California Independent
System Operator Corporation

October 6, 2014

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. ER15-____-000

Tariff Amendment to Set Flexible Ramping Constraint Parameter

Dear Secretary Bose:

The California Independent System Operator Corporation (CAISO) submits tariff revisions to set the flexible ramping constraint parameter and include the parameter value in its tariff.[1] The CAISO respectfully requests that the proposed tariff amendment including the new parameter value become effective January 15, 2015.

The CAISO proposes to adjust the parameter setting associated with the constraint it enforces in the real-time market for procuring flexible ramping capacity from the current level of $247 to $60. The CAISO enforces this parameter in its fifteen-minute market to determine when the fifteen-minute market process stops procuring ramping capacity, which the CAISO uses in the five-minute real-time dispatch process. Since implementing the financially binding fifteen-minute market, the CAISO clears binding fifteen-minute energy schedules and produces fifteen-minute financially binding locational marginal prices for energy. Although the parameter does not directly set the price the CAISO pays for the flexible ramping capacity, under the CAISO's recently implemented fifteen-minute market, it now may collaterally impact the price for energy in such market. These market changes necessitated that the CAISO take a closer look at whether the parameter is set at a level that ensures the CAISO

[1] The CAISO submits this filing pursuant to section 205 of the Federal Power Act, 16 U.S.C. § 824d. Capitalized terms not otherwise defined herein have the meanings set forth in the CAISO tariff, and references to specific sections are references to sections of the CAISO tariff as revised by this filing unless stated otherwise.

can procure needed flexible capacity without unnecessarily constraining the fifteen-minute market and increasing the price for energy in the fifteen-minute market.

The CAISO analyzed the performance of the constraint using actual 2013 market data and determined that at levels above $60 the constraint ceases to procure marginally beneficial flexible capacity. Therefore, by setting the parameter at $60, the CAISO can limit the amount of capacity that is procured, but that is not ultimately needed or used in the five-minute dispatch, and avoid unnecessarily constraining the fifteen-minute market. On the other hand, setting the parameter above $60 would potentially over-constrain the fifteen-minute market while not adding any beneficial capacity to the five-minute market. Because the parameter impacts the energy price in the fifteen-minute market, and in response to concerns by participants, the CAISO has agreed to include this parameter in the tariff even though the parameter had not previously been included in the tariff.

I. Background

A. Overview of CAISO Market Structure

The CAISO administers both day-ahead and real-time wholesale electricity markets. One of the primary objectives of these interrelated markets is to ensure that there is sufficient supply of electricity to satisfy demand in the CAISO balancing authority area while maintaining the reliability of the transmission system operated by the CAISO (*i.e.*, the CAISO controlled grid). These markets simultaneously optimize the procurement of energy and ancillary services and allocate the use of transmission capacity on the CAISO controlled grid based on locational marginal pricing at both internal nodes (*i.e.*, locations within the CAISO balancing authority area) and the interties (*i.e.*, locations for imports to and exports from the CAISO balancing authority area).

The day-ahead market includes a market power mitigation process that mitigates submitted bids when the potential to exercise market power exists. The integrated forward market – the next process in the day-ahead market – considers available supply and demand bids to identify the most efficient set of resources to address system needs. When the integrated forward market process does not meet forecasted load, the residual unit commitment process enables the CAISO to procure additional capacity to meet the forecast.

The real-time market is a spot market that uses security constrained unit commitment and security constrained economic dispatch to commit and dispatch resources to serve demand in the real-time.[2] As of May 1, 2014, the CAISO's

[2] Fewer resources generally are available to be committed in the real-time compared with the day-ahead.

real-time market includes a fifteen-minute market that produces financially binding 15-minute prices for energy and ancillary services for all internal transactions and for transactions of market participants that choose to schedule on the interties on a fifteen-minute basis. The economic dispatch process dispatches imbalance energy, or the energy that deviates from the schedule, and energy from ancillary services every five minutes for a single five-minute interval. To the extent that supply bid into the real-time market processes is insufficient, the CAISO redispatches resources and performs exceptional dispatch (*i.e.*, dispatch of resources outside of the normal market processes) in order to meet real-time demand.

When transmission capacity is scarce, the CAISO markets result in transmission congestion charges, which are incorporated into locational marginal prices. Market participants can acquire congestion revenue rights, which are financial instruments that allow market participants to manage exposure to congestion charges in the day-ahead market. In addition, market participants can engage in convergence bidding to hedge their physical market positions and manage their exposure to differences between day-ahead and real-time prices.[3]

Through its markets, the CAISO procures four types of ancillary services: regulation up and down and spinning and non-spinning operating reserves. The CAISO day-ahead and real-time markets co-optimize the procurement of energy and ancillary services.

B. The Flexible Ramping Constraint

On October 7, 2011, the CAISO filed a tariff amendment in Docket No. ER12-50 requesting authority to implement the flexible ramping constraint in the real-time market processes and provide appropriate compensation for resources that assist in resolving the constraint. The Commission accepted implementation of the constraint but also established a hearing and settlement judge procedures to consider the contested factual issues regarding compensation to those resources and the allocation of such costs.[4]

The CAISO implemented the flexible ramping constraint to address situations in which operating reserves and regulation service procured in the real-time market, combined with the units awarded energy in the fifteen-minute real-time unit commitment process, do not provide the CAISO sufficient ramping capability and flexibility to meet conditions in the five-minute real-time dispatch interval. This problematic lack of ramping capability was a function of differences

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[3] Market participants engage in convergence bidding by submitting financial bids called virtual bids.

[4] *Cal. Indep. Sys. Operator Corp.*, 137 FERC ¶ 61,191 (2011) (FRC Order).

in how the real-time unit commitment and real-time dispatch optimize resources. The real-time unit commitment optimized resources to meet a single imbalance energy forecast amount for the fifteen-minute interval by committing or de-committing resources sufficient to meet that forecast. The real-time unit commitment process assumes a perfect load forecast, generation resources acting in accordance with their dispatch, and constant conditions over the fifteen-minute interval. However, the conditions assumed in the forecast often do not materialize as forecasted. This can occur for a number of reasons, including but not limited to the following: five-minute interval granularity: resources shutting down without sufficient notice; variable energy resources delivering more or less than forecast, including sudden changes in expected deliveries; contingency events; high hydro run-off decreasing resource flexibility; interties tagging and delivering less than awarded in hour-ahead scheduling process; and interchange ramp in and out between hours.

Where there are changes between the real-time unit commitment forecast assumptions and actual conditions during real-time dispatch, the CAISO may not have sufficient ramping capability to meet its needs. This can occur because there are times when real-time unit commitment optimizes resources so efficiently based on the forecast that there is little or no additional on-line and available unscheduled capacity for five-minute dispatch to meet any variation from the forecast assumed in real-time unit commitment.

Combined with the uncertain magnitude of differences between expected conditions in real-time unit commitment and real-time dispatch, these limitations can result in adverse operational and market impacts. During conditions of real-time imbalance flexibility shortages, the CAISO will automatically begin leaning on regulation capacity and available operating reserves that have not been flagged for use only in case of a contingency. The CAISO's next available options are either to begin leaning on other balancing authority areas in the interconnection or dispatch and potentially deplete its operating reserves.

The CAISO enforces the flexible ramping constraint in the market optimization in all of the real-time pre-dispatch runs. At the time the CAISO adopted the constraint this included the hour-ahead scheduling process for the interties, the real-time unit commitment process, the short-term unit commitment process, and real-time economic dispatch run as part of the real-time dispatch process. Since May 1, 2014, the real-time market also includes a fifteen-minute market in which the CAISO clears all supply and demand including the interties.[5]

The flexible ramping constraint ensures that there is sufficient available upward-ramping capability in the hour-ahead scheduling process, short-term unit

[5] *Cal. Indep. Sys. Operator Corp.*, 146 FERC ¶ 61,204 (FMM Order), *order on compliance filing*, 148 FERC ¶ 61,023 (2014).

commitment process, real-time unit commitment, the fifteen-minute market, and real-time dispatch. The unloaded ramping capability resulting from this constraint in the pre-dispatch processes is provided by committed flexible resources not designated to provide regulation or contingency reserves (spinning and non-spinning reserves) and whose upward capacity is not committed to meet load forecast needs. This capacity is available for five-minute dispatch instructions from the real-time dispatch, and, if dispatched above minimum load, the capacity will be eligible to set real-time locational marginal prices subject to other eligibility provisions established in the CAISO tariff.[6] By providing the CAISO with greater dispatch flexibility, this constraint alleviates the above-described reliability and operational issues observed in the CAISO's operation of the grid.[7]

C. Settlement-Based Compensation

While the Commission accepted the CAISO's filing to implement the flexible ramping constraint as of December 13, 2011, it set certain aspects of the CAISO proposal for hearing and settlement judge procedures. Specifically, the Commission found that the CAISO's filed proposal in Docket No. ER12-50 raised "issues of material fact (including but not limited to the compensation and cost allocation methodologies) that cannot be discerned based on the information provided." The Commission noted that with respect to compensation, the difference between the flexible ramping constraint service and non-contingent spinning reserves is not clear, nor is the difference in the price paid for the two services.[8] The Commission also found that with respect to cost allocation methodology, the CAISO had not demonstrated that its proposed allocation reflects the Commission's cost causation principles.

The parties resolved all of the issues set for hearing pursuant to the hearing and settlement judge procedures established by the Commission. On July 27, 2012, the CAISO filed an uncontested offer of settlement. The Commission accepted the offer of settlement and approved the revised tariff sheets appended thereto.[9]

With respect to compensation paid to resources identified as having contributed to the relief of the flexible ramping constraint, the offer of settlement provided for the inclusion of new language in tariff section 11.25.1 to reflect that

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6 *See* CAISO tariff section 34.19.2.3.

7 Further information regarding the flexible ramping constraint is provided in the transmittal letter for the CAISO's October 7, 2011, tariff amendment in Docket No. ER12-50 to implement the flexible ramping constraint and provide related compensation.

8 FRC Order, 137 FERC ¶ 61,191, at P 28.

9 *Cal. Indep. Sys. Operator Corp.*, 140 FERC ¶ 61,012 (2012).

resources eligible to contribute to relieving the flexible ramping constraint would be compensated based on a price that would be derived as follows:

> Scheduling coordinators would be paid if their resources are identified as having resolved the Flexible Ramping Constraint, *i.e.*, if awarded Flexible Ramping Capacity, in the applicable real-time unit commitment (RTUC) interval, whether or not the Flexible Ramping Constraint is binding in that interval. Proposed Section 11.25.1 also provides that the payment will be limited by the quantity of Flexible Ramping Constraint requirements set by the CAISO operators. The scheduling coordinator will be paid the product of the upward MW of capacity identified to satisfy the constraint and the Flexible Ramping Constraint derived price for each applicable fifteen-minute RTUC interval. For each applicable fifteen-minute RTUC interval, the Flexible Ramping Constraint derived price will be equal to the lesser of:
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> 1) $800/MWh; or
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> 2) the greater of:
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> (a) 0;
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> (b) the Real-time Ancillary Services Marginal Price for Spinning Reserves for the applicable fifteen-minute RTUC interval; or
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> (c) the Flexible Ramping Constraint Shadow Price minus seventy five percent of the maximum of (i) zero (0); or (ii) the Real-Time System Marginal Energy Cost, calculated as the simple average of the three five-minute Dispatch Interval System Marginal Energy Costs in the applicable fifteen-minute RTUC interval.

The CAISO included this provision in tariff section 11.25.1, as part of a set of tariff changes to implement the offer of settlement as accepted by the Commission. The Commission accepted the tariff changes by letter order issued on November 29, 2012, in Docket No. ER12-50-001.

D. Fifteen-Minute Market and the Flexible Ramping Constraint

On November 26, 2013, the CAISO submitted a tariff amendment in Docket No. ER14-480 proposing significant modifications to its real-time market structure to more effectively and efficiently integrate a large amount of variable energy resources, align its market design with certain reforms mandated in the Commission's Order No. 764,[10] and address identified inefficiencies in the CAISO's real-time market that would also facilitate reinstatement of convergence bidding on the interties.

As part of that filing, the CAISO proposed tariff amendments to conform the enforcement and payment of the flexible ramping constraint to the new market design. Specifically, the CAISO made the following changes:

(1) The CAISO amended tariff sections 11.25.1 and 27.10 to reflect that the relevant fifteen-minute interval is the fifteen-minute market interval and not the real-time unit commitment interval, which was the case prior to the introduction of the fifteen-minute market.

(2) The CAISO amended tariff section 11.25.1 to specify the applicable system marginal cost of energy to be used for the applicable fifteen-minute market interval in order to calculate the real-time system energy cost used in the compensation formula.

(3) The CAISO amended tariff section 11.25.2 to align the calculation of uninstructed imbalance energy with the introduction of the fifteen-minute market. Specifically, the CAISO made amendments to language addressing how to calculate the rescission of payments for non-performance of capacity selected as part of the enforcement of flexible ramping constraints

In response to the CAISO's filing, certain parties submitted comments in which they cautioned that the Commission should direct the CAISO to explain the causes of price divergence among day-ahead, hour-ahead, fifteen-minute pre-dispatch, and five-minute real-time dispatch. These parties cited a 2013 report of the CAISO's Department of Market Monitoring, which indicated that the fifteen-minute real-time pre-dispatch prices exceeded day-ahead prices by about 19 percent, and five-minute real-time prices by about 26 percent. They also noted that the Department of Market Monitoring concluded that the CAISO's use of the flexible ramping constraint, which is enforced only in the real-time pre-dispatch market run, is a factor in the price divergence.

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[10] *Integration of Variable Energy Resources*, Order No. 764, FERC Stats. & Regs. ¶ 31,331 (Order No. 764), *order on reh'g and clarification*, Order No. 764-A, 141 ¶ 61,232 (Order No. 764-A) (2012), *order on clarification and reh'g*, Order No. 764-B, 144 FERC ¶ 61,222 (2013).

In its January 2, 2014, answer to these comments, the CAISO stated that it was already addressing issues related to price divergence under the current market design. The CAISO explained that, in order to address this issue, it was exploring ways to fine-tune the use of the flexible ramping constraint to enhance convergence between the fifteen-minute and five-minute prices. The CAISO also explained the relationship between the flexible ramping constraint and the divergence between fifteen-minute real-time unit commitment advisory prices and five-minute real-time dispatch prices. The CAISO stated that the flexible ramping constraint is uniquely enforced in the real-time unit comment process, and the real-time unit commitment is the only market process in which the market solution must (1) consider commitment of resources for energy and procurement of ancillary services, and (2) solve the flexible ramping constraint. The CAISO recognized that this can exert upward pressure on the fifteen-minute advisory prices produced in the real-time unit commitment process. The CAISO noted that the observed difference between the fifteen-minute advisory prices and the five-minute real-time dispatch prices was driven by the need to address all of these constraints and system needs, causing fifteen-minute real-time unit commitment advisory energy prices to be higher than day-ahead energy prices.[11]

The Commission conditionally approved the new market design, including all of the tariff changes listed above, in an order issued on March 20, 2014.[12] The Commission stated that it was "not convinced by commenters' assertions that the current price divergence between CAISO markets warrants delay or modification of the new market design."[13] Instead, the Commission found that "the proposed market design should enhance price convergence between the markets due to the use of shorter lead times, more granular forecasts, and the elimination of the dual market settlement structure between the HASP [hour-ahead scheduling process] and real-time market."[14] In addition, the Commission found that the CAISO adequately explained how the flexible ramping constraint contributed to price divergence, and noted the CAISO's commitment to "fine-tuning its use of the flexible ramping constraint, which should improve price convergence between the 15-minute and 5-minute prices."[15]

The CAISO implemented the fifteen-minute market on May 1, 2014.

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[11] *See* CAISO answer to comments, protests, and request for clarification, Docket No. ER14-480-000, at 14-20 (Jan. 2, 2014).

[12] FMM Order, 146 FERC ¶ 61,204.

[13] *Id.* at P 55.

[14] *Id.*

[15] *Id.*

E. Stakeholder Process, Stakeholder Comments, and Board Approval

The CAISO initiated the stakeholder process for this tariff amendment filing in April 2014 as part of its ongoing stakeholder initiative regarding the flexible ramping product.[16] Specifically, the CAISO issued a technical bulletin regarding the proposed reduction of the flexible ramping constraint parameter on April 14,[17] and held a conference call with stakeholders on April 21 to discuss the technical bulletin. The CAISO then posted draft tariff revisions on May 9, requested written stakeholder comments on May 19, and held a stakeholder conference call to discuss the tariff revisions on May 21.

On the conference call, a stakeholder raised concerns that this tariff amendment may violate the settlement accepted in Docket No. ER12-50. In response, the CAISO explained that the flexible ramping constraint relaxation parameter is not addressed anywhere in the settlement or the tariff revisions to implement it.

Further, section 6.4 of the offer of settlement states that "[n]othing in this Offer of Settlement is intended to prejudge or limit the [CA]ISO's authority to make a filing with the Commission pursuant to Section 205 of the Federal Power Act ('FPA') . . . regarding any separate flexible ramping product or other measures that may be necessary, and to propose revisions for such new products or measures, which may be the same as or different from the Revised Tariff Provisions" contained in the offer of settlement. Thus, even if the flexible ramping constraint relaxation parameter is considered to be a "new product or measure," the offer of settlement permits the CAISO to file this tariff amendment.

Also, on the May 21 conference call, some generator owners expressed concern about the adverse impact that lowering the relaxation parameter would have on compensation to resources dispatched to resolve a flexible ramping constraint. In response, the CAISO stated that its analysis indicated that lowering the relaxation parameter would, in the aggregate, reduce compensation for such resources. However, the CAISO also explained that it is not appropriate to maintain the current, higher level of the relaxation parameter, which drives

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[16] Materials regarding the stakeholder initiative on the flexible ramping product are available on the CAISO website at http://www.caiso.com/informed/Pages/StakeholderProcesses/FlexibleRampingProduct.aspx.

[17] Technical Bulletin: Flexible Ramping Constraint Penalty Price in the Fifteen Minute Market (Apr. 14, 2014) (Technical Bulletin). The Technical Bulletin is available on the CAISO website at http://www.caiso.com/Documents/TechnicalBulletin-FlexibleRampingConstraintPenaltyPrice-FifteenMinuteMarket.pdf and is provided in Attachment C to this filing.

inefficient higher prices in the fifteen-minute market.[18]

At its May 28-29, 2014, meeting, the CAISO Governing Board (Board) approved the reduction of the flexible ramping constraint parameter proposed in this filing.[19]

II. Description of the CAISO's Proposal

As noted in the FMM Order, the CAISO committed to fine-tune its use of the flexible ramping constraint. Pursuant to that commitment, the CAISO has evaluated its use of the flexible ramping constraint and determined that under its new market design it is appropriate to (1) lower the flexible ramping constraint parameter from the $247 to $60, and (2) now include the parameter in the CAISO tariff.

A. Role of the Flexible Ramping Constraint Parameter in the CAISO Markets

By enforcing the flexible ramping constraint in the fifteen-minute real-time unit commitment process, the CAISO ensures that sufficient ramping capability is available for it to use in clearing the five-minute real-time dispatch market. The CAISO enforces the flexible ramping constraint in the real-time market as part of the real-time unit commitment process, which is where the CAISO procures flexible capacity.[20] The real-time unit commitment process runs in fifteen-minute intervals prior to the five-minute dispatch. The need to commit additional resources or redispatch more economic resources decreases the pool of resources available for economic dispatch in the fifteen-minute interval. Consequently, enforcing the flexible ramping constraint increases the market clearing prices for energy in the interval in which it is enforced.

The flexible ramping constraint relaxation parameter defines the marginal cost above which the real-time market optimization will forego procuring additional flexible ramping capacity. This parameter is currently set to $247, which is slightly less than the constraint relaxation parameter for ancillary

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[18] The inefficient higher prices resulting from the current level of the relaxation parameter are discussed in section II.B of this transmittal letter.

[19] Materials related to the Board's May 28-29 meeting are available on the CAISO website at http://www.caiso.com/informed/Pages/BoardCommittees/BoardGovernorsMeetings.aspx. These materials include a Board memorandum issued on May 21, 2014 (Board Memorandum), which is provided in Attachment D to this filing.

[20] The flexible ramping constraint is enforced in all of the pre-dispatch processes, which include the short-term unit commitment, the real-time unit commitment, and the fifteen-minute market.

services. This relationship between relaxation parameters ensures that the CAISO will forgo procuring additional ramping capability in the current interval before the CAISO is compelled to fail to meet its contingency reserve requirements and energy forecast. It would be imprudent for the CAISO to procure ramping capability to meet future variability and uncertainty at the expense of the more important goal of supporting reliability by meeting the contingency reserve obligation in the current interval. Thus, the relaxation parameter is the cost at which the marginal benefit of procuring additional ramping capability is greater than the potential benefit of meeting potential uncertainty and variability in the future.

Prior to implementation of the fifteen-minute market on May 1, 2014, the real-time unit commitment process served primarily to commit or de-commit generation and schedule and price ancillary services. The fifteen-minute market did not issue financially binding schedules. Therefore, prices and energy schedules calculated through the real-time unit commitment were only advisory and had no financial impact. In contrast, since implementation of the fifteen-minute market on May 1, the CAISO now issues financially binding schedules to resources in the fifteen-minute market and settles such generation schedules using prices determined within the real-time unit commitment interval designated as the fifteen-minute market. The CAISO settles imbalance energy incurred due to differences between a scheduling coordinator's day-ahead schedule and the fifteen-minute market schedule at the fifteen-minute market locational marginal price, and settles differences between fifteen-minute schedules and the five-minute real-time dispatches based on the five-minute real-time locational marginal price.[21] The real-time unit commitment process also produces ancillary services marginal prices, which are used for the settlement of ancillary services in the real-time.[22]

There are two ways the market optimization software can satisfy the flexible ramping constraint if it is not met: (1) it may commit more units: or (2) it may redispatch resources out of merit order to hold back more economic and faster resources from their economic dispatch level in order to free up ramping capability. In any given interval, the optimization uses one, or both, of these methods to meet the constraint. The commitment of additional units provides additional flexible ramping capability to the five-minute dispatch because the unit commitments are operationally binding and, therefore, are available for five-minute real-time dispatch. Thus, even if commitment of additional resources in the fifteen-minute market increases locational marginal prices in the interval, the availability of such resources for real-time dispatch justifies the increase in the locational marginal prices for intervals in which it is enforced. In contrast, the

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[21] CAISO tariff sections 11.5.1.1, 11.5.1.2.

[22] CAISO tariff section 34.4.

out-of-merit-order dispatches are not operationally binding and may be partially undone in the five-minute dispatch. In part, the CAISO market may undo these out-of-merit-order dispatches because the constraint is not enforced in the financially binding interval of the five-minute dispatch. Under these circumstances, it is possible for the CAISO to hold a resource back only to unwind that commitment in the five-minute dispatch. Consequently, while out-of-merit-order dispatches may increase the fifteen-minute market energy price, they do not necessarily provide effective, increased flexible ramping capability to the five-minute dispatch. This calls into question the basis for the increase in the fifteen-minute price that resulted from enforcing the constraint.

As an example of how the parameter functions, assume the CAISO's requirement for flexible ramping is 300 MW. If the cost to resolve the constraint is less than the relaxation parameter, the market maintains the requirement. If the cost to resolve the constraint is greater than the relaxation parameter, the market reduces the megawatt (MW) quantity until the cost reaches the relaxation level. So, if the relaxation parameter cost was $247 and the initial cost to resolve the constraint was $400, the market optimization would reduce the requirement by the megawatt quantity necessary to not violate the relaxation parameter. For example, if this megawatt quantity was 50 megawatts, then the CAISO would procure/award 250 megawatts of flexible ramping capacity at a price of $247. Lowering the relaxation price to $60 will naturally reduce the megawatt quantity necessary to not violate the relaxation parameter. However, as discussed below, the updated relaxation parameter reflects the price at which the CAISO receives a marginal benefit in the real-time dispatch from reserving ramping capability in the fifteen-minute market.

B. Need to Lower the Flexible Ramping Constraint Parameter

The CAISO's analysis of market data supports the need to lower the flexible ramping constraint parameter. Figures 1 and 2 below plot the hourly average system-wide energy prices produced in the real-time unit commitment and the five-minute real-time dispatch, against the flexible ramping constraint shadow price.[23] Figure 1 includes all real-time intervals, while Figure 2 only includes intervals when enforcing the flexible ramping constraint produced positive shadow prices. The two figures depict prices over the period from September 2012 to August 2013.

Figures 1 and 2 show that over the period September 2012 to August 2013, enforcing the flexible ramping constraint (listed as FRC in the figures) in the fifteen-minute real-time unit commitment process (listed as RTUC) drove locational marginal prices for energy (listed as LMP EN) higher than they

[23] The shadow price is defined in appendix A to the CAISO tariff as the marginal value of relieving a particular constraint.

otherwise would have been in those intervals and higher than prices cleared in the five-minute dispatch (listed as RTD). Based on its analysis of the performance of the parameter during those intervals, the CAISO determined that the out-of-merit-order dispatch driven by the constraint did not provide additional useful capacity for the five-minute dispatch. The capacity retained was not useful because, as discussed above, rather than committing more units, the market was redispatching resources out of merit order to hold back more economic and faster resources from their economic dispatch level to free up flexible capacity, but is not operationally binding and may be undone in the five-minute dispatch. The redispatch was driven by the amount of additional capacity influenced by the current $247 parameter setting. During the historical time period used for this analysis, the fifteen-minute prices were not binding. This was not an issue because even though the constraint put upward pressure on advisory price, there was no financial consequence of this action. But under the new fifteen-minute market design, this outcome is not warranted because the flexible ramping constraint constrains the fifteen-minute market and puts upward pressure on prices, but provides no extra assured benefits to the five-minute dispatch. Lowering the parameter to $60 should moderate this outcome. A parameter of $60 reflects the marginal cost of additional flexible ramping capacity that effectively addresses ramping constraints in the five-minute market.

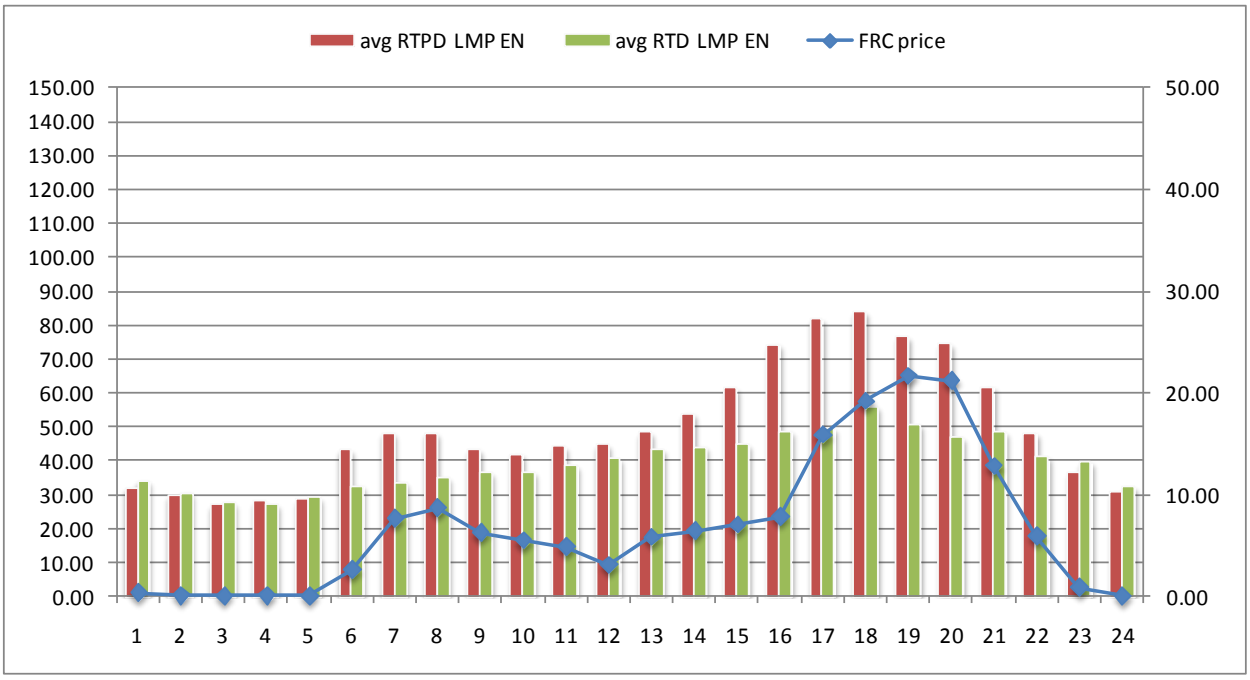

Figure 1: RTUC price vs. RTD price and FRC price

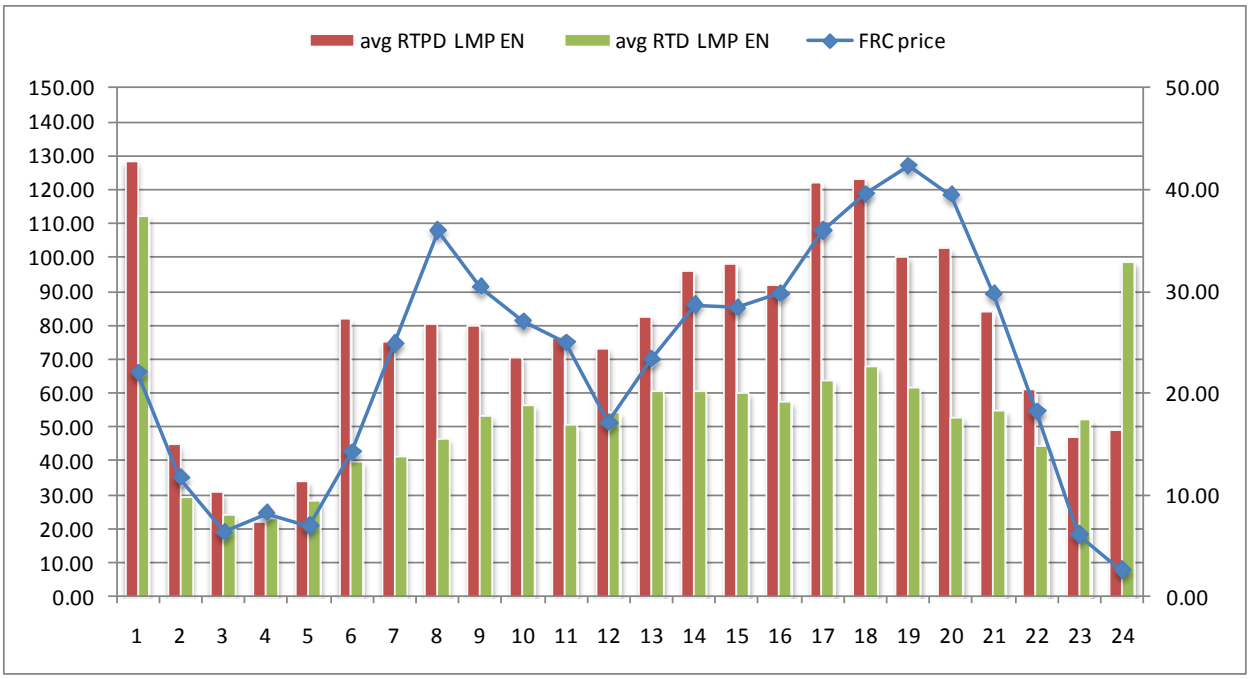

Figure 2: RTUC price vs. RTD price and FRC price when FRC is binding

As shown in Figure 1 and Figure 2, the real-time unit commitment and the real-time dispatch price divergence move in the same direction with the flexible ramping constraint shadow price, and are about the same magnitude. As the marginal cost of meeting the constraint increases, so does the fifteen-minute price. This suggests that the flexible ramping constraint is a significant driver for the real-time unit commitment and real-time dispatch price divergence.

This also suggests that pre-dispatch in the real-time unit commitment process is not only costly, it does not provide the benefits the flexible ramping constraint is expected to provide in the real-time dispatch. Prior to implementing the financially binding fifteen-minute market, the CAISO was less concerned with this dynamic because there was no financial impact to the market as the result of the fifteen-minute prices. However, with the new market design, the CAISO now uses marginal prices cleared in the fifteen-minute market to settle imbalance energy. As a result, the CAISO is more concerned with the relationship between the constraint and fifteen-minute market locational marginal prices and believes there is a need to balance these two elements.

The CAISO analyzed the performance of flexible ramping constraint to evaluate whether it needed to be calibrated to ensure that the CAISO continues to commit additional units to meet ramping needs in the five-minute dispatch, while minimizing out-of-merit-order dispatch and the undesirable effects such action has on the fifteen-minute market energy prices.

C. Fine-tuning the Flexible Ramping Constraint to $60 Provides the Appropriate Amount of Flexible Capacity Needed for the Real-Time Dispatch

The CAISO analyzed the flexible ramping constraint's performance in the real-time market in 2013 to determine what aspects of the constraint required adjustments in the context of the new fifteen-minute market. Specifically, the CAISO evaluated the correlation between the flexible ramping shadow price and violations of the power balance constraint, which is a constraint enforced in the CAISO real-time market to balance supply and constraint as discussed further below. The CAISO made this evaluation to determine how the power balance constraint impacts prices and schedules in the fifteen-minute real-time unit commitment process. The real-time unit commitment process is the fifteen-minute process on which the fifteen-minute market is built. Prior to the implementation of the fifteen-minute market, the real-time unit commitment process produced energy schedules and prices that were not financially binding, but such schedules and prices were nevertheless useful for this study because they were indicative of the need to relax the power balance constraint.

The power balance constraint is one of a number of requirements enforced in the market at all times to ensure that electricity generation and demand are balanced. In the real-time, the CAISO clears the markets based on bid-in supply and the CAISO's forecast of demand. Scheduling coordinators can submit bids for supply with an economic price or without a price, in which case the bids are price-taker bids (*i.e.*, supply self-schedules). When there is an insufficiency of economic bids to meet the demand in the real-time market clearing process, the market optimization is unable to generate a feasible dispatch. In such cases, there is a need to relax the constraint to let the market clear. When the constraint is relaxed, the locational marginal price will be based on the parameter (dollars per megawatt-hour ($/MWh)) set for the power balance constraint. This reflects the price of the lack of economic bids to clear the market and the need to resort to using regulation to meet the difference between the insufficient five-minute dispatch and actual system conditions.

In the pricing run, the CAISO sets the power balance constraint parameter to the maximum and minimum bid prices that scheduling coordinators may submit to the CAISO markets. The maximum bid price is $1,000/MWh. The minimum bid price prior to May 1 was negative $30/MWh; since May 1, 2014, it has been negative $150/MWh.[24] When in the market clearing process the CAISO must rely on regulation up capacity to meet forecasted demand, there is a "shortage" of economic bids, and the constraint is relaxed at the price of $1,000/MWh. Similarly, when in the market clearing process the CAISO must rely on regulation down to balance supply and demand, there is an "excess" of

[24] *Cal. Indep. Sys. Operator Corp.*, 145 FERC ¶ 61,254, at P 34 (2013).

supply that requires the constraint to be relaxed. Prior to May 1, the constraint was relaxed at the price of negative $30/MWh; now it is relaxed at the price of negative $150/MWh

The relationship between the flexible ramping constraint and the power balance constraint is an important one because it reflects the tradeoff of using the flexible ramping constraint to hold back capacity in order to avoid violations of the power balance constraint. If sufficient capacity is available to meet the demand forecast, the CAISO can avoid using regulation to meet demand. This has reliability benefits because the CAISO is less likely to have to rely on its regulation service to serve its forecasted load.

Based on actual market data for 2013, the CAISO evaluated the number of times the CAISO would have relaxed the power balance constraint in four ranges of the flexible ramping constraint parameter: (1) less than $20; (2) $20 to $60; (3) $60 to $240; and (4) $240 to $250. The CAISO selected these price ranges because they reflect a significant number of observations (at least 300) in each of the price ranges. The CAISO calculated the frequency with which the power balance constraint was violated in the positive direction, *i.e.*, insufficient generation, and the average amount of the violation per price range.

The results of this analysis are provided in Table 1 below.

Table 1: FRC shadow price and power balance violation in 2013

FRC shadow price range	Average power balance violation (MW)	Number of instances
<20	3.87	3141
[20, 60)	3.27	691
[60, 240)	8.20	364
[240, 250]	9.90	473

When the flexible ramping constraint was set to less than $20, the power balance constraint was relaxed in the positive direction by an average of 3.87 MW. This indicates that while the CAISO held back ramping capability in the fifteen-minute market, it was insufficient to meet the realized load forecast in the five-minute dispatch. When the flexible ramping constraint was between $20 and $60, the power balance constraint was relaxed in the positive direction by an average of 3.27 MW. Thus, setting the constraint in this range reduced the average amount of insufficient energy. This recognizes that the flexible ramping constraint is providing additional benefits relative to the higher clearing price of the flexible ramping constraint.

However, at the higher price ranges, the data reveals a contrasting pattern in the power balance constraint violations. While the flexible ramping constraint

price increases, the amount of positive power balance constraint violations starts to increase rather than decrease. For example, when the parameter price is set between $60 and $240, the average amount of positive power balance violations is 8.2 MW; and when it is between $240 and $250, the average amount of positive power balance violations increases to 9.9 MW. Thus, even though the CAISO paid a higher price for the flexible ramping capability, such capacity did not provide a benefit because the average power balance violation MW quantity actually increased. It logically follows that if procuring additional flexible ramping capability does not reduce the average amount of power balance violations, it is not efficient to procure additional flexible ramping capability (that will not be effective in reducing power balance violations).

This analysis demonstrates that the flexible ramping constraint continues to be effective when the parameter is set below $60 because in this price range the market still commits resources to resolve the constraint, which will help the real-time dispatch to mitigate power balance violations. When the parameter is above $60, the flexible ramping constraint is less effective in procuring needed flexible capacity because when the constraint's shadow price is high, the constraint relies on more out-of-merit-order redispatches rather than actual unit commitments.

The CAISO validated the relationship between the parameter and the flexible ramping constraint's ability to commit needed flexible resources by examining the constraint's shadow price in market intervals where the constraint drove generating resource start-ups. The CAISO considers the constraint to drive a resource's start-up if in a given interval the resource is on-line providing flexible ramping capacity when in the prior interval it was offline. This means the resource was started to provide flexible ramping capacity.

The CAISO's analysis of the 2013 market data shows that in those market intervals in which the flexible ramping constraint drove resource start-ups, the constraint's shadow prices were always below $60. In cases where the shadow price was above $60, the out-of-merit-order redispatches inflated the real-time unit commitment shadow price without being helpful in providing more ramping capacity to the real-time dispatch. This leads to the conclusion that when the parameter is above $60, even though it may cause the CAISO to procure more flexible ramping capacity, such capacity is in the form of out-of-merit-order redispatches, which do not provide the CAISO real-time dispatch market with usable ramping capacity.

Based on the analysis, the CAISO proposes to reduce the flexible ramping constraint parameter from its current $247 setting to $60. This will result in the constraint being relaxed only in cases that the cost of redispatch exceeds the $60 parameter. In any given market interval, when the constraint is relaxed, the shadow price of the constraint will be set at the $60 parameter setting. This will

reduce the out-of-merit-order dispatches driven by constraint, but still maintain the beneficial unit commitments necessary to meet the CAISO's flexible ramping needs.

The $60 parameter setting does not set the energy price in any given market interval. However, the parameter impacts the degree to which the energy procurement in the interval in which it is enforced may be constrained, which in turn would limit the quantity of resources available for energy dispatch. For example, at the $247 setting, the constraint is not likely to be relaxed until the cost of redispatch exceeds $247. This causes the interval to be more constrained for purposes of energy procurement and will result in higher locational marginal prices in the given real-time unit commitment interval. Prior to May 1, 2014, the fifteen-minute prices were not financially binding and only served as advisory results of market conditions in upcoming market intervals. With the adoption of the financially binding fifteen-minute market, the locational marginal prices impact the market directly. Given the lack of marginal benefits provided by the flexible ramping constraint when the parameter is set above $60, it is not justifiable to continue to maintain the $247 parameter. The CAISO will include the $60 parameter in the tariff given its impact on prices.

III. Effective Date

The CAISO respectfully requests that the Commission accept the proposed tariff effective January 15, 2015.

IV. Communications

Correspondence and other communications regarding this filing should be directed to:

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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 this Filing

In addition to this transmittal letter, this filing includes the following attachments:

Attachment A	Clean CAISO tariff sheets incorporating this tariff amendment
Attachment B	Red-lined document showing the revisions contained in this tariff amendment
Attachment C	Technical Bulletin
Attachment D	Board Memorandum

VII. Conclusion

For the reasons set forth in this filing, the CAISO respectfully requests that the Commission accepts the proposed tariff amendments effective January 15, 2015.

Respectfully submitted,

/s/ Anna McKenna

Roger E. Collanton
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250 Outcropping Way
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Counsel for the California Independent System Operator Corporation

Attachment A – Clean Tariff Sheets

Tariff Amendment – Set Flexible Ramping Constraint Parameter

California Independent System Operator Corporation

27.10 Flexible Ramping Constraint

The CAISO may enforce a Flexible Ramping Constraint in the RTM. Any flexible Dispatch capacity constrained to be available as a result of the Flexible Ramping Constraint in RTM will come from capacity that is not designated to provide Regulation or Operating Reserves, and will not offset the required procurement of Regulation or Operating Reserves in RTUC. To the extent a resource incurs an opportunity cost for not providing Energy or Ancillary Services in the FMM or RTD interval as a result of a binding Flexible Ramping Constraint, all resources resolving that Flexible Ramping Constraint will be compensated pursuant to Section 11.25. In the FMM or RTD the resources identified as resolving the Flexible Ramping Constraint in the corresponding RTUC run will be the only resources used to resolve the Flexible Ramping Constraint enforced in FMM or RTD. The Flexible Ramping Constraint can be satisfied only by committed online dispatchable Generating Units, Participating Load, and Proxy Demand Response resources with ramping capability for which a Scheduling Coordinator has submitted Economic Bids for Energy for the applicable Trading Hour, and Dynamic System resources as specified below. This constraint cannot be satisfied by System Resources that are not Dynamic System Resources. Dynamic System Resources can become eligible to participate in relieving the Flexible Ramping Constraint if the Scheduling Coordinator scheduling that Resource can demonstrate that it has firm transmission service to the CAISO Balancing Authority Area intertie that allows the resource to deliver additional Energy in Real-Time, consistent with the requirements of Section 1.5 of the Dynamic Scheduling Protocol in Appendix M. This Dynamic System Resource must demonstrate that the Dynamic System Resource has acquired sufficient firm transmission to support the total quantity of Energy and Ancillary Services offered in the Real-Time Market by submitting an E-Tag with a transmission profile that reflects the necessary transmission reservation(s) outside the CAISO Balancing Authority Area.

Procurement of Flexible Ramping Constraint capacity from Dynamic System Resources is limited by the available capacity in Real-Time for the applicable interval on the applicable intertie transmission constraint with which the Dynamic System Resource is associated. The quantity of the flexible ramping capacity for each applicable CAISO Market run will be determined by CAISO

operators using tools that estimate the: 1) expected level of imbalance variability; 2) uncertainty due to forecast error; and 3) differences between the hourly, fifteen (15) minute average and historical five (5) minute Demand levels. The Flexible Ramping Constraint relaxation parameter is $60.

Attachment B – Marked Tariff Sheets

Tariff Amendment – Set Flexible Ramping Constraint Parameter

California Independent System Operator Corporation

27.10 Flexible Ramping Constraint

The CAISO may enforce a Flexible Ramping Constraint in the RTM. Any flexible Dispatch capacity constrained to be available as a result of the Flexible Ramping Constraint in RTM will come from capacity that is not designated to provide Regulation or Operating Reserves, and will not offset the required procurement of Regulation or Operating Reserves in RTUC. To the extent a resource incurs an opportunity cost for not providing Energy or Ancillary Services in the FMM or RTD interval as a result of a binding Flexible Ramping Constraint, all resources resolving that Flexible Ramping Constraint will be compensated pursuant to Section 11.25. In the FMM or RTD the resources identified as resolving the Flexible Ramping Constraint in the corresponding RTUC run will be the only resources used to resolve the Flexible Ramping Constraint enforced in FMM or RTD. The Flexible Ramping Constraint can be satisfied only by committed online dispatchable Generating Units, Participating Load, and Proxy Demand Response resources with ramping capability for which a Scheduling Coordinator has submitted Economic Bids for Energy for the applicable Trading Hour, and Dynamic System resources as specified below. This constraint cannot be satisfied by System Resources that are not Dynamic System Resources. Dynamic System Resources can become eligible to participate in relieving the Flexible Ramping Constraint if the Scheduling Coordinator scheduling that Resource can demonstrate that it has firm transmission service to the CAISO Balancing Authority Area intertie that allows the resource to deliver additional Energy in Real-Time, consistent with the requirements of Section 1.5 of the Dynamic Scheduling Protocol in Appendix M. This Dynamic System Resource must demonstrate that the Dynamic System Resource has acquired sufficient firm transmission to support the total quantity of Energy and Ancillary Services offered in the Real-Time Market by submitting an E-Tag with a transmission profile that reflects the necessary transmission reservation(s) outside the CAISO Balancing Authority Area.

Procurement of Flexible Ramping Constraint capacity from Dynamic System Resources is limited by the available capacity in Real-Time for the applicable interval on the applicable intertie transmission constraint with which the Dynamic System Resource is associated. The quantity of the flexible ramping capacity for each applicable CAISO Market run will be determined by CAISO

operators using tools that estimate the: 1) expected level of imbalance variability; 2) uncertainty due to forecast error; and 3) differences between the hourly, fifteen (15) minute average and historical five (5) minute Demand levels. The Flexible Ramping Constraint relaxation parameter is $60.

Attachment C – Technical Bulletin

Tariff Amendment – Set Flexible Ramping Constraint Parameter

California Independent System Operator Corporation

California ISO
Shaping a Renewed Future

TECHNICAL BULLETIN

Flexible Ramping Constraint Penalty Price In the Fifteen Minute Market

April 14, 2014

www.caiso.com | 250 Outcropping Way, Folsom, CA 95630 | 916.351.4400
Author: Lin Xu

Revision History

Date	Version	Description	Author
2014-04-08	1.0		Lin Xu

Contents

Executive Summary

This technical bulletin provides the background and analyses that lead to the ISO's setting of the flexible ramping constraint penalty price in the Fifteen Minute Market (FMM). The FMM will be in production starting May 01, 2014 as part of the FERC Order No. 764 market design changes. One significant change from the current market design is that the energy award difference between the Integrated Forward Market (IFM) and the FMM will be settled at the FMM price. The ISO has observed price divergence between the Real-Time Unit Commitment (RTUC) and the Real-Time Dispatch (RTD). The price divergence is largely correlated with the flexible ramping constraint (FRC) shadow price. The FRC is a constraint implemented in the RTUC to procure 15-minute ramping capability to handle real-time net load variability and uncertainties. The FRC may either commit units, or redispatch resources to make room for 15-minute ramping capability. When the FRC redispatches, the opportunity cost from the out of merit dispatch will manifest itself in the shadow price of the FRC. Unit commitment, as opposed to RTUC redispatch, has been most effective to improve disaptch flexibility.

Under today's market, the RTUC energy price is only advisory and does not have an economic consequence. Under the FERC Order No. 764 market design the FMM price is financially binding and therefore the price divergence between the FMM and RTD should be addressed. The ISO performed analyses to tune the FRC penalty price setting to minimize the price divergence. The FRC penalty price will allow the FRC to be relaxed if the redispatch cost exceeds the penalty price, and the FRC shadow price is set at the FRC penalty price should any relaxation occur. Based on analyses of FRC effectiveness in reducing power balance violations and in committing units, the ISO plans to reduce the FRC penalty price from its current value of $247 to $60 starting May 01, 2014. The ISO will continue to monitor the FRC performance, and its impacts on the FMM, and make adjustments accordingly if the need arises in the future. In addition, the ISO will start soon the stakeholder process of the flexible ramping product, which is a superior design to permanently replace the FRC.

Background

On December 13, 2011, the ISO implemented a new flexible ramping constraint in the market optimization to address certain observed reliability and operational issues. The ISO has observed that the unit commitments and dispatch levels in real-time lack sufficient ramping capability and flexibility to meet system conditions in the five minute market when the system conditions have changed from the assumptions made in RTUC. To address this issue, the ISO enforces the FRC in the fifteen minute RTUC process to ensure ramping capability is available to be used by the five minute real-time dispatch. If the FRC requirement is not already met, there are two way to satisfy the FRC requirement in RTUC: by committing more units, or by redispatching resources out of merit so that more economic fast resources are held back from their economic dispatch level to free up ramping capability. When the FRC redispathes, the opportunity cost from the out of merit dispatch will manifest itself in the shadow price of the FRC.

The unit commitments driven by the FRC are binding and passed to RTD for 5-minute granularity dispatch, so the unit commitment portion of the FRC is effective in addressing RTD ramping needs. In contrast, the out of economic merit order pre-dispatches driven by the FRC are not operationally binding in RTUC and may be partially unwound in RTD, because RTD does not model the FRC in the binding interval but FRC is increasingly enforced in subsequent advisory intervals of RTD. Therefore, the redispatch portion of FRC is less effective than additional unit committmentto RTD. This ineffective redispatch has been referred to as "phantom" ramp by the Market Surveliance Committee[1].

Resources which resolve the flexible ramping constraint are compensated based upon the formula agreed to through the FERC settlement process which is capped at $800 and based upon the maximum of the resource's spinning reserve price or the shadow price of the constraint.

Need for Adjustment of Shadow Price

The ISO has recognized the existence of "phantom" ramp in the context of the current market, which is not currently an issue because the RTUC is not a financially binding energy market. With the introduction of the FMM on May 1, 2014, the energy award difference between the IFM and the FMM will be settled at the FMM price. RTUC performs a multi-

[1] http://www.caiso.com/Documents/Order764Implementation-MSC_Presentation.pdf

interval optimization extending between 4 and 7 fifteen minute intervals. The FMM is created by calculating financially binding energy schedules in the second RTUC interval which is 37.5 minutes prior to flow. This allows the market results to align with WECC e-Tag submission deadlines for schedules changes of imports and exports. In the Department of Market Monitoring's Q3 2013 Report on Market Issues and Peformance, the DMM identified divergence between the RTUC price and the RTD price.[2] Under the new market design, the price divergence is a concern because the RTUC price will be become financially binding in the FMM. The DMM recommended that the ISO place a high priority on addressing the issue prior to implementation of the FERC Order No. 764 market design changes in Spring 2014.

The ISO has observed that the price difference between the RTUC and the RTD is strongly correlated with the FRC shadow price. Figure 1 and Figure 2 plot the hourly average RTUC and RTD system wide energy prices against the FRC shadow price using September 2012 to August 2013 market data. Figure 1 includes all real-time intervals, while Figure 2 only includes intervals when the FRC has positive shadow prices. As shown in Figure 1 and Figure 2, the RTUC and RTD price divergence moves in the same direction with the FRC shadow price, and is about the same magnitude. This suggests that the FRC might be a main driver for the RTUC and RTD price divergence, and the costly but potentially ineffective pre-dispatch in RTUC may have resulted in higher RTUC prices.

The ISO has discussed the flexible ramping constraint implementation with the Market Surveillance Committee. The ISO presented its findings at the March 11, 2014 MSC meeting and outlined steps to address "phantom" ramp[3]. To address this issue, the ISO strives to tune the penalty price of the FRC to reduce the out of merit dispatches, but still maintain the beneficial unit commitments.

[2] See page 23 of the report which is available at http://www.caiso.com/Documents/2013ThirdQuarterReport-MarketIssues_Performance-Nov2013.pdf

[3] http://www.caiso.com/informed/Pages/BoardCommittees/MarketSurveillanceCommittee/Default.aspx

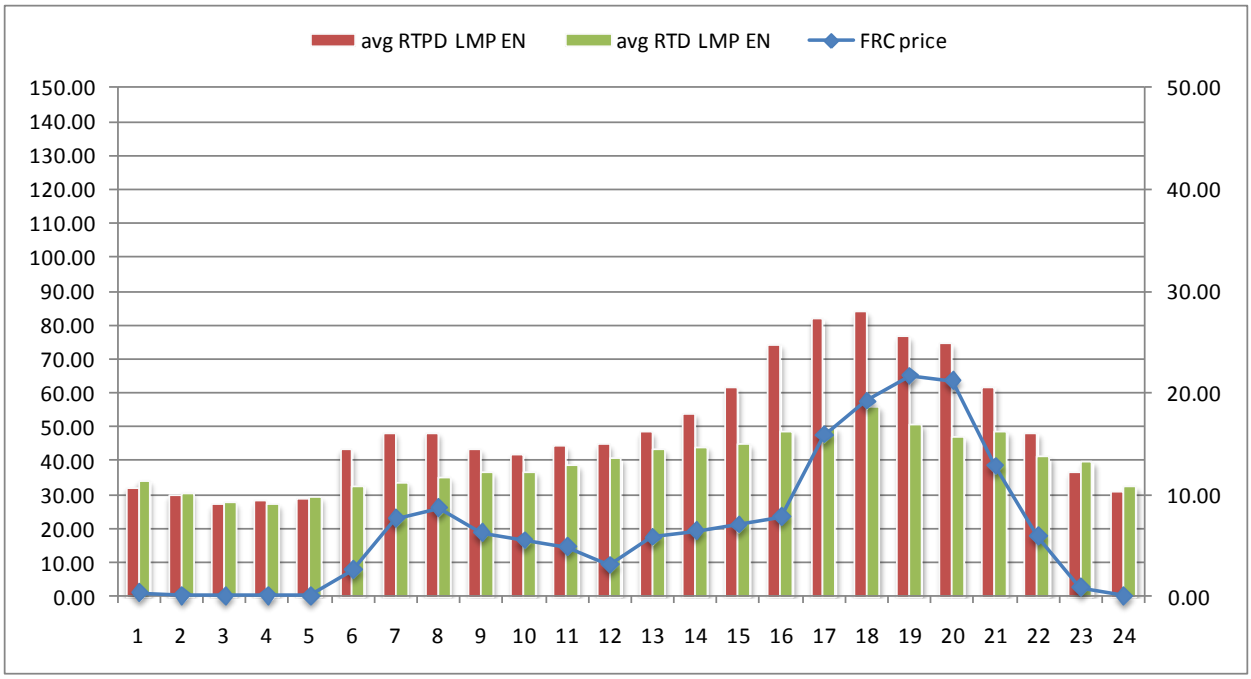

Figure 1: RTUC price vs RTD price and FRC price

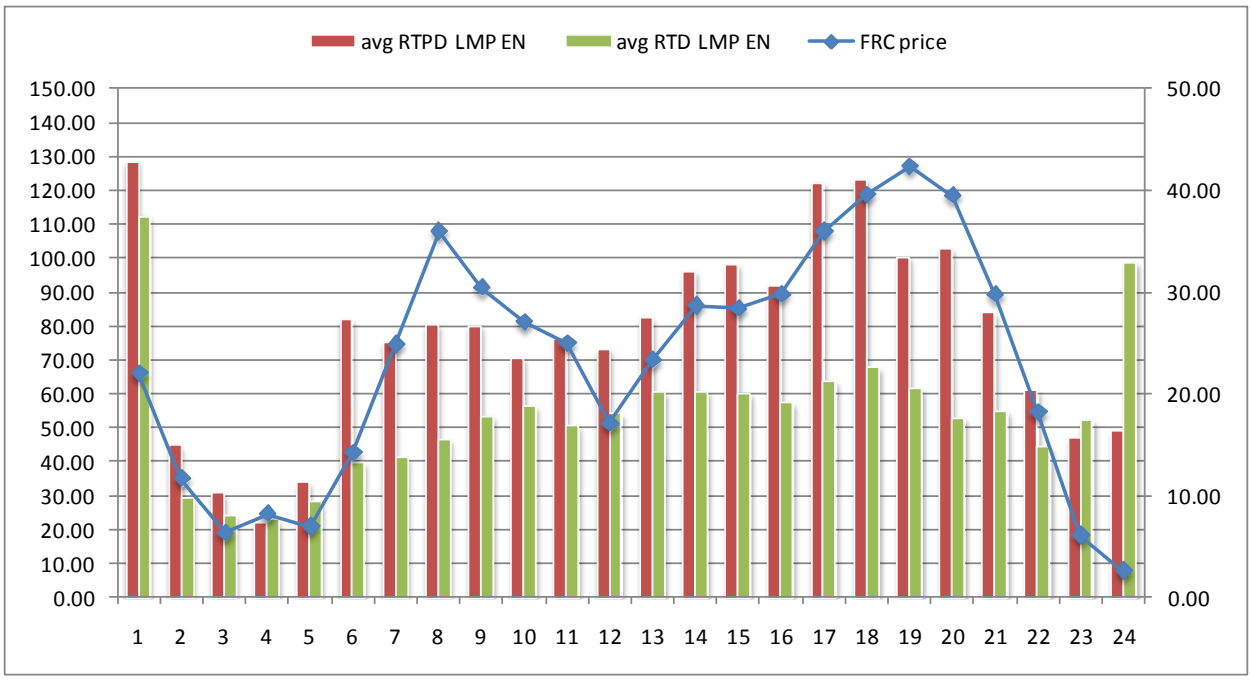

Figure 2: RTUC price vs RTD price and FRC price whe FRC is binding

Analyses

The ISO analyzed the correlation between the FRC shadow price and the power balance violations in 2013, and summarized the results in Table 1. The ISO divide the FRC shadow prices into four ranges: below $20, $20 to $60, $60 to $240, and $240 to $250. The size of the price ranges are chosen such that there are a significant number (at least 300) of observations in each of the price range. Table 1 lists the number of instances of positive power balance violation, i.e. under generation, and the averge amount of the violation per price range. The average amount of positive power balance violations when the FRC shadow price is less than $20 is 3.87 MW, and it is reduced to 3.27 MW when the FRC shadow price range is between $20 and $60. This indicates that the FRC is effective at a higher price in reducing the amount of positive power balance violations.

However, when the FRC shadow price increases, we observe that the amount of positive power balance violations starts to increase rather than decrease. For example, when the FRC shadow price is between $60 and $240, the average amount of positive power balance violations is 8.2 MW. When the FRC shadow price is between $240 and $250, the average amount of positive power balance violations increases to 9.9 MW. This means that the FRC is less effective in reducing the amount of positive power balance violations even though the cost has increased in the RTUC.

The reason that the FRC is effective when the shadow price is below $60 is that in this price range, units likely have been committed to resolve the FRC, which will help RTD mitigate power balance violations. The FRC is less effective when the shadow price is above $60, because when the FRC shadow price is high, the FRC relies on more out of merit order redispatches than unit commitments. The ISO validated this by examining the FRC shadow price when there are unit startups driven by the FRC. The criteria that is used to determine if a unit startup is driven by the FRC is whether an online unit providing flexible ramping is offline in the previous interval. It is then assumed that the resource is started up in the current interval to provide flexible ramping. It turns out that for intervals that have these FRC driven unit startups in 2013, the FRC shadow prices are always below $60. As discussed earlier, out of merit order redispatches inflate the RTUC price without being helpful to RTD. So the FRC is less effective when the shadow price is above $60 than when the shadow price is blow $60.

Based on the analysis, the ISO will reduce the FRC penalty price from its current $247 setting to $60 starting May 1, 2014. The FRC penalty price will allow the FRC to be relaxed if

the redispatch cost exceeds the penalty price, and the FRC shadow price is set at the FRC penalty price should any relaxation occur. The $60 penalty price is expected to reduce the out of merit dispatches driven by FRC, but maintain the beneficial unit commitments.

Table 1: FRC shadow price and power balance violation in 2013

FRC shadow price range	Average power balance violation MWs	Number of instances
<20	3.87	3141
[20, 60)	3.27	691
[60, 240)	8.20	364
[240, 250]	9.90	473

Next Steps

The ISO will continue to monitor the FRC performance, and its impacts of the FMM, and make adjustments accordingly if the need arises in the future. The ISO will start soon the stakeholder process of the flexible ramping product, which is a superior design to permanently replace the FRC. The planned implementation date of the flexible ramping product is Fall 2015.

Attachment D – Board Memo

Tariff Amendment – Set Flexible Ramping Constraint Parameter

California Independent System Operator Corporation

Memorandum

To: ISO Board of Governors

From: Keith Casey, Vice President, Market & Infrastructure Development

Date: May 21, 2014

Re: **Decision on flexible ramping constraint relaxation parameter**

This memorandum requires Board action.

EXECUTIVE SUMMARY

The flexible ramping constraint ensures the ISO market's five-minute dispatch has sufficient upward ramping capability to meet system conditions. However, under the fifteen-minute market recently established with the implementation of FERC Order No. 764 (Order 764) market design changes implemented on May 1, 2014, the current $247 flexible ramping constraint relaxation parameter has the potential to unduly raise energy prices that are now the basis for financial settlement in the fifteen-minute market. Accordingly, Management proposes to reduce the flexible ramping constraint relaxation parameter from $247/MW to $60/MW.

The flexible ramping constraint relaxation parameter defines the marginal cost above which the real-time market optimization will forego procuring flexible ramping capacity. Management's analysis shows the proposed $60/MW flexible ramping constraint relaxation parameter provides the maximum benefit from the flexible ramping constraint while not unduly increasing fifteen-minute market energy and ancillary services prices.

Management recommends the following motion:

> ***Moved, that the ISO Board of Governors approves the proposal to reduce the flexible ramping constraint relaxation parameter, as described in the memorandum dated May 21, 2014; 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 proposed tariff change.***

DISCUSSION AND ANALYSIS

On December 13, 2011, the ISO implemented the flexible ramping constraint to ensure the ISO market's five-minute dispatch has sufficient upward ramping capability to meet unforeseen system conditions caused by variations in load and variable energy resources. The ISO enforces the flexible ramping constraint in the real-time market as part of the real-time unit commitment process. The real-time unit commitment process runs in fifteen-minute intervals prior to the five-minute dispatch.

During the FERC proceeding on the ISO's Order 764 market design proposal, intervenors expressed concern about price divergence between the fifteen-minute market and real-time dispatch. The ISO responded and FERC agreed that fine tuning the flexible ramping constraint relaxation parameter is appropriate to manage this price divergence.

On April 14, 2014 the ISO published a technical bulletin outlining the proposed reduction in the relaxation parameter from $247/MW to $60/MW to be effective with the start of the fifteen-minute market on May 1, 2014. The ISO held a stakeholder conference call on April 21, 2014 to discuss the analysis supporting this change. As a result of stakeholder comments, Management decided that it would be prudent to seek a tariff amendment to implement the lower relaxation parameter due to the relationship of the compensation to resources and the fifteen-minute market price.

Flexible ramping constraint's effect on fifteen minute market prices

Prior to the ISO's implementation of Order 764 market design changes on May 1, 2014, the real-time unit commitment process served primarily to commit or de-commit generation and to schedule and price ancillary services. Although the real-time unit commitment also calculated generation schedules and prices, they were only advisory.

Order 764 market design changes established a fifteen-minute market that now settles these generation schedules using prices determined by the real-time commitment process. Under the Order 764 market design, imbalance energy scheduled between the day-ahead market and the fifteen-minute market is settled at the fifteen-minute market price and imbalance energy between the fifteen-minute market and five-minute dispatch is settled at the five-minute dispatch price.

Management has observed that the real-time unit commitment energy prices, now used by the fifteen-minute market, tend to be driven higher than the five-minute dispatch prices by the flexible ramping constraint. The fifteen minute prices are strongly correlated with the marginal cost of meeting the flexible ramping constraint. The flexible ramping constraint's impact on the energy prices calculated by the real-time unit commitment process is now more important because, with the implementation of the fifteen-minute market, the ISO uses these prices for imbalance energy in addition to ancillary services settlement.

In light of this, Management has analyzed the flexible ramping constraint's effect on the energy prices from the real-time unit commitment process. Management has determined it is appropriate to reduce the parameter that forgoes flexible ramping procurement above a specified marginal cost for the reasons discussed below.

The flexible ramping constraint can be met by the real-time unit commitment process in two ways: (1) by committing more generating units, or (2) by dispatching generation out-of-merit so that more economic and fast generation is held back from its economic dispatch level to free up ramping capability. The additional generation committed through the flexible ramping constraint is effective in providing additional flexible ramping capability to the five-minute dispatch because the unit commitments are operationally binding.

In contrast, the out-of-merit order dispatches in the real-time unit commitment process are not operationally binding and may be partially undone in the five-minute dispatch because the flexible ramping constraint is not enforced in the binding five-minute dispatch interval. Consequently, the out-of-merit dispatches caused by the flexible ramping constraint tend to increase the fifteen-minute market energy price while not effectively providing increased flexible ramping capability to the five-minute dispatch. Therefore, Management proposes to change the value of the flexible ramping constraint relaxation parameter so that the flexible ramping constraint will continue to commit additional units to meet ramping needs in the five minute dispatch while minimizing the out-of-merit order dispatch and its undesirable effect on the fifteen-minute market energy prices.

This issue will be further addressed when the flexible ramping constraint is replaced by the planned flexible ramping product. The flexible ramping product will contain several design advantages over the flexible ramping constraint including consistent implementation and price impacts between the fifteen-minute market and five-minute dispatch. The flexible ramping product stakeholder initiative will recommence in June 2014. Management plans to seek Board approval of the design in December 2014 and is targeting implementation in Fall 2015.

Optimal flexible ramping constraint relaxation parameter value

Management analyzed the impact of the flexible ramping constraint on the fifteen-minute market prices and the effectiveness of the constraint on meeting the five-minute dispatch ramping needs. The analysis shows that the flexible ramping constraint is effective when the marginal cost is below $60. At this level, the constraint results in additional unit commitment that can be used in the five-minute dispatch to meet ramping needs but not cause significant out-of-merit dispatch that drives up the fifteen-minute market prices.

Based on the analysis, Management proposes to reduce the flexible ramping constraint relaxation parameter from its current level of $247 to $60. The $60 relaxation

parameter is expected to reduce the out-of-merit dispatches driven by flexible ramping constraint while maintaining the beneficial unit commitment decisions.

Compensation to resources for the flexible ramping constraint

Resources used to meet the flexible ramping constraint are compensated based upon the formula agreed to through the FERC settlement process, which is capped at $800 and based upon the maximum of the resource's spinning reserve price or the marginal cost of the constraint, less seventy-five percent of real-time dispatch prices. Management is not proposing any changes to the compensation formula.

The relaxation parameter is the cost at which the market optimization will reduce the procurement requirement of the flexible ramping constraint. As a result, the relaxation parameter will make lower awards to resources by restricting additional procurement when the flexible ramping constraint marginal cost exceeds $60. Since the flexible ramping requirement is reduced, the marginal cost of the flexible ramping constraints will also be lower. While lowering the relaxation parameter will result in lower payments to generators, it is not appropriate to maintain the current parameter level that will drive inefficient higher prices in the fifteen-minute market which is now settled under the Order 764 market design changes.

POSITIONS OF THE PARTIES

Stakeholders broadly support the fundamental goal of this initiative, which is to improve price convergence between the day-ahead market, fifteen-minute market and real-time dispatch. However, some generator owners expressed concern about the adverse impact that lowering the relaxation parameter will have on compensation to resources dispatched to resolve the flexible ramping constraint.

Some stakeholders also raised concerns that the ISO should not change the flexible ramping constraint relaxation parameter without obtaining Board approval and a subsequent FERC filing to include the parameter value in the ISO's tariff. As a result Management is bringing the proposed change to the parameter value to the Board for decision.

CONCLUSION

Management requests Board approval to reduce the flexible ramping constraint relaxation parameter to $60/MW. The flexible ramping constraint is necessary to ensure sufficient upward ramping capability to reliably manage the grid. Setting the relaxation parameter to $60/MW provides the reliability benefits without unduly impacting the fifteen-minute market that are now settled under the Order 764 market design.

Board of Governors **May 28-29, 2014** **Decision on flexi-ramp constraint parameter**

Motion

Moved, that the ISO Board of Governors approves the proposal to reduce the flexible ramping constraint relaxation parameter, as described in the memorandum dated May 21, 2014; 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 proposed tariff change.

Moved: Galiteva **Second: Maullin**

Board Action: **Passed**	Vote Count: **5-0-0**
Bhagwat	Y
Foster	Y
Galiteva	Y
Maullin	Y
Olsen	Y

Motion Number: 2014-05-G3