Day-Ahead Market Enhancements

Third Revised Straw Proposal

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Day-Ahead Market Enhancements: Third Revised Straw Proposal

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Executive Summary

The objective of this initiative is to enhance the California ISO's (CAISO's) day-ahead market by:

- Introducing an imbalance reserve product in the integrated forward market that procures flexible capacity to cover real-time ramping needs that are not covered by hourly day-ahead market schedules and to cover uncertainty in the net load forecast between day-ahead and real-time markets.
- Enhancing the residual unit commitment process to enable the procurement of downward dispatch capability and to include local market power mitigation measures.
- Enhancing the day-ahead market to maximize benefits of greater West-wide diversity in the day-ahead optimization for Western Energy Imbalance Market participants.

This paper describes the CAISO's proposed day-ahead market design enhancements.

The integrated forward market will continue to co-optimize energy and ancillary services but will include imbalance reserves within the same co-optimization to reserve resources' ramp capability for real-time dispatch. Imbalance reserves will ensure the day-ahead market schedules sufficient real-time dispatch capability to meet net load imbalances and ramping needs that materialize between the day-ahead and real-time markets. Net load imbalances are changes between the net load forecasted in day-ahead market and real-time net load. Net load imbalances are caused by net load forecasting uncertainty and granularity differences between the hourly day-ahead market schedules and real-time market schedules. These imbalances have increased in recent years because of increasing amounts of weather-dependent supply and load resources on the CAISO grid.

The CAISO day-ahead market currently lacks a product that procures flexible capacity to address day-ahead to real-time imbalances. Without a day-ahead flexible capacity product, uncertainty around imbalances that materialize in real-time poses operational risks. This increased risk causes system operators to procure additional capacity in the day-ahead timeframe through out-of-market actions. Specifically, system operators manually increase the net load forecast used in the residual unit commitment process to commit and schedule additional units to address the net load uncertainty between the day-ahead and real-time markets. Persistent and systematic out-of-market actions taken by CAISO operators signal a gap in the CAISO's market design. The CAISO believes the implementation of imbalance reserves will greatly decrease the need for system operators to manually adjust the load forecast used in the residual unit commitment process, creating a more efficient and effective market outcome.

By reducing out-of-market actions in the residual unit commitment process, imbalance reserves will return the residual unit commitment process to its original purpose. The purpose of the residual unit commitment process is to procure capacity for three reasons: (1) to meet the difference between the market-cleared load schedules and the load forecast, (2) to meet the difference between the market-cleared variable energy resource schedules and variable energy resource forecasts, and (3) to backfill cleared virtual bids with physical resources.

The residual unit commitment process is an essential part of the day-ahead market and the CAISO is proposing several enhancements to the current residual unit commitment process. The CAISO will continue to run the existing residual unit commitment process after the integrated forward market co-optimizes energy, ancillary services, and imbalance reserves. However, the CAISO proposes to enhance the residual unit commitment process so that it also provides downward dispatch capability if the net load forecast is less than the net load that clears the integrated forward market. This incremental or decremental capacity awarded in the residual unit commitment process is called reliability capacity up and reliability capacity down, respectively. All resources that can participate in the residual unit commitment process today are eligible to provide reliability capacity. Reliability capacity awards are capped at the resource's 60-minute ramping capability. In addition to procuring reliability capacity down, the CAISO proposes to enhance the residual unit commitment process by establishing the binding configuration for multi-stage generating resources and incorporating local market power mitigation measures for reliability capacity offers through an additional market pass.

Under the proposed enhancements, suppliers will provide price and quantity bids for capacity availability in both the upward and downward direction that the market will use to award imbalance reserves and reliability capacity. The market will consider transmission constraints to ensure imbalance reserves and reliability capacity are deliverable in the day-ahead timeframe. Resources awarded imbalance reserves or reliability capacity will receive a day-ahead payment at the locational marginal price for the relevant product.

Resources that receive an imbalance reserve or reliability capacity award will be obligated to provide economic energy bids in the real-time market. Only resources that can be dispatched in the fifteen-minute market will be eligible to provide imbalance reserves. Imbalance reserve awards will be capped at the resource's 15-minute ramping capability.

Ramping capability provided by imbalance reserve awards in the day-ahead market will be settled against flexible ramping product in the real-time market. The market will recover the costs of imbalance reserves and reliability capacity through cost allocations that collect payments from entities based on their contribution to the need to procure the product.

The enhancements proposed in this initiative are also essential elements of an extended day-ahead market (EDAM) in which Western Energy Imbalance Market participants outside of the CAISO's balancing authority area can also participate.[1] Imbalance reserves would optimize the scheduling of reserve capacity across the EDAM footprint to meet each EDAM participants' net load uncertainty and real-time ramping needs. Imbalance reserves also provide the EDAM a consistent method for evaluating and addressing uncertainty in each EDAM BAA. Additionally, reliability capacity up and down will be procured in the EDAM to ensure each EDAM participant has sufficient physical supply scheduled in the day-ahead timeframe to meet their net load forecast.

[1] This stakeholder process is underway. More information can be found at: http://www.caiso.com/StakeholderProcesses/Extended-day-ahead-market

1. Changes from Revised Straw Proposal and Responses to Stakeholder Feedback

The CAISO published the Day-Ahead Market Enhancements (DAME) second revised straw proposal on July 21, 2021 and held a web meeting to discuss the proposal on June 28, 2021.

The second revised straw proposal promoted a sequential integrated forward market (IFM) and residual unit commitment (RUC) process, as opposed to a co-optimized IFM and RUC processes. The second revised straw proposal continued to propose a new imbalance reserve product in the IFM that reserves flexible capacity for net load uncertainty and intra-hour ramping capability. The second revised straw proposal continued to propose to enhance the RUC process by enabling the procurement of downward dispatch capability and proposed a new local market power mitigation pass for RUC. This third revised straw proposal does not change these earlier proposed day-ahead market structures. However, this third revised straw proposal does change, clarify, or confirm many important elements of the overall proposal based on stakeholder feedback. This third revised straw proposal:

- **Refreshes the discussion on the need for day-ahead market enhancements in Section 2.** Some stakeholders commented on the previous proposal that the CAISO had not sufficiently justified the need for imbalance reserves or estimated its market impacts. CAISO staff presented the benefits of imbalance reserves to the Market Surveillance Committee on November 19, 2021[2] and held a broader discussion on the need for day-ahead market enhancements at a stakeholder workshop on January 24, 2022.[3] The CAISO also posted and presented a Day-Ahead Market Enhancements analysis report on January 24, 2022.[4,5] Elements from these presentations and reports are included in this proposal to provide the CAISO's latest thinking.
- **Clarifies the bidding obligations for all resources that want to provide or are awarded imbalance reserves or reliability capacity in Section 3.1.**
- **Clarifies day-ahead bidding obligations for resource adequacy resources to provide imbalance reserves and reliability capacity in Section 3.1.** Stakeholders asked the CAISO to clarify resource adequacy bidding obligations for imbalance reserves and reliability capacity in the day-ahead market. All resources that are providing RA capacity and that are eligible to provide imbalance reserves will have a must-offer obligation to bid for imbalance reserves up and down in the day-ahead market. All resources that currently have a day-ahead must-offer obligation to

[2] Day-Ahead Market Enhancements discussion. Market Surveillance Committee Meeting General Session. November 19, 2021. http://www.caiso.com/Documents/Day-AheadMarketEnhancements-Presentation-Nov19_2021.pdf.
[3] Day-Ahead Market Enhancements. CAISO Stakeholder Workshop. January 24, 2022. Presentation-Day-AheadMarketEnhancements-StakeholderWorkshop-Jan24-2022.pdf(caiso.com).
[4] Alderete, Guillermo Bautista and Zhao, Kun. Day-Ahead Market Enhancements Analysis. January 24, 2022. Day-AheadMarketEnhancementsAnalysisReport-Jan24-2022.pdf (caiso.com).
[5] Day-Ahead Market Enhancements Analysis. CAISO Stakeholder Workshop. January 24, 2022. Presentation-Day-AheadMarketEnhancementsAnalysis-Jan24-2022.pdf (caiso.com).

provide RUC availability will have a day-ahead must-offer obligation to bid for reliability capacity up and down.

- **Confirms the CAISO's proposal to enhance real-time must-offer obligation rules by allocating real-time availability based on obligations associated with imbalance reserve and reliability capacity awards. Also confirms the CAISO's proposal to allow resource adequacy capacity to bid for reliability capacity at non-zero prices and for resource adequacy capacity to be compensated the marginal price of reliability capacity up and down.** CAISO staff presented this proposal to the Market Surveillance Committee on February 11, 2022.[6] Several stakeholders expressed opposition to this proposal. Stakeholders argue that imbalance reserves would replace the general RA real-time must-offer obligation in a way that would reduce system reliability and undermine capacity procurement decisions made by the load-serving entities. Stakeholders felt that RA capacity was paid and, therefore, RA resources should retain a real-time must offer obligation as a general requirement regardless of day-ahead imbalance reserves or reliability capacity awards. The CAISO maintains that only requiring must-offer obligations from resources awarded imbalance reserves or reliability capacity in the day-ahead market would be a more efficient way of allocating real-time availability without jeopardizing reliability. Today, certain resource adequacy resources have an obligation to be available in the real-time market without receiving a day-ahead schedule. Suppliers have costs and face risks by committing their availability without the certainty of a market award and payments. Because resource adequacy resources receive no market compensation for their real-time availability, they must recover the costs and risks through resource adequacy contract payments, which adds cost to resource adequacy capacity.

  The CAISO maintains that compensating suppliers for their availability through imbalance reserves and reliability capacity payments is a more efficient way to procure reserves, compensate resources, and ensure efficient resource adequacy capacity pricing. First, by allocating real-time availability based on bid costs, the market optimization will be able to choose the most efficient and least-cost resources to be available when and where needed. Second, if the RA real-time must-offer obligations is retained, some resource adequacy resources will receive market payments for imbalance reserve awards when they would have been required to be available in real-time anyway. This would constitute a double payment. Finally, under the status quo, resource adequacy resources would be required to offer their capacity at $0 into the EDAM. This puts CAISO resource adequacy resources at a competitive disadvantage compared to the rest of the EDAM participating resources and would essentially be used to serve the reliability of the EDAM footprint (as opposed to just the CAISO BAA) at artificially low costs.

  In terms of reliability, the CAISO maintains it will be able to implement imbalance reserves to achieve a comparable (or higher) level of reliability to the RA real-time must-offer obligation. The CAISO is working on data analysis to inform this conclusion. Even so, there are several

[6] Day-Ahead Market Enhancements discussion. Market Surveillance Committee Meeting General Session. February 11, 2022. http://www.caiso.com/Documents/Day-AheadMarketEnhancements-Presentation-Feb11_2022.pdf.

additional reasons the CAISO feels that reliability can be maintained or strengthened in this new paradigm. First, imbalance reserves allow the market to line up short and long start resources in the day-ahead market rather than waiting for the real-time market to address flexibility concerns. For example, because they are scheduled in the day-ahead timeframe, use limited resources will be able to better manage their use limitations to be available when needed for flexibility in real-time. Second, the CAISO expects many resources (both RA and non-RA) will offer supply into the real-time market even without day-ahead awards or real-time must-offer obligations. Third, the CAISO will maintain the ability to exceptionally dispatch resources not scheduled in the day-ahead market. Fourth, in the Extended Day-Ahead Market, the CAISO BAA will share in the benefit of access to a larger pool of resources to meet uncertainty needs over the entire EDAM footprint. In any case, the CAISO proposes that the relevant Local Regulatory Authority can enforce a real-time must-offer obligation for supply contracted by its jurisdictional entities.

- **Clarifies in Section 3.2 the CAISO is moving forward with a proposal to apply local market power mitigation measures to imbalance reserve offers. Also adds an example in Appendix C to demonstrate local market power mitigation of energy and imbalance reserves in the upward deployment scenario.** In the previous proposal, the CAISO proposed to mitigate both energy and imbalance reserve offers when a resource could provide counter-flow to an uncompetitive transmission constraint in the deployment scenarios. Some stakeholders asked in their comments for the CAISO to justify why the market should mitigate energy offers in the deployment scenarios. Section 3.2 provides that explanation and Appendix C provides an example and accompanying commentary for further justification. The CAISO also presented at the March 2, 2022 stakeholder workshop that it did not need to mitigate imbalance reserve offers. There were two parts to the CAISO's rationale. First, imbalance reserve requirements are system-wide and fungible with energy. If a resource tries to exercise local market power through its imbalance reserve bid, the market solution will instead procure energy from that resource and find another resource to provide imbalance reserves. Second, mitigating energy bids when the upward deployment scenario has uncompetitive constraints also mitigates the opportunity cost portion of the marginal price for imbalance reserves. The CAISO originally believed based on these observations that mitigating imbalance reserve offers was not necessary. However, the CAISO included examples in Appendix C that show that although a resource may find it challenging to profitably withhold imbalance reserve capacity, attempting to do so can force the market into a less economic solution through a higher-cost energy dispatch. This can lead to uncompetitive prices and higher overall costs to load. The CAISO also does not presume this simple example used for illustrative purposes captures the nuances of a more complicated network with potentially more opportunities for suppliers to drive up costs through economic withholding of imbalance reserves. In fact, a resource can exercise local market power through its imbalance reserve offer and therefore it is appropriate to mitigate these bids.
- **Clarifies in Section 3.3 the constraint on imbalance reserve awards based on a resource's 15-minute ramping capability and the percentiles to which the uncertainty requirements are estimated (e.g., 97.5 and 2.5) will be adjustable parameters.** Some stakeholders suggested in

their comments that the 15-minute ramping nature of imbalance reserve is overly restrictive. The CAISO's Department of Market Monitoring put out data that suggest the hourly forecast errors in the real-time market are correlated with each other. DMM suggests the imbalance reserve product does not need to be designed around 15-min ramping capability because real-time market processes (e.g., STUC) would likely anticipate some of the uncertainty and would position units to meet the uncertainty a few hours in advance. In recognition of this, the CAISO proposes to implement imbalance reserves such that the parameters that 1) restrict awards to the 15-minute ramping capability of the resource and 2) restrict awards to offline units to those that can start-up in 15 minutes or less, would be adjustable parameters. The CAISO will commit to monitoring the performance of the imbalance reserve product and will evaluate after some operational experience whether allowing some of the imbalance reserve requirement to be met over longer ramp horizons is necessary or desirable.

- **Updates the proposal in Section 3.3 to procure imbalance reserves based on graduated penalty price parameters rather than a single penalty price parameter.** This policy addresses how imbalance reserves will be procured when supply is scarce. The previous proposal was to procure imbalance reserve based on a single constraint relaxation penalty price. This penalty price would have been set to a level above low-priority self-scheduled exports but below self-scheduled CAISO demand and high-priority self-scheduled exports. This would protect the procurement of the full imbalance reserve requirement over low-priority exports. Procuring the full imbalance reserve requirement would also minimize future operator adjustments to the RUC load forecast. However, the CAISO has several concerns with this approach. First, to keep pricing consistent, the CAISO would have to implement a pricing run penalty parameter of $247 (compared with a penalty parameter somewhere between $1050 and $1800 in the scheduling run), which is equal to the imbalance reserve bid cap. This large difference between scheduling run and pricing run penalty prices could cause inefficient market results. For example, load and exports will potentially not clear at prices they are willing to pay. When supply is scarce, the market optimization would award imbalance reserves over clearing an export or load bid with a $1000 bid price. The day-ahead market prices from the pricing run would be based on the $247 penalty price, which is lower than demand's willingness to pay $1000. This would create an incentive for load and exports to self-schedule rather than economically bid and risk losing a demand schedule to imbalance reserves at a much lower market price, which undermines market efficiency and market power protections. The CAISO also does not find that a marginal unit of imbalance reserves would necessarily be worth procuring at the energy bid cap price. That is why the CAISO proposes a graduated penalty price structure. The CAISO would gradually relax the imbalance reserve requirements as prices got higher but establish a minimum threshold of imbalance reserves to procure at a high penalty price. The CAISO believes this approach results in more efficient market outcomes and balances the reliability benefit of imbalance reserves without incurring excessive costs.
- **Confirms CAISO's intention to maintain imbalance reserves as a nodal product through use of deployment scenarios in Section 3.3.** Some stakeholders argued in their comments that the CAISO should implement imbalance reserves as a nodal product that respects transmission constraints using deployment scenarios. The rationale given by several entities was that real-

time congestion can vary greatly from day-ahead congestion to the point where modeling imbalance reserves to respect transmission constraints in the day-ahead timeframe may not be worth the additional complexity. The CAISO disagrees that this concern is sufficient to justify moving to a zonal imbalance reserve approach. Although congestion patterns between markets can change, zonal procurement of imbalance reserves could result in capacity procured behind known transmission constraints in the day-ahead timeframe. This procured capacity would be worthless if needed outside of the transmission-constrained area. Nodal procurement of imbalance reserves offers the best reliability that the real-time market will be sufficiently prepared to address uncertainty that materializes. Nodal procurement also results in locational prices that reflect the value of flexible capacity at each location, providing proper market signals.

- **Clarifies bid insertion rules in Sections 3.3 (for imbalance reserves) and 3.5 (for reliability capacity).** Stakeholders requested in their comments the CAISO clarify how day-ahead market and real-time market bid insertion would apply to these products.
- **Clarifies how energy storage resources fit into the cost allocation for imbalance reserves in Section 3.3.** Stakeholders requested this clarification in their comments.
- **Includes a new section discussing export protection in the day-ahead market after implementing imbalance reserves and clarifying the relationship between imbalance reserves and high-priority exports rules in Section 3.3.** Some stakeholders commented that non-RA capacity supporting high-priority exports should be exempt from providing imbalance reserves. Commenters representing non-RA backed exports argued that non-RA capacity should not be considered for imbalance reserves because the supply is under contract with a non-CAISO load serving entity and should not be dedicated to CAISO to meet its uncertainty requirements. On the other hand, commenters representing CAISO load interests argued the CAISO should ensure imbalance reserve capacity should not be able to be exported because it is intended to meet CAISO net load uncertainty. The CAISO reiterates in this proposal that because exports backed by non-RA capacity are not directly linked to the output of the resource, neither concern is framed correctly. The CAISO's validation process considers the export self-schedule "supported" if there are sufficient bids provided from non-RA capacity on a supporting resource.
- **Clarifies the CAISO's rationale for proposing to mitigate reliability capacity bids in Section 3.4.** Some stakeholders contend that FERC has already rejected local market power mitigation measures for the residual unit commitment process under MRTU. The CAISO acknowledges this, but the context for that FERC decision is different from what is proposed in this initiative. In its order, FERC was not concerned about the exercise of local market power in RUC because CAISO resource adequacy resources were required to submit zero dollar bid prices for all available resource adequacy capacity. This would tend to limit any exercise of local market power because in most cases the clearing price of RUC supply was expected to be $0. The presence of significant $0 bids from resource adequacy capacity was itself a form of market power mitigation. This initiative proposes changes to allow CAISO resource adequacy resources to submit non-zero bid prices in RUC. Stakeholders also commented that the CAISO has not demonstrated the presence of local market power in RUC. Section 3.4 describes that reliability

capacity will respect transmission constraints. This is done by modeling reliability capacity awards as energy flows to ensure the energy that would result from reliability capacity awards is deliverable. Thus, reliability capacity marginal prices will include a marginal congestion contribution that could be uncompetitive. Therefore, it is appropriate to implement local market mitigate measures for RUC given the changes proposed in this initiative.

- **Documents in Section 3.4 the rationale for CAISO's low concern about market solve time and performance by implementing a new RUC Market Power Mitigation pass.** Some stakeholders expressed concern in their comments that implementing a new market pass may jeopardize the time it takes to solve the market and related market performance. The CAISO does not share this concern and justifies its rationale in Section 3.4.
- **Clarifies in Section 3.5 how high-priority export rules interact with the proposal that RUC will be able to transition down a multi-stage generator (MSG) resource.**
- **Clarifies treatment of EIM base schedules within the real-time market settlement of ramp deviations in Section 4.1.** EIM participants will be subject to a forecasted movement deviation settlement in FMM.
- **Provides additional context regarding Congestion Revenue Rights in Section 4.2.** The CAISO continues to propose no changes to the CRR model or the CRR allocation or auction processes. This means the CAISO will not reserve transmission in the CRR model for imbalance reserve flows. The CAISO clarifies in this section that because the imbalance reserve product is settled through a cost allocation instead of a direct settlement, that may result in underfunding for CRRs because the CAISO will not collect congestion revenue on the imbalance reserve flow. The CAISO believes in practice the impact to CRRs will be minimal, but proposes to monitor the performance of CRRs and be prepared to act if necessary. This also presents two options that could address the underfunding of CRRs if it becomes a significant issue.
- **Updates how the market will account for a resource's underlying energy cost when awarding upward capacity products in Section 4.3.** The CAISO previously proposed that resources would be ineligible for imbalance reserve up or reliability capacity up on any capacity segment with an associated energy bid price that exceeded the marginal price of meeting the 97.5 percentile of upward net load uncertainty. The CAISO found it was not able to implement this proposal. The CAISO proposes instead to implement a real-time energy bid price cap on all resources that receive an imbalance reserve up or reliability capacity up award. The real-time energy bid price cap would still be set based on the marginal price of meeting the 97.5 percentile of upward net load uncertainty. The objective is to prevent opportunities for high energy cost resources from routinely being awarded imbalance reserve up and reliability capacity up (and the resulting capacity payments) when the resources will rarely be dispatched for energy in the real-time market.
- **Removes the section on the proposed calculation of default availability bids for imbalance reserve and reliability capacity local market power mitigation.** The CAISO had previously proposed to set the default bid price for mitigation of imbalance reserve and reliability capacity offers for all resources to the 90th percentile historical spinning reserve bid. The CAISO no longer proposes to use default availability bids for mitigation. The CAISO has struggled to come

up with an agreeable way to set a default bid for imbalance reserves and reliability capacity. Many stakeholders believed tying the default availability bids to the 90th percentile spinning reserve bid was too arbitrary. The CAISO agrees with stakeholders. The costs for a resource to be available in the real-time market without a day-ahead schedule would vary by the resource's fuel type, hedging strategies and risk assessments, opportunity costs, transmission costs, etc. The CAISO believes deriving a reasonable methodology to calculate a default availability bid for all resources would be excessively complicated. The proposal to mitigate imbalance reserve and reliability capacity offers to the competitive locational marginal price is based on an established and FERC-approved methodology that the CAISO believes balances the risk to suppliers of over-mitigation with the risk to demand for uncompetitive prices driven by exercise of local market power.

- **Confirms the CAISO's position in Section 4.4 to enable VERs to provide imbalance reserves up and reliability capacity up but the specific mechanics are being re-evaluated.** In the previous proposal, the CAISO proposed that variable energy resources (VERs) would be eligible to provide imbalance reserves up or reliability capacity up if they elected to be a "forecasted VER". A forecasted VER would not be able to receive a combination of day-ahead energy and capacity awards in the IFM that exceed its CAISO VER forecast. Some stakeholders commented that the CAISO should not allow VERs to provide imbalance reserves up or reliability capacity up because their output is uncertain. The CAISO acknowledges this. However, the CAISO allows variable energy resources to participate in other capacity services that the resources are technically able to provide. Variable energy resources would be exposed to deviation settlements, rescission payments, and other financial penalties to the extent they could not meet their capacity awards, which provide financial incentives for VERs to have high certainty in their expected output if they bid to provide imbalance reserves up or reliability capacity up.
  However, the CAISO is re-evaluating the mechanisms by which VERs would be enabled to provide imbalance reserves up and reliability capacity up. The specific details will be included in the next proposal. The CAISO also proposes to alleviate concern around VERs providing imbalance reserve up or reliability capacity up by requiring VERs to provide the CAISO their High Sustainable Limit (HSL), which estimates a VERs maximum output capability.
- **Adds a section on the Energy Storage Resource model proposed in the Energy Storage Enhancements initiative[7] and its relationship to imbalance reserves and reliability capacity.**
- **Removes the section on the proposed transition period.** The previous proposal included a transition period that maintained the resource adequacy rules around the real-time must-offer obligation and $0 bidding requirement for reliability capacity and imbalance reserves. The CAISO proposed the transition period would end at the start of the calendar year in which EIM entities will onboard into the extended day-ahead market (EDAM). The CAISO has since updated the policy schedule to implement the DAME and EDAM initiatives together. Thus, a transition period as described above is no longer relevant.

[7] California ISO. Energy Storage Enhancements stakeholder initiative. https://stakeholdercenter.caiso.com/StakeholderInitiatives/Energy-storage-enhancements.

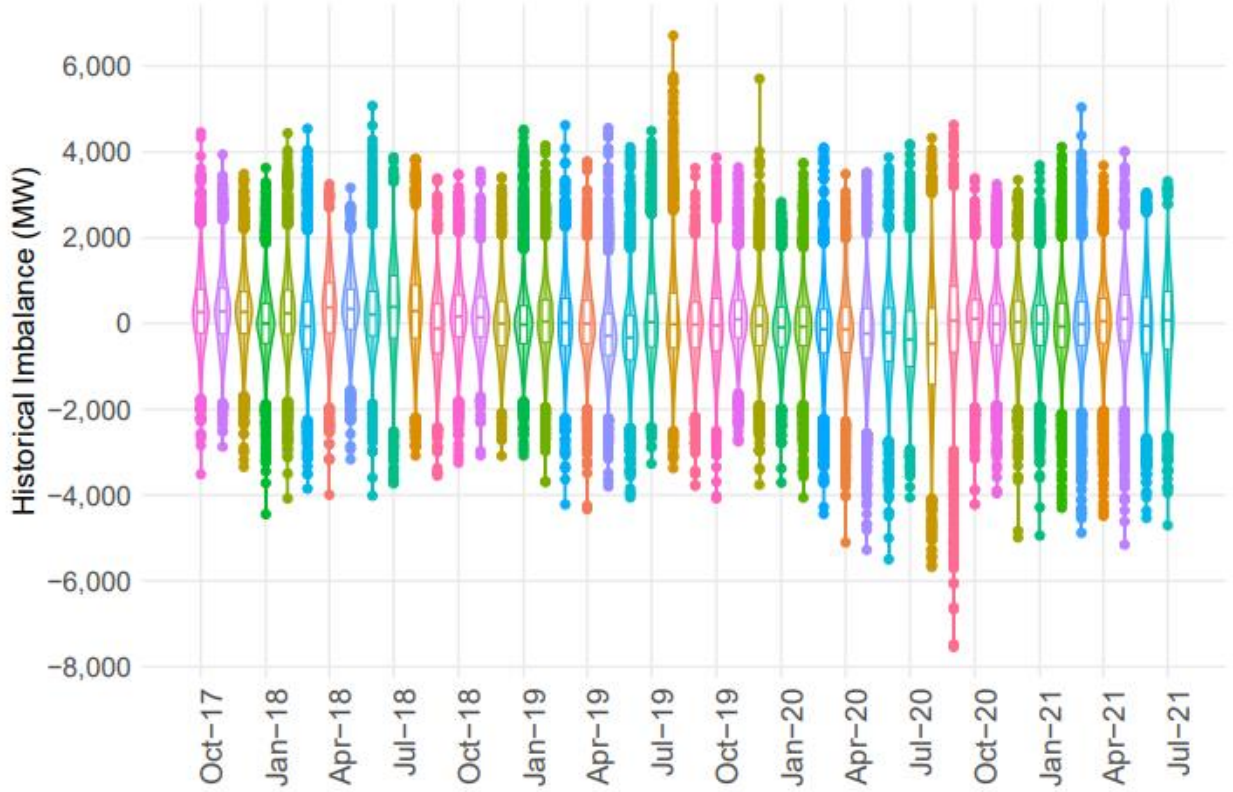
- **Updates implementation date and policy process schedule of Day-Ahead Market Enhancements in Section 7.** DAME is scheduled to be implemented in fall 2023. This aligns with the planned implementation of the extended day-ahead market to support onboarding in spring 2024.

2. Need for Day-Ahead Market Enhancements

Historically, the CAISO balancing authority area consisted of a predictable generation fleet and a predictable load. Resources were scheduled hourly in the day-ahead market with relatively predictable real-time load and ramping needs. Over the last 10 years, variable energy resources (i.e., wind and solar resources) have become more prevalent. While these resources are critical in meeting renewable energy and greenhouse gas emission goals, they also introduce supply uncertainty and can create challenging conditions for system operators. Rather than the relatively predictable gross load differences, system operators must manage the more unpredictable and variable net load differences, which is gross load minus variable energy resource generation.

Changes between day-ahead market schedules and real-time market schedules are commonly referred to as energy imbalances. Energy imbalances can occur for two reasons. First, the day-ahead market schedules energy in hourly time increments compared to 15- and 5-minute energy schedules in the real-time market. These granularity differences cause imbalances because the real-time market schedules fluctuate within the hour while the day-ahead market schedules are fixed for the hour. In other words, the real-time market can require faster, more granular intra-hour ramping capability when compared to the ramp rate needed to simply transition from one hourly schedule to the next. Second, there is uncertainty in the day-ahead net load forecast. The day-ahead net load forecast cannot perfectly predict the actual net load during the operating day. Any differences between the day-ahead forecast and what actually occurred results in imbalances. Figure 1 illustrates a monthly trend in day-ahead imbalances, calculated as the difference between the net load from the day-ahead market and the net load from the fifteen-minute market.

Figure 1: Monthly Trend of Day-Ahead Imbalance



Source: Day-Ahead Market Enhancements Analysis, page 7

The real-time market must manage energy imbalances that occur between the day-ahead and real-time markets. The real-time market will continue to serve this purpose under the redesigned day-ahead market. The CAISO proposes a new day-ahead market product called "imbalance reserves" to better accommodate net load imbalances. The new day-ahead market will co-optimize energy, ancillary services, and imbalance reserves, and will preserve the sequential integrated forward market and residual unit commitment structure.

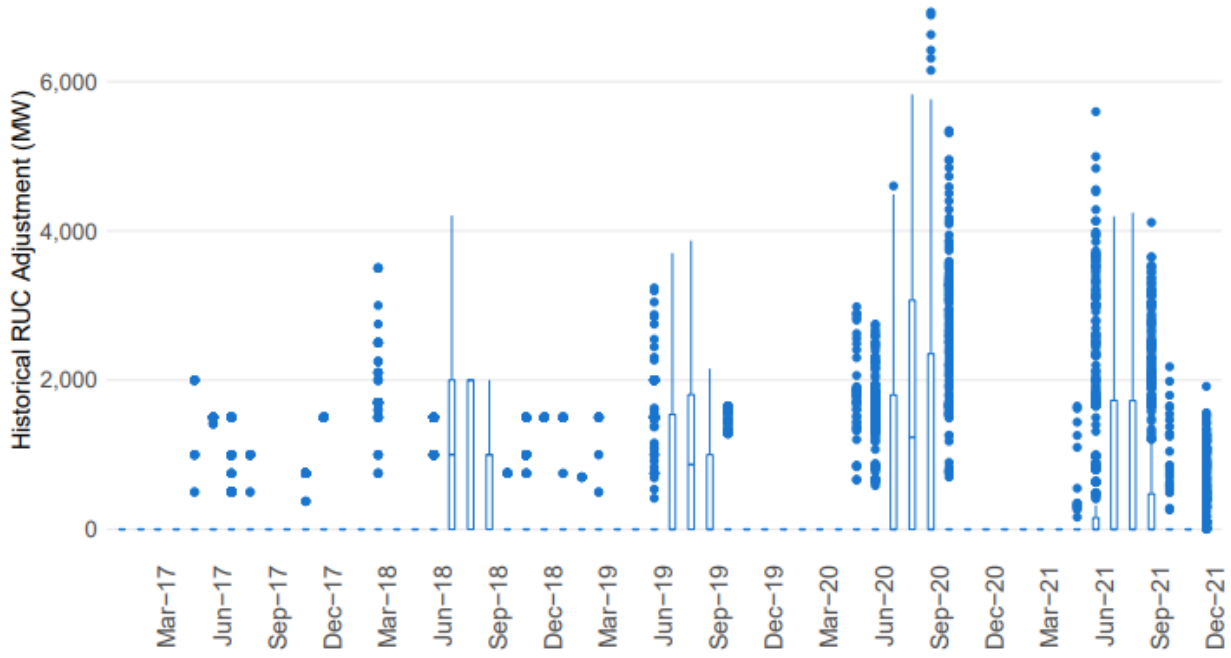
2.1. Improve Market Efficiency

Changes between the day-ahead market and real-time market are inevitable. Energy imbalances occur for many reasons including weather changes, outages, and forecasting uncertainty. Ultimately, the system operator is responsible for responding to energy imbalances between the day-ahead and real-time to ensure load is served reliably at all times.

Large imbalances between the day-ahead and real-time market can result in challenging conditions for system operators. When there is a risk that imbalances are too large to address through the real-time market, system operators must rely on out-of-market actions to cover these imbalances. CAISO operators have had to make upward adjustments to the forecast used in the RUC process for the last several years to ensure system reliability (see Figure 2). These operator adjustments to the RUC forecast have increased in frequency and magnitude over the last several years. CAISO system operators

systematically manually increase the RUC forecast because they need to procure capacity in addition to the supply scheduled in the IFM to address the high net load uncertainty.

Figure 2: Monthly Distribution of Operator Adjustments to RUC Forecast



Source: Day-Ahead Market Enhancements Analysis, page 12

CAISO system operators have to rely on systematic out-of-market actions because the IFM lacks a product that is optimized with energy and ancillary services that procures flexible capacity to cover net load uncertainty. Procuring flexible capacity to meet net load uncertainty through imbalance reserves, as opposed to through out-of-market actions such as operator adjustments to the RUC forecast, will provide substantial benefits:

- **Imbalance reserves will be co-optimized with energy and ancillary services in the IFM, as opposed to procured separately in RUC.** Co-optimization of imbalance reserve procurement with energy and ancillary services will help maximize the value of this capacity by resulting in more optimal unit commitment decisions and more optimal allocation of system ramping capability. In addition, marginal prices will consider the opportunity costs of not providing the other products. For example, if a resource is economic for energy but is held back to provide imbalance reserves instead, the marginal prices will ensure that resource earns sufficient revenue from providing imbalance reserves to cover the opportunity cost of not selling energy. In this way, the resource is indifferent to receiving an incremental energy schedule or imbalance reserve award.
- **Flexible reserves will be procured based on costs represented by imbalance reserves bids.** Today, resource adequacy resources that are required to participate in RUC must do so with a bid price of $0 for all resource adequacy capacity. Furthermore, resource adequacy resources do not receive compensation when the marginal clearing price of RUC capacity is non-zero.

However, there are costs to make resources available in the real-time market. These can be gas scheduling costs, costs to set up a hydro system, opportunity costs from other market opportunities, transmission costs for imports, etcetera. Resource adequacy resources do not recover these costs through market payments; they must recover these costs through resource adequacy contract payments. The CAISO believes it is more efficient, for both the overall system and individual resources, to procure flexible capacity using bids and compensate resources for that flexible capacity through direct market payments. Using bids allows the market optimization to consider costs when scheduling and committing units, leading to better economic outcomes. Marginal prices are a more appropriate mechanism to compensate resources for their availability than fixed contract payments and results in compensation that reflects when and where the capacity is most valued.

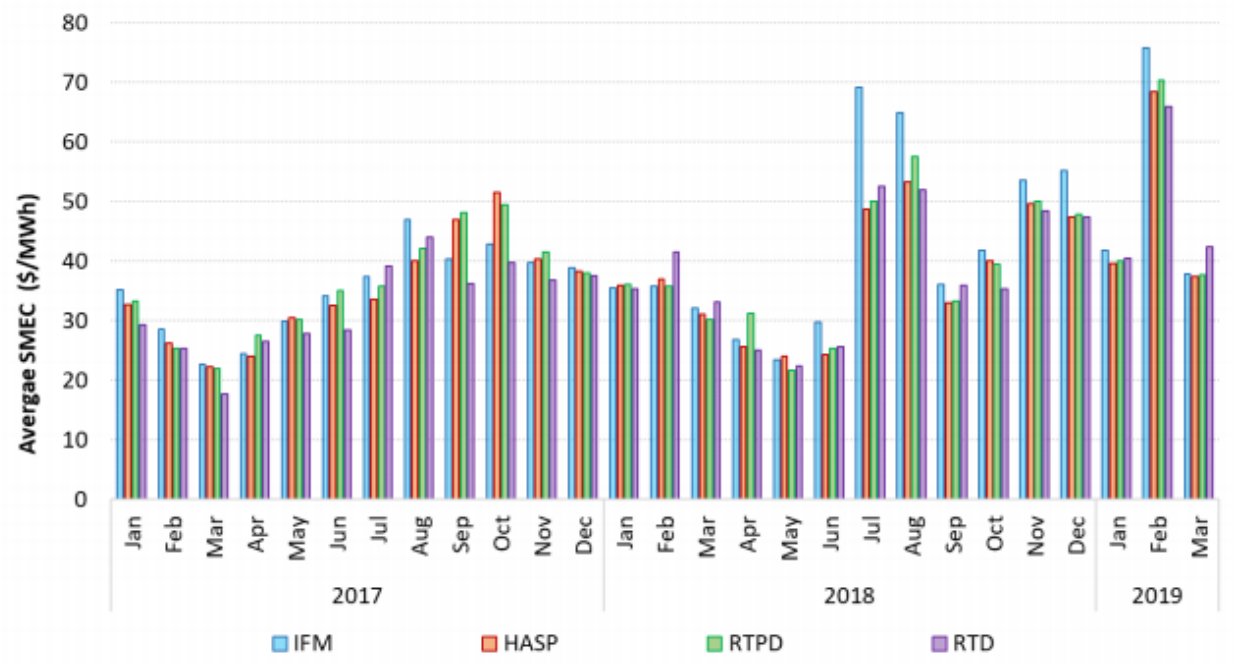
- **Imbalance reserves ensure the system has sufficient ramping capability.** By being co-optimized with energy, imbalance reserves allow the market optimization to consider the full ramping needs of the system (energy + uncertainty). In addition, because imbalance reserves are 15-minute dispatchable, they are designed to be more nimble and flexible than RUC capacity, because they are procured to meet the actual potential 15-minute ramping needs in responding to uncertainty or ramping needs that materialize intra-hour in real-time. There is no assurance the capacity committed or scheduled in RUC is sufficient to meet 15-minute ramping needs
- **Deliverability of capacity through imbalance reserves is more sophisticated than the deliverability of capacity procured through RUC adjustments.** Unlike like RUC adjustments, imbalance reserve deployment scenarios ensure that flexible capacity is deliverable to locations on the system where uncertainty needs are anticipated.
- **Procuring flexible reserves in the IFM better ensures that IFM export schedules are feasible.** Relying on RUC adjustments to procure capacity pushes the RUC procurement target farther away from the IFM solution. This can lead to export schedules that were cleared in IFM no longer being feasible in RUC. Because imbalance reserves are expected to significantly reduce the use of RUC adjustments, export schedules cleared in the IFM have a lower chance of being curtailed in RUC.
- **Imbalance reserves will encourage more 15-minute import schedules.** The opportunity to sell imbalance reserves into the CAISO market should encourage importers to set up their system resources as 15-minute dispatchable. This would give the CAISO real-time market additional flexibility.
- **Imbalance reserves aligns CAISO resource adequacy resources with other EDAM participants.** Imbalance reserves are the mechanism by which the EDAM establishes each participating BAAs uncertainty requirements. It would not be desirable in EDAM for the CAISO BAA to continue to procure additional supply to meet uncertainty through RUC adjustments.

2.2. Price Performance Analysis Report

The CAISO completed a comprehensive report titled *Price Performance Analysis* that summarized and analyzed price formation in the CAISO markets.[8] The report identified factors that contribute to price differences between the day-ahead and real-time markets and proposed solutions to mitigate potential inefficiencies.

As a part of this effort, the report analyzed imbalances across market runs. The greatest magnitude of imbalance occurs between the day-ahead and fifteen-minute market (as opposed to between the fifteen-minute market and the five-minute market). These imbalances can be as large as 6,000 MW in a single hour. The *Price Performance Analysis* report confirmed that large imbalances between the day-ahead and real-time market occur because of load forecast error and variable energy resource output changes. As shown in Figure 3, the "IFM prices are persistently higher than real-time prices starting in 2018 and continue in 2019."[9] CAISO believes this occurs because operators use out-of-market actions to procure additional capacity to meet potentially large imbalances. These out-of-market actions may then lead to less efficient and accurate pricing in the real-time market relative to the day-ahead market.

Figure 3: Pricing Differences across Day-Ahead and Real-Time Markets (Jan 2017 - Mar 2019)



Source: Price Performance Report, Page 22

Sustained price differences are a signal that the market is not functioning optimally. The actions the CAISO must take outside of the market to ensure grid reliability contribute to price differences. While

[8] CAISO Energy Markets Price Performance Report. September 23, 2019. http://www.caiso.com/Documents/FinalReport-PricePerformanceAnalysis.pdf

[9] Ibid., page 22

the CAISO must operate the system reliably, the CAISO also recognizes that consistent out-of-market actions signal there may be gaps in the current market design. Ultimately, the CAISO's goal is to produce a market solution that accurately reflect costs and system conditions, and is consistent with reliable operations.

The *Price Performance Analysis* report identifies the Day-Ahead Market Enhancements initiative as an opportunity to address the large imbalances between markets and reduce operator out-of-market actions. One of the goals of this initiative is to identify and implement enhancements to the day-ahead market design that will enhance price convergence between markets.

2.3. Imbalance Reserves Role in EDAM

The benefit of EDAM is to utilize diverse resources across balancing authority areas to meet load and operational needs across the west more efficiently. Imbalance reserves will be an important component of the EDAM in doing this and increasing its benefits:

- **Imbalance reserves enhance the reliability of the EDAM because of the diversity benefit of pooling multiple balancing authority areas.** While each EDAM BAA is required to bring supply and transmission to the EDAM to meet their own 97.5 percentile of net load uncertainty, by pooling the uncertainty risk over a wider geographic footprint, the EDAM will provide a much higher uncertainty coverage because uncertainty is not expected to materialize coincidently across the West.
- **Imbalance reserves will more efficiently reserve resource capacity by allowing balancing authority areas access to resources across the EDAM.** In addition to reducing the overall amount of capacity needed to meet net load in real-time, imbalance reserves will more efficiently select the resources to provide this capacity. It will provide balancing authority areas access to resources that can potentially provide this capacity at lower cost than their own resources. In addition, it will provide additional revenue opportunities to balancing authority areas with these more efficient and flexible resources.
- **Imbalance reserves establish a consistent treatment of uncertainty in the EDAM resource sufficiency evaluation.** This ensures that each BAA's uncertainty needs are evaluated equitably. **Imbalance reserves come with a real-time must-offer obligation.** EDAM participants can be assured they can rely on their neighbors to support their transfer obligations.

Reliability capacity is needed in the EDAM to ensure physical supply is committed to cover differences in cleared physical supply and each BAA's net load forecast. The integrated forward market is a financial market where bid-in load clears against bid-in supply while also meeting the ancillary services and imbalance reserve requirements. On the other hand, the residual unit commitment is a physical market that clears physical supply to meet the net load forecast. The EDAM will facilitate reliability capacity transfers between BAAs to minimize the cost of ensuring each BAA has enough physical supply committed to meet its net load forecast.

3. Proposed Day-Ahead Market Enhancements

Section 3 describes the proposed day-ahead market enhancements and is organized as follows:

- Section 3.1 provides an overview of the proposed changes and the various bidding obligations, including obligations specific to resource adequacy resources.
- Section 3.2 describes the proposed changes to the market power mitigation pass for the integrated forward market.
- Section 3.3 describes the proposed changes to the integrated forward market.
- Section 3.4 introduces and describes an additional market pass to perform local market power mitigation for the residual unit commitment process.
- Section 3.5 describes the proposed changes to the residual unit commitment process.

3.1 Overview

The day-ahead market will consist of four sequential market passes:

1. IFM market power mitigation (MPM) pass
2. Integrated forward market (IFM) pass
3. RUC market power mitigation pass
4. Residual unit commitment (RUC) pass

The IFM market power mitigation pass identifies potentially uncompetitive energy bids and mitigates them accordingly to ensure prices remain competitive throughout the system. Nothing is scheduled or dispatched in the IFM market power mitigation pass. If the potential for market power is detected in the IFM market power mitigation pass, energy reserve bids will be mitigated, and these mitigated bids will be used in the integrated forward market. The CAISO proposes in this initiative to include mitigation of imbalance reserve offers in the IFM market power mitigation pass.

Today, the integrated forward market uses supply and demand bids to determine the amount of energy that will clear in the day-ahead market. Convergence bids, also known as virtual supply and virtual demand bids, are allowed to participate in this financial market. The integrated forward market also procures ancillary services and commits resources to meet the CAISO's ancillary service requirements. The integrated forward market pass co-optimizes energy and ancillary services to produce financially binding day-ahead schedules and ancillary services awards. The CAISO proposes in this initiative to add an imbalance reserves up and down product to the integrated forward market. Imbalance reserves will be procured based on a requirement established by the CAISO that is calculated based on historical net load imbalance between the day-ahead and real-time markets.

The CAISO also proposes to include a new market power mitigation pass before the residual unit commitment to assess the competitiveness of reliability capacity offers. In the event the potential for market power is detected in the second market power mitigation pass, reliability capacity bids will be mitigated. Any mitigated bids will be used as inputs to the residual unit commitment pass.

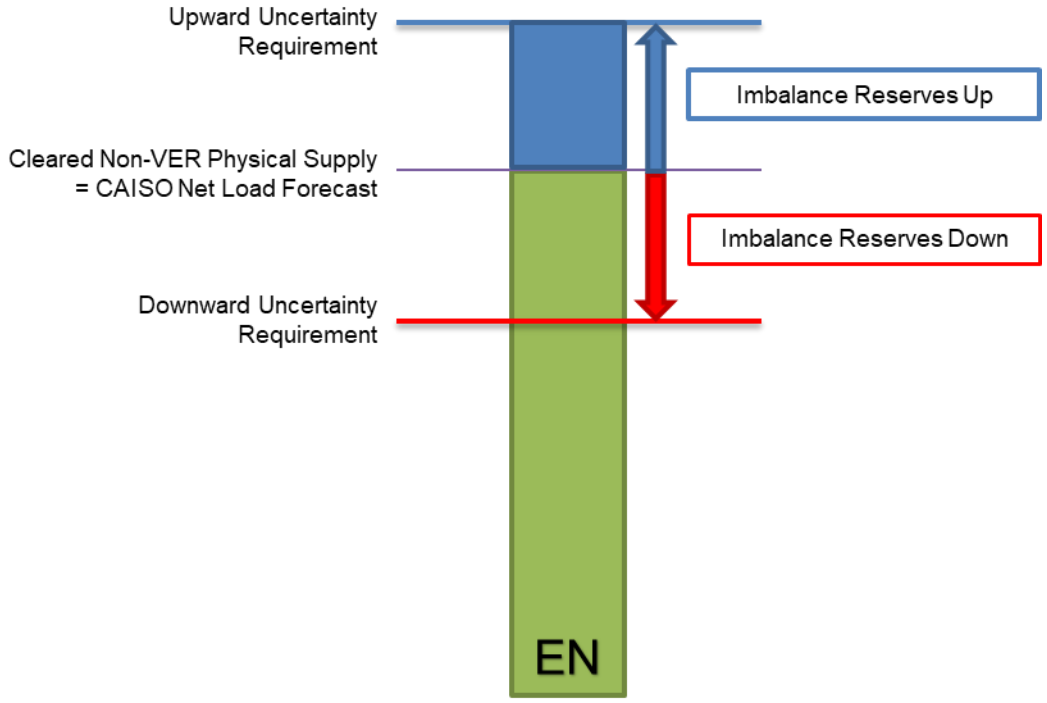
The residual unit commitment pass bridges the gap between the CAISO's load forecast and the physical energy cleared in the integrated forward market by procuring incremental capacity that was not scheduled or awarded in the integrated forward market. This additional capacity ensures there is sufficient physical supply available to meet the day-ahead net load forecast. The CAISO proposes to enhance the residual unit commitment process to begin procuring downward dispatch capability when the physical supply cleared in the integrated forward market exceeds the net load forecast.

New Day-Ahead Market Products

This third revised straw proposal continues to propose imbalance reserves as a new market product to address ramping differences and net load uncertainty between the day-ahead and real-time markets. Imbalance reserves will minimize the need for out-of-market actions and appropriately value resources' flexible capacity. The CAISO also proposes to enhance the residual unit commitment process by adding a downward reliability capacity product.

Figures 3, 4 and 5 represent the relationship between energy and imbalance reserves (procured in the integrated forward market) and reliability capacity (procured in the residual unit commitment process). Figure 3 illustrates the scenario where the integrated forward market clears non-VER physical supply equal to the CAISO's net load forecast. The market will procure imbalance reserves to cover upward and downward uncertainty requirements. The day-ahead market would not need to procure reliability capacity in the residual unit commitment process.

Figure 3: Day-ahead market products when forecast is equal to non-VER physical supply



However, rarely will the non-VER physical supply clear equal to the net load forecast. Several factors contribute to this and thus drive the need for the residual unit commitment to procure reliability capacity. The drivers for reliability capacity up are:

- Bid-in load clears the integrated forward market less than the CAISO load forecast
- Virtual supply clears the integrated forward market in excess of virtual demand
- Variable energy resources clear the integrated forward market greater than the CAISO variable energy resource forecast

The drivers for reliability capacity down are:

- Bid-in load clears the integrated forward market greater than the CAISO load forecast
- Virtual demand clears the integrated forward market in excess of virtual supply
- Variable energy resources clear the integrated forward market less than the CAISO variable energy resource forecast

These drivers can also offset each other. For example, virtual demand may clear to address under-scheduled load and virtual supply may clear to address under-scheduled variable energy resources.

Figure 4 illustrates the relationship between energy, imbalance reserves, and reliability capacity when the CAISO's net load forecast is greater than the cleared non-VER physical supply. When this occurs, the residual unit commitment procures reliability capacity up to provide upward dispatch capability, relative to the energy schedules, to meet the net load forecast. The integrated forward market still procures the full imbalance reserve requirements to meet the upward and downward uncertainty.

Figure 4: Day-ahead market products when forecast is greater than non-VER physical supply

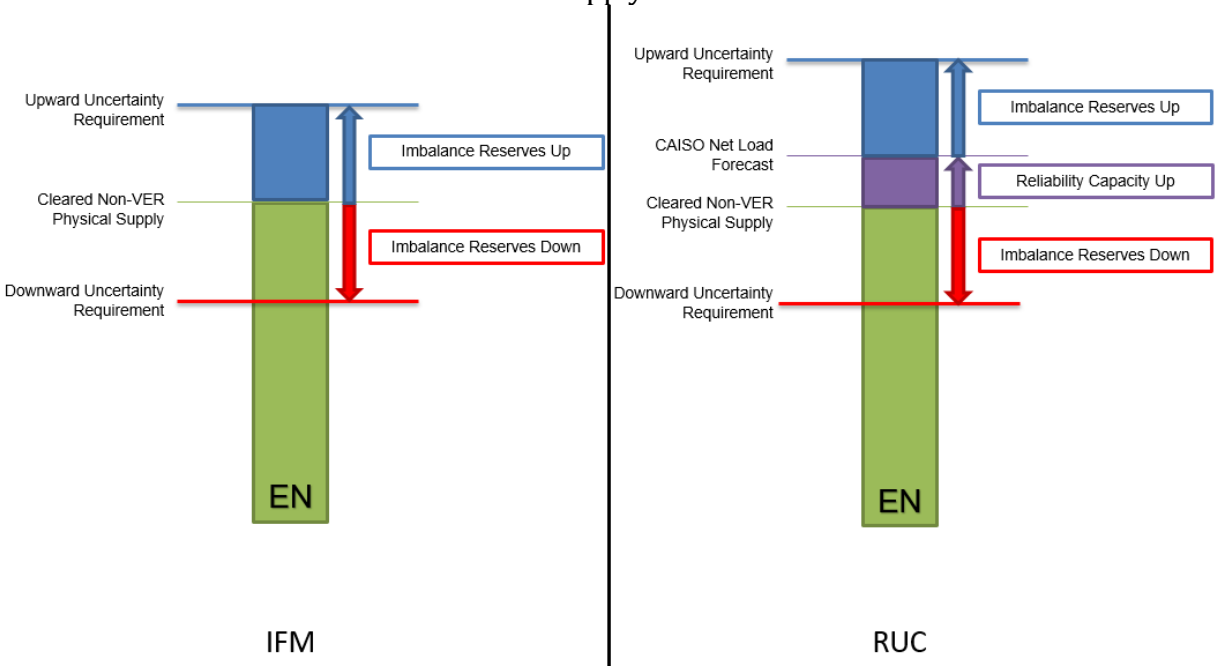
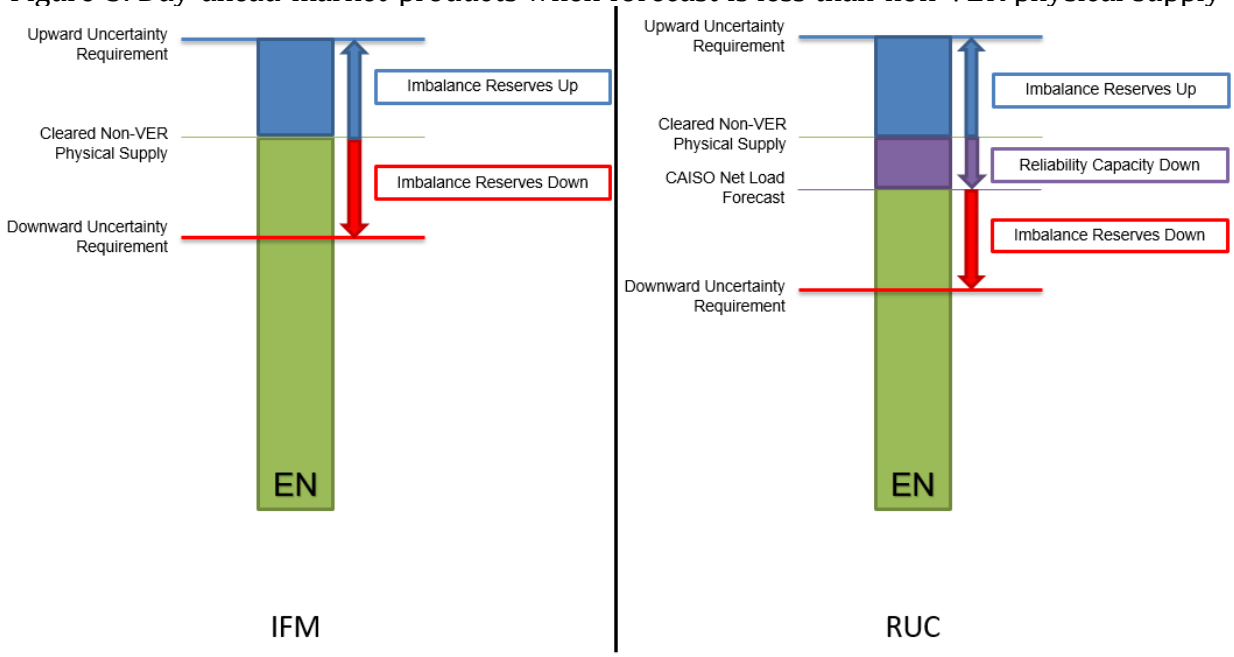


Figure 5 illustrates this relationship when the CAISO's net load forecast is less than the cleared non-VER physical supply. When this occurs, the residual unit commitment procures reliability capacity down to provide downward dispatch capability, relative to the energy schedules, to meet the net load forecast. The integrated forward market still procures the full imbalance reserve requirements to meet the upward and downward uncertainty.

Figure 5: Day-ahead market products when forecast is less than non-VER physical supply



The net load forecast and the amount of net load uncertainty determines the amount of physical energy and dispatch capability from physical resources needed to ensure reliability.

Table 1 Table 1summarizes the proposed day-ahead market products. It also includes the existing day-ahead market products for completeness.

Table 1: Proposed and existing day-ahead market products

Title	Acronym	Time Granularity	Purpose	Eligibility*	Procured In	Status
Energy	EN	Hourly	Energy schedules cleared to meet bid-in demand	All resources	IFM	Existing
Reliability Capacity, Up	RCU	Hourly	Incremental capacity procured to meet the positive difference between the net load forecast and cleared non-VER physical supply	Physical resources based on 60-minute ramp capability	RUC	Replaces RUC awards
Reliability Capacity, Down	RCD	Hourly	Decremental capacity procured to meet the negative difference between net load forecast and cleared non-VER physical supply	Physical resources based on 60-minute ramp capability	RUC	Proposed
Imbalance Reserves, Up	IRU	15-min	Incremental capacity procured relative to the net load forecast to meet the upward uncertainty requirement	15-minute dispatchable physical resources, award based on 15-minute ramp capability	IFM	Proposed

Title	Acronym	Time Granularity	Purpose	Eligibility*	Procured In	Status
Imbalance Reserves, Down	IRD	15-min	Decremental capacity procured relative to the net load forecast to meet the downward uncertainty requirement	15-minute dispatchable physical resources, award based on 15-minute ramp capability	IFM	Proposed
Ancillary Services	AS	10-min	Incremental capacity procured and reserved to meet real-time regulation and contingency reserve requirements	Resources certified to provide the respective service	IFM	Existing

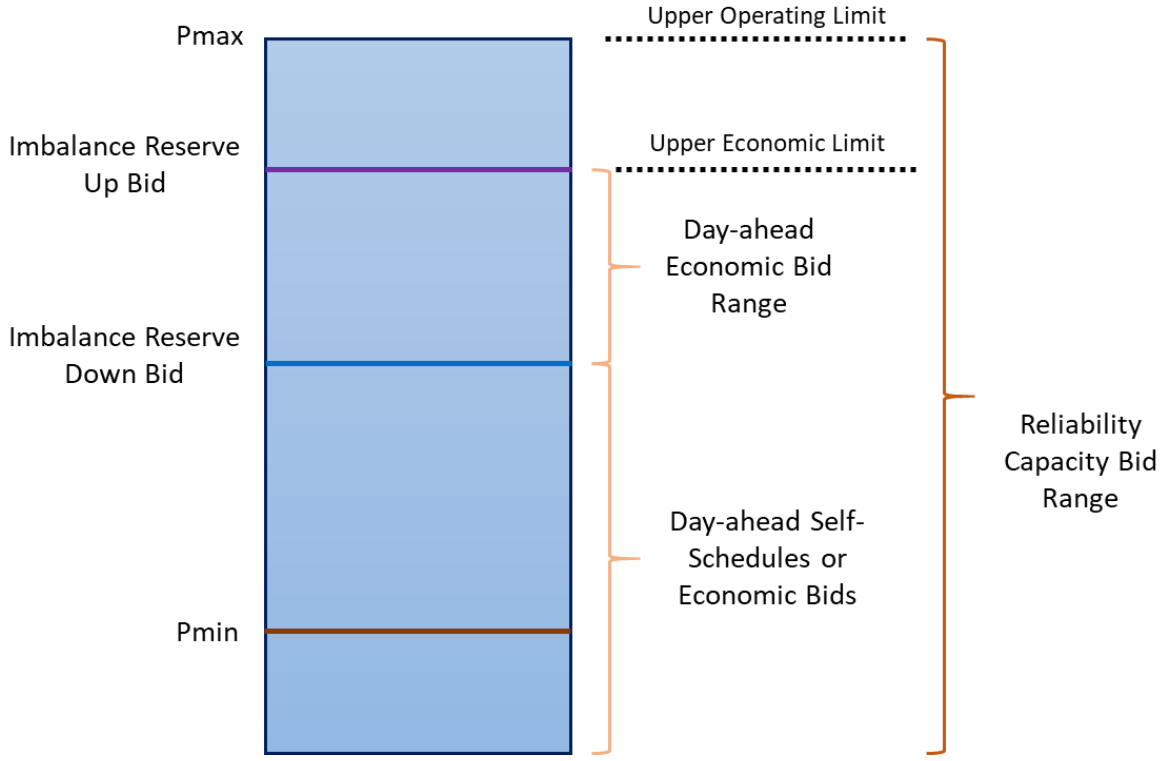
Day-Ahead Bidding Rules for Imbalance Reserves and Reliability Capacity

Scheduling coordinators can submit bids for imbalance reserves from their eligible resources (see Appendix A for eligibility by resource type). In order to bid for imbalance reserves, scheduling coordinators must provide an energy bid in the day-ahead market and must economically bid the portion of the energy bid that overlaps with the imbalance reserve bid. Figure 6 provides an illustration of this bidding requirement.

Scheduling coordinators can also submit bids for reliability capacity from their eligible resources (see Appendix A for eligibility by resource type). Scheduling coordinators need to provide an energy bid in the day-ahead market to bid for reliability capacity, but reliability capacity bids do not need to overlap with economic energy bids.

The total quantity of energy and imbalance reserves scheduled on a resource will be capped based on the resource's upper economic limit. The upper economic limit is the highest operating level submitted in the resource's energy bid. The total quantity of energy, imbalance reserves, and reliability capacity scheduled on a resource will be capped based on the resource's upper operating limit. The upper operating limit is the resource's maximum capacity (Pmax) adjusted by any applicable de-rates.

Figure 6: Day-Ahead Bidding Rules for Imbalance Reserves and Reliability Capacity



Real-Time Bidding Obligations based on Day-Ahead Awards

Resources that receive an energy schedule, ancillary service awards, reliability capacity awards, or imbalance reserve awards in the day-ahead market will have real-time market bidding obligations. Resources must economically bid the full range of their reliability capacity and imbalance reserve awards in the real-time market. Real-time must-offer obligations apply in the hours that a resource has a reliability capacity or imbalance reserve award.

The purpose of the real-time must-offer obligation is to provide economic bids to the real-time market. Economic bids enable the real-time market to re-dispatch resources to meet real-time system conditions and imbalances. Real-time self-schedules do not provide the real-time market with the ability to re-dispatch the resource.

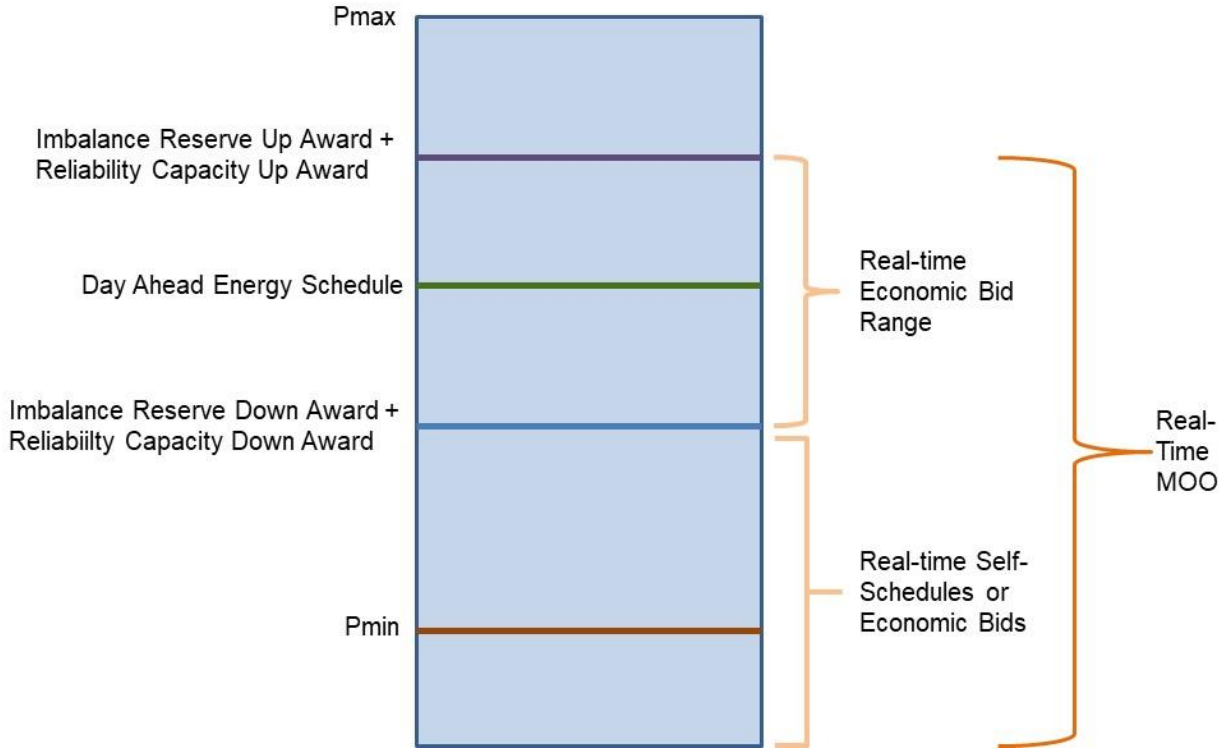
The minimum real-time bidding obligations are illustrated in Figure 7. A resource must submit economic bids above its day-ahead energy schedule by the amount of imbalance reserves up and reliability capacity up awarded. The resource is not required to submit additional bids up to its Pmax but may elect to do so. This ensures there are sufficient economic offers to allow the real-time market to dispatch the resource above its day-ahead energy schedule.

Any portion of this resource's day-ahead energy schedule below the imbalance reserves down and reliability capacity down awards can be either self-scheduled or economically bid. A resource cannot submit a self-schedule that exceeds its energy schedule less its imbalance reserves down and reliability

capacity down awards. This ensures that there are sufficient economic offers to allow the real-time market to dispatch the resource below its day-ahead energy schedule.

A resource that can be committed in the real-time market can submit start up and minimum load bids to enable the market to re-optimize the unit commitment decision. This is not a requirement because the resource can elect to self-schedule a portion of its output.

Figure 7: Real-time Bidding Obligations



Day-Ahead Must-Offer Obligations for Resource Adequacy Resources

The following summarizes the resource adequacy must-offer obligations for the day-ahead market. Additional rules are being developed in the Resource Adequacy Enhancements initiative.[10]

Resource adequacy resources will continue to be required to economically bid or self-schedule their resource adequacy capacity into the integrated forward market. This applies all hours of the month the resource is physically available. Resources providing system and local resource adequacy will continue to be required to economically bid or self-provide ancillary services.

Resources providing resource adequacy capacity that are currently required to submit RUC availability bids will be required to bid their resource adequacy capacity into the residual unit commitment for reliability capacity up and down. This applies all hours of the month the resource is physically available. The CAISO will not require that resource adequacy resources offer resource adequacy capacity into RUC

[10] CAISO Resource Adequacy Enhancements initiative.
https://stakeholdercenter.caiso.com/StakeholderInitiatives/Resource-adequacy-enhancements

with $0 availability bids. Instead, resource adequacy capacity can be bid into RUC at any price between the bid floor and bid cap.

Resource adequacy requirements should ensure that resource adequacy resources provide sufficient imbalance reserve bids to meet the imbalance reserve requirements. The CAISO proposes that resource adequacy resources that are eligible to provide imbalance reserves have a must-offer obligation to bid for imbalance reserves in the day-ahead market. This would also require those resources to economically bid for energy +/- their 15-minute ramping capability. This modification could eliminate maintaining a separate flexible resource adequacy requirement and help simplify the resource adequacy program. Stakeholder feedback on this proposal to modify the day-ahead must-offer obligation is requested.

Real-Time Must-Offer Obligations for Resource Adequacy Resources

Currently, resource adequacy provisions create a must-offer obligation in the real-time market for resource adequacy resources that did not receive a day-ahead market schedule, depending on the characteristics of the resource. In this initiative, the CAISO proposes to change the nature of the real-time must-offer obligation for resource adequacy resources. Going forward, the real-time obligation for all resources, including resource adequacy resources, will be based on imbalance reserve and reliability capacity awards. In other words, resource adequacy resources will have the same real-time must-offer obligation as any other resource based upon day-ahead awards.

The CAISO acknowledges this new design differs from the existing resource adequacy paradigm and market functionality. To that end, the CAISO proposes that the Local Regulatory Authority, at their discretion, can enforce that their load-serving entities require their RA capacity suppliers to adhere to a real-time must-offer obligation in their supply contracts. The CAISO would no longer enforce bid insertion for unscheduled resource adequacy capacity that does not bid in the real-time market. The CAISO would establish procedures to provide data and information to Local Regulatory Authorities to help their enforcement.

3.2 Market Power Mitigation Pass for IFM Changes

In the market power mitigation pass for IFM, the market will use unmitigated bids to clear bid-in load, bid-in supply, imports, exports, ancillary services requirements, and the imbalance reserve requirements. Binding transmission constraints in the base scenario (cleared bid-in load), the imbalance reserve up deployment scenario, and the imbalance reserve down deployment scenario are evaluated to determine if they are uncompetitive. The CAISO will continue to use the dynamic competitive path assessment (DCPA) to determine whether a transmission constraint is uncompetitive.

Resources that can provide counter-flow to an uncompetitive constraint in the base scenario will have their energy bids mitigated. Resources that can provide counter-flow to an uncompetitive constraint in the upward and downward deployment scenarios will have their energy bids mitigated. Energy bids are mitigated in the upward and downward deployment scenarios because energy marginal prices have congestion contributions from all binding constraints in all scenarios.

Resources that can provide counter-flow to an uncompetitive constraint in the upward deployment scenario will also have their imbalance reserve up bid mitigated. Imbalance reserve up marginal prices have congestion contributions only from binding constraints in the upward deployment scenario. The CAISO proposes not to mitigate imbalance reserve down bids. Appendix C provides a detailed example of local market power mitigation applied to energy and imbalance reserve offers.

The CAISO mitigates energy offers to the greater of what it calls "default energy bids" or the competitive locational marginal price.[11] Default energy bids are the CAISO's estimate of a resource's marginal cost. The competitive locational marginal price is the marginal price of energy minus the non-competitive congestion components at the location of the mitigated resource. The competitive locational marginal price represents the going rate for competitive energy at the relevant location and ensures resources are mitigated only to the extent needed to resolve market power for higher-priced bids.

The CAISO proposes to extend this method of determining the mitigation bid prices for imbalance reserve offers. However, the CAISO no longer proposes to calculate a "default availability bid" for mitigation of imbalance reserves. Instead, the CAISO proposes only to mitigate imbalance reserves offers to a "competitive locational marginal price" for imbalance reserves. The competitive locational marginal price for imbalance reserves is the marginal price of imbalance reserves minus the non-competitive congestion components in the upward deployment scenario at the location of the mitigated resource.

3.3 Integrated Forward Market Changes

The integrated forward market obtains a full market solution using mitigated bids from the market power mitigation pass. The integrated forward market solves the optimal unit commitment to clear bid-in load, bid-in supply, imports, exports, and ancillary services requirements. The CAISO proposes to enhance the day-ahead market by introducing a new day-ahead market imbalance reserves product co-optimized and procured in the integrated forward market.

Energy (EN)

The energy (EN) schedule will be the same day-ahead market schedule that results from the current integrated forward market. The market determines energy schedules by clearing physical and virtual supply against bid-in load and virtual demand. The energy will continue to be priced at each node resulting in a locational marginal price. Resources with a day-ahead energy schedule can re-bid (self-schedule or economically bid) the energy into the real-time market.

Ancillary Services

The day-ahead market procures 100 percent of the expected requirement for four ancillary services:

[11] If the resource's unmitigated energy bid is less than the default energy bid or the competitive locational marginal price, no modification is made to the resource's bid.

- Regulation up is procured from certified resources that can respond to the 4 second automated generation control signal to address increases in the net load that occur within a five minute dispatch interval.
- Regulation down is procured from certified resources that can respond to the 4 second automated generation control signal to address decrease in the net load that occur within a five minute dispatch interval.
- Spinning reserves are procured from certified resources that are synchronized to the grid and can be called upon if a contingency event occurs.
- Non-spinning reserves are procured from certified resources that either are or are not synchronized to the grid and can be called upon if a contingency event occurs.

The CAISO is not proposing any changes to ancillary services procurement. They will continue to be procured on a system and regional basis as opposed to a nodal basis and subject to the existing cascading procurement rules where regulation up can substitute for spinning and non-spinning reserves, and spinning reserve can substitute for non-spinning reserve.[12]

Imbalance Reserves (IRU/IRD)

Imbalance reserves will ensure the integrated forward market schedules sufficient real-time dispatch capability to meet net load imbalances between the day-ahead and real-time markets. These imbalances are caused by uncertainty in the day-ahead net load forecast and granularity differences between hourly day-ahead market and fifteen-minute real-time market schedules. Imbalance reserves will be comprised of imbalance reserves up (IRU) that will provide upward dispatch capability and imbalance reserves down (IRD) that will provide downward dispatch capability. An imbalance reserve schedule will result in an obligation to provide economic energy bids to the real-time market. The market may schedule a resource to provide both IRU and IRD.

The integrated forward market will co-optimize and procure imbalance reserves to meet the hourly imbalance reserve procurement requirement. The market optimization will consider transmission constraints to ensure imbalance reserves are deliverable by using imbalance reserve deployment scenarios. The market will price imbalance reserves at each node reflecting deliverability constraints.

Imbalance reserves will enable the day-ahead market to compensate resources that provide flexible capacity to meet net load uncertainty. Today, system operators may take out-of-market actions, including increasing the load forecast used in RUC and issuing exceptional dispatches to secure additional supply to increase the ramp capability available to the real-time market and to address uncertainty between the day-ahead and real-time markets. System operators are taking such actions because of the increased variability resulting from increasing amounts of variable energy resources.

[12] The CAISO may consider an initiative in 2023 to explore collapsing the current spin and non-spin requirement into a single contingency reserve requirement. This initiative will also examine removing the current cascading rule between upward ancillary service products.

Imbalance reserves will minimize the need for these out-of-market actions and will create a market price signal for flexible capacity.

The day-ahead market will only award imbalance reserves to resources that are dispatchable in the fifteen-minute market. Although the day-ahead market will schedule imbalance reserves hourly, the maximum award will be based on a resource's 15-minute ramp capability. Resources that are not committed in the IFM can still be awarded imbalance reserves if the resource has a start-up time of 15 minutes or less. The CAISO proposes to make these parameters adjustable in response to stakeholder feedback that these requirements may be overly restrictive. The CAISO will monitor the performance of the imbalance reserve product once implemented to assess whether allowing for longer start-up times or longer ramp horizons is necessary or desirable.

Imbalance Reserve Procurement Requirement

This section provides a high-level overview of the method used to calculate the imbalance reserve requirements in the day-ahead market. This method intends to align with the approach proposed for the real-time market flexible ramping product requirements.[13]

Historical data will be used to identify the net load forecast error between the day-ahead market and fifteen-minute market. These historical net load forecast errors will then be used to determine the imbalance reserves up and down requirement based on the prevailing load, wind, and solar forecasts for each hour of each day using statistical regression. The CAISO proposes to use quantile regression to determine the imbalance reserve requirements. A quantile regression estimates quantiles of a dependent variable conditional on the values of a set of independent variables. A quantile regression is preferred to standard linear regression in this case because the imbalance reserve requirements are based on relatively extreme high and low (i.e., 97.5 and 2.5 percentile) observations of net load imbalances, as opposed to the average net load imbalance. The regressors (independent variables) include the day-ahead load, solar, and wind forecasts, as well as the operating hour and month or season.

The CAISO will implement the quantile regression such that percentiles used (2.5 and 97.5) are configurable so that the CAISO can make adjustments after gaining operational experience.

In the EDAM, the CAISO intends to calculate the imbalance reserve requirement for each EDAM BAA separately using historical data specific to the BAA. The CAISO will need to develop a process for collecting load forecast and VER forecast data from EDAM entities during the EDAM onboarding process so the CAISO can calculate an accurate imbalance reserve requirement when the EDAM entity goes live in the market.

[13] CAISO Flexible Ramping Product Refinements initiative. Appendix C – Quantile Regression Approach. http://www.caiso.com/InitiativeDocuments/AppendixC-QuantileRegressionApproach-FlexibleRampingProductRequirements.pdf

Imbalance Reserve Graduated Penalty Prices

In this third revised straw proposal, the CAISO no longer proposes, as it did in previous proposals, that the integrated forward market procure imbalance reserves based on a single constraint relaxation penalty price. The CAISO proposes instead to introduce a graduated penalty price structure that will gradually relax the imbalance reserve procurement requirement at higher costs. The imbalance reserve requirement will begin to relax as the cost of procuring an incremental unit of imbalance reserves exceeds the imbalance reserve bid cap ($247). The CAISO would also establish a minimum threshold of imbalance reserves it would procure over high-priced economic demand bids and low-priority export self-schedules. For example, Table 3 shows procurement to the 75th percentile of upward uncertainty at a penalty price of $1200.[14]

The CAISO proposes to retain discretion to set the penalty price and procurement relaxation values in a flexible manner to allow reconsideration of appropriate values as more entities join the Extended Day-Ahead Market. Each EDAM participant is required to bring sufficient supply to the EDAM to meet its upward uncertainty requirement (among other things) in the EDAM resource sufficiency evaluation. The upward uncertainty requirement is set based on the imbalance reserve procurement requirement (described in the section above), representing the 97.5th percentile of upward uncertainty in each individual BAA. As the number of EDAM participants grow, the greater the uncertainty coverage *over the EDAM footprint* will be by requiring each BAA to meet its own 97.5th percentile uncertainty. That is because uncertainty materializing in one BAA may be non-coincident with uncertainty materializing in another BAA (in fact, the uncertainty could materialize in opposite directions, offsetting each other over the footprint). In other words, the market can procure towards a lower uncertainty percentile as more EDAM BAAs join the EDAM because it spreads the uncertainty risk across a more diverse footprint.

The CAISO plans to conduct data analysis to inform this effort of determining penalty price and procurement relaxation values, but ultimately the EDAM stakeholders will have a strong say in where the CAISO should draw the line between cost and reliability.

Table 2: Imbalance Reserve Graduated Penalty Prices in IFM

Scheduling run IRU relaxation (%)	Scheduling run penalty price ($)	Upward uncertainty percentile	Pricing run penalty price ($)
0.000	247	97.5	247
0.026	300	95	300
0.051	400	92.5	400
0.077	500	90	500
0.103	600	87.5	600
0.128	700	85	700
0.154	800	82.5	800
0.179	900	80	900
0.205	1000	77.5	1000
0.231	1200	75	1000

[14] For reference, low-priority export self-schedules currently have a scheduling run penalty price of $1050.

**Values are for illustrative purposes only. Actual implemented penalty price and procurement relaxation values may differ.*

Imbalance Reserve Deliverability

Under this proposal, the market will consider transmission constraints when awarding imbalance reserves in the integrated forward market to ensure they are deliverable if deployed in real-time. The approach will be similar to the upward and downward deployment scenarios developed in the flexible ramping product refinements initiative. The deployment scenarios will result in nodal imbalance reserves that ensure scheduled day-ahead physical supply can meet the uncertainty requirements if deployed without violating transmission constraints. The nodal approach results in more accurate prices for imbalance reserve awards because they represent a locational value of the capacity product, similar to energy.

The upward deployment scenario ensures physical supply and imbalance reserves up awards are deliverable to where upward net load uncertainty may materialize. The downward deployment scenario ensures physical supply less imbalance reserves down awards are deliverable to where the downward net load uncertainty may materialize. The net load uncertainty that materializes occurs at load nodes and variable energy resource nodes. The CAISO will use allocation factors derived by historical data to distribute the IRU/IRD requirements among load and VER nodes.

Bidding Rules

The CAISO proposes the following bidding rules for products procured in the integrated forward market:

- Market participants will submit separate bids for energy, ancillary services (regulation up, regulation down, spinning reserves, non-spinning reserves), imbalance reserves up, and imbalance reserves down.
- The bidding deadline will continue to be 10:00AM, at which point the day-ahead market closes.
- The current bid structure for energy and ancillary services will not change.
- Imbalance reserve bids can have different hourly price/quantity pairs but only a single price/quantity pair in each hour.
- The imbalance reserve bid quantity (MW) must be greater than zero and will be capped by the associated certification quantities that considers the resource's ramp rate over the product horizon (e.g., imbalance reserves are 15-minute products).
- Resource adequacy resources with a day-ahead must-offer obligation for imbalance reserves will be subject to bid insertion. If the required amount of resource adequacy capacity for imbalance reserves is not offered into the day-ahead market, the CAISO will insert imbalance reserve bids at $0 for the portion of the resource's capacity that is subject to a must-offer obligation.
- All resources with imbalance reserve awards will be subject to bid insertion in the real-time market. This means that resources that do not submit the bids that are required based on their imbalance reserve award will have economic energy bids inserted for them at their Default Energy Bid in the real-time market.

IFM Payments and Charges

The CAISO proposes the following day-ahead charges and payments for load, virtual supply, virtual demand, physical supply, imports, and exports. These resources will be settled for differences between the day-ahead energy schedule and real-time market energy schedule.

- Bid-in load will be charged the locational marginal price of its load aggregation point for energy.
- Internal generation, participating load models, imports, exports, virtual supply, and virtual demand will be paid/charged the locational marginal price for energy.
- Suppliers awarded ancillary services will be paid the ancillary service's marginal price.

The CAISO proposes the following day-ahead payments for eligible resources that are awarded imbalance reserve awards.

- Resources that receive an imbalance reserve up award will be paid the locational marginal price for imbalance reserves in the upward direction.
- Resources that receive an imbalance reserve down award will be paid the locational marginal price for imbalance reserves in the downward direction.

The CAISO does not propose a direct settlement for imbalance reserve charges but instead will distribute the costs based on a cost allocation as described in the section below.

Imbalance Reserve Cost Allocation

Imbalance reserves are deployed when system conditions change between day-ahead and real-time, which requires the re-dispatch of available resources in real time. For example, if a generator or an import is unable to meet its day-ahead energy schedule, another resource must be scheduled in FMM to replace the lost supply. In the event a variable energy resource submits a self-schedule and its forecast exceeds its day-ahead schedule, all else being equal, a dispatchable resource will need to be scheduled below its day-ahead schedule. Imbalance reserves up/down costs will be allocated as follows:

Imbalance Reserves Up

- Tier 1
    - Generation: MAX(0, Day-ahead energy schedule – FMM upper economic limit as affected by de-rates and VER forecast (if applicable))
    - Load: Negative uninstructed imbalance energy
    - Imports: MAX(0, Day-ahead energy schedule – FMM upper economic limit as affected by e-Tag transmission profile)
    - Exports: MIN(0, FMM self-schedule – Day-ahead energy schedule)
- Tier 2
    - Metered demand

The price used for the imbalance reserve up tier 1 cost allocation is the minimum of the imbalance reserve up price and the imbalance reserve up derived price. The imbalance reserve up derived price is the imbalance reserve up cost divided by the imbalance reserve up tier 1 allocation quantity.

Imbalance Reserves Down

- Tier 1
    - Generation: MAX(0, FMM lower economic limit as affected by rerates and VER forecast (if applicable) – Day-ahead energy schedule)
    - Load: Positive uninstructed imbalance energy
    - Imports: MIN(0, MAX(e-Tag transmission profile, FMM self-schedule) – Day-ahead energy schedule)
    - Exports: MAX(0, Day-ahead energy schedule – e-Tag transmission profile)
- Tier 2
    - Metered demand

The price used for the imbalance reserve down tier 1 cost allocation is the minimum of the imbalance reserve down price and the imbalance reserve down derived price. The imbalance reserve down derived price is the imbalance reserve down cost divided by the imbalance reserve down tier 1 allocation quantity.

Energy storage resources (using either the Non-Generator Resource model or the proposed Energy Storage Resource mode) will be considered under the "Generation" component of the cost allocations above.

Imbalance Reserve Unavailability No Pay

Capacity that is not available in real time reduces the available supply of real-time energy and flexible ramping product and drives up their price. A stronger incentive than a no-pay mechanism is needed to ensure resources follow through on their must-offer obligations. Resources should be penalized commensurate with the harm they cause to the system by not being available. The CAISO proposes to implement the following unavailability penalties for imbalance reserves:

Imbalance reserves up: Resources with an upper economic limit in FMM that does not support their day-ahead energy + IRU award less the 5-minute ramp-capable portion[15] will be charged the higher of the RTPD FRU price, the RTD FRU price, or the IRU price.

Imbalance reserves down: Resources with a lower economic limit in FMM that does not support their day-ahead energy - IRD award plus the 5-minute ramp-capable portion will be charged the higher of the RTPD FRD price, the RTD FRD price, or the IRD price.

[15] This term is included so that a resource is not charged no pay and a deviation settlement for ramp when the resource is unavailable. In Section 4.1 discusses the proposed settlement of ramp deviation.

These unavailability penalties provide a strong incentive to deliver imbalance reserves and reflect the full cost of unavailability. That is because suppliers can be charged the cost of real-time flexible ramping product, whose price may spike because of a shortage of flexible capacity, for the portion of their award that was not provided. Resources that receive both a reliability capacity and imbalance reserve award and are not available, or only bid a portion of their combined award, will have the unavailability charge applied first to reliability capacity and then to imbalance reserves.

Bid Cost Recovery

Currently, bid cost recovery is calculated separately for the day-ahead and real-time market. This will not change. However, the revenue and bid costs from imbalance reserve awards will be included in the calculation of day-ahead bid cost recovery. Resources committed in the integrated forward market, including resources that are scheduled for imbalance reserves, are eligible to receive day-ahead bid cost recovery.

Application of Grid Management Charge to Imbalance Reserves

The market services charge of the grid management charge covers the cost of bidding and clearing the market. Currently, the market services charge is applied to ancillary services awards in the day-ahead market and real-time market. Suppliers include this cost in the bid price for ancillary services. The market services charge is not applied to the flexible ramping product because suppliers do not submit bids for that product. Since bids can be submitted for imbalance reserves, the market services charge will be applied for imbalance reserve awards. Suppliers will include this cost in their bids.

Exports and Imbalance Reserves

Export Protection

One of the benefits of imbalance reserves is they should reduce the quantity of export schedules curtailed in the RUC process. That is because implementing imbalance reserves should greatly reduce the use of manual operator adjustments to the RUC forecast. Operator RUC adjustments push the RUC procurement target further away from the IFM results, which increases the risk that an export scheduled in IFM will be reduced in RUC.

Previously, the CAISO proposed to procure the full imbalance reserve target in IFM up to a constraint relaxation penalty price above low-priority (LPT) self-schedule exports but below self-scheduled load and high-priority (PT) self-scheduled exports. That would have meant awarding imbalance reserves would come at the expense of scheduling economic exports or LPT exports in IFM in scarce supply conditions. Exports without an IFM schedule cannot be cleared in RUC, and therefore could not get day-ahead priority.

Under the new proposal, the graduated imbalance reserve penalty prices would relax the imbalance reserve target at sufficiently high costs. Therefore, more economic exports and LPT exports could clear the IFM instead of imbalance reserves in scarce supply conditions (up to a minimum threshold of the imbalance reserve target). However, there is a risk that CAISO system operators will feel the need to "backfill" the reduced imbalance reserves with RUC adjustments, which would increase export

curtailment risk in RUC. Note that imbalance reserve relaxation is likely to happen mostly in tight supply conditions where there is already heightened risk of export reduction in RUC.

High-Priority (PT) Self-Scheduled Export Rules

High-priority (PT) self-scheduled exports are supported by a resource with non-RA capacity bid into the day-ahead market. It is feasible that a resource with non-RA capacity could both support a PT export and receive an imbalance reserve award in the day-ahead market. That is because there is no direct link between the supporting resource's output and the export quantity.

As an example, assume an exporting scheduling coordinator bids a 100MW PT export that is supported by a non-RA resource with a 100MW energy bid and 20MW imbalance reserve up bid. The PT export would pass the day-ahead market validation because its supporting resource has sufficient energy bids to cover the export quantity. Assume the IFM results in the non-RA resource receiving an 80MW energy schedule and a 20MW imbalance reserve up award. In the real-time market, the non-RA resource submits a 100MW economic energy bid. This real-time energy bid is consistent with the resource's real-time bidding obligations based on its day-ahead schedule (80MW energy + 20MW imbalance reserve up). Assuming the PT export rebid in the real-time market, this real-time time energy bid also enable the PT export to pass the real-time market validation.

Again, this outcome is enabled by the fact there is no direct link between the supporting resource's output and the export quantity. The supporting resource just needs to submit sufficient bids in the day-ahead and real-time market. In the example above, presumably the market deemed it optimal to award the supporting resource 20MW of imbalance reserves and instead "support" the remaining 20MW of the export with energy with a different resource in the bid stack.

In the Market Enhancements for Summer 2021 Readiness stakeholder initiative[16], the CAISO implemented a rule that non-RA resources designated to support a PT export must bid into RUC up to the export self-scheduled quantity. Under this initiative, non-RA resources designated to support a PT export will now have a requirement to bid for reliability capacity up to the export self-scheduled quantity.

3.4 Market Power Mitigation Pass for RUC

Reliability capacity up and down awards are priced in RUC at locational marginal prices that have marginal congestion contributions from binding constraints. Therefore, it is appropriate to perform local market power mitigation for reliability capacity bids in RUC. This is achieved by adding a new market power mitigation pass after IFM and before RUC.

The market power mitigation pass for RUC will use unmitigated reliability capacity bids to procure reliability capacity to meet the CAISO net demand forecast. The demand forecast is distributed to load nodes in the market footprint using load distribution factors. Transmission constraints are enforced in RUC using the same shift factors from IFM. Reliability capacity awards will be modeled as energy flows

[16] California ISO. Market Enhancements for 2021 Summer Readiness stakeholder initiative. https://stakeholdercenter.caiso.com/StakeholderInitiatives/Market-enhancements-for-summer-2021-readiness.

and the market will evaluate whether binding transmission constraints are uncompetitive using a dynamic competitive path assessment (DCPA). Resources that can provide counter-flow to uncompetitive constraints will have their reliability capacity bids mitigated. .

In this proposal, the CAISO no longer proposes to calculate a "default availability bid" for mitigation of reliability capacity offers. Instead, the CAISO proposes only to mitigate reliability capacity offers to a "competitive locational marginal price" for reliability capacity. The competitive locational marginal price for reliability capacity is the marginal price of reliability capacity minus the non-competitive congestion components at the location of the mitigated resource. If the resource's reliability capacity bid is less than the competitive locational marginal price for reliability capacity, no modification will be made to the resource's reliability capacity bid.

Market Performance and Solve Time

Stakeholders expressed concern in their comments that a new market pass could hinder market solve time and performance. The CAISO does not share this concern. The RUC market power mitigation pass should have a minimal impact on market performance and solve time because RUC is much less computationally complex than IFM. For example:

- **There is no co-optimization in RUC.** RUC only clears reliability capacity up and reliability capacity down.
- **There are no upward and down deployment scenarios in RUC.** There is only a base scenario in RUC.
- **IFM schedules are fixed in RUC.** RUC is only procuring incremental or decremental capacity to meet the RUC procurement target using the residual supply that is left over from IFM.
- **RUC has fewer binary variables.** Most of the resources are already committed in IFM.
- **RUC has fewer bids to consider.** For example, there are no load bids, no virtual bids, bids can only have a single capacity segment, etc.

Furthermore, to aid in the performance and solution time of the overall day-ahead market, the CAISO proposes to limit the RUC market power mitigation pass to a 24-hour horizon, rather than RUC's default optimization horizon of 72 hours.

3.5 Residual Unit Commitment Changes

Today, the residual unit commitment process runs after the integrated forward market produces energy schedules and ancillary service awards. The residual unit commitment process procures incremental capacity based on CAISO's net demand forecast. The need for incremental capacity is based on the difference between the amount of physical energy that clears the integrated forward market and the amount of physical energy needed to meet the net demand forecast. Resources participate in the residual unit commitment process by providing reliability capacity bids.

The CAISO proposes several enhancements to the residual unit commitment process. First, physical capacity will be procured in the residual unit commitment through a new day-ahead market product called reliability capacity. Reliability capacity can be procured in the upward or downward direction.

Second, the residual unit commitment will be able to transition multi-stage generating resources in the downward direction (but not turn them off completely) and will establish their binding configuration. These enhancements are described in detail in the following sections.

Reliability Capacity (RCU/RCD)

The proposed reliability capacity product will improve the existing residual unit commitment process as the mechanism to ensure the day-ahead market schedules sufficient capacity to meet the net load forecast. Unlike the existing residual unit commitment process, reliability capacity will provide both upward and downward dispatch capability. If the CAISO's net load forecast is greater than the non-VER physical supply that clears the integrated forward market, the residual unit commitment process will procure reliability capacity up to provide upward dispatch capability and/or commit additional units. If the net load forecast is less than the non-VER physical supply that clears the integrated forward market, the residual unit commitment process will procure reliability capacity down to provide downward dispatch capability.

Similar to the existing residual unit commitment process, the market optimization will consider transmission constraints when scheduling reliability capacity. Energy schedules, imbalance reserve awards, and ancillary services awards will be held fixed in RUC at their integrated forward market schedules.

A reliability capacity award results in an obligation to provide economic energy bids to the real-time market. Resources awarded reliability capacity will have their reliability capacity schedule settled at a reliability capacity locational marginal price. The market will recover the costs of reliability capacity through a cost allocation including allocation to virtual supply and demand (described in more detail in a later section).

Reliability capacity awards will be limited to a resource's 60-minute ramp capability. A resource can receive reliability capacity awards only in one direction (i.e., either reliability capacity up or reliability capacity down, not both).

Multi-Stage Generating Resource Configuration in the Residual Unit Commitment

Currently, multi-stage generating resource configurations are committed in the integrated forward market. These commitments are passed to the residual unit commitment as an input. The residual unit commitment is able to commit multi-stage generating resources or transition them to a higher configuration. System operators report seeing congestion or oversupply in the residual unit commitment where multi-stage generating resources should be allowed to transition downward but the current residual unit commitment does not have that functionality. This causes system operators to exceptionally dispatch the units down manually.

The CAISO proposes to allow the residual unit commitment to transition multi-stage generating resources in the downward direction but not turn them off completely (i.e., transition down to their lowest configuration range but not shut down). This will help manage congestion in the residual unit commitment and avoid out-of-market actions by system operators.

This new functionality interacts with the process to validate high-priority (PT) exports. For example, assume an MSG resource is designated as a non-RA supporting resource for a PT export. Assume the exporter bids 80MW as a PT export. Assume the designated MSG resource bids 80MW into IFM, receives an 80MW IFM schedule, and is transitioned down to 60MW in RUC. The day-ahead market will validate support for an 80MW PT export schedule because the designated resource bid at least 80MW into the day-ahead market. The day-ahead market does not require that a supporting resource actually clear the IFM or the RUC to support a PT export. Note that scenarios where RUC would de-commit an MSG to a lower configuration would tend to occur only when CAISO is in an over-generation situation or otherwise low price conditions, which are not associated with tight system conditions.

Reliability Capacity Bidding Rules

The CAISO proposes the following bidding rules for products procured in the residual unit commitment process:

- Market participants will submit separate bids for RCU and RCD.
- The bidding deadline will continue to be 10:00AM, at which point the day-ahead market closes.
- Reliability capacity bids can have different hourly price/quantity pairs but only a single price/quantity pair in each hour.
- Reliability capacity bid MW quantity must be greater than zero and will be capped by the associated resource's 60-minute ramp rate over the product horizon.
- CAISO resource adequacy resources will be able to bid non-zero prices for reliability capacity.
- Resource adequacy resources with a day-ahead must-offer obligation for reliability capacity will be subject to bid insertion. If the required amount of resource adequacy capacity for reliability capacity is not offered into the day-ahead market, the CAISO will insert reliability capacity bids at $0 for the portion of the resource's capacity that is subject to a must-offer obligation.
- All resources with reliability capacity awards will be subject to bid insertion in the real-time market. This means that resources that do not submit the bids that are required based on their reliability capacity award will have economic energy bids inserted for them at their Default Energy Bid in the real-time market.

Reliability Capacity Payments

The CAISO proposes the following day-ahead payments for eligible resources that are awarded reliability capacity awards.

All resources (including CAISO resource adequacy resources) that receive a reliability capacity up or down award will be paid the locational marginal price for reliability capacity in the upward or downward direction, respectively.

Reliability Capacity Cost Allocation

It is appropriate to design a cost allocation for these reliability capacity payments that builds off the existing cost allocation for the residual unit commitment and accounts for the drivers of reliability

capacity needs (load, virtual bids, and VERs[17]). The uplift cost for reliability capacity will be allocated as follows:

Reliability Capacity Up

- RCU Tier 1 cost is allocated to net virtual supply, under-scheduled load, and over-scheduled (non-forecasted) variable energy resources.
    - The net virtual supply allocation quantity will be a maximum of (a) zero or (b) scheduling coordinator net virtual supply awards. Thus, net virtual demand does not net against the other allocation bases for RCU. This assumes a balancing authority area total net virtual supply.
    - Under-scheduled load will be defined using net negative metered demand. The net negative metered demand will exclude net negative demand associated with balanced ETC/TOR rights, negative deviation for Participating Load resulting from a market dispatch, and metered sub-systems that have elected not to participate in reliability capacity.
    - The over-scheduled variable energy resource allocation quantity will be a maximum of (a) zero or (b) sum of the variable energy resource day-ahead schedules less their day-ahead VER forecast.
- RCU Tier 2 cost is allocated to metered demand.

The CAISO also proposes that RCU Tier 1 costs should be limited by the minimum of the RCU capacity price and the RCU Tier 1 price.[18] In other words, if the RCU obligation is higher than the RCU awards, all of the cost will be allocated to RCU Tier 1. If RCU awards are greater than the RCU obligation, then costs will be split between Tier 1 and Tier 2.

Reliability Capacity Down

- RCD Tier 1 cost is allocated to net virtual demand, over-scheduled load, and under-scheduled (non-forecasted) variable energy resources.
    - The net virtual demand allocation quantity will be a maximum of (a) zero or (b) scheduling coordinator net virtual demand awards. Thus, net virtual supply does not net against the other allocation bases for RCD. This assumes a balancing authority area total net virtual demand.
    - Over-scheduled load will be defined using net positive metered demand. The net positive metered demand will exclude net positive demand associated with balanced ETC/TOR rights, positive deviation for Participating Load resulting from a market dispatch, and metered sub-systems that have elected not to participate in reliability capacity.

[17] VERs can avoid being allocated reliability capacity by participating as a "forecasted variable energy resource". See Section 4.6.4.

[18] RCU Tier 1 price is the minimum of the RCU allocation price and the RCU capacity price. The RCU allocation price is the RCU cost divided by the total RCU Tier 1 allocation quantity. RCD Tier 1 price is calculated similarly.

  - The under-scheduled variable energy resource allocation quantity will be a minimum of (a) zero or (b) sum of the variable energy resource day-ahead schedules less their day-ahead VER forecast.
- RCD Tier 2 cost is allocated to metered demand.

The CAISO also proposes that RCD Tier 1 costs should be limited by the minimum of the RCD capacity price and the RCD Tier 1 price. In other words, if the RCD obligation is higher than the RCD awards, all of the cost will be allocated to RCD Tier 1. If RCD awards are greater than the RCD obligation, then costs will be split between Tier 1 and Tier 2.

Reliability Capacity Unavailability No Pay

Capacity that is not available in real time reduces the available supply of real-time energy and flexible ramping product and drives up their price. A stronger incentive than a no-pay mechanism is needed to ensure resources follow through on their must-offer obligations. Resources should be penalized commensurate with the harm they cause to the system by not being available. The CAISO proposes to implement the following unavailability penalties for reliability capacity:

Reliability capacity up: Resources with an upper economic limit that does not support their day-ahead energy + RCU award will be charged the higher of the RTPD FRU price or the RCU price.

Reliability capacity down: Resources with a lower economic limit that does not support their day-ahead energy - RCD award will be charged the higher of the RTPD FRD price or the RCD price.

These unavailability penalties provide a strong incentive to deliver reliability capacity and reflect the full cost of unavailability. That is because suppliers can be charged the cost of real-time flexible ramping product, whose price may spike because of a shortage of flexible capacity, for the portion of their award that was not provided. Resources that receive both a reliability capacity and imbalance reserve award and are not available or only bid a portion of their combined award will have the unavailability charge applied first to reliability capacity and then to imbalance reserves.

Bid Cost Recovery

Currently, bid cost recovery is calculated separately for the day-ahead and real-time market. This will not change. However, resources committed in the residual unit commitment process are eligible to receive real-time bid cost recovery.[19] The revenue and bid costs from reliability capacity awards will be included in the calculation of real-time bid cost recovery. Resources committed after the close of the day-ahead market through a real-time market schedule or an exceptional dispatch will also continue to be eligible for real-time bid cost recovery.

[19] Units committed in RUC are included in the real-time market BCR (as opposed to day-ahead market BCR) because 1) many commitments made in RUC are non-binding so the real-time market makes the binding commitment decision and 2) long-start and extra-long-start resources that do receive binding commitments in RUC are only committed to their PMin so they can participate in the real-time market.

Any surplus revenues from the residual unit commitment process will be netted against revenue shortfalls in the real-time market. A revenue surplus would occur in the residual unit commitment when the marginal price of reliability capacity exceeds a resource's reliability capacity bid cost. Conversely, any surplus revenues from the real-time market will be netted against revenue shortfalls in the residual unit commitment process. Bid cost recovery payments from the integrated forward market and the residual unit commitment/real-time market will continue to be kept separate because they have different cost allocations. RUC bid cost recovery costs will be allocated to net virtual supply, under-scheduled load, and over-scheduled VERs in alignment with reliability capacity up cost allocation.

Application of Grid Management Charge to Reliability Capacity

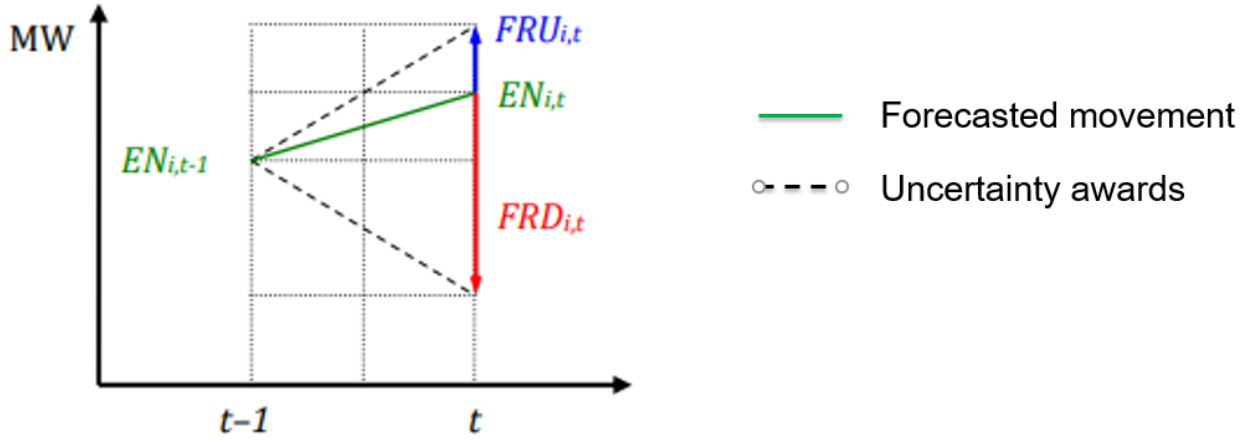
The market services charge of the grid management charge covers the cost of bidding and clearing the market. Currently, the market services charge is applied to ancillary services awards in the day-ahead market and real-time market. Suppliers include this cost in the bid price for ancillary services. The market services charge is not applied to the flexible ramping product and corrective capacity because suppliers are not allowed to submit bids for those products. Since bids can be submitted for reliability capacity, the market services charge will be applied for reliability capacity awards. Suppliers will include this cost in their bids.

4. Additional Day-Ahead Market Enhancement Design Considerations

4.1 Real-Time Market Ramp Deviation Settlement

The deviation settlement of ramp involves two components: (1) forecasted movement and (2) uncertainty awards (see Figure). Forecasted movement is the change in energy schedules between market intervals. Uncertainty awards reserve additional ramping capability that is needed to meet net load forecast uncertainty in the next market run. The marginal value of providing ramp capability is the same for both forecasted movement and uncertainty awards.

Figure 7: Forecasted movement and uncertainty awards



Imbalance reserves in the day-ahead market and flexible ramping product in the real-time market both provide additional capacity for ramping. Market payments for the provision of ramping services should net in each market. However, there are differences in the configuration, eligibility, and pricing of these products that make a direct deviation settlement infeasible. Table 4 describes these differences.

Table 3: Differences between Imbalance Reserves and Flexible Ramping Product

Imbalance Reserves	**Flexible Ramping Product**
Single settlement (uncertainty awards)	Dual settlement (uncertainty awards and forecasted movement)
Awards based on resource's 15-min ramp capability	Awards based on resource's 5-min ramp capability
Marginal clearing price based on bids and opportunity cost	Marginal clearing price based only on opportunity cost

The CAISO proposes a deviation settlement for ramp services. This approach is necessary to avoid the following issues:

- **Double payment of opportunity costs.** Resources that receive an imbalance reserve award in the day-ahead market are paid the locational marginal price of imbalance reserves for the corresponding interval. The locational marginal price of imbalance reserves is based on two factors: imbalance reserve bids and any opportunity costs. Opportunity costs for imbalance reserves occur when a resource is held out of merit for energy or ancillary services to preserve its ramp capability to provide upward capacity to meet the uncertainty requirements in a given interval. Similarly, opportunity costs for energy can occur when a resource is held out of merit for energy in order to preserve its downward capability to provide sufficient ramping to meet the load in a subsequent interval. However, the marginal clearing price of flexible ramping product is based only on opportunity costs; there are no bids associated with this product. A resource awarded both imbalance reserves and flexible ramping product could thus be paid opportunity costs from both products, even if its energy and ancillary service schedules did not change. This represents a double payment. However, the resource should retain its imbalance reserve bid costs, which reflect the resource's marginal cost of being available for dispatch in the real-time market.
- **Double payment of forecasted movement.** In the day-ahead market, all hourly schedules are financially binding across the 24-hour horizon. That is, there are no unsettled advisory intervals in the day-ahead market. As a result, there is no need to settle forecasted movement in the day-ahead market because the energy prices already reflect the opportunity cost of resources scheduled out-of-merit in previous hourly intervals. However, in the real-time market, only one market interval is financially binding over the optimization horizon. The market produces unsettled "advisory" prices for the remaining market intervals. If a resource is dispatched for energy in the binding interval to provide ramp capability to meet the energy dispatch of an advisory interval, the resource can incur an opportunity cost if the binding interval price is less than its energy bid. If in this market run the resource incurs an opportunity cost, the advisory

interval energy price will increase to reflect this tradeoff. However, the advisory interval energy price is not settled, and when it becomes binding in the next market run, the out-of-merit dispatch is unknown and the opportunity cost is not embedded in the binding energy price. In order to compensate the resource, it receives a separate payment for forecasted movement at the marginal price of ramp capability.[20] This incentivizes the resource to follow its energy dispatch because the resource is indifferent to receiving an incremental energy schedule or a forecasted movement payment because it earns the same profit under both scenarios. However, a resource may receive compensation for forecasted movement both in the day-ahead market (embedded in the energy prices) and in the real-time market (as a side payment). This represents a double payment.

- **Unavailable ramp drives up real-time prices.** Capacity that is not available in real-time reduces the available supply of ramp and drives up its price. Therefore, resources that do not provide the ramp they are obligated to should settle those deviations at prices reflecting real-time conditions.

The proposed settlement for imbalance reserves has several components:

- **The 5-minute ramp-capable portion of an imbalance reserve award will be subject to a deviation settlement with a flexible ramping product award in FMM.** Imbalance reserve is 15-minute ramp capability reserved for use in FMM to address the granularity difference between IFM and FMM, and uncertainty that may materialize between IFM and FMM. The uncertainty that may materialize between FMM and RTD is addressed by the flexible ramping product, which is 5-minute ramp capability reserved in FMM and RTD. Therefore, the 5-minute ramp-capable portion of imbalance reserve can be procured as flexible ramping product in FMM.
- **The portion of an imbalance reserve award in excess of the 5-minute ramp-capable portion will not be subject to a deviation settlement but will be subject to no pay provisions.** This portion of the imbalance reserve award can be scheduled as energy in FMM to address the uncertainty that may materialize in FMM or the granularity difference between IFM and FMM. This portion of the imbalance reserve award is not subject to a deviation settlement. However, if any of this portion is unavailable due to outages, it is subject to no pay provisions at the higher of the IFM marginal price for imbalance reserves, the FMM marginal price for flexible ramping product, or the RTD marginal price for flexible ramping product (see Section 3.3).
- **Forecasted movement in the FMM will be subject to a deviation settlement with forecasted movement in the IFM.** Forecasted movement in the FMM is paid the flexible ramp up price and charged the flexible ramp down price. Therefore, an upward deviation in forecasted movement is paid the flexible ramp up price and charged the flexible ramp down price, and a downward deviation in forecasted movement is paid the flexible ramp down price and charged the flexible ramp up price. This aligns with the deviation settlement between FMM forecasted movement and RTD forecasted movement.

[20] See Section 7.1.3.1.4 of the Market Operations BPM for numerical examples.

The ramp capability of a resource may manifest as forecasted movement between energy schedules or it may be awarded as uncertainty awards, or any combination in between. That is why it is important the overall settlement of these complementary products have the following property: If the 5-minute ramp capability that is awarded in IFM (as either energy movement or an imbalance reserve award) is available and awarded in FMM (as either forecasted movement or a flexible ramping product award), there should be no net deviation settlement in FMM. Furthermore, if the 5-minute ramp capability that is awarded in FMM is available and awarded in RTD (as either forecasted movement or a flexible ramping product award), there should be no net deviation settlement in RTD.

The CAISO has published an Excel spreadsheet model[21] that illustrates that if the 5-minute ramp capability of a resource is awarded between forecasted movement and uncertainty awards the same across markets, from IFM to FMM to RTD, there are no net payments or charges due to deviations in the real-time market. The only exceptions are when a resource reaches their PMin or PMax at a different time than in the preceding market, there is a ramp rate de-rate, or the resource's ramp capability is not fully used.

Impacts to EIM from Ramp Settlement

The Energy Imbalance Market also procures flexible ramping product to commit and position resources to meet future load and supply variability and uncertainty. Therefore, EIM participants will also be subject to a forecasted movement deviation settlement in FMM. The baseline forecasted movement for each resource will be based on EIM base schedules. For EIM participants, forecasted movement from base schedules is equivalent to forecasted movement in the integrated forward market. If resources are already scheduled to ramp in EIM base schedules, then paying an additional forecasted movement payment in FMM for the same ramp constitutes a double payment.

Impact to Convergence Bidding from Ramp Settlement

Convergence bids, also known as virtual bids, are settled at the day-ahead price and liquidated in the FMM. Virtual supply is paid the IFM price and charged the FMM price. Virtual demand is charged the IFM price and paid the FMM price. Since the IFM energy price includes the settlement of forecasted movement, virtual supply and demand will have a forecasted movement deviation settlement at the FMM FRP prices.

4.2 Congestion Revenue Rights

Congestion revenue rights (CRRs) are CAISO forward market products that hedge integrated forward market congestion costs. Today, CRR holders receive congestion revenues collected in the integrated forward market due to each binding transmission constraint between the CRR source and sink. The CRR settles at the difference between the marginal congestion components of the energy LMP at the sink and source of the CRR.

[21] FMM and RTD Settlement Example - Day-Ahead Market Enhancements.
http://www.caiso.com/InitiativeDocuments/FMM-RTDSettlementExample-Day-AheadMarketEnhancements.xlsx

CRR payments due to a binding constraint are adjusted so that they do not exceed the congestion revenue collected due to that constraint. All binding constraints, from both the base case and contingencies, are considered. With DAME, any additional base case and contingency constraints that are binding in the imbalance reserve deployment scenarios will also be considered.

No changes are proposed to the existing CRR nomination and auction processes to account for imbalance reserves. Transmission capacity will not be withheld in the CRR model for the CRR nomination and auction processes. However, the CAISO proposes to settle the cost of imbalance reserves through a cost allocation rather than a direct settlement with load and VERs using the locational marginal price of imbalance reserves. In this way, the CAISO may not collect enough congestion revenues to cover the MCC of imbalance reserves in the imbalance reserve deployment scenarios. Whenever a constraint is binding in the deployment scenario and there is transmission reserved for deployed imbalance reserves on that constraint, there may be a shortfall in paying CRRs on that constraint because the CAISO will not collect congestion revenue on the imbalance reserve flow. This will result in the CRR not being paid its full amount because of existing rules that reduce congestion revenue right payments for a CRR on a particular path to not exceed the congestion revenue collected for that path. Generally, if the imbalance reserve bid prices are much lower than energy bid prices, the CAISO expects the constrained transmission to be mostly consumed by energy. Thus, the CAISO does not expect this to be a major issue. However, the CAISO proposes to monitor the issue and be prepared to act quickly if large issues arise. The CAISO would propose to take one of the following two actions:

1. **Reserve transmission capacity in the CRR model for imbalance reserve deployment.** This would require a large implementation effort and would require assumptions about long-term reservations of imbalance reserve flows. These assumptions would be more reasonable after some operational experience.
2. **Directly settle the locational imbalance reserve price with load and VERs.** This would ensure enough congestion revenue would be collected so that CRRs are fully funded.

4.3 Accounting for Energy Offer Cost in Upward Capacity Procurement

Suppliers offering upward capacity (i.e., imbalance reserves up or reliability capacity up) in the day-ahead market would presumably bid their cost of making the resource available in real-time. However, if two resources have the same capacity bids but different underlying energy costs, the optimization cannot differentiate between the two resources when awarding upward capacity. In this situation, the preferred solution would be to award imbalance reserve up or reliability capacity up to the resource with unloaded capacity with the lowest underlying energy cost because that resource would be most cost-effective if needed in real time.

Currently the day-ahead market does not attempt to distinguish the energy cost of resources when awarding existing reserve products such as contingency reserves. This is not as much of a concern for contingency reserves because the real-time market only dispatches contingency reserves during relatively infrequent contingency events. A resource's energy cost is a greater concern for reliability

capacity and imbalance reserves because there is a higher likelihood of being dispatched for energy in the real-time market.

Thus, this proposal intends to implement rules that distinguish resources with high energy costs from resources with low energy costs when awarding reliability capacity up and imbalance reserves up. The objective is to prevent opportunities for high energy cost resources from routinely being awarded imbalance reserve up and reliability capacity up (and the resulting capacity payments) when the resources will rarely be dispatched for energy in the real-time market.

Previously, the CAISO proposed to estimate the marginal price of meeting the P97.5 net load forecast using all available day-ahead energy bids, and to make resources ineligible for RCU and IRU awards on any capacity segment with an associated energy bid that exceeds this forecasted P97.5 price. The CAISO later determined this solution was not feasible to implement.

The CAISO instead proposes to implement a real-time energy bid price cap on all resources that receive an imbalance reserve up or reliability capacity up award. The policy objective would be achieved by providing incentives for high energy cost resources to differentiate themselves from low energy cost resources through their capacity bids. Resources with energy costs above the real-time energy bid price cap will need to incorporate the financial risk of being subject to the real-time cap into their imbalance reserve up and reliability capacity up bids. The financial risk would incentivize those resources to provide higher priced bids for imbalance reserve up and reliability capacity up, making them less favorable in the optimization compared to resources whose energy costs are below (and thus unaffected by) the real-time energy bid price cap.

The CAISO proposes to set the real-time energy bid price cap consistent with the expected system marginal price if the entire upward uncertainty requirement materialized. For brevity, the CAISO will refer to this as the "P97.5 price". Another way to think about the P97.5 price is it represents the system marginal price if all of the capacity awarded imbalance reserve up and reliability capacity up were needed for energy dispatch.

The CAISO does not have a proposal at this time for the specific methodology of how the P97.5 price that sets the real-time energy bid cap would be determined. The CAISO is looking to establish some general acceptance of the concept before working on the detailed methodology. However, generally the P97.5 price would likely take one of these forms:

- A calculated price using available bids or DEBs that clear against the P97.5 net load forecast
- A forecasted price using statistical regression
- Some combination of the two

The P97.5 price would have to be published in advance of the day-ahead market close (10:00AM) so that scheduling coordinators could incorporate the real-time energy bid price cap into their day-ahead bids.

The CAISO proposes to limit the quantity of real-time energy bids subject to the real-time energy bid price cap to the MW quantity of imbalance reserve up and reliability capacity up awards in the day-

ahead market. For example, assume the P97.5 price is $250 and a resource receives a 20MW imbalance reserve up award and a 20MW reliability capacity award. In the real-time market, this resource must provide at least 40MWs of energy bids priced below $250.

The CAISO proposes to implement functionality to turn off the real-time energy bid price cap during pre-defined tight system conditions. The CAISO will need to consider the Extended Day-Ahead Market when defining these tight system conditions.

4.4 Variable Energy Resources Eligibility to Provide New Products

The CAISO maintains that variable energy resources (VERs) should be eligible to provide imbalance reserves and reliability capacity in both directions. The CAISO is re-evaluating the specific mechanics by which VERs would be eligible for and participate in these products. The CAISO will provide these details in the next proposal.

The CAISO also proposes to alleviate concern around VERs providing imbalance reserve up or reliability capacity up by requiring VERs to provide the CAISO their High Sustainable Limit (HSL). HSL is a real-time estimate of a VERs maximum output capability and is continuously updated in real-time at a 5-minute granularity.[22] Providing HSL data points will help improve forecasting of VER resources.

4.5 Energy Storage Enhancements

The CAISO is currently undertaking the Energy Storage Enhancements stakeholder initiative. In this initiative, the CAISO proposes a new Energy Storage Resource model to allow energy storage resources to submit bids based on incremental or decremental state-of-charge (as opposed to incremental or decremental capacity (MWs)).

The proposed Energy Storage Resource model will be aligned with the day-ahead market enhancements. The DAME mathematical formulation has state-of-charge constraints that limit the imbalance reserve awards based on the available state-of-charge and the applicable state-of-charge limits:

$$\left.\begin{array}{l} \underline{SOC}_{i,t} + RU_{i,t} + SR_{i,t} + NR_{i,t} + IRU_{i,t} \leq SOC_{i,t} \\ SOC_{i,t} \leq \overline{SOC}_{i,t} - \eta_i \left(RD_{i,t} + IRD_{i,t}\right) \end{array}\right\}, \forall i \in S_{LESR} \wedge t = 1,2,\dots,T$$

A resource's state-of-charge is calculated based on energy schedules. An imbalance reserve award does not expend state-of-charge as if that award were dispatched, but the required state-of-charge must be available to support the potential dispatch of the award in the real-time market. The real-time market bid insertion rules for imbalance reserve awards guarantees that a bid will be submitted (or generated by SIBR) for the potential dispatch of the award in the real-time market while the required state-of-charge is reserved. The imbalance reserve award is released in the real-time market for optimal energy dispatch or optimal conversion to a flexible ramping product award.

[22] For more information see: http://www.caiso.com/InitiativeDocuments/FinalWhitePaper-HighSustainableLimit-HybridResourcesPhase2.pdf.

Storage resources utilizing the ESR model will need to ensure their real-time energy bids reflect a state-of-charge that is consistent with their obligations based on any day-ahead imbalance reserve or reliability capacity award. For example, assume a 100MW ESR with 4-hour duration. Thus, the state-of-charge is between 0 and 400MWh. In the day-ahead market, assume in a given hour the resource receives a schedule to operate at 200MWh of state-of-charge and receives a 100MW imbalance reserve up award and a 100MW imbalance reserve down award. In the real-time market, this resource is obligated to provide economic energy bids between 100MWh – 300MWh of state-of-charge for that hour to be consistent with their imbalance reserve awards.

4.6 Treatment of Metered Subsystems, Existing Transmission Contracts, and Transmission Ownerships Rights

Metered Subsystems

Currently, metered subsystem operators must make an election on four issues that govern the manner in which the metered subsystem participates in the markets. The metered subsystem operator must choose either:

i. Net settlements or gross settlements.
ii. To load follow or not to load follow with its generating resources.
iii. To have its load participate in residual unit commitment procurement or not have its load participate in residual unit commitment procurement.
iv. To charge or not to charge the CAISO for their emissions costs.

With the day-ahead market enhancements, metered subsystem operators must make an election on three issues that will govern the manner in which the metered subsystem participates in the markets. The metered subsystem operator must choose either:

i. Net settlements or gross settlements.
ii. To load follow or not load follow with its designated generating resources.
iii. To charge or not to charge the CAISO for their emissions costs.

A metered subsystem operator may:

i. Bid to supply energy to or purchase energy from the markets.
ii. Bid to provide available capacity for imbalance reserves up/down to meet uncertainty requirements.
iii. Bid to provide available capacity for reliability capacity up/down to meet net load forecast
iv. Bid or self-provide an ancillary service from a system unit or from individual generating units, participating loads or proxy demand response resources within the metered subsystem. A metered subsystem operator also may purchase ancillary services from CAISO or third parties to meet its ancillary service obligations under the CAISO tariff.

The CAISO proposes to maintain the current settlement of metered subsystem operator day-ahead energy schedules who have elected gross settlement or net settlement. The CAISO proposes to settle

metered subsystem resources that have received imbalance reserves or reliability capacity awards in a similar manner as non-metered subsystem resources, regardless of the metered subsystem operator's selection of net or gross settlement. Imbalance reserve up/down awards will settle at the relevant locational marginal price for imbalance reserves. Reliability capacity up/down awards will settle at the relevant locational marginal price for reliability capacity. For both reliability capacity tier 1 and reliability capacity tier 2 cost allocations, metered subsystem operators will settle in a similar manner as non-metered subsystem resources, regardless of their net versus gross selection. A metered subsystem operator that has elected to load follow to manage its own load variability shall not receive a reliability capacity tier 1 or a reliability capacity tier 2 cost allocation. For both imbalance reserve tier 1 and imbalance reserve tier 2 cost allocations, metered subsystem operators will settle in a similar manner as non-metered subsystem resources, regardless of their net versus gross selection. A metered subsystem operator that has elected to load follow to manage its own load variability shall receive imbalance reserve tier 1 and imbalance reserve tier 2 cost allocations based on the metered subsystem operator's net portfolio uninstructed deviations.

Existing Transmission Contracts and Transmission Ownership Rights

The CAISO proposes to maintain the current energy settlement for existing transmission contract rights (ETCs) and transmission ownership rights (TORs). Day-ahead energy schedules associated with an ETC or TOR self-schedule will settle at the relevant integrated forward market locational marginal price. In addition, the CAISO proposes to maintain the settlement of integrated forward market congestion credit for the valid and balanced portion of ETC or TOR self-schedules and relative eligible point of receipt of delivery.

Reliability capacity will ensure sufficient physical resources are committed to meet the net load forecast with adjustments for known differences between what cleared the integrated forward market including under-scheduled variable energy resources. As long as the ETC/TOR self-schedules supply to meet their demand, the market does not need to procure reliability capacity to meet the valid and balanced portion of ETC or TOR self-schedule. As such, the CAISO proposes to exclude the ETC and TOR self-schedules from reliability capacity tier 1 and reliability capacity tier 2 allocations up to the valid and balanced portion of ETC and TOR self-schedules. In contrast, the ETC and TOR self-schedules are subject to reliability capacity tier 1 and reliability capacity tier 2 allocations for quantities above the valid and balanced portion of the ETC or TOR self-schedules.

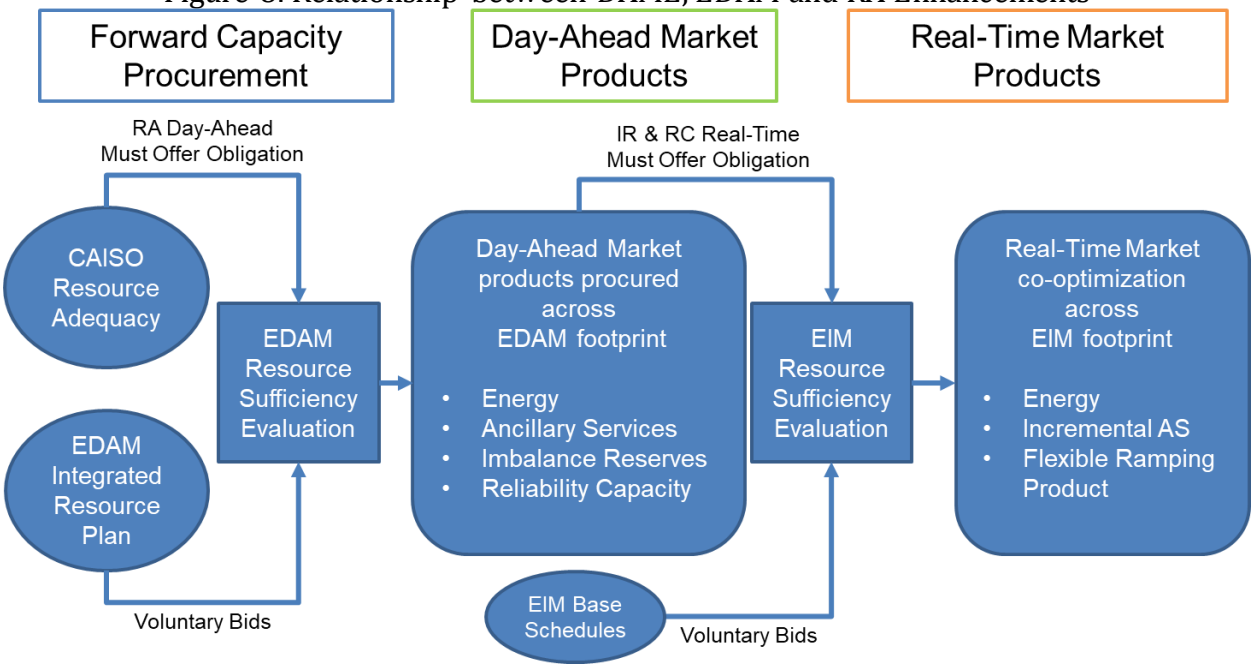
Imbalance reserves will ensure the day-ahead market schedules sufficient real-time dispatch capability to meet net load imbalances between the day-ahead and real-time markets. As long as the ETC and TOR self-schedules supply to meet their demand, the CAISO does not need to procure additional imbalance reserves. As such, the CAISO is proposing to exclude the ETC and TOR self-schedules from imbalance reserve tier 1 and imbalance reserve tier 2 allocations up to the valid and balanced portion of ETC and TOR self-schedules. In contrast, the ETC and TOR self-schedules are subject to imbalance reserve tier 1 and imbalance reserve tier 2 allocations for quantities above the valid and balanced portion of the ETC or TOR self-schedules.

5. Alignment between RA Enhancements, DAME, and EDAM

The CAISO is coordinating the stakeholder initiatives for the Resource Adequacy Enhancements, Day-Ahead Market Enhancements, and Extended Day-Ahead Market to ensure alignment and consistency in determining forward capacity procurement requirements, bidding obligations, and market solutions. The goal of this effort is to ensure an efficient and robust market design that bridges the various election/bidding and program/market timelines.

Error! Reference source not found. Figure 8 is a flowchart depicting the correlation between RA Enhancements, DAME, and EDAM.

Figure 8: Relationship between DAME, EDAM and RA Enhancements



The flowchart can be summarized as follows:

1. The CAISO resource adequacy program or a non-CAISO EDAM participants' integrated resource plan are the forward procurement processes that ensure the balancing authority area has forwarded contracted with adequate supply to meet their anticipated system needs. To participate in the day-ahead market and benefit from EDAM transfers, each EDAM participant must pass the EDAM resource sufficiency evaluation. The EDAM resource sufficiency evaluation ensures all EDAM participants have sufficient bids from participating resources to individually meet their demand forecast, ancillary service requirements, and uncertainty requirements for each hour of the operating day. This prevents EDAM participants from leaning on the capacity of others in the day-ahead timeframe. For the CAISO, the resource adequacy program requires resource adequacy capacity to bid in the day-ahead market through must-offer obligation rules. Non-CAISO EDAM participants provide voluntary bids to the day-ahead market that must be sufficient for the participant to meet its day-ahead resource sufficiency requirements.

2. EDAM participants will have their energy and imbalance reserves co-optimized to meet daily load and uncertainty requirements.[23] In addition, the residual unit commitment will procure reliability capacity in each EDAM balancing authority area across the EDAM footprint to meet difference in cleared physical supply and the load forecast. The day-ahead market will result in must-offer obligations and bids into the real-time market.[24] For EDAM participants, these real-time market bids are inputs into the WEIM resource sufficiency evaluation. EDAM participants will benefit in the WEIM RSE by the assurance their day-ahead schedules are balanced. Entities participating in the WEIM but not in the EDAM will continue to provide WEIM base schedules. In order to benefit from transfers in the real-time market, WEIM participants must pass the WEIM real-time resource sufficiency evaluation.

3. The real-time market will co-optimize energy, incremental ancillary services, and real-time flexible ramping product across the entire WEIM footprint.[25]

6. EIM Governing Body Role

Although this initiative focuses mainly on the day-ahead market, which falls outside the authority of the WEIM Governing Body, it includes proposals to change five types of real-time market rules:

1. Financial settlement of flexible ramping product, to remove the double payment of forecasted movement (§ 4.1);

2. Other changes to the financial settlement of flexible ramping product (§4.1);

3. Real-time offer obligation for resources with California Resource Adequacy obligations (§ 3.1);

4. Real-time energy bidding rules for resources that received awards in the day-ahead market to provide imbalance reserve up or reliability capacity up (§ 3.3); and

5. Bidding obligations for resources that have day-ahead schedules for imbalance reserve or reliability capacity (§ 3.1).

As explained below, CAISO staff believes that the WEIM Governing Body has joint authority with the Board of Governors over the financial settlement of flexible ramping product to remove the double-payment of forecasted movement – proposal 1. The WEIM Governing Body would have an advisory role with respect to proposals 2 through 5, and would not have any role with respect to the remainder of this initiative.

[23] CAISO is currently proposing not to co-optimize ancillary services at the onset of EDAM.
[24] For the CAISO, the real-time must-offer obligations from day-ahead capacity awards replace the real-time must-offer obligations from the resource adequacy program. However, Local Regulatory Authorities could enforce real-time must-offer obligations with their contracted supply at their discretion.
[25] The Energy Imbalance Market currently does not procure incremental ancillary services outside of the CAISO balancing authority area.

The role of the WEIM Governing Body with respect to policy initiatives changed on September 23, 2021, when the Board of Governors adopted revisions to the corporate bylaws and the Charter for EIM Governance to implement the Governance Review Committee's Part Two Proposal. Under the new rules, the Board and the EIM Governing Body have joint authority over any

> proposal to change or establish any CAISO tariff rule(s) applicable to the EIM Entity balancing authority areas, EIM Entities, or other market participants within the EIM Entity balancing authority areas, in their capacity as participants in EIM. This scope excludes from joint authority, without limitation, any proposals to change or establish tariff rule(s) applicable only to the CAISO balancing authority area or to the CAISO-controlled grid.

Charter for EIM Governance § 2.2.1

The changes to the settlement of flexible ramping product, to remove the double payment of forecasted movement (proposal 1) would be "applicable to EIM Entity balancing authority areas, EIM Entities, or other market participants within EIM Entity balancing authority areas, in their capacity as participants in EIM." This proposed change therefore falls within the scope of joint authority.

On the other hand, proposals 2 through 5, to the extent they change rules of the real-time market, would not be applicable to EIM Entities through EIM. To be clear, they may apply to some EIM Entities, but only as importers into or exporters from the ISO balancing authority, unrelated to EIM. Accordingly, these proposed tariff changes fall outside the scope of joint authority.

These proposed changes (2 through 5) do fall within the scope of the EIM Governing Body's advisory role, because the "EIM Governing Body may provide advisory input over proposals to change or establish tariff rules that would apply to the real-time market but are not within the scope of joint authority." Id.

Stakeholders are encouraged to submit a response to this proposed decisional classification of this initiative as described above in their written comments, particularly if they have concerns or questions.

7. Stakeholder Engagement, Implementation Plan & Next Steps

Table 6 outlines the proposed schedule to complete the policy and implementation of the Day-Ahead Market Enhancements initiative. CAISO has moved the implementation of DAME to fall 2023 to be concurrent with EDAM. Some stakeholders have requested that both the DAME and EDAM initiatives take place within the same stakeholder forum. While the CAISO is committed to aligning the objectives and functionalities of these initiatives, they will continue as distinct stakeholder processes. The day-ahead market enhancements lay the foundation for EDAM. However, the day-ahead market enhancements will be implemented for the CAISO balancing authority area regardless of the outcome of EDAM. For this reason, it is critical to keep the initiatives, board decisions, FERC filings, and implementations separate.

Table 4: Stakeholder engagement and implementation development plan

Date	Milestone
Second Revised Straw Proposal	
Paper Posted	April 22, 2022 April 27, 2022 (updated)
Stakeholder Meeting	April 29, 2022
Comments Due	May 19, 2022
Draft Final Proposal	
Post Paper - *tentative*	July 19, 2022
Stakeholder Meeting - *tentative*	July 26, 2022
Comments Due - *tentative*	August 9, 2022
Start Tariff Stakeholder Process	July 2022
Start Business Requirement Specification (BRS) Development	July 2022
ISO Board of Governors and WEIM Governing Body joint meeting	September 1, 2022
Implementation	Fall 2023

The CAISO will discuss the third revised straw proposal with stakeholders during the stakeholder call scheduled on April 29. Stakeholders should submit comments on the proposal and meeting discussions May 19, 2022.

Appendices

Appendix A: Eligibility Table

	EN	RCU	RCD	EN needed for RCU/D award	IRU	IRD	EN needed for IRU award	EN needed for IRD award
Non-Participating Load	Yes	Not Eligible	Not Eligible	N/A	Not Eligible	Not Eligible	N/A	N/A
Virtual Supply	Yes	Not Eligible	Not Eligible	N/A	Not Eligible	Not Eligible	N/A	N/A
Virtual Demand	Yes	Not Eligible	Not Eligible	N/A	Not Eligible	Not Eligible	N/A	N/A
Hourly Block Import	Yes	Eligible	Eligible	None	Not Eligible	Not Eligible	N/A	N/A
Hourly Block Export	Yes	Eligible	Eligible	None	Not Eligible	Not Eligible	N/A	N/A
15-Min Import	Yes	Eligible	Eligible	None	Eligible	Eligible	None	EN >= IRD
15-Min Export	Yes	Eligible	Eligible	None	Eligible	Eligible	EN >= IRU	None
Dynamic Import	Yes	Eligible	Eligible	None	Eligible	Eligible	EN >= Pmin EN <= Pmax - IRU	EN <= Pmax EN >= Pmin + IRD
Long-Start Generator	Yes	Eligible	Eligible	EN >= Pmin	Eligible	Eligible	EN >= Pmin EN <= Pmax - IRU	EN <= Pmax EN >= Pmin + IRD
Short-Start Generator	Yes	Eligible	Eligible	None	Eligible	Eligible	EN >= Pmin EN <= Pmax - IRU	EN <= Pmax EN >= Pmin + IRD
Participating Load w/ 15-Min dispatch capability	Yes	Eligible	Eligible	None	Eligible	Eligible	EN >= Pmin EN <= Pmax - IRU	EN <= Pmax EN >= Pmin + IRD
Participating Load w/ Hourly dispatch capability	Yes	Eligible	Eligible	None	Not Eligible	Not Eligible	N/A	N/A

	EN	RCU	RCD	EN needed for RCU/D award	IRU	IRD	EN needed for IRU award	EN needed for IRD award
Variable Energy Resources (Wind/Solar)	Yes	Eligible	Eligible	TBD	Eligible	Eligible	TBD	TBD
Non-Generator Resources (Storage)	Yes	Eligible	Eligible	N/A	Eligible	Eligible	N/A	N/A
Hybrid Resource	Yes	Eligible	Eligible	N/A	Eligible	Eligible	N/A	N/A
Co-Located Resource	--- Eligibility determined by individual storage and VER components ---							
Energy Storage Resource	Yes	Eligible	Eligible	N/A	Eligible	Eligible	N/A	N/A
60-Minute Proxy Demand Resource	Yes	Eligible	Eligible	None	Not Eligible	Not Eligible	N/A	N/A
15-Minute Proxy Demand Resource	Yes	Eligible	Eligible	None	Eligible	Eligible	EN >= Pmin EN <= Pmax – IRU	EN <= Pmax EN >= Pmin + IRD
5-Minute Proxy Demand Resource	Yes	Eligible	Eligible	None	Eligible	Eligible	EN >= Pmin EN <= Pmax – IRU	EN <= Pmax EN >= Pmin + IRD
Reliability Demand Response Resource	Yes	Not Eligible	Not Eligible	None	Not Eligible	Not Eligible	N/A	N/A

Appendix B: Draft Technical Description

See separate document.

Appendix C: Example of Local Market Power Mitigation of Energy and Imbalance Reserves

See separate document.