California ISO

Day-Ahead Market Enhancements

Final Proposal

January 11, 2023

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Day-Ahead Market Enhancements: Final Proposal

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Executive Summary

The objective of this initiative is to enhance the California ISO's (CAISO's) day-ahead market to better account for net load variability and uncertainty by:

- Introducing an imbalance reserve product in the integrated forward market that procures flexible reserves to cover uncertainty in the net load forecast between day-ahead and real-time markets and to cover real-time ramping needs that are not covered by hourly day-ahead market schedules.
- Enhancing the residual unit commitment process to enable the procurement of downward dispatch capability and to include local market power mitigation measures.

The enhancements proposed in this initiative are also essential elements of an extended day-ahead market (EDAM) as they maximize the benefits of West-wide diversity in the day-ahead market's optimization.

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

Under these enhancements, the day-ahead market's integrated forward market would continue to co-optimize energy and ancillary services, but would also include imbalance reserves within the same co-optimization to reserve resources' flexible ramping capability for real-time dispatch and commit resources needed to provide this ramping capability. Imbalance reserves would ensure the day-ahead market schedules sufficient flexible reserves 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 day-ahead net load forecast and the actual 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 reserves to address day-ahead to real-time uncertainty. Without a day-ahead flexible reserve product, uncertainty around imbalances that may materialize in real-time poses operational risks. This increased risk causes market operators to take manual actions outside of the market framework to procure additional capacity in the day-ahead timeframe. Specifically, grid operators manually increase the demand forecast used in the day-ahead market's residual unit commitment process. The higher demand forecast leads to additional units committed and scheduled to address 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 market operators to manually adjust the demand forecast used in the residual unit commitment process, creating a more efficient and effective market outcome.

Imbalance reserves would be procured in the upward direction (imbalance reserves up) and downward direction (imbalance reserves down). The quantity of imbalance reserves the market would procure would be based on the historical uncertainty in the day-ahead load, solar, and wind forecasts. Only resources that can be dispatched in the fifteen-minute market would be eligible to provide imbalance reserves. Imbalance reserve awards would be capped at the resource's 15-minute ramping capability. Suppliers would provide price and quantity bids separately for imbalance reserves up and imbalance reserves down that the market would use to determine optimal imbalance reserve awards. The market would consider transmission constraints to ensure imbalance reserves are deliverable in the day-ahead timeframe to locations where uncertainty historically materializes. Resources awarded imbalance reserves would receive a day-ahead payment at the product's locational marginal price.

By reducing out-of-market actions in the residual unit commitment process, imbalance reserves would return the residual unit commitment process to its intended purpose, rather than using it to commit resources for flexible ramping capability. The purpose of the residual unit commitment process is to procure capacity for two reasons: (1) to meet the difference between the market-cleared load schedules and the demand forecast, and (2) to backfill cleared virtual supply with physical resources.

The residual unit commitment process is an essential part of the day-ahead market and this proposal considers several enhancements to the current residual unit commitment process. The CAISO would continue to run the residual unit commitment process after the integrated forward market co-optimizes energy, ancillary services, and imbalance reserves. This proposal would enhance the residual unit commitment process to procure downward dispatch capability if the demand forecast is less than a balancing area's demand that clears the integrated forward market. The reserves awarded in the residual unit commitment process would be called *reliability capacity*.

All resources that can participate in the residual unit commitment process today would be eligible to provide reliability capacity. Reliability capacity awards would be capped at the resource's 60-minute ramping capability. Suppliers would provide price and quantity bids separately for reliability capacity up and reliability capacity down that the market would use to determine optimal reliability capacity awards. The market would consider transmission constraints to ensure reliability capacity is deliverable in the day-ahead timeframe. Resources awarded reliability capacity would receive a day-ahead payment at the product's locational marginal price.

In addition to procuring downward dispatch capability, this proposal enhances 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.

Resources that receive an imbalance reserve or reliability capacity award would be obligated to provide economic energy bids in the real-time market for the quantity of their awards.

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

The enhancements proposed in this initiative are also essential elements of the proposed design for the EDAM, in which Western Energy Imbalance Market participants outside of the CAISO's balancing area would also participate in the day-ahead market. Imbalance reserves would optimize the scheduling of flexible reserves across the EDAM footprint to meet each EDAM participants' net load uncertainty and real-time ramping needs while maximizing the diversity benefit of a large market footprint. Imbalance reserves also provide the EDAM a consistent method for evaluating and addressing uncertainty needs in each EDAM balancing area. Additionally, reliability capacity up and down would be procured in the EDAM to ensure each EDAM participant has sufficient physical supply scheduled in the day-ahead timeframe to meet their balancing area's load forecast.

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

The CAISO published the Day-Ahead Market Enhancements (DAME) draft final proposal on December 1, 2022 and held a web meeting to discuss the proposal on December 7, 2022. This final proposal changes, clarifies, or confirms a few elements of the draft final proposal based on stakeholder feedback. This final proposal:

- **Clarifies in Section 3.1 the resource adequacy (RA) must-offer obligation for reliability capacity only includes reliability capacity up.** Reliability capacity down bids from RA resources will be optional in order to maintain consistency with the current RA rules. Related, Section 3.5 clarifies that any bid insertion in RUC related to RA obligations only extends to reliability capacity up.
- **Clarifies the proposal will not mitigate imbalance reserve down bids.** The final DAME technical description will be updated to exclude any mitigation of imbalance reserve down bids; consideration of such mitigation will be deferred to a future initiative to allow for sufficient stakeholder discussion.
- **Includes in Sections 3.2 and 3.4 a negotiated rate option for establishing a resource's default availability bid for imbalance reserve and reliability capacity mitigation.** A negotiated rate option already exists for energy mitigation. The CAISO would implement a similar process and apply it to imbalance reserve and reliability capacity mitigation.
- **Proposes in Section 3.3 a demand curve for imbalance reserve procurement.** This proposal puts forth the use of a demand curve for the procurement of imbalance reserves, allowing the market to determine whether to meet all or some of the upward and downward uncertainty requirements. The imbalance reserve demand curve would establish the price of not fulfilling the imbalance reserve requirement for a given hourly interval, allowing the market to assess the trade-off between the cost and value of an incremental unit of imbalance reserves. If the imbalance reserve price is lower than the expected cost of not meeting the imbalance reserve uncertainty requirement, the market will continue to procure imbalance reserves, and if the imbalance reserve price is higher than the expected cost of not meeting the imbalance reserve uncertainty requirement, then no additional imbalance reserves will be procured.
- **Describes in Section 4.1 measures to accommodate long-term contracts.** CAISO will provide information to market participants to help them settle revenues from the new day-ahead market products in accordance with their contractual provisions. The CAISO considered an automated settlement mechanism to facilitate contractual agreements between parties, but determined that it was not feasible due to the complexity of the settlement process required and the resources needed to implement and maintain it. The CAISO will instead work with parties to understand the information they need to facilitate contractual settlement provisions themselves. CAISO will develop a process for providing this information to the relevant parties in a regularly issued settlement report.
- **Adds a third option in Section 4.3 to address potential CRR issues if necessary.** If CRR issues arise, CAISO would consider collecting congestion rents through an uplift of the allocated cost of

the imbalance reserve. The allocated cost of the imbalance reserve would be calculated based on the prices at withdrawal points rather than injection points. Any revenue collected that is above the amount paid to the suppliers of the imbalance reserve would go towards the CRR balancing account.

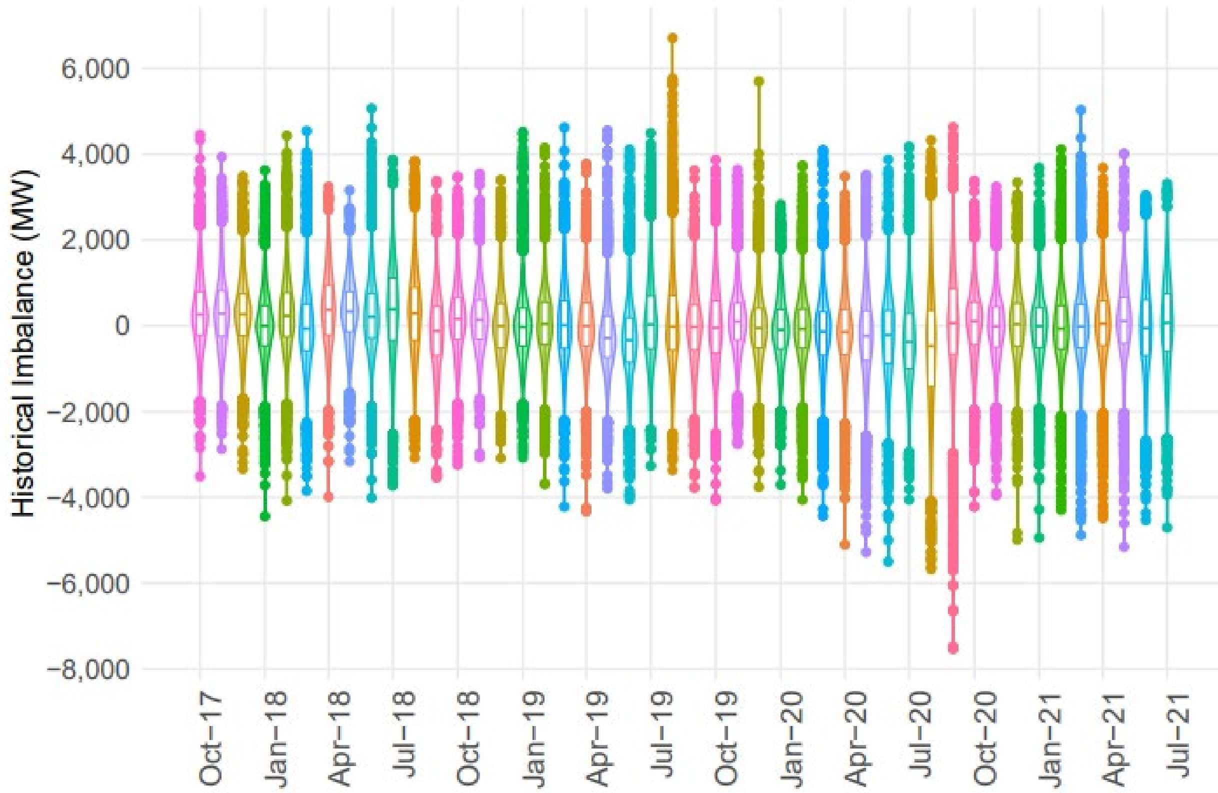
- **Removes the proposal for accounting for energy cost in imbalance reserve procurement.** The draft final proposal considered establishing criteria for procuring imbalance reserves based on the resource's energy bid costs; however, this element of the proposal has been removed. The Final Proposal will not include any method for accounting for energy cost in imbalance reserve procurement. The CAISO is still concerned about this potential issue, so CAISO will monitor it and be prepared to address it if needed when the data become available.
- **Defers the extension of storage state of charge constraint equations to the Energy Storage Enhancements initiative.** The final DAME technical description will remove equations that are being discussed within the stakeholder process of the Energy Storage Enhancements initiative.

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 load conditions, system operators must manage the more unpredictable and variable net load differences.

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 forecasted in the day-ahead market and the net load forecasted in the fifteen-minute market.

Figure 1: Monthly Trend of Day-Ahead Net Load Imbalance



Source: Day-Ahead Market Enhancements Analysis, page 7

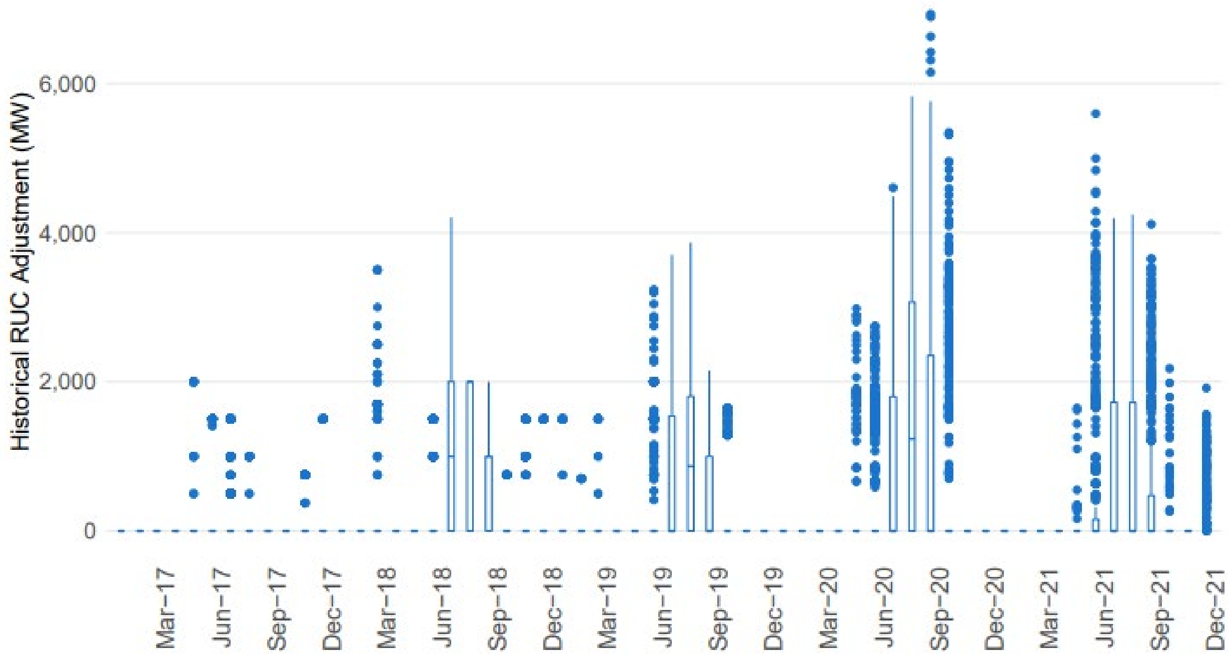
The real-time market must manage energy imbalances that occur between the day-ahead and real-time markets. The real-time market will continue to serve this purpose under the redesigned day-ahead market. This proposal introduces a new day-ahead market product called “imbalance reserves” to better accommodate 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 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 reserves to cover net load uncertainty. Procuring flexible reserves 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 these reserves 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 supply is non-zero.

However, there are costs to make resources available in the real-time market. These costs can include 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. It is more efficient, for both the overall system and individual resources, to procure flexible reserves using bids and compensate resources for those flexible reserves 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 reserves are most valued.

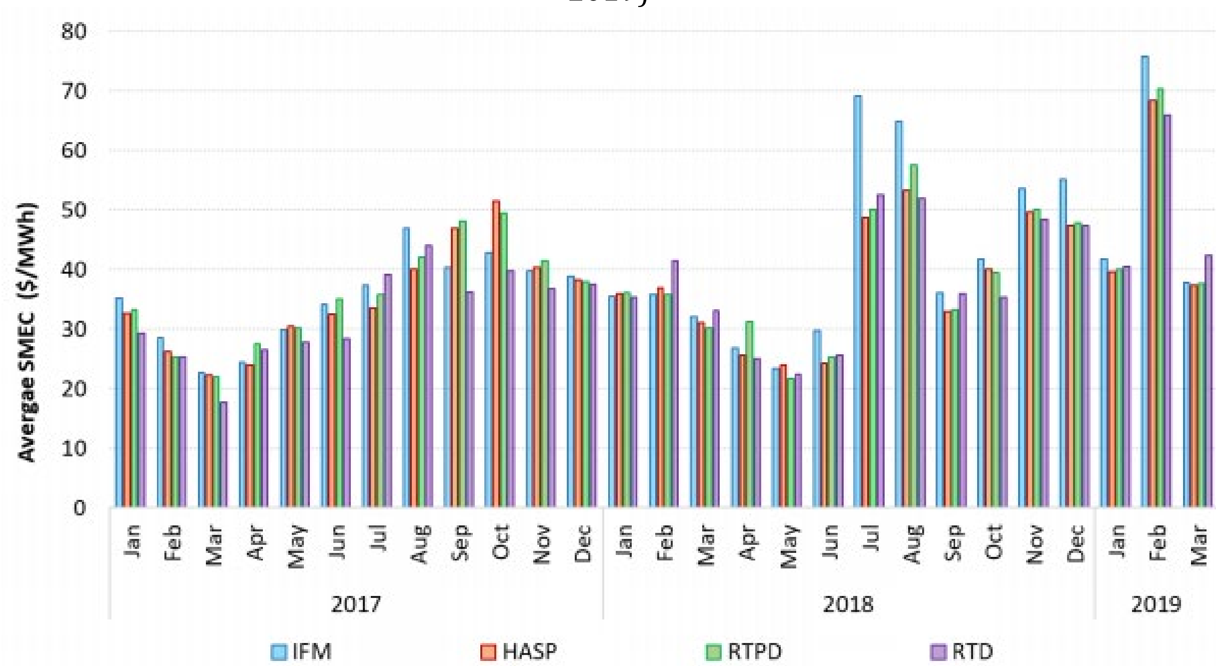
- **Imbalance reserves ensure the system has sufficient ramping capability.** By being co-optimized with energy, imbalance reserves allow the market optimization to consider the full ramping needs of the system (for energy and uncertainty). In addition, because imbalance reserves are 15-minute dispatchable, they are designed to be more flexible than RUC supply, 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 supply 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 reserves are 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 supply 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 non-EDAM import schedules.** The opportunity to sell imbalance reserves into the CAISO market should encourage non-EDAM importers to set up their system resources as 15-minute dispatchable. This would give the CAISO real-time market additional flexibility.
- **Imbalance reserves align 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.[1] 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."[2] 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

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

[2] 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.[3] Imbalance reserves will be an important component of the EDAM in doing this and increasing its benefits for the following reasons:

- **Reduces each EDAM BAAs individual net load uncertainty requirements and capacity procurement through the EDAM diversity benefit.** By pooling the uncertainty risk over a wider geographic footprint, the EDAM reduces the flexible reserves needed to meet each individual BAA's uncertainty because uncertainty is not expected to materialize coincidently across the larger and more geographically diverse EDAM market footprint.
- **Builds confidence in energy transfers between BAAs scheduled in the day-ahead market through a common market product to address forecast net load uncertainty in the day-ahead timeframe.** EDAM participants can be assured they can rely on other BAAs in the EDAM to support their transfer obligations because of a common day-ahead market imbalance reserve product.
- **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 reserves needed to address net load forecast uncertainty in the day-ahead timeframe, imbalance reserves will more efficiently select the resources to provide these reserves. It will provide EDAM BAAs access to resources that can potentially provide these reserves 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 reserve transfers will be firm, ensuring a BAA can access any imbalance reserves to meet its net load uncertainty that come from another BAA.
- **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.

As with the existing day-ahead market, 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.

[3] More information about the EDAM stakeholder process can be found at: http://www.caiso.com/StakeholderProcesses/Extended-day-ahead-market

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 BAA's load forecast. The EDAM will facilitate reliability capacity transfers between BAAs to minimize the cost of ensuring there is enough physical supply in the EDAM footprint to meet each BAA's load forecast.

2.4. Imbalance Reserve Net Benefits

The CAISO commissioned a study to estimate EDAM benefits. As part of that study, in response to stakeholder requests, CAISO requested a sensitivity study to elaborate on the role of imbalance reserves in the EDAM benefit. The CAISO published this study on November 15, 2022 and held a public webinar to discuss the study results on November 18, 2022.[4]

The study results showed the imbalance reserve is an important component in realizing the inter-regional dispatch efficiency. The study found that without the imbalance reserve component, the EDAM benefit would be about 60% lower. In addition, removing the imbalance product from the EDAM market was estimated to reduce the benefit to California by $120 million annually.

Figure 1: Annualized EDAM Operational Savings with and without Imbalance Reserves

Study Summary: Annualized Operational Savings
($M/year)

Scenario	California	Other Western States	TOTAL
West-wide EDAM	$214	$329	**$543**
No Imbalance Product	$86	$120	**$206**

Source: CAISO EDAM Benefits Study, page 22

[4] The study presentation materials can be found at http://www.caiso.com/Documents/Presentation-CAISO-Extended-Day-Ahead-Market-Benefits-Study.pdf and the webinar can be accessed at https://www.westernenergyboard.org/webinar-energy-strategies-findings-of-edam-benefits-study-sponsored-by-caiso/.

3. Proposed Day-Ahead Market Enhancements

Section 3 describes the proposed day-ahead market enhancements. This section 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 would 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

Today, the IFM market power mitigation pass identifies and mitigates potentially uncompetitive energy bids to ensure market prices remain competitive. Nothing is scheduled or committed in the IFM market power mitigation pass. Any bids that are mitigated in the IFM MPM pass are used in the integrated forward market. This proposal would 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 the day-ahead market will clear. Convergence bids, also known as virtual supply and virtual demand bids, can participate in this financial market. The integrated forward market also procures ancillary services and commits resources to meet the CAISO BAA's ancillary service requirements. The integrated forward market co-optimizes energy and ancillary services to produce financially binding day-ahead schedules and ancillary services awards. This proposal introduces an imbalance reserves up and down product to the integrated forward market. Imbalance reserves would be procured based on historical net load imbalance between the day-ahead and real-time markets.

This proposal also includes a new market power mitigation pass before the residual unit commitment to assess the competitiveness of reliability capacity offers. In the event the RUC market power mitigation pass detects the potential for market power, reliability capacity bids would be mitigated. Any mitigated bids would be used as inputs to the residual unit commitment process.

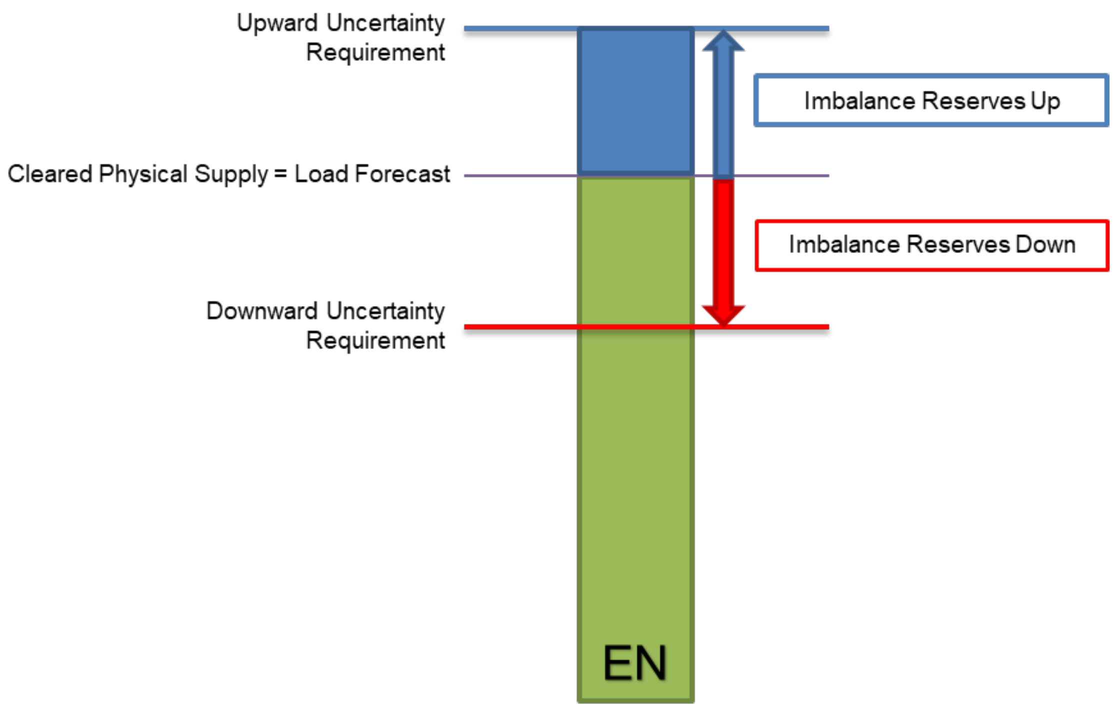
Today, the residual unit commitment process bridges the gap between the CAISO's load forecast and the physical energy cleared in the integrated forward market by procuring incremental supply that was not scheduled or committed in the integrated forward market. This additional supply ensures there is sufficient physical supply available to meet the day-ahead load forecast. In addition, this proposal enhances the residual unit commitment process to procure downward dispatch capability when the physical supply cleared in the integrated forward market exceeds the load forecast.

New Day-Ahead Market Products

This proposal introduces imbalance reserves as a new market product to address net load uncertainty and granularity differences between the day-ahead and real-time markets. Imbalance reserves would minimize the need for out-of-market actions and appropriately value a resource's flexible reserves. This proposal also enhances the residual unit commitment process by adding a downward reliability capacity product.

Figures 3, 4 and 5 illustrate the proposed 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 a scenario where the integrated forward market clears physical supply equal to the BAA's load forecast. The market would 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 physical supply equals load forecast



However, rarely does physical supply clear equal to the BAA's load forecast. Several factors would contribute to the need for the residual unit commitment to procure reliability capacity. The drivers for reliability capacity up would be:

- 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

The drivers for reliability capacity down would be:

- 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

These drivers could 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 5 illustrates the proposed relationship between energy, imbalance reserves, and reliability capacity when the cleared physical supply is greater than the BAA's load forecast. When this occurs, the residual unit commitment would procure reliability capacity up to provide upward dispatch capability, relative to the energy schedules, to meet the load forecast. The integrated forward market would still procure the full imbalance reserve requirements to meet the upward and downward uncertainty.

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

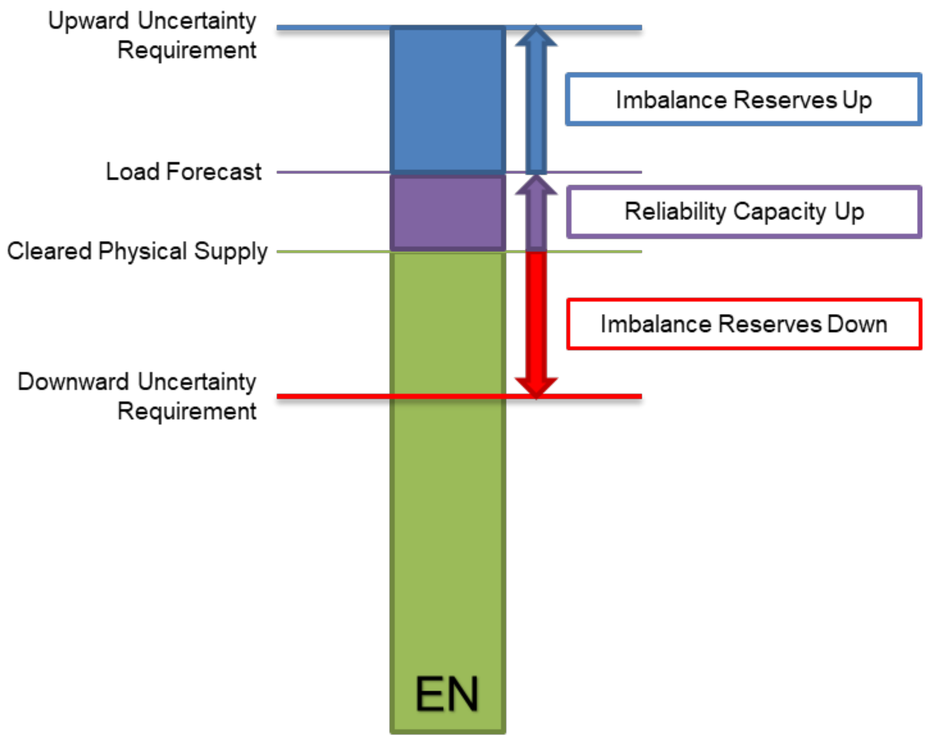
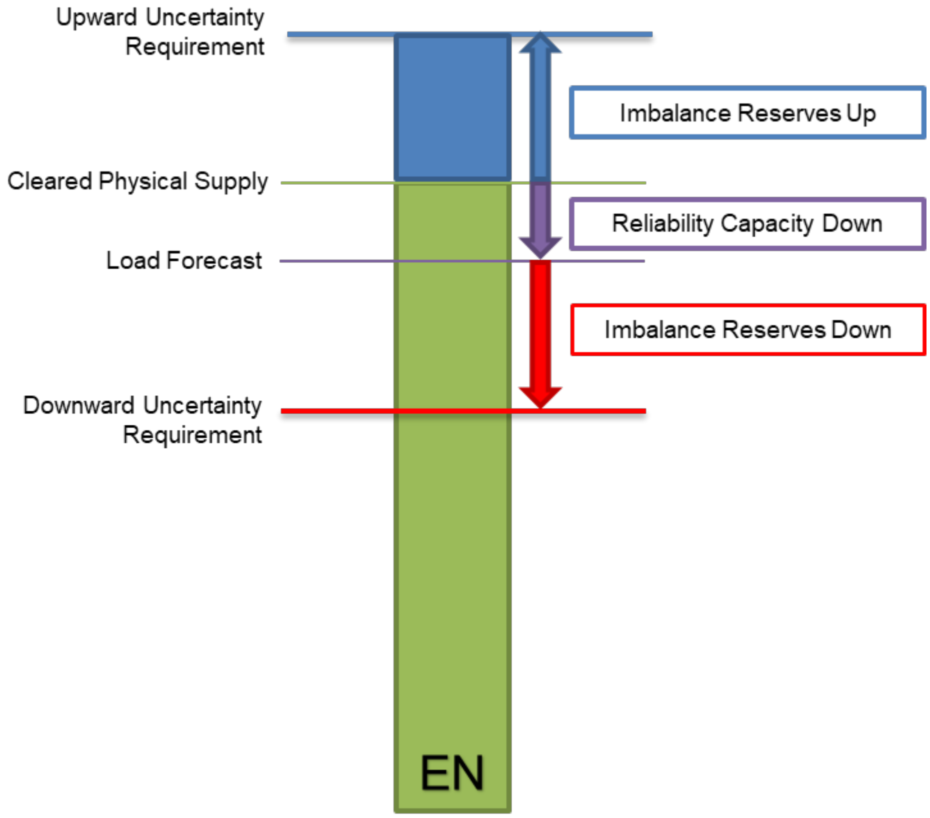


Figure 6 illustrates this relationship when the cleared physical supply is less than the BAA's load forecast. When this occurs, the residual unit commitment would procure reliability capacity down to provide downward dispatch capability, relative to the energy schedules, to meet the load forecast. The integrated forward market would still procure the full imbalance reserve requirements to meet the upward and downward uncertainty.

Figure 6: Day-ahead market products when physical supply is greater than load forecast



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

Table 1 summarizes 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	Purpose	Eligibility*	Procured In	Status
Energy	EN	Energy schedules cleared to meet bid-in demand	All resources	IFM	Existing
Reliability Capacity Up	RCU	Incremental supply procured to meet the positive difference between the load forecast and cleared physical supply	Physical resources based on 60-minute ramp capability	RUC	Replaces RUC awards
Reliability Capacity Down	RCD	Decremental supply procured to meet the negative difference between the load	Physical resources based on 60-minute ramp capability	RUC	Proposed

Title	Acronym	Purpose	Eligibility*	Procured In	Status
		forecast and cleared physical supply			
Imbalance Reserves Up	IRU	Incremental reserves procured to meet the upward uncertainty requirement	15-minute dispatchable physical resources, award based on 15-minute ramp capability	IFM	Proposed
Imbalance Reserves Down	IRD	Decremental reserves procured to meet the downward uncertainty requirement	15-minute dispatchable physical resources, award based on 15-minute ramp capability	IFM	Proposed
Ancillary Services	AS	Incremental reserves procured and reserved to meet real-time regulation and contingency reserve requirements	Resources certified to provide the respective service	IFM	Existing

Differences between Imbalance Reserve and Reliability Capacity

Some stakeholders have questioned why the day-ahead market needs both imbalance reserves and reliability capacity. While both these market products procure reserves in the day-ahead market, they serve different purposes and procure reserves based on different resource characteristics and system needs.

There could be perfect certainty between day-ahead and real-time markets and the market would still need reliability capacity. That is because the integrated forward market is a financial market (as opposed to a physical market) that clears based on demand bids instead of a demand forecast. Therefore, the integrated forward market can clear supply at a different quantity than the BAA demand forecast. Reliability capacity is procured in RUC to meet that difference. In addition, the integrated forward market allows for virtual bids, which are not backed by physical resources. If virtual bids clear the market, reliability capacity is procured in RUC to ensure there are sufficient physical resources to meet the BAA demand forecast.

The day-ahead market would procure reliability capacity based only on the load forecast. Assuming no operator load biasing, the reliability capacity procurement requirement does not address net load forecast uncertainty between the day-ahead timeframe and real-time. In contrast, the day-ahead market would procure imbalance reserve to cover this net load uncertainty. Imbalance reserves also provide additional ramping capability for real-time five-minute ramping needs that can be greater than the ramp capability procured in the day-ahead market.

If the integrated forward market clears physical resource supply up the day-ahead load forecast, then RUC would not schedule reliability capacity because there would already be enough scheduled supply (assuming that supply could meet the load forecast based on RUC's 60-minute ramp modeling.) However, the actual real-time net load and associated ramping needs could be much greater if net load comes in above or below the day-ahead forecast. These ramping needs can also be highly variable and can be greater than that scheduled by RUC's modeling of ramping for 60-minute granularity net load changes.

Imbalance reserves addresses this by procuring upward and downward resource ramping capability to meet differences in net load in each real-time market 15-minute interval that are different than that scheduled to be met in 60-minute granularity RUC schedules.

Procuring only imbalance reserves and not procuring reliability capacity is not an option because imbalance reserves should be procured relative to the day-ahead forecast, not the IFM market cleared load. If reliability capacity did not exist, then imbalance reserves would be procured to the wrong reference. In the initial DAME straw proposal, the ISO considered whether to eliminate reliability capacity and have imbalance reserves procured relative to the IFM market cleared load. It was decided this method could not guarantee there was sufficient physical supply to meet the forecasted demand, and that the relative quantity of imbalance reserves would have been unnecessarily high, and so abandoned this approach.

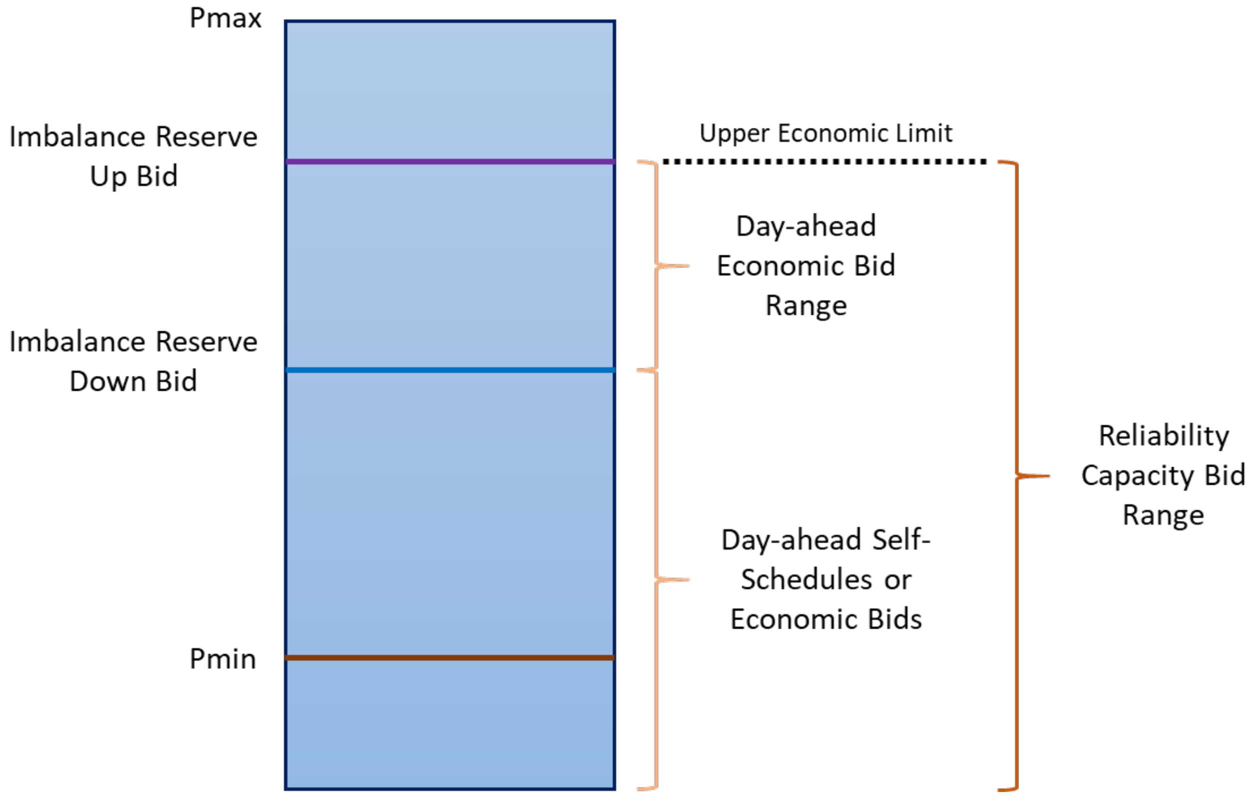
Day-Ahead Bidding Rules for Imbalance Reserves and Reliability Capacity

Eligible resources would submit bids for imbalance reserves (see Appendix A for eligibility by resource type). In order to bid for imbalance reserves, resources 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 7 provides an illustration of this bidding requirement.

Eligible resources would also submit bids for reliability capacity (see Appendix A for eligibility by resource type). Resources need to provide an energy bid in the day-ahead market to bid for reliability capacity but do not need to overlap with the economically bid portion of the energy bid. As part of EDAM, all resources offering energy bids in the IFM (and thus included in the EDAM resource sufficiency evaluation) must submit bids for reliability capacity up at the same quantity as their energy bid plus ancillary service self-provision. This ensures all resources shown in the EDAM RSE are fully available for use in RUC, including excess supply that participants offered above their RSE requirements.

The total quantity of energy, imbalance reserves, and reliability capacity scheduled on a resource would 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.

Figure 7: 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 provide economic energy bids for 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.

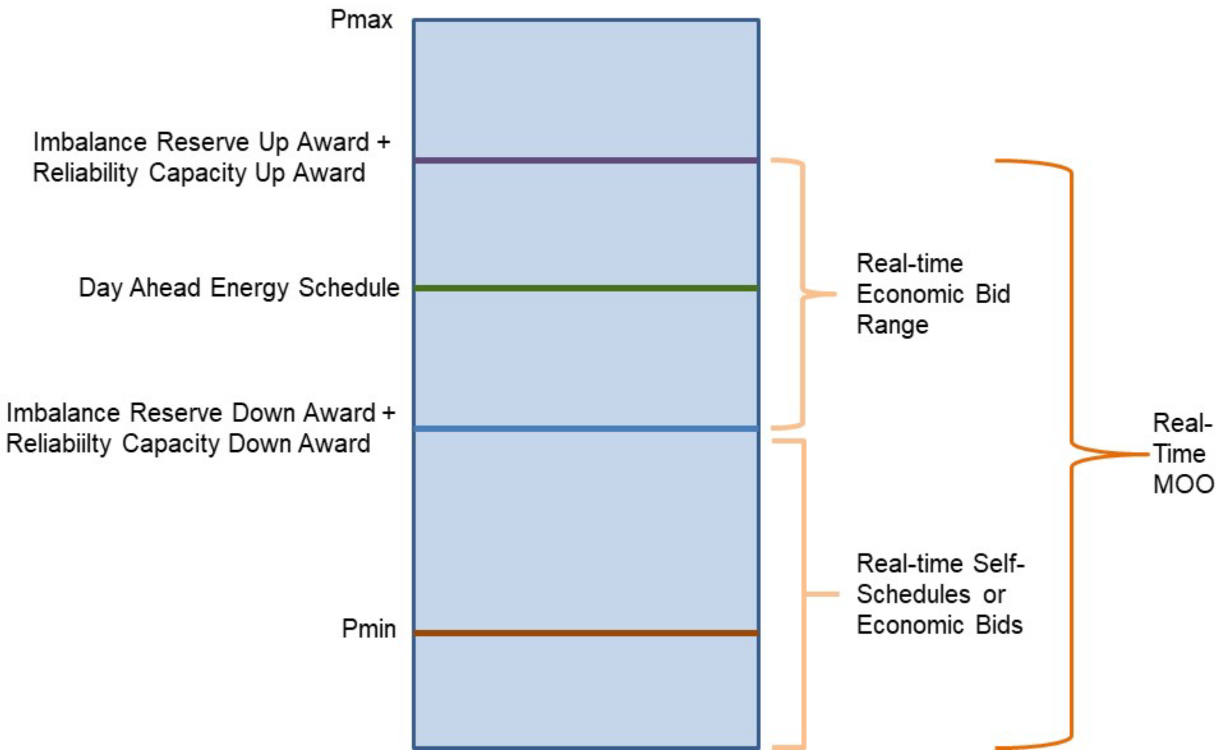
The purpose of the real-time must-offer obligation is to provide economic bids to the real-time market. Economic bids enable the real-time market to re-dispatch resources to meet real-time system conditions and imbalances. Real-time self-schedules do not provide the real-time market with the ability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

The minimum real-time bidding obligations are illustrated in Figure 8. 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 or below 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 8: 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.

CAISO BAA 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. Bids for reliability capacity down will be optional. The CAISO will not require that resource adequacy resources offer resource adequacy capacity into RUC with $0 availability bids. Instead, resource adequacy capacity can be bid into RUC at any price between the bid floor and bid cap.[5]

Resource adequacy capacity would be leveraged to facilitate a day-ahead must-offer obligation for imbalance reserves. This proposal would require that all RA capacity eligible to provide imbalance reserves (i.e., 15 minute dispatchable) have a must-offer obligation for imbalance reserves for the portion of their energy bid that is not self-scheduled (i.e., economically bid). Thus, this must-offer obligation would apply to all flex RA capacity since flex RA capacity is 15-minute dispatchable and already required to economically bid in the day-ahead market. System RA capacity that is eligible for imbalance reserves would maintain its ability to self-schedule or economically bid for energy, but any portion of the energy bid that is economic must be accompanied by an imbalance reserve offer. System RA capacity that is not eligible for imbalance reserve would have no change to their existing must-offer requirements from this rule. These must-offer requirements would maximize participation of RA capacity in imbalance reserve to increase competitiveness of the product, improve congestion management, reduce concerns about physical withholding, and help the CAISO BAA pass the EDAM resource sufficiency evaluation. At the same time, these must-offer requirements do not prevent any RA capacity from self-scheduling – an option that stakeholders expressed was extremely important. Imbalance reserve must-offer obligations would not be subject to RAAIM (Resource Adequacy Availability Incentive Mechanism) penalties.

Real-Time Must-Offer Obligations for Resource Adequacy Resources

This proposal maintains the CAISO BAA resource adequacy real-time must-offer obligation. Today, certain resource adequacy resources have an obligation to bid or self-schedule in the real-time market even if they do not receive an IFM schedule or binding RUC commitment. The CAISO enforces these obligations through its tariff and through mechanisms like bid insertion, which enables the market to generate real-time bids for eligible resource adequacy capacity that did not submit bids and is not on outage.

This proposal would initially implement DAME with the resource adequacy real-time must-offer obligation in place. After some future operational experience with EDAM, the CAISO could engage stakeholders to re-discuss whether an ISO-enforced resource adequacy real-time must-offer obligation continues to be needed.

Mechanism to Protect RA Capacity in EDAM

Some stakeholders from the CAISO BAA have expressed concerns about asymmetrical participation between CAISO and other BAAs in EDAM that center around the CAISO resource adequacy program's day-ahead and real-time must-offer obligations. Whereas non-CAISO BAAs are only obligated to offer into the EDAM market sufficient supply to pass their resource sufficiency evaluation, the CAISO resource adequacy program obligates all resource adequacy capacity to offer into the day-ahead market. The CAISO load serving entities would have no mechanism to "hold back" or "protect" a certain portion of

[5] RCU/RCD payments that overlap with RA capacity would be subject to reverse settlement as described in Section 3.5.

their resource adequacy capacity from supporting firm EDAM transfers. The EDAM proposal considers a net export transfer constraint to address this concern.

3.2 Market Power Mitigation Pass for IFM Changes

In the market power mitigation pass for IFM, the market would 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 would be evaluated for competitiveness. This proposal would continue use of the dynamic competitive path assessment (DCPA) to determine whether a transmission constraint is competitive.

Today, resources that can provide counter-flow to an uncompetitive constraint in the base scenario have their energy bids subject to mitigation. That would not change in this proposal. However, with the introduction of upward and downward deployment scenarios in the integrated forward market, this proposal would mitigate energy bids from resources that can provide counter-flow to an uncompetitive constraint in these deployment scenarios as well. This is because energy marginal prices have congestion contributions from binding constraints in the deployment scenarios.[6]

Resources that can provide counter-flow to an uncompetitive constraint in the upward deployment scenario would 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.[7] This proposal would not mitigate imbalance reserve down bids. This proposal would also not mitigate the imbalance reserve up bids of non-EDAM intertie resources certified to provide imbalance reserves, consistent with current policy for energy bid mitigation.

Local market power mitigation of energy and imbalance reserve up would be based on the same optimization, bids, set of binding constraints, and set of shift factors. The supply of counter flow for a binding transmission constraint in the upward deployment scenario would be the product of the negative shift factor and the energy schedule plus the imbalance reserve up award.[8]

CAISO provided detailed examples of local market power mitigation applied to energy and imbalance reserve offers.[9] The examples show that while energy mitigation alone does help mitigate market power exercised through imbalance reserve bids, it does not fully prevent it. Because energy and imbalance reserve up are fungible, the market will attempt to reorient energy and imbalance reserve schedules to avoid awarding resources with high priced imbalance reserve bids in favor of awarding

[6] See the DAME technical description. The terms $\sum SF_{i,m,t}\,\mu^{(\mathrm{u})}{}_{m,\mathrm{t}}$ and $\sum SF_{i,m,t}\,\mu^{(\mathrm{d})}{}_{m,\mathrm{t}}$ represent how transmission constraints in the upward and downward deployment scenarios contribute to the LMP.
[7] Id. The term $\sum SF_{i,,}\,\mu^{(\mathrm{u})}{}_{m,\mathrm{t}}$ represents how transmission constraints in the upward deployment scenario contribute to the IRU marginal price.
[8] Detailed description of the RSI calculation is provided in the DAME technical description.
[9] http://www.caiso.com/InitiativeDocuments/Appendix-C-Third-Revised-Straw-Proposal-Day-Ahead-Market-Enhancements.pdf

them energy schedules. However, this forces the market to schedule energy on a resource with higher bid costs, which drives up the total production cost. In this way, suppliers could utilize their position on the grid to exercise local market power, driving up costs to the system and increasing their market payments above competitive levels.

Today, the CAISO mitigates energy offers to the greater of what it calls *default energy bids* or the *competitive locational marginal price*.[10] 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.

This proposal maintains this method of determining mitigated bid prices for energy offers and extends this method to imbalance reserve up offers. This proposal would mitigate imbalance reserve up offers to the higher of a *default availability bid* or the competitive locational marginal price for imbalance reserve up. The latter would be derived as the marginal price of imbalance reserve minus the non-competitive congestion components from binding constraints in the imbalance reserve up deployment scenario at the location of the mitigated resource. This proposal would also include a Negotiated Rate Option, under which the CAISO would use information provided by the Scheduling Coordinator to determine the negotiated default availability bid.

Default availability bids would be distinct from default energy bids. Default energy bids (DEBs) are specific to each resource and are generally designed to approximate a resource's variable costs of providing energy, using any of the five methodology options the CAISO offers.[11] The variable costs of providing energy can be approximated based on generally understood criteria such as generator performance data, fuel costs, and opportunity costs. However, costs related to a resource's ability to provide reserves are more nebulous. Estimating the variable costs of each resource to provide reserves is subject to significant uncertainty.

Therefore, this proposal considers a static system-wide default availability bid for imbalance reserve mitigation when DAME is first implemented. This default availability bid would be the same price for all resources and across all market intervals. It would provide a mitigation "floor" that balances the need to protect consumers against market power but also protect producers against excessive mitigation by forcing offers below their costs. The imbalance reserve up default availability bid would be set conservatively using a high percentile value of historical spinning reserve bids. After the CAISO and market participants gain operational experience with imbalance reserves, and more information is

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[10] If the resource's unmitigated energy bid were less than the default energy bid or the competitive locational marginal price, there would be no modification to the resource's bid.

[11] LMP option, negotiated rate option, variable cost option, hydro DEB option, storage DEB option. See attachment D of the Business Practice Manual for Market Instruments - https://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Market%20Instruments.

available on the costs of offering imbalance reserves under competitive conditions, the CAISO could re-engage with stakeholders to develop a more rigorous default availability bid methodology.

The CAISO proposes the default availability bid for imbalance reserves be set to $55/MWh. This represents greater than the 80th percentile of spinning reserve bids using historical data (see Table 2). Spinning reserve bids is a reasonable approximation of a resource's cost to provide reserves. CAISO will investigate whether spinning reserve bid prices are related to prevailing gas prices to potentially make the default bid scalable by gas prices.

Table 2: Spinning Reserve Bid Prices (Jan - Jun 2022)

Type	Spinning Reserve Bid Price ($/MWh)
50 Percentile	$1.90
60 Percentile	$5.00
70 Percentile	$21.70
80 Percentile	$50.00
90 Percentile	$100.00

3.3 Integrated Forward Market Changes

Today, 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. This proposal enhances the day-ahead market by introducing an imbalance reserves product that is co-optimized and procured in the integrated forward market.

Energy (EN)

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

Ancillary Services

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

- 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.[12]
- 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.

This proposal considers no changes to ancillary service procurement. Ancillary services would 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.[13]

Imbalance Reserves (IRU/IRD)

Imbalance reserves would ensure the integrated forward market schedules sufficient 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 would be comprised of imbalance reserves up (IRU) that provide upward dispatch capability and imbalance reserves down (IRD) that provide downward dispatch capability. An imbalance reserve schedule would 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 would co-optimize and procure imbalance reserves to meet an hourly imbalance reserve requirement. The market would use imbalance reserve deployment scenarios to ensure imbalance reserves are transmission-feasible to the locations the uncertainty is expected to materialize if they are fully deployed. The market would price imbalance reserves at each node, resulting in locational marginal prices that reflect transmission constraints.

Imbalance reserves would enable the day-ahead market to compensate resources that provide flexible reserves to meet net load uncertainty and ramping needs. Today, system operators frequently take out-of-market actions, including increasing the load forecast used in RUC, 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

[12] In addition, there is a mileage requirement for regulation up and regulation down, representing the expected amount of system-wide resource operating point travel needed to provide the service.

[13] 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 would also examine removing the current cascading rule between upward ancillary service products.

net load variability and uncertainty resulting from increasing amounts of weather-dependent supply and demand. Imbalance reserves would reduce the need for these out-of-market actions and would create a market price signal for day-ahead flexible reserves.

The day-ahead market would 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 would be based on a resource's 15-minute ramp capability. Offline resources could be awarded imbalance reserves if the resource has a start-up time of 15 minutes or less. This proposal would make these parameters adjustable in response to stakeholder feedback that these requirements may be overly restrictive. The CAISO would 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 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.[14]

Historical data would be used to identify the load, wind, and solar forecast error between the day-ahead market and fifteen-minute markets. These historical forecast errors would 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. This proposal considers use of 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 forecast error, as opposed to the average forecast error. Furthermore, the quantile regression produces a polynomial function of the forecast that can be evaluated at the forecast for the relevant hour of the trading day, thus yielding an imbalance reserve requirement that does not only depend on historical forecast error, but also on the VER forecast used in the IFM and the demand forecast used in RUC.

Separate regressions need to be run using load, solar, and wind as dependent variables and then the estimated parameters are combined using the identity Net Load = Load – Wind – Solar. Calculating an imbalance reserve up requirement would then involve the following steps:

1. Use quantile regression to estimate parameters of load forecast, month, and hour on the 97.5 percentile of load imbalance
2. Use quantile regression to estimate parameters of wind forecast, month, and hour on the 2.5 percentile of wind imbalance

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

3. Use quantile regression to estimate parameters of solar forecast, month, and hour on the 2.5 percentile of solar imbalance
4. Combine estimated parameters from steps 1-3 using the identity Net Load = Load – Wind – Solar

However, the method above systematically over-estimates the 97.5 percentile of net load imbalance because a 97.5 percentile net load imbalance (using the identity Net Load = Load – Wind – Solar) would not simultaneously have 97.5 percentile load imbalance *and* 2.5 percentile wind imbalance *and* 2.5 percentile solar imbalance at the same time. Therefore, the output values from the three quantile regressions are synthesized using a formula for the Net Load and they go through an additional quantile regression to produce the final imbalance reserve up requirement polynomial (see link in Footnote 14 for more detail). A similar process is undertaken to calculate the imbalance reserve down requirement. This results in an independent imbalance reserve up and imbalance reserve down requirement for each hour in the day-ahead market.

The CAISO would implement the quantile regression such that the percentiles used (2.5 and 97.5) are configurable so the CAISO could 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 would develop a process for collecting load, wind, and solar 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.

Imbalance Reserve Demand Curve

The market uses penalty prices to establish the priority of different schedules and constraints and to set market prices when schedules or constraints need to be relaxed. Previous DAME proposals have suggested various penalty price structures, ranging from demand curves to graduated penalty prices that relax the imbalance reserve requirement as the cost increases, to strict penalty prices that protect the full imbalance reserve requirement at higher costs.

Based on stakeholder feedback, this proposal would procure imbalance reserves based on a demand curve. The imbalance reserve demand curve would mimic the designs of the demand curve established for flexible ramping product. The CAISO would use statistical analysis to calculate the amount of the imbalance reserve requirement that should be relaxed at different price levels to ensure the cost of imbalance reserve awards does not exceed the expected cost of power balance constraint violations without them. This amount would be set separately for each EDAM entity.

The imbalance reserve demand curve would establish the price of not fulfilling the imbalance reserve requirement for a given hourly interval. This would allow the market to determine whether to meet all or some of the upward and downward uncertainty requirements. The market would make this determination by assessing the trade-off between the cost and the value of an incremental unit of imbalance reserves. The cost of an incremental unit of imbalance reserves is the imbalance reserve marginal price. The value of an incremental unit of imbalance reserves is the probabilistic avoidance cost of a power balance violation; derived as the power balance constraint penalty price multiplied by the probability the real-time net load imbalance exceeds the uncertainty requirement being procured. If the imbalance reserve price is lower than the expected cost of not meeting the imbalance reserve uncertainty requirement, the market will continue to procure imbalance reserves. On the other hand, if the imbalance reserve price is higher than the expected cost of not meeting the imbalance reserve uncertainty requirement, then no additional imbalance reserves will be procured to cover the uncertainty requirement.

Some additional considerations are listed below:

- The imbalance reserve administrative price ceiling would be set to $1000, as opposed to FRP, which has an administrative price ceiling of $247.
- The uncertainty requirement used in the demand curve would include the EDAM diversity benefit.
- There would be separate demand curves for imbalance reserve up and down for each hour and for each BAA in the EDAM footprint.
- The EDAM resource sufficiency evaluation (RSE) would not use the imbalance reserve demand curve that will be used in the IFM. Instead, the RSE will penalize any imbalance reserve requirement relaxation at a high penalty price to ensure that all economic imbalance reserve bids are fully used before incurring an imbalance reserve shortfall, which would result in failing the RSE in that direction.

Imbalance Reserve Deliverability

Under this proposal, the market would consider transmission constraints when awarding imbalance reserves in the integrated forward market to ensure they are deliverable if deployed in real-time. The proposed approach is similar to the upward and downward deployment scenarios developed in the flexible ramping product refinements initiative. The integrated forward market would solve the base scenario and deployment scenarios simultaneously to ensure all scenarios are transmission feasible. The deployment scenarios would result in nodal imbalance reserves that ensure scheduled day-ahead physical supply can meet the uncertainty requirements if deployed without violating transmission constraints.

The upward deployment scenario would ensure supply and imbalance reserves up awards are deliverable to where upward net load uncertainty may materialize. The downward deployment scenario would ensure 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.

Some stakeholders have urged this proposal adopt a zonal approach to imbalance reserves procurement, similar to ancillary services. Stakeholders argue a zonal approach would simplify the market design and would reduce the need for additional elements like local market power mitigation.

This proposal continues to put forth nodal procurement of imbalance reserves, which has the following benefits:

- Nodal procurement supports an operationally feasible and reliable day-ahead market because the market would ensure the reserves are deliverable to locations where the uncertainty is expected to materialize without violating transmission constraints.
- Nodal procurement assures the market would not award and pay for reserves on resources that are behind constraints and undeliverable in the day-ahead timeframe. Zonal procurement could lead to awarding and paying for reserves on resources that are knowingly behind constraints. As a result, operators would have to continue to take out-of-market actions to make up for undeliverable imbalance reserves.
- Nodal procurement results in more accurate prices for imbalance reserve awards because they represent a locational value of flexible reserves, similar to energy. Locational prices facilitate efficient investment in flexible capacity when and where it is most needed.
- Nodal procurement improves confidence in EDAM transfers by modeling the deliverability of imbalance reserves.

In addition, there are some practical concerns with moving to a zonal approach. First, nodal procurement allows for an imbalance reserve deviation settlement with FRP because FRP will be procured nodally. Second, imbalance reserve requirements are calculated on a BAA level. The methodology would need to change to calculate uncertainty requirements by AS zone. This would increase the total quantity of reserves needed (before the EDAM diversity benefit) because up/down uncertainty can offset over a BAA footprint whereas it would not offset between zones. Third, system operators would have a much harder time managing undeliverable imbalance reserves than they do today with undeliverable ancillary services since the quantity of procurement is greater and would be deployed regularly rather than just under contingencies. This would likely lead to more out-of-market actions to manage.

Imbalance Reserves from Intertie Resources

Hourly intertie resources would not eligible for IRU/IRD awards because they are not 15-minute dispatchable. However, 15-minute or dynamic intertie resources could offer imbalance reserves if they are certified to do so. To be certified to provide imbalance reserves, intertie resources would have to be registered with a resource ID defined in the CAISO Master File. This is so the market can certify the resource's ramp capability and capacity constraints to ensure the market awards are accurate. The market would not allow intertie resources to bid for imbalance reserves with only a transaction ID. The corresponding intertie schedule must be tagged after RUC with a transmission profile equal to the sum of the day-ahead energy schedule, plus the imbalance reserve award, if any.

Bidding Rules

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

- Market participants would submit separate bids for energy, ancillary services (regulation up, regulation down, regulation up/down mileage, spinning reserves, and non-spinning reserves), imbalance reserves up, and imbalance reserves down.
- The bidding deadline would continue to be 10:00AM, at which point the day-ahead market closes.
- The current bid structure for energy and ancillary services would not change.
- Imbalance reserve bids could 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 limited to the resource's maximum 15-minute ramp capability.[15]
- The imbalance reserve up and down bid prices will be capped at $247/MWh.
- All resources with imbalance reserve awards would be subject to bid insertion in the real-time market. This means that resources that do not submit the real-time energy bids that are required based on their imbalance reserve award will have economic energy bids[16] inserted for them at their Default Energy Bid in the real-time market.

IFM Payments and Charges

This proposal would not change day-ahead charges and payments for load, ancillary services, virtual supply, virtual demand, physical supply, imports, and exports. These would continue to be settled for differences between the day-ahead energy schedule and real-time market energy schedule at the relevant market prices.

This proposal considers the following day-ahead payments for 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 up.
- Resources that receive an imbalance reserve down award will be paid the locational marginal price for imbalance reserves down.

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. If a variable energy resource submits a self-schedule and its real-time forecast

[15] The market will enforce dynamic ramp capability constraints for resources with dynamic ramp rates.
[16] The CAISO Tariff refers to these as Generated Bids.

exceeds its day-ahead schedule, all else being equal, a dispatchable resource will need to be re-dispatched in real-time 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 reduction in VER forecast (if applicable))[17]
  - Load: Negative uninstructed imbalance energy
  - Imports: MAX(0, Day-ahead energy schedule – FMM upper economic limit as affected by e-Tag transmission profile)
  - Exports: MAX(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 or self-schedules – Day-ahead energy schedule)
  - Load: Positive uninstructed imbalance energy
  - Imports: MAX(0, 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) would be considered under the “Generation” component of the cost allocations above.

[17] The determinant is the portion of the day-ahead schedule that is rendered undeliverable because of a de-rate or reduction in VER forecast. The priority order of the capacity services are (from highest to lowest priority): regulation, spin, non-spin, IRU, RCU.

This proposal considers a cost allocation instead of a direct settlement for a few reasons. First, the cost allocation aligns with flexible ramping product such that the cost allocation is based on the drivers of uncertainty. Second, there would be challenges in determining which loads and resources to charge at each nodal location and in what proportion since demand does not bid to buy imbalance reserves and imbalance reserve requirements are determined on a system level. The CAISO acknowledges the implications this has on congestion revenue rights and discusses this further in Section 4.2.

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[18] 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.

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 would not change in this proposal. However, the revenue and bid costs from imbalance reserve awards would 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, would be 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

[18] 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.

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 would be applied for imbalance reserve awards. Suppliers would 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 further away from the IFM results, which increases the risk that an export scheduled in IFM would be reduced 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.

For 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[19], 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 would be required to bid for reliability capacity up to the export self-scheduled quantity.

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

3.4 Market Power Mitigation Pass for RUC

Reliability capacity up and down awards would be priced in RUC at locational marginal prices that have marginal congestion contributions from binding constraints. All resources (including RA resources) would have the ability to offer non-zero prices for reliability capacity up and down in RUC. Therefore, it would be appropriate to perform local market power mitigation for reliability capacity up bids in RUC.[20] This would be achieved by adding a new market power mitigation pass after IFM and before RUC.

The market power mitigation pass for RUC would use unmitigated reliability capacity bids to procure reliability capacity to meet the CAISO demand forecast. The demand forecast would be distributed to load nodes in the market footprint using load distribution factors. Transmission constraints would be enforced using the same shift factors from IFM. Reliability capacity awards would be modeled as energy flows and the market would evaluate whether binding transmission constraints are uncompetitive using a dynamic competitive path assessment (DCPA). Resources that could provide counter-flow to uncompetitive constraints would have their reliability capacity up bids mitigated. Reliability capacity down bids would not be mitigated. The market would also not mitigate the reliability capacity up bids of non-EDAM intertie resources certified to provide reliability capacity, consistent with procedures for energy bid mitigation.

This proposal would mitigate reliability capacity offers to the higher of a default availability bid or the competitive locational marginal price for reliability capacity up. The latter would be derived as the marginal price of reliability capacity up minus the non-competitive congestion components from binding constraints in RUC at the location of the mitigated resource. This proposal would also include a Negotiated Rate Option, under which the CAISO would use information provided by the Scheduling Coordinator to determine the negotiated default availability bid.

The RUC default availability bid would be a static system-wide default availability bid for reliability capacity mitigation when DAME is first implemented. This default availability bid would be the same price for all resources and across all market intervals. It would provide a mitigation "floor" to balance the need to protect consumers against market power but also protect producers against excessive mitigation by forcing offers above a resource's costs. The reliability capacity up default availability bid would be set conservatively using a high percentile value of historical non-RA RUC availability offers. After the CAISO and market participants gain operational experience with biddable reliability capacity, and more information is available on the costs of offering reliability capacity under competitive conditions, the CAISO could re-engage with stakeholders to develop a more rigorous default availability bid methodology.

Similar to imbalance reserves, this proposal considers a default bid for reliability capacity mitigation of $55/MWh.

[20] RUC availability is nodally procured today, but market power is not a concern because RA capacity must participate in RUC at $0 price, so there is no ability for RA resources to physically or economically withhold.

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.

Market Performance and Solve Time

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 schedule, ancillary services, and imbalance reserve awards are fixed in RUC.** RUC is only procuring incremental or decremental supply to meet the BAA's demand forecast 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 optimization horizon that may extend past the trading day.

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 demand forecast. The need for incremental capacity is based on the difference between the amount of physical supply that clears the integrated forward market and the amount of physical supply needed to meet the demand forecast. Resources participate in the residual unit commitment process by providing RUC availability bids.

This proposal considers several enhancements to the residual unit commitment process. First, physical capacity would be procured in the residual unit commitment process through a new day-ahead market product called reliability capacity. Reliability capacity could be procured in the upward or downward direction. Second, the residual unit commitment would be able to transition multi-stage generating resources in the downward direction (but not turn them off completely) and would establish their binding configuration. These enhancements are described in detail in the following sections.

Reliability Capacity (RCU/RCD)

The proposed reliability capacity product would improve the existing residual unit commitment process as the mechanism to ensure the day-ahead market schedules sufficient supply to meet a BAA's demand forecast. Unlike the existing residual unit commitment process, reliability capacity would provide both upward and downward dispatch capability. If a BAA's demand forecast is greater than the physical supply that clears the integrated forward market, the residual unit commitment process would procure reliability capacity up to provide upward dispatch capability and/or commit additional units. If the BAA's demand forecast is less than the physical supply that clears the integrated forward market, the residual unit commitment process would procure reliability capacity down to provide downward dispatch capability (but would not de-commit units).

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

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

Reliability capacity awards would 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.

This proposal would enhance 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 would 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 would validate support for an 80MW PT export schedule because the designated resource bid at least 80MW of energy into the day-ahead market. The day-ahead market does not require that a supporting resource actually clear IFM or RUC to support a PT export. Note that scenarios where RUC would de-commit an MSG to a lower configuration would tend to occur when CAISO is in an over-generation situation or otherwise low price conditions, which are not associated with tight system conditions.

Market Operator Adjustments to RUC Demand Forecast

One of the driving factors of this initiative is the increased frequency and magnitude of market operator adjustments to the RUC demand forecast. The cause and effect of these RUC adjustments are described in Section 2. As described in the Day-Ahead Market Enhancement Analysis Report[21], market operators reference an "upper confidence" demand forecast that assesses the maximum demand expected under current weather conditions. When the day-ahead forecasted load exceeds a certain level, market operators consider this upper confidence forecast to determine the size of the RUC adjustments.

The implementation of imbalance reserves into the day-ahead market should greatly reduce the amount of RUC adjustments going forward. However, market operators would still have the authority to use RUC adjustments as needed. Although net load uncertainty is the main reason market operators use RUC adjustments, RUC adjustments can be used to cover other operational risks as well, such as wildfire risks. Therefore, market participants should not expect the use of operator RUC adjustments to completely disappear.

The CAISO publishes the RUC load adjustment (MW) and RUC load adjustment reason in OASIS to provide transparency. The CAISO would continue to do so after DAME is implemented.[22]

Reliability Capacity and Intertie Resources

Hourly intertie resources are eligible to provide reliability capacity up and down if they are certified to do so. To be certified to provide reliability capacity, intertie resources would have to be registered with a resource ID defined in the Master File. This is so the market can certify the resource's ramp capability and capacity constraints to ensure the market awards are accurate. The market would not allow intertie resources to bid for reliability capacity with only a transaction ID.

The corresponding intertie schedule must be tagged after RUC with a transmission profile equal to the sum of the day-ahead energy schedule, plus the reliability capacity award, if any. Hourly exports to non-EDAM BAAs can also provide reliability capacity up at ISO interties, with the obligation to provide a decremental energy bid to dispatch down the export schedule in the FMM if needed.

Reliability Capacity Bidding Rules

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

- Market participants would submit separate bids for RCU and RCD.
- Reliability capacity bids could have different hourly price/quantity pairs but only a single price/quantity pair in each hour.

[21] California ISO. Day-Ahead Market Enhancements Analysis. Alderete, Guillermo Bautista and Zhao, Kun. January 24, 2022. http://www.caiso.com/InitiativeDocuments/Day-AheadMarketEnhancementsAnalysisReport-Jan24-2022.pdf.

[22] California ISO OASIS. See System Demand > Load Adjustments. http://oasis.caiso.com/mrioasis/logon.do.

- Reliability capacity up and down bid MW quantity must be greater than zero and would be capped by the associated resource's 60-minute ramp rate over the product horizon.
- Reliability capacity up and down bid prices will be capped at $250/MWh.
- Reliability capacity up bid MW quantity must be greater than or equal to the sum of the resource's energy bid quantity.
- CAISO resource adequacy resources would be able to bid non-zero prices for reliability capacity.
- CAISO resource adequacy resources with a day-ahead must-offer obligation in RUC will be subject to bid insertion for reliability capacity up. If the required amount of resource adequacy capacity is not offered as reliability capacity into the day-ahead market, the CAISO will
    - Extend the bid quantity to the required amount using the submitted bid price if the resource provided a partial reliability capacity up bid
    - Insert reliability capacity bids at $0 bid price for the required amount if the resource did not submit a reliability capacity up bid
- All resources with reliability capacity awards would be subject to energy bid insertion in the real-time market. This means that resources that do not submit the energy bids that are required based on their reliability capacity award would have energy bids inserted for them at their Default Energy Bid price in the real-time market.

Reliability Capacity Payments

The CAISO proposes the following day-ahead payments for 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 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 bids, virtual bids). The uplift cost for reliability capacity would be allocated as follows:

Reliability Capacity Up

- RCU Tier 1 cost would be allocated to net virtual supply and under-scheduled load.
    - The net virtual supply allocation quantity would be a maximum of (a) zero or (b) scheduling coordinator net virtual supply awards. Thus, net virtual demand would not net against the load allocation base for RCU. This assumes a balancing authority area procures net virtual supply.
    - Under-scheduled load would be defined using net negative metered demand. The net negative metered demand would 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.

- RCU Tier 2 cost would be allocated to metered demand.

RCU Tier 1 costs would be limited by the minimum of the RCU capacity price and the RCU Tier 1 price.[23] In other words, if the RCU obligation were higher than the RCU awards, all of the cost would be allocated to RCU Tier 1. If RCU awards were greater than the RCU obligation, then costs would be split between Tier 1 and Tier 2.

Reliability Capacity Down

- RCD Tier 1 cost would allocated to net virtual demand and over-scheduled load.
    - The net virtual demand allocation quantity would be a maximum of (a) zero or (b) scheduling coordinator net virtual demand awards. Thus, net virtual demand would not net against the other allocation bases for RCD. This assumes a balancing authority area procures net virtual demand.
    - Over-scheduled load would be defined using net positive metered demand. The net positive metered demand would 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.
- RCD Tier 2 cost would be allocated to metered demand.

RCD Tier 1 costs would be limited by the minimum of the RCD capacity price and the RCD Tier 1 price. In other words, if the RCD obligation were higher than the RCD awards, all of the cost would be allocated to RCD Tier 1. If RCD awards were greater than the RCD obligation, then costs would 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. This proposal considers 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 would be charged the RCU price.

Reliability capacity down: Resources with a lower economic limit that does not support their day-ahead energy - RCD award would be charged the RCD price.

[23] 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.

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 would not change under this proposal. However, all resources committed in the residual unit commitment process are eligible to receive real-time bid cost recovery.[24] The revenue and bid costs from reliability capacity awards would be included in the calculation of real-time bid cost recovery.[25] Resources committed after the close of the day-ahead market through a real-time market schedule or an exceptional dispatch would also continue to be eligible for real-time bid cost recovery.

Any surplus revenues from the residual unit commitment process would continue to 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 would 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 would continue to be kept separate because they have different cost allocations. RUC bid cost recovery costs would be allocated to net virtual supply and under-scheduled load 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 would be applied for reliability capacity awards. Suppliers would include this cost in their bids.

[24] 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.

[25] Reliability capacity payments and bids would not be considered in the RUC/RT BCR calculation for RA resources.

4. Additional Day-Ahead Market Enhancement Design Considerations

4.1 Measures to Accommodate Long-Term Contracts

No matter how the day-ahead market settles the payments for the new day-ahead market products, RA contracts ultimately dictate how the revenue generated from the new market products is settled between counterparties. CAISO is concerned about getting into the middle of procurement contracts; however, it recognizes that entities may need additional information to settle revenues from the new market products in accordance with their contractual provisions.

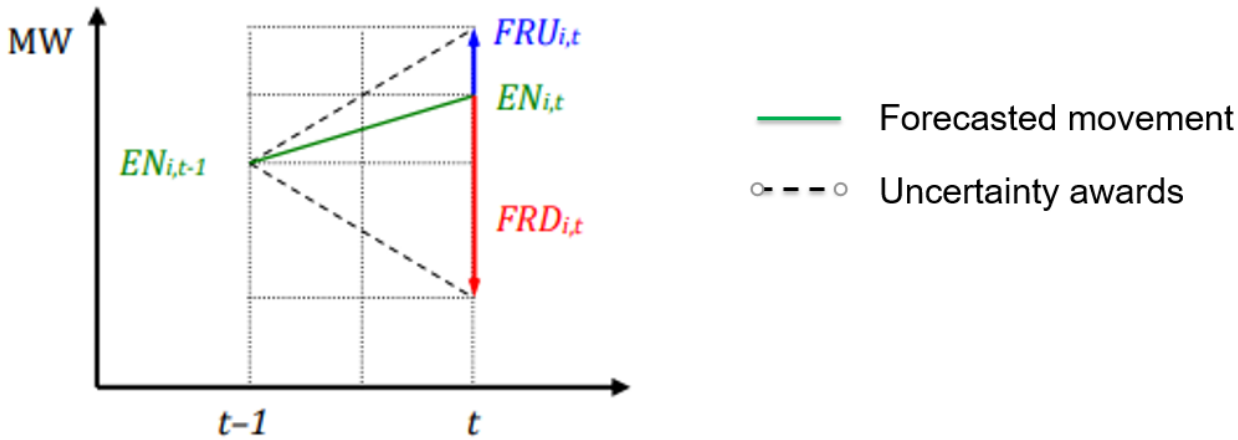
During the implementation of DAME, CAISO will work with parties to understand and provide to the greatest extent possible the information needed to facilitate contractual settlement provisions and develop a process for providing this information to the relevant parties in a regularly issued settlement report. In particular, the CAISO will provide a breakdown of the imbalance reserve marginal price by capacity versus opportunity cost, which several stakeholders have indicated is important.

The CAISO recognizes a subset of stakeholders' comments that it should provide an automated settlement mechanism to facilitate contractual agreements between parties for the new market products. Previous iterations of this proposal have suggested inter-SC trades, 50/50 revenue splits, and other such mechanisms. Stakeholders suggested that an automated function could help facilitate the settlement of the new market products without the CAISO dictating the contractual allocation of capacity payments. Ultimately, the CAISO determined that a "one size fits all" settlement solution was not possible; that LSEs would still need to perform a settlement function regardless of CAISO functionality; and that the resources required to develop, implement, and maintain the necessary settlement processes and systems outweigh the potential benefit.

4.2 Real-Time Market Ramp Deviation Settlement

The deviation settlement of ramp would involve two components: (1) forecasted movement and (2) uncertainty awards (see Figure 9). 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 9: 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 would make a direct deviation settlement infeasible. Table 3 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

This proposal considers 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.[26] 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.

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

This portion of the imbalance reserve award would not be subject to a deviation settlement. However, if any of this portion were unavailable due to outages, it would be 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.

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[27] 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 WEIM from Ramp Settlement

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

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

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 would have a forecasted movement deviation settlement at the FMM FRP prices.

4.3 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.

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.

This proposal continues to put forth no changes to the existing CRR nomination and auction processes to account for imbalance reserves. Transmission capacity would not be withheld in the CRR model for the CRR nomination and auction processes.

This proposal would 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 imbalance reserve marginal cost of congestion 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. The trade-off between using transmission for energy or imbalance reserves flows depends on the relative difference between the marginal energy and imbalance reserve offers inside and outside the constrained area. Generally, we expect that the differences in imbalance reserve bid prices will often be much lower than differences in energy bid prices due to the lower cost of providing imbalance reserves compared to providing energy. As a result the CAISO expects the constrained transmission to be mostly consumed by energy. Thus, the CAISO does not expect this to be a major issue.

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 three 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 may 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.
3. **Collect congestion rents through an uplift via the imbalance reserve cost allocation.** The allocated cost of imbalance reserves could be calculated based on prices at "withdrawal" points rather than "injection" points. The portion of the revenue collected that exceeds the amount paid to imbalance reserve suppliers would be used to fund the CRR balancing account.

4.4 Variable Energy Resources Eligibility to Provide New Products

This proposal maintains that variable energy resources (VERs) would be eligible to provide imbalance reserves and reliability capacity in both directions. This proposal no longer considers distinguishing VER resources in the Master File to determine their eligibility to provide imbalance reserve up. All VERs would be eligible for imbalance reserve up awards. However, the ISO continues to be concerned about awarding upward reserves on VERs above their day-ahead forecast. To prevent this, the IFM would apply a capacity constraint to VERs such that their energy, upward ancillary services, and imbalance reserve up awards could not exceed their VER forecast.

A similar capacity constraint would apply in RUC where the sum of IFM awards and reliability capacity up awards could not exceed the VER forecast. This proposal would also require VERs to bid reliability capacity up quantity equal to their VER forecasted output. This is consistent with an EDAM proposal where all resource capacity shown in the EDAM resource sufficiency evaluation must be bid into RUC as reliability capacity up. Since VERs would be considered in the EDAM resource sufficiency evaluation at their forecast, they must bid reliability capacity up into RUC at their forecast MW. Independent of EDAM, this rule would be necessary to ensure that RUC can consider all physical supply, including the supply forecasted for VERs that is not bid into the IFM. If VERs do not bid reliability capacity up to their VER forecast, the ISO will generate bids at a bid price of $0. As part of these changes, this proposal would no longer consider VERs in the RCU/RCD cost allocation, because they no longer contribute to the reliability capacity requirement (see Section 3.4). In addition, this proposal updates the RCU no pay rule such that resources would only have to pay back the RCU price, instead of the higher of the RCU price or RTPD FRU price, if the resource capacity is unavailable. This is so VERs that are awarded reliability capacity up but cannot produce to their day-ahead forecast in real-time only have their RCU awards rescinded and do not face any further financial penalty. This is also consistent with the current no pay RUC settlement (charge code 6824). Finally, VERs would be exempt from a current rule enforced in SIBR that capacity bid in RUC must first bid in IFM, which would force VERs to bid energy up to their forecast.

4.5 Storage Resources

The policy proposes a change to the requirements that govern the amount of state of charge that a storage resource must hold in the day-ahead market. This change will help ensure that storage resources have sufficient state of charge to provide energy if imbalance reserves are converted to energy.

Existing and New Constraints on Storage

A storage resource's state of charge is currently calculated based on previous state of charge and incremental energy schedules (equation 1). A resource's state of charge in the current interval is defined as the state of charge in the previous interval plus or minus the charging or discharging schedule during each interval. This relationship includes a resource specific round trip efficiency values, which captures the imperfect relationship between the quantity of energy charged and discharged.

$$(1)\ SOC_{i,t} = SOC_{i,t-1} - (EN_{i,t}^{(+)} + \eta_i EN_{i,t}^{(-)})$$

Where

$SOC_{i,t}$	State of charge for resource *i* at time *t*
$P_{i,t}^{()}$	Discharging (+) or charging (-) instruction for resource *i* at time *t*
η_i	Round trip efficiency for resource *i*

Today the day-ahead market also ensures that ancillary services awarded to storage resources will have sufficient state of charge to deliver those awards. The market accomplishes this by enforcing the ancillary service state of charge constraint (equation set 2). These equations state that a storage resource must have sufficient state of charge to ensure that they can provide any awarded capacity of ancillary services for at least one hour. For example, if a storage resource receives an award for 10 MW of regulation up in the day-ahead market, it is required to have a state of charge of 10 MWh (10 MW multiplied by 1 hour) above the minimum state of charge, to ensure the resource's ability to deliver the regulation for the entire 60-minute period. Similarly, these constraints ensure sufficient state of charge headroom for resources providing regulation down.[28]

$$(2)\ \begin{aligned} &SOC_{i,t-1} - RU_{i,t} - SR_{i,t} - NR_{i,t} \geq \underline{SOC}_{i,t} \\ &SOC_{i,t-1} + \eta_i RD_{i,t} \leq \overline{SOC}_{i,t} \end{aligned}$$

Where

$RU_{i,t}$	Regulation up award for resource *i* at time *t*
$SR_{i,t}$	Spinning reserve for resource *i* at time *t*
$NR_{i,t}$	Non-spinning reserve for resource *i* at time *t*
$\underline{SOC}_{i,t}$	Minimum state of charge for resource *i* at time *t*
$RD_{i,t}$	Regulation down for resource *i* at time *t*
$\overline{SOC}_{i,t}$	Maximum state of charge for resource *i* at time *t*

[28] These constraints are based on reliability requirements and are specified in the tariff.

A proposal outlined in the energy storage enhancements initiative, expands equation 1, to include multipliers on awarded regulation up and regulation down, to better estimate impacts of regulation on state of charge for storage resources. The equation proposed for this in the energy storage enhancements policy is reflected in equation 3.

$$(3)\ SOC_{i,t} = SOC_{i,t-1} - (EN_{i,t}^{(+)} + \eta_i EN_{i,t}^{(-)} + a_{RU} RU_{i,t} - a_{RD} \eta_i RD_{i,t})$$

Where, the coefficients "a" would be adjustable parameters between 0 and 1 and are intended to reflect the expectation that some energy would be depleted during periods when a storage resource is awarded regulation up and state of charge is increased during periods when a resource is awarded regulation down.

Finally, the energy storage enhancements policy also set a new requirement for storage resources to bid in such a way that they could receive energy awards in the opposite direction for at least 50% of awarded ancillary services, in the real-time market. However, because the day-ahead market awards ancillary services, the day-ahead market must consider potential feasible energy schedules in the real-time market when designating ancillary service award for storage resources. The day-ahead constraints enforcing this requirement are outlined in equation set 4.[29]

$$\begin{aligned}(4)\ \ & CF\left(RU_{i,t} + SR_{i,t} + NR_{i,t}\right) \le -LCL_{i,t} - RD_{i,t} \\ & CF\ RD_{i,t} \le UCL_{i,t} - RU_{i,t} - SR_{i,t} - NR_{i,t}\end{aligned}$$

Where

CF	Coverage factor; variable set between 0 and 1, initially set to 0.5
$LCL_{i,t}$	Lower capacity limit for resource *i* at time *t*
$UCL_{i,t}$	Upper capacity limit for resource *i* at time *t*

For example, the day-ahead market could award a +/- 100 MW storage resource 100 MW of regulation up with no award for other ancillary services. This ensures that the real-time market could dispatch the resource for up to 100 MW of charging energy, meeting the 50 MW bidding requirement. However, the day-ahead market could not award this same resource 100 MW of regulation up and 100 MW of regulation down during the same hour. In real-time, because of the regulation awards, the market is only able to award this resource 0 MW for energy. In this scenario, the market constraint would require the resource be able to receive an energy award of 50 MW for charging and 50 MW for discharging, which is not possible.

[29] These equations outline constraints that the day-ahead market will enforce, which aligns with the intent of the policy. This proposal is not meant to replace the business requirement process where the full set of constraints will be formally developed, vetted and ultimately implemented. These constraints could change slightly between this final proposal and development of the business requirements. These constraints may also be further developed in the DAME technical description.

Changes to Requirements for State of Charge

This policy proposes enhancements to the day-ahead state of charge requirements for storage resources providing imbalance reserves. The current requirements, outlined in equation set 2, ensure that storage resources have sufficient state of charge to provide all four ancillary services including regulation up, regulation down, spinning reserve and non-spinning reserve. This policy proposes expanding these requirements, outlined in equation set 5, to require sufficient state of charge to provide imbalance reserve up and imbalance reserve down in addition to the other ancillary services. These changes should help to ensure that storage resources have sufficient state of charge to provide awarded products.

(5) $SOC_{i,t-1} - RU_{i,t} - SR_{i,t} - NR_{i,t} - IRU_{i,t} \geq \underline{SOC}_{i,t}$

$SOC_{i,t-1} + \eta_i\left(RD_{i,t} + IRD_{i,t}\right) \leq \overline{SOC}_{i,t}$

Potential Future Policy

Equation 1 and equation 3 indicate that the energy and ancillary schedules impact state of charge for each hour. The idea behind these equations is that state of charge is maintained in the day-ahead market and that values for state of charge reflect – as close as possible – what expectations for state of charge will be in the real-time market. These values reflect physical limitations for how much energy a storage resource is able to charge and discharge.

It is clear that if imbalance reserves are called as energy in the real-time market, these energy awards will impact real-time state of charge for storage resources. However, it is not clear how much of these awards may eventually become energy awards that impact state of charge. This proposal notes that this could jeopardize the ability for storage resources to deliver day-ahead schedules because of differences in state of charge between the two markets and could ultimately threaten reliability. This policy does not directly address this concern. Future policy work may attempt to better align state of charge between the day-ahead and real-time markets in an effort to ensure storage resource availability.

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.

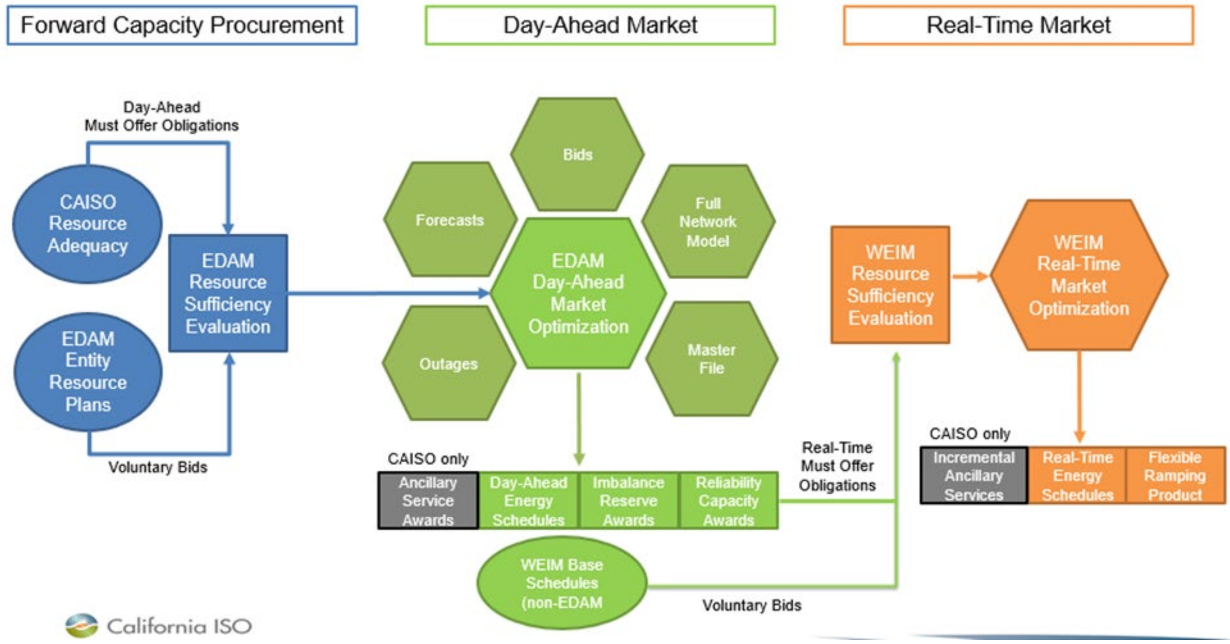
Imbalance reserves will ensure the day-ahead market schedules sufficient real-time dispatch capability to meet net load imbalances between the day-ahead and real-time markets. As long as the ETC and TOR self-schedules supply to meet their demand, the CAISO does not need to procure additional imbalance 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 Resource Adequacy, 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.

Figure 8 is a flowchart depicting the correlation between resource adequacy, DAME, and EDAM.

Figure 8: Relationship between DAME, EDAM and Resource Adequacy



The flowchart can be summarized as follows:

1. The CAISO resource adequacy program and non-CAISO EDAM participants' integrated resource plan are the forward procurement processes that ensure the balancing authority areas have 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.[30] 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 BAA's demand forecast. The day-ahead market will result in must-offer obligations and bids into the real-time market. For EDAM participants, these real-time market bids are inputs into the WEIM resource sufficiency evaluation. EDAM participants will benefit in the WEIM RSE with assurance their day-ahead schedules are balanced. Entities participating in the WEIM but not in the EDAM will continue to provide WEIM

[30] The EDAM proposal would not co-optimize ancillary services at the onset of EDAM.

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 and real-time flexible ramping product across the entire WEIM footprint, and incremental ancillary services for the CAISO BAA.[31]

6. WEIM Governing Body Role

Under the rules currently effective *Charter for EIM Governance*, this initiative would fall mostly outside the authority of the WEIM Governing Body because it focuses on the day-ahead market. As explained below, there are four proposed changes to real-time market rules where the Governing Body would have a decisional role, as noted:

1. Financial settlement of flexible ramping product, to remove the double payment of forecasted movement (§ 4.1) – Joint authority
2. Other changes to the financial settlement of flexible ramping product (§4.1) – Advisory role
3. 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) – Advisory role; and
4. Bidding obligations for resources that have day-ahead schedules for imbalance reserve or reliability capacity (§ 3.1) – Advisory role.

The Governing Body would not have any role with respect to the remainder of this initiative.

The Board and the WEIM 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 would fall within the scope of joint authority under the currently effective rules.

[31] The Western Energy Imbalance Market currently does not procure incremental ancillary services outside of the CAISO balancing authority area.

On the other hand, proposals 2 through 4, to the extent they change rules of the real-time market, would not be applicable to WEIM Entities in their capacity as participants in WEIM. To be clear, they may apply to some market participants within a WEIM Entity balancing authority area, but only as importers into or exporters from the ISO balancing authority, which are transactions that occur outside of the WEIM. Accordingly, these proposed tariff changes fall outside the scope of joint authority. These proposed changes (2 through 4), however, do fall within the scope of the WEIM Governing Body's advisory role, because the WEIM 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.

Regardless, CAISO management believes it would be appropriate to consider a possible adjustment of this classification, subject to Board approval. Stakeholder comments on previous papers indicate broad support for requiring joint approval of both the Board and the WEIM Governing Body for all aspects of this initiative. Such a classification could be appropriate given the unique nature of this initiative in the sense that it is foundational for EDAM because the imbalance reserve product developed in this initiative drives a significant portion of the potential benefits of EDAM.

At the December 14, 2022 Board of Governors meeting, Board Chair Ash agreed to provide joint authority over all aspects of the proposal that were not strictly related to California Resource Adequacy provisions. The resource adequacy must-offer provisions included in the proposal are consistent with current resource adequacy rules. Therefore, in alignment with Chair Ash's direction, Management proposes that all elements of the proposal fall under the joint authority of the WEIM Governing Body and the ISO Board of Governors.

7. Stakeholder Engagement, Implementation Plan & Next Steps

Table 4 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 3: Stakeholder engagement and implementation development plan

Date	Milestone
Final Proposal	
Paper Posted	January 11, 2022
Joint ISO Board of Governors and WEIM Governing Body meeting (decision)	February 1, 2023

Draft Tariff Publication and Stakeholder Process	January 2023 – March 2023
Business Requirement Specification (BRS) Development	January 2023 – March 2023
Implementation	Fall 2023

Appendices

Appendix A: Eligibility Table

	EN	RCU	RCD	IRU	IRD
Non-Participating Load	Yes	Not Eligible	Not Eligible	Not Eligible	Not Eligible
Virtual Supply	Yes	Not Eligible	Not Eligible	Not Eligible	Not Eligible
Virtual Demand	Yes	Not Eligible	Not Eligible	Not Eligible	Not Eligible
Hourly Block Import	Yes	Eligible	Eligible	Not Eligible	Not Eligible
Hourly Block Export	Yes	Eligible	Eligible	Not Eligible	Not Eligible
15-Min Import	Yes	Eligible	Eligible	Eligible	Eligible
15-Min Export	Yes	Eligible	Eligible	Eligible	Eligible
Dynamic Import	Yes	Eligible	Eligible	Eligible	Eligible
Long-Start Generator	Yes	Eligible	Eligible	Eligible	Eligible
Short-Start Generator	Yes	Eligible	Eligible	Eligible	Eligible
Participating Load w/ 15-Min dispatch capability	Yes	Eligible	Eligible	Eligible	Eligible
Participating Load w/ Hourly dispatch capability	Yes	Eligible	Eligible	Not Eligible	Not Eligible
Variable Energy Resources (Wind/Solar)	Yes	Eligible	Eligible	Eligible	Eligible
Non-Generator Resources (Storage)	Yes	Eligible	Eligible	Eligible	Eligible
Hybrid Resource	Yes	Eligible	Eligible	Eligible	Eligible
Energy Storage Resource	Yes	Eligible	Eligible	Eligible	Eligible
60-Minute Proxy Demand Resource	Yes	Eligible	Eligible	Not Eligible	Not Eligible
15-Minute Proxy Demand Resource	Yes	Eligible	Eligible	Eligible	Eligible
5-Minute Proxy Demand Resource	Yes	Eligible	Eligible	Eligible	Eligible
Reliability Demand Response Resource	Yes	Not Eligible	Not Eligible	Not Eligible	Not Eligible