



**Day-Ahead Market Enhancements  
Phase 2:  
Flexible Ramping Product**

**Issue Paper / Straw Proposal**

**February 28, 2019**

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# Day Ahead Market Enhancements – Phase 2

## Issue Paper / Straw Proposal

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## 1. Purpose

The purpose of this initiative is to improve the reliability and efficiency of the California ISO's (CAISO) day-ahead market. Enhancements to the day-ahead market will better position the system to accommodate net load variability that occurs in real-time. The CAISO proposes to change the day-ahead market from hourly to fifteen-minute granularity in Phase 1 of this initiative, and introduce a day-ahead flexible ramping product in Phase 2.

Currently the real-time market must dispatch resources to manage granularity differences between the day-ahead market and fifteen-minute market (FMM). Fifteen-minute scheduling granularity (Phase 1) will enable the day-ahead market to commit and schedule resources by capturing ramping that more closely aligns with real-time conditions.

The real-time market must also manage the uncertainty that occurs between the day-ahead and real-time markets by dispatching resources economically, based on supply bids and load forecasts. To ensure sufficient real-time supply bids, the CAISO proposes to add a day-ahead flexible ramping product to compensate resources that would have a must-offer obligation to bid into the real-time market.

### 1.1 Background

The CAISO split this initiative into two phases in late-2018 after considering stakeholder feedback and the substantial impacts being proposed. The first phase of the initiative proposes changing the day-ahead scheduling granularity from hourly to four fifteen-minute intervals. Policy changes pertaining to day-ahead market fifteen-minute scheduling granularity are discussed in Phase 1, with planned implemented for the fall 2020.<sup>1</sup>

This second phase will analyze and propose efficiencies to the day-ahead market formulation and processes, while adding a flexible ramping product (in the upward and downward directions) to the current co-optimization of energy and ancillary services. The day-ahead flexible ramping product will include a must-offer obligation to submit economic bids to the real-time market. Implementation for Phase 2 is scheduled for fall 2021.

This paper includes a straw proposal for the restructuring of the day-ahead market (Section 3), as well as an issue paper (Section 4 and 5) on the potential design elements of the day-ahead flexible ramping product and the re-optimization of ancillary services. Stakeholder discussions during 2018 of the proposed day-ahead market enhancements focused on structural changes to support the introduction of a day-ahead flexible ramping product. The potential structural changes included combining the integrated forward market (IFM) and residual unit commitment process (RUC). However, the re-optimization resulted in unintended price formation concerns caused by the introduction of the CAISO

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<sup>1</sup> Day-Ahead Market Enhancements Phase 1 is available here: <http://www.caiso.com/informed/Pages/StakeholderProcesses/Day-AheadMarketEnhancements.aspx>.

net load forecast into the clearing of day-ahead energy schedules. A stakeholder workshop held on November 30, 2018 discussed changing the sequence of the day-ahead market applications and suggested running the residual unit commitment prior to the integrated forward market. The sequence change was not favorable to stakeholders and was eliminated as a potential option.

The updated straw proposal for Phase 2 proposes procuring a flexible ramping product (FRP) in the integrated forward market, based upon historical forecast error between cleared physical supply in the integrated forward market and physical supply needed to meet the CAISO's fifteen-minute market forecast of net load. By avoiding procurement of the flexible-ramping product in relation to a demand curve (as was previously proposed), the CAISO can assure that 95% of the forecast error (relative to integrated forward market schedules) can be met and reconsider the necessity and functionality of the residual unit commitment process.

Ensuring that the market has sufficient ramping capability committed in the day-ahead market to meet the difference between the integrated forward market and the fifteen-minute market reduces the need for additional unit commitment through the residual unit commitment. The CAISO will propose replacing the residual unit commitment process with a reliability and deliverability assessment that uses cleared energy schedules and flexible ramping product awards to identify and validate resources that can meet CAISO's net load forecast. The deliverability assessment will not commit resources but instead will identify congested areas or sub-regions, enabling operators to identify appropriate resources for exceptional dispatch, if needed, including start-up of long-start resources that are not committed in the integrated forward market.

Sections 4 and 5 introduce additional design considerations to support the proposed market framework with a day-ahead flexible ramping product, described in Section 3. These considerations include establishing the day-ahead requirements, resource eligibility, performance thresholds, cost allocation, and other design elements. Similar considerations were discussed with stakeholders during 2018, but with less detail and with a different proposed market design. The CAISO also held multiple workshops, as well as two meetings with the Market Surveillance Committee (MSC) on the alternatives. Ultimately, the market design considerations are dependent on finalizing the structural changes to the day-ahead market.

## 2. Issues

### 2.1 Uncertainty from Day-Ahead to Real-Time Market

The CAISO's day-ahead market is designed to schedule resources in advance of the real-time market to improve operational reliability and allow participants to establish a financial position to hedge against real-time price volatility.

The CAISO's current market design consists of the integrated forward market and the residual unit commitment process, which are run sequentially. The integrated forward market clears bid-in supply against bid-in demand, procures all ancillary services, and commits resources on an hourly basis. After the integrated forward market process is complete, the residual unit commitment process is initiated to ensure physical supply can meet the CAISO hourly load forecast. During this process, additional capacity is procured and/or committed to ensure the CAISO's load forecast can be met. The combination of the integrated forward market and the residual unit commitment process should provide adequate supply to meet the load forecast used in the real-time market.

After the day-ahead market run, changes to the load forecast may arise necessitating the re-dispatch of energy in the CAISO's real-time market. The CAISO refers to these changes as **uncertainty**. Uncertainty is the difference between market runs, such as between the day-ahead market and fifteen-minute market. The CAISO needs to ensure its resource fleet can respond to uncertainty changes that may materialize.

## 2.2 Undeliverable and Inefficient Procurement of Ancillary Services

Incremental ancillary services are currently procured in the day-ahead market using regional zones. In cases when conditions improve between the day-ahead and real time markets (fifteen minute and five minute), operators currently have no ability to convert unneeded ancillary services to energy. Ensuring operators have this ability will improve the overall efficiency of the market.

# 3. Proposed Day-Ahead Market Structure

## 3.1 Day-Ahead Flexible Ramping Product

The CAISO proposes a new day-ahead market structure that will co-optimize energy and ancillary services with a new day-ahead flexible ramping product. The flexible ramping product<sup>2</sup> currently exists in the CAISO's real-time market. The proposed day-ahead flexible ramping product will procure resources to address uncertainty that materializes between the integrated forward market and the real-time market.

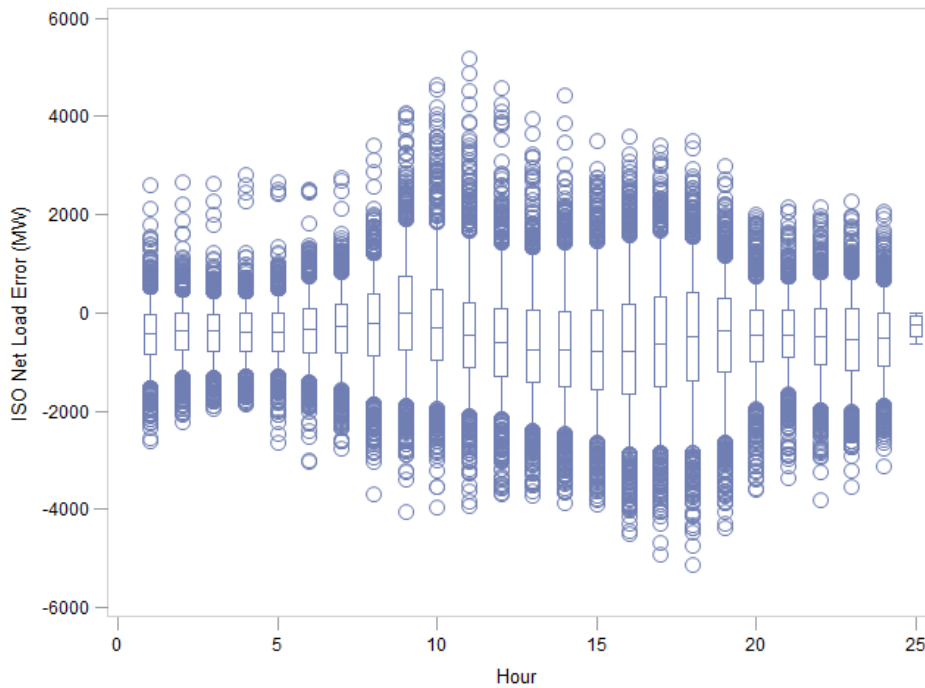
The CAISO has identified two options for a reference point to procure the day-ahead flexible-ramping product. The first option bases the reference point on market-cleared net load from the integrated forward market. The second option bases the reference point on the CAISO net load forecast.

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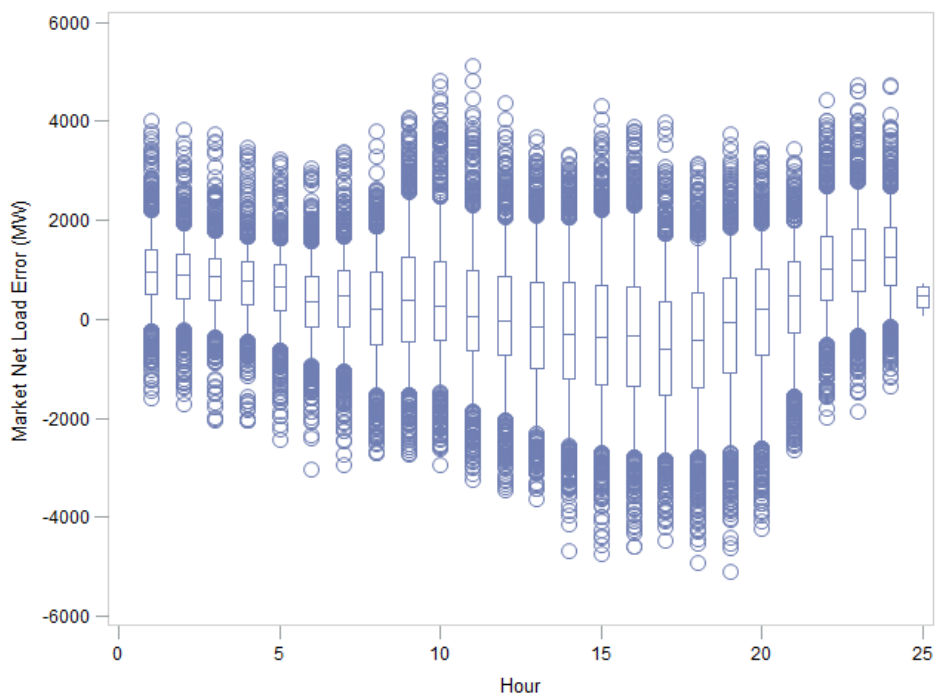
<sup>2</sup> Additional information on the flexible ramping product is available at:  
<http://www.aiso.com/informed/Pages/StakeholderProcesses/CompletedClosedStakeholderInitiatives/FlexibleRampingProduct.aspx>

To determine the appropriate option, the CAISO has analyzed differences between the integrated forward market and fifteen-minute market net load and compared it to differences between the CAISO residual unit commitment and fifteen-minute market net load. This analysis examines one year of hourly net load forecast error, as presented in **Figure 1** and **Figure 2**.

*Figure 1: CAISO Hourly Distribution of Forecasted Net Load Error*



*Figure 2: Hourly Distribution of Market Net Load Error (integrated forward market to fifteen-minute market)*



This analysis demonstrates that the CAISO generally over-forecasted in nearly all hours of the day (on average). The market net load error has generally under-forecasted during the evening, but was generally more accurate during the middle of the day. However, the *range* of forecast errors was similar between the market cleared net load uncertainty and CAISO forecast net load uncertainty. Therefore, the amount of day-ahead flexible ramping product needed relative to integrated forward market net load is not materially different than the amount of day-ahead flexible ramping product needed relative to CAISO net load (as currently used for the residual unit commitment process).

Based on the analysis performed, the CAISO proposes using historical observations of integrated forward market net load error to identify how much day-ahead flexible ramping product is needed for the following day. By using the integrated forward market net load as the reference point, differences between the CAISO net load forecast (used for the residual unit commitment) and integrated forward market net load will not require the flexible ramping product to be procured through residual unit commitment availability bids.<sup>3</sup> This is because sufficient flexible ramping product will be procured to cover differences between integrated forward market net load and fifteen-minute market net load, regardless of what is identified in the CAISO's current residual unit commitment (based on the CAISO's day-ahead net load forecast).

Ultimately, capacity that is currently procured through the residual unit commitment process will instead be procured based on the corresponding requirements for the new flexible ramping product. This further assumes that the entire flexible ramping product requirement will be procured in day-ahead market, which can only be achieved if the demand curve is *not* used to procure the flexible ramping product in the day-ahead market. This topic will be further discussed in Section 4.

### 3.2 Reliability and Deliverability Assessment

The existing residual unit commitment process is designed to procure and commit additional capacity to meet the CAISO's net load forecast when the forecast is above what has cleared the integrated forward market. Based on the analysis presented in **Figure 1** and **Figure 2**, the CAISO believes that the procurement of sufficient flexible ramping product (in both the upward and downward directions) in the day-ahead market will essentially eliminate the need for the existing residual unit commitment process.

The introduction of the day-ahead flexible ramping product will ensure sufficient capacity is procured to address steep ramps. This capacity can then be converted (*i.e.*, dispatched) as energy in the real-time market to meet uncertainty that may materialize (relative to integrated forward market schedules). The CAISO further proposes to design a flexible ramping product requirement to procure sufficient resources in the day-ahead market at a pre-defined confidence level (e.g., 95%). By requiring this level of certainty, there is an inconsequential difference in whether this requirement is based on the market-cleared demand or the CAISO forecast. Procuring the entire requirement for the flexible ramping product in the

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<sup>3</sup> The detailed market is included as a technical appendix and posted separately on the DAME website: <http://www.aiso.com/informed/Pages/StakeholderProcesses/Day AheadMarketEnhancements.aspx>.



integrated forward market will reduce or eliminate the need for operators to make additional commitments outside of the market, unless capacity shortages materialize. Shortages could occur due to periods of extreme load, wide-spanning capacity outages or derates, deliverability challenges, or erroneous bids submissions.

With the introduction of both a day-ahead flexible ramping product and corresponding requirements, the CAISO proposes eliminating the residual unit commitment process in its current form. Instead, the CAISO proposes the introduction of a day-ahead reliability and deliverability assessment (RDA) that would be executed following the completion of the integrated forward market.

The new reliability and deliverability assessment will run a power flow using the energy schedules and flexible ramping product awards from the integrated forward market. The reliability and deliverability assessment will not commit additional resources. Instead, it will determine if the power flow resulted in a feasible solution.

If the solution is feasible, no additional action will be needed. If the solution is infeasible, operators will have the opportunity to complete engineering studies and determine if and where exceptional dispatches are necessary. The ability for operators to exceptionally dispatch supply resources following the close of the day-ahead market already exists today. The CAISO may also utilize the reliability and deliverability assessment to evaluate different scenarios, such as modeling CAISO net load plus 10%, derating import capability, or losing a large generator.

Finally, to address deliverability of day-ahead flexible ramping product awards, the CAISO proposes to enforce sub-regional constraints for the flexible-ramping product. The sub-regional zones are described in [Section 4.3](#). If deliverability issues persist, the CAISO could leverage this information to justify changing the composition of the established sub-regions.

## 4. Market Design Considerations: Day Ahead Flexible Ramping Product

This section introduces and describes the general purpose and design features of the day-ahead flexible ramping product and identifies potential market design considerations that will require additional input from stakeholders.

### 4.1 Introduction to the Day-Ahead Flexible Ramping Product

The CAISO is proposing to establish a flexible ramping product in the day-ahead market, which will consist of two subsets: the flexible ramping product in the upward direction (FRU) and the flexible ramping product in the downward direction (FRD). These products are designed to ensure that adequate

resources are scheduled in the day-ahead market to address uncertainty that materializes in the real-time market, as well as imbalances that occur in the fifteen-minute market.

The flexible ramping product is different from – and does not overlap with – contingency reserves. Contingency reserves include only capacity set aside specifically to address contingencies (as opposed to addressing demand deviations or uncertainty).

### **Must-Offer Obligation for the Flexible Ramping Product in the Real-Time Market**

The CAISO proposes to apply a must-offer obligation in the real-time market to any resource that receives a day-ahead flexible ramping product award. This will enable the real-time market to address and resolve uncertainty in an economic manner, instead of administratively through out-of-market actions. Specifically, must offer obligations for flexible ramping product awarded in the day-ahead market will ensure sufficient real-time economic bids are available to resolve deviations that occur between the integrated forward market and the real-time market.

In the real-time market, flexible ramping product awards from the day-ahead market can either be converted into energy, or maintained as flexible ramping product awards to meet the requirement for the flexible ramping product in the real-time market. The flexible ramping product will be deployed in the real-time market (in either the upward or downward directions) when load or supply schedules deviates from what was cleared in the integrated forward market.

- **Imbalance of Demand:** Real-time load deviations from what was cleared in the integrated forward market must be balanced with supply. In order to address these imbalances, the real-time market currently dispatches resources with economic bids, based on the resource's integrated forward market schedules.
- **Imbalance of Supply:** If a generator is unable to meet its integrated forward market schedule, the real-time market will dispatch resources that have economically bid above the resource's integrated forward market schedule to resolve the imbalance. In this scenario, the generator has caused the imbalance. As a result, flexible ramping product is deployed as energy to balance the change in supply.
- **Imbalance Settlement:** An imbalance settlement results when a generator is dispatched below its integrated forward market schedule, as the result of an economic bid. However, this outcome doesn't require the real-time market to dispatch *other* resources to honor the schedule change. Moreover, the real-time market has the ability to determine whether or not the schedule change is consistent with system conditions.

The example below demonstrates how an imbalance may occur between the integrated forward market and real-time market. For this example, assume:

- Load has increased by 100 MW from the day-ahead forecast;
- A generator has self-scheduled 40 MW above its forward schedule;
- A variable energy resource is unable to meet its day-ahead forecast by 15 MW;
- An import did not tag 20 MW; and
- An export self-scheduled an additional 10 MW above its forward scheduled.

The total imbalance is the difference between integrated forward market and real-time for both supply and demand. The combination of these events will result in an upward imbalance amounting to 105 MW, as shown in **Table 1**.

**Table 1: Deviations Create Imbalances due to Differences between the Integrated Forward Market and the Real-Time Market**

Reason for Deviation	Difference between IFM and real-time
Bid in demand is lower than actual load increase	+ 100 MW
Generator self-schedule increase from IFM	- 40 MW
VER unable to meet day-ahead forecast by 15 MW	+15 MW
Import under tags 20 MW	+ 20 MW
Export self-schedule increase from IFM	+ 10 MW
<b>TOTAL IMBALANCE</b>	<b>105 MW</b>

If the total of the day-ahead flexible ramping product-up awards is at or above 105 MW, the market is assured that the materialized deviations from day-ahead schedules can be addressed by deploying flexible ramping product-up as energy through their bids. Ultimately, the day-ahead flexible ramping product requirement should ensure enough flexible ramping product capacity is available in the day-ahead market to address the potential imbalance that occurs.

### **Drivers of flexible ramping product in the upward direction for imbalance energy in the fifteen-minute market**

The flexible ramping product in the upward direction (FRU) is designed to address the operational challenges of maintaining power balance in the real-time dispatch. Flexible ramping product-up is reserved capacity that is reserved from scheduling or dispatch to address uncertainty that may materializes in real-time. The purpose of flexible ramping product-up is to protect the real-time market against insufficient ramp capability in real-time that may result in extreme prices.

Flexible ramping product-up is converted to energy when the real-time market must accommodate an inflexible schedule change. Resources that have been awarded flexible ramping product will have provided economic bids which allow the real-time market to schedule/dispatch the resource above its

integrated forward market schedule. Assuming there are no other changes from the integrated forward market, the CAISO has identified the following drivers that may require the use of flexible ramping product-up:

- Load that is higher than the integrated forward market schedule
- Virtual supply
- Conventional generators that are unable to meet their integrated forward market schedule
- Variable energy resources that are unable to meet their integrated forward market schedule
- Imports that don't tag their integrated forward market schedule
- Exports that self-schedule above integrated forward market schedule<sup>4</sup>

#### **Drivers of flexible ramping product in the downward direction for imbalance energy in the fifteen minute market**

The flexible ramping product in the downward direction (FRD) is designed to address the operational challenges of maintaining power balance in the real-time dispatch. The purpose of flexible ramping product-down is to protect against insufficient ramp capability in the downward direction in the real-time market that may result in extreme prices. Flexible ramping product-down is designed to ensure downward ramping capability is available over the market clearing interval.

Day-ahead flexible ramping product-down awards are converted to energy when the real-time market must accommodate an inflexible schedule change. Resources that have been awarded day-ahead flexible ramping product-down will have provided economic bids, which will allow the real-time market to schedule and dispatch the resource below its schedule for the integrated forward market. Assuming no other changes materialize from the integrated forward market, the CAISO has identified the following drivers for the use of flexible ramping product-down:

- Load that is lower than the integrated forward market schedule
- Virtual demand
- Conventional generators that self-schedule above their integrated forward market schedule
- Variable energy resources that self-schedule above their integrated forward market schedule
- Imports that self-schedule above their integrated forward market schedule

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<sup>4</sup> If the export submitted an economic bid rather than submitting a self-schedule, this would not cause flexible ramping product to be deployed to address uncertainty. This is because the real-time market can evaluate both export bid and supply bids to determine if it is economic to increase the export schedule. If the market determines it is not economic based upon current system conditions, the export will not clear the real-time market.

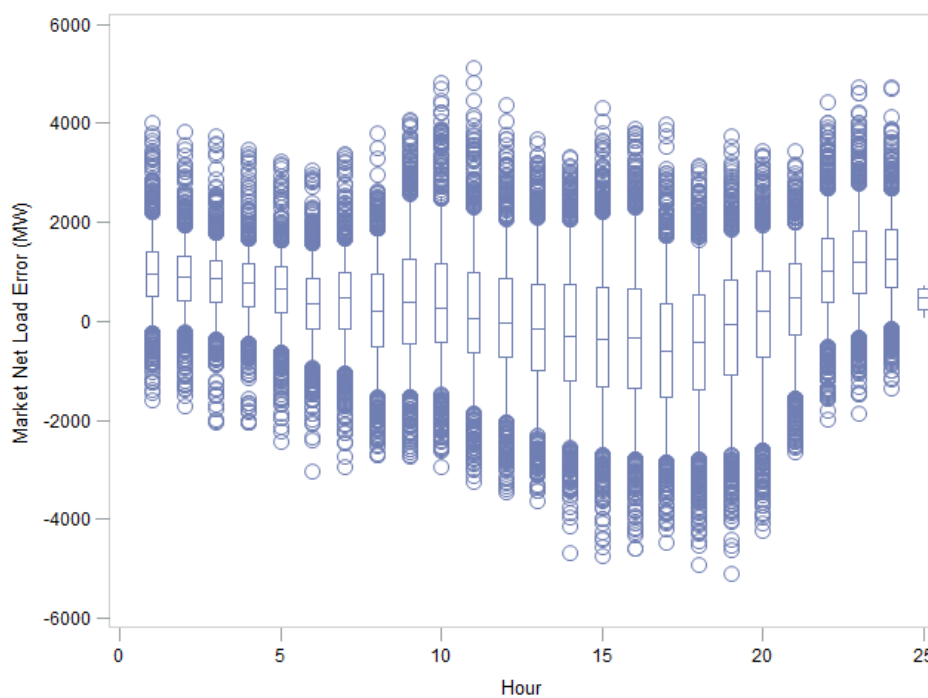
- Exports that don't tag their integrated forward market schedule

The CAISO invites additional stakeholder feedback on these identified drivers for both flexible ramping product-up and flexible ramping product-down. The CAISO further recognizes that not all drivers described above need to be directly considered when developing the appropriate flexible ramping product requirements, which are further discussed in the next section.

## 4.2 General Requirements

The CAISO proposes establishing a flexible ramping product requirement to ensure sufficient resources can be dispatched to address market uncertainty that materializes between the day-ahead and real-time market. The CAISO proposes to base the flexible ramping product requirement on the net load (load, less wind, less solar) forecast error, as shown in **Figure 3**.

**Figure 3: Hourly Distribution of Market Net Load Error between the Integrated Forward Market and the Real-Time Market**



The CAISO examined basing the flexible ramping product requirement on forecasted load error. Because the CAISO believes economics and other measures will incentivize delivery of day-ahead schedules, it is more efficient to instead base the flexible ramping product requirement around the market's forecasted error. This is supported by the data in **Figure 3**. The market net load error will adequately capture potential uncertainty and ensure adequate procurement of flexible ramping product to cover potential deviations between the integrated forward market and the real-time market.

The CAISO further believes that other existing or proposed market rules can minimize the need to procure flexible ramping product to cover imbalances from self-schedule changes, as well as challenges to meet the integrated forward market schedule. Concerns related to imbalances resulting from inertia deviations have also been addressed through a separate initiative.<sup>5</sup>

### Resource Requirements

Flexible ramping product in the upward (FRU) and downward (FRD) directions can both be awarded to fifteen-minute and five-minute dispatchable resources meet the day-ahead flexible ramping product requirement. This will be a single requirement (in the upward and downward directions) that can be met using either type of resource:

- **Fifteen-minute resources:** static inertias and slow demand response
- **Five-minute resources:** internal supply and dynamic inertias

In addition to the day-ahead flexible ramping product requirement, the CAISO is also considering procuring a portion of the real-time flexible ramping product requirement during the day-ahead timeframe. Because five-minute resources are needed to meet the real-time flexible ramping product requirement, this proposal would ensure five-minute dispatchable resources are available instead of only fifteen-minute dispatchable resources. Stakeholder input is requested to determine whether the CAISO should procure a portion of the real-time flexible ramping product requirement in the day-ahead timeframe.

The real-time market is designed to procure sufficient ramping capability to address uncertainty that may materialize in real-time between the fifteen-minute market and the five-minute market. In the fifteen-minute market, the flexible ramping product requirement ensures that sufficient ramping capability is available to resolve differences between the cleared fifteen-minute market schedule, as well as each corresponding five-minute interval. This addresses both the granularity differences and uncertainty between fifteen-minute market and the five-minute real-time dispatch. All resources that have submitted a real-time economic bid and can be dispatched in the real-time market are eligible for flexible ramping product awards in the fifteen-minute market. Thus, the day-ahead flexible ramping product requirement should be designed so that there are sufficient real-time economic bids to meet the uncertainty that can potentially materialize in the fifteen-minute market.

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<sup>5</sup> Information on the Intertie Deviation Settlement is available here:  
<http://www.caiso.com/informed/Pages/StakeholderProcesses/IntertieDeviationSettlement.aspx>

## Demand Curve and Penalty Prices

In the real-time market, the flexible ramping product currently uses a demand curve to determine if a resource should be dispatched for energy or held to maintain ramping capability in subsequent intervals. The demand curve is calculated based on the probability of a violation of the power balance constraint occurring in a future market run. This violation could result from insufficient ramp capability in a later market run, since that capacity was converted to energy in a prior market run. This is an efficient trade-off in the real-time market. However, in the day-ahead timeframe, if cleared ramp capability does not meet the total requirement in the market, the balancing authority would need to subsequently commit additional resources. Because the resource adequacy resources are procured to meet the maximum flexibility needs and because there is sufficient supply, a demand curve should not be needed in the day-ahead market. The total integrated forward market to fifteen-minute market uncertainty, plus the fifteen-minute market flexible ramping product requirement, should be procured in day-ahead market. The CAISO further believes that not using a demand curve in day-ahead will allow additional assurance that the reliability and deliverability assessment will only be needed as a backstop for extreme events or significant market input errors.

The CAISO proposes procuring the entire flexible ramping product requirement for the fifteen-minute market within a specified confidence interval (e.g., 95%) in the day-ahead market. By doing so, additional commitments outside of the market will not be necessary, unless a capacity shortage materializes as the result of extreme load or capacity outages. In the unlikely event that there are inadequate flexible ramping bids, the requirement will be relaxed at a penalty price to appropriately prioritize ancillary services over other products.<sup>6</sup> For example, ancillary services (e.g., regulation, spinning and non-spinning reserves) will always be awarded at a higher price compared to the flexible ramping product. The CAISO is considering two approaches for the flexible ramping penalty price:

1. The penalty price will be set at the real-time flexible reserve product penalty price.
2. The penalty price will be tiered based on the deficient amount of flexible ramping product bids. If the market recognizes a small shortage of flexible ramping product bids (~25 MW), a lower penalty price will be used. However, if the market recognizes a significant shortage of flexible ramping product bids (~200 MW) a larger penalty price will be used.

The CAISO requests stakeholder input on the appropriate approach for procuring the day-ahead flexible ramping product.

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<sup>6</sup> The FRACMOO initiative is establishing resource adequacy requirements that ensure sufficient resources have been procured by load serving entities to meet their allocable share of the highest potential flexible ramping product requirement for each month. These flexible resource adequacy resources have a must-offer obligation to submit economic energy bids into the day-ahead market. Thus, the potential for scarcity in the day-ahead market is extremely low and may not justify the added complexity of tiered penalty prices or a demand curve.

### 4.3 Sub-Regional Deliverability

The CAISO seeks input on market design considerations for deliverability of flexible ramping product to address potential cases when awarded capacity is located behind a constraint. This topic was discussed during the April 5, 2018 Market Surveillance Committee.<sup>7</sup> The CAISO is proposing to not explicitly ensure deliverability of flexible ramping product, but instead leverage sub-regional requirements to distribute a portion of the overall requirement across each balancing authority area. This approach for sub-regional procurement insures that all flexible ramping product is not procured from a single area (e.g., prevents all flexible ramping product being procured from resources in Northern California only). Similar to ancillary services, the sub-regional approach will provide sufficient confidence that flexible ramping product can be dispatched in subsequent intervals.

The utilization of sub-regions currently used for ancillary services, will help to address deliverability issues. The CAISO further proposes to establish a constraint for each sub-region to insure that day-ahead ancillary services and flexible ramping product-up awards will meet or exceed the individual minimum requirements in the upward direction. The constraint will also consider relevant export transmission limits to ensure delivery outside of the sub-region. A similar constraint will apply to the downward ancillary services and flexible ramping product-down awards in with consideration for relevant import transmission limits.

Detailed information related to sub-regional deliverability is described in the technical appendix.<sup>8</sup>

### 4.4 Resource Eligibility

The CAISO seeks to identify appropriate resource characteristics to determine resource eligibility for receiving flexible ramping product awards in either the upward and downward directions. These operational characteristics include the start-up time and ramp rate for a given resource.

In order to procure sufficient day-ahead flexible ramping product and ensure deliverability in the fifteen-minute market, the appropriate ramp rates must be prioritized over the procurement of upward services (day-ahead flexible ramping product-up). This will ensure an energy schedule change does not exceed the ramp capability for a given resource. The CAISO plans to leverage existing shared ramping model, which considers awards for both energy and ancillary services. With the proposed enhancements in this initiative, the CAISO would consider using dynamic ramp rates in the market optimization for all

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<sup>7</sup> Related meeting materials are available here:  
<http://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=A4C61AE7-58FA-4016-BE5C-B5D2178E7905>.

<sup>8</sup> The detailed market formulation is included as a technical appendix and posted separately on the DAME website: <http://www.caiso.com/informed/Pages/StakeholderProcesses/Day-AheadMarketEnhancements.aspx>.



energy schedules and ancillary services. The proposed eligibility requirements are outlined in **Table 2** below:

*Table 2: Flexible Ramping Product Eligibility Based on Resource Characteristics*

Status	Maximum MW Quantity	Award Eligibility
Online	Dynamic Ramp Rate over 15-minutes from energy schedule	<ul style="list-style-type: none"> <li>Eligible for <u>up</u> award to min(Pmax, maximum quantity)</li> <li>Eligible for <u>down</u> award of min (IFM energy – Pmin, maximum quantity), but Pmin can be included if the resource can shut down</li> </ul>
Offline short-start unit (start-up time less than 15 minutes)	Maximum MW Quantity = LOL + Dynamic Ramp Rate over (15 minutes – SUT) from LOL	<ul style="list-style-type: none"> <li>Eligible for <u>up</u> award to min (Pmax, maximum quantity)</li> <li>Not eligible for <u>down</u> award</li> </ul>

### Eligibility Certification Process

The CAISO has previously discussed whether a process is needed to certify that resources are eligible to provide flexible ramping product (similar to what is performed for ancillary services).<sup>9</sup> Following stakeholder discussions, the CAISO has determined the certification process is not necessary. Similar to the flexible ramping product in the real-time market, the ramp rate associated with providing energy will determine the eligible quantity of the flexible ramping product that can be awarded.

Although a certification process is not needed, the CAISO proposes introducing a performance evaluation, in addition to the no-pay provision, to ensure resources that are awarded flexible ramping product will meet the real-time market must-offer obligation. The CAISO discusses two proposed approaches below:

1. Introduce a minimum performance threshold with potential for disqualification from providing future service
2. Modify the no-pay rules to further penalize non-performance

The CAISO is requesting stakeholder input on these two approaches, as well as additional suggestions for an eligibility certification process.

### Eligibility for Interties

The CAISO intends to allow intertie resources to meet the requirement for the day-ahead flexible ramping product. However, it is essential to ensure that intertie capacity scheduled as flexible ramping product in the day-ahead timeframe has adequate transmission procured and is fully dispatchable as

<sup>9</sup> The CAISO is not proposing changes for must-offer rules or no-pay provisions for ancillary services.

energy in the real-time market. Without assurance of deliverable flexible ramping product on the interties, the CAISO would be unable to ensure potential uncertainty could be met. Consequently, the CAISO would need to utilize internal supply to meet the uncertainty requirement.

The objective of this section is to establish eligibility rules to ensure transmission capacity is available and energy can be delivered when an intertie resource is awarded flexible ramping product. The CAISO has identified four potential approaches to meet this objective and requests stakeholder feedback. The CAISO also invites stakeholders to propose alternative approaches, beyond what is identified below.

- 1. Require E-Tag submission prior to the day-ahead market run:** An intertie resource will only be able to receive a day-ahead flexible ramping product award if an E-Tag with a valid transmission profile is submitted to support the bid in advance of the day-ahead market run. This ensures transmission capacity is available, which provides assurance energy will be deliverable if needed in the real-time market. If a transmission profile is not submitted to match the bid, the market has the opportunity to schedule another intertie resources to meet the flexible ramping product requirement. This option provides the greatest assurance to the CAISO that the intertie energy is available and can be scheduled for energy in the real-time market.
- 2. Require E-Tag submission after the publication of the day-ahead market run:** An intertie resource that receives a day-ahead flexible ramping product award will be required to submit an E-Tag with a valid transmission profile by 15:00. This ensures that once awarded, the scheduling coordinator has demonstrated transmission capacity is available and reserved to deliver the energy if needed in the real-time market. If a transmission profile is not submitted to match the corresponding award, the CAISO intends to utilize a claw-back tool (similar to the existing hour-ahead scheduling process (HASP) claw-back rule). This option provides more flexibility to scheduling coordinators because they only need to procure transmission if awarded. However, it reduces the assurance that the transmission and energy will be available in real-time. Additionally, the day-ahead market will not be able to procure additional flexible ramping product if the E-Tag is not submitted by 15:00, which puts a burden on the real-time flexible ramping product requirement.
- 3. Require E-Tag submission before the real-time market (at T-40):** An intertie resource that has received a day-ahead flexible ramping product or energy award will be required to submit an E-Tag with a valid transmission profile at least forty minutes before the real-time market. This ensures that the scheduling coordinator has demonstrated transmission capacity is available and reserved to deliver the energy if needed in the real-time market. If a transmission profile is not submitted to match the corresponding flexible ramping product award, then energy will not be awarded to that resource. As with option 2, the CAISO proposes to utilize a claw-back tool (similar to the existing HASP claw-back rule) to address these occurrences.
- 4. Only allow resource adequacy resources to provide flexible ramping product:** Resource adequacy will be awarded on a monthly basis and requires a must-offer-obligation (MOO) into

the real-time market. By only allowing resource adequacy inertia resources to be awarded flexible ramping product, the CAISO would ensure that the transmission capacity is already available. The CAISO is currently working on an initiative titled Resource Adequacy Enhancements,<sup>10</sup> which is addressing the deliverability of resource adequacy on the inertias. This option coupled with the outcome of the Resource Adequacy Enhancements initiative would ensure the availability and dispatchability of flexible ramping product awarded to qualifying resource adequacy resources on the inertias.

## 4.5 Bidding

The CAISO proposes to design the market such that eligible market participants can bid on the following products: Flexible ramping product (upward and downward) and corrective capacity (upward or downward). The CAISO is considering whether the same bid can be used for both directions.

All generators, as well (as imports and exports) can submit bids to provide flexible ramping product in the upward or downward directions. However, the CAISO will not support the self-provision of flexible ramping product (in contrast to the current approach for ancillary services).

If a resource is unable to respond to fifteen-minute schedule changes, the resource will be unable to provide flexible ramping product. These resources need to be identified in the Master File. All other resources will be eligible to receive flexible ramping product awards.

Only a bid price will be submitted because the total quantity that a resource can be awarded will be determined based upon its energy bid range and its ramp capability over the fifteen-minute interval. The default bid price for day-ahead flexible ramping product will be set at \$0.00/MWh. If a resource doesn't submit an energy bid, the resource will be ineligible for flexible ramping product awards. Unlike current residual unit commitment availability bids, resource adequacy resources will not be required to bid \$0.00/MWh.<sup>11</sup> Resources that are awarded flexible ramping product will be paid the marginal clearing

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<sup>10</sup> The Resource Adequacy Enhancements initiative is available here:  
<http://www.caiso.com/informed/Pages/StakeholderProcesses/ResourceAdequacyEnhancements.aspx>.

<sup>11</sup> In the current EIM, a key design principle is that participation is voluntary and therefore there is no must-offer obligation in the EIM. When the day-ahead market is extended to EIM entities, it would be inappropriate to require CAISO RA resources to bid in for flexible ramping product at a price of \$0.00 while other EIM entities would not have a similar requirement given the voluntary nature. Similar to the real-time flexible ramping product in the real-time market, day ahead flexible ramping product will be able to be met by resources in the EIM footprint not solely those located in a given balancing authority area. Allowing RA resources to economically bid will allow the scheduling coordinator to express the price at which it is willing to provide the flexible ramping product to either the CAISO or another EIM balancing authority area and be compensated at the marginal clearing price of the flexible ramping product.

price. All resources that are awarded flexible ramping product in the day-ahead market must submit economic bids for energy to cover the MW quantity of the flexible ramping product award.

### **Resource Adequacy Resources and Day-Ahead Flexible Ramping Product**

The CAISO proposes that all resource adequacy (RA) resources will initially be required to bid \$0.00/MWh during the transition period, which will allow time for the resource adequacy paradigm to recognize that marginal costs of real-time market availability will be compensated through the day-ahead flexible ramping product. Accordingly, it will be appropriate for the resources to be paid for any opportunity costs from not providing energy to meet the day-ahead flexible ramping product uncertainty requirement.<sup>12</sup> The CAISO proposes to continue this approach through either the end of 2021, or when the extended day-ahead market (EDAM) initiative is implemented (whichever is sooner). The EDAM initiative will allow other balancing authority areas to use CAISO resources to meet flexible ramping product requirements. Therefore, marginal capacity costs should be recovered through the market price.

### **Corrective Capacity Bids and Market Power Mitigation**

The CAISO proposes allowing corrective capacity<sup>13</sup> and day-ahead flexible ramping product to have the same capacity cost in order to be available in real-time with economic bids. The CAISO further proposes applying the day-ahead flexible ramping product bid price for corrective capacity in the real-time market. Because corrective capacity is procured on a nodal-basis, mitigation rules will need to be developed to address the potential exercise of market power.

The CAISO seeks stakeholder input on the approach to calculating default “capacity” bids to address potential market power and proposes the following considerations:

1. Fuel type of the resource
2. Cost of procuring and/or disposing of gas in real-time
3. Cost to modify hydro systems from what was scheduled in the day-ahead market
4. Cost of preparation for demand response
5. Regional or sub-regional procurement of flexible ramping product

The CAISO also seeks stakeholder input on the magnitude of these costs, as well as how these costs would be considered for flexible ramping product-up and flexible ramping product-down. The magnitude of the potential costs can inform the mitigation approach. If these costs are low and similar for different technologies, then a bid cap may be sufficient. Sub-regional procurement should minimize

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<sup>12</sup> The CAISO will insert the market service cost as the bid cost.

<sup>13</sup> As developed in the Contingency Modeling Enhancement (CME) initiative:  
<http://www.aiso.com/informed/Pages/StakeholderProcesses/ContingencyModelingEnhancements.aspx>.

the need for mitigation for the flexible ramping product, if the sub-regions are sufficiently competitive. However, this may not be assured if system conditions change. In this case, a nodal approach would be needed for corrective capacity.

The CAISO is interested in stakeholder input related to approaches for calculating a default capacity bid. Previously, the CAISO considered an approach similar to the historical locational marginal price. For example: if the dynamic competitive path assessment (DCPA) is non-competitive, the corrective capacity bid price would be set to the historic day-ahead flexible ramping product clearing bid cost. The historical average day-ahead flexible ramping product clearing price would include opportunity costs, which would not be reflected in the corrective capacity bid.

#### 4.6 Performance Thresholds and Disqualification Processes

The CAISO proposes to establish minimum performance thresholds and disqualification processes with the introduction of the day-ahead flexible ramping product. Specifically, if a resource fails to have sufficient economic bids to cover its flexible ramping product award, the shortfall will count against the monthly performance threshold required to continue to receive flexible ramping product awards in future months.

This approach would establish a minimum monthly performance threshold that must be met in order for a resource to continue to be awarded flexible ramping product. Assume the minimum performance threshold is set at 95% of awarded flexible ramping product. The minimum performance threshold will be calculated for both upward and downward flexible ramping product separately. Accordingly, a resource will be disqualified only for the direction it has not met the minimum performance threshold. The CAISO proposes the disqualification guidelines for receiving future flexible ramping product awards when a resource fails to meet the minimum performance threshold:

1. Fails month M1: cannot be awarded flexible ramping product in M3
2. Fails month M2: cannot be awarded flexible ramping product in M4
3. In a rolling 12-month period, fails three months: cannot be awarded flexible ramping product for the upcoming quarter
4. After the quarterly period, performance threshold resets for the rolling 12-month window

For example, assume a resource was awarded 100 MW of flexible ramping product-up for a single fifteen-minute interval. In the real-time market, the resource has only 80 MW of economic bids above its day-ahead schedule. The resource has failed to meet its must-offer obligation by 20 MW. Since the resource was awarded for a single fifteen-minute interval, this is a 5 MWh shortfall.

The CAISO further proposes that any disqualification process should align with the resource adequacy program to allow a scheduling coordinator to know, prior to the monthly showing, if a resource will be eligible to provide flexible ramping product. Currently, monthly resource adequacy showings are made 45 days prior to the operating month. In order to align, a resource's performance will be calculated

using the monthly data prior to the resource showing. For example, if a resource fails the performance threshold in June it will be ineligible to be awarded flexible ramping product in August. This will provide market participants the opportunity to adjust their monthly resource adequacy showings if needed because one of their resources has been disqualified from providing flexible ramping product.

#### 4.7 Settlement of Imbalances

The CAISO proposes to settle day-ahead flexible ramping product awards at the marginal day-ahead price. Resources that meet the system requirement will be paid the system marginal price. Resources that meet the sub-regional requirement will be paid the sub-regional marginal price which includes the value of also meeting the system requirement. Any deviation between the integrated forward market award and the fifteen-minute market award will be settled at the fifteen-minute market flexible ramping product price. As is done today, any deviation between the fifteen-minute market award and the real-time dispatch award will be settled at the real-time market flexible ramping product price.

#### No-Pay Provision

The CAISO proposes that resources without sufficient economic bids to cover the flexible ramping product award will result in no-pay provisions to address the shortfall, which will claw back payments made to the resource in the day-ahead market. An alternative option (in lieu of proposing a disqualification process) is to determine a settlement mechanism to incentivize appropriate bidding behavior for the flexible ramping product must-offer obligation into the real-time market. Rather than only clawing back the day-ahead award, the no-pay provision would require the clawback to be twice the day-ahead amount.

#### Bid Cost Recovery

The CAISO proposes to split bid cost recovery for flexible ramping product between the day-ahead and real-time markets. This approach is further detailed in **Table 3** below:

**Table 3: Bid Cost Recovery for the Flexible Ramping Product between Day-Ahead and Real-Time Markets**

Bid Cost Recovery	Cost	Revenue
Day-Ahead Market	Bid * DA Award	Award & DA Price
Real-Time Market	0\$	FMM: Deviation * FMM Price RTD: Deviation * RTD Price

## 4.8 Cost Allocation

Cost allocation for the flexible ramping product in the real-time market is based upon movement that requires changes in real-time dispatch of resources. Movement for load is defined as changes in forecasted BAA load every five minutes. Movement for interties (fixed ramps) is calculated based upon the netted change in MWhs deemed delivered every five minutes for all imports/exports, plus operational adjustments not reflected in the fifteen-minute market schedule. Movement for supply is defined as netted supply imbalance changes every five minutes that are not the result of a real-time dispatch. The upward flexible ramping product is procured to address negative movement between dispatch intervals. The downward flexible ramping product is procured to address positive movement between dispatch intervals.

There are currently four monthly costs allocated for flexible ramping product: (1.) FRU Peak, (2.) FRD Peak, (3.) FRU Off-Peak, and (4.) FRD Off-Peak. The flexible ramping product-up and flexible ramping product-down values in each five-minute interval for each category are summed for the month over each range of trading hours. Then each category is allocated its pro-rata share of the monthly flexible ramping product costs. Each category allocates its four costs according to its own billing determinant.

- 1. Load:** allocated to each scheduling coordinator, based on the pro-rata share of gross uninstructed imbalance energy (UIE) over the month. There is no netting between settlement intervals. Negative (increased consumption) UIE is allocated flexible ramping product-up and positive (decreased consumption) UIE is allocated flexible ramping product-down. If a load uses five minute metering, such as load following metered sub-systems, then the load would be included within the supply category.
- 2. Supply:** allocated by calculating the observed forecast error (the vertical advisory – binding) plus any uninstructed imbalance energy. Each resource is allocated its pro-rata share of gross (A-B-UIE) for over the month for each cost bucket. There is no netting between settlement intervals. Positive (A-B-UIE) is allocated flexible ramping product-up and negative (A-B-UIE) is allocated flexible ramping product-down. Uninstructed imbalance energy was included to provide an additional incentive for dispatchable resources to follow their dispatch instruction. If UIE persists, this can increase the need for ramping capability.
- 3. Interties:** allocated to each SC based upon the pro-rata share of gross operational adjustment in each cost bucket over the month. Uncertainty costs for interties will be small. The uncertainty is realized only if an operational adjustment occurs after the binding real-time dispatch interval prior to the start of the next real-time dispatch interval. Otherwise, the operational adjustment will be resettled as a forecasted movement in real-time dispatch. Most operational adjustments occur prior to the start of the operating hour and will be settled through the forecasted movement deviation between fifteen-minute market and real-time dispatch.

Currently, net virtual bids are allocated to residual unit commitment costs. The CAISO is considering an approach to allocate a portion of flexible ramping product costs to net virtual bids and create a separate flexible ramping product cost allocation category. For this new category, the CAISO has identified two potential options. The first option would build on the existing flexible ramping product approach and include a category for virtual bids (similar to inertia bidding). The second option would allocate a sub-regional requirement, based on the existing flexible ramping product approach described above.

### **Application of Grid Management Charge**

Currently, the CAISO only procures incremental ancillary services in the fifteen-minute market. Ancillary services are charged the Market Services rate for all awards and deviations. Additionally, corrective capacity and flexible ramping product is not charged the Market Services rate, as marginal cost and bidding is not allowed. The CAISO believes market efficiency could be improved if day-ahead cost can be captured in the capacity bid. In real-time, the capacity bid will be set equal to the market service charge.

## **5. Market Design Considerations: Re-Optimization of Ancillary Services**

This section examines market design considerations for the re-optimization of ancillary services. The CAISO invites stakeholder input on all elements, including sub-regional granularity, day-ahead bidding approaches, real-time re-optimization, and settlements.

The CAISO proposes no bidding in the real-time market for spinning and non-spinning reserves. By submitting bids into the real-time market, there will be no marginal cost for making resources available to the real-time-market (*i.e.*, sunk cost). Energy opportunity cost will establish the price and bid costs will be set equal to the market services grid management charge (GMC). Regulation up and down can continue to submit bids in the real-time market, creating a potential need for an estimation of regulation energy settlement. This estimation may need to be included in capacity bids. The allowance of mileage bids will continue in the real-time market and the self-provision quantity will be supported (as currently applies for AS).

The CAISO further proposes retiring the flag to allow market participants to select contingency-only option, with all awards categorized as contingency only-in the real-time dispatch. Operators will maintain the ability to block a resource from being awarded AS to avoid awarding resources behind a constraint. Operators will also be able to lock the day-ahead AS awards in the real-time market, allowing confirmation of deliverability. This will prevent re-optimization from shifting AS from a deliverable resource to a non-deliverable resource. Operators will log and report these cases.



## 6. EIM Governing Body Classification

The CAISO believes the appropriate classification for Phase 2 of this initiative is as advisory to the Board regarding the entire initiative.

Under the decisional classification rules in the Guidance Document and Charter for EIM Governance, the EIM Governing Body would have no decisional role for most of the market rule changes proposed in this initiative, because they involve the day-ahead market. Consequently, they fall outside the Board's delegation of authority to the EIM Governing Body.

The initiative includes a few changes to the rules of the real-time market, for example to implement the zonal flexible ramping product. The ISO anticipates that these changes will involve generally applicable rules of the real time market, as opposed to EIM-specific rules, which would mean the EIM Governing Body would have an advisory role regarding those specific changes.

However, the proposed changes to day-ahead market rules, to change the structure of the day-ahead market (Section 2), along with the introduction of the day-ahead flexible ramping product and the deliverability assessment (sections 4 and 5) are meant to lay the foundation for a future initiative that would give EIM Entities the option of participating in the day ahead market, among other things. Given the unique foundational nature of the initiative, Management believes it would be appropriate for the EIM Governing Body to have an advisory role on all aspects of this initiative, and not just the changes to real-time market rules. This would be consistent with the intentions of the EIM Transitional Committee, which expected that EIM Governance would have a role in "decisions ... that would ... [a]llow options to expand the functionality of the market to provide additional services ...." Final Proposal, August 19, 2015, p.14.<sup>14</sup> Management acknowledges this proposed advisory classification for the entire initiative would depart to some extent from a strict application of Guidance Document and Charter.

To be clear, this recommendation is not intended to limit the role that the EIM Governing Body would have if the initiative were to evolve. For example, if in a later phase the initiative includes changes to EIM-specific rules of the real-time market, the ISO's recommendation would be revised to reflect the hypothetical role the EIM Governing Body would have in terms of approving or rejecting such a change.

Stakeholders are encouraged to submit a response to the EIM categorization in their written comments following the conference call for the Issue Paper/Straw Proposal, particularly if they have concerns or questions.

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[https://www.westerneim.com/Documents/Decision\\_EIM\\_Governance\\_Proposal-Proposal-Aug2015.pdf](https://www.westerneim.com/Documents/Decision_EIM_Governance_Proposal-Proposal-Aug2015.pdf).

## 7. Stakeholder Engagement

Stakeholder input is critical for developing market design policy. The schedule proposed below allows opportunity to for stakeholder involvement and feedback. This initiative will require briefing to EIM Governing Body to support its advisory role and subsequent approval by the CAISO Board of Governors.

### 7.1 Schedule

The proposed schedule for the DAME Phase 2 stakeholder process is provided below in **Table 4**.

*Table 4: Schedule for DAME Phase 2 Stakeholder Process*

<b>Item</b>	<b>Date</b>
<b>Post Issue Paper</b>	February 28, 2018
Stakeholder Meeting	March 7, 2018
Stakeholder Comments Due	March 21, 2017
<b>Post Revised Straw Proposal</b>	April 11, 2018
Stakeholder Meeting	April 18, 2018
Stakeholder Comments Due	May 2, 2018
Stakeholder Meeting/Workshop	June 19, 2018
<b>Post Phase 2 as Issue Paper / Straw Proposal</b>	February 28, 2019
Stakeholder Meeting	March 7, 2019
Stakeholder Comments Due	March 21, 2019
<b>Post Revised Straw Proposal</b>	TBD Summer 2019
Stakeholder Conference Call	TBD Summer 2019
Stakeholder Comments Due	TBD Summer 2019
<b>Post Revised Straw Proposal</b>	TBD Fall 2019
Stakeholder Conference Call	TBD Fall 2019
Stakeholder Comments Due	TBD Fall 2019
<b>Post Draft Final Proposal</b>	TBD Late Fall 2019
Stakeholder Conference Call	TBD Late Fall 2019
Stakeholder Comments Due	TBD Late Fall 2019
<b>EIM Governing Body Meeting</b>	TBD Winter 2019
<b>CAISO Board of Governors Meeting</b>	TBD Winter 2019

The CAISO proposes to present its proposal for Phase 2 to the EIM Governing Body and CAISO Board of Governors in at the end of 2019 or beginning of 2020. The CAISO is committed to providing ample opportunity for stakeholder input into its market design, policy development, and implementation activities. Stakeholders should submit written comments to [InitiativeComments@caiso.com](mailto:InitiativeComments@caiso.com).

## 7.2 Next Steps

The CAISO requests stakeholders to submit written comments by March 21, 2019.