



California ISO

Price Formation Enhancements

Discussion Paper and Stakeholder Recommendations

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1 Introduction

Price formation is a fundamental element of market design. The California Independent System Operator (the ISO) launched the Price Formation Enhancements initiative in July 2022 to explore comprehensive reforms to its market design and price formation. These reforms aim to improve market price signals, incentivize resource performance, and ensure that market-clearing prices accurately reflect grid conditions. As the Western grid evolves rapidly to integrate more variable energy resources and storage, and as the Western Energy Imbalance Market (WEIM) and Extended Day-Ahead Market (EDAM) expand, it is essential that market-clearing prices provide correct signals that support reliability and facilitate efficient market and operational outcomes.

Phase 1 of the Price Formation Enhancements initiative served as a foundational stage for exploring comprehensive reforms to the ISO's market design and price formation. Starting in August 2023, the ISO established working groups to facilitate inclusive and robust design discussions on three key topics:

- **Scarcity pricing:** Pricing mechanisms to ensure prices accurately reflect the scarcity of energy and reserves during tight supply conditions.
- **Market power mitigation:** Improvements to the WEIM/EDAM balancing authority area-level market power mitigation mechanism.
- **Fast-start pricing:** Pricing mechanisms to incorporate the commitment costs of fast-start resources in market-clearing prices.

In Phase 1, the working groups focused on identifying problem statements, setting guiding principles, and prioritizing issues. They provided a forum for stakeholders to engage in detailed discussions, review existing market mechanisms, and explore potential solutions. These discussions served to inform and guide the policy development in the upcoming Phase 2 of the initiative.

All three topics in the Price Formation Enhancements initiative will move from the Phase 1 working group process to the Phase 2 working group process. This transition marks the completion of the Phase 1 working group process for all topics.

In Phase 2, stakeholders will actively engage and contribute detailed proposals and analyses to formulate and evaluate various market design options. Scarcity pricing and market power mitigation will advance together under the same working group given their overlap and interdependency. In this working group, ISO staff and stakeholders will present and develop market rule changes to address the problems identified in the Phase 1 working group, ultimately culminating in a straw proposal.

Fast-start pricing will proceed through a parallel but separate series of working group meetings to discuss detailed design options and interactions with other ISO market features. Unlike the scarcity pricing and market power mitigation working group, the fast-start pricing working group will not immediately turn to producing a straw proposal in Phase 2. Instead, it will focus first on thorough exploration and discussion of design options.

The proposed transition to Phase 2 considers stakeholder feedback on prioritization between topics. Section 4 of this discussion paper outlines the planned next steps for this new phase of the initiative.

This document serves two key purposes. First, it summarizes the extensive stakeholder discussions and feedback received during Phase 1 of the Price Formation Enhancements initiative. Second, based on this input, it proposes a scope, process, and timeline for Phase 2 of the initiative. The ISO seeks further stakeholder input on this proposed approach before proceeding.

The ISO is committed to closely collaborating with stakeholders to develop future market design enhancements. In this Phase 2 policy development, the ISO will use a working group style for stakeholder engagement, similar to the successful approach used for the Extended Day-Ahead Market (EDAM) policy. The ISO looks forward to working with a diverse set of stakeholders to create market design solutions that ensure efficient and balanced price formation outcomes.

2 Stakeholder Process

2.1 Phase 1 PFE Working Groups

The first phase of the Price Formation Enhancements initiative leveraged extensive stakeholder engagement to inform recommended market design policy changes.

Starting in August 2023, the ISO established a stakeholder working group for this initiative and held 18 meetings to facilitate inclusive and robust stakeholder discussions. The working group identified problem statements, set guiding principles, and prioritized issues.

For Phase 1, the working groups focused on scarcity pricing and BAA-level market power mitigation, and scoped and reviewed a fast-start pricing analysis.

This document is the main deliverable from Phase 1 of the PFE working group. It summarizes the various topics, alternatives, and perspectives discussed, and

recommends issues for policy development in upcoming straw proposals in Phase 2 of this initiative.

Stakeholders are encouraged to provide written comments on the proposed scope and schedule of the recommended issues for policy development described in Section 4 of this paper.

2.2 Phase 2 Stakeholder Engagement

As the Price Formation Enhancements initiative transitions to Phase 2, the ISO is committed to further evolving its stakeholder engagement process to be more inclusive and collaborative. Based on stakeholder feedback and internal discussions, the ISO proposes to implement enhancements to the stakeholder process for Phase 2.

2.2.1 *Iterative Design Process for Scarcity Pricing and Market Power Mitigation*

For the development of scarcity pricing and market power mitigation proposals in Phase 2, the ISO plans to implement an iterative, working group style design process similar to the collaborative approach used in the EDAM policy design. This process will involve a series of working group sessions that gradually build the proposal, allowing stakeholders to provide feedback at each stage. This approach encourages a more dynamic environment than the traditional formal stakeholder process that allows stakeholders to actively shape the evolving design instead of merely reacting to a finalized proposal. The process will include:

- **Concept Development:** Building on the work and discussions from the Phase 1 working groups, ISO staff will present initial high-level concepts for scarcity pricing and BAA-level MPM enhancements to advance these ideas beyond the foundational discussions of Phase 1. Stakeholders will have the opportunity to discuss these concepts, ask questions, and offer feedback.
- **Design Element Workshops:** A series of focused workshops will address specific design elements for each topic. For example:
 - Scarcity pricing workshops might cover improvements to ancillary service procurement, mechanisms for prices to rise ahead of shortages, and pricing during emergency actions.
 - BAA-level MPM workshops could explore the BAA grouping approach, potential modifications to mitigation triggers, and treatment of the CAISO BAA.

- **Iterative Refinement:** Both stakeholders and ISO staff will present design proposals and discuss the trade-offs of each proposal. After each workshop, the ISO will incorporate feedback from the working group discussion and share updated design elements in future sessions. This iterative approach allows for continuous improvement and ensures stakeholders understand and actively contribute to the evolving design.
- **Preliminary Design Synthesis:** Before drafting a formal straw proposal, the ISO will present a synthesis of the design elements discussed and refined throughout the working group process. This preliminary design will serve as a foundation for the straw proposal and allow for a final round of stakeholder feedback.
- **Straw Proposal Development:** The ISO will incorporate all previous discussions and feedback to develop a comprehensive straw proposal. This proposal will reflect the collaborative efforts throughout the design process, which ensures stakeholders are familiar with and have had ample opportunity to shape its core elements.

This approach will ensure that stakeholders deeply understand the proposed design elements and feel a sense of ownership in the proposal's development. By involving stakeholders throughout the design process, instead of presenting a fully developed straw proposal from the start, the ISO will foster more robust discussions, address stakeholder concerns during the design phase, make better-informed decisions, and ultimately create a more effective and widely accepted market design.

3 Price Formation Enhancements

The stakeholder engagement process described in Section 2 builds on the extensive discussions from the Phase 1 Price Formation Enhancements working group. The following sections detail the key topics explored in these working group sessions to date.

3.1 Scarcity Pricing

3.1.1 Working Group Discussions

The working group held several meetings to review scarcity pricing concepts and mechanisms.^{1,2} These discussions covered existing CAISO market mechanisms related to scarcity pricing, including:

- Ancillary service shortage pricing using an ancillary service demand curve.
- The flexible ramping product demand curve.
- Power balance constraint violations.
- Specific pricing rules during emergency events like load shedding or demand response activation.
- FERC Order 831 conditions that raise bid caps and penalty prices.

ISO staff presentations explained key market optimization concepts such as surplus variables and penalty prices that enable these scarcity pricing mechanisms. They showed how penalty prices determine scheduling priorities and contribute to pricing. The ISO presented examples showing how reserve shortages cause higher energy prices through co-optimization. The market balances energy and reserve prices to make suppliers indifferent between providing either product.

The ISO presented four draft problem statements for stakeholder discussion. The sections below discuss these problem statements.

Inconsistent application of the Scarcity Reserve Demand Curve

The Scarcity Reserve Demand Curve (SRDC) is a market mechanism that raises ancillary service prices during reserve shortages.³ Although the SRDC applies directly only to

¹ Slides 13-22. <https://stakeholdercenter.caiso.com/InitiativeDocuments/Presentation-Price-Formation-Enhancements-Aug3-2023.pdf>

² <https://stakeholdercenter.caiso.com/InitiativeDocuments/Presentation-Price-Formation-Enhancements-Oct25-2023.pdf>

³ It can also raise energy prices through co-optimization. See slides 17-19: <https://stakeholdercenter.caiso.com/InitiativeDocuments/Presentation-Price-Formation-Enhancements-Oct25-2023.pdf>.

CAISO, since CAISO is the sole WEIM participant that procures ancillary services through the market, it can still influence price formation across the entire market footprint.

The SRDC aims to incentivize additional supply and voluntary demand reductions to maintain grid reliability during tight supply conditions in the CAISO BAA. The prices that form the SRDC are meant to be incorporated into market prices when the supply cannot meet the CAISO's minimum procurement requirements for ancillary services. However, this problem statement highlights potential inconsistent application of this scarcity pricing mechanism because:

- The ISO real-time market only procures *incremental* ancillary services for the CAISO BAA, rather than fully re-optimizing them. This approach could potentially result in less efficient procurement and pricing.
- The ISO market applies ancillary service scarcity pricing only during an actual shortage. This practice prevents prices from rising gradually as scarcity conditions approach, reducing the market's ability to incentivize additional supply and lower demand before a shortage occurs.
- The ISO market procures incremental ancillary services only in the fifteen-minute market (FMM) and not in the five-minute market, also known as real-time dispatch (RTD). This policy can disconnect ancillary service and energy prices in RTD, which may result in less efficient dispatch and pricing outcomes.
- The WEIM does not procure ancillary services outside the CAISO BAA. This creates asymmetry in scarcity pricing across the WEIM footprint, potentially leading to less efficient outcomes during tight supply conditions.

These limitations prevent the SRDC from triggering or applying in all necessary situations, thus failing at times to reflect tight supply conditions and the scarcity value of reserves.

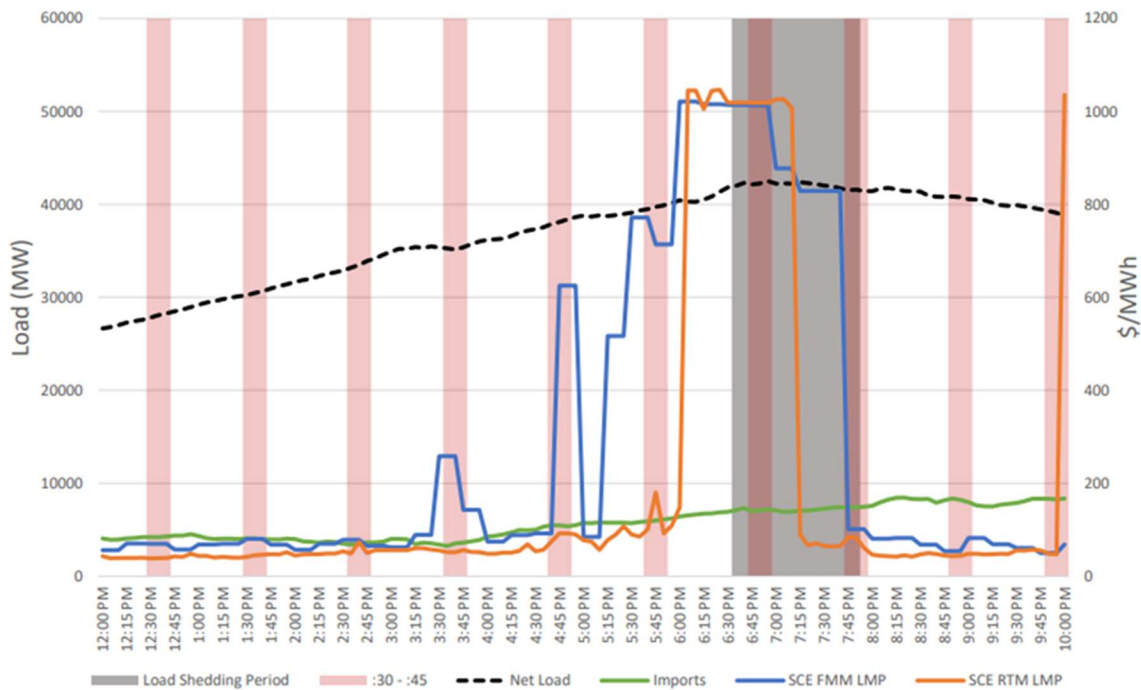
This inconsistent application causes real-time energy and reserve prices not to incorporate the scarcity value of reserves when supply is tight, both within the CAISO BAA and across the broader WEIM footprint, as long as the WEIM entities are not price-separated from the CAISO due to congestion. As a result, real-time market prices may not consistently reflect the true short-term operating conditions during scarcity events. Addressing this issue would allow prices to reflect real-time grid conditions more accurately across the market footprint.

Insufficient mechanisms for prices to rise ahead of shortages

The ISO market lacks sufficient scarcity pricing mechanisms that gradually increase energy and reserve prices ahead of shortages. Since this process involves reserves beyond the required ancillary services (e.g., the Flexible Ramping Product in the WEIM), it impacts the entire WEIM footprint and poses challenges for all participants.

Instead of gradual increases, when scarcity prices set the market-clearing price, they may cause sharp price spikes. Figure 1 illustrates this with dramatic, sudden spikes in both the FMM LMP (blue line) and RTM LMP (orange line) prices, particularly between 4:30 PM and 8:00 PM. Before these spikes, the price curves showed little indication of impending scarcity. The prices remained relatively low and stable until they suddenly jumped, providing little advance warning of potential load shedding conditions.

Figure 1: Market Pricing during Load Shedding Event – August 14, 2020



Source: Market Surveillance Committee Scarcity pricing background discussion, slide 8

This issue limits the time market participants have to respond to price signals and impending shortages. An ideal scarcity pricing mechanism might provide signals multiple hours in advance to allow market participants adequate time to adjust their bids, increase supply, or reduce demand in response to anticipated tight conditions. Additionally, sudden price spikes during shortages creates volatile and unpredictable price signals for market participants.

The current market design fails to consistently project the increased risk of a shortage into higher prices as the system nears scarcity conditions, reflecting scarcity only after a shortage hits. Developing mechanisms for prices to rise earlier and more gradually as shortage risks increase could produce more actionable and effective scarcity price signals. This approach could encourage market-based solutions to resolve shortages and reduce the need for disruptive emergency actions, particularly if these signals can be provided sufficiently in advance of real-time operations.

Outdated administrative penalty prices

This problem statement highlights concerns that some key administrative penalty prices in the ISO market's pricing run may no longer align with the evolving conditions in the Western Interconnection.⁴ Currently, the ISO's pricing run penalty prices are anchored and scaled based on the prevailing bid cap. However, this approach may not be optimal for reflecting the true value of reliability and scarcity in the market. The working group also noted that these pricing run penalty prices might be outdated due to both tighter supply conditions across the West in recent years and general economy-wide inflation.

While the bid cap does influence penalty prices in the current market design, there is no inherent reason why penalty prices must be tied to a bid cap. An alternative approach could be to anchor and scale penalty prices based on a Value of Lost Load (VOLL) estimate, which may better reflect the economic impact of supply shortages and reliability events. It is important to note that these pricing run penalty prices apply equally to all participants across the entire WEIM footprint, including both the CAISO BAA and all other WEIM entities.

If these pricing run penalty prices remain too low and fail to keep pace with changing market conditions, they may hinder the ISO market's ability to compete for supply and accurately reflect the value of reliability in prices. This potential misalignment impacts the market in two ways:

1. It may make selling energy outside the WEIM footprint more profitable for some voluntary market participants when the system is stressed. If the ISO's pricing run penalty prices are too low compared to prices elsewhere, it could reduce the overall supply available to the ISO for managing tight conditions and resolving shortages within the WEIM footprint. In other words, outdated penalty prices

⁴ In the CAISO market, penalty prices serve different functions in the scheduling run and the pricing run. Scheduling run penalty prices determine the priority under which constraints may be relaxed or self-schedules curtailed. Pricing run penalty prices, which are the focus of this discussion, establish market prices when these events occur.

may weaken suppliers' incentives to offer supply in the ISO market during scarcity conditions compared to other opportunities.

2. The current pricing run penalty prices may understate the value consumers place on a reliable electricity supply. This could weaken incentives for reliability-supporting actions, such as voluntarily reducing consumption or adjusting export schedules during scarcity conditions.

By not sending accurate price signals to both supply and demand, outdated penalty prices may hinder the market's ability to efficiently balance supply and demand and maintain reliability during tight system conditions.

The working group identified this issue and suggested to reevaluate and potentially update the pricing run penalty prices to ensure they align with current conditions. This process would involve carefully considering whether to maintain the connection between penalty prices and bid caps, or to explore alternative approaches such as basing penalty prices on VOLL estimates.

Aligning market prices with system conditions during emergencies

This problem statement relates to concerns about how the ISO market reflects the pricing impacts of emergency actions taken by grid operators during times of extreme system stress. Specifically, the working group noted that the current market design might not adequately reflect the scarcity and severity of conditions when emergency actions are taken, such as:

- Activating emergency demand response programs that reduce load.
- Dispatching backstop "strategic reserve" resources that are not normally participating in the market.
- Ordering firm load shed (rotating outages) as a last resort to maintain system stability.

The market impact of this issue is that real-time prices may not consistently reflect the true level of supply scarcity and operational risk when these emergency actions occur. While the market does incorporate these emergency actions into its optimization, this can paradoxically lead to downward pressures on prices due to the influx of supply or reduction in demand. This could lead to a disconnect in which market prices are not fully capturing the seriousness of the grid emergency and the costs being incurred to maintain reliability in a particular area, which may impact flows in and out of the market. The working group suggested this might result in price signals that fail to reflect the actual real-time operational conditions and scarcity.

Moreover, the working group emphasized the need to enhance transparency regarding out-of-market operator actions that affect supply and demand during tight conditions. While the ISO provides some after-the-fact information on out-of-market actions, market participants have expressed a desire for greater real-time visibility into these actions, which can significantly influence market outcomes and price formation. Enhancing the timeliness and detail of this information could further improve market transparency and efficiency.

The working group considered whether market mechanisms to ensure that prices align with and account for emergency actions could improve price formation during these critical periods. This could involve developing market mechanisms to better reflect the true scarcity conditions during emergency events and accounting for various types of operator actions. While some actions, such as emergency demand response and deployment of strategic reserves, tend to suppress prices by increasing supply or reducing demand, other actions like operator load biasing can actually increase prices. Stakeholders have argued for pricing mechanisms that would more accurately reflect the underlying scarcity conditions during such events. The goal would be to ensure market prices consistently reflect the level of scarcity indicated by the need for these emergency actions, including potential firm load curtailment, rather than being primarily driven by the direct effects of emergency interventions. Additionally, the working group emphasized the need to enhance reporting and communication of out-of-market actions to stakeholders, contributing to better-informed market participation and more accurate price formation during scarcity conditions.

Overall, these working group discussions thoroughly reviewed current CAISO scarcity pricing to identify issues and laid the groundwork for developing potential enhancements.

3.1.2 Scarcity Pricing “Sprint”

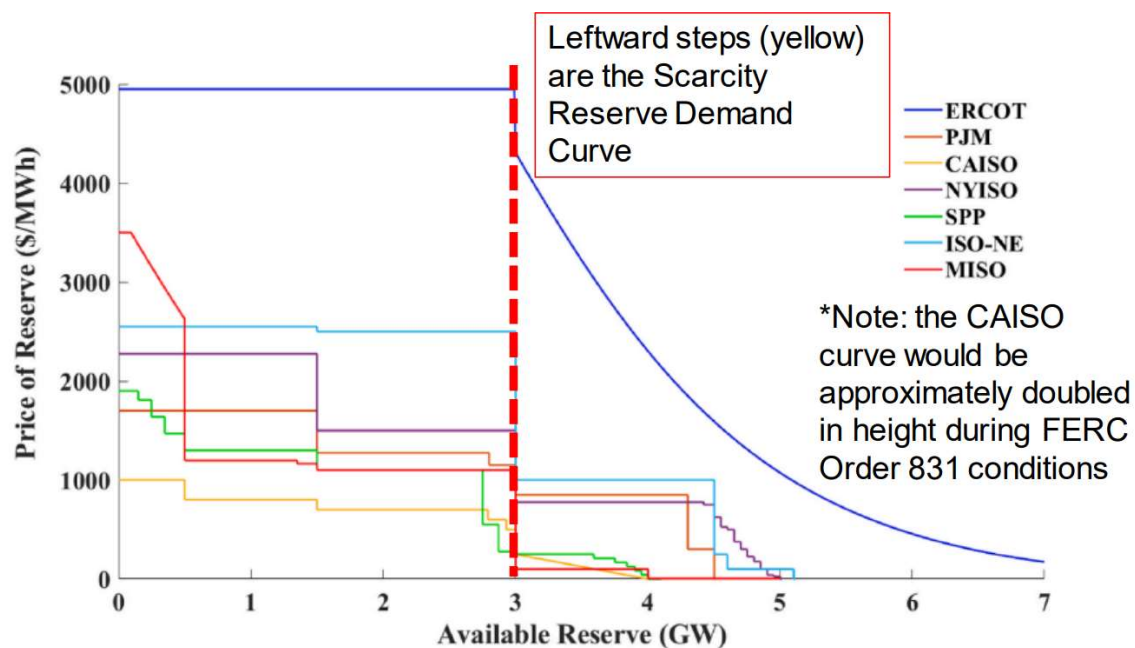
The ISO organized a scarcity pricing “sprint” for the working group. The sprint concentrated efforts within a short, intensive period to quickly identify and characterize specific issues related to scarcity pricing mechanisms, enabling more rapid progress and stakeholder engagement. The following sections review the sprint discussions.

Sprint Session #1

The working group reviewed scarcity-pricing concepts and continued to discuss issues that limit the SRDC’s activation. The ISO and stakeholders shared initial solutions for the working group’s consideration as the PFE initiative progresses.

Scarcity pricing occurs when market prices exceed the offer price of the most expensive available resource due to insufficient supply. As mentioned in earlier sections, ISO uses an SRDC when supply cannot meet minimum ancillary service procurement requirements. The SRDC provides price signals during reserve shortages to encourage more supply and reduce demand, helping maintain reliability. It consists of the leftmost steps in ISO's overall operating reserve demand curve (see Figure 2).

Figure 2: Reserve shortage pricing in ISO/RTO markets



Source: Mehrtash, Mahdi, Benjamin F. Hobbs, and Erik Ela. "Reserve and energy scarcity pricing in United States power markets: A comparative review of principles and practices." *Renewable and Sustainable Energy Reviews* (2023). Figure adapted by CAISO with additional annotations.

The problem statement is that ISO's market design limits the SRDC's ability to set market prices during tight conditions, leading to inadequate price signals, reliability risk, market inefficiencies, and misaligned incentives.

Preliminary options for discussion included introducing a more robust deliverability test for ancillary services and fully re-optimizing ancillary services in both the fifteen-minute market and the five-minute market.

Implementing a more robust deliverability test is a necessary step towards increasing system operators' confidence that ancillary service awards are feasible and accessible despite transmission constraints. This confidence is a prerequisite to the full re-optimization of ancillary services in the real-time market. By re-optimizing ancillary

services in the fifteen- and five-minute markets, the market could trigger scarcity pricing through the SRDC when system conditions justify it. This approach would allow for more accurate scarcity pricing in real-time, and ensure that prices reflect tight supply and demand conditions more effectively compared to the current limited application of the SRDC.

Scarcity Sprint #2

This working group discussion built on the previous week's session to examine issues with prices not rising in advance of shortages and exploring reserve-based solutions for earlier scarcity price signals, including comparisons to other ISOs' practices.

This discussion focused on proactive market actions to take before a shortage occurs. The problem statement is that ISO's market design limits the opportunity for energy prices to rise gradually ahead of impending demand shortfalls. Issues with prices not rising ahead of shortages include:

- Limiting market participants' ability to respond proactively to impending shortages.
- More frequent and sudden price spikes, creating volatile signals and greater risk.
- Operators taking actions that can either suppress or increase prices, potentially distorting market signals.

Preliminary options to address this issue included:

- Extending the procurement curve for the flexible ramp product.
- Extending the procurement curve for spin/non-spin beyond the minimum requirements.
- Implementing a new 30-minute reserve product and associated demand curve similar to those found in Eastern U.S. markets.
- Implementing a latent-supply-based operating reserve demand curve or a new reserve product.

Figure 2 above compares ISO's flexible ramp product curve to other ISOs' reserve product curves that extend farther to the right.

Scarcity Sprint #3

This discussion explored how various actions can distort scarcity-pricing signals, and considered initial ideas to better capture their price impacts. It also addressed specific storage bidding issues and the concept of a scarcity pricing "circuit breaker."

The working group noted that the price formation process does not fully capture the price impacts of reliability use-limited resources and non-market actions during emergencies. Examples include strategic reserves, demand response, voluntary conservation, and load shedding, which can put downward pressure on prices, distorting scarcity signals and reducing incentives to perform. The working group discussed using price floors activated under certain triggers as a potential solution.

The group also highlighted that the \$1000/MWh limit on energy storage bids may not reflect their opportunity costs when the bid cap rises to \$2000/MWh in tight conditions. This limitation can lead to inefficient early dispatch of storage and suppress pre-shortage prices.

Finally, the group discussed the absence of a circuit breaker mechanism in the ISO to protect consumers and participants from the financial impacts of extended scarcity pricing.

Symmetry of scarcity pricing mechanisms across WEIM BAAs

As the ISO and stakeholders explored potential scarcity pricing enhancements, a key principle emerged from the discussions: scarcity pricing changes should apply symmetrically across all BAAs in the WEIM whenever possible. This principle ensures fair treatment and consistent price signals throughout the market, recognizing that some existing mechanisms, like the SRDC, currently apply only to the CAISO BAA. The ISO is committed to exploring ways to implement scarcity pricing enhancements that uphold this symmetry, while acknowledging the unique characteristics and needs of different BAAs within the WEIM.

3.1.3 Stakeholder Comments on Scarcity Pricing

The ISO sought stakeholder feedback on the problem statements and potential solutions. Stakeholder comments covered a wide range of perspectives on the scarcity pricing issues discussed during the working group sessions. (See Figure 3). Overall, stakeholders appreciated the focused discussions, identified several high-priority areas for enhancement, and highlighted the need to ensure compatibility across the ISO's evolving markets.

Figure 3: Stakeholder Feedback on Scarcity Pricing

Feedback on specific problem statements:

- **SRDC activation** - Many agree this is an issue but note that SRDC improvements alone may not be sufficient. Ensuring feasibility of real-time AS optimization is an important concern. Additional energy scarcity pricing mechanisms may be needed.
- **Gradual price increases** - Broad agreement this is important. A latent supply curve is a potential solution to explore further. New reserve products should be operationally justified, not just for pricing.
- **Reliability actions and pricing** - Strong agreement that reliability actions and out-of-market dispatches should not undermine scarcity price signals. Considered a high priority issue. Suggestions include an ERCOT-style reliability adder.
- **Storage bid cap** - Many support allowing storage to bid up to \$2000/MWh when the cap is raised to reflect opportunity costs. Considered a high priority for a fast-track solution before summer 2024.
- **Circuit breaker** - Lower priority for most given current price levels. Could become important if much higher scarcity prices are pursued.

Additional issues to explore

- Ensuring scarcity pricing solutions work effectively across the ISO's different market contexts (CAISO BA, WEIM, EDAM) and don't create unintended asymmetries.
- Considering the broader benefits of scarcity pricing for both load and supply in terms of improved incentives, reliability, and cost-effectiveness.
- Revisiting whether current scarcity price levels (\$1000-2000/MWh) are sufficient or if higher levels aligned with the value of lost load (VOLL) should be considered.

Prioritization

- Most considered the storage bid cap issue to be the top priority for fast-tracking.
- Issues a, b, and c (SRDC, gradual prices, reliability actions) are generally high priority.
- Issue e (circuit breaker) is lower priority unless higher scarcity prices are considered.

Additional analyses requested

- Provide a comprehensive list of reliability actions and out-of-market dispatches that could undermine scarcity pricing.
- Assess FERC Order 831 performance and bidding limitations for storage and demand response.
- Study pricing and conditions leading up to recent tight supply events.

3.1.4 Rules for Bidding above the Soft Offer Cap

In response to stakeholder feedback during the working group process, the ISO proposed expedited changes to bidding rules above the soft offer cap, aiming for implementation in summer 2024. These changes address concerns about energy-limited resources such as storage and hydro accurately reflecting intra-day opportunity costs in their bids.⁵

The proposal had two main components:

- **Raise the cap on all Default Energy Bids from \$1,000/MWh to \$2,000/MWh.** This change allows resources, especially hydro, to bid up to a value reflecting opportunity costs defined in their Default Energy Bids (DEBs), even if it exceeds \$1,000/MWh. The previous \$1,000/MWh DEB cap prevented resources from bidding up to verified costs without a reference-level change request.
- **Modify the bid cap for energy storage resources to provide bidding flexibility using a proxy opportunity cost based on the maximum of the fourth highest hourly Maximum Import Bid Price (MIBP) value and highest cost-verified bid.** Analysis showed uncapped storage DEBs may frequently fall below \$1,000/MWh, so the storage-specific bid cap enhancement ensures sufficient bidding flexibility for storage when market prices rise above \$1000/MWh.

The ISO developed these proposals through a stakeholder process that considered various options. The ISO Board and WEIM Governing Body approved the changes in May 2024 for implementation targeted in summer 2024. The ISO filed this with FERC on May 31, 2024⁶, received FERC approval on July 31, 2024⁷, and implemented these changes on August 1, 2024.

⁵ <https://stakeholdercenter.caiso.com/InitiativeDocuments/Final-Proposal-Price-Formation-Enhancements-May17-2024.pdf>

⁶ May 31, 2024 Tariff amendment filing (ER24-2168), available at <https://www.caiso.com/documents/may-31-2024-tariff-amendment-price-formation-enhancements-er24-2168.pdf>

⁷ *Cal. Indep. Sys. Operator Corp.*, 188 FERC ¶ 61,089 (2024).

3.2 BAA-Level Market Power Mitigation

The working group discussed BAA-level market power mitigation (MPM) in the Western Energy Imbalance Market.^{8,9} These discussions began with a history and overview of BAA-level MPM. When forming the WEIM, concerns arose about potential structural market power, especially for entities that own most of the generation in their BAA. To address this concern, the original WEIM design included a methodology to expand local market power mitigation techniques to include congestion on transmission constraints into a WEIM BAA that results in price separation.¹⁰ When BAAs in the WEIM are price separated, a dynamic competitive path assessment (DCPA) evaluates whether internal generation can meet demand competitively without additional transfers. If not, the market mitigates the bids of resources in that BAA.

This design worked well with only a few entities in the WEIM, but now with 22 WEIM entities, testing each BAA independently may no longer be optimal. Furthermore, some market participants question whether excluding the CAISO BAA from the BAA-level market power tests remains appropriate. These concerns led to the following two problem statements:

1. The BAA-level market power test may underestimate a BAA's true structural competitiveness because it tests BAAs in isolation without considering external supply.
2. The BAA-level Dynamic Competitive Path Assessment does not apply to the CAISO BAA. It always considers the CAISO BAA structurally competitive. This could lead to under-mitigation during those market intervals in which the CAISO BAA is not structurally competitive.

The working group considered potential improvements to BAA-level MPM. One key suggestion was to perform a DCPA for grouped BAAs rather than conducting independent tests for each area. The idea is to progressively group and test BAAs together based on their marginal energy costs and transfer connections, rather than testing each BAA individually. The ISO provided examples showing how mitigation would be applied based on the results of the DCPA tests for the grouped BAAs. Ultimately, a

⁸ <https://stakeholdercenter.caiso.com/InitiativeDocuments/Presentation-Price-Formation-Enhancements-Sep14-2023.pdf>

⁹ <https://stakeholdercenter.caiso.com/InitiativeDocuments/Presentation-Price-Formation-Enhancements-Nov16-2023.pdf>

¹⁰ Except for the CAISO BAA.

grouping method could reduce test failures and more accurately assess a BAA's structural competitiveness.

Working group participants requested additional information, such as data on frequency of mitigation and more details on the MPM testing process. The Department of Market Monitoring (DMM) provided an overview of the BAA-level MPM process and presented data on the frequency and magnitude of BAA-level mitigation in the WEIM across different regions from January to October 2023.¹¹ The data showed the percentage of intervals each BAA was subject to mitigation when import constrained and the percentage of offered resource capacity actually mitigated by having bids lowered. The figures provided by DMM broke this down by region, BAA, time of day, and month.

Stakeholders found the data analysis on current BAA-level market power mitigation in the WEIM informative and insightful. However, some were surprised that mitigation occurred most frequently in shoulder months and off-peak hours when market power is least expected, because there is typically a high penetration of low cost renewable generation and prices are generally low during those periods. This raised questions about whether the current triggers for testing structural competitiveness are appropriate, leading to the formation of an additional problem statement:

3. The current BAA-level MPM uses triggers that subject BAAs to mitigation most frequently during hours when prices are generally low.

In response to problem statement #3, some stakeholders suggested an "impact test" that would only mitigate bids if the change in locational marginal price (LMP) from an uncompetitive bid exceeds a certain threshold.

Other stakeholder comments on the BAA-level MPM topic included:

- Stakeholders generally supported exploring the BAA grouping concept to improve MPM accuracy but emphasized the need to ensure that the benefits outweigh the added design complexity. They requested more technical details and examples, and a clear algorithm for the grouping approach.
- Stakeholders sought clarifications on various design elements of the BAA grouping approach, such as its applicability to EDAM, treatment of BAAs without direct connections, setting of competitive LMPs, and interactions with new market products and other design changes.

¹¹ Ibid 17. PDF pages 10-26.

- Several stakeholders supported applying BAA-level MPM to the CAISO BAA like other BAAs, rather than assuming it is always competitive, to prevent potential under-mitigation.

3.3 Fast-Start Pricing

3.3.1 Foundational Workshops

The ISO began exploring enhancements to its price formation through a series of foundational workshops held from November 2022 to March 2023. These workshops focused on developing market pricing principles, understanding how market prices are determined, and discussing the potential implementation of fast-start pricing in ISO markets. The presentations provided insights into the complexities of price formation and the potential impacts of various pricing methodologies on market efficiency, transparency, and reliability. This section summarizes the key points and findings from the first three workshops in the series.

The first presentation focused on developing price formation principles and building foundational understanding through simple examples.¹² The presentation included four examples illustrating how different scenarios affect market prices, considering factors such as resource dispatchability, minimum output constraints, and fixed commitment costs. The examples showed how a market based on marginal cost pricing motivates sellers to bid their actual costs, leading to more efficient dispatch and better market power monitoring compared to a pay-as-bid pricing market. They also demonstrated the need for uplift payments for resources with fixed costs and minimum output constraints when the resources' costs were not recovered through the market.

The second presentation focused on the fundamentals of fast-start pricing.¹³ Fast-start resources are unique because the market often dispatches them to their inflexible minimum or maximum operating limits, making them ineligible to set the LMP. Fast-start pricing aims to recognize that fast-start resources may effectively serve as the marginal resource used to meet the next increment of energy or operating reserves demand. The basic components of fast-start pricing include relaxing minimum output

¹² Presentation - Price Formation Enhancements - Nov 16, 2022

<https://www.caiso.com/InitiativeDocuments/Presentation-PriceFormationEnhancements-Nov16-2022.pdf>

¹³ Presentation - Price Formation Enhancements – Dec 16, 2022

<https://www.caiso.com/InitiativeDocuments/Presentation-PriceFormationEnhancements-Dec16-2022.pdf>

limits in the pricing run (allowing fast-start resources to operate across their entire capacity range for pricing purposes) and including commitment costs in pricing. Fast-start pricing utilizes separate market runs — a scheduling run and a pricing run — for unit commitment/dispatch and pricing. Two examples illustrated the status quo and the potential implementation of fast-start pricing, focusing on minimum output relaxation and the inclusion of commitment costs. The examples highlighted the importance of incentivizing participants to follow their market schedules and dispatch, which under fast-start pricing may require opportunity cost payments or financial penalties. Additional considerations included defining eligible fast-start resources and the duration of commitment costs in the LMP price signal.

The third presentation aimed to show how an alternative fast-start pricing mechanism could address concerns about the impact of fast-start pricing on flexible ramping product prices while still allowing fast-start resources to set prices when appropriate.¹⁴

The “alternative approach” relaxes the minimum output constraint for fast-start resources in the binding interval of the pricing dispatch but enforces it during the advisory intervals. This contrasts with the “ordinary approach” to fast-start pricing, which relaxes the minimum output constraint in all intervals. Two examples illustrated the differences between the status quo (the ISO’s current market solution), the ordinary approach, and the alternative approach. In Example 1, where the fast-start resource does not operate in the binding interval, the alternative approach produces the same results as the status quo, avoiding issues from the ordinary approach. In Example 2, where the fast-start resource operates in the binding interval and is needed to meet the load, the alternative approach allows the fast-start resource to set the LMP while properly accounting for opportunity costs in the flexible ramping product (FRP) prices.

The presentation raised discussion points about the fairness of FRP compensation under the alternative approach and the potential need to relax ramping constraints for fast-start resources between binding and advisory intervals.

3.3.2 Working Group Discussions

At the conclusion of these foundational workshops, stakeholders requested that the ISO estimate the potential market impacts of implementing fast-start pricing. Stakeholders

¹⁴Presentation - Price Formation Enhancements – Mar 20, 2023.

<https://www.caiso.com/InitiativeDocuments/Presentation-Price-Formation-Enhancements-Mar20-2023.pdf>. For additional background on these concerns see ISO Comments filed in RM17-3 dated February 28, 2017; see also ISO Supplemental Comments dated August 17, 2017.

said they needed this information to understand the economic and operational implications of fast-start pricing in order to make more informed decisions and provide constructive feedback to the ISO. The ISO committed to analyzing this in the first phase of the fast-start pricing working group before discussing a potential design.

The ISO engaged stakeholders and requested feedback on the proposed analysis approach and information needed to support robust discussions on potential fast-start pricing implementation.

The ISO proposed a two-stage analysis of fast-start pricing impacts:

- **Stage 1:** Analysis using historical bid data and some simplifying assumptions to estimate price impacts under different fast-start pricing scenarios in the CAISO BAA
- **Stage 2:** A more detailed analysis incorporating stakeholder feedback on the analysis scope and including all WEIM BAAs.

Incorporating feedback from stakeholders, the ISO presented its first stage of analysis at the December 2023 working group session.¹⁵ The first stage focused on the ISO area only and building foundational features of fast-start pricing.

The presentation started with various relevant summary statistics for fast-start pricing. First, the analysis showed the WEIM generation fleet includes a significant share of resources that meet various fast-start time definitions. These definitions depend on a resource's startup time, minimum up time, and transition time.¹⁶ The fleet also features a variety of resource technology types that meet fast-start criteria. Next, the analysis revealed that gas-fired units receive the largest share of historical bid cost recovery (BCR). This indicates that market prices alone may not fully compensate these units and suggests these units are the most likely to impact market prices if their commitment costs are included. BCR is more balanced across startup time categories but leans towards units with minimum up times over 60 minutes. These units often face higher operational costs due to longer required running times but are not typically considered fast-start resources in other markets.

¹⁵ <https://www.aiso.com/InitiativeDocuments/Presentation-Price-Formation-Enhancements-Dec12-2023.pdf>

¹⁶ "Start-up time" is the amount of time it takes a resource to begin operating. "Minimum up time" is the shortest period a resource must stay active once it starts operating. "Transition time" is the duration needed for a multi-stage generator to switch from one configuration to another.

The fast-start pricing analysis estimated the potential impact on market prices under various sensitivity scenarios. It applied two different methods to amortize commitment costs into energy bids (constant adder and minimum average cost)¹⁷ and tested 30-minute and 60-minute startup time and minimum up time thresholds.¹⁸ Preliminary results for the CAISO balancing area in 2022-23 showed:

- Minor average price increases (<\$1/MWh) with either 30- or 60-minute scenarios, but the 60-minute scenario had a much larger average impact.
- Fast-start pricing increases tended to occur during peak hours when units are more likely to start or transition. Price impacts during peak hours were negligible under the 30-minute scenario and ranged from \$2-10/MWh increases under the 60-minute scenario. The constant adder consistently led to higher peak price impacts.
- Incremental fast-start pricing costs averaged \$120,000 to \$270,000 per month under the 30-minute scenario and \$10 million to \$13 million per month under the 60-minute scenario.

The ISO asked stakeholders for feedback on the analysis scope and approach to expand the analysis to all WEIM areas. The ISO held a workshop in February 2024 to elaborate on methods for including commitment costs in LMPs, with the aim of facilitating better stakeholder understanding of the analysis methods.¹⁹ Additionally, the ISO received feedback from an independent market consultant Mike Cadwalader²⁰ and the Market Surveillance Committee²¹.

¹⁷ The constant adder approach applies a single fixed adder to each segment of the variable-cost bid curve to reflect commitment costs. The minimum average cost approach identifies the least-cost segment across the variable range and uses that to define the adjusted bid curve.

¹⁸ Multi-stage generator transitions were modeled as flexible startup/transitions.

¹⁹ <https://stakeholdercenter.caiso.com/InitiativeDocuments/Presentation-Price-Formation-Enhancements-Workshop-Feb12-2024.pdf>

²⁰ <https://stakeholdercenter.caiso.com/InitiativeDocuments/Mike-Cadwalader-comments-Price-Formation-Enhancements-Working-Group-Session9-Jan-11-24.pdf>

²¹ Dec 18, 2023 - Market Surveillance Committee meeting. <https://www.youtube.com/watch?v=bK26k3-IVhk>

In April 2024, the ISO expanded on its initial analysis from December 2023 by presenting the second stage on potential fast-start pricing impacts. The presentation addressed several stakeholder requests for more data and sensitivity scenarios. However, suggestions such as detailed reliability or energy storage impacts were considered out of scope. The second stage analysis covered:

- Identification of resource types and WEIM regions with fast-start capable units based on startup time, minimum up time, and transition time.
- Additional data on bid cost recovery and unit commitment.
- Fast-start pricing impacts for all WEIM areas in the real-time market.
- Twelve sensitivity scenarios varying the amortization method and time thresholds.

ISO staff introduced a new amortization method called the “adjusted constant adder”²² based on feedback from Mike Cadwalader, who explained the “constant adder” approach inappropriately increases the total cost of dispatching a fast-start unit. The analysis also included two scenarios representing the bookends of fast-start pricing impacts in the WEIM.²³ In the “BAA-level” scenario, each BAA cleared separately with its resources to meet its demand plus net transfers, resulting in different prices for each BAA. This scenario assumes fast-start resources in one BAA do not impact prices in another BAA. In the “system-level” scenario, a single system-wide price is determined by clearing all resources across the entire WEIM footprint to meet total system demand, implying that fast-start resources in one BAA can set the price for the whole WEIM region.

The analysis showed that the impact of fast-start pricing on the WEIM appears to be generally moderate and suggests it would not cause significant price changes. Over 90% of intervals show no fast-start pricing impact in most areas. Cost impacts in the WEIM are also relatively moderate because they only apply to incremental market dispatches

²² The adjusted constant adder approach is similar to the constant adder approach but subtracts the cost of the first bid segment from the adder before applying it to each segment.

²³ These approaches are not design alternatives but simplifications made for the analysis because modeling the fast-start pricing impacts with local transmission constraints or the dynamic impact of WEIM transfers was not achievable. This distinction matters because, as noted in the presentation, some Northwest BAAs without their own fast-start resources see no price impact under the BAA-level scenario but could face higher prices set by fast-start resources in other areas under the system-wide scenario. The actual impact would fall somewhere in between.

relative to base schedules. However, some BAAs with small resource pools and high commitment costs could lead to very high price increases in the top 1-3% of intervals.

The analysis revealed regional variations in price impacts, with the Southwest and CAISO BAA experiencing the largest increases and the Pacific Northwest the smallest increases. This suggests that regions with more fast-start units, especially fast-start gas units with high commitment costs, are more sensitive to changes in fast-start pricing. The analysis also showed seasonal and time-of-day variations in price impacts, with higher changes occurring during summer months and peak hours in the morning and evening. This reflects the times when fast-start resources are needed most to meet demand.

Price impacts also varied greatly depending on the resources that qualify as fast-start and the amortization method used. Fewer qualifying resources resulted in a lower impact. Across the scenarios, the adjusted constant adder and minimum average cost amortization methods had the lowest price impact, while the constant adder had the highest. Ultimately, the choice of fast-start resource definitions and amortization methods must align with market goals and the characteristics of the fleet.

3.3.3 Stakeholder Comments on Fast-Start Pricing

Stakeholders offered a range of perspectives on CAISO's final fast-start pricing analysis. (See Figure 4.) Some recognized the value of fast-start pricing and advocated for prioritizing it. However, most stakeholders suggested prioritizing scarcity pricing and market power mitigation efforts, arguing that fast-start pricing needs further evaluation of costs and benefits depending on the design and its interaction with existing market features.

Figure 4: Summary of Stakeholder Comments to Fast-Start Pricing Analysis

Support for fast-start pricing

- Some stakeholders, particularly those in the Pacific Northwest with hydro resources, support fast-start pricing as a way to improve price signals and resource compensation when fast-start resources are needed.
- They argue fast-start pricing would ensure equitable compensation across resource types, attract lower-cost supply, and reinforce GHG pricing.
- While not the top priority, they want to see fast-start pricing kept in scope for future phases of the initiative.

Opposition to fast-start pricing

- Other stakeholders oppose implementing fast-start pricing, arguing the ISO's analysis shows limited benefits and increased costs.
- They argue the current market structure already provides fast-start pricing's intended benefits, and implementing it could undermine other market features like the flexible ramping product.

Clarification requested

- Stakeholders want more clarity on the net benefits of fast-start pricing after accounting for potential reductions in bid cost recovery payments.
- Some ask for elaboration on why the ISO is reconsidering fast-start pricing now after not adopting it in prior years.

Future suggestions

- Focus on lower-impact scenarios like 30-min startup/60-min minimum run time, and average cost amortization methods.
- Test in actual market software to understand interactions with other market features.
- Estimate impact on day-ahead market and EDAM.
- Explain treatment of opportunity costs and resources like energy storage.
- Clarify interaction with market power mitigation.
- Assess potential for gaming.

Prioritization

- Most rank fast-start pricing as low to medium priority compared to other topics like scarcity pricing, market power mitigation, and FRP improvements.
- Stakeholders want a roadmap of all topics in the initiative and when fast-start pricing might be designed and implemented.

3.3.4 Perspectives from Independent Market Experts

Dr. Susan Pope, the WEIM Governing Body market expert, presented a briefing on March 19, 2024, covering aspects of fast-start pricing in the context of the WEIM.²⁴ The Governing Body sought her expert opinion on fast-start pricing to gain an informed perspective for guiding their decision-making process.

She argued that fast-start pricing provides efficient price signals when dispatching fast-start units to meet load, and said it addresses potential price anomalies. She compared fast-start pricing with mechanisms like FRP and shortage pricing, noting that although they can overlap, FRP and shortage pricing do not specifically address pricing issues related to starting up fast-start units. She noted that insights from regions like MISO and NYISO show that successful fast-start pricing involves refining resource definitions and pricing calculations.

Dr. Pope pointed out that the ISO's analysis suggests modest price impacts, especially during high load periods. This aligns with the expectation that fast-start pricing will raise LMPs when fast-start resources meet incremental load. In her view, this would improve price signals for real-time imports, exports, and price-responsive load. She expects fast-start pricing would boost market efficiency by increasing real-time offers from importers and other non-offering resources, improving performance incentives for supply resources and day-ahead imports, possibly lowering costs and emissions by reducing the starts of fast-start units in response to better price signals, and generally decreasing BCR payments.

Dr. Pope also recognized that market monitor opinions on fast-start pricing are mixed. Potomac Economics, which serves as market monitor for MISO and NYISO, supports it for improving price formation, while CAISO's DMM and Monitoring Analytics, the market monitor for PJM, see it as potentially distorting market signals. Overall, she identified opportunities for fast-start pricing to enhance market efficiency and price signals in the WEIM.

²⁴ <https://www.westerneim.com/Documents/BriefingbyWEIMGoverningBodyMarketExpertonFast-StartPricing-Presentation-Mar2024.pdf>

Michael Cadwalader also provided comments on fast-start pricing, responding to both Dr. Pope's presentation²⁵ and the ISO's analysis.²⁶ He agreed with Dr. Pope that fast-start pricing generates price signals that accurately reflect the marginal cost of meeting load, thereby improving market efficiency. Mr. Cadwalader agreed that fast-start pricing, FRP, and shortage pricing are intended to address different situations and should be implemented in a manner that would ensure that they do not interfere with each other.

He agreed that fast-start pricing implementations can benefit from other markets' experiences but warned against assuming direct application in ISO markets due to market structure differences. Mr. Cadwalader evaluated the ISO's analysis, finding the impacts generally align with his expectations. He pointed out that most fast-start pricing impacts occur during upward or downward ramping periods, with greater effects in high-demand seasons and regions with more gas peakers.

Mr. Cadwalader observed that the constant adder approach typically results in higher LMPs compared to other methods because this method overstates costs and makes the fast-start generator appear more expensive in the pricing pass than in the dispatch pass. This can reduce the need for BCR payments but might also result in lost opportunity costs (LOCs), because generators could profit more by producing additional energy at the higher prices. He stressed the need to assess each approach's impact on BCR payments and LOCs and to consider the potential for gaming under different amortization methods.

4 Price Formation Enhancements Phase 2

The next phase of the Price Formation Enhancements initiative will move all three topics to the policy design phase. This phase will include detailed proposals and analyses, with stakeholders actively engaging and providing input to evaluate different market design options. Figure 5 outlines the proposed timeline, incorporating stakeholder feedback and the readiness of design proposals for each topic.

²⁵ Slides 102-108. <https://stakeholdercenter.caiso.com/InitiativeDocuments/Presentation-Price-Formation-Enhancements-Apr8-2024.pdf>

²⁶ <https://stakeholdercenter.caiso.com/InitiativeDocuments/Mike%20Cadwalader%20Comments%20Price%20Formation%20Enhancements%20Working%20Group%20Session%2016%20-%20April%208,%202024.pdf>

The timeline indicates that proposal development and stakeholder engagement will occur in stages. Scarcity pricing and BAA-level MPM will advance together under the same proposal due to their overlap and interdependency. For these topics, the ISO aims to begin work with stakeholders on a straw proposal in October 2024.

Fast-start pricing policy will proceed separately and start its policy development process later. The ISO plans to conduct working group sessions from October 2024 to August 2025 to discuss detailed design options and interactions with other ISO market features before developing a straw proposal. These working groups will launch concurrently with the scarcity pricing and market power mitigation efforts.

This staged approach allows for thorough stakeholder engagement, analysis, and refinement of proposals over time. The extended periods for each stage reflect the complexity of the topics and the need for comprehensive stakeholder input and analysis.

Figure 5: Phase 2 Proposed Timeline

	Phase 1			Phase 2	
	Scarcity Pricing	BAA-Level MPM	Fast-Start Pricing (Analysis)	Scarcity Pricing / BAA-Level MPM	Fast-Start Pricing (Policy)
Jul-23	Working group preparation				
Aug-23	Conduct working groups	Conduct working groups	FSP data analysis		
Sep-23					
Oct-23					
Nov-23					
Dec-23					
Jan-24					
Feb-24					
Mar-24	Bidding above soft offer cap				
Apr-24					
May-24					
Jun-24	Discussion paper and stakeholder recommendations				
Jul-24					
Aug-24					
Sep-24					
Oct-24				Working group preparation	
Nov-24				Conduct working groups	
Dec-24					
Jan-25					
Feb-25					
Mar-25					
Apr-25					
May-25					
Jun-25					
Jul-25					
Aug-25					
Sep-25				Proposal development and iteration	
Oct-25					
Nov-25					
Dec-25					
Jan-26					
Feb-26					
Mar-26					
Apr-26					
May-26					
Jun-26					
Jul-26					
Aug-26					
Sep-26					
Oct-26					
Nov-26				BOG/GB meeting	
Dec-26					
Jan-27					
Feb-27					
Mar-27					
Apr-27					
5 May-27				BOG/GB meeting	

4.1 Phase 2 - Scarcity Pricing and BAA-Level Market Power Mitigation

The ISO plans to address BAA-level MPM and scarcity pricing as a single, integrated policy. This approach provides a unified strategy for ensuring competitive pricing during tight supply conditions. It also streamlines stakeholder engagement with a single set of proposals, meetings, and comment periods, making it easier to balance diverse interests.

To ensure thorough stakeholder involvement and understanding, the ISO will implement an iterative design process similar to the approach used in the EDAM policy design. This process will involve a series of working group sessions that gradually build the proposal, allowing stakeholders to provide informal feedback at each stage. The design process will unfold as described in Section 2.2.1:

1. Initial concept development
2. Focused workshops on specific design elements
3. Iterative refinement based on stakeholder feedback
4. Preliminary design synthesis
5. Development of a comprehensive straw proposal

For BAA-level market power mitigation, high-priority items include thoroughly evaluating the proposed BAA grouping approach, analyzing the competitiveness of the CAISO BAA, and considering connections with scarcity pricing. The ISO plans to provide detailed examples and analysis to help refine the BAA grouping concept.

Scarcity pricing is a crucial focus area. Top priorities include improving ancillary service procurement and the SRDC's ability to reflect tight conditions, developing mechanisms for prices to rise ahead of shortages, ensuring emergency actions are priced appropriately, and enhancing out-of-market action transparency. The ISO will advance detailed proposals on enhancing deliverability and re-optimizing ancillary services in the real-time market. New reserve products and refinements to the flexible ramping product will be explored to support pre-shortage price formation. Mechanisms to model emergency actions in pricing and ensure consistency with load shed are expected to also progress.

The ISO acknowledges that scarcity pricing design choices may influence BAA-level MPM design choices. Prioritizing MPM and scarcity pricing together allows the ISO and stakeholders to consider both pricing elements holistically. For example, designing

scarcity pricing mechanisms might depend on the market's ability to distinguish between market power and legitimately high prices during scarcity events. Additionally, stakeholder comfort with different levels of administrative pricing during scarcity events might depend on measures that ensure prices are competitive.

4.1.1 BAA-Level MPM Proposed Scope

Scope	Progress	Complexity	Stakeholder Priority / Urgency
	Low progress (1) – High progress (5)	Low complexity (1) – High complexity (5)	Low priority (1) – High priority (5)
<p>Consideration of how to define the groups and sequence the assessments.</p> <p>Detailed examples and walk-throughs of how the grouping approach would work.</p> <p>Analysis of how the grouping approach impacts the frequency and accuracy of mitigation compared to the current approach.</p>	<p>4</p> <p>Concept introduced, initial discussions held, draft design shared and discussed.</p>	<p>4</p> <p>Requires detailed examples, analysis, and consideration of various design aspects.</p>	<p>4</p> <p>High priority to thoroughly evaluate and refine the proposed BAA grouping approach, as it is potentially a significant improvement from the current methodology.</p>
<p>Consider modifications to the BAA-level mitigation approach, such as only mitigating pivotal suppliers</p>	<p>2</p> <p>Potential modifications briefly mentioned, but not thoroughly discussed.</p>	<p>4</p> <p>Requires evaluating various design options and their impacts.</p>	<p>3</p> <p>Moderate priority, some stakeholders feel it would improve the targeting of mitigation.</p>

rather than all suppliers.			
Consider modifications to the BAA-level mitigation approach, such as an “impact test” to only mitigate offers with LMP impacts above a defined threshold.	1 Briefly mentioned by stakeholders, but not discussed in detail.	5 Requires significant changes to the mitigation approach and extensive analysis.	4 High priority, some stakeholders feel an impact test could significantly reduce over-mitigation by focusing on offers that have a material effect on prices.
Determine if the CAISO BAA should be included in the BAA-level market power mitigation and treated like any other BAA, rather than assuming it is always competitive. Provide data analysis on the competitiveness of the CAISO BAA.	2 Issue identified, but limited discussion and analysis so far.	3 Requires data analysis and potential changes to current assumptions.	4 High priority, as the current assumption that CAISO is always competitive is a significant issue for many stakeholders and should be thoroughly evaluated.

4.1.2 Scarcity Pricing Proposed Scope

Scope	Progress	Complexity	Priority / Urgency
Evaluate enhancements to ancillary service procurement in the real-time market to	3 Moderate progress made, with initial discussions and	4 Significant complexity expected, as it involves changes to	4 High priority, improving the ability of the SRDC to reflect scarcity

<p>improve the ability of the SRDC to reflect tight supply conditions and scarcity value of reserves, such as:</p> <ul style="list-style-type: none"> -Considering enhancements to ancillary service deliverability and full re-optimization of ancillary services in real time -Procuring ancillary services in RTD -Exploring SRDC-like mechanisms for WEIM areas outside of the CAISO BAA that don't procure ancillary services through the market 	<p>potential solutions identified.</p>	<p>core market optimization and potential seams issues with WEIM/EDAM.</p>	<p>conditions is crucial for sending appropriate price signals and incentivizing resource performance during tight supply conditions.</p>
<p>Develop market-based mechanisms for prices to rise gradually as the risk of shortages increases and the system approaches scarcity conditions, such as:</p> <ul style="list-style-type: none"> -Considering a new 30-minute reserve 	<p>2 Limited progress made, with high-level concepts introduced but no detailed proposals yet.</p>	<p>4 Significant complexity expected, as it involves designing new products or demand curves that interact with existing market features.</p>	<p>4 High priority, having prices gradually rise ahead of shortages is essential for providing early signals to the market and allowing participants to</p>

<p>product and demand curve</p> <ul style="list-style-type: none"> -Evaluating refinements to the Flexible Ramping Product to support price formation ahead of shortages -Exploring other mechanisms to reflect tightening supply such as a demand curve based on “latent supply” 			<p>respond effectively to tight conditions.</p>
<p>Review and consider updates to key pricing run penalty prices to ensure alignment with current Western Interconnection market conditions and incentivize participation during tight supply. Potentially anchor them to Value of Lost Load (VOLL) estimates.</p>	<p>1 Limited progress made, with the issue identified but no specific analysis or proposals discussed.</p>	<p>3 Moderate complexity expected, as it involves reviewing and adjusting existing penalty price parameters and may involve a Value of Lost Load (VOLL) study.</p>	<p>3 Moderate priority, ensuring penalty prices are aligned with current market conditions is important for incentivizing participation, but is less urgent than improving the core scarcity pricing mechanisms.</p>
<p>Develop market mechanisms to incorporate the pricing impacts of</p>	<p>3 Moderate progress made, with several potential actions</p>	<p>3 Significant complexity expected, as it</p>	<p>4 High priority, reflecting the impacts of</p>

<p>emergency actions during scarcity events, such as:</p> <ul style="list-style-type: none"> -Activation of emergency demand response -Dispatch of backstop supply -Firm load shed orders -Out-of-market operator actions that affect supply and demand during tight conditions. 	<p>identified and initial discussions on approaches to reflect them in pricing.</p>	<p>involves modeling and incorporating various types of emergency actions into the market optimization and pricing.</p>	<p>emergency actions in pricing is critical for maintaining proper incentives and avoiding price distortions during scarcity events. Enhancing transparency around out-of-market actions is also crucial for stakeholders.</p>
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4.2 Phase 2 - Fast-Start Pricing

While fast-start pricing remains an important element of the Price Formation Enhancements initiative, the ISO will prioritize scarcity pricing and market power mitigation policy design. At the same time, the ISO will facilitate working groups to explore potential design features of fast-start pricing. These additional discussions will support the development of more detailed design options and proposals for stakeholder input. This prioritization reflects stakeholder feedback and the practical considerations of market design and implementation.

Throughout the stakeholder process, the ISO has observed that while some stakeholders recognize the potential benefits of fast-start pricing, such as improved price signals and reduced uplifts, others prioritize other issues and believe fast-start pricing requires further justification. Stakeholders have emphasized the need for a clearer understanding of the costs and benefits of fast-start pricing based on the different design options, including impacts on bid cost recovery, uplift payments, and interactions with other market design features.

The complexity of designing a fast-start pricing mechanism that is compatible with the unique features of the ISO’s market warrants more time for consideration. Developing a fast-start pricing design that ensures consistency across market timeframes and

settlement mechanisms, avoids unintended consequences, and maintains the integrity of other market features is a significant undertaking. The ISO recognizes that rushing this process could produce poor results and potentially undermine the initiative’s goals and other market design objectives.

The ISO remains committed to working with stakeholders to evaluate the potential benefits and challenges of fast-start pricing and to develop a design that aligns with the overarching goals of the initiative. By prioritizing more urgent topics such as scarcity pricing and market power mitigation, the ISO can make incremental progress on price formation while allowing more time for a thorough evaluation of design options, analysis, and stakeholder engagement on fast-start pricing.

The ISO seeks to begin stakeholder working groups in October 2024 focused on the design components of fast-start pricing. Following those working groups, the ISO seeks to work with stakeholders toward a straw proposal in Q4 2025.

4.2.1 Fast-Start Pricing Proposed Scope

Scope	Progress	Complexity	Stakeholder Priority / Urgency
Propose a fast-start pricing design: -Define qualifying resources based on start-up times and minimum up times -Select an amortization methodology -Consider interactions with other market features like flexible ramping product, multi-interval optimization,	3 Moderate progress discussing the definition of qualifying resources and amortization methodologies. Interactions with other market features have not been fully explored. The ISO has analyzed the impact of fast-start pricing on market prices in bookend scenarios.	5 A design that considers all the mentioned market features and their interactions is highly complex and will require significant effort to ensure compatibility and avoid unintended consequences.	3 Stakeholders identified fast-start pricing as an important price formation enhancement following the resolution of higher priority price formation concerns including scarcity prices and changes to market power mitigation.

<p>HASP/FMM, multi-stage generator modeling, EDAM/WEIM transfers and WEIM base scheduling practices, GHG constraints, and pricing run penalty parameters</p> <p>-Consider the feasibility of some areas of analysis to support policy development</p>			
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4.3 Phase 2 – Bidding above the Soft Offer Cap

On July 31, 2024, FERC approved the ISO’s tariff revisions on bidding above the soft offer cap, and CAISO implemented the policy on August 1, 2024. As discussed during the tariff amendment process, the ISO will continue to evaluate with stakeholders potential future enhancements in this area.

These potential enhancements include exploring opportunity costs of hybrid resources and proxy demand resources (PDR); refining storage bid cost recovery, storage default energy bids, and the Maximum Import Bid Price (MIBP) shaping factor calculation; and continuing the conversation on potential changes to the storage bid cap in the day-ahead market.

The ISO has initiated work on these efforts, publishing a Maximum Import Bid Price Shaping Factor Analysis and holding a stakeholder call on May 28, 2024.²⁷ The ISO is currently assessing targeted enhancements to the logic of these shaping factors. Additionally, the ISO announced a new initiative on Storage Bid Cost Recovery and

²⁷ Maximum Import Bid Price Shaping Factor Analysis, available at [whitepaper-maximum-import-bid-shaping-factor.pdf \(caiso.com\)](https://www.caiso.com/whitepaper-maximum-import-bid-shaping-factor.pdf)

Default Energy Bids Enhancements, which may also address the other potential enhancements related to storage and hybrid opportunity costs, and has now held several stakeholder calls beginning on July 8, 2024.²⁸

As these work streams proceed, the ISO will continue to communicate the performance of new functionality through its regular analysis such as in the market planning and performance forum (MPPF). These assessments, together with stakeholder feedback, will guide further efforts to enhance and refine bidding above the soft offer cap. The ISO remains committed to an open and collaborative process in defining and prioritizing these potential future enhancements.

Next Steps

The ISO is actively seeking stakeholder feedback on the proposed scope and timeline for Phase 2. This engagement is crucial for ensuring that the initiative effectively addresses the most pressing concerns, aligns with stakeholder priorities, and follows a feasible implementation schedule.

The ISO recognizes that the proposed scope, which encompasses BAA-level market power mitigation, scarcity pricing, and fast-start pricing, is ambitious and complex. Each of these topics involves significant changes to market design, with potential implications for market efficiency, reliability, and participation. As such, it is essential that stakeholders have the opportunity to provide input on the relative priority and urgency of each topic, as well as the specific design elements and analyses that they think are necessary for informed decision-making.

The ISO is committed to working collaboratively with stakeholders to refine the scope and timeline based on the feedback received. This may involve adjusting the relative priority of certain topics, modifying the specific design elements or analyses included in each topic, or revising the timeline to better accommodate stakeholder needs and market realities.

²⁸ New initiative: Storage bid cost recovery and default energy bids enhancements, information available at <https://stakeholdercenter.caiso.com/StakeholderInitiatives/storage-bid-cost-recovery-and-default-energy-bids-enhancements>