InitiativeComments@caiso.com.

6.2. Governing Body Classification

This initiative proposes changes to allow certain resources to bid above the soft offer cap of $1,000 MWh. As explained below, CAISO staff believes that the WEIM Governing Body has joint authority with the Board of Governors over the proposed change.

The role of the WEIM Governing Body with respect to policy initiatives changed on March 20, 2024, when the Board of Governors adopted revisions to the corporate bylaws and the Charter for WEIM and EDAM Governance to implement the Governance Review Committee's EDAM governance proposal. Under the new rules, the Board and the WEIM Governing Body have joint authority over any

> proposal to change or establish a tariff rule applicable to the WEIM/EDAM Entity balancing authority areas, WEIM/EDAM Entities, or other market participants within the WEIM/EDAM Entity balancing authority areas, in their capacity as participants in WEIM/EDAM… The scope of this joint authority excludes, without limitation, any other proposals to change or establish tariff rule(s) applicable only to the CAISO balancing authority area or to the CAISO-controlled grid.

Charter for WEIM and EDAM Governance § 2.2.1. The proposed tariff changes to implement the initiative would apply to the entire market footprint, and thus be "applicable to WEIM/EDAM Entity balancing authority areas, WEIM/EDAM Entities, or other market participants within WEIM/EDAM Entity balancing authority areas, in their capacity as participants in WEIM/EDAM." They would not be applicable "only to the CAISO balancing authority area or to the CAISO-controlled grid." Accordingly, the proposed changes fall within the scope of joint authority.

This proposed classification reflects the current state of this initiative and could change as the stakeholder process moves ahead. Stakeholders are encouraged to submit a response in their written comments to the proposed classification of as described above, particularly if they have concerns or questions.

6.3. Next Steps

The CAISO will discuss the Draft Final Proposal during the stakeholder meeting on May 2, 2024. The CAISO requests stakeholders submit written comments on this proposal by May 8, 2024.

7. Appendices

7.1. Appendix A: The storage and hydro DEB calculations

Stakeholders and the ISO developed technology-specific DEB options for storage and hydro resources to better reflect their unique opportunity costs.

See BPM for Market Instruments Attachment D for more detail on DEB calculations.

The Storage DEB Calculation

This option reflects the costs of storage resources with a limited storage duration and variable operating costs. This option is available to applicable, participating storage resources. Because the costs defined in this DEB calculation use data from the day-ahead market, this option is not available to WEIM storage resources outside of the CAISO BAA.

This storage DEB option was developed through recent stakeholder policy initiatives: Energy Storage and Distributed Energy Resources Phase 4[14], and Energy Storage Enhancements[15].

The Storage DEB has three main cost components:

1. Energy costs
2. Variable storage operations costs
3. Price-based opportunity costs

$$\text{Storage DEB} = \text{Max}\left\{\left[\text{Max}\left(\text{En}_{\delta/\eta}, 0\right) + \rho\right], \text{PB\_OC}_{\gamma}\right\} * \text{DEB Multiplier}$$

Where:

En	Energy Cost	Estimates the average cost of energy needed to charge the storage resource, using LMP prices from the relevant PNode
η	Round-Trip Efficiency	A resource-specific static value
δ	Energy Charging Duration	Based on a resource's registered max/min continuous energy limit and Pmin, adjusted for round trip efficiency
γ	Energy Discharge Duration	Based on a resource's registered max/min continuous energy limit and Pmin, adjusted for round trip efficiency
ρ	Variable Storage Operations Cost	A resource-specific registered value representing costs associated with variable operation of the resource, including cycling and cell degradation costs
PB_OC	Price-based Opportunity Cost	Estimates the market opportunity cost corresponding to the *n*th highest LMP, where *n* corresponds to the discharge duration of the resource (e.g. 4th highest hour for a 4 hour discharge duration)
DEB Multiplier	110% Multiplier (1.1)	Multiplier to cover any potential variability between the storage DEB calculation and

[14] FinalProposal-EnergyStorage-DistributedEnergyResourcesPhase4-DefaultEnergyBid.pdf (caiso.com)
[15] FinalProposal-EnergyStorageEnhancements.pdf (caiso.com)

		resource's actual marginal costs; consistent with other DEB calculations

The Hydro DEB Calculation

The Hydro DEB option reflects opportunity costs a hydroelectric generator faces due to their limited water supply. This option is available to hydroelectric resources in both CAISO and WEIM that have storage and can demonstrate limited water storage capability.

The hydro DEB option was developed through the Local Market Power Mitigation Enhancements stakeholder initiative to offer more flexibility for hydro resources. Stakeholders noted that the existing opportunity cost adders calculated monthly could account for the intertemporal energy sales at a unit's specific location, but did not capture the opportunity for intertemporal sales outside of the CAISO's real-time energy market, or reflect short-term (daily) limitations[16].

The cost components are linked to resource-specific parameters including the resource's maximum storage horizon, electric pricing hub based on the resource's location, other electric pricing hubs to which the resource has firm transmission rights.

Hydro DEB = MAX[Gas floor, Short-term component, Long-term component]

Where:

Gas floor	The gas floor represents the opportunity cost for the hydroelectric generator to sell electricity generated from a similarly-situated gas resource instead of the hydro resource. This is formulated similarly to the variable cost DEB calculation for gas generators and uses a standard peaker heat rate.	1.1 * [11,068 MMBtu/MWh * Fuel region gas price]
Short-term component	The short term component represents the opportunity cost of sales at the local wholesale electric pricing hub.	1.4 * MAX[Day Ahead$_{L}$, Balance-of-Month$_{L}$, Month Ahead$_{L,+1}$]

[16] Local Market Power Mitigation Enhancements, Draft Final Proposal P 31 DraftFinalProposal-LocalMarketPowerMitigationEnhancements2018.pdf (caiso.com)

	The Day Ahead component is the DA power price index at the local default electric pricing hub. Balance of month and future monthly index prices are also included. This is the same bilateral price index used to calculate the MIBP.	
Long-term component	The long-term component represents the opportunity cost of sales at the default and additional electric pricing hubs over future months of the storage horizon using future monthly index prices.	1.1 * MAX[Day Ahead$_L$, Balance-of-Month$_L$, Month Ahead$_{L,+1}$]

7.2. Appendix B: Scalars

Scalars incorporated within DEB calculations can account for a margin of error between the information available to the ISO when the DEB is calculated and the actual incremental costs facing generators. The DEB is a single value calculated each day but updated information may become available that can inform the DEB. The reasonableness threshold, which can also have a scalar, can account for intra-day variation and facilitate hourly adjustments through the automated RLCR process.

Scalars incorporated into DEB calculations represent a margin of error between what is known by the ISO and what is reasonably expected to materialize. For a scalar to be an effective proxy, it should be resource specific, or based on observations or known variations between the actual and expected marginal costs to which it is being applied.

Hydro DEB option: Hydro uses a 140% scalar for the short-term component of the DEB. The analysis to inform the scalar calculated the default energy bid for each day without a scalar and compared it to real-time FMM prices in the resource's balancing area over a year[17]. It was observed that a resource would be dispatched any time EIM prices are greater than the DEB. The scalar equivocates the cost where the storage resource would be expected to be dispatched less than the potential daily energy availability 95% of the intervals assessed.

Previous policy discussions have considered the scalar on the DEB a safe harbor, while adjustments through the RLCR process require documentation to support actual costs. A larger scalar would account for a greater range of potential outcomes, but could also inflate costs unnecessarily if more precise information is available. Reasonableness thresholds based on a resource's specific parameters should

[17] Local Market Power Mitigation Enhancements October – December 2018: Presentation-LocalMarketPowerMitigationEnhancements-WorkingGroup-Oct10_2018.pdf (caiso.com), Presentation-LocalMarketPowerMitigationEnhancements-Nov28_2018-UpdatedVersion.pdf (caiso.com)

allow resources to reflect costs no less than the value of their DEB, and request adjustments beyond that value hourly in real-time given supporting documentation.

7.3. Appendix C: Conditions to raise the energy bid cap

Today, one of two conditions must be met to raise the energy bid cap above the soft offer cap:

1. The market accepts a bid above $1,000/MWh from a resource-specific resource, or
2. The allowable MIBP goes above $1,000/MWh

Today, the tariff requires resource-specific resources to successfully cost-verify and receive an adjusted DEB through the reference level change request (RLCR) process in order for the market to accept a bid above $1,000/MWh. From a systems perspective, any bid above $1,000/MWh from a resource specific resource would fulfill the condition to change the energy bid cap. However, the market only clears resource-specific resource bids above $1,000/MWh that have been successfully verified through the RLCR process because that is the only way for resource-specific resources to reflect a bid above $1,000/MWh in the market today.

When the bid cap goes up, a set of penalty price parameters are doubled so that priorities are preserved.

If the bid cap is raised in any hour of the day-ahead market, the penalty prices will be scaled up for all trading hours of the day-ahead market and real-time market for the same trading day.

If the bid cap is not raised in any hour of the day-ahead market, but the conditions apply to raise the bid cap in hours of the real-time market, the real-time market will use the scaled up penalty price for all intervals of overlapping real-time market horizons.

7.4. Appendix D: Examples of battery storage bidding rules and MPM outcomes

The proposal to revise the DEB cap to $2,000/MWh may impact the outcome of MPM without otherwise changing existing market power policy. For battery storage resources, the impact depends on the degree of bidding flexibility provided by the proposal in Section 4.2.

<u>The following examples are for illustrative purposes only.</u>

In each example scenario illustrated in Table 3 below, two representative resources have the same calculated DEB value, submit the same bid, and are subject to the same bid cap. If the resource's bid is capped, **the revised bid is shown in bold**. If the resource's bid is subject to MPM, **the mitigated bid is shown in bold**.[18] A resource's bid could be both capped and subject to MPM.

[18] The CAISO proposes no changes to existing MPM logic; for simplicity, these examples assume that if mitigated, resources are mitigated to the lower of their DEB value and submitted bid.

The difference between the two resources being compared is the implementation timeline for each resource's DEB option:

- Resource A's bids are capped by the battery storage bid cap without consideration of the DEB because Resource A uses a DEB option that can not be used to inform the bid cap pre-market consistently across both markets (e.g. storage DEB)
- Resource B's bids are capped by the higher of the LESR bid cap and its DEB (it uses a DEB option that can be used to inform a pre-market bid cap, e.g. negotiated DEB).

Takeaways

If the DEB is not included in the bid cap logic, there is a risk that the battery storage bid cap may be too restrictive and could prevent a resource from reflecting the calculated DEB value in its bid. The two scenarios in which the outcome for Resource A and B differ, highlighted in blue in the table below, are Scenarios B and E where the DEB is higher than the highest value in the battery storage bid cap. However, the counterfactual analysis of storage DEB values suggests that this risk is low. The incremental proposal in Section 4.2 is expected to provide sufficient bidding flexibility to allow resources to reflect at least the value of their uncapped DEB.

In Scenario G, the resource submits a bid less than the bid cap and DEB. If MPM is triggered, neither resource A nor B's bid is mitigated. Resource bids will not be revised up to the DEB if they cannot bid up to the value of the DEB, or choose not to bid up to the value of the DEB.

Even if a resource is able to bid above the value of the DEB and above $1,000, there is still a risk that the resource's bid will be mitigated down to the value of the DEB.

Table3: Battery storage bidding rules and MPM outcomes

Scenario	Both resources			Resource A, DEB is not considered in the bid cap		Resource B, DEB informs the bid cap	
	DEB ($/MWh)	Bid ($/MWh)	Battery Storage Bid Cap ($/MWh)	If Capped ($/MWh)	If Mitigated ($/MWh)	If Capped ($/MWh)	If Mitigated ($/MWh)
A	900	2,000	900	**1,000**	**900**	**1,000**	**900**
B	1,400	2,000	900	**1,000**	1,000	**1,400**	1,400
C	900	2,000	1,400	**1,400**	**900**	**1,400**	**900**
D	1,400	2,000	1,400	1,400	1,400	1,400	1,400
E	2,000	2,000	1,400	**1,400**	1,400	2,000	2,000
F	1,400	2,000	2,000	2,000	**1,400**	2,000	**1,400**
G	2,000	1,100	2,000	1,100	1,100	1,100	1,100

Contents of Table 1 by column

- DEB: values in this column represent the calculated, uncapped DEB consistent with the proposal in Section 4.1
- Bid: The values in this column represent the bid submitted by the resource prior to the bid being validated and submitted into the market for the MPM pass and the market clearing process.

- Battery Storage Bid cap: The value in this column is the highest value of the cap on battery storage resources, described in Section 4.2, that considers the fourth-highest value of the MIBP and the highest cost-verified bid. This column does not consider the DEB value.
- Resources:
    - Resource A: the bid cap is set by the battery storage bid cap
    - Resource B: the bid cap is set by the higher of the battery storage bid cap and the DEB.
- "If capped": Bids are capped by the higher of the Battery Storage bid cap and the DEB if applicable. Bolded values are capped values used in the market. Un-bolded values would not be capped going into the market.
- "If mitigated": bolded values are mitigated values. Un-bolded values would not have been impacted by MPM. These examples assume mitigated resources are mitigated down to the DEB, and do not consider the competitive LMP.