Market Parameters Enhancement

April 22, 2022

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Introduction

As part of its continued assessment of market performance, CAISO has identified two enhancements to how it manage market parameters. Since implementing either change would require amending the CAISO tariff, CAISO is initiating a formal Stakeholder process to introduce the issues to be addressed and identify a solution. The scope of this initiative is twofold:

i) Address market issues arising from the utilization of a shift factor threshold in the CAISO's energy market, which has implications in the congestion revenue right market, and
ii) Create a mechanism to effectuate expedited changes to the values of the penalty prices utilized in the CAISO's energy market to address production issues that may arise

These two items fall within the same general subject matter but they are not interdependent.

The following sections described the market issue and the straw proposal to address these.

Shift Factor Threshold

Background

Since the inception of its nodal market in 2009, CAISO has used a threshold for shift factors in its market optimization. This threshold effective determines what power injections (from resources) are used in the congestion management process Based on impact studies and simulations, CAISO arrived at a 2 percent threshold to determine which resources will be used for congestion management in its markets. CAISO deemed this threshold to achieve a reasonable balance between good utility practice for grid operations and undesirable market outcomes.

In the time since that initial implementation, CAISO has identified two impacts. First, CAISO identified a discrepancy in the price formation for aggregated pricing locations. In 2014, CAISO pursued a market enhancement to change the price formation logic for these aggregated locations. This new logic effectively eliminated the potential for a price discrepancy on default load aggregation points (DLAPs) and trading hubs (THs). Second, as early as 2014, CAISO identified that the threshold also exacerbated revenue inadequacy for congestion revenue rights (CRRs). Since then, CAISO has continued to monitor its impacts on the market.

On January 1, 2019 CAISO implemented a new policy of pro-rata funding for CRRs. Under this policy, the market outcomes more clearly showed the impacts of a shift factor threshold on the CAISO markets. Under certain conditions, the threshold negatively impacted the efficient interaction of the day-ahead market with the CRR market. CAISO provided specific analysis on this interplay in its CRR market

performance report published on May 2020[1]. This straw proposal is the initiation of a stakeholder process to address the inefficiency introduced by the use of the shift factor threshold for aggregated locations in the CAISO's markets.

Shift factors

Shift factors, also known as sensitivity factors, measure a specific location's effectiveness relative to the change of power flow on a specific constraint. The shift factors depend on the transmission topology, the slack node choice and the transmission system's specific characteristics, such as impedances. A location will typically be either a supply (generation) or demand (load) node. For instance, a 40 percent shift factor means that 0.4 MW will flow on a constraint if 1 MW is injected and withdrawn between a given node and the slack node. If the shift factor is positive, the flow will increase by 0.4MW on the given constraint. If the shift factor is negative, the flow will reduce by 0.4 MW on the given constraint. CAISO's market uses shift factors in both its congestion management process which, as a by-product, impacts its price formation mechanism. Shift-factor values are typically in the range of -100% to +100%.[2] CAISO's market produces and uses shift factors for both individual and aggregated nodes, such as specific generator nodes or DLAPs. These are calculated for both physical and virtual resources, such as interties, internal generators, convergence bids and demand resources. The market calculates shift factor values relative to the slack node choice, which is currently distributed slack reference.

Congestion management in CAISO's market

CAISO's market uses locational marginal pricing in its clearing process. This accounts for the locational nature of congestion and losses by producing Locational marginal prices (LMPs) with energy, congestion and loss components. CAISO's market bases the LMPs' decomposition on the slack reference choice. However, that choice does not affect the overall LMP value.

Congestion management refers to re-dispatches of market resources to comply with transmission limits. In order to comply with a transmission limit, the market relies on resources' operational characteristics, shift factors and market bids. The shift factors determine the direction of the redispatch since some resources will exacerbate congestion while others could mitigate congestion. Resources located on one side of the constraint will be required to increase generation, while resources located on the other side of the constraint will be required to decrease generation.

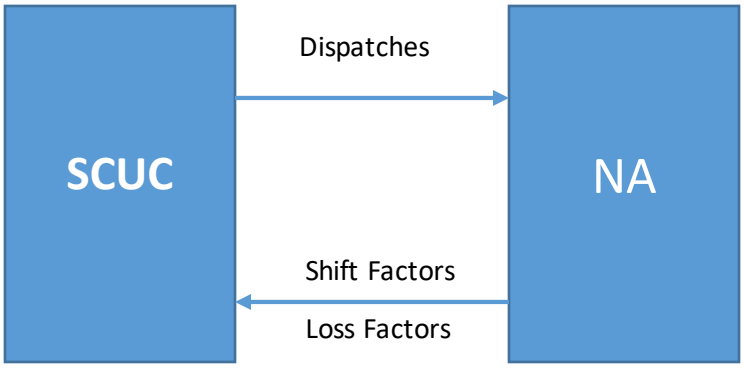
[1] Full analysis results can be found in section 8.3 of the CRR performance report available at http://www.caiso.com/InitiativeDocuments/CongestionRevenueRightsMarketAnalysisReport-May12-2020.pdf

[2] There have been some infrequent instances in which CAISO portal have posted shift factors outside the 100% range; this will be for nomograms which typically have not been normalized.

Re-dispatching resources for congestion management is an integral part of the market clearing process. Transmission constraints are one type of constraint the market optimization considers to achieve a least-cost solution.

The CAISO's market clearing process uses a Security Constraint Unit Commitment (SCUC). This type of technology has become ubiquitous in electricity markets. The CAISO's SCUC design relies on two modules, as shown in Figure 1. One that solves for the SCUC problem and another that handles the calculation of power flows, known as the network application (NA).

Figure 1: Iterative calculation in the CAISO's market clearing process



The SCUC module solves for unit commitments and dispatches. Then the NA module uses these resource dispatches to run a full alternate current (AC) power flow. The AC power flow produces both shift factors and loss penalty factors at a given operating point. Then the SCUC module uses these shift factors to form linearized power flow constraints. These constraints also rely on the base operating point to estimate the full power flow contribution. The SCUC module will enforce these constraints and dispatch resources so that transmission limits are respected. This is the congestion management done through the market clearing process.

As part of the solution, the market determines updated resource dispatches, which in turn are sent again to the NA module for one more estimation of AC power flows. Based on this new operating point, the NA module calculates a new set of shift factors and loss penalty factors, which in turn are sent back to the SCUC module. This iterative process converges to a solution after a finite number of cycles and within certain timeframe and optimality criteria.

Every SCUC-NA iteration finds what transmission constraints become overloaded in the AC power flow to then enforce them in the SCUC module and apply congestion management. Since a given market may have hundreds of transmission constraints with hundreds of locations with associated shift factors, the number of shift factors and constraints to optimize can grow rapidly and pose a computational burden on the SCUC solution. For this reason, only constraints that are at least with a capacity loading of 85 percent are actively considered in the market and considered in congestion management.

When any linearized power flow enforced in the SCUC module binds (reach their limit), it will be priced accordingly with a shadow price.[3] The marginal congestion component of the LMPs at a given node *i* is formed by using the linear combination of the shadow prices μ_k of all transmission constraints *k* binding and the shift factor $SF_{k,i}$ of that given node-constraint relationship,

$$MCC_i = \sum_k SF_{k,i}\mu_k \quad \forall\, i$$

Shift factor threshold

CAISO markets apply a 2 percent threshold on shift factors. This threshold effect reflects on both resource redispatch and price formation.

In the congestion management process, only resources with a shift factor greater than 2 percent will be effectively considered for redispatch. When the nodal market was launched in 2009, there was a practical concern from the solutions observed that the market could utilize generators located far away, electrically speaking and measured by a small shift factor, from constraints being congestion managed. This could lead to an unreasonable redispatch of such generators for very little congestion relief on the constraint. This would not be prudent or consistent with good utility practice.

In the price formation process, shift factors below the threshold for any binding constraint are not utilized to derive the marginal congestion component. This consistently disregards the impact of shift factors on both resource dispatches and their prices. This also means that resources will receive dispatches that are consistent with the prices cleared in the market.

The threshold applies to any shift factors derived in the market, with no consideration if they are associated with locations for only certain type of resources. It applies the same way to individual resources or aggregated resources, and to physical or virtual resources.

Market issues

The use of a shift factor threshold in the congestion management of day-ahead market have manifested in two main outcomes. First, it can result in an overpayment of CRR settlements due to overestimating the implied CRR flow on a given transmission constraint. Second, the use of a shift factor threshold may result in flow contributions not accounted for in the day-ahead flow settlements by means of not collecting sufficient congestion rents, and in some extreme cases it can lead to flow reversals in the CRR settlements.

[3] As part of the transparency effort, CAISO posts all shadow prices for the various types of constraints binding across the CAISO markets.

Over-estimation of CRR payments

The first issue due to the use of a shift factor threshold was identified in the analysis of the CRR performance. Both the day-ahead energy and the congestion revenue right markets do congestion management as part of the clearing process. Both markets calculate shift factors and produce marginal pricing for congestion as part of the clearing process.

The shift factors from the CRR auction can be different than the day-ahead shift factors due to a variety of reasons but related to transmission configuration and model differences. For instance, an outage modelled in the day-ahead market but not modelled in the CRR auction may potentially lead to different shift factors. One contributor to the CRR deficit is the use of the shift factor threshold in the day-ahead market but its absence in the CRR markets. The CRR auctions use DC-based shift factors with no threshold in place. When the CRR auction clears for CRRs it takes into account any shift factor contribution even if they are smaller than 2 percent. The flow estimated in the CRR auction will consider every single contribution of all CRRs. When all these CRR injections are applied to the day-ahead shift factors to calculate CRR payments, only the injections and withdrawals related to shift factors greater than 2 percent will contribute to the CRR estimated flow. These flow contributions on the CRR flows can be in either direction – prevailing or counter-flow – and can result in a higher or lower CRR flow than was released in the CRR processes. The lack of accounting for the contributions for locations with shift factors below the threshold has resulted in some instances in a settlements CRR flow higher than what the CRR flow was in the CRR process. Once these contributions are actually factored in, the flows between the day-ahead market and the CRRs processes converge fairly close.

Although this issue can generally be observed for any location, the most significant impact occurs when it involves DLAPs and THs with shift factors below the 2 percent threshold. Since these aggregated locations have large injections, in some cases in the thousands of MW, dropping a relative small shift factor even under 2 percent will still not account for a large flow contribution.

This issue was systemic and resulted in CRR deficits for the Devers-Valley constraint, which was binding in last quarter of 2019 and the first two months of 2020. Based on a targeted analysis of this issue, about 40 percent of the CRR deficit on this constraint was caused by this delta in the use of shift factor threshold in the energy market but not applied the CRR markets.[4]

[4] Full analysis results can be found in section 8.3 of the CRR performance report available at http://www.caiso.com/InitiativeDocuments/CongestionRevenueRightsMarketAnalysisReport-May12-2020.pdf

Under collection of congestion rents

As described above, in the congestion management process of the day ahead market, the linearized power flows are estimated at a given based flow from the most recently estimated operating point, and the incremental change around that operating point given the using day-ahead shift factors and the day-ahead injections from supply and demand.

The base flow is not optimized in the market, only the incremental flow using the shift factors with the supply and demand dispatches being the optimized variables. When estimating the base flow on a constraint in the NA module, the contribution of the aggregate locations will be accounted for but if the DLAPs and THs have shift factors below 2 percent, they will not contribute to the redispatch for congestion management in the SCUC module. The market issue identified in the CRR performance becomes relevant when dealing with aggregated locations such as default load aggregation points (DLAPs) or Trading Hubs, which are significantly larger than any typical individual resource. For instance, in the summer with loads over 45,000 MW of peak load, the DLAPs can easily be greater than 10,000 MW. When the shift factor of 2 percent is applied, it means that an injection of 10,000 MW with an effectiveness of, say, 1.5 percent will not contribute to congestion rents, even though this means a flow contribution of 150 MW (10,000 MW * 1.5%) on a given constraint.

This market issue of under collecting congestion rents can be observed only for constraints in which DLAPs and THs have shift factors that may fall below the 2 percent threshold. In the analysis of the CRR performance, CAISO observed multiple instances of this interplay being more likely to occur when constraints are of small capacity relative to the DLAPs and THs flow contributions. This condition can easily lead the constraint to reverse direction in the CRR settlements. In relative terms to the overall CRR settlements, this issue is small, but it alone does represented an impact of $3 million of settlements reversal in the first 15 months of the implementation of the new policy[5].

A more recent case of this market issue was observed in the first months of 2022 on the constraint 33020_MORAGA _115_32780_CLARMNT _115_BR_1 _1. This constraint started binding frequently in the IFM market from January 31, 2022 to March 31, 2022. Since it was binding in the day ahead market, the congestion rents collected from the day ahead market should ideally be sufficient to fund the CRR payments for this constraint.

Since the implementation of the CRR auction efficiency initiative in January 2019, the CRR payments are adjusted based on the entities CRRs contributions on deficits on a constraint by constraint basis. It has introduced the term called the notional amount, which the face value based on the CRR awarded amounts, while the offset amount represents the revenues that would be reduced due to the mechanism of partial funding. When the difference between the notional amount of the constraint and offset amount on the same constraint for the trade date is positive the SC will be paid the reduced amount through the

[5] Full analysis results can be found in section 8.2 of the CRR performance report available at http://www.caiso.com/InitiativeDocuments/CongestionRevenueRightsMarketAnalysisReport-May12-2020.pdf

CRR settlement. However if the difference is negative, the SC will be charged the CRR settlement (negative amount).

Figure 2: Difference between Notional and Offset amount for this constraint

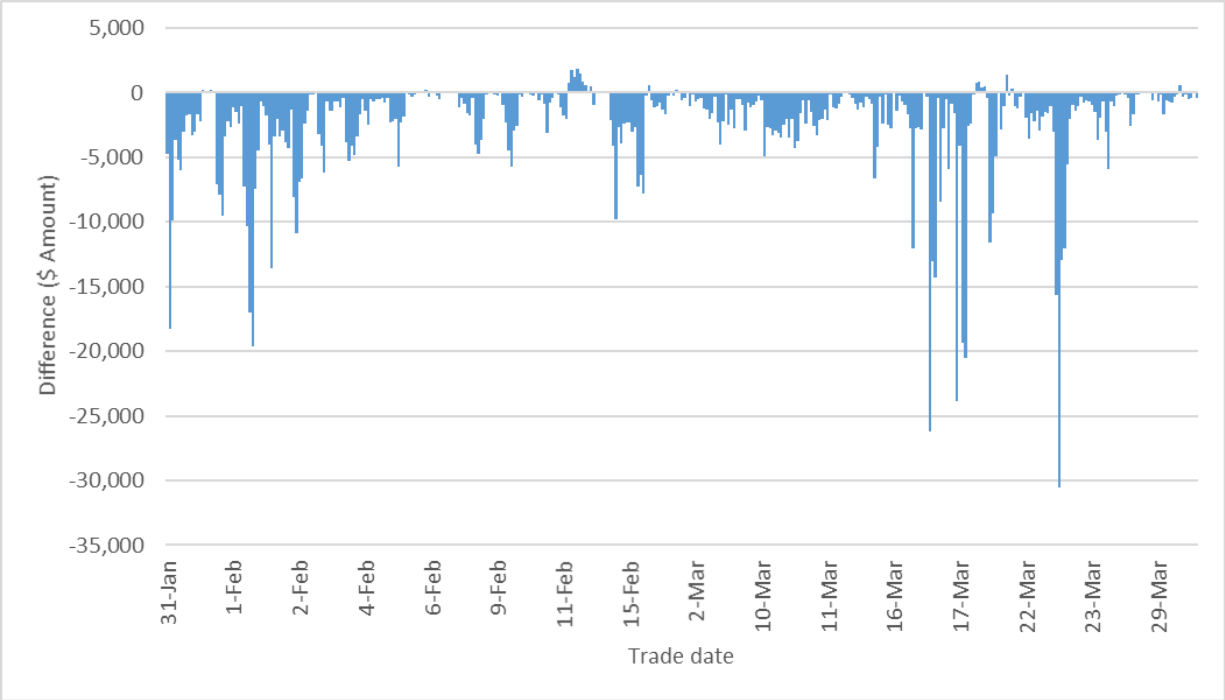


Figure 2 shows the difference between the notional amount and offset amount (deficit) for the 33020_MORAGA _115_32780_CLARMNT _115_BR_1 _1 constraint starting January 31, 2022 up to March 31, 2022. For about 89 percent of the hours when the constraint was binding, the difference was negative. Consequently, scheduling coordinators holding CRRs on this constraint have to pay for holding CRRs.

More granular analysis of February 1, 2022 provides a reference for deeper understanding of these issues. Figure 3 shows the comparison of notional amount and offset amount (deficit) and shows clearly the offset amount was significantly higher than notional amount, which is the face value of CRR awarded payments.

Figure 3 Comparison of Notional Revenue and Offset Revenue for one sample trade (February 1, 2022)

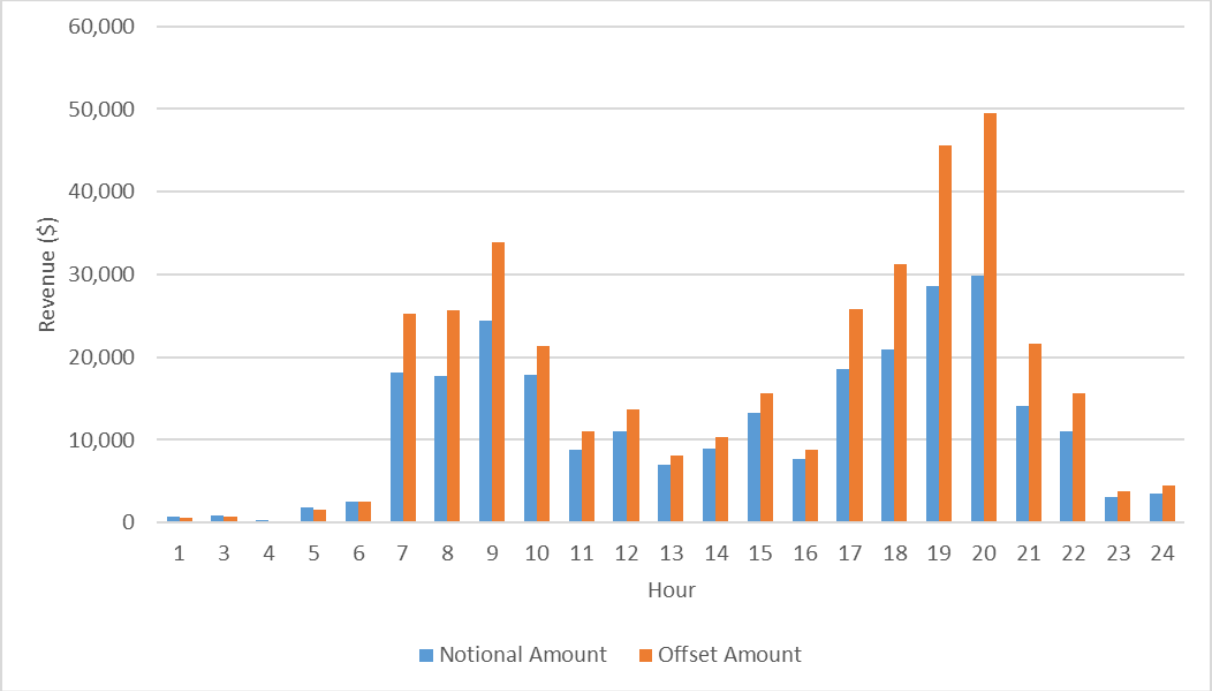
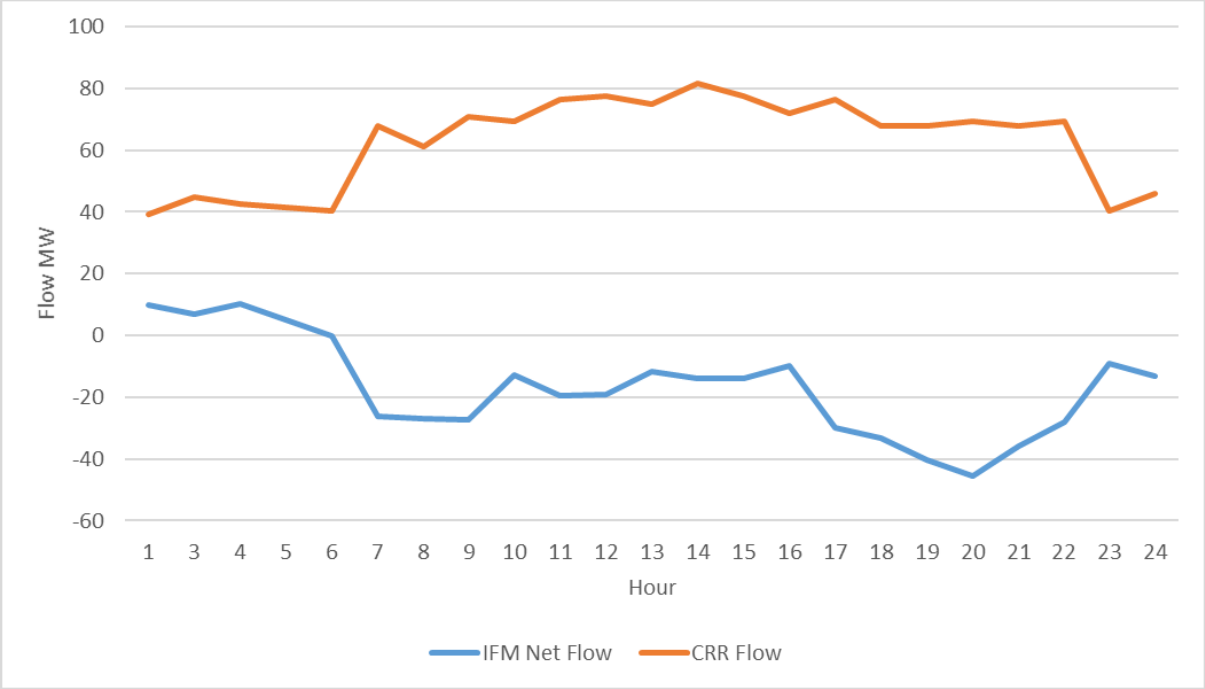


Figure 4 below shows the comparison of IFM flows and CRR flows on this constraint for the same trade. It shows that the IFM flows and the CRR flows are significantly different. The IFM net flow is the amount of flow that collected congestion rents on this constraint from the day ahead market. The limit of this constraint is about 120 MW for this trade date and the equivalent CRR flow on this constraint (based on the awarded CRRs) is between 60 and 80 MW, while the settled IFM flows are actually negative between -5 and -45 MW.

Figure 4 Comparison of IFM net flows with the CRR flows for the sample trade date (February 1, 2022)



For instance, the CRR flows for HE 20 is about 69 MW; however, the corresponding IFM net flow was around -45 MW. For this scenario, the flow contribution of the DLAP was not being accounted for in the calculation of IFM net flow because the DLAP shift factor was below the threshold of 2percent. By missing that contribution, the resulting IFM flow is much lower with less congestion rents collected.

Proposed solution

To address the issues identified with the use of a shift factor threshold in the CAISO's energy market, CAISO proposes to adjust the use of the shift factor. The 2 percent threshold will continue to apply to all individual (non-aggregated) locations. However, for large aggregated locations, namely DLAPs, THs and ELAPs, the 2 percent threshold will be reduced to effectively zero or very close to a zero value. In practical terms this is equivalent to not applying a threshold to these aggregated locations. This logic will apply in both the congestion management process and in the price formation of MCCs, such that dispatches and prices remain consistent.

This modification will apply to both physical and virtual resources in both the day-ahead and real-time markets to maintain consistency. In the day-ahead market, DLAP resources are active variables use for congestion management and thus the use or not of the threshold has implications on these resources dispatches and their price formation. In the real-time market, such DLAPs and ELAPs are not variables in the congestion management because the real-time market uses demand forecast instead of bid-in

demand. Thus, this has no implications in the real-time redispatch of DLAPs, but it is still used in the real-time price formation to derive MCCs. Thus, this will also apply in the price formation process in the real-time market.

Market Parameter Change Process

Background

The optimization process of the CAISO's energy market uses a set of parameters known as penalty prices to enforce the relative scheduling and relaxation priorities in the market clearing process. The values of these parameters are defined based on studies and analysis to ensure the expected priority under different scenarios is maintained. When new functionality and market features are introduced, all the values of these parameters are assessed for any needed updates. However, given the large number of different scenarios and conditions that the market can encounter from running every day, there may be some conditions under which the pre-defined values of the penalty prices may not work as intended. This may typically arise under extreme and stressed market and system conditions that require the market to clear in the range of uneconomical adjustments in which the penalty prices play a role to attain a solution. The resulting market solutions under this type of condition may pose a market inefficiency or/and operational inefficacy. To mitigate for this type of risk, CAISO would assess required changes to some of these penalty prices. Since some of these penalty prices may be defined in the CAISO's tariff provisions, CAISO may not have the ability to effectuate these changes expeditiously.

These events are not frequent but have occurred in the past. Indeed, the first part of this stakeholder initiative refers to a market issue that can be addressed by changing a market parameter for the shift factor threshold. Another case of this condition is the overscheduling of imports observed on July 9, 2021 when CAISO's system faced tight supply conditions due to supply imports lost due to fire impacts. This issue has been addressed through a targeted stakeholder initiative with the expectation to implement it prior to summer 2022. This last issue highlights the concern of the long process period it may take to pursue a parameter value change currently defined in the tariff while the market be still producing unintended outcomes.

On April 28, 2021, the CAISO submitted a tariff amendment to modify load, export, and wheeling through priorities in the day-ahead and real-time market optimization processes and implement other market rules (Tariff Amendment). The Commission accepted the proposed tariff revisions in a June 25 Order. However, the Commission also found that "the penalty pricing parameters that determine the relative scheduling priorities of transactions in the CAISO market optimization software must be in the Tariff." The Commission concluded such penalty prices significantly affect the conditions of transmission service on the CAISO grid. Accordingly, the Commission directed the CAISO to submit a compliance filing within 30

days of the June 25 Order that "incorporates the penalty pricing parameters associated with the revised scheduling priorities into the relevant sections of the CAISO tariff."[6]

To comply with the June 25 Order, on June 26, 2021 the CAISO submitted tariff revisions in a compliance filing (June 26 Compliance Filing) that reflected the penalty pricing parameters associated with the revised scheduling priorities. The proposed tariff revisions included the addition of tables to existing tariff sections 31.4, 34.12.1, and 34.12.2 listing the revised scheduling priorities and their associated penalty pricing parameters.

The tariff revisions in the June 26 Compliance Filing also included a new tariff section 31.4.1 to provide "a process for making temporary changes to the scheduling parameter values specified in sections 31.4, 34.12.1, and 34.12.2 (referred to hereinafter as the 'Parameter Change Procedure')."[7] The CAISO stated that the Parameter Change Provision "will allow the CAISO to modify the scheduling run parameters when necessary to ensure feasible market solutions or avoid future operational or reliability problems the resolution of which would require recurring operator intervention outside of normal market scheduling procedures."[8] As explained in the Compliance Filing, other independent system operators (ISOs) and regional transmission organizations (RTOs) have tariff provisions permitting them to make temporary changes to the transmission constraint penalty factor values specified in their tariffs.[9] Further, in Order No. 844, where the Commission required each ISO and RTO to include in its tariff its transmission constraint penalty factor values, the Commission also permitted them to include any procedures for temporarily changing such values with "notice of the change to market participants."[10] The proposed Parameter Change Procedure also tracks the CAISO's current authority to change the penalty pricing parameter values on an expedited basis in emergency situations without following the usual procedure for revising the business practice manual.

After the CAISO submitted the June Compliance Filing, some stakeholders expressed concern about the potential scope of the Parameter Change Provision. They suggested the Parameter Change Provision might be interpreted as allowing the CAISO to change temporarily not only the scheduling parameter values (*i.e.*, the dollar amounts shown in the second and third columns of the new tables in revised tariff sections 31.4, 34.12.1, and 34.12.2), but also the revised scheduling priorities in the tariff (*i.e.*, the scheduling priorities shown in the first column of the new tables).

Accordingly, on August 4, 2021, the CAISO made a supplemental compliance filing. Because the CAISO did not intend that the Parameter Change Procedure would allow it to change the relative scheduling priorities (as opposed to the penalty price values), the CAISO proposed to add the following sentence to

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6 *California Independent System Operator Corporation,* 175 FERC ¶61, 181 at P 167 (2021).

7 Transmittal letter for June 26 Compliance Filing at 6; Compliance Filing, attachment B, new tariff section 31.4.1.

8 Transmittal letter for June 26 Compliance Filing at 6-7.

9 Midcontinent Independent System Operator Tariff, Schedule 28A, § 3.3; New York Independent System Operator, Inc. Market Administration and Control Area Services Tariff, § 17.1.4; PJM Interconnection, L.L.C. Open Access Transmission Tariff, Attachment K –Appendix, § 5.6.3.

10 *Uplift Cost Allocation and Transparency in Markets Operated by Regional Transmission Organizations and Independent System Operators*, Order No. 844, 163 FERC ¶ 61,041, at PP 121-22 (2018).

the end of the Parameter Change Procedure in section 31.4.1: "This section does not authorize the CAISO to change the scheduling run parameter values in a manner that changes the relative scheduling run priorities specified in sections 31.4, 34.12.1, and 34.12.2."

On March 15, 2022, FERC issued an order on the CAISO's compliance filing, as supplemented.[11] FERC rejected the Parameter change Procedure "as outside the scope of the compliance directive."[12] However, FERC ruled that if it wished to pursue the Parameter Change Procedure, the CAISO could submit a tariff amendment filing under Section 205 of the Federal Power Act.[13]

Proposed parameter change procedure

The CAISO seeks to pursue the same Parameter Change Procedure it proposed in its July 26 Compliance Filing, as supplemented on August 4, 2021. Specifically, the CAISO proposes to add the following provision to its tariff:

31.4.1 Temporary Changes to Scheduling Run Parameter Values

If the CAISO determines it is necessary to modify the scheduling run parameter values in sections 31.4, 34.12.1, or 34.12.2 to ensure the market clearing solution is feasible or avoid operational or reliability problems the resolution of which would otherwise require recurring operator intervention outside normal scheduling and market procedures, it may temporarily modify the value for a period up to ninety days, provided however CAISO will file such change with FERC under Section 205 of the Federal Power Act within thirty days of such modification. If circumstances reasonably allow, CAISO will consult with FERC and the CAISO's Market Monitoring Unit before implementing such modification. In all circumstances, the CAISO will (i) consult with those entities as soon as reasonably possible after implementing a temporary modification, and (ii) notify Market Participants of any temporary modification and explain the reasons for the change. This section does not authorize the CAISO to change the scheduling run parameter values in a manner that changes the relative scheduling run priorities specified in sections 31.4, 34.12.1, and 34.12.2."

The parameter change provisions the Commission has approved for other ISOs and RTOs informed the CAISO's development of its Parameter Change Procedure. The Parameter Change Procedure will allow the CAISO to modify the scheduling run parameters **only on a temporary basis** when necessary to ensure feasible market solutions or avoid future operational or reliability problems the resolution of which would require recurring operator intervention outside of normal market

11 *California Independent System Operator Corporation,* 178 FERC ¶ 61,181 (2022).
12 *Id.* at P 9.
13 *Id.* at n 17.

scheduling procedures. The CAISO may temporarily modify the scheduling run parameter for a period up to 90 days, provided the CAISO must file a tariff amendment with the Commission within 30 days of the modification. If circumstances reasonably allow, the CAISO will consult with the Commission and Department of Market Monitoring (DMM) before implementing any such modification. In all circumstances, the CAISO must consult with DMM and the Commission as soon as reasonably possible after implementing a temporary modification. Further, under the Parameter Change Procedure, the CAISO must notify market participants of any temporary modification and explain the reasons for the change. Importantly, the proposed Parameter Change Procedure only allows the CAISO to change temporarily the scheduling parameter values themselves (*i.e.*, the dollar amounts shown in the second and third columns of the tables in tariff sections 31.4, 34.12.1, and 34.12.2); it does not allow the CAISO to change the scheduling priorities in the tariff (*i.e.*, the scheduling priorities shown in the first column of the tables).

Next Steps

The ISO will discuss this straw proposal during a stakeholder web conference on May 2, 2022. Stakeholders are asked to submit written comments by May 9, 2022 through the CAISO's commenting tool.