



August 15, 2022

The Honorable Kimberly D. Bose  
Secretary  
Federal Energy Regulatory Commission  
888 First Street, NE  
Washington, DC 20426

**Re: California Independent System Operator Corporation  
Docket No. ER22-\_\_\_\_-000**

## **Tariff Amendment to Refine Flexible Ramping Product**

Dear Secretary Bose:

The California Independent System Operator Corporation (CAISO) submits this tariff amendment to refine its flexible ramping product by: (1) introducing nodal procurement to the uncertainty award element of the product; (2) revising the default master file setting for proxy demand resources; and (3) clarifying certain existing flexible ramping product-related tariff provisions.<sup>1</sup> These tariff changes will enhance the flexible ramping product consistent with Commission guidance to evaluate performance of the product continually and explore ways to improve that performance.

The CAISO requests the Commission issue an order approving this amendment by October 17, 2022, to allow the CAISO and its stakeholders to complete implementation activities with the certainty the Commission has accepted these market enhancements. The CAISO intends to implement these revisions on November 1, 2022, as part of the CAISO's fall 2022 market software release. Out of an abundance of caution and in case the CAISO and its stakeholders need additional implementation time, the CAISO requests the Commission authorize an effective date for the tariff revisions on or before December 15, 2022, subject to the CAISO filing a notice with the Commission within 5 days of the actual effective date.

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<sup>1</sup> The CAISO submits this filing pursuant to section 205 of the Federal Power Act (FPA), 16 U.S.C. § 824d, and Part 35 of the Commission's Regulations, 18 C.F.R. Part 35. Capitalized terms not otherwise defined herein have the meanings set forth in Appendix A to the CAISO tariff, and references herein to specific tariff sections are references to sections of the CAISO tariff unless otherwise specified.

## I. Background

### A. The Flexible Ramping Product

The CAISO implemented the flexible ramping product under a tariff amendment the Commission accepted in 2016 (FRP Tariff Amendment).<sup>2</sup> The flexible ramping product replaced the flexible ramping constraint the CAISO had applied on an interim basis in its real-time market, including the Western Energy Imbalance Market (WEIM).

The CAISO developed the flexible ramping product to manage the ramping capability needed to meet changes in net demand – both forecasted net demand changes and unexpected net demand changes – which had become more challenging with increased variability in demand and increased participation of variable energy resources in the real-time market. Ramping capability means a resource’s ability to move from one energy output to a higher (upward ramp) or lower (downward ramp) energy output. Flexible ramping capability means a resource’s ability to change its output rapidly to respond to a change in forecasted net load.<sup>3</sup>

The flexible ramping product has two components.<sup>4</sup>

First, the flexible ramping product compensates resources for ramping capability provided through the real-time market’s energy scheduling and dispatch process, which the tariff designates as “forecasted movement.” Each run of the CAISO real-time market’s multi-interval optimization provides a binding energy dispatch or schedule for the upcoming market interval and nonbinding advisory schedules for the subsequent intervals. The forecasted movement represents the change in energy schedule between the binding schedule or dispatch for the upcoming market interval and the advisory schedule for the following market interval of that market run. The CAISO compensates or charges resources and demand for this forecasted movement at a flexible ramping up price or flexible ramping down price, depending on the direction of the total ramp relative to the forecasted movement of the resource or demand.

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<sup>2</sup> The Commission accepted the FRP Tariff Amendment in *Cal. Indep. Sys. Operator Corp.*, 156 FERC ¶ 61,226 (2016) (FRP Tariff Amendment Order).

<sup>3</sup> Forecasted net load is the difference between total system demand and the demand met by non-dispatchable resources.

<sup>4</sup> The tariff provisions regarding the flexible ramping product are primarily set forth in tariff section 44. In addition, tariff section 11.5.9 includes the flexible ramping product in the list of real-time market settlements and specifies that the CAISO will settle it pursuant to section 11.25.

Second, the CAISO issues uncertainty awards, which address the potential for errors in the advisory interval demand or supply forecasts that may materialize in a subsequent market run when the interval is financially binding.<sup>5</sup> The CAISO determines the uncertainty requirement based on a statistical estimation of load and supply forecast error. The CAISO then procures additional ramping capacity through uncertainty awards in an amount up to the uncertainty requirement using a procurement curve that weighs the quantity procured against the costs. This procurement curve ensures the total cost of uncertainty awards will not exceed the expected cost of a power balance violation absent the uncertainty awards.<sup>6</sup> This tends to increase the flexible ramping product price and decrease the total uncertainty awards as supply becomes tighter and the opportunity costs of not being dispatched increase.

Under the CAISO's current practice, the CAISO sets separate uncertainty requirements and issues separate uncertainty awards for each individual balancing authority area and for the entire WEIM area.<sup>7</sup> In the FRP Tariff Amendment, the CAISO explained that including more granular (*i.e.*, sub-balancing authority area) locational procurement requirements would require significant enhancements that would unnecessarily delay implementing the tariff revisions. Therefore, the CAISO proceeded without more granular procurement, but it emphasized its intent to draw upon actual market experience to refine the determination of ramping needs.<sup>8</sup> The Commission accepted the CAISO's tariff revisions and stated that, "[c]onsistent with CAISO's routine practice of sharing market performance information in its monthly reports, we expect CAISO to share with its stakeholders the information necessary to evaluate the performance of the flexible ramping product and to evaluate the potential for further refinements to the flexible ramping product."<sup>9</sup>

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<sup>5</sup> Tariff section 44.3 *et seq.* Market participants do not submit separate bids for the flexible ramping product, but instead the CAISO uses energy bids for optimizing procurement of the uncertainty awards. Tariff sections 27.4.1 and 34.9.

<sup>6</sup> Tariff section 44.2 *et seq.* A power balance violation means a situation in which there is no feasible system-wide real-time dispatch schedule to maintain supply and demand power balance. As stated in tariff section 44.2.4.2, implementation details regarding the procurement curve are set forth in the business practice manual.

<sup>7</sup> Tariff section 44.2.4.1. The WEIM area consists of the combined CAISO balancing authority area and all WEIM entity balancing authority areas.

<sup>8</sup> See FRP Tariff Amendment Order at P 8 (citing transmittal letter for FRP Tariff Amendment at 18-20).

<sup>9</sup> FRP Tariff Amendment Order at P 37. See *also id.* at P 42 (stating that the Commission "encourage[s] CAISO to continue to work with its stakeholders to explore any further refinements as CAISO gains experience with the [flexible ramping] product and evaluates the product's performance over time").

Early in 2019, in response to stakeholder requests, the CAISO committed to analyze price formation in its electricity markets. Stakeholders asked the CAISO to evaluate: (1) whether real-time prices adequately reflect constrained system conditions; (2) why real-time prices have trended lower than day-ahead prices; and (3) whether intertie energy deviation settlements are setting the correct incentives.<sup>10</sup> The CAISO analyzed these topics in its September 2019 Energy Markets Price Performance Report (Markets Performance Report).<sup>11</sup> The Markets Performance Report identified several issues with the flexible ramping product, including: (1) challenges to ensuring deliverability, for which an identified potential solution was locational procurement of the flexible ramping product; and (2) the need for the CAISO's master file to reflect the actual operational characteristics and capabilities of proxy demand resources awarded the flexible ramping product.<sup>12</sup> On March 29, 2022, the CAISO posted a report on Flexible Ramping Product Performance (FRP Performance Report) analyzing the pricing performance of the flexible ramping product.<sup>13</sup> The FRP Performance Report found that deliverability of the product from resources behind transmission constraints remains a problem that undermines the efficacy of the product.<sup>14</sup>

## **B. Stakeholder Processes Preceding this Tariff Amendment**

To address the issues identified in the Markets Performance Report and refine the flexible ramping product consistent with the guidance provided in the FRP Tariff Amendment Order, the CAISO began the Flexible Ramping Product Refinements stakeholder initiative in November 2019.<sup>15</sup> The CAISO issued four iterations of the proposed refinements and related technical documents, and produced draft tariff language in the stakeholder initiative.<sup>16</sup> The CAISO also

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<sup>10</sup> The CAISO's analysis on these issues focused only the markets within the CAISO balancing authority area. However, the CAISO determined that the results of its analysis of price performance in the real-time market may be instructive to other WEIM areas because the WEIM is part of the overall real-time market.

<sup>11</sup> The Markets Performance Report is available at <http://www.caiso.com/Documents/FinalReport-PricePerformanceAnalysis.pdf>.

<sup>12</sup> Markets Performance Report at 13-14, 17-18, & 72-103.

<sup>13</sup> The FRP Performance Report is available at <http://www.caiso.com/Documents/Report-FlexibleRampingProductPerformance.pdf>.

<sup>14</sup> FRP Performance Report at 30-31.

<sup>15</sup> Materials related to this stakeholder initiative are available at <https://stakeholdercenter.caiso.com/StakeholderInitiatives/Flexible-ramping-product-refinements>. The stakeholder initiative also addressed refinements to the flexible ramping product that did not require any tariff revisions to implement, including refinements the CAISO will make by modifying the business practice manual.

<sup>16</sup> The last of the four iterations, entitled *Flexible Ramping Product Refinements Final Proposal* (FRP Refinements Final Proposal), is provided in attachment C to this filing.

provided opportunities for stakeholders to submit written comments and held conference calls with stakeholders. No stakeholder opposed the tariff refinements proposed in this filing.

The CAISO Governing Board (Board) voted to authorize this filing at its public meeting held on October 1, 2020.<sup>17</sup> Based on interdependencies with other software projects and reprioritization of various initiatives, the CAISO delayed implementation to its fall 2022 software release.

As the CAISO moved into planning for the fall 2022 implementation, it identified an aspect of the proposal inconsistent with intervening market rule changes. The CAISO met with stakeholders on May 10, 2022, to discuss the issue, and posted a paper on May 18, 2022, describing how it intended to resolve the issue. That resolution required a minor amendment to the prior Board-approved policy. The Board authorized that amendment at its public meeting held on July 20, 2022.<sup>18</sup>

## **II. Proposed Tariff Revisions**

### **A. Nodal Procurement of Uncertainty Awards**

Currently, the CAISO sets separate uncertainty requirements for each individual balancing authority area and for the entire WEIM area rather than undertaking more detailed modeling of transmission constraints to ensure flexible ramping product is deliverable.<sup>19</sup> The CAISO proposes herein to model uncertainty awards by network node while considering all transmission constraints as part of procuring the uncertainty component of the flexible ramping product.<sup>20</sup>

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<sup>17</sup> Materials related to the Board's authorization are available at <http://www.caiso.com/informed/Pages/BoardCommittees/Default.aspx>. These materials include a memorandum from Mark Rothleder to the Board dated September 23, 2020 (FRP Refinements Board Memorandum), which is provided in attachment D to this filing.

<sup>18</sup> A memorandum from Anna McKenna to the Board dated July 13, 2022, which is provided in attachment E to this filing (FRP Refinements Amendment Board Memorandum), describes the amendment to the previously-approved policy.

<sup>19</sup> Tariff section 44.2.4.1. The WEIM area consists of the combined CAISO balancing authority area and all WEIM entity balancing authority areas.

<sup>20</sup> The real-time market already models the flexible ramping product "forecasted movement" component nodally because it models transmission constraints as part of its energy dispatch.

## 1. *Rationale for Nodal Procurement*

The CAISO procures uncertainty awards based on opportunity costs, which arise from the tradeoff between the need for energy in the current interval and the need for ramping capability to meet uncertainty in following intervals.<sup>21</sup> Because there is only one uncertainty requirement for each balancing authority area and one requirement for the WEIM area, the market does not consider more granular locational constraints when procuring the uncertainty awards. As a result, the market may issue uncertainty awards that are not deliverable because of transmission congestion within a balancing authority area or scheduling limits on transfers between balancing authority areas.

The CAISO explained the extent of this problem in both the Markets Performance Report and the FRP Performance Report. For example, the Markets Performance Report identified hour ending 20 on June 25, 2019, as a representative example of flexible ramping product uncertainty awards being undeliverable because of transmission constraints between WEIM balancing authority areas.<sup>22</sup> The WEIM system flexible ramp requirement for that hour was 1,032 MW. Because of schedule deviations from wind and solar resources and other resource outages, the five-minute real-time dispatch reflected a supply shortfall of slightly over 936 MW. The flexible ramping product procured for that hour should have been more than sufficient to cover this materialized uncertainty. It was insufficient, however, because slightly over 400 MW of the procured flexible ramping capacity was not deliverable into the balancing authority area that needed the ramping capability due to transfer limitations. The Markets Performance Report also identified the peak hours on June 12, 2019, as a representative case of undeliverable flexible ramping product caused by internal transmission constraints within a WEIM balancing authority area.<sup>23</sup> During the third fifteen-minute interval of hour ending 18, “[o]ut of the 1,025 MW of economically procured capacity, 585 MW of flexible capacity was undeliverable, with most of the undeliverable capacity (510 MW) due to the flexible capacity conflicting with congestion management.”<sup>24</sup>

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<sup>21</sup> In its order accepting the FRP Tariff Amendment, the Commission found that “opportunity cost will provide a just and reasonable basis for compensation for flexible ramping product providers because it appropriately captures the costs associated with providing flexible ramping capability while avoiding the market inefficiencies that may be associated with a bid-based product given the other elements of CAISO’s flexible ramping product design.” FRP Tariff Amendment Order at P 36.

<sup>22</sup> Markets Performance Report at 79.

<sup>23</sup> *Id.* at 80.

<sup>24</sup> *Id.*

On March 29, 2022, CAISO issued the FRP Performance Report. In this report the CAISO analyzed more recent performance of the flexible ramping product, including critical periods of summer 2021.<sup>25</sup> This report shows that a meaningful share of awarded flexible ramping product uncertainty awards continue to be undeliverable either due to transfer limitations or internal transmission constraints.

This phenomenon of undeliverable flexible ramping product arises from the enforcement of transmission constraints for energy flows within each balancing authority area. Enforcing the transmission constraints allows the market to manage energy congestion economically, and it also allows the CAISO to dispatch resources optimally to meet the demand forecast. The CAISO market's congestion management process generally dispatches resources higher if they mitigate congestion and dispatches them lower if they exacerbate congestion. This optimal dispatch is matched with the corresponding price signal through the marginal cost of congestion component of the energy locational marginal price (LMP) at each resource's location.<sup>26</sup> Resources dispatched down for congestion management have relatively greater (negative) congestion component prices, resulting in relatively lower LMPs.

Because the real-time market does not model transmission constraints as part of its uncertainty award procurement, the market may schedule a resource for flexible ramping product that cannot be delivered because of congestion. For instance, the market can procure upward flexible ramping capacity from resources dispatched down for congestion management, which, if uncertainty materializes, cannot be deployed in the next market run. This can occur because the market awards flexible ramping product uncertainty awards to the resources with the lowest energy opportunity costs, and the lower LMPs at these resources behind transmission constraints means they tend to have the lowest opportunity costs. A lower LMP for a resource means being held out of the energy market for flexible ramping represents less of a foregone opportunity to earn energy market revenue. That makes the resource appear attractive for procuring flexible ramping product. The fact that the congestion management process lowered the resource's energy award also creates available upward capacity. A mirror-image dynamic exists for downward flexible ramping capacity and resources dispatched up for energy to provide counterflow to mitigate congestion. Essentially, the

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<sup>25</sup> FRP Performance Report at 30-31.

<sup>26</sup> For every pricing interval of the real-time market, the LMP for each pricing node comprises three components: system marginal cost, marginal cost of congestion, and marginal cost of losses. In addition, for each pricing node within an WEIM entity balancing authority area, the locational marginal price includes a fourth component, the WEIM bid adder component. Tariff appendix C, existing subsection (B). Tariff appendix A defines a location as either a pricing node or an aggregated pricing node.

existing process makes resources that cannot deliver flexible ramping product appear especially affordable and ready sources of the product. The market has no mechanism to avoid this outcome, which has occurred in both the CAISO balancing authority area and in WEIM entity balancing authority areas. Absent a deliverable flexible ramping product, CAISO operators have needed to take manual out-of-market actions to maintain reliable system operations.<sup>27</sup>

The CAISO's proposed nodal flexible ramping product uncertainty award procurement, described below, will help ensure that both energy and flexible ramping product awards are transmission-feasible, *i.e.*, are feasible given the available transmission capacity. Nodal flexible ramping product uncertainty award modeling will address operational concerns that flexible ramping capacity may not be dispatchable for energy because of transmission constraints. Absent these enhancements to the flexible ramping product, the CAISO would need to continue taking inefficient out-of-market actions to manage uncertainty to ensure capacity to address uncertainty is deliverable.

Nodal uncertainty award procurement also will produce more accurate pricing of the flexible ramping capacity of individual resources. Flexible ramping product prices more frequently will be greater than zero because the supply of deliverable flexible ramping product capacity that is deliverable will be lower once uncertainty award capacity is modeled nodally. The flexible ramping product uncertainty awards will create a locational value for the flexible ramping product similar to how nodal energy prices reflect the locational value of energy. This will also improve energy price formation because flexible ramping prices are reflected in energy prices if there is insufficient supply to meet the load forecast and the uncertainty requirement.

## 2. *Implementing Nodal Procurement*

To implement nodal procurement of flexible ramping product uncertainty awards, the CAISO proposes to revise its tariff to state it will optimize procurement of uncertainty awards so energy that can be dispatched from resource capacity corresponding to the uncertainty awards will not result in flows exceeding transmission constraints and scheduling limits, including WEIM

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<sup>27</sup> See *Market Performance and Planning Forum presentation*, at 9 & 21 (March 31, 2022), available at: <http://www.caiso.com/Documents/Presentation-MarketPerformancePlanningForum-Mar31-2022.pdf>. See also *Market Surveillance Committee, Opinion on Flexible Ramping Product Refinements*, at 8 (Sept. 9, 2020) ("current ineffectiveness of the flexiramp product implementation has apparently caused operators to continue to take other actions in order to try to ensure that they generally have enough ramp capability"), available at: [http://www.caiso.com/Documents/MSO-OpiniononFlexibleRampingProductEnhancements-Sep8\\_2020.pdf](http://www.caiso.com/Documents/MSO-OpiniononFlexibleRampingProductEnhancements-Sep8_2020.pdf).



transfer limits.<sup>28</sup> The CAISO also proposes to revise the tariff definitions of the terms flexible ramp up price and flexible ramp down price to specify that they will be prices determined by location (*i.e.*, by each individual pricing node or aggregated pricing node).<sup>29</sup>

To ensure energy that can be dispatched from capacity with uncertainty awards will not result in flows exceeding transmission constraints and scheduling limits, the CAISO will introduce “deployment scenarios.”<sup>30</sup> The deployment scenarios are how the real-time market will model the energy flows that would exist at the extremes if the market dispatches (*i.e.*, deploys) all of the scheduled flexible ramping product capacity in either the upward or downward direction. The rationale for constructing the scenarios this way is that if the CAISO procures flexible ramping product to meet a certain level of deviation from the forecast, then the CAISO also should test to make sure the awarded product is expected to be deliverable if that level of deviation materializes.

The CAISO will implement the deployment scenarios so the market treats each of the three scenarios (base case of meeting demand, upward deployment scenario, and downward deployment scenario) as a separate set of constraints. The CAISO will assess each scenario simultaneously in each market run by modeling a separate set of constraints relating to the upward and downward deployment scenarios.<sup>31</sup> The market optimization will make uncertainty awards to a resource only if its flexible ramping award is deliverable in the base case, in the case where the market calls on all upward flexible ramping product, and in the case where the market calls on all downward flexible ramping product. This approach will not eliminate the occurrence of undeliverable flexible ramping product, but it will mitigate this risk.<sup>32</sup> Even with the CAISO’s proposed nodal approach, system conditions can change or the forecast error can fall at the extreme margins of the historical values. The CAISO’s approach will, however,

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<sup>28</sup> New tariff section 44.2.1.2 (Uncertainty Award procurement cannot exceed “Transmission Constraints and scheduling limits, including EIM transfer limits”).

<sup>29</sup> Tariff appendix A, revised definitions of “Flexible Ramp Up Price” and “Flexible Ramp Down Price.” The CAISO does not propose to revise the existing definition in tariff appendix A of a location.

<sup>30</sup> New tariff section 44.2.1.2 (Uncertainty Award procurement optimized “in the event modeled uncertainty arises fully for either the upward or downward directions”).

<sup>31</sup> Largely because the CAISO is not proposing to add further markets runs, the CAISO does not anticipate that accounting for the deployment scenarios will impact market solve time materially.

<sup>32</sup> FRP Refinements Final Proposal at 12 (“The goal of the nodal approach is to not eliminate stranded ramping capability when system conditions change. The goal is to not knowingly strand capacity because the optimization awards resources with zero opportunity cost due to congestion.”).

avoid awarding flexible ramping product to resources that cannot, *ex ante*, reasonably be expected to deliver the awarded product if modeled uncertainty materializes.

Procuring flexible ramping product at the nodal level also requires the CAISO to consider the location at which the system will need the energy from the awarded resources. To provide a more accurate estimate of where the flexible ramping product will be needed, the CAISO will distribute the energy corresponding to uncertainty awards as sinking at the load and variable energy resource locations within each balancing authority area in the WEIM area based on allocation factors derived from historical and/or forecasted information that reflect the relative contributions of demand and variable energy resources to the overall uncertainty requirement.<sup>33</sup> The CAISO will model energy from flexible ramping product uncertainty awards as sinking at load and variable energy resource locations because these are where the CAISO anticipates needing energy from the uncertainty awards. Uncertainty awards address uncertainty in the forecast of net demand, which is load minus variable energy resource output. Consequently, modeling energy from uncertainty awards as sinking at load and variable energy resource locations helps ensure the energy is deliverable to where net demand variation occurs.

3. *Establishing a Single Set of Uncertainty Requirements for WEIM Balancing Areas Passing the Bid Range Capacity and Flexible Ramping Sufficiency Tests*

A key part of the WEIM is the resource sufficiency evaluation. As explained in a recent filing with the Commission, the resource sufficiency evaluation “is a collection of four tests – the balancing test, capacity test, flexibility test, and feasibility test – and associated procedures the CAISO administers in the real-time market.”<sup>34</sup> This filing pertains to the capacity test and the flexibility test. The capacity test assesses whether a WEIM entity has provided incremental bid-in capacity to meet the imbalance between load, inertia, and generation base schedules (or market schedules in the case of the CAISO).<sup>35</sup> The flexibility test assesses whether a WEIM entity has sufficient ramping capability from the start of an hour to meet the demand forecast and

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<sup>33</sup> New tariff section 44.2.4.3. The CAISO also will modify the business practice manual to provide further implementation detail regarding the distribution of uncertainty requirements and calculation of the allocation factors.

<sup>34</sup> *Cal. Indep. Sys. Operator Corp.*, Transmittal Letter, at 2 FERC Docket No. ER22-1604-000 (Mar. 11, 2022) (RSE Enhancements Filing).

<sup>35</sup> Existing tariff section 29.34(I).

uncertainty in each of the four 15-minute intervals in that hour.<sup>36</sup> Both tests have a directional component; they separately evaluate sufficiency in the up direction and the down direction. A WEIM entity can fail the test in one direction and pass in the other direction. Both tests ensure a WEIM entity has sufficient resources to cover its needs and deters inappropriate “leaning” by WEIM entities.<sup>37</sup> The CAISO holds WEIM entities that fail either test at the less restrictive of the base schedule for the failed 15-minute interval or the net transfer schedule for 15-minute interval before the failed interval.<sup>38</sup>

The CAISO is not proposing to change the nature of either the bid range capacity test or the flexible ramp sufficiency test. Instead, the CAISO proposes three conforming changes to how the market takes further action based on the test results.

First, as part of the CAISO’s shift to nodal procurement for the uncertainty component of the flexible ramping product, the CAISO markets will: (1) determine the respective upward and downward uncertainty requirements for the group of balancing areas that pass both the capacity test and the flexibility test for that direction; and (2) set a separate uncertainty requirement for each balancing area that fails either of the two tests for a direction. Creating distinct uncertainty requirements allows the real-time market to isolate balancing authority areas that fail the capacity or flexible ramping tests in the market’s uncertainty award procurement. This effectuates the intent of these tests to prevent a balancing authority area from inequitably “leaning” on the capacity of another balancing authority area. If a balancing authority area fails the capacity or flexible ramping test, the real-time market will procure uncertainty awards for that balancing authority based on its separate uncertainty requirement and using only that balancing authority area’s internal resources.<sup>39</sup> Once a WEIM entity establishes it has sufficient capacity by passing both tests, it obtains the efficiency benefits of having optimized flexible ramping product procurement across all the WEIM entities that passed the tests.

Second, the CAISO will settle uncertainty awards for a direction for the group of balancing authority areas that passed both the capacity and flexibility tests for that direction.<sup>40</sup> Balancing authority areas that fail either test for a

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<sup>36</sup> Existing tariff section 29.34(m).

<sup>37</sup> RSE Enhancements Filing, at 4.

<sup>38</sup> Existing tariff section 29.34(n)(1)(B) and Business Practice Manual for the Western Energy Imbalance Market section 11.3.2.

<sup>39</sup> Revised tariff section 44.2.4.1. Per existing tariff sections 29.34(m)(3) and 29.34(n)(1)(B), a WEIM entity that fails the flexibility test is also excluded from the EIM diversity benefit.

<sup>40</sup> New tariff sections 11.25.1.1 and 11.25.2.2.1(a).

direction will have their flexible ramping product awards settled just for their balancing authority area. It would violate cost causation principles for the CAISO to allocate the costs of meeting flexible ramping needs in a failing balancing authority area across the broader WEIM footprint. It is more appropriate to allocate the costs from meeting ramping needs specific to a WEIM entity only to that entity.

Third, for a failing balancing authority area with a distinct upward or downward uncertainty requirement, the CAISO will procure flexible ramping product awards assuming that the failing balancing authority area is limited to its final hourly Real-Time EIM Base Schedule (or CAISO equivalent) in the upward or downward deployment scenario, respectively, depending on the direction for which the balancing authority area failed the tests.<sup>41</sup> This assumption ensures that flexible ramping product is procured with the failing balancing authority area's internal resources. Limiting the deployment scenarios to the base case accomplishes that because the market then will not use available transmission to transfer flexible ramping product into the failing balancing authority area.

At first glance it may seem more reasonable for the deployment scenarios to allow the same transfers as permitted in the base case of meeting demand, *i.e.*, the amount permitted under tariff section 29.34(n)(1)(B). However, this is inappropriate because it would permit the real-time market to replace energy transfers into the failing balancing authority area that exceed the hourly base schedule with flexible ramping product imported into the failing BAA. The following example demonstrates the issue of concern. Assume a balancing authority area has an hourly base schedule of 50 MW and an additional 20 MW of transfers in a 15-minute interval of that hour for which it has failed the upward capacity test. If the upward deployment scenario assumed a transfer of 70 MW for that interval (50 MW plus 20 MW), rather than just the 50 MW of the hourly base schedule, then the real-time market could dispatch resources elsewhere in the WEIM down by that 20 MW and replace such 20 MW of energy with 20 MW of additional flexible ramping product in the balancing authority area that failed the upward capacity test for that interval. This occurs because energy and flexible ramping product are fungible commodities; increasing energy transfers into the failed balancing authority area unloads supply capacity inside that area that can in turn be used to meet flexible ramping product requirements. Such a result would undermine the goal of isolating a balancing authority area that fails the resource sufficiency evaluation for a given direction. For this reason it is appropriate for a balancing authority area that fails the resource sufficiency evaluation in a given direction to have transfers limited to its final hourly Real-Time EIM Base Schedule (or CAISO equivalent) in the deployment scenario corresponding to the direction for which it failed the test.

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<sup>41</sup> New tariff section 44.2.1.3.

#### 4. *Conforming Changes to Market Power Mitigation*

The CAISO's proposed nodal procurement of flexible ramping product also warrants conforming changes to the CAISO's market power mitigation measures.

The CAISO mitigates the potential exercise of local market power through a dynamic local market power mitigation process. This process identifies when a local area is not competitive by identifying the potentially pivotal suppliers in the area and evaluating whether the non-pivotal suppliers could resolve congestion on the binding constraint. When non-pivotal suppliers cannot resolve the congestion on the binding constraint, the CAISO deems the transmission constraint non-competitive and mitigates energy offers. Moving to nodal procurement of the flexible ramping product creates new ways transmission constraints can bind in the market and thus creates new ways suppliers could exercise market power. Essentially, by creating a new product awarded at a nodal level, the CAISO has created a new trigger for a transmission constraint to bind. When this constraint binds, a generator with market power can bid high to exercise market power in a local area for energy or flexible ramp.

To account for these new market power concerns, the CAISO must adjust how it defines what capacity it considers in determining if a transmission constraint is competitive. Part of nodal procurement is that the market will consider all constraints simultaneously from the base case and the two deployment scenarios. Accordingly, the dynamic competitive path assessment will now also consider all constraints from the base case and the two deployment scenarios. The CAISO will then include Uncertainty Awards (*i.e.*, flexible ramp up and flexible ramp down awards) in the dynamic competitive path assessment's evaluation of the capacity awarded to both pivotal suppliers and non-pivotal suppliers.<sup>42</sup> If a constraint is deemed non-competitive through this process, then any non-competitive congestion component for a resource's price identified in the mitigation process (whether it arose from the base case or a flexible ramping deployment scenario) would trigger potential mitigation to the resource's default energy bid.<sup>43</sup>

#### **B. Default Master File Setting for Proxy Demand Resources**

The CAISO can award the flexible ramping product to various types of resources, including proxy demand resources.<sup>44</sup> The existing tariff states that a

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<sup>42</sup> Revised tariff section 39.7.2.2.

<sup>43</sup> Revised tariff sections 34.1.5.2 and 34.1.5.3.

<sup>44</sup> A proxy demand resource is a type of demand response resource that can provide demand response services by bidding into the day-ahead and real-time markets and being

demand response provider for a proxy demand resource may elect to specify in the CAISO's master file whether the proxy demand resource will be bid and dispatched in the real-time market in hourly blocks, 15-minute intervals, or five-minute intervals.<sup>45</sup> If a demand response provider does not make a selection, the tariff sets the five-minute option as the default setting.<sup>46</sup>

The CAISO implemented the tariff provisions providing these three options and the default five-minute selection in 2019.<sup>47</sup> After implementation, the CAISO determined that very few proxy demand resources had changed their bid-and-dispatch option from the five-minute interval option, which is the only one of the three options eligible to be awarded the flexible ramping product.<sup>48</sup> The CAISO contacted scheduling coordinators for proxy demand resources to ensure they elected an option consistent with their actual operational characteristics.<sup>49</sup> Based on this outreach, the vast majority of scheduling coordinators changed their elections in the master file for their proxy demand resources to either the hourly block or the 15-minute interval option.<sup>50</sup>

Consistent with these CAISO findings and scheduling coordinator elections, the CAISO proposes to revise the existing tariff to make hourly block (rather than five-minute intervals) the default master file setting for demand

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dispatched at the direction of the CAISO. See tariff section 4.13.5; tariff appendix A, definitions of "Proxy Demand Resource," "Demand Response Resource," and "Demand Response Services." A demand response provider is the entity responsible for delivering demand response services from a proxy demand resource pursuant to a demand response provider agreement between the CAISO and the demand response provider. See tariff section 4.13.5; tariff appendix A, definitions of "Demand Response Provider" and "Demand Response Provide Agreement."

<sup>45</sup> Existing tariff section 4.13.3.

<sup>46</sup> *Id.*

<sup>47</sup> See Commission letter order, *Cal. Indep. Sys. Operator Corp.*, Docket No. ER19-2733-000 (Nov. 6, 2019) (order accepting these and other tariff provisions resulting from phase three of the CAISO's Energy Storage and Distributed Energy Resource stakeholder initiative).

<sup>48</sup> See existing tariff section 44.2.3.1.

<sup>49</sup> The CAISO had determined that the market frequently awarded the flexible ramping product to proxy demand resources because they had energy bids at or close to the bid cap of \$1,000/MWh (see existing tariff section 39.6.1.1). However, the market did not view the proxy demand resources as economic to be dispatched for energy in the binding market interval. This issue was exacerbated because many proxy demand resources could not respond to five-minute dispatches. Proxy demand resources that the market procures, but that are unable to respond to such five-minute dispatches, cannot be used as energy in a subsequent five-minute real-time market run.

<sup>50</sup> The CAISO tariff requires that all "information provided to the CAISO regarding the operational and technical constraints in the Master File" for demand response providers be "accurate and actually based on physical characteristics of the resources." Existing tariff section 4.13.3.

response providers.<sup>51</sup> This tariff revision reflects the reality that today few proxy demand resources can bid and respond to dispatch instructions in five-minute intervals. The CAISO concluded from its outreach it was not sensible to establish a default option for proxy demand resources that few could meet. Rather than expecting those resources to opt out of an inappropriate default selection, the CAISO chose to default them to the option that generally applied to most proxy demand resources. Those proxy demand resources capable of responding to five-minute dispatch will retain the ability to bid and be dispatched at that granularity. This change maintains optionality for proxy demand resources, but it does so in a way that removes the burden for a proxy demand resource to opt out of a default selection that likely does not apply to its resource. This change also promotes more accurate market dispatch by reducing the chances that a proxy demand resource will bid and be dispatched in a time granularity that does not apply to the resource.

### **C. Other Clarifications**

The CAISO proposes to clarify other tariff provisions related to the flexible ramping product. These clarifications are non-substantive.

First, the CAISO proposes to add more detail in describing how it settles forecasted movement and uncertainty awards.<sup>52</sup> This description accords with how the CAISO settles the flexible ramping product today.

Second, the CAISO proposes conforming changes to Appendix C of the CAISO tariff, which contains detailed provisions governing calculation of the marginal congestion component of the LMP. Section D of Appendix C includes a formula for how the “CAISO calculates the Marginal Costs of Congestion at each bus.” The variables “K” and “M” in the formula refer to the number of preventive transmission contingencies and number of monitored elements, respectively, that apply for a bus.<sup>53</sup> In recognition of the role that the deployment scenarios will now hold in facilitating nodal procurement of flexible ramping product, the CAISO proposes conforming edits to note that the CAISO market model will account for the number of contingencies and monitored elements in the base case of meeting demand and in both deployment scenarios.<sup>54</sup>

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<sup>51</sup> Revised tariff section 4.13.3.

<sup>52</sup> New tariff sections 11.25.1.1 and 11.25.2.2.1(a).

<sup>53</sup> These components were added in 2019 as part of the CAISO’s implementation of generator contingency and remedial action scheme modeling. *Cal. Indep. Sys. Operator Corp.*, 166 FERC ¶ 61,158 (2019) (letter order accepting CAISO tariff revisions).

<sup>54</sup> Tariff appendix C, revised subsection (D).

Third, the CAISO spells out certain acronyms used in the tariff provisions to match the tariff-defined terms they represent,<sup>55</sup> clarifies that awards in the tariff provisions mean uncertainty awards,<sup>56</sup> and capitalize terms defined in the tariff.<sup>57</sup>

Fourth, the CAISO proposes a clarifying change to tariff section 29.34(n)(1)(B). This section states that for WEIM entities failing the resource sufficiency evaluation, “the CAISO will hold the EIM Transfer limit into or from the EIM Entity Balancing Authority Area or the CAISO Balancing Authority Area . . . at the value for the last 15-minute interval.” In applying this rule, it is implicit that the CAISO still would respect a WEIM entity’s base schedule for the interval.<sup>58</sup> Section 11.3.2 of the CAISO’s Business Practice Manual for the Western Energy Imbalance Market reflects this concept by holding a failing WEIM entity “to the less-restrictive of the . . . Base Transfer Schedule for the failed 15-minute interval; or Net WEIM transfer schedule for the interval prior to the failed 15-minute interval as provided by the last successful FMM market run (*i.e.* the ‘last previous’ 15-minute interval.” The CAISO proposes to clarify tariff section 29.34(n)(1)(B) by incorporating the existing “less-restrictive of” rule.

Finally, the CAISO corrects internal cross-references to other tariff provisions and inadvertent upload errors to the Commission’s eTariff system.<sup>59</sup>

### **III. Effective Date and Request for Waiver**

The CAISO intends to implement these revisions on November 1, 2022, as part of the CAISO’s fall 2022 market software release. The CAISO requests an order approving these amendments by October 17, 2022. Finally, the CAISO requests the Commission authorize an effective date for the revisions on or

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<sup>55</sup> Revised tariff sections 11.25.1.2, 11.25.1.3, 11.25.2.1, and 11.25.3 (as renumbered pursuant to this tariff amendment).

<sup>56</sup> Revised tariff section 11.25.2.1.

<sup>57</sup> Revised tariff section 27.5.6(a).

<sup>58</sup> The base schedule is what the WEIM entity brings into the WEIM before any CAISO market processes. It would undermine the structure and purpose of the WEIM not to allow an entity to at least access the supply shown in its base schedule simply because it failed to meet the WEIM resource sufficiency evaluation. That would make the WEIM entity worse off for having participated in the WEIM. Stated differently, the outcome of the WEIM resource sufficiency evaluation should only impact WEIM economic transfers and not affect transactions that occurred outside of the WEIM.

<sup>59</sup> Revised tariff section 11.25.2.2.1; tariff section 11.25.3 to be reinstated, as 11.25.2 was inadvertently uploaded in its place to the Commission’s eTariff system in the 2016 FRP Tariff Amendment.



before December 15, 2022, subject to the CAISO filing a notice with the Commission within 5 days of the actual effective date.<sup>60</sup>

A Commission order before the planned implementation will provide regulatory certainty to the CAISO and stakeholders as they complete implementation activities associated with the tariff revisions. Because the software changes needed to implement the tariff changes proposed in this filing are part of comprehensive software package, an unfavorable regulatory outcome on one element too close to the planned implementation date could delay the whole package. Regulatory certainty several weeks before planned implementation will provide an opportunity to identify ways to isolate the software relating to aspects that are not going to be implemented without delaying the entire release. A flexible implementation date is also appropriate because of the interdependencies with other aspects of the fall release. Permitting the requested effective date of no later than December 15, 2022, will provide the CAISO and its stakeholders beneficial flexibility in addressing any unforeseen challenges that may occur in implementing these new measures or other parts of the fall 2022 software release.

#### **IV. Communications**

Under Rule 203(b)(3) of the Commission's Rules of Practice and Procedure,<sup>61</sup> the CAISO requests that all correspondence, pleadings, and other communications about this filing be served upon:

Andrew Ulmer  
Assistant General Counsel  
David S. Zlotlow  
Senior Counsel  
California Independent System  
Operator Corporation  
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<sup>60</sup> The CAISO has included an effective date of 12/31/9998 for the tariff records in this filing. The CAISO will notify the Commission of the actual effective date of these tariff records within five business days after implementation in an eTariff submittal using Type of Filing code 150 – Report.

<sup>61</sup> 18 C.F.R. § 385.203(b)(3).

## **V. Service**

The CAISO has served copies of this filing on the California Public Utilities Commission, the California Energy Commission, and all parties with Scheduling Coordinator Agreements under the CAISO tariff. In addition, the CAISO has posted a copy of the filing on the CAISO website.

## **VI. Contents of Filing**

Besides this transmittal letter, this filing includes these attachments:

- Attachment A Clean CAISO tariff sheets reflecting this tariff amendment
- Attachment B Red-lined tariff sheets showing the revision in this tariff amendment
- Attachment C FRP Refinements Final Proposal
- Attachment D FRP Refinements Board Memorandum
- Attachment E FRP Refinements Amendment Board Memorandum

## **VII. Conclusion**

The CAISO requests that the Commission accept the tariff changes proposed in this filing. These revisions enhance the flexible ramping product consistent with Commission guidance to evaluate performance of the product continually and explore ways to improve that performance.

Respectfully submitted,

**/s/ David S. Zlotlow**

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**Attachment A – Clean Tariff**

**Flexible Ramping Product**

**California Independent System Operator Corporation**

**August 15, 2022**

### **4.13.3 Identification of RDRRs and PDRs**

Each Demand Response Provider shall provide data, as described in the Business Practice Manual, identifying each of its Reliability Demand Response Resources or Proxy Demand Resources and such information regarding the capacity and the operating characteristics of the Reliability Demand Response Resource or Proxy Demand Resource as may be reasonably requested from time to time by the CAISO. All information provided to the CAISO regarding the operational and technical constraints in the Master File shall be accurate and actually based on physical characteristics of the resources. For Proxy Demand Resources and Reliability Demand Response Providers whose maximum Load curtailment is 1 MW or more, Demand Response Providers may elect to specify in the Master File the maximum number of Operating Hours in which the CAISO could commit or dispatch the Proxy Demand Resources or Reliability Demand Response Resources in the Operating Day. Demand Response Providers for Proxy Demand Resources and Reliability Demand Response Resources may elect to specify in the Master File how the Proxy Demand Resource and Reliability Demand Response Resources will bid and be dispatched in the Real-Time Market: in (i) Hourly Blocks, (ii) fifteen (15) minute intervals, or (iii) five (5) minute intervals. Proxy Demand Resources using the load-shift methodology described in Section 4.13.4.7 may elect to bid and be dispatched in the Real-Time Market in fifteen (15) minute intervals or five (5) minute intervals. If Demand Response Providers do not submit an election in the Master File, the CAISO will set Hourly Blocks as the default.

\* \* \* \* \*

## **11.25 Settlement of Flexible Ramping Product**

### **11.25.1 Settlement of Forecasted Movement**

#### **11.25.1.1 Generally**

The CAISO will settle Forecasted Movement for a direction as specified in this Section 11.25.1 by Balancing Authority Area for each Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as specified in Section 44.2.4.1, and separately will settle Forecasted Movement for a direction as specified in this Section 11.25.1 for the group of Balancing Authority Areas that shares a

common Uncertainty Requirement for that direction, as specified in Section 44.2.4.1.

**11.25.1.2 FMM.**

The CAISO will settle FMM Forecasted Movement with Scheduling Coordinators as follows, where upward movement is a positive amount and downward movement is a negative amount:

- (a) the product of the Forecasted Movement calculated for each resource pursuant to Section 44.3 in MWhs and the applicable FMM Flexible Ramp Up Price; plus
- (b) the product of the Forecasted Movement calculated for each resource pursuant to Section 44.3 in MWhs and the product of the applicable FMM Flexible Ramp Down Price and negative one.

**11.25.1.3 RTD.**

The CAISO will settle RTD Forecasted Movement with Scheduling Coordinators as follows, where upward movement is a positive amount and downward movement is a negative amount:

- (a) the product of the difference between the RTD Forecasted Movement and the FMM Forecasted Movement for the relevant Settlement Interval, both calculated for each resource pursuant to Section 44.3 in MWhs, and the applicable RTD Flexible Ramp Up Price, less any rescission amounts pursuant to section 11.25.3; plus
- (b) the product of the difference between the RTD Forecasted Movement and the FMM Forecasted Movement for the relevant Settlement Interval, both calculated for each resource pursuant to Section 44.3 in MWhs, and the product of the applicable RTD Flexible Ramp Down Price and negative one, less any rescission amounts pursuant to section 11.25.3.

**11.25.1.4 Allocation of Residual Forecasted Movement Settlements.**

For Balancing Authority Areas that share a common Uncertainty Requirement for a direction, as specified in Section 44.2.4.1, the CAISO will settle amounts remaining after settlement of Forecasted Movement pursuant to Section 11.25.1 to each Scheduling Coordinator based on its EIM Demand or metered CAISO Demand in proportion to the total EIM Demand and metered CAISO Demand within that group of Balancing Authority Areas sharing a common Uncertainty Requirement.

For a Balancing Authority Area that has a distinct Uncertainty Requirement for a direction, as specified in

Section 44.2.4.1, the CAISO will settle amounts remaining after settlement of Forecasted Movement pursuant to Section 11.25.1 to each Scheduling Coordinator based on its EIM Demand or metered CAISO Demand in proportion to the total EIM Demand or metered CAISO Demand within that single Balancing Authority Area.

## **11.25.2 Settlement of Uncertainty Requirement**

### **11.25.2.1 Payment to Resources.**

On a daily basis, the CAISO will settle Uncertainty Awards to resources for providing the Uncertainty Requirement at the applicable Flexible Ramp Up Price or Flexible Ramp Down Price less any payment rescission for each interval pursuant to Section 11.25.3.

### **11.25.2.2 Allocation of Costs of Uncertainty Movement Procured.**

#### **11.25.2.2.1 Settlement Process.**

- (a) **Generally.** The CAISO will settle Uncertainty Awards for a direction as specified in this Section 11.25.2.2 by Balancing Authority Area for each Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as specified in Section 44.2.4.1, or separately will settle Uncertainty Awards for a direction as specified in this Section 11.25.2.2 for the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction, as specified in Section 44.2.4.1.
- (b) **Daily.** The CAISO will initially –
  - (1) allocate the cost of the Uncertainty Awards for a direction on a daily basis according to the categories as set forth in Sections 11.25.2.2.2 and 11.25.2.2.3 within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable; and
  - (2) allocate the daily amounts to Scheduling Coordinators as set forth in Section 11.25.2.2.4.
- (c) **Monthly.** The CAISO will resettle the costs of the Uncertainty Awards by –
  - (1) reversing the daily allocation;
  - (2) assigning the monthly costs of the Uncertainty Awards to Peak Flexible Ramp

Hours and Off-Peak Flexible Ramp Hours;

- (3) separately allocating the monthly Peak Flexible Ramp Hours amounts and Off-Peak Flexible Ramp Hours amounts to the categories as set forth in Sections 11.25.2.2.2 and 11.25.2.2.3 within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable; and
- (4) allocating the monthly amounts in each category to Scheduling Coordinators as set forth in Section 11.25.2.2.4.

#### **11.25.2.2.2 Allocation of Charges to Categories.**

- (a) **Determination of Uncertainty Movement for Resources.** For each interval, the CAISO will calculate the net Uncertainty Movement of each resource according to the following categories:
  - (1) for Supply resources other than non-Dynamic System Resources as the difference between the Dispatch Instruction of the binding interval in the next RTD run and the first advisory RTD interval in the current run.
  - (2) for non-Dynamic System Resources and export schedules as the difference between the schedule used in the RTD (accounting for ramp) for the binding interval in the next RTD run and the schedule used for the first advisory interval in the current RTD run.
- (b) **RTD Uncertainty Movement.** The CAISO will determine the total net RTD Uncertainty Movement for each category separately for the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable—
  - (1) for the category of Supply resources, which shall not include non-Dynamic System Resources, as the net sum of the five-minute Uncertainty Movement determined pursuant to Section 11.25.2.2.2 of all the Supply resources in the category.

- (2) for the category of Intertie resources, which shall comprise non-Dynamic System Resources and exports, as the net sum of the five-minute Uncertainty Movement determined pursuant to Section 11.25.2.2 of all the non-Dynamic System resources and export schedules.
- (3) for the non-Participating Load category, as the difference between –
  - (A) the CAISO Forecast of CAISO Demand, the CAISO forecast of Balancing Authority Area EIM Demand, or the CAISO forecast of EIM Area EIM Demand, as applicable, of the binding interval in the next RTD run; and
  - (B) the CAISO Forecast of CAISO Demand, the CAISO forecast of Balancing Authority Area EIM Demand, or the CAISO forecast of EIM Area EIM Demand, as applicable, for the first advisory interval in the current RTD run.

#### **11.25.2.2.3 Assignment of Uncertainty Costs to Categories.**

The CAISO will allocate the total Uncertainty Award cost calculated pursuant to this section 11.25.2.2 to each category described in Section 11.25.2.2(b) based on –

- (a) for upward Uncertainty Award cost, the ratio of such category's positive Uncertainty Movement to the sum of the positive Uncertainty Movements of all categories with positive Uncertainty Movement for each Balancing Authority Area within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable; and
- (b) for downward Uncertainty Award costs, the ratio of such category's negative Uncertainty Movement to the sum of the negative Uncertainty Movements of all categories with negative Uncertainty Movement for each Balancing Authority Area within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable.



#### **11.25.2.2.4 Allocation to Scheduling Coordinators.**

- (a) **Non-Participating Load Category.** The CAISO will allocate the Uncertainty Awards costs of the non-Participating Load category to Scheduling Coordinators –
- (1) for upward Uncertainty Award cost in proportion to the Scheduling Coordinator's negative non-Participating Load UIE, excluding the non-Participating Load of an MSS that has elected to load-follow according to an MSS Agreement, without netting that UIE across Settlement Intervals, to the total of such negative non-Participating Load UIE, without netting that UIE across Settlement Intervals, within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable, and
  - (2) for downward Uncertainty Award cost calculated pursuant to Section 11.25, in proportion to the Scheduling Coordinator's daily positive non-Participating Load UIE, excluding the non-Participating Load of an MSS that has elected to load-follow according to an MSS Agreement, without netting that UIE across Settlement Intervals, to the total of such positive non-Participating Load UIE, without netting that UIE across Settlement Intervals, within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable.
- (b) **Supply Category.** The CAISO will allocate the Uncertainty Awards costs of the Supply category to Scheduling Coordinators for each resource in the Supply category based on the sum of the resource's Uncertainty Movement and UIE –
- (1) for upward Uncertainty Award cost in proportion to the Scheduling Coordinator's positive sum of the resource's Uncertainty Movement and UIE, without netting that sum across Settlement Intervals, to the total positive sum of all resources' Uncertainty Movement and UIE, without netting that sum across Settlement Intervals, within the group of Balancing Authority Areas that shares a common

Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable; and

- (2) for downward Uncertainty Award cost in proportion to the Scheduling Coordinator's negative sum of the resource's Uncertainty Movement and UIE, without netting that sum across Settlement Intervals, to the total negative sum of all resources' Uncertainty Movement and UIE, without netting that sum across Settlement Intervals, within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable; except that
- (3) for the MSS that have elected to load follow pursuant to an MSS Agreement, the CAISO will calculate the positive and negative sums specified above for each Settlement Interval as the sum of MSS non-Participating Load UIE, Supply resources within the MSS UIE, MSS Load Following Energy, MSS Load Following Operational Adjustments, and Uncertainty Movement of resources within the MSS Aggregation.

(c) **Intertie Category.** The CAISO will allocate the Uncertainty Awards costs of the Intertie category to Scheduling Coordinators for each non-Dynamic System Resource and export based on the sum of the resource's Uncertainty Movement and Operational Adjustment –

- (1) for upward Uncertainty Award cost in proportion to the magnitude of the Scheduling Coordinator's negative Operational Adjustment for non-Dynamic System Resources, or positive Operational Adjustment for export resources, to the sum of the magnitudes of such Operational Adjustments within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable, without netting that sum across Settlement Intervals; and
- (2) for downward Uncertainty Award cost in proportion to the magnitude of the

Scheduling Coordinator's positive Operational Adjustment for non-Dynamic System Resources, or negative Operational Adjustment for export resources, to the sum of the magnitudes of such Operational Adjustments within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable, without netting that sum across Settlement Intervals; and

(3) for the purposes of the allocations specified above, the MSS Load Following Operational Adjustment is excluded.

(d) **Uncertainty Award Cost Offset.** If the sum of the settlement of Uncertainty Awards and the charges to Scheduling Coordinators for Uncertainty Award costs is nonzero, either within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, then the CAISO will allocate such amounts to Scheduling Coordinators based on their metered EIM Demand or metered CAISO Demand in proportion to the total metered EIM Demand and metered CAISO Demand within that group of Balancing Authority Areas sharing a common Uncertainty Requirement for that direction or based on their metered CAISO Demand or metered EIM Demand in proportion to the total metered demand within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, respectively.

### **11.25.3 Rescission**

#### **11.25.3.1 Amount of Rescission.**

For each Settlement Interval in which a resource has either a UIE deviation or Operational Adjustment and a Flexible Ramping Product settlement, separately for upward and downward, the CAISO will rescind Settlement Amount for the overlap of the UIE or Operational Adjustment and the sum of RTD Forecasted Movement and Uncertainty Award, at the RTD Flexible Ramp Up Price or Flexible Ramp Down Price.

#### **11.25.3.2 Order of Rescission.**

The CAISO will apply any rescission amount first to any Uncertainty Award, in the applicable direction,

and then apply any remaining rescission amount to Forecasted Movement, in the applicable direction.

\* \* \* \* \*

### **27.5.6 Management & Enforcement of Constraints in the CAISO Markets**

The CAISO operates the CAISO Markets through the use of a market software system that utilizes various information including the Base Market Model, the State Estimator, submitted Bids including Self-Schedules, Generated Bids, Transmission Constraints, and transmission and generation Outages, including due to Remedial Action Schemes. The market model used in each of the CAISO Markets is derived from the most current Base Market Model available at that time. To create a more relevant time-specific network model for use in each of the CAISO Markets, the CAISO will adjust the Base Market Model to reflect Outages and derates that are known and applicable when the respective CAISO Market will operate, and to compensate for observed discrepancies between actual real-time power flows and flows calculated by the market software. Through this process the CAISO creates the market model to be used in each Day-Ahead Market and each process of the Real-Time Market. The CAISO will manage the enforcement of Transmission Constraints, consistent with good utility practice, to ensure, to the extent possible, that the market model used in each market accurately reflects all the factors that contribute to actual Real-Time flows on the CAISO Controlled Grid and that the CAISO Market results are better aligned with actual physical conditions on the CAISO Controlled Grid. In operating the CAISO Markets, the CAISO may take the following actions so that, to the extent possible, the CAISO Market solutions are feasible, accurate, and consistent with good utility practice:

- (a) The CAISO may enforce, not enforce, or adjust flow-based Transmission Constraints if the CAISO observes that the CAISO Markets produce or may produce results that are inconsistent with observed or reasonably anticipated conditions or infeasible market solutions either because (a) the CAISO reasonably anticipates that the CAISO Market run will identify Congestion that is unlikely to materialize in Real-Time even if the Transmission Constraint were to be ignored in all the markets leading to Real-Time, or (b) the CAISO reasonably anticipates that the CAISO Market will fail to identify Congestion that is likely to appear in the Real-Time. The

CAISO does not make such adjustments to intertie scheduling limits.

(b) The CAISO may enforce or not enforce Transmission Constraints if the CAISO has determined that non-enforcement or enforcement, respectively, of such Transmission Constraints may result in the unnecessary pre-commitment and scheduling of use-limited resources.

(c) The CAISO may not enforce Transmission Constraints if it has determined it lacks sufficient visibility to conditions on transmission facilities necessary to reliably ascertain constraint flows required for a feasible, accurate and reliable market solution.

(d) For the duration of a planned or unplanned Outage, the CAISO may create and apply alternative Transmission Constraints that may add to or replace certain originally defined constraints.

(e) The CAISO may adjust Transmission Constraints for the purpose of setting prudent operating margins consistent with good utility practice to ensure reliable operation under anticipated conditions of unpredictable and uncontrollable flow volatility consistent with the requirements of Section 7.

To the extent that particular Transmission Constraints are not enforced in the operations of the CAISO Markets, the CAISO will operate the CAISO Controlled Grid and manage any Congestion based on available information including the State Estimator solutions and available telemetry to Dispatch resources through Exceptional Dispatch to ensure the CAISO is operating the CAISO Controlled Grid consistent with the requirements of Section 7.

\* \* \* \* \*

#### **29.34 EIM Operations**

(n) **Effect of EIM Resource Capacity or Flexibility Insufficiency.**

(1) **Insufficient Capacity.** If, after the final opportunity for the EIM Entity to revise hourly Real-Time EIM Base Schedules as provided in Section 29.34(f)(1)(c), the EIM Resource Plan or the CAISO equivalent has insufficient Supply as determined according to Section 29.34(l) -

(A) the CAISO will not include the EIM Entity Balancing Authority Area or the

CAISO Balancing Authority Area in the Uncertainty Requirement of the EIM Area;

- (B) the CAISO will hold the EIM Transfer limit into or from the EIM Entity Balancing Authority Area or the CAISO Balancing Authority Area, as specified in Section 29.34(n)(2), at the less restrictive of the value for the last 15-minute interval with sufficient Supply or the hourly Real-Time EIM Base Schedule corresponding to the 15-minute interval with insufficient Supply.

\* \* \* \* \*

### **34.1.5 Mitigating Bids in the RTM**

#### **34.1.5.1 Generally**

After the Market Close of the RTM, after the CAISO has validated the Bids pursuant to Section 30.7 and Section 34.1.4, and prior to conducting any other RTM processes, the CAISO conducts a MPM process. The results are used in the RTM optimization processes. Bids on behalf of Demand Response Resources, Participating Load, Hybrid Resources, and Non-Generator Resources are considered in the MPM process but are not subject to Bid mitigation. Bids from resources comprised of multiple technologies that include Non-Generator Resources will remain subject to all applicable market power mitigation under the CAISO Tariff, including Local Market Power Mitigation.

#### **34.1.5.2 Fifteen-Minute MPM**

The CAISO conducts the MPM process as the first pass of each fifteen-minute interval in the RTUC horizon starting with the unmitigated Bid set as validated pursuant to Section 30.7 and Section 34.1.4. The MPM process produces results for each fifteen-minute interval of the RTUC horizon and thus may produce mitigated Bids for any given resource for any fifteen-minute interval in the RTUC run horizon that applies to any CAISO Market Process that is based on a specific RTUC run. The determination as to whether a Bid is mitigated is made based on the non-competitive Congestion component of each LMP for each fifteen-minute interval of the RTUC run horizon, using the methodology set forth in Section 31.2.3 except that a resource may have a non-competitive Congestion component in a fifteen-minute interval

based on a Transmission Constraint deemed non-competitive either in the base case for meeting Demand or in the cases of modeling the dispatch of Energy for the capacity corresponding to upward and downward Uncertainty Awards, respectively. If a Bid is mitigated in the MPM pass for a fifteen-minute interval in the RTUC run horizon, the mitigated Bid will be utilized in the corresponding binding HASP and FMM process for the fifteen-minute interval. If a Bid is not mitigated in a fifteen-minute MPM pass, the CAISO will still mitigate that Bid in subsequent fifteen-minute intervals of the RTUC horizon if the MPM pass for the subsequent intervals determine that mitigation is needed.

### **34.1.5.3 Real-Time Dispatch MPM**

The RTD MPM process produces results for each five-minute interval of a Trading Hour. The determination as to whether a Bid is mitigated is made based on the non-competitive Congestion component of each LMP for each five-minute interval, using the methodology set forth in Section 31.2.3 except that a resource may have a non-competitive Congestion component in a five-minute interval based on a Transmission Constraint deemed non-competitive either in the base case for meeting Demand or in the cases of modeling the dispatch of Energy for the capacity corresponding to upward and downward Uncertainty Awards, respectively. The RTD MPM process is performed for a configurable number of RTD advisory intervals after the binding RTD interval, and the mitigated Bids are used in the corresponding RTD intervals of the following RTD.

\* \* \* \* \*

## **39.7.2 Competitive Path Designation**

### **39.7.2.1 Timing of Assessments**

For the DAM and RTM, the CAISO will make assessments and designations of whether Transmission Constraints are competitive or non-competitive as part of the MPM runs associated with the DAM and RTM, respectively. Only binding Transmission Constraints determined by the MPM process will be assessed in the applicable market.

### **39.7.2.2 Criteria**

(A) Notwithstanding the provisions in Section 39.7.2.2(B), when the CAISO enforces the natural gas constraint pursuant to Section 27.11, the CAISO may deem selected internal constraints to be

non-competitive for specific days or hours based on its determination that actual electric supply conditions may be non-competitive due to anticipated electric supply conditions in the Southern California Gas Company and San Diego Gas & Electric Company gas regions.

- (B) Subject to Section 39.7.3, for the DAM and RTM, a Transmission Constraint will be non-competitive only if the Transmission Constraint fails the dynamic competitive path assessment pursuant to this Section 39.7.2.2.
- (a) Transmission Constraints for the DAM - As part of the MPM process associated with the DAM, the CAISO will designate a Transmission Constraint for the DAM as non-competitive when the fringe supply of counter-flow to the Transmission Constraint from all portfolios of suppliers that are not identified as potentially pivotal is less than the demand for counter-flow to the Transmission Constraint. For purposes of determining whether to designate a Transmission Constraint as non-competitive pursuant to this Section 39.7.2.2(B)(a):
- (i) Counter-flow to the Transmission Constraint means the delivery of Power from a resource to the system load distributed reference bus. If counter-flow to the Transmission Constraint is in the direction opposite to the market flow of Power to the Transmission Constraint, the counter-flow to the Transmission Constraint is calculated as the shift factor multiplied by the resource's scheduled Power. Otherwise, counter-flow to the Transmission Constraint is zero.
  - (ii) Fringe supply of counter-flow to the Transmission Constraint means all available capacity from internal resources not controlled by the identified potentially pivotal suppliers and all internal Virtual Supply Awards not controlled by the identified potentially pivotal suppliers that provide counter-flow to the Transmission Constraint. Available capacity reflects the highest capacity of a resource's Energy Bid adjusted for Self-Provided Ancillary Services and derates.
  - (iii) Demand for counter-flow to the Transmission Constraint means all internal dispatched Supply and Virtual Supply Awards that provide counter-flow to the Transmission Constraint.



- (iv) Potentially pivotal suppliers mean the three (3) portfolios of net sellers that control the largest quantity of counter-flow supply to the Transmission Constraint.
- (v) Portfolio means the effective available internal generation capacity under the control of the Scheduling Coordinator and/or Affiliate determined pursuant to Section 4.5.1.1.12 and all effective internal Virtual Supply Awards of the Scheduling Coordinator and/or Affiliate. Effectiveness in supplying counter-flow is determined by scaling generation capacity and/or Virtual Supply Awards by the shift factor from that location to the Transmission Constraint being tested.
- (vi) A portfolio of a net seller means any portfolio that is not a portfolio of a net buyer. A portfolio of a net buyer means a portfolio for which the average daily net value of Measured Demand minus Supply over a twelve (12) month period is positive. The average daily net value is determined for each portfolio by subtracting, for each Trading Day, Supply from Measured Demand and then averaging the daily value for all Trading Days over the twelve (12) month period. The CAISO will calculate whether portfolios are portfolios of net buyers in the third month of each calendar quarter and the calculations will go into effect at the start of the next calendar quarter. The twelve (12) month period used in this calculation will be the most recent twelve (12) month period for which data is available. The specific mathematical formula used to perform this calculation will be set forth in a Business Practice Manual. Market Participants without physical resources will be deemed to be net sellers for purposes of this Section 39.7.2.2(a)(vi).
- (vii) In determining which Scheduling Coordinators and/or Affiliates control the resources in the three (3) identified portfolios, the CAISO will include resources and Virtual Supply Awards directly associated with all Scheduling Coordinator ID Codes associated with the Scheduling Coordinators and/or Affiliates, as well as all resources that the Scheduling Coordinators and/or Affiliates control pursuant to Resource Control Agreements registered with the CAISO as set forth Section 4.5.1.1.13. Resources identified pursuant to Resource Control Agreements will

only be assigned to the portfolio of the Scheduling Coordinator that has control of the resource or whose Affiliate has control of the resource pursuant to the Resource Control Agreements.

(b) Transmission Constraints for the RTM - As part of the MPM processes associated with the RTM, the CAISO separately evaluates Transmission Constraints for the base scenario for meeting Demand, for the scenario of modeling the dispatch of Energy for the capacity corresponding to upward Uncertainty Awards, and for the scenario of modeling the dispatch of Energy for the capacity corresponding to downward Uncertainty Awards. The CAISO will designate a Transmission Constraint for the RTM as non-competitive when the sum of the supply of counter-flow from all portfolios of potentially pivotal suppliers to the Transmission Constraint and the fringe supply of counter-flow to the Transmission Constraint from all portfolios of suppliers that are not identified as potentially pivotal is less than the demand for counter-flow to the Transmission Constraint. For purposes of determining whether to designate a Transmission Constraint as non-competitive pursuant to this Section 39.7.2.2(b):

- (i) Counter-flow to the Transmission Constraint has the meaning set forth in Section 39.7.2.2(B)(a)(i).
- (ii) Supply of counter-flow from all portfolios of potentially pivotal suppliers to the Transmission Constraint means the minimum available capacity from internal resources controlled by the identified potentially pivotal suppliers that provide counter-flow to the Transmission Constraint. The minimum available capacity for the current market interval will reflect the greatest amount of capacity that can be physically withheld. The minimum available capacity is the lowest output level the resource could achieve in the current market interval given its dispatch in the last market interval and limiting factors including Minimum Load, Ramp Rate, Self-Provided Ancillary Services, Ancillary Service Awards (in the Real-Time Market only), derates, and Uncertainty Awards.
- (iii) Potentially pivotal suppliers mean the three (3) portfolios of net sellers that

control the largest quantity of counter-flow supply to the Transmission Constraint that can be withheld. Counter-flow supply to the Transmission Constraint that can be withheld reflects the difference between the highest capacity and the lowest capacity of a resource's Energy Bid (not taking into account the Ramp Rate of the resource), measured from the Dispatch Operating Point for the resource in the immediately preceding fifteen (15) minute FMM interval or the preceding five (5) minute RTD interval, as applicable (taking into account the Ramp Rate of the resource), adjusted for Self-Provided Ancillary Services/Ancillary Service Awards, derates, and Uncertainty Awards in determining whether to designate a Transmission Constraint as non-competitive for the RTM. In determining whether to designate a Transmission Constraint as non-competitive for the RTM, counter-flow supply to the Transmission Constraint that can be withheld also reflects the PMin of each Short Start Unit with a Start-Up Time of sixty (60) minutes or less that was off-line in the immediately preceding fifteen (15) minute interval of the FMM. In determining whether to designate a Transmission Constraint as non-competitive for the RTM, counter-flow supply to the Transmission Constraint that can be withheld also reflects the PMin of each Short Start Unit with a Start-Up Time of fifteen (15) minutes or less that was off-line in the immediately preceding fifteen (15) minute interval.

- (iv) Portfolio means the effective available internal generation capacity under the control of the Scheduling Coordinator and/or Affiliate determined pursuant to Sections 4.5.1.1.12 and 39.7.2.2(a)(vii). Effectiveness in supplying counter-flow is determined by scaling generation capacity by the shift factor from that location to the Transmission Constraint being tested.
- (v) A portfolio of a net seller has the meaning set forth in Section 39.7.2.2(a)(vi).
- (vi) Fringe supply of counter-flow to the Transmission Constraint means all available capacity from internal resources not controlled by the identified potentially pivotal suppliers that provide counter-flow to the Transmission Constraint. Available

capacity reflects the highest capacity of a resource's Energy Bid (not taking into account the Ramp Rate of the resource), measured from the Dispatch Operating Point for the resource in the immediately preceding fifteen (15) minute interval of the FMM or five (5) minute interval of the RTD, as applicable (taking into account the Ramp Rate of the resource), adjusted for Self-Provided Ancillary Services/Ancillary Service Awards, derates, and Uncertainty Awards in determining whether to designate a Transmission Constraint as non-competitive for the RTM.

- (vii) Demand for counter-flow to the Transmission Constraint means all internal dispatched Supply that provides counter-flow to the Transmission Constraint.

\* \* \* \* \*

#### **44.2.1 Optimization.**

##### **44.2.1.1 Generally.**

The CAISO will optimize the procurement of Uncertainty Awards in the Real-Time Market simultaneously with the procurement of Energy and Ancillary Services, as applicable. Uncertainty Awards do not overlap with Ancillary Services Awards or Available Balancing Capacity.

##### **44.2.1.2 Nodal Procurement of Uncertainty Awards**

The CAISO will optimize procurement of Uncertainty Awards such that, in the event modeled uncertainty arises fully for either the upward or downward directions, Energy that would be dispatched from resource capacity corresponding to the Uncertainty Awards would not result in flows exceeding Transmission Constraints and scheduling limits, including EIM transfer limits.

##### **44.2.1.3 Optimization for Balancing Authority Areas with Distinct Uncertainty Requirements**

For Balancing Authority Areas with a distinct Uncertainty Requirement per Section 44.2.4.1, the CAISO will optimize procurement of Uncertainty Awards assuming that the Balancing Authority Area would be limited to its final hourly Real-Time EIM Base Schedule or the CAISO equivalent in the event modeled uncertainty arises fully in the direction for which there is a distinct Uncertainty Requirement.

\* \* \* \* \*

#### **44.2.4 Determination of Uncertainty Requirement.**

##### **44.2.4.1 Requirement.**

For each Real-Time Market run, the CAISO determines a distinct upward Uncertainty Requirement for each Balancing Authority Area that fails either the: (a) capacity test specified in Section 29.34(l) because the incremental offers in the Energy Bid range above the EIM Base Schedule (or equivalent for the CAISO) are not sufficient; or (b) flexibility test specified in Section 29.34(m) because of insufficient upward Ramping capacity. For each Real-Time Market run, the CAISO determines an upward Uncertainty Requirement for the group of Balancing Authority Areas that passes both the capacity test and flexibility tests in the upward direction.

For each Real-Time Market run, the CAISO determines a distinct downward Uncertainty Requirement for each Balancing Authority Area that fails either the: (a) capacity test specified in Section 29.34(l) because the decremental offers in the Energy Bid range below the EIM Base Schedule (or equivalent for the CAISO) are not sufficient; or (b) flexibility test specified in Section 29.34(m) because of insufficient downward Ramping capacity. For each Real-Time Market run, the CAISO determines a downward Uncertainty Requirement for the group of Balancing Authority Areas that passes both the capacity test and flexibility tests in the downward direction.

##### **44.2.4.2 Procurement Curve.**

- (a) **Generally.** Based on statistical analysis of the Uncertainty Requirement, the CAISO will calculate constraint relaxation parameters to ensure the total cost of the Uncertainty Awards will not exceed the cost of expected power balance violations in absence of the Uncertainty Award, by each Balancing Authority Area and for the EIM Area overall, as set forth in the Business Practice Manual.
- (b) **Procurement Curve Cap.** The CAISO will establish in the Business Practice Manual a limit on the procurement curve –
  - (1) at an amount less than the contingency relaxation penalty pricing parameter specified in the Business Practice Manual for market operations, in the case of

- an upward demand curve; and
- (2) at an amount more than the regulation down relaxation penalty pricing parameter specified in the Business Practice Manual for market operations, in the case of a downward demand curve.

#### **44.2.4.3 Nodal Distribution of Requirements**

The CAISO will distribute the upward and downward Uncertainty Requirement to the Demand and Variable Energy Resources Locations within each Balancing Authority Area in the EIM Area based on allocation factors derived from historical and/or forecasted information that reflect the relative contributions of Demand and Variable Energy Resources to overall Uncertainty Requirement.

\* \* \* \* \*

### **Appendix A**

#### **Definitions**

\* \* \* \* \*

#### **- Flexible Ramp Down Price**

The Shadow Price of the downward Uncertainty Requirement constraint, which is the cost sensitivity of relaxing the downward Uncertainty Requirement constraint (\$/MWh), by Location.

#### **- Flexible Ramp Up Price**

The Shadow Price of the upward Uncertainty Requirement constraint, which is the cost sensitivity of relaxing the upward Uncertainty Requirement constraint (\$/MWh), by Location.

\* \* \* \* \*

## **Appendix C**

### **Locational Marginal Price**

\* \* \* \* \*

#### **C. The System Marginal Energy Cost Component of LMP (Day-Ahead and Real-Time Market)**

The SMEC shall be the same for each location throughout the system. SMEC is the sensitivity of the power balance constraint at the optimal solution. The power balance constraint ensures that the physical law of conservation of Energy (the sum of Generation and imports equals the sum of Demand, including exports and Transmission Losses) is accounted for in the network solution. This system level power balance constraint is enforced over the CAISO Balancing Authority Area for the Day-Ahead Market and over the EIM Area in the Real-Time Market. For the designated reference location the CAISO will utilize a distributed Load Reference Bus for which constituent PNodes are weighted using the Reference Bus distribution factors. The Load distributed Reference Bus distribution factors are based on the Load Distribution Factors at each PNode that represents cleared Load in the Integrated Forward Market or forecast Load for MPM, RUC and RTM. In the Integrated Forward Market, in the event that the market is not able to clear based on the use of a distributed load Reference Bus, the CAISO will use a distributed generation Reference Bus for which the constituent nodes and the weights are determined economically within the running of the Integrated Forward Market based on available economic bids. In the event that the CAISO employs a distributed generation Reference Bus, it will notify Market Participants of which Integrated Forward Market runs required the use of this backstop mechanism. A distributed Load Reference Bus will be used for RUC and RTM regardless of whether a distributed Generation Reference Bus were used in the corresponding Integrated Forward Market run. If the market-clearing problem is limited by the system-level power balance constraint, the market clearing process would create a Shadow Price for the power balance constraint only when the relaxation of the constraint would result in a reduction in the total cost to operate the system.

#### **D. Marginal Congestion Component Calculations (Day-Ahead and Real-Time)**

The CAISO calculates the Marginal Costs of Congestion at each bus as a component of the bus-level LMP. The Marginal Cost of Congestion (MCC<sub>i</sub>) component of the LMP at bus *i* is calculated in the Day-

Ahead Market using the equation:

$$MCC_i = - \sum_{m=1}^M \sum_{j=1}^{J_m} c_{j,m} PTDF_{i,j} \mu_m - \sum_{k=1}^K \sum_{m=1}^M PTDF_{i,m}^k \mu_m^k - \sum_{g=1}^{K_g} \sum_{m=1}^M \left( PTDF_{i,m}^g + \delta_{O_g,i} \sum_{n=1}^N PTDF_{n,m}^g GLDF_{O_g,n} \right) \mu_m^g$$

where:

- $i$  is a node index.
- $n$  is a node index.
- $m$  is the constraint or monitored element index.
- $k$  is the preventive contingency case.
- $g$  is the generation contingency case.
- $O_g$  is the node index associated with the generator contingency case  $g$ .
- $j$  is the transmission component index of Transmission Constraint  $m$ . When Transmission Constraint  $m$  is a Nomogram, there can be more than one transmission component. When Transmission Constraint  $m$  is any other Transmission Constraint, there shall be only one transmission component.
- $N$  is the number of preventive contingencies.
- $K$  is the number of preventive transmission contingencies, both in the base case for meeting Demand and in the case of modeling the dispatch of Energy for the capacity corresponding to the Uncertainty Awards.
- $K_g$  is the number of preventive generation contingencies.
- $M$  is the number of monitored elements, both in the base case for meeting Demand and in the case of modeling the dispatch of Energy for the capacity corresponding to the Uncertainty Awards.
- $J_m$  is the number of transmission components for constraint  $m$ .

\* \* \* \* \*



**Attachment B – Marked Tariff**

**Flexible Ramping Product**

**California Independent System Operator Corporation**

**August 15, 2022**

### 4.13.3 Identification of RDRRs and PDRs

Each Demand Response Provider shall provide data, as described in the Business Practice Manual, identifying each of its Reliability Demand Response Resources or Proxy Demand Resources and such information regarding the capacity and the operating characteristics of the Reliability Demand Response Resource or Proxy Demand Resource as may be reasonably requested from time to time by the CAISO. All information provided to the CAISO regarding the operational and technical constraints in the Master File shall be accurate and actually based on physical characteristics of the resources. For Proxy Demand Resources and Reliability Demand Response Providers whose maximum Load curtailment is 1 MW or more, Demand Response Providers may elect to specify in the Master File the maximum number of Operating Hours in which the CAISO could commit or dispatch the Proxy Demand Resources or Reliability Demand Response Resources in the Operating Day. Demand Response Providers for Proxy Demand Resources and Reliability Demand Response Resources may elect to specify in the Master File how the Proxy Demand Resource and Reliability Demand Response Resources will bid and be dispatched in the Real-Time Market: in (i) Hourly Blocks, (ii) fifteen (15) minute intervals, or (iii) five (5) minute intervals. Proxy Demand Resources using the load-shift methodology described in Section 4.13.4.7 may elect to bid and be dispatched in the Real-Time Market in fifteen (15) minute intervals or five (5) minute intervals. If Demand Response Providers do not submit an election in the Master File, the CAISO will set Hourly Blocks ~~set five (5) minute intervals~~ as the default.

\* \* \* \* \*

## 11.25 Settlement of Flexible Ramping Product

### 11.25.1 Settlement of Forecasted Movement

#### 11.25.1.1 **Generally**

The CAISO will settle Forecasted Movement for a direction as specified in this Section 11.25.1 by Balancing Authority Area for each Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as specified in Section 44.2.4.1, and separately will settle Forecasted Movement for a direction as specified in this Section 11.25.1 for the group of Balancing Authority Areas that shares a

common Uncertainty Requirement for that direction, as specified in Section 44.2.4.1.

**11.25.1.24 FMM.**

The CAISO will settle FMM Forecasted Movement with Scheduling Coordinators as follows, where upward movement is a positive amount and downward movement is a negative amount:

- (a) the product of the Forecasted Movement calculated for each resource pursuant to Section 44.3 in MWhs and the applicable FMM Flexible Ramp Up Price~~FRUP~~; plus
- (b) the product of the Forecasted Movement calculated for each resource pursuant to Section 44.3 in MWhs and the product of the applicable FMM Flexible Ramp Down Price~~FRDP~~ and negative one.

**11.25.1.32 RTD.**

The CAISO will settle RTD Forecasted Movement with Scheduling Coordinators as follows, where upward movement is a positive amount and downward movement is a negative amount:

- (a) the product of the difference between the RTD Forecasted Movement and the FMM Forecasted Movement for the relevant Settlement Interval, both calculated for each resource pursuant to Section 44.3 in MWhs, and the applicable RTD ~~FRUP~~Flexible Ramp Up Price, less any rescission amounts pursuant to section 11.25.3; plus
- (b) the product of the difference between the RTD Forecasted Movement and the FMM Forecasted Movement for the relevant Settlement Interval, both calculated for each resource pursuant to Section 44.3 in MWhs, and the product of the applicable RTD ~~FRDP~~Flexible Ramp Down Price and negative one, less any rescission amounts pursuant to section 11.25.3.

**11.25.1.43 Allocation of Residual Forecasted Movement Settlements.**

For Balancing Authority Areas that share a common Uncertainty Requirement for a direction, as specified in Section 44.2.4.1, tThe CAISO will settle amounts remaining after settlement of Forecasted Movement pursuant to Section 11.25.1 to each Scheduling Coordinator based on its's EIM Demand or metered CAISO Demand in proportion to the total EIM Demand and metered CAISO Demand within that group of Balancing Authority Areas sharing a common Uncertainty Requirement.

For a Balancing Authority Area that has a distinct Uncertainty Requirement for a direction, as specified in

Section 44.2.4.1, the CAISO will settle amounts remaining after settlement of Forecasted Movement pursuant to Section 11.25.1 to each Scheduling Coordinator based on its EIM Demand or metered CAISO Demand in proportion to the total EIM Demand or metered CAISO Demand within that single Balancing Authority Area.

~~-metered EIM Demand or metered CAISO Demand in proportion to its share of the total metered EIM Demand and metered CAISO Demand.~~

## **11.25.2 Settlement of Uncertainty Requirement**

### **11.25.2.1 Payment to Resources.**

On a daily basis, the CAISO will settle ~~awards~~ Uncertainty Awards to resources for providing the Uncertainty Requirement at the applicable ~~FRUP~~ Flexible Ramp Up Price or ~~FRDP~~ Flexible Ramp Down Price less any payment rescission for each interval pursuant to Section 11.25.3.

### **11.25.2.2 Allocation of Costs of Uncertainty Movement Procured.**

#### **11.25.2.2.1 Settlement Process.**

(a) **Generally.** The CAISO will settle Uncertainty Awards for a direction as specified in this Section 11.25.2.2 by Balancing Authority Area for each Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as specified in Section 44.2.4.1, or separately will settle Uncertainty Awards for a direction as specified in this Section 11.25.2.2 for the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction, as specified in Section 44.2.4.1.

(b) **Daily.** The CAISO will initially –

- (1) allocate the cost of the Uncertainty Awards for a direction ~~within each Balancing Authority Area in the EIM Area and within the EIM Area~~ on a daily basis according to the categories as set forth in ~~this~~ Sections 11.25.2.2.2 and 11.25.2.2.3 within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable; and
- (2) allocate the daily amounts to Scheduling Coordinators as set forth in ~~this~~ Section

11.25.2.2.4.

- (cb) **Monthly.** The CAISO will resettle the costs of the Uncertainty Awards by –
- (1) reversing the daily allocation;
  - (2) assigning the monthly costs of the Uncertainty Awards to Peak Flexible Ramp Hours and Off-Peak Flexible Ramp Hours;
  - (3) separately allocating the monthly Peak Flexible Ramp Hours amounts and Off-Peak Flexible Ramp Hours amounts to the categories ~~within each Balancing Authority Area in the EIM Area and within the EIM Area~~ as set forth in this Sections 11.25.2.2.2 and 11.25.2.2.3 within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable; and
  - (4) allocating the monthly amounts in each category to Scheduling Coordinators as set forth in ~~this~~ Section 11.25.2.2.4.

**11.25.2.2.2 Allocation of Charges to Categories.**

- (a) **Determination of Uncertainty Movement for Resources.** For each interval, the CAISO will calculate the net Uncertainty Movement of each resource according to the following categories:
- (1) for Supply resources other than non-Dynamic System Resources as the difference between the Dispatch Instruction of the binding interval in the next RTD run and the first advisory RTD interval in the current run.
  - (2) for non-Dynamic System Resources and export schedules as the difference between the schedule used in the RTD (accounting for ramp) for the binding interval in the next RTD run and the ~~scheduled~~ used for the first advisory interval in the current RTD run.
- (b) **RTD Uncertainty Movement ~~by Balancing Authority Area and by EIM Area.~~** The CAISO will determine the total net RTD Uncertainty Movement for each category separately for the group of Balancing Authority Areas that shares a common Uncertainty

Requirement for that direction or a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable each Balancing Authority Area in the EIM Area and by EIM Area –

- (1) for the category of Supply resources, which shall not include non-Dynamic System Resources, as the net sum of the five-minute Uncertainty Movement determined pursuant to Section 11.25.2.2.2 of all the Supply resources in the category.
- (2) for the category of Intertie resources, which shall comprise non-Dynamic System Resources and exports, as the net sum of the five-minute Uncertainty Movement determined pursuant to Section 11.25.2.2 of all the non-Dynamic System resources and export schedules.
- (3) for the non-Participating Load category, as the difference between –
  - (A) the CAISO Forecast of CAISO Demand, the CAISO forecast of Balancing Authority Area EIM Demand, or the CAISO forecast of EIM Area EIM Demand, as applicable, of the binding interval in the next RTD run; and
  - (B) the CAISO Forecast of CAISO Demand, the CAISO forecast of Balancing Authority Area EIM Demand, or the CAISO forecast of EIM Area EIM Demand, as applicable, for the first advisory interval in the current RTD run.

**11.25.2.2.3 Assignment of Uncertainty Costs to Categories.**

The CAISO will allocate the total Uncertainty Award cost calculated pursuant to this section 11.25.2.2 to each category described in Section 11.25.2.2.2(b) based on –

- (a) for upward Uncertainty Award cost, the ratio of such category's positive Uncertainty Movement to the sum of the positive Uncertainty Movements of all categories with positive Uncertainty Movement for each Balancing Authority Area within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement

for that direction, as applicable in the EIM Area and the EIM Area; and

- (b) for downward Uncertainty Award costs, the ratio of such category's negative Uncertainty Movement to the sum of the negative Uncertainty Movements of all categories with negative Uncertainty Movement for each Balancing Authority Area within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable in the EIM Area and the EIM Area.

#### **11.25.2.2.4 Allocation to Scheduling Coordinators.**

- (a) **Non-Participating Load Category.** The CAISO will allocate the Uncertainty Awards costs of the non-Participating Load category to Scheduling Coordinators –
- (1) for upward Uncertainty Award cost in proportion to the Scheduling Coordinator's negative non-Participating Load UIE, excluding the non-Participating Load of an MSS that has elected to load-follow according to an MSS Agreement, without netting that UIE across Settlement Intervals, to the total of such negative non-Participating Load UIE, without netting that UIE across Settlement Intervals, within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable in the Balancing Authority Area or EIM Area as applicable, and
- (2) for downward Uncertainty Award cost calculated pursuant to Section 11.25, in proportion to the Scheduling Coordinator's daily positive non-Participating Load UIE, excluding the non-Participating Load of an MSS that has elected to load-follow according to an MSS Agreement, without netting that UIE across Settlement Intervals, to the total of such positive non-Participating Load UIE, without netting that UIE across Settlement Intervals, within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable in the BAA or EIM Area as

~~applicable.~~

- (b) **Supply Category.** The CAISO will allocate the Uncertainty Awards costs of the Supply category to Scheduling Coordinators for each resource in the Supply category based on the sum of the resource's Uncertainty Movement and UIE –
- (1) for upward Uncertainty Award cost in proportion to the Scheduling Coordinator's positive sum of the resource's Uncertainty Movement and UIE, without netting that sum across Settlement Intervals, to the total positive sum of all resources' Uncertainty Movement and UIE, without netting that sum across Settlement Intervals, within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable in the BAA or EIM Area as applicable; and
  - (2) for downward Uncertainty Award cost in proportion to the Scheduling Coordinator's negative sum of the resource's Uncertainty Movement and UIE, without netting that sum across Settlement Intervals, to the total negative sum of all resources' Uncertainty Movement and UIE, without netting that sum across Settlement Intervals, within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable in the Balancing Authority Area or EIM Area as applicable; except that
  - (3) for the MSS that have elected to load follow pursuant to an MSS Agreement, the CAISO will calculate the positive and negative sums specified above for each Settlement Interval as the sum of MSS non-Participating Load UIE, Supply resources within the MSS UIE, MSS Load Following Energy, MSS Load Following Operational Adjustments, and Uncertainty Movement of resources within the MSS Aggregation.
- (c) **Intertie Category.** The CAISO will allocate the Uncertainty Awards costs of the Intertie category to Scheduling Coordinators for each non-Dynamic System Resource and export



based on the sum of the resource's Uncertainty Movement and Operational Adjustment –

- (1) for upward Uncertainty Award cost in proportion to the magnitude of the Scheduling Coordinator's negative Operational Adjustment for non-Dynamic System Resources, or positive Operational Adjustment for export resources, to the sum of the magnitudes of such Operational Adjustments within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable in the Balancing Authority Area or EIM Area, without netting that sum across Settlement Intervals; and
  - (2) for downward Uncertainty Award cost in proportion to the magnitude of the Scheduling Coordinator's positive Operational Adjustment for non-Dynamic System Resources, or negative Operational Adjustment for export resources, to the sum of the magnitudes of such Operational Adjustments within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, as applicable in the Balancing Authority Area or EIM Area, without netting that sum across Settlement Intervals; and
  - (3) for the purposes of the allocations specified above, the MSS Load Following Operational Adjustment is excluded.
- (d) **Uncertainty Award Cost Offset.** If the sum of the settlement of Uncertainty Awards and the charges to Scheduling Coordinators for Uncertainty Award costs is nonzero, either within the group of Balancing Authority Areas that shares a common Uncertainty Requirement for that direction or within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, then, the CAISO will allocate such amounts to Scheduling Coordinators based on their metered EIM Demand or metered CAISO Demand in proportion to the total metered EIM Demand and metered CAISO Demand within that group of Balancing Authority Areas sharing a common Uncertainty Requirement for that direction or based on their ~~the ratio of their~~ metered CAISO Demand

or and-metered EIM Demand in proportion to the total ~~EIM area~~-metered demand within a Balancing Authority Area that has a distinct Uncertainty Requirement for that direction, respectively.

### **11.25.3 Rescission**

#### **11.25.3.1 Amount of Rescission.**

For each Settlement Interval in which a resource has either a UIE deviation or Operational Adjustment and a Flexible Ramping Product settlement, separately for upward and downward, the CAISO will rescind Settlement Amount for the overlap of the UIE or Operational Adjustment and the sum of RTD Forecasted Movement and Uncertainty Award, at the RTD ~~FRUP~~Flexible Ramp Up Price or ~~FRDP~~Flexible Ramp Down Price.

#### **11.25.3.2 Order of Rescission.**

The CAISO will apply any rescission amount first to any Uncertainty Award, in the applicable direction, and then apply any remaining rescission amount to Forecasted Movement, in the applicable direction.

\* \* \* \* \*

### **27.5.6 Management & Enforcement of Constraints in the CAISO Markets**

The CAISO operates the CAISO Markets through the use of a market software system that utilizes various information including the Base Market Model, the State Estimator, submitted Bids including Self-Schedules, Generated Bids, Transmission Constraints, and transmission and generation Outages, including due to Remedial Action Schemes. The market model used in each of the CAISO Markets is derived from the most current Base Market Model available at that time. To create a more relevant time-specific network model for use in each of the CAISO Markets, the CAISO will adjust the Base Market Model to reflect Outages and derates that are known and applicable when the respective CAISO Market will operate, and to compensate for observed discrepancies between actual real-time power flows and flows calculated by the market software. Through this process the CAISO creates the market model to be used in each Day-Ahead Market and each process of the Real-Time Market. The CAISO will manage the enforcement of Transmission Constraints, consistent with good utility practice, to ensure, to the extent

possible, that the market model used in each market accurately reflects all the factors that contribute to actual Real-Time flows on the CAISO Controlled Grid and that the CAISO Market results are better aligned with actual physical conditions on the CAISO Controlled Grid. In operating the CAISO Markets, the CAISO may take the following actions so that, to the extent possible, the CAISO Market solutions are feasible, accurate, and consistent with good utility practice:

- (a) The CAISO may enforce, not enforce, or adjust flow-based Transmission Constraints if the CAISO observes that the CAISO Markets produce or may produce results that are inconsistent with observed or reasonably anticipated conditions or infeasible market solutions either because (a) the CAISO reasonably anticipates that the CAISO Market run will identify Congestion that is unlikely to materialize in Real-Time even if the Transmission Constraint were to be ignored in all the markets leading to Real-Time, or (b) the CAISO reasonably anticipates that the CAISO Market will fail to identify Congestion that is likely to appear in the Real-Time. The CAISO does not make such adjustments to intertie ~~S~~Scheduling ~~L~~Limits.
- (b) The CAISO may enforce or not enforce Transmission Constraints if the CAISO has determined that non-enforcement or enforcement, respectively, of such Transmission Constraints may result in the unnecessary pre-commitment and scheduling of use-limited resources.
- (c) The CAISO may not enforce Transmission Constraints if it has determined it lacks sufficient visibility to conditions on transmission facilities necessary to reliably ascertain constraint flows required for a feasible, accurate and reliable market solution.
- (d) For the duration of a planned or unplanned Outage, the CAISO may create and apply alternative Transmission Constraints that may add to or replace certain originally defined constraints.
- (e) The CAISO may adjust Transmission Constraints for the purpose of setting prudent operating margins consistent with good utility practice to ensure reliable operation under anticipated conditions of unpredictable and uncontrollable flow volatility consistent with the requirements of Section 7.

To the extent that particular Transmission Constraints are not enforced in the operations of the CAISO Markets, the CAISO will operate the CAISO Controlled Grid and manage any Congestion based on

available information including the State Estimator solutions and available telemetry to Dispatch resources through Exceptional Dispatch to ensure the CAISO is operating the CAISO Controlled Grid consistent with the requirements of Section 7.

\* \* \* \* \*

## 29.34 EIM Operations

### (n) Effect of EIM Resource Capacity or Flexibility Insufficiency.

(1) **Insufficient Capacity.** If, after the final opportunity for the EIM Entity to revise hourly Real-Time EIM Base Schedules as provided in Section 29.34(f)(1)(c), the EIM Resource Plan or the CAISO equivalent has insufficient Supply as determined according to Section 29.34(l) -

(A) the CAISO will not include the EIM Entity Balancing Authority Area or the CAISO Balancing Authority Area in the Uncertainty Requirement of the EIM Area;

(B) the CAISO will hold the EIM Transfer limit into or from the EIM Entity Balancing Authority Area or the CAISO Balancing Authority Area, as specified in Section 29.34(n)(2), at the less restrictive of the value for the last 15-minute interval with sufficient Supply or the hourly Real-Time EIM Base Schedule corresponding to the 15-minute interval with insufficient Supply.

\* \* \* \* \*

## 34.1.5 Mitigating Bids in the RTM

### 34.1.5.1 Generally

After the Market Close of the RTM, after the CAISO has validated the Bids pursuant to Section 30.7 and Section 34.1.4, and prior to conducting any other RTM processes, the CAISO conducts a MPM process. The results are used in the RTM optimization processes. Bids on behalf of Demand Response Resources, Participating Load, Hybrid Resources, and Non-Generator Resources are considered in the

MPM process but are not subject to Bid mitigation. Bids from resources comprised of multiple technologies that include Non-Generator Resources will remain subject to all applicable market power mitigation under the CAISO Tariff, including Local Market Power Mitigation.

#### **34.1.5.2 Fifteen-Minute MPM**

The CAISO conducts the MPM process as the first pass of each fifteen-minute interval in the RTUC horizon starting with the unmitigated Bid set as validated pursuant to Section 30.7 and Section 34.1.4. The MPM process produces results for each fifteen-minute interval of the RTUC horizon and thus may produce mitigated Bids for any given resource for any fifteen-minute interval in the RTUC run horizon that applies to any CAISO Market Process that is based on a specific RTUC run. The determination as to whether a Bid is mitigated is made based on the non-competitive Congestion component of each LMP for each fifteen-minute interval of the RTUC run horizon, using the methodology set forth in Section 31.2.3 except that a resource may have a non-competitive Congestion component in a fifteen-minute interval based on a Transmission Constraint deemed non-competitive either in the base case for meeting Demand or in the cases of modeling the dispatch of Energy for the capacity corresponding to upward and downward Uncertainty Awards, respectively. If a Bid is mitigated in the MPM pass for a fifteen-minute interval in the RTUC run horizon, the mitigated Bid will be utilized in the corresponding binding HASP and FMM process for the fifteen-minute interval. If a Bid is not mitigated in a fifteen-minute MPM pass, the CAISO will still mitigate that Bid in subsequent fifteen-minute intervals of the RTUC horizon if the MPM pass for the subsequent intervals determine that mitigation is needed.

#### **34.1.5.3 Real-Time Dispatch MPM**

The RTD MPM process produces results for each five-minute interval of a Trading Hour. The determination as to whether a Bid is mitigated is made based on the non-competitive Congestion component of each LMP for each five-minute interval, using the methodology set forth in Section 31.2.3 except that a resource may have a non-competitive Congestion component in a five-minute interval based on a Transmission Constraint deemed non-competitive either in the base case for meeting Demand or in the cases of modeling the dispatch of Energy for the capacity corresponding to upward and downward Uncertainty Awards, respectively. The RTD MPM process is performed for a configurable

number of RTD advisory intervals after the binding RTD interval, and the mitigated Bids are used in the corresponding RTD intervals of the following RTD.

\* \* \* \* \*

## **39.7.2 Competitive Path Designation**

### **39.7.2.1 Timing of Assessments**

For the DAM and RTM, the CAISO will make assessments and designations of whether Transmission Constraints are competitive or non-competitive as part of the MPM runs associated with the DAM and RTM, respectively. Only binding Transmission Constraints determined by the MPM process will be assessed in the applicable market.

### **39.7.2.2 Criteria**

(A) Notwithstanding the provisions in Section 39.7.2.2(B), when the CAISO enforces the natural gas constraint pursuant to Section 27.11, the CAISO may deem selected internal constraints to be non-competitive for specific days or hours based on its determination that actual electric supply conditions may be non-competitive due to anticipated electric supply conditions in the Southern California Gas Company and San Diego Gas & Electric Company gas regions.

(B) Subject to Section 39.7.3, for the DAM and RTM, a Transmission Constraint will be non-competitive only if the Transmission Constraint fails the dynamic competitive path assessment pursuant to this Section 39.7.2.2.

(a) Transmission Constraints for the DAM - As part of the MPM process associated with the DAM, the CAISO will designate a Transmission Constraint for the DAM as non-competitive when the fringe supply of counter-flow to the Transmission Constraint from all portfolios of suppliers that are not identified as potentially pivotal is less than the demand for counter-flow to the Transmission Constraint. For purposes of determining whether to designate a Transmission Constraint as non-competitive pursuant to this Section 39.7.2.2(B)(a):

(i) Counter-flow to the Transmission Constraint means the delivery of Power from a resource to the system load distributed reference bus. If counter-flow to the

Transmission Constraint is in the direction opposite to the market flow of Power to the Transmission Constraint, the counter-flow to the Transmission Constraint is calculated as the shift factor multiplied by the resource's scheduled Power. Otherwise, counter-flow to the Transmission Constraint is zero.

- (ii) Fringe supply of counter-flow to the Transmission Constraint means all available capacity from internal resources not controlled by the identified potentially pivotal suppliers and all internal Virtual Supply Awards not controlled by the identified potentially pivotal suppliers that provide counter-flow to the Transmission Constraint. Available capacity reflects the highest capacity of a resource's Energy Bid adjusted for Self-Provided Ancillary Services and derates.
- (iii) Demand for counter-flow to the Transmission Constraint means all internal dispatched Supply and Virtual Supply Awards that provide counter-flow to the Transmission Constraint.
- (iv) Potentially pivotal suppliers mean the three (3) portfolios of net sellers that control the largest quantity of counter-flow supply to the Transmission Constraint.
- (v) Portfolio means the effective available internal generation capacity under the control of the Scheduling Coordinator and/or Affiliate determined pursuant to Section 4.5.1.1.12 and all effective internal Virtual Supply Awards of the Scheduling Coordinator and/or Affiliate. Effectiveness in supplying counter-flow is determined by scaling generation capacity and/or Virtual Supply Awards by the shift factor from that location to the Transmission Constraint being tested.
- (vi) A portfolio of a net seller means any portfolio that is not a portfolio of a net buyer. A portfolio of a net buyer means a portfolio for which the average daily net value of Measured Demand minus Supply over a twelve (12) month period is positive. The average daily net value is determined for each portfolio by subtracting, for each Trading Day, Supply from Measured Demand and then averaging the daily value for all Trading Days over the twelve (12) month period. The CAISO will calculate whether portfolios are portfolios of net buyers in the third month of each

calendar quarter and the calculations will go into effect at the start of the next calendar quarter. The twelve (12) month period used in this calculation will be the most recent twelve (12) month period for which data is available. The specific mathematical formula used to perform this calculation will be set forth in a Business Practice Manual. Market Participants without physical resources will be deemed to be net sellers for purposes of this Section 39.7.2.2(a)(vi).

(vii) In determining which Scheduling Coordinators and/or Affiliates control the resources in the three (3) identified portfolios, the CAISO will include resources and Virtual Supply Awards directly associated with all Scheduling Coordinator ID Codes associated with the Scheduling Coordinators and/or Affiliates, as well as all resources that the Scheduling Coordinators and/or Affiliates control pursuant to Resource Control Agreements registered with the CAISO as set forth Section 4.5.1.1.13. Resources identified pursuant to Resource Control Agreements will only be assigned to the portfolio of the Scheduling Coordinator that has control of the resource or whose Affiliate has control of the resource pursuant to the Resource Control Agreements.

(b) Transmission Constraints for the RTM - As part of the MPM processes associated with the RTM, the CAISO separately evaluates Transmission Constraints for the base scenario for meeting Demand, for the scenario of modeling the dispatch of Energy for the capacity corresponding to upward Uncertainty Awards, and for the scenario of modeling the dispatch of Energy for the capacity corresponding to downward Uncertainty Awards. ¶The CAISO will designate a Transmission Constraint for the RTM as non-competitive when the sum of the supply of counter-flow from all portfolios of potentially pivotal suppliers to the Transmission Constraint and the fringe supply of counter-flow to the Transmission Constraint from all portfolios of suppliers that are not identified as potentially pivotal is less than the demand for counter-flow to the Transmission Constraint. For purposes of determining whether to designate a Transmission Constraint as non-competitive pursuant to this Section 39.7.2.2(b):



- (i) Counter-flow to the Transmission Constraint has the meaning set forth in Section 39.7.2.2(B)(a)(i).
- (ii) Supply of counter-flow from all portfolios of potentially pivotal suppliers to the Transmission Constraint means the minimum available capacity from internal resources controlled by the identified potentially pivotal suppliers that provide counter-flow to the Transmission Constraint. The minimum available capacity for the current market interval will reflect the greatest amount of capacity that can be physically withheld. The minimum available capacity is the lowest output level the resource could achieve in the current market interval given its dispatch in the last market interval and limiting factors including Minimum Load, Ramp Rate, Self-Provided Ancillary Services, Ancillary Service Awards (in the Real-Time Market only), ~~and derates,~~ and Uncertainty Awards.
- (iii) Potentially pivotal suppliers mean the three (3) portfolios of net sellers that control the largest quantity of counter-flow supply to the Transmission Constraint that can be withheld. Counter-flow supply to the Transmission Constraint that can be withheld reflects the difference between the highest capacity and the lowest capacity of a resource's Energy Bid (not taking into account the Ramp Rate of the resource), measured from the Dispatch Operating Point for the resource in the immediately preceding fifteen (15) minute FMM interval or the preceding five (5) minute RTD interval, as applicable (taking into account the Ramp Rate of the resource), adjusted for Self-Provided Ancillary Services/Ancillary Service Awards, and derates, and Uncertainty Awards in determining whether to designate a Transmission Constraint as non-competitive for the RTM, ~~or adjusted for Ancillary Service Awards and derates in determining whether to designate a Transmission Constraint as non-competitive for the RTM.~~ In determining whether to designate a Transmission Constraint as non-competitive for the RTM, counter-flow supply to the Transmission Constraint that can be withheld also reflects the PMin of each Short Start Unit with a Start-Up Time of

sixty (60) minutes or less that was off-line in the immediately preceding fifteen (15) minute interval of the FMM. In determining whether to designate a Transmission Constraint as non-competitive for the RTM, counter-flow supply to the Transmission Constraint that can be withheld also reflects the PMin of each Short Start Unit with a Start-Up Time of fifteen (15) minutes or less that was off-line in the immediately preceding fifteen (15) minute interval.

- (iv) Portfolio means the effective available internal generation capacity under the control of the Scheduling Coordinator and/or Affiliate determined pursuant to Sections 4.5.1.1.12 and 39.7.2.2(a)(vii). Effectiveness in supplying counter-flow is determined by scaling generation capacity by the shift factor from that location to the Transmission Constraint being tested.
- (v) A portfolio of a net seller has the meaning set forth in Section 39.7.2.2(a)(vi).
- (vi) Fringe supply of counter-flow to the Transmission Constraint means all available capacity from internal resources not controlled by the identified potentially pivotal suppliers that provide counter-flow to the Transmission Constraint. Available capacity reflects the highest capacity of a resource's Energy Bid (not taking into account the Ramp Rate of the resource), measured from the Dispatch Operating Point for the resource in the immediately preceding fifteen (15) minute interval of the FMM or five (5) minute interval of the RTD, as applicable (taking into account the Ramp Rate of the resource), adjusted for Self-Provided Ancillary Services/Ancillary Service Awards, and derates, and Uncertainty Awards in determining whether to designate a Transmission Constraint as non-competitive for the RTM, ~~or adjusted for Ancillary Service Awards and derates in determining whether to designate a Transmission Constraint as non-competitive for the RTM.~~
- (vii) Demand for counter-flow to the Transmission Constraint means all internal dispatched Supply that provides counter-flow to the Transmission Constraint.

\* \* \* \* \*

#### **44.2.1 Optimization.**

##### **44.2.1.1 Generally.**

The CAISO will optimize the procurement of Uncertainty Awards in the Real-Time Market simultaneously with the procurement of Energy and Ancillary Services, as applicable. Uncertainty Awards do not overlap with Ancillary Services Awards or Available Balancing Capacity.

##### **44.2.1.2 Nodal Procurement of Uncertainty Awards**

The CAISO will optimize procurement of Uncertainty Awards such that, in the event modeled uncertainty arises fully for either the upward or downward directions, Energy that would be dispatched from resource capacity corresponding to the Uncertainty Awards would not result in flows exceeding Transmission Constraints and scheduling limits, including EIM transfer limits.

##### **44.2.1.3 Optimization for Balancing Authority Areas with Distinct Uncertainty Requirements**

For Balancing Authority Areas with a distinct Uncertainty Requirement per Section 44.2.4.1, the CAISO will optimize procurement of Uncertainty Awards assuming that the Balancing Authority Area would be limited to its final hourly Real-Time EIM Base Schedule or the CAISO equivalent in the event modeled uncertainty arises fully in the direction for which there is a distinct Uncertainty Requirement.

\* \* \* \* \*

#### **44.2.4 Determination of Uncertainty Requirement.**

##### **44.2.4.1 Requirement.**

For each Real-Time Market run, the CAISO determines a distinct upward Uncertainty Requirement for each Balancing Authority Area that fails either the: (a) capacity test specified in Section 29.34(l) because the incremental offers in the Energy Bid range above the EIM Base Schedule (or equivalent for the CAISO) are not sufficient; or (b) flexibility test specified in Section 29.34(m) because of insufficient upward Ramping capacity. For each Real-Time Market run, the CAISO determines an upward Uncertainty Requirement for the group of Balancing Authority Areas that passes both the capacity test and flexibility tests in the upward direction.

For each Real-Time Market run, the CAISO determines a distinct downward Uncertainty Requirement for each Balancing Authority Area that fails either the: (a) capacity test specified in Section 29.34(l) because the decremental offers in the Energy Bid range below the EIM Base Schedule (or equivalent for the CAISO) are not sufficient; or (b) flexibility test specified in Section 29.34(m) because of insufficient downward Ramping capacity. For each Real-Time Market run, the CAISO determines a downward Uncertainty Requirement for the group of Balancing Authority Areas that passes both the capacity test and flexibility tests in the downward direction.

~~The CAISO will determine the Uncertainty Requirement for each Real-Time Market run, by each BAA and for the EIM Area overall.~~

#### **44.2.4.2 Procurement Curve.**

- (a) **Generally.** Based on statistical analysis of the Uncertainty Requirement, the CAISO will calculate constraint relaxation parameters to ensure the total cost of the Uncertainty Awards will not exceed the cost of expected power balance violations in absence of the Uncertainty Award, by each Balancing Authority Area and for the EIM Area overall, as set forth in the Business Practice Manual.
- (b) **Procurement Curve Cap.** The CAISO will establish in the Business Practice Manual a limit on the procurement curve –
  - (1) at an amount less than the contingency relaxation penalty pricing parameter specified in the Business Practice Manual for market operations, in the case of an upward demand curve; and
  - (2) at an amount more than the regulation down relaxation penalty pricing parameter specified in the Business Practice Manual for market operations, in the case of a downward demand curve.

#### **44.2.4.3 Nodal Distribution of Requirements**

The CAISO will distribute the upward and downward Uncertainty Requirement to the Demand and Variable Energy Resources Locations within each Balancing Authority Area in the EIM Area based on allocation factors derived from historical and/or forecasted information that reflect the relative contributions of Demand and Variable Energy Resources to overall Uncertainty Requirement.

\* \* \* \* \*

## **Appendix A**

### **Definitions**

\* \* \* \* \*

#### **- Flexible Ramp Down Price**

The Shadow Price of the downward Uncertainty Requirement constraint, which is the cost sensitivity of relaxing the downward Uncertainty Requirement constraint (\$/MWh), by Location.

#### **- Flexible Ramp Up Price**

The Shadow Price of the upward Uncertainty Requirement constraint, which is the cost sensitivity of relaxing the upward Uncertainty Requirement constraint (\$/MWh), by Location.

\* \* \* \* \*

## **Appendix C**

### **Locational Marginal Price**

\* \* \* \* \*

#### **C. The System Marginal Energy Cost Component of LMP (Day-Ahead and Real-Time Market)**

The SMEC shall be the same for each location throughout the system. SMEC is the sensitivity of the power balance constraint at the optimal solution. The power balance constraint ensures that the physical law of conservation of Energy (the sum of Generation and imports equals the sum of Demand, including exports and Transmission Losses) is accounted for in the network solution. This system level power balance constraints is enforced over the CAISO Balancing Authority Area for the Day-Ahead Market and over the EIM Area in the Real-Time Market. For the designated reference location the CAISO will utilize a

distributed Load Reference Bus for which constituent PNodes are weighted using the Reference Bus distribution factors. The Load distributed Reference Bus distribution factors are based on the Load Distribution Factors at each PNode that represents cleared Load in the Integrated Forward Market or forecast Load for MPM, RUC and RTM. In the Integrated Forward Market, in the event that the market is not able to clear based on the use of a distributed load Reference Bus, the CAISO will use a distributed generation Reference Bus for which the constituent nodes and the weights are determined economically within the running of the Integrated Forward Market based on available economic bids. In the event that the CAISO employs a distributed generation Reference Bus, it will notify Market Participants of which Integrated Forward Market runs required the use of this backstop mechanism. A distributed Load Reference Bus will be used for RUC and RTM regardless of whether a distributed Generation Reference Bus were used in the corresponding Integrated Forward Market run. If the market-clearing problem is limited by the system-level power balance constraint, the market clearing process would create a Shadow Price for the power balance constraint only when the relaxation of the constraint would result in a reduction in the total cost to operate the system.

#### D. Marginal Congestion Component Calculations (Day-Ahead and Real-Time)

The CAISO calculates the Marginal Costs of Congestion at each bus as a component of the bus-level LMP. The Marginal Cost of Congestion (MCC<sub>i</sub>) component of the LMP at bus *i* is calculated in the Day-Ahead Market using the equation:

$$MCC_i = - \sum_{m=1}^M \sum_{j=1}^{J_m} c_{j,m} PTDF_{i,j} \mu_m - \sum_{k=1}^K \sum_{m=1}^M PTDF_{i,m}^k \mu_m^k - \sum_{g=1}^{K_g} \sum_{m=1}^M \left( PTDF_{i,m}^g + \delta_{O_g,i} \sum_{n=1}^N PTDF_{n,m}^g GLDF_{O_g,n} \right) \mu_m^g$$

where:

- *i* is a node index.
- *n* is a node index.
- *m* is the constraint or monitored element index.
- *k* is the preventive contingency case.
- *g* is the generation contingency case.

- $Og$  is the node index associated with the generator contingency case  $g$ .
- $j$  is the transmission component index of Transmission Constraint  $m$ . When Transmission Constraint  $m$  is a Nomogram, there can be more than one transmission component. When Transmission Constraint  $m$  is any other Transmission Constraint, there shall be only one transmission component.
- $N$  is the number of preventive contingencies.
- $K$  is the number of preventive transmission contingencies, both in the base case for meeting Demand and in the case of modeling the dispatch of Energy for the capacity corresponding to the Uncertainty Awards.
- $Kg$  is the number of preventive generation contingencies.
- $M$  is the number of monitored elements, both in the base case for meeting Demand and in the case of modeling the dispatch of Energy for the capacity corresponding to the Uncertainty Awards.
- $Jm$  is the number of transmission components for constraint  $m$ .

\* \* \* \* \*

**Attachment C – Final Proposal**

**Flexible Ramping Product**

**California Independent System Operator Corporation**

**August 15, 2022**





# **Flexible Ramping Product Refinements**

## **Final Proposal**

**August 31, 2020**

# Flexible Ramping Product Refinements

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## 1 Purpose

This paper addresses the flexible ramping product issues identified in the CAISO Energy Markets Price Performance Report<sup>1</sup> published on September 23, 2019. The flexible ramping product<sup>2</sup> was introduced into the real-time market to manage ramp capability to address uncertainty caused by load and variable energy resources that materializes between market runs. Prior to the flexible ramping product implementation, the CAISO observed that the multi-interval market optimization would solve forecasted net load by utilizing the precise amount of ramp needed across the market horizon. However, when system conditions changed in subsequent market runs, the market would lack sufficient ramping capability in the real-time dispatch. The flexible ramping product secures additional ramping capability that can be dispatched in subsequent market runs to cover uncertainty in forecasted net load (i.e., load forecast net of variable energy production). Resources providing this ramping capability are compensated at the marginal opportunity cost (which is related to the cost of energy) for both forecasted movement and uncertainty awards.

## 2 Changes from Draft Final Proposal

The table below outlines the issues identified in the CAISO Energy Markets Price Performance Report that need to be addressed and additional issues added to the scope of the initiative after the issue paper. The table also identifies whether the changes being considered require tariff changes or can be implemented through BPM changes.

Issue	BPM or Tariff Change	Targeted Implementation	Change from draft final proposal
Proxy demand response eligibility	Both	Fall 2021	None
Ramp management between FMM and RTD	BPM only	Fall 2020	None
Minimum FRP requirement	BPM only	Fall 2020	None
Deliverability enhancement	Both	Fall 2021	Removed provisions for not including deployment scenario congestion in virtual supply real-time market close out settlement.
FRP demand curve and scarcity pricing	None	Fall 2021	None
Scaling FRP requirement	BPM only	No later than Fall 2021	None

<sup>1</sup> The report is available at <http://www.caiso.com/Documents/FinalReport-PricePerformanceAnalysis.pdf>

<sup>2</sup> Information on the flexible ramping product design is available at <http://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=24AB06E3-B018-4DEC-8F43-28B8A0E90514>

### 3 Stakeholder Comments and Changes from the Draft Final Proposal

The CAISO appreciates the written stakeholder comments received in response to this initiative's draft final proposal and the subsequent stakeholder call. The CAISO posted responses<sup>3</sup> to stakeholder comments to the initiative webpage on July 8, 2020.

### 4 Proxy Demand Response Eligibility

The CAISO can award the flexible ramping product to multiple types of resources, including proxy demand resources (PDR). Recent trends show the market frequently awards flexible ramping product to PDRs because they have energy bids at or close to the bid cap of \$1,000/MWh. The market views the PDRs with high priced positive energy bids as economic to provide the upward flexible ramping product because their opportunity cost of providing the flexible ramping product is zero. The market does not view the PDR economic to be dispatched for energy in the binding market interval.

This issue is currently exacerbated because many PDRs cannot respond to the 5-minute dispatch. If PDRs are unable to respond to five-minute real-time dispatches, the procured flexible ramping product cannot be used as energy in a subsequent RTD run.

In the *Energy Storage and Distributed Energy Resources Phase 3A* initiative, additional bidding options were made available to PDRs. These included a 60-minute and 15-minute dispatchable bid option. Unlike the 5-minute dispatch which has a 2.5 minute notification to curtail load, these options provide 22.5 minutes and 52.5 minutes notification prior to the time load needs to be curtailed. Consistent with newly FERC-approved provisions in section 4.13.3 of the CAISO tariff, PDRs will be able to specify in the Master File how the PDR will bid and be dispatched in the real-time market: in (i) hourly blocks, (ii) fifteen minute intervals, or (iii) five minute intervals.

These provisions became effective as of November 13, 2019. Consistent with existing section 4.6.4, the Master File must be an accurate reflection of the design capabilities of the resources. Therefore, scheduling coordinators will be required to ensure their Master File designation appropriately reflects their PDR capabilities and if they do not have the ability to respond to five minute dispatch, the scheduling coordinator should designate their resource as hourly blocks or 15-minute dispatchable. Consistent with section 44.2.3.1, the 15-minute and 60-minute options will not be eligible to be awarded the flexible ramping products.

Although this was not an integral element of the ESDER policy as approved by the board, in developing implementation details for this initiative, expecting that PDRs would accurately reflect the resource's characteristics in the Master File, the CAISO decided to set the default Master File entry to "5-minute dispatchable" should the scheduling coordinator fail to make an election. The CAISO also included the

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<sup>3</sup> The document is available at <http://www.caiso.com/InitiativeDocuments/CommentsMatrix-FlexibleRampingProductRefinements-DraftFinalProposal.pdf>

default detail in the tariff. The CAISO proposes to modify the default setting to be 60-minute dispatchable.

After implementation of the bid options, very few PDR resources changed their bid option from 5-minute dispatchable even though the inability to respond to 5-minute dispatch instructions has not changed. The CAISO has reached out to scheduling coordinators of PDRs to ensure that they selected the correct dispatch setting consistent with their actual operational characteristics. The vast majority of PDRs have selected either the 15-minute or hourly dispatch option. As a result, the implementation date has been changed to Fall 2021 so that this tariff change can be submitted with the tariff changes needed to support nodal deliverability rather than in a separate filing.

## 5 Ramp Management between FMM and RTD

The CAISO procures the flexible ramping product in both the 15-minute market (FMM) and the 5-minute real-time dispatch (RTD). In the FMM, the flexible ramping product covers the uncertainty between the advisory FMM interval and the highest/lowest binding RTD interval for the same 15-minute time interval. This ensures that there is sufficient ramp capability committed in the real-time unit commitment process (RTUC) to cover uncertainty materializing in RTD. The flexible ramping product requirement does not cover uncertainty between FMM runs.

The FMM is part of the RTUC process. The RTUC runs every fifteen minutes to determine binding unit commitment decisions for fast and short start units within the RTUC horizon. The RTUC horizon is the next four to seven fifteen-minute intervals, depending on when during the hour the run occurs. The second interval of each RTUC run horizon is designated as the FMM and is the financially binding interval for energy prices and schedules used for settlements. The first interval in an RTUC run horizon, or the interval preceding FMM, is referred to as the buffer interval. The logic of the buffer interval was introduced in the market with the implementation of the FERC Order No. 764 in order to provide sufficient time for tagging purposes once fifteen-minute interties could economically participate in the real-time market. The buffer interval can be used to issue binding unit commitment of fast and short start units. The schedules and prices in the buffer interval are not financially binding. The remaining intervals in the horizon can also have binding unit commitments and advisory schedules and prices.

Currently, the flexible ramping product awards are not reserved in the buffer interval. As a result, the ramping capability procured in the prior RTUC run, when the time interval was financially binding (FMM), may be used to meet the ramping needs of the current market run. When system conditions change between FMM runs there may no longer be any ramping capability available for the RTD intervals within that timeframe, or the ramping capability may be lost. Ramping capability is lost when projected start-ups of units with flexible ramping product awards are not started in the next run when they are no longer needed because of additional ramping capability resulting from the release of the flexible ramping product from the buffer interval to the binding interval.

The CAISO proposes to maintain a portion, up to 100%, of the FRP awards in the buffer interval that were procured in the prior FMM. This will ensure that ramping capability will be preserved for RTD.

This can result in a resource not being scheduled in the FMM interval because its ramping capability was secured through a flexible ramping product award in the previous market run. For example, assume a resource with the following characteristics:  $P_{min} = 100$  MW,  $P_{max} = 200$  MW, and a ramp rate of 5 MW/Minute. In market run #1, the resource receives a binding commitment in FMM and is scheduled for energy at 100 MW and awarded flexible ramping up of 75 MW. In market run #2, if the flexible ramping product awards are not reserved in the buffer interval, the resource could receive an energy schedule of up to 175 MW in the FMM. However, if the flexible ramping product is reserved in the buffer interval for potential deployment in RTD, the resource could receive an energy schedule of up to 125 MW because the 75 MW flexible ramping up award is maintained.

## 6 Minimum Flexible Ramping Product Requirement for BAA

The net import/export capabilities (NIC/NEC) are used to reduce a balancing authority area's requirement. The basic idea is that flexible ramping awards can be supplied from other balancing authority areas through the import or export transfer capability. The CAISO has previously found<sup>4</sup> that requirement reductions counting on imports and exports were beyond levels that a balancing authority area could feasibly support. If the import capability is higher than the balancing authority area's flexible ramping product up requirement, then the balancing authority area's flexible ramping product requirement is effectively 0 MW. That is, none of the balancing authority area's upward flexible ramping product needs to be awarded to internal resources. Under typical conditions, all balancing authority areas generally have larger import or export limits than their flexible ramping up or flexible ramping down requirement. Within an interconnected system with multiple areas, a flexible ramping product can be counted towards other areas by wheeling through other balancing authority areas. However, only the transfer capability with adjacent balancing authority areas is considered when calculating the net import/export capability. This is true for all balancing authority areas in the EIM footprint.

Currently, the CAISO is the largest driver of the system-wide flexible ramping product requirement because it has the largest load and penetration of variable energy resources. The CAISO requirement for the flexible ramping product that must be procured from internal resources is effectively zero<sup>5</sup> given the large import and export capability of the CAISO. However, since the CAISO has such a large share of the requirement, a portion needs to be procured within the balancing authority area in order to be available for uncertainty that materializes in the CAISO balancing authority area.

The CAISO and other large EIM balancing authority areas have been seen to be driving a large share of the total EIM requirement. Therefore, the proposal is to set a minimum requirement for an EIM

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<sup>4</sup> This was discussed at the February 2, 2018 Market Surveillance Committee meeting. The presentation is available at <http://www.aiso.com/Documents/Presentation-FlexibleRampingProductPerformanceDiscussionFeb22018.pdf>

<sup>5</sup> See figure 73 from the Price Performance Report available at <http://www.aiso.com/Documents/FinalReport-PricePerformanceAnalysis.pdf>

balancing authority area that is a pivotal share (greater than 60%) of the entire system requirement in a given hour.

The CAISO will calculate the minimum requirement based on the existing flexible ramping product requirements. The existing requirement calculates the uncertainty for the individual balancing authority area along with the EIM footprint. The CAISO can estimate the requirement for the pivotal areas based on these uncertainty calculations, historical percentages, comparison of the area to the EIM footprint, and diversity benefit factors for the pivotal areas. Requirement data from the flexible ramping product procured in 2019 was used to determine the minimum requirement and when it should be enforced. In Table 1 the percentage of the balancing authority area requirement is shown in comparison to the EIM footprint requirement. This comparison is important because in applying the NIC/NEC credit to the individual area leads to the EIM footprint requirement being the only requirement for the flexible ramping product. The data summarized in Table 1 shows that in 2019 CAISO was the pivotal, with the next five largest areas' total percentage of the requirement still less than the CAISO percentage of the total EIM area requirement. It is important to note that both upward and downward flexible ramping product for the 4<sup>th</sup> largest area is around 67% to 68%, as noted in Table 2.

**Table 1: Average percentage of EIM footprint requirement**

Balancing Authority Area	2019-Flex Up	Rank-Flex Up	2019-Flex Down	Rank-Flex Down
CAISO	80.56%	1	83.54%	1
APS	15.24%	4	13.09%	6
BANC SMUD	1.93%	10	2.48%	10
PWRX	16.80%	3	16.36%	3
IPC	12.76%	5	14.27%	5
NVP	11.38%	7	10.91%	8
PACE	21.54%	2	22.69%	2
PACW	11.33%	8	9.18%	9
PGE	12.48%	6	14.31%	4
PSE	9.59%	9	11.43%	7

**Table 2**

Next largest areas	Total Flex Up	Total Flex Down
Top 3	53.59%	53.37%
Top 4	66.35%	67.64%
Top 5	78.83%	80.73%
Top 6	90.21%	92.16%

The CAISO's share of the EIM area's uncertainty requirement in 2019 was between 80% to 84%. Therefore those percentages can be set as the higher bound for the requirement. The lower bound can

be established by looking at the procurement CAISO had in comparison to the EIM area. Table 3 shows these percentages and the lower bound can be establish between 45% and 52% of the EIM area requirement.

**Table 3: Procurement of Area Requirement**

Balancing Authority Area	Flex Up	Flex Down
CAISO	45.67%	51.76%
APS	2.34%	2.09%
BANC SMUD	8.99%	5.13%
PWRX	20.46%	5.13%
IPC	4.27%	3.88%
NVP	1.24%	3.96%
PACE	7.10%	14.42%
PACW	4.61%	6.76%
PGE	4.52%	4.68%
PSE	5.68%	5.71%

Although this average procurement is not an established minimum because this is the average for the year and there are several data points where the procurement is well below 52%, this data shows that the minimum for the pivotal area should be greater than the current procurement.

The diversity benefit is an important factor to consider for the minimum requirement. The diversity benefit factor is the ratio of the EIM area uncertainty requirement to the sum of all the uncertainty requirements over all balancing authority areas in the EIM area. The average requirements and diversity benefits per hour for 2019 have been calculated in Table 4 and Table 5.

**Table 4: Flexible Ramping Up Requirement Amounts**

HE-Flex Up	Avg of CAISO REQ	Avg of EIM REQ	Avg of EIM TOT	Avg of DB Factor	Avg of MW CAISO DB	Avg of Min Req CAISO	Avg of Min Req Percent of CAISO REQ
1	531.98	769.46	1488.17	51.46%	280.16	294.76	55.21%
2	509.27	605.64	1297.21	45.78%	240.59	287.78	57.41%
3	479.58	601.10	1186.34	50.50%	246.54	267.08	55.56%
4	469.76	601.11	1151.45	51.62%	250.51	262.35	55.67%
5	503.38	690.56	1208.16	56.68%	290.91	296.39	58.31%
6	561.43	734.10	1344.99	53.41%	312.49	325.71	57.62%
7	748.01	931.33	1689.99	54.28%	418.93	435.50	57.66%
8	1295.05	1509.77	2355.19	63.84%	831.34	832.08	63.92%
9	1055.74	1340.93	3353.36	43.02%	504.94	697.83	66.68%
10	966.70	1073.12	2009.24	51.85%	526.26	563.05	57.69%



11	785.73	861.03	1797.80	47.63%	382.47	433.47	55.67%
12	760.76	835.88	1742.73	47.76%	368.11	423.19	55.66%
13	838.64	924.65	1848.60	49.06%	430.79	479.70	57.29%
14	964.74	1038.01	1938.98	51.67%	531.51	572.65	59.04%
15	1114.30	1219.24	2134.50	55.36%	649.59	683.00	60.52%
16	1071.11	1183.33	2141.65	54.18%	600.28	633.79	59.10%
17	979.74	1160.73	2059.01	55.71%	560.89	570.51	57.71%
18	991.28	1203.19	2102.63	56.61%	569.89	584.51	58.62%
19	732.39	936.16	1816.00	50.61%	383.55	412.17	56.40%
20	643.57	813.16	1656.54	48.20%	324.01	363.99	56.66%
21	469.28	691.24	1416.12	48.80%	231.79	264.19	56.46%
22	582.82	852.51	1580.79	52.15%	328.12	354.25	60.33%
23	664.36	961.99	1647.63	57.79%	393.48	398.54	58.86%
24	565.63	817.14	1470.94	54.82%	319.59	328.89	58.07%
<b>Grand Total</b>	<b>777.94</b>	<b>953.99</b>	<b>1855.84</b>	<b>51.69%</b>	<b>420.51</b>	<b>462.24</b>	<b>58.64%</b>

Table 5: Flexible Ramping Down Requirement Amounts

HE-Flex Down	Avg of CAISO REQ	Avg of EIM REQ	Avg of EIM TOT	Avg of DB Factor	Avg of CAISO DB	Avg of Min Req CAISO	Avg of Min Req Percent of CAISO REQ
1	484.19	573.08	1269.81	44.65%	225.90	275.74	58.08%
2	462.32	535.01	1191.67	44.70%	211.64	266.66	58.04%
3	447.90	495.22	1123.23	43.60%	202.57	266.80	60.58%
4	412.18	472.65	1057.56	43.71%	192.39	242.60	59.91%
5	443.18	586.37	1124.13	51.70%	235.67	253.70	56.84%
6	520.10	711.63	1280.36	52.98%	303.71	325.67	59.92%
7	526.17	694.07	1369.73	48.85%	275.84	321.50	61.33%
8	751.28	863.45	1748.35	48.16%	380.90	424.35	57.13%
9	971.03	1117.24	3156.15	38.80%	402.06	643.87	67.21%
10	1087.27	1245.23	2236.45	55.19%	610.06	620.24	56.64%
11	985.41	1135.39	2097.09	53.78%	537.73	548.39	55.14%
12	978.26	1096.81	2029.58	53.49%	537.31	560.00	56.65%
13	943.04	1096.64	2002.52	54.63%	518.79	526.05	55.61%
14	963.63	1121.13	2007.17	55.75%	541.61	543.98	56.06%
15	1075.91	1238.62	2212.33	55.94%	603.48	606.71	56.38%
16	1109.53	1320.89	2295.54	57.77%	643.42	649.98	58.49%
17	1208.23	1423.05	2408.23	59.04%	716.16	717.93	59.25%
18	1044.67	1265.72	2273.67	55.72%	587.16	603.85	57.47%
19	913.84	1071.38	1988.03	54.10%	494.10	518.33	56.97%
20	727.47	874.48	1726.42	50.43%	374.20	420.11	58.12%

21	770.86	965.13	1787.59	53.73%	417.03	428.22	55.42%
22	748.51	967.58	1744.26	55.29%	416.87	430.78	57.29%
23	610.00	841.92	1517.44	54.95%	348.81	360.94	58.23%
24	534.60	671.86	1388.38	47.58%	267.47	296.84	56.19%
<b>Grand Total</b>	<b>790.34</b>	<b>942.65</b>	<b>1868.41</b>	<b>50.73%</b>	<b>417.46</b>	<b>462.71</b>	<b>58.55%</b>

A flat 60 percent requirement is chosen to test whether a minimum requirement is to be enforced or stated differently, the balancing authority area is pivotal. This is based on the finding that the pivotal areas of Top 4 is around 68%, current procurement for CAISO is approximately 50%, and considering diversity benefit averages around 58%. The enforcement will be for situations where the uncertainty requirement or flexible ramping product requirement is greater than or equal to 60% of the EIM requirement on an hourly basis. Because this rule does have the possibility to apply to other EIM areas for specific hours, this will not be limited just to the CAISO.

An example is provided in Table 6. Assume that the sum of the individual balancing authority area requirements is 1000 MW. The EIM area system requirement is 450 MW. This results in a diversity benefit factor of 45%. A pivotal balancing authority area (BAA 1) is identified because its requirement with its share of the diversity benefit is 292.5 MW. This is greater than 60% of the 450 MW which means the balancing authority area is pivotal. The sum of the remaining balancing authority areas requirement is 157.5 MW. In order to ensure a portion of the remaining requirement is procured locally, a nominal portion of the non-pivotal balancing authority area may be allocated to support a minimum requirement in each of the non-pivotal balancing authority areas. The 10% is for illustrative purposes only. By only using a nominal portion the remaining requirement can ensure the flexible ramping awards are distributed and continue to allow the requirement met by the least cost resources in other balancing authority areas.

**Table 6: Example of minimum requirement being enforced**

	BAA1	BAA2	BAA3	Total	System
Independent FRU requirement	650	150	200	1000	
Diversity Benefit Factor					45%
EIM System Requirement	292.5	67.5	90	450	
Pivotal BAA Threshold %					60%
Pivotal BAA	Yes	No	No		
Minimum BAA Requirement	292.5	0	0	292.5	
Remaining EIM System Requirement				157.5	
Nominal % to be Held Local for Remaining					10%
Minimum BAA Requirement all BAAs	292.5	6.75	9		

With the implementation of nodal deliverability of the flexible ramping product, the need to enforce a minimum requirement in a balancing authority area will no longer be needed. In the event the implementation of nodal deliverability is delay the CAISO will maintain the minimum BAA requirement,

which is in effect a zonal requirement at the balancing authority area level and will consider if sub-BAAAs are warranted as well.

## 7 Nodal Procurement

Procurement of the flexible ramping product is based on opportunity costs, which arise from the trade-offs between the need for energy and the need for ramping capability. The current market does not consider locational constraints when procuring the flexible ramping product. This results in procuring flexible ramp awards that may not be fully deliverable.

The complication relates to congestion from internal constraints within a balancing authority area and from scheduling limits on transfers between balancing authority areas. The market enforces transmission constraints within each balancing authority area to economically manage congestion while resources are optimally dispatched to meet the demand forecast. As part of the congestion management process, resources move up if they help to mitigate the congestion, or down if they exacerbate congestion. Since flexible ramping product is not locational-based, this part of congestion management does not explicitly account for the flexible ramping product procurement. As a result, the market can procure upward flexible ramping capacity from resources that are dispatched down for congestion management, which in the next market run when uncertainty materializes cannot be deployed due to congestion. This interplay between congestion and flexible ramping product procurement can be further exacerbated because the market may find it optimal to allocate upward flexible ramping product capacity precisely to resources dispatched down for congestion management. A similar dynamic exists for downward flexible ramping capacity and resources dispatched higher for energy to provide counter flow to mitigate congestion. In its current implementation, the market has no mechanism to avoid this outcome.

Nodal procurement ensures that both energy and flexible ramping product awards are transmission feasible. This requires the introduction of deployment scenarios to ensure that energy plus upward flexible ramping product awards and energy less downward flexible ramping product awards are transmission feasible. This ensures that upward flexible ramping product awards are not given to resources located behind a transmission constraint and downward flexible ramping product awards are not given to resources providing counter flow to resolve a transmission constraint. The updated market formulation is included in Appendix B: Procurement and Deployment Scenarios Draft Technical Description.

The nodal approach addresses operational concerns that flexible ramping capacity may not be dispatchable and more accurately prices individual resource's flexible ramping capacity. The flexible ramping product awards will result in a locational value of flexible ramping product similar to energy. As more solar, wind and other zero marginal energy cost resources make up a larger portion of the generation fleet, the marginal cost of energy will be lowered. As a result, in the future the compensation of flexible generation will come more from flexible ramping product payments than energy payments.

The goal of the nodal approach is to not eliminate stranded ramping capability when system conditions change. The goal is to not knowingly strand capacity because the optimization awards resources with zero opportunity cost due to congestion. In response to stakeholder comments, the CAISO is proposing two changes to the deployment scenarios to improve deliverability and availability.

1. Distributing the uncertainty requirement to load and VER locations versus just load.
2. Distributing the demand curve surplus variable as a decision variable at load aggregation points versus balancing authority areas.

The CAISO proposes to distribute the requirement to both load and VER supply nodes based upon historically how uncertainty has materialized. Table 6 below shows the average P97.5 uncertainty for load, wind and solar individually by operating hour for 2019. Table 7 below shows the average P2.5 uncertainty for load, wind and solar individually by operating hour for 2019. As the data shows in the middle of the day, uncertainty in VER forecast is the predominant driver of uncertainty. Therefore, the deployment scenario will more accurately reflect the dispatch of the flexible ramping product by distributing a larger portion of the requirement to VER nodes.

**Table 7: P97.5 Uncertainty by Load, Wind and Solar**

Hour	Load	Wind	Solar	Load	Wind	Solar	Load	VER
1	188	272	1	41%	59%	0%	41%	59%
2	143	322	1	31%	69%	0%	31%	69%
3	97	302	1	24%	76%	0%	24%	76%
4	81	285	1	22%	78%	0%	22%	78%
5	140	293	1	32%	68%	0%	32%	68%
6	209	322	10	39%	59%	2%	39%	61%
7	239	278	214	33%	38%	29%	33%	67%
8	205	270	697	18%	23%	59%	18%	82%
9	253	277	678	21%	23%	56%	21%	79%
10	214	246	475	23%	26%	51%	23%	77%
11	228	232	480	24%	25%	51%	24%	76%
12	258	227	483	27%	23%	50%	27%	73%
13	228	201	501	25%	22%	54%	25%	75%
14	243	204	638	22%	19%	59%	22%	78%
15	277	215	635	25%	19%	56%	25%	75%
16	390	255	680	29%	19%	51%	29%	71%
17	384	262	572	32%	22%	47%	32%	68%
18	353	303	465	32%	27%	41%	32%	68%
19	311	303	269	35%	34%	30%	35%	65%
20	284	343	62	41%	50%	9%	41%	59%
21	190	320	5	37%	62%	1%	37%	63%
22	253	306	1	45%	55%	0%	45%	55%
23	276	325	1	46%	54%	0%	46%	54%
24	228	306	1	43%	57%	0%	43%	57%

Table 8: P92.5 Uncertainty by Load, Wind and Solar

Hour	Load	Wind	Solar	Load	Wind	Solar	Load	VER
1	-171	-255	-1	40%	60%	0%	40%	60%
2	-153	-248	-1	38%	62%	0%	38%	62%
3	-120	-240	-1	33%	67%	0%	33%	67%
4	-94	-237	-1	28%	72%	0%	28%	72%
5	-122	-213	-1	36%	63%	0%	36%	64%
6	-206	-212	-7	48%	50%	2%	48%	52%
7	-244	-201	-113	44%	36%	20%	44%	56%
8	-243	-202	-492	26%	22%	53%	26%	74%
9	-316	-228	-709	25%	18%	57%	25%	75%
10	-319	-256	-613	27%	22%	52%	27%	73%
11	-346	-276	-469	32%	25%	43%	32%	68%
12	-243	-283	-423	26%	30%	45%	26%	74%
13	-237	-232	-342	29%	29%	42%	29%	71%
14	-238	-321	-340	26%	36%	38%	26%	74%
15	-238	-286	-393	26%	31%	43%	26%	74%
16	-272	-332	-505	24%	30%	46%	24%	76%
17	-326	-364	-529	27%	30%	43%	27%	73%
18	-296	-287	-488	28%	27%	46%	28%	72%
19	-260	-264	-301	32%	32%	36%	32%	68%
20	-265	-260	-122	41%	40%	19%	41%	59%
21	-272	-257	-10	50%	48%	2%	50%	50%
22	-288	-248	-2	54%	46%	0%	54%	46%
23	-286	-250	-1	53%	47%	0%	53%	47%
24	-224	-254	-1	47%	53%	0%	47%	53%

The flexible ramping product requirement is relaxed by a demand price curve that reflects the expected cost of foregoing the procurement of the flexible ramping product, so that it is not procured when it is more expensive than the benefit it provides. In order to implement the demand curve, the market uses a flexible ramping product surplus variable to add “supply,” and procure less flexible ramping product, if the opportunity cost of providing the flexible ramping product exceeds a given segment of the demand price curve. In the previous straw proposal, there was a ramping product surplus variable for each BAA that fails the flexible ramping sufficiency test, and one for the group of balancing authority areas that pass it. In the revised straw proposal, the CAISO proposes a more granular flexible ramping product surplus variable for each major load aggregation point (LAP) in each balancing authority area. As a result, the ramping product surplus variables will be independent decision variables to relax the flexible ramping requirements separately for each major LAP as needed. This may limit the shortfall to an individual LAP while allowing the requirement in other LAPs to be fully met.

The inclusion of deployment scenarios and their structure in the day-ahead market is being considered as part of the day-ahead market enhancements initiative. Depending upon the final market design to implement imbalance reserves, the settlement rules for virtuals will be re-evaluated.

Additional detail on the market formulation for nodal deliverability of the flexible ramping product is included in Appendix B: Procurement and Deployment Scenarios Draft Technical Description<sup>6</sup>.

## 8 Flexible Ramping Product Demand Curve and Scarcity Pricing

Various stakeholders have recently commented as part of several other CAISO market design initiatives that the CAISO market should have improved scarcity pricing provisions. Scarcity pricing is typically intended to set market pricing at higher levels than submitted energy bids when there is not enough bid-in supply to meet demand. Stakeholders have suggested that the market should produce scarcity pricing that increases in steps, similar to other ISO/RTOs<sup>7</sup>, based on the amount that supply is short, before setting prices at \$1,000/MWh. The market currently sets prices at \$1,000/MWh when it relaxes its power balance constraint.<sup>8</sup> The flexible ramping product will produce this stepped scarcity pricing if the CAISO implements the nodal flexible ramping product procurement described in the preceding section. Appendix A provides an outline of how other ISO/RTOs employ demand curves to relax reserve constraints and produce stepped price signals during scarcity conditions.

The flexible ramping product design includes a procurement demand price curve that is calculated based on the probability of a power balance constraint occurring if the flexible ramping product was not procured. For example, assume there is a 10% chance of an upward power balance constraint violation, then the market optimization would not procure additional upward flexible ramping product if the cost exceeded \$100/MWh. This is because when the power balance constraint is relaxed prices are administratively set at the \$1000/MWh bid cap. If there is a 10% chance of a power balance constraint can be avoided, then the expected value of the upward flexible ramping product is \$100/MWh. The demand price curve applies to both the upward and downward flexible ramping product. The demand price curve is capped to ensure that the flexible ramping products are fully relaxed prior to deploying ancillary services.

The procurement demand curve was intended to provide improved scarcity pricing signals in the real-time market. If the upward flexible ramping product requirement was relaxed, the demand curve value would increase the energy price above last economic energy bid. Using the previous example, if the upward flexible ramping product requirement was relaxed at \$100/MWh and the last economic bid was \$200/MWh, then energy price would be \$300/MWh. If the downward flexible ramping product

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<sup>6</sup> Appendix B will be provided on the initiative webpage. This is available at

<http://www.aiso.com/StakeholderProcesses/Flexible-ramping-product-refinements>

<sup>7</sup> The CAISO's documented the scarcity pricing in Appendix A: Other ISO/RTO Demand Curve Summaries available on this initiative's webpage at <http://www.aiso.com/StakeholderProcesses/Flexible-ramping-product-refinements>.

<sup>8</sup> As part of its effort to comply with FERC Order No. 831, the CAISO this methodology.

<http://www.aiso.com/StakeholderProcesses/FERC-Order-831-Import-bidding-and-market-parameters>.

requirement was relaxed, the demand curve value would decrease the energy price below last economic energy bid. Only if the full flexible ramping product requirement was not procured would prices increase to the administrative rate.

However, the flexible ramping product is not providing the intended scarcity pricing signals because the flexible ramping product requirement is not always relaxed prior to the power balance constraint due to congestion. As discussed in the previous section, the market optimization can award the upward flexible ramping product to resources that are located behind a transmission constraint. No additional energy can be dispatched from this resource, so the resource cannot be used to meet power balance constraint. However, since it can be awarded the upward flexible ramping product at no opportunity cost, the upward flexible ramping product requirement is not relaxed based upon the demand curve because the market can make capacity awards to resources that cannot be awarded additional energy. Moving to nodal procurement of the flexible ramping product will ensure that the flexible ramping product requirement is fully relaxed prior to the power balance constraint being relaxed because the market will no longer make awards to transmission infeasible capacity.

## 9 Calculating Flexible Ramping Product Requirements

This section describes a high level overview of how the CAISO plans to evolve the current methodology for setting real-time flexible ramping product requirements to incorporate forecasts for load, wind, and solar into the formulation. The currently implemented approach uses a histogram method to set the flexible ramping product requirements. Historical data is used to calculate the net load forecast error between FMM and RTD for the determination of the fifteen-minute market requirements, and the net load forecast error between advisory and binding intervals for the RTD requirement. The net load forecast error data is then used to determine the upward and downward uncertainty requirements for each hour of the day that are posted the day prior.

For example, the upward requirement would be set using values measuring the difference between the hourly RTD net load maximum and the FMM net load forecast. As we have seen, the histogram approach yields uncertainty up and down requirements that vary seasonally and by time of the day. The histogram methodology also has the benefit of being relatively simple to calculate. However, the main drawback of this approach is it is only looking using historical data and not taking into consideration the variability that is forecasted to exist in a given point on time due to differing weather conditions.

Following the implementation of the flexible ramping product, the CAISO intended to enhance the current logic towards a methodology that takes into consideration the forecasted conditions that will be occurring on the system throughout the day. Consistent with this goal, the CAISO proposes to enhance the current approach by adopting a quantile regression method to adjust the current system up and down requirement similar to what it has proposed in the day-ahead market enhancements initiative to determine imbalance reserves.

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 requirement is based on relatively extreme high and low (i.e., 2.5 and 97.5 percentile) observations of net load imbalances, as opposed to the average net load imbalance. The regressors (independent variables) include forecasted load, solar, and wind values, as well as the operating hour and month.

Additional details outlining the proposed quantile regression methodology, as well as results observed simulating the new methodology in comparison to the current histogram approach can be found in Appendix C: Quantile Regression Approach to Enhance the Flexible Ramping Product Requirements. The formulation of the regression model used to set the flexible ramping product requirement will be described in the business practice manual.

## 10 Stakeholder Engagement and Next Steps

Stakeholder input is critical for developing market design policy. The schedule proposed below allows several opportunities for stakeholder's involvement and feedback.

### 10.1 Schedule

Table 9 lists the planned schedule for the *Flexible Ramping Product Refinements* stakeholder process.

**Table 9 : Proposed schedule for the Flexible Ramping Product Refinements stakeholder process**

Item	Date
Post draft tariff language	August 10, 2020
Stakeholder comments due	August 25, 2020
Post Final Proposal	August 31, 2020
Draft Tariff Language and Stakeholder Conference Call	September 2, 2020
BPM Language within a Proposed Revision Request – Buffer, Minimum, Requirement	Mid-September 2020
Complete Business Requirement Specifications for nodal deliverability	October, 2020
EIM Governing Body Briefing	September 16, 2020
ISO Board of Governors Decision	September 30 – October 1, 2020

### 10.2 EIM Governing Body Role

The rules that govern decisional classification were amended in March 2019 when the Board adopted changes to the Charter for EIM Governance and the Guidance Document. An initiative proposing to change rules of the real-time market now falls within the primary authority of the EIM Governing Body



either if the proposed new rule is EIM-specific in the sense that it applies uniquely or differently in the balancing authority areas of EIM Entities, as opposed to a generally applicable rule, or for proposed market rules that are generally applicable, if “an issue that is specific to the EIM balancing authority areas is the primary driver for the proposed change.”

This initiative does not satisfy the first test, because any proposed rules would be generally applicable to the entire CAISO market footprint, rather than EIM-specific. Moreover, primary driver for pursuing these objectives is not an issue that is specific to the EIM balancing authority areas. The improvements to FRP deliverability will seek to minimize instances where ramping capability is stranded behind all kinds of transmission constraints. While EIM transfer limits are one type of constraint, they are only one of several types. Moreover, the CAISO identified the need for this initiative based on a study of pricing in the CAISO’s balancing authority area. Accordingly, this initiative would fall entirely within the advisory role of the EIM Governing Body.

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

**Attachment D – Board Memorandum**

**Flexible Ramping Product**

**California Independent System Operator Corporation**

**August 15, 2022**



# Memorandum

**To:** ISO Board of Governors

**From:** Mark Rothleder, Vice President, Market Policy and Performance

**Date:** September 23, 2020

**Re:** **Decision on flexible ramping product refinements proposal**

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*This memorandum requires Board action.*

## EXECUTIVE SUMMARY

The ISO's Energy Markets Price Performance Report, published September 23, 2019, identified issues that limit the effectiveness of the flexible ramping product. The flexible ramping product is intended to address uncertainty caused by load and variable energy resources that materializes between market runs. The current design does not allow the market to consider locational constraints when procuring the flexible ramping product. This results in the market awarding the flexible ramping product to resources that may not be fully deliverable when and where uncertainty materializes.

Management proposes to implement nodal procurement of the flexible ramping product. The nodal procurement is accomplished through incorporating in the real-time market potential congestion scenarios that consider whether the resources awarded flexible ramping product can be deployed when needed for energy in the real-time market. The scenarios would ensure that upward flexible ramping product awards are not given to resources located behind a transmission constraint, and downward flexible ramping product awards are not given to resources providing counter flow to resolve a transmission constraint. This is accomplished by ensuring that (1) energy plus upward flexible ramping product awards and (2) energy less downward flexible ramping product awards are deliverable.

The proposed enhancements provide several benefits that will result in more efficient real-time commitment of resources. The enhancements will reduce the need for out-of-market actions to meet intra-hour ramping uncertainty. They will also improve the pricing of flexibility by no longer awarding product to undeliverable resources with no opportunity cost. Finally, enhancements that ensure the deliverability of products that address uncertainty is key to the success of both the day-ahead market enhancements and extended day-ahead market initiatives.

Management proposes the following motion:

***Moved, that the ISO Board of Governors approves flexible ramping product refinements proposal described in the memorandum dated September 23, 2020; and***

***Moved, that the ISO Board of Governors authorizes Management to make all necessary and appropriate filings with the Federal Energy Regulatory Commission to implement the proposal described in the memorandum, including any filings that implement the overarching initiative policy but contain discrete revisions to incorporate Commission guidance in any initial ruling on the proposed tariff amendment.***

## **DISCUSSION AND ANALYSIS**

The flexible ramping product was introduced in Fall 2016 to improve the pricing and management of ramping capability in the real-time market. The flexible ramping product addresses uncertainty caused by load and variable energy resources that materializes between real-time market runs. Prior to the flexible ramping product implementation, the multi-interval market optimization would solve forecast net load<sup>1</sup> utilizing the precise amount of ramping capability across the market horizon. However, when system conditions changed in subsequent market runs, the market would often lack sufficient ramping capability to meet the updated net load forecast. The flexible ramping product secures additional ramping capability that can be dispatched in subsequent market runs to cover uncertainty in forecast net load. Resources providing this ramping capability are compensated at the marginal opportunity cost for both changes in their energy schedules between the binding and advisory intervals and uncertainty awards.

The ISO's Energy Markets Price Performance Report, published September 23, 2019, identified issues that limit the effectiveness of the flexible ramping product. Procurement of the flexible ramping product is based on minimizing energy opportunity costs, which arise from the trade-offs between the need for energy and the need for ramping capability. The current market does not consider locational constraints when procuring the flexible ramping product. This results in the market awarding the flexible ramping product to resources that may not be fully deliverable.

The complication relates to congestion from internal constraints within a balancing authority area and from scheduling limits on transfers between balancing authority areas. The market enforces transmission constraints within each balancing authority area to economically manage congestion while resources are optimally dispatched for energy to meet the net load forecast. As part of the congestion management process, resources move up if they help to mitigate the congestion, or down if they exacerbate

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<sup>1</sup> Net load is gross load less wind and solar resource output.

congestion. Currently, congestion management does not explicitly account for the flexible ramping product procurement.

As a result, the market can procure upward flexible ramping capacity from resources that are dispatched down for congestion management, which in the next market run when uncertainty materializes cannot be deployed due to congestion. This interplay between congestion and flexible ramping product procurement can be further exacerbated because the market may find it optimal to allocate upward flexible ramping product capacity precisely to resources dispatched down for congestion management. A similar dynamic exists for downward flexible ramping capacity and resources dispatched higher for energy to provide counter flow to mitigate congestion. In its current implementation, the market has no mechanism to avoid this outcome.

### *Deliverability of flexible ramping products*

Management proposes to implement nodal procurement of the flexible ramping product. The nodal procurement approach addresses operational concerns that flexible ramping capacity may not be dispatchable and more accurately prices an individual resource's flexible ramping capacity. The flexible ramping product awards will result in a locational value of flexible ramping product similar to energy.

Nodal flexible ramping product procurement is accomplished through the introduction of deployment scenarios to ensure that (1) energy plus upward flexible ramping product awards and (2) energy less downward flexible ramping product awards are transmission feasible. This ensures that upward flexible ramping product awards are not given to resources located behind a transmission constraint, and downward flexible ramping product awards are not given to resources providing counter flow to resolve a transmission constraint.

The goal of the nodal procurement approach is to not eliminate stranded ramping capability when system conditions change. The goal is to not knowingly strand capacity because the optimization awards resources with zero energy opportunity cost due to congestion.

In response to stakeholder comments, Management is proposing two refinements to the deployment scenarios to improve deliverability and availability, as follows: (1) recognize that uncertainty can materialize at load and variable energy resource locations versus just load, and (2) distribute the demand curve surplus variable as a decision variable at load aggregation points versus balancing authority areas to minimize excess relaxation.

Management analyzed uncertainty for load, wind and solar individually by operating hour for 2019. The data shows that in the middle of the day uncertainty in the forecast of variable energy resources is the predominant driver of uncertainty. Therefore, the deployment scenario will more accurately reflect the dispatch of the flexible ramping product by distributing a larger portion of the deployment scenario to variable energy resource nodes.

The flexible ramping product requirement is relaxed by a demand price curve that reflects the expected cost of foregoing the procurement of the flexible ramping product. Therefore, it is not procured when it is more expensive than the benefit it provides. In order to implement the demand curve, the market uses a demand curve surplus variable to add “supply,” and procure less flexible ramping product. Ideally, the demand curve would be considered on a nodal basis, but this is not practical from an implementation standpoint. As a result, the demand curve surplus variables will be considered for each load aggregation point. This can limit the shortfall to an individual load aggregation point while allowing the requirement in other load aggregation points to be fully met.

### *Proxy demand response*

The flexible ramping product can only be awarded to resources that can respond to the 5-minute real-time dispatch. In the ISO’s Energy Markets Price Performance Report it was observed that proxy demand response resources that cannot respond to the 5-minute real-time dispatch have been awarded the flexible ramping product because of their low energy opportunity costs.

In the energy storage and distributed energy resources phase 3A initiative, additional bidding options were made available to proxy demand response resources. These included a 60-minute and 15-minute dispatchable bid option. Unlike the 5-minute dispatch which has a 2.5 minute notification to curtail load, these options provide 22.5 minutes and 52.5 minutes notification prior to the time load needs to be curtailed. These provisions became effective November 13, 2019. To ensure that the flexible ramping product is not awarded to proxy demand response resources that cannot respond to a 5-minute real-time dispatch, Management proposes to set the default setting for proxy demand response resources to be 60-minute dispatchable. Under this approach, proxy demand resources will have to take action to affirm their ability to respond to 5-minute dispatch instructions and thus be eligible for flexible ramping product awards.

## **POSITIONS OF THE PARTIES**

Stakeholders agree with the principles of nodal procurement but are concerned about its complexity and potential impact to the ISO’s market system performance. Management is confident that the proposed nodal design can be implemented in both the real-time market for the flexible ramping product and in the day-ahead market for the imbalance reserves and reliability capacity currently being developed in the day-ahead market enhancements initiative. Management believes it is important to focus resources on nodal deliverability of the flexible ramping product versus developing interim solutions. This will provide additional operational experience prior to implementing imbalance reserves and reliability capacity in the day-ahead market.

Prior to the development of the draft final proposal, PG&E questioned if distributing the uncertainty of the flexible ramping product to load only is appropriate given that uncertainty is driven by both load and variable energy resource variation. Also, PG&E

requested that the approach for distributing the demand curve surplus variable be reconsidered. Management modified the proposed design to address these concerns.

The Department of Market Monitoring reiterated their request to increase the uncertainty requirement to cover larger uncertainty that can occur over an hour or longer than the current approach which includes the 15-minute uncertainty in each of the advisory intervals in the real-time market. Since the current flexible ramping product is not fully deliverable, Management is unsure of the incremental benefit of adding an additional time horizon of uncertainty into the optimization at this time since the 15-minute requirement is already included in each advisory interval. However, Management is considering the potential need to model longer uncertainty horizons as part of the day-ahead market enhancements initiative.

## **CONCLUSION**

Management recommends the Board of Governors approve the proposed changes discussed above. The refinements will result in more efficient real-time unit commitment reducing the need for out-of-market actions to meet intra-hour ramping uncertainty, improve the pricing of flexibility by no longer awarding product to undeliverable resources with no opportunity cost, and deliverability of products that address uncertainty is key to the success of the day-ahead market enhancements and extended day-ahead market.

**Attachment E – Amendment Board Memorandum**  
**Flexible Ramping Product**  
**California Independent System Operator Corporation**  
**August 15, 2022**





# Memorandum

**To:** ISO Board of Governors and Western Energy Imbalance Market Governing Body  
**From:** Anna McKenna, Vice President of Market Policy & Performance  
**Date:** July 13, 2022  
**Re:** Decision on flexible ramping product refinements initiative

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***This memorandum requires ISO Board of Governors and WEIM Governing Body action.***

## EXECUTIVE SUMMARY

Management proposes a change to the approach developed in the *Flexible Ramping Product Refinements* initiative that the ISO Board of Governors (Board) approved in October 2020 with advisory input from the Western Energy Imbalance Market (WEIM) Governing Body. The ISO has not yet filed the tariff changes to implement the flexible ramping product refinements, but plans to do so in time to implement them in fall of 2022.

The flexible ramping product reserves resource capacity in the real-time market so sufficient ramping capability is available and appropriately compensated to address uncertainty in the load forecast. The most significant enhancement from the *Flexible Ramping Product Refinements* initiative was the real-time market's ability to model the flexible ramping product by node location in the ISO market's network model. Procuring flexible ramping product at the nodal level will help ensure that flexible ramping product awards are feasible to deliver and appropriately priced.

In preparing to implement the October 2020 ISO Board-approved *Flexible Ramping Product Refinements* policy, the ISO identified an aspect of the proposal that conflicts with more recent consensus among stakeholders, the ISO Board, and the WEIM Governing Body to leverage the WEIM to increase reliability and not limit transfers – to the extent possible – during stressed system conditions. Specifically, a technical implementation element of the refinements approved in October 2020 would have limited WEIM transfers to zero as a consequence of failing the resource sufficiency evaluation (RSE). At the time of approval, the proposal to limit transfers to zero was a change from the status quo of holding transfers constant at the level prior to the hour in which an entity fails the RSE. Significant additional

stakeholder dialogue in recent months has concluded that limiting WEIM transfers to zero in the event of an RSE failure would exacerbate reliability issues during stressed system conditions. As a result, Management is proposing a modification to this element of the original *Flexible Ramping Product Refinements* proposal, effectively proposing to retain the existing consequences for failing the RSE while we work to establish a framework of financial consequences for RSE failure. This modification will allow the ISO to implement the *Flexible Ramping Product Refinements* policy on schedule during the fall of 2022, without causing any adverse reliability impacts.

***Moved, that the ISO Board of Governors and WEIM Governing Body approve the change to the flexible ramping product refinements proposal as described in the memorandum dated July 13, 2022; and***

***Moved, that the ISO Board of Governors and the WEIM Governing Body authorize Management to make all necessary and appropriate filings with the Federal Energy Regulatory Commission to implement the change proposed in this memorandum, including any filings that implement the overarching initiative policy but contain discrete revisions to incorporate Commission guidance in any initial ruling on the proposed tariff amendment.***

## **DISCUSSION AND ANALYSIS**

The ISO originally implemented the flexible ramping product in the fall of 2016 to improve the real-time market's management and pricing of resource ramping capability. The ISO initiated the *Flexible Ramping Product Refinements* initiative, which developed the changes the Board ultimately approved in October 2020, after analyses showed that energy from a large portion of scheduled flexible ramping product capacity is actually not deliverable because of congested transmission. In addition to reducing the flexible ramping product's effectiveness in addressing load uncertainty, this situation tends to make flexible ramping prices artificially low and not reflective of the value of capacity that can provide flexible ramping capability.

The *Flexible Ramping Product Refinements* initiative developed changes to address these issues, the most important of which was to model the flexible ramping product by location of the nodes that are in the ISO market's network model. The real-time market currently does not consider transmission constraints within balancing authority areas when scheduling the flexible ramping product. This locational modeling consists of the real-time market considering transmission constraints and the energy flows that would occur when the real-time market dispatches energy from capacity scheduled to provide flexible ramping product. This ensures energy from the capacity scheduled to provide flexible ramping product can be delivered.

The technical specifications of the approach developed in the *Flexible Ramping Product Refinements* initiative also included provisions that the real-time market will isolate a

balancing authority area in a market interval in which it fails the WEIM resource sufficiency evaluation. This was proposed so that in such a case, the real-time market will only procure the balancing authority area's required amount of flexible ramping product from the balancing authority area's own resources. This would result in not allowing a balancing authority area to have economic WEIM energy transfers in a market interval in which it fails the resource sufficiency evaluation.

Since these provisions were developed, the ISO has had extensive discussion with stakeholders regarding the consequences of failing the resource sufficiency evaluation. The current resource sufficiency evaluation rules do not completely eliminate economic WEIM energy transfers when a balancing authority area fails the resource sufficiency evaluation. Rather, the resource sufficiency evaluation rules limit transfers to the amount scheduled in the market interval preceding the failure. Since the Board approved the *Flexible Ramping Product Refinements* proposal in 2020, there has been increasing consensus that completely limiting energy transfers when a balancing authority area fails the resource sufficiency evaluation would create unacceptable risks to reliability. In addition, the Board and WEIM Governing Body at their February 2022 joint meeting encouraged Management to develop a resource sufficiency evaluation approach that avoided limiting transfers.

## **POSITIONS OF THE PARTIES**

### *ISO Proposal*

Rather than disallowing economic WEIM transfers when a balancing authority area fails the resource sufficiency evaluation, Management proposes to maintain the current resource sufficiency evaluation rules that limit WEIM energy transfers, when a balancing authority area fails the resource sufficiency evaluation, to the amount scheduled in the market interval preceding the failure. This is appropriate because reducing transfers completely to zero in such a case could pose unacceptable reliability risks. For example, a balancing authority area may not have sufficient energy ramping capability to replace the energy it is receiving as transfers in only one interval.

However, even though a balancing authority area may still receive energy transfers when it fails the resource sufficiency evaluation, Management proposes to maintain the approach developed in the *Flexible Ramping Product Refinements* initiative, in which the real-time market will only procure flexible ramping product from a failing balancing authority area's own resources. The procurement target will be the amount calculated to meet the balancing authority area's individual uncertainty and forecasted ramping needs, and would be feasible to deliver. The target would not, however, include the benefit of pooling the uncertainty of all the balancing authority areas across the WEIM footprint. This is appropriate to prevent a balancing authority area with insufficient resources to meet its flexible ramping product needs from leaning on the capacity of other balancing authority areas.

## Stakeholder Positions

Stakeholders generally support Management's proposal to maintain the existing consequences for failing the WEIM resource sufficiency evaluation that limit WEIM energy transfers to the amount scheduled in the market interval immediately preceding the failure, rather than zeroing them out completely. They support maintaining the existing consequences until a new methodology can be developed and implemented as a result of the ongoing resource sufficiency evaluation initiative. Stakeholders are in near unanimous agreement that this approach is appropriate and that doing otherwise would unduly threaten reliability in a failing balancing authority area.

One stakeholder raised the concern that allowing a balancing authority area that fails the resource sufficiency evaluation to still receive energy transfers could unload capacity in the balancing authority area and create flexible ramping product capacity through leaning. This stakeholder urges the ISO to not implement the flexible ramping product refinements until the ISO implements an approach to allow a balancing authority area that fails the resource sufficiency evaluation to receive WEIM transfers at a penalty price. Management does not agree that the flexible ramping product refinements should be delayed. Management notes this same situation where energy transfers can unload resources and create flexible ramping product capacity exists today, so that should not be a reason to delay the flexible ramping product refinements.

Stakeholders also pointed out that the ISO should have better communicated the ramifications of the approach developed in the *Flexible Ramping Product Refinements* initiative on the resource sufficiency evaluation consequences. They are also concerned about the rapid timeline for developing the change proposed in this memorandum. However, they also recognize that the flexible ramping product refinements are important changes and do not want to further delay implementing them past fall 2022.

## **CONCLUSION**

Management requests the ISO Board of Governors and the WEIM Governing Body approve Management's change to the approach developed in the *Flexible Ramping Product Refinements* initiative described in this memorandum. This change is important to preserve the current functioning of the WEIM resource sufficiency evaluation while still allowing the ISO to implement the important refinements to the flexible ramping product in fall 2022.