Revised Draft Proposal

Reserve Scarcity Pricing Design

May 20, 2008
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Revision Summary

This Revised Draft Proposal for Reserve Scarcity Pricing Design is a modified version of the Draft Proposal for Reserve Scarcity Pricing Design dated February 6, 2008. The modifications that are intended to address issues raised by stakeholder are summarized as follows:

1) As an alternative to the proposal to decide now to implement both system-wide and sub-regional Scarcity Pricing together, the CAISO offers an option for consideration that is to wait until nine months after the startup of MRTU to decide with stakeholders when to enable sub-regional Scarcity Pricing.

2) The CAISO now proposes a tiered Scarcity Reserve Demand Curve. The Non-Spinning Reserve would be divided into three segments with three different scarcity prices to reflect the severity of shortage. The CAISO also proposes revisions to the scarcity prices in A/S Sub-Regions.

3) The proposed rules for Hydro Units and Pumping Load would allow intra-monthly updates to comply with the RA resources DAM A/S must-offer requirement. The exemption for RA contracts signed before Jan 1, 2009 would be removed due to the change of MRTU startup date.

4) In addition, the CAISO proposes to change the MRTU system-wide A/S cost allocation to locational A/S cost allocation.
Executive Summary

Scarcity Pricing is a mechanism that lets the market prices rise automatically, potentially beyond any applicable bid cap, when there is a shortage of supply in the market. Following general practice in other ISO markets, shortage is defined as the inability by CAISO to procure sufficient regulation or operating reserves through market mechanisms. Properly designed scarcity prices should enhance short-term and long-term market efficiency and reliability because they stimulate Demand Response, draw supply from outside of the CAISO control area, create incentives for availability of generation during peak load periods, promote long-term contracting, and attract investment in new generation resources.

The Federal Energy Regulatory Commission (FERC) directed the CAISO to file tariff language and to implement a reserve shortage Scarcity Pricing mechanism within 12 months after MRTU startup as part of its September 21 Order. The September 21 Order provided guidance that “prices should rise to reflect the increased need for reserves and energy, whether or not the shortage arises in conjunction with a generation or transmission outage, in both the day-ahead and real-time markets.” In addition, the September 21 Order directed the CAISO to develop a “mechanism that applies administratively-determined graduated prices to various levels of reserve shortage.”

In order to implement the Scarcity Pricing mechanism successfully and efficiently, the CAISO believes the design should be guided by the following considerations: 1) consistency with the Ancillary Service (A/S) reserve requirements and the A/S Regions definitions under the MRTU Tariff; 2) lessons learned from the design and operational experiences of other ISOs; and 3) the effective interaction between Scarcity Pricing and other MRTU components.

Since the Issue Identification Paper for Reserve Scarcity Pricing Design was posted on May 31, 2007, the CAISO has: (1) posted a Straw Proposal, a Revised Straw Proposal, and a Draft Proposal for Reserve Scarcity Pricing Design; (2) hosted four stakeholder meetings discussing the CAISO Scarcity Pricing design and a panel discussion stakeholder conference call on the Scarcity Pricing designs of NYISO and ISO-NE; and (3) requested and responded to stakeholder comments on all papers. The purpose of this Proposal is resolve issues which have been raised in the stakeholder discussion of Scarcity Pricing design, building on the previous Draft Proposal, and focusing on specific solutions for the following design issues.

1) Scope of Scarcity Pricing: As an alternative to the original proposal to decide now to implement both system-wide and zonal Scarcity Pricing together 12 months after MRTU startup, the CAISO offers an option to wait until nine months after the startup of MRTU to decide when to enable the sub-regional Scarcity Pricing so that the

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2 September 21 Order at PP 1077, 1079.
3 Id. at P 1079.
4 All versions of proposal and stakeholder written comments are posted on the CAISO web site at [http://www.caiso.com/1bef/1bef12b9b420b0.html](http://www.caiso.com/1bef/1bef12b9b420b0.html).
CAISO and stakeholders can learn from the experience of market operation and, if necessary, develop needed market power mitigation measures. Both options will use the A/S Regions and Sub-Regions as defined in the MRTU Tariff. The CAISO proposes to develop the software capability for sub-regional Scarcity Pricing function regardless which option will be adopted.

2) Triggers of Scarcity Pricing: The CAISO proposes to use the minimum A/S requirements of the Region (the CAISO system) and Sub-Regions as the triggers of Scarcity Pricing. That is, if any of the minimum requirements are violated, Scarcity Pricing will be triggered in the A/S Region or Sub-Regions.

3) A/S Reserves in Scarcity Pricing: The CAISO proposes a joint Scarcity Reserve Demand Curve for the three upward A/S reserves including Regulation Up, Spinning, and Non-Spinning Reserves. Regulation Down Reserve will have a separate Scarcity Reserve Demand Curve, as suggested by stakeholders.

4) Scarcity Reserve Demand Curve: Based on the analysis of CAISO historical A/S bids and market clearing prices and the experience of NYISO and ISO-NE, the CAISO proposes a tiered Scarcity Reserve Demand Curve and set the Scarcity Reserve Demand Curve Values of three tiers of Non-Spinning, Spinning, and Regulation Up Reserves as 50%, 60%, 70%, 10%, and 20% of energy bid cap respectively in the A/S Region and 25%, 10% and 10% of energy bid cap for Non-Spinning, Spinning, and Regulation Up Reserves respectively in Sub-Regions. The lowest scarcity price in the A/S Region is higher than the A/S bid cap and the second tier Non-Spinning scarcity price can trigger Interruptible Load Demand Response resources. The highest A/S market clearing price in the A/S Region, when supply of all upward A/S reserves are short, can get as high as the energy bid cap. Regulation Down has a Scarcity Reserve Demand Curve Value of 60% of energy bid cap in the A/S Region.

5) Energy price in case of reserve scarcity: Under MRTU, the prices of energy and A/S are co-optimized in both Day-Ahead and Real-Time Markets. The opportunity cost of capacity is reflected in both prices. When Scarcity Pricing is triggered, the prices of A/S will rise automatically to the values determined by the Scarcity Reserve Demand Curves. The price of energy could be impacted through the opportunity cost of capacity, as ordered by FERC, if the marginal capacity is capable and needed for providing both energy and A/S.

6) Resource Adequacy (RA) resources A/S must-offer requirement: The MRTU Tariff requires that RA resources offer capacity into the Day-Ahead energy market as Energy or A/S or a combination thereof, but does not expressly require that RA resources make 100% of their A/S certified capacity available in the Day-Ahead Market (DAM) through A/S bids. To minimize the possibility of artificial scarcity caused by A/S capacity withholding in the DAM, the CAISO proposes that RA resources be required to offer 100% of their A/S certified RA capacity in the form of A/S Bids into the DAM. The CAISO also proposes exemption from the A/S offer requirement for RA capacity self-scheduled for energy. However, CAISO will require that such capacity make their A/S available in the event the CAISO is unable to procure 100% of its A/S requirements in the DAM. In such case, the CAISO would curtail the Self-Schedule, or portion thereof, to allow certified A/S capacity to be used for A/S.

7) A/S cost allocation: With strong support from stakeholders, the CAISO proposes to change the MRTU Release 1 system-wide A/S cost allocation to locational A/S cost allocation.
8) Interaction of Scarcity Pricing and Demand Response: Under Markets and Performance (formerly known as Release 1A) Demand Response initiative, the CAISO proposes enhanced functionality which effectively provides demand resources with full comparable functionality to that of a generator in the CAISO's market. The proposed design provides considerable flexibility for demand resources, allowing Participating Loads to bid into the CAISO Markets with a forward energy bid and to provide Non-Spinning Reserve or other A/S. These enhanced functionalities for dispatchable Participating Load will allow more Demand Response to be available for meeting the requirements for energy and A/S and could have a significant impact on the extent to which Scarcity Pricing is triggered. At the same time, the potential for Scarcity Pricing to be triggered should also stimulate the participation of the Demand Response from price responsive loads to reduce overall Demand.

9) Scarcity Pricing and capacity payment adjustment: Some stakeholders suggested that RA resources, which have received a capacity payment towards coverage of annual fixed costs through an RA contract, should be disqualified from receiving scarcity prices. The CAISO believes that it is inappropriate to disqualify RA contract holders from receiving scarcity prices or to adjust any particular resource’s capacity payments. Both RA and non-RA resources will be needed at times of scarcity and should face the same incentive to provide their resource into the market. Therefore RA resources should be compensated for providing services (energy or A/S) no differently than non-RA resources during times of scarcity. Consistent with general market design principles, the appropriate response in bilateral RA contract negotiations should be to estimate the price of capacity on the basis of expected total market revenues, including those due to scarcity pricing. It is through bilateral contracts that parties can decide the appropriate revenue to accrue to buyer or seller.

The CAISO requests stakeholder comments on this Revised Draft Proposal. Based on the feedback received, the CAISO will finalize the Proposal for Reserve Scarcity Pricing Design. The Scarcity Pricing project is scheduled for the CAISO Board of Governors’ consideration and decision in July 2008.

1 Introduction

Scarcity pricing can redress one of the recognized market inefficiencies of Bid caps. Although Bid caps are necessary due to the inelasticity of demand in real-time, Bid caps can prevent prices from rising sufficiently for certain resources, such as peaking units, to be profitable. This problem can be addressed by eliminating bid caps, which the CAISO does not propose, or by other mechanisms, such as capacity payments and scarcity pricing, both of which are on the drawing board for post Release 1 MRTU.

As an additional enhancement to MRTU, Scarcity Pricing is a mechanism that will let the prices of reserves and electricity rise automatically, even beyond the price cap, when there is inadequate supply in the market to maintain the target level of reserves and regulation on the CAISO coordinated transmission grid. Scarcity Pricing is designed to set prices that reflect the level of shortage in supply. More accurate price signals will stimulate participation in Demand Response programs, attract supply from outside of the CAISO control area, and provide

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5 Future designs for the RA markets may include a centralized market element that incorporates a mechanism for deducting peak energy rents from the capacity market clearing prices.
incentives for existing generation owners to make more generation capacity available during peak demand periods and for investments in new generation resources, particularly in flexible generation units. The automatic trigger of Scarcity Pricing ensures that suppliers do not need to raise their Bid prices above competitive levels to achieve the higher prices.

Under MRTU, the CAISO has included a limited scarcity pricing mechanism that raises energy bids to the bid cap when there are insufficient energy bids in Real-Time Market and when no contingency events have occurred. In its September 21, 2006 Order, the Federal Energy Regulatory Commission (FERC) accepted the CAISO’s initial scarcity proposal, but directed the CAISO to develop a more extensive reserve shortage scarcity pricing approach be filed and implemented within 12 months of the implementation of MRTU. In its April 20, 2007 Order, FERC further emphasized these requirements and stated that “the concept of scarcity pricing involves a systematic procedure to ensure that prices can rise during periods of genuine scarcity”. The FERC Orders specified that:

1) Prices should rise when energy and reserves are short in both the day-ahead and real-time markets whether or not there is a transmission or generation outage.

2) The scarcity pricing mechanism should apply administratively-determined graduated prices to various levels of reserve shortage. This requirement calls for a Scarcity Reserve Demand Curve with different pre-determined prices at different levels of scarcity. The Order also stated that “In the event that a shortage occurs, prices should reflect the economic value of the reserves necessary to resolve the shortage. Thus, the prices for both reserves and energy in California should increase automatically as the severity of the shortage increases.”

Since the new Scarcity Pricing will be implemented within 12-months after the start of MRTU, it must be consistent with the pre-existing MRTU design and systems. In addition, because both NYISO and ISO-NE have implemented Scarcity Pricing mechanisms with a Reserve Demand Curve, the CAISO intends to study these mechanisms as appropriate, for potential use in the CAISO’s Scarcity Pricing design. Accordingly, to ensure successful and efficient implementation of Scarcity Pricing, the mechanism should be designed with the following guidelines in mind:

1) While meeting all the requirements specified by FERC Orders, the design should be consistent with the MRTU Tariff as much as possible to minimize changes to the existing system.

2) The CAISO’s design should consider the designs of NYISO and ISO-NE as those have been tested in the market operation.

3) The design should take into account the impacts of Scarcity Pricing on other existing and future components of MRTU, such as congestion revenue rights (CRR), Demand Response (DR) programs, and a capacity market (centralized or bilateral). Market monitoring and mitigation functions should not be weakened.

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7 September 21 Order, at P1077.
8 September 21 Order at P1079.
Scarcity Pricing is an enhancement to Energy and A/S market prices that is intended to reflect underlying market conditions. As such, and consistent with the “locational” nature of the MRTU energy markets, any increased price volatility in the wholesale spot market arising from Scarcity Pricing can be avoided by load serving entities (LSEs) entering into long-term bilateral contracts to hedge the price of power, by providing DR, and through holdings of CRRs.

2 Reserve Scarcity Pricing Design Issues & Proposed Solutions

This section discusses major design issues and proposes specific solutions for stakeholders to review and discuss.

2.1 Scarcity Pricing Scope

The MRTU Tariff defines A/S Regions and Sub-Regions. There are two A/S Regions and eight A/S Sub-Regions. The A/S Regions are the System Region and the Expanded Region (i.e., the System Region and the intertie Scheduling Points with adjacent Control Areas). The eight A/S Sub-Regions are the following:

1. the South of Path 15 Sub-Region
2. the Expanded South of Path 15 Sub-Region
3. the South of Path 26 Sub-Region
4. the Expanded South of Path 26 Sub-Region
5. the North of Path 15 Sub-Region
6. the Expanded North of Path 15 Sub-Region
7. the North of Path 26 Sub-Region
8. the Expanded North of Path 26 Sub-Region

There were two options for the scope of Scarcity Pricing proposed in the Draft Proposal: system-wide only or system-wide and zonal. The majority of stakeholders, based on their written and verbal comments, support system-wide and zonal pricing scope using the A/S Regions and Sub-Regions defined in the MRTU Tariff.

2.2 Triggers of Reserve Scarcity Pricing

Each ISO with a Scarcity Pricing mechanism defines Scarcity Pricing triggers according to its own reliability criteria and operating procedures. The CAISO reliability requirements are based on the WECC Minimum Operating Reliability Criteria (MORC) and NERC control performance criteria. When the reliability requirements are violated, the CAISO may issue an alert, warning, or declare an emergency based on the available reserve margin. In the MRTU Tariff, the reliability requirements criteria and procedures are defined as the following:

“The CAISO shall maintain sufficient Generating Units immediately responsive to Automatic Generation Control (AGC) in order to provide sufficient Regulation service to allow the CAISO Control Area to meet WECC and NERC control performance criteria by continuously balancing Generation to meet deviations between actual and scheduled Demand and to maintain interchange schedules.”

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10 MRTU Tariff Section 8.3.3
11 MRTU Tariff Section 8.2.3.1
“The CAISO shall maintain minimum contingency Operating Reserve made up of Spinning Reserve and Non-Spinning Reserve in accordance with WECC MORC criteria equal to (a) 5% of the Demand to be met by Generation from hydroelectric resources (excluding the Demand covered by firm purchases from outside the CAISO Control Area) plus 7% of the Demand to be met by Generation from other resources (excluding the Demand covered by firm purchases from outside the CAISO Control Area), or (b) the single largest Contingency, if this is greater. “The Spinning Reserve component of Operating Reserve shall be no less than one-half the Operating Reserve required for each Settlement Period of the Day-Ahead Market, each hour in the HASP, and in each 15 minute period in Real-Time.” 12

“Within the Expanded System Region, the System Region, and any the Sub-Regions, the CAISO may establish limits on the amount of Ancillary Services that can be provided from each region or can be provided within each region. When used, these limits identify either a maximum or a minimum (or both a maximum and a minimum) amount of Ancillary Services to be obtained within the region.” 13

“The CAISO’s use of an Ancillary Service Sub-Region occurs when the CAISO establishes a minimum or maximum limit for that Sub-Region. The CAISO will evaluate the use of minimum and maximum procurement limits for Ancillary Services on a daily and hourly basis in order to ensure that the dispersion of Ancillary Services throughout the CAISO Control Area accurately reflects the current system topology and deliverability needs. The CAISO will use the following considerations and criteria to determine whether to establish minimum and maximum Ancillary Service limits: (a) the CAISO Forecasts of CAISO Demand, (b) the location of Demand within the Control Area, (c) the amount of Ancillary Services needed to meet NERC and WECC requirements based on the CAISO Forecasts of CAISO Demand, (d) DA Schedules or HASP Intertie Schedules, (e) whether any Ancillary Services provided from System Resources requiring a NERC tag fail to have a NERC tag, and (f) current information regarding network and resource operating constraints that restrict the deliverability of Ancillary Services into or out of a Ancillary Service region. Factors affecting these considerations include, but are not limited to, the locational mix of generating resources, generating resource outages, historical patterns of transmission and generating resource availability, regional transmission limitations and constraints, transmission outages, Available Transmission Capacity, and other factors affecting reliability. Ancillary Services procured within a Sub-Region count toward satisfying the Ancillary Service requirements for the System Region or the Expanded System Region.” 14

“Pursuant to Section 6.5.2.3.3, the CAISO will publish forecasted Ancillary Service requirements, regional constraints, and the minimum and/or maximum Ancillary Service limits for the Ancillary Service Regions and any Sub-Regions by 6:00 pm prior to the Day-Ahead Market (two days prior to the Operating Day). During the Operating Day, any significant changes to the forecasted information will be published after HASP Intertie Schedules are published on OASIS.” 15

12 MRTU Tariff Section 8.2.3.2. The WECC/NERC new paradigm that will be enforced does not require the exporting control area to back firm energy interchanges with Operating Reserves.
13 MRTU Tariff Section 8.3.3.1
14 MRTU Tariff Section 8.3.3.2
15 MRTU Tariff Section 8.3.3.3
In the Draft Proposal the CAISO proposed to use the minimum requirements for A/S reserves in the A/S Regions and Sub-Regions as the triggers of reserve Scarcity Pricing in the Regions and Sub-Regions. Each time any of these requirements is violated, whether in the Day-Ahead Market (DAM) or Real-Time Market (RTM), the reserve Scarcity Pricing mechanism would be activated in the A/S Region or Sub-Region in which the reserve requirement violation occurred.

Use of these requirements as triggers for reserve Scarcity Pricing preserves consistency between Scarcity Pricing and the A/S procurement requirements, and requires minimal changes to the MRTU market design for implementation.

However, due to the lack of experience of CAISO A/S Sub-Regional procurement and in light of the fact that the CAISO will not be proposing fixed A/S Sub-Regional procurement requirements, but will be determining them on the basis of actual system conditions, stakeholders expressed concerns as to how Scarcity Pricing in A/S Sub-Regions will be triggered and how to hedge exposure to such pricing. Based on the feedback from stakeholders, the CAISO believes that it is an appropriate option to defer a decision on whether and when to implement Sub-Regional scarcity pricing until after the CAISO and Market Participants have gained some experience in A/S Sub-Regional procurement.

The CAISO, therefore, proposes two options for stakeholders to decide.

1) To decide now to implement Scarcity Pricing in both the CAISO system and Sub-Regions together.

2) To defer the decision on Sub-Regional Scarcity Pricing until nine months after the startup of MRTU so that the CAISO and stakeholders will have time to learn from market operation, to examine the criteria and procedures for Sub-Regional A/S procurement, and to develop needed market power mitigation measures. The market operation experience should allow for a more robust consideration of A/S Sub-Regional triggers.

The software will be developed with the function of Sub-Regional Scarcity Pricing even if Option 2 is adopted. Nine months after the startup of MRTU, if the decision is to implement Sub-Regional Scarcity Pricing, the function can be simply enabled once the proposal is approved by CAISO Board of Governors and accepted by FERC.

2.3 A/S Reserves in Scarcity Pricing Mechanism

There are four types of A/S reserves under MRTU: Regulation Up, Regulation Down, Spinning Reserves, and Non-Spinning Reserves. The substitution capability among the different types of A/S reserves is an important factor in determining which types of A/S reserves are to be included in Scarcity Pricing mechanism. Reserves that can substitute for other reserves are often called “higher quality” than reserves that cannot substitute. Hence, Regulation Up is higher quality than Spinning Reserves, which is higher quality than Non-Spinning Reserves.

The MRTU Tariff Section 8.2.3.5 defines the relationship among the A/S reserves as the follows:

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The Regulation requirement must be satisfied only by Regulation Bids for Resources qualified to provide Regulation;

Additional Regulation Up capacity can be used to satisfy requirements for Spinning Reserve, or Non-Spinning Reserve;

Regulation Up and Spinning Reserve requirements must be collectively satisfied by the combination of Regulation Up and Spinning Reserve Bids. Spinning Reserve and Regulation may be provided as separate services from the same Generating Unit, provided that the sum of Spinning Reserve and Regulation Up provided is not greater than the maximum ramp rate of the Generating Unit (MW/minute) times ten;

Additional Regulation Up and Spinning Reserve capacity can be used to satisfy requirements for Non-Spinning Reserve.

Regulation Up, Spinning Reserve, and Non-Spinning Reserve requirements must be collectively satisfied by the combination of Regulation Up, Spinning Reserve and Non-Spinning Reserve Bids; and

Total MW purchased from the Regulation Up, Spinning Reserve, and Non-Spinning Reserve markets will not be changed by this [MRTU Tariff] Section 8.2.3.5.

The substitution capability among the three upward A/S reserves and the minimum A/S requirements can be described using the following constraints:

**Regulation Up Requirements:**

\[ \text{RegUp} \geq \text{RegUpMinReq} \]

**Spinning Reserve Requirements:**

\[ \text{RegUp} + \text{Spin} \geq \text{RegUpMinReq} + \text{SpinMinReq} \]

**Non-Spinning Reserve Requirements:**

\[ \text{RegUp} + \text{Spin} + \text{Non-Spin} \geq \text{RegUpMinReq} + \text{SpinMinReq} + \text{Non-SpinMinReq} \]

where, \( \text{RegUpMinReq} \), \( \text{SpinMinReq} \), and \( \text{Non-SpinMinReq} \) represent the minimum procurement requirements for the A/S reserves.

Because of the substitution capability among Regulation Up, Spinning, and Non-Spinning, the CAISO proposed in the Draft Proposal that these three types of reserves be considered jointly for Scarcity Pricing. Stakeholders support this proposal.

Regulation Down Reserve is provided by resources that can decrease their actual operating level in response to direct electronic signals from the CAISO to maintain standard frequency in accordance with established reliability criteria. In some situations the CAISO could face a shortage of supply for Regulation-Down Reserve. Such shortages could become more prevalent in the near future since California is moving forward to meet Renewable Portfolio Standards. Connecting more renewable resources (primarily wind generation) to the CAISO grid will increase the demand for Regulation Reserves. The CAISO therefore proposes to include Regulation-Down Reserve in the Scarcity Pricing mechanism in order to provide proper price signal and incentives to potential AGC resources. Due to its lack of compatibility, Regulation-Down Reserve will be measured separately in Scarcity Pricing from the other three types of upward A/S reserves.
2.4 Scarcity Reserve Demand Curve

As noted above, the September 21, 2006 FERC Order specified that the Scarcity Pricing mechanism should apply administratively-determined graduated prices to various levels of reserve shortage. This requirement implies that it is necessary to define a Scarcity Reserve Demand Curve with pre-determined prices at different levels of shortages, similar to that which NYISO and ISO-NE have implemented. A Scarcity Reserve Demand Curve sets a Scarcity Reserve Demand Curve Value (SRDCV) for each of the A/S reserves and allows the market to clear in shortage conditions. Based on the experiences of these ISOs, the design of the Reserve Scarcity Demand Curve needs to decide rules for (1) setting the SRDCVs for each type of A/S reserves in each A/S Region and Sub-Region; (2) calculating cumulative reserve market clearing prices (MCPs) based on SRDCVs across different types of A/S reserves and A/S Regions and Sub-Regions; and (3) determining energy prices (i.e., LMPs) when reserve supply is short.

The following sections discuss the Scarcity Reserve Demand Curve for the CAISO. In order to compare with that of NYISO and ISO-NE, Table 1 lists the equivalent terminologies describing the reserve demand curves used by the three ISOs.

Table 1. Equivalent Terminologies

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<th>NYISO</th>
<th>ISO-NE</th>
<th>CAISO</th>
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<tbody>
<tr>
<td>Demand curve</td>
<td>Reserve Demand Curve</td>
<td>Reserve Constraint Penalty Factor (RCPF)</td>
<td>Scarcity Reserve Demand Curve</td>
</tr>
<tr>
<td>Pre-determined price for reserve scarcity</td>
<td>Reserve Demand Curve Value</td>
<td>RCPF</td>
<td>Scarcity Reserve Demand Curve Value (SRDCV)</td>
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2.4.1 Overall Considerations

The CAISO, per the FERC Order, will implement a Scarcity Pricing mechanism very similar to that which has been implemented by the NYISO and ISO-NE. The proposed CAISO Scarcity Pricing mechanism will be similar to the NYISO and ISO-NE approach in the following aspects.

1) Under MRTU, the CAISO will co-optimize energy dispatch and reserve procurements in both the DAM and the RTM, similar to the mechanism implemented by the NYISO and the ISO-NE. The energy and reserve co-optimization model provides a foundation for implementing a Scarcity Reserve Demand Curve for Scarcity Pricing.

2) The three ISOs all have well-defined A/S zones that provide a basis for zonal Scarcity Pricing.

3) Due to the substitution capability between different types of A/S reserves and the nested A/S Regions and Sub-Regions, the reserve market clearing prices derived from the SRDCVs will cascade up from a lower quality to a higher quality reserve and from A/S Region to its more granular Sub-Regions.

In addition, the CAISO Scarcity Pricing mechanism will be different from that of NYISO and ISO-NE because of the integration of Regulation Up with Spinning and Non-Spinning Reserves in Scarcity Pricing. Under MRTU, Regulation Up can substitute for both Spinning and Non-Spinning Reserve in meeting the minimum reserve requirements. In contrast, the ISO-NE did not include Regulation in its Scarcity Pricing mechanism since the ISO-NE is never short of...
Regulation Reserve. The NYISO chose to implement separate demand curves for Operating Reserve and Regulation because Regulation cannot substitute for Operating Reserve. One additional difference is that the CAISO does not have a reserve product to meet 30-minute contingencies as do the other two ISOs.

2.4.2 Benchmark Price for Scarcity Reserve Demand Curve

ISO-NE, NYISO, and PJM established their maximum A/S scarcity prices in reference to the energy bid cap. The CAISO, based on its research and communication with other ISOs in regarding to the selection of the Benchmark Price, is in agreement with ISO-NE that

“The RCPF’s reflect the costs the ISO would be willing to incur to procure reserves given the $1,000/MW Energy Price cap. In other words, when the ISO is sufficiently short of reserves it would be willing to pay up to $1,000 for energy to create additional reserves.”

The CAISO, therefore, proposes to establish the maximum A/S scarcity price (Benchmark Price) for the Scarcity Reserve Demand Curve based on the energy bid cap under MRTU.

According to the Tariff, the CAISO will have an energy bid cap of $500/MWh for the first year of MRTU, $750/MWh for the second year, and $1000/MWh thereafter. The Benchmark Price will therefore increase progressively based on the energy bid cap.

2.4.3 Scarcity Reserve Demand Curve Values for A/S Reserves

To determine the scarcity price for each A/S reserve, that is the SRDCVs of the Scarcity Reserve Demand Curve, the CAISO proposed to consider the following factors.

1) The SRDCVs should be set high enough in order to accommodate the offer prices of expensive generators and demand response resources (price-responsive demands). Otherwise, some available resources might not be dispatched to restore reserves during periods in which the Scarcity Pricing mechanism is triggered.

2) The SRDCVs should not be set too high for the A/S reserves that are likely to have transitory supply deficiency due to resource constraints but not in conditions where maximum generation availability is required. For example, during the morning and evening ramping up period, load sometimes picks up more quickly than generators can ramp up. Regulation Up and Spinning Reserve could face a periodic, transitory supply shortage during this time, although clearly there are sufficient generation resources available to the system such that at some cost, sufficient Regulation Up and Spinning Reserve could be available (e.g., by maintaining uneconomic units at minimum operating levels). At such times, the CAISO may desire additional reserves, and to send a price signal that indicates the value of additional reserves, but may not seek to mobilize the degree of resource response needed during, e.g., system emergencies or annual peak load hours. Hence, to minimize the cost of serving the demand, it may be appropriate to set the SRDCV for Regulation Up and Spinning Reserve at moderate levels, despite the fact that Regulation Up and Spinning Reserve are high quality reserves, and rely on the expected correlation between shortage of Non-Spinning Reserve and more serious reliability situations to

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16 Rationale and Derivation of proposed Real Time Reserve Constraint Penalty Factors, ISO-NE, April 29, 2005, pp. 4.
trigger high prices for Spinning. Additional details on this pricing relationship are provided below.

For example, the ISO-NE, which does not have scarcity price for Regulation Reserve, sets the demand curve price, called the RCPF for 10-minute Spinning Reserve (TMSR) to $50/MWh. “The TMSR RCPF value must serve two purposes. First, it must maintain TMSR during a capacity deficiency. Second, when the system becomes briefly ramp constrained, during the morning pick-up for example, the RCPF will trigger re-dispatch to preserve spinning reserve. The value of $50 meets both needs.”  The CAISO has determined that a similar approach meets the Scarcity Pricing objectives in the CAISO markets while protecting the market from extreme price volatility in periods (such as the morning and evening ramp) that do not reflect the need for such a price signal.

3) The SRDCVs should be set to reflect the cost the ISO will pay to obtain additional supply at different levels of reserve shortage. That is, shortage of higher quality reserves should generally trigger higher scarcity prices than shortages of lower quality reserves to induce sufficient re-dispatch of generation resources (internal and external) to meet the reserve requirements. However, this pricing rule needs to be balanced, for economic reasons, with the expected frequency that a particular reserve may encounter shortages, as discussed above.

An example of such ranking is the ISO-NE rules for ranking different reserve scarcity prices. The ISO-NE offers the following rationales for setting RCPFs. “The $100/MW TMOR [Thirty Minute Operating Reserve] RCPF value is calibrated to allow for re-dispatch of the system to create reserve under the majority of system condition.” “Shortages of system TMNSR [Ten Minute Non-Spinning Reserve] represent a serious reduction of reliability…. The system TMNSR RCPF value of $850 is set high enough to create re-dispatch of virtually all internal resources. … It would allow purchases of very expensive energy from external sources and backing down internal resources.” “The RCPF of local TMOR must be set lower than system reserve.”

4) Because reserves should generally be substituted to maintain the highest quality reserve, in a reserve shortage situation, the prices should cascade up from lower quality to higher quality A/S reserves and from system region to spatially granular nested sub-regions. Specifically, the market clearing price of a higher quality A/S reserve should be higher than or equal to the price of a lower quality reserve, and the market clearing price in a sub-region should be no less than the price in its parent region. This rule is called price cascading.

5) In case of a severe reserve scarcity, the market clearing price of Regulation Up, calculated as the sum of the SRDCVs of Non-Spinning, Spinning, and Regulation Up should be equal to the Benchmark Price set for the Scarcity Reserve Demand Curve.

In order to evaluate the appropriate distribution of the SRDCV values between a minimum value for the lowest quality reserve and the maximum total scarcity value determined by the MRTU price caps the SRDCVs, the CAISO conducted analyses based on the historical market data. The pre-MRTU market data, though not necessarily consistent with the design of MRTU, should provide useful support for determining the SRDCVs.

17 Direct Testimony of Marc D. Montalvo, ISO-NE, February 3, 2006, pp. 44.
18 Direct Testimony of Marc D. Montalvo, ISO-NE, February 3, 2006, pp. 41-44.
In Figure 1 are the distributions of SP15 Regulation Up Reserve market clearing prices based on the hourly prices from Jan. 1 2004 to Dec. 31, 2006 (during which the price cap was $400/MWh). The horizontal axis is the Regulation Up price in $/MWh, and the vertical axis is the frequency of occurrences.

**Figure 1. Distribution of CAISO SP15 Regulation Up Prices**

![Graph showing distribution of CAISO SP15 Regulation Up Prices]

Table 2 presents a more comprehensive summary of the statistical analysis of the CAISO SP15 A/S market clearing prices.

**Table 2. Statistics of Historical CAISO SP15 A/S Prices ($/MWh)**

<table>
<thead>
<tr>
<th>A/S Reserve</th>
<th>Market</th>
<th>Mean</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
<th>99.5th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reg Up</td>
<td>DAM</td>
<td>18.56</td>
<td>14.91</td>
<td>0.00</td>
<td>400.00</td>
<td>72.20</td>
</tr>
<tr>
<td>Reg Up</td>
<td>HAM</td>
<td>13.99</td>
<td>10.99</td>
<td>-0.01</td>
<td>399.99</td>
<td>213.00</td>
</tr>
<tr>
<td>Reg Down</td>
<td>DAM</td>
<td>13.76</td>
<td>9.36</td>
<td>-25.55</td>
<td>399.99</td>
<td>59.40</td>
</tr>
<tr>
<td>Reg Down</td>
<td>HAM</td>
<td>12.06</td>
<td>8.63</td>
<td>-85.69</td>
<td>399.99</td>
<td>53.80</td>
</tr>
<tr>
<td>Spinning</td>
<td>DAM</td>
<td>8.19</td>
<td>2.57</td>
<td>0.00</td>
<td>400.00</td>
<td>68.50</td>
</tr>
<tr>
<td>Spinning</td>
<td>HAM</td>
<td>5.23</td>
<td>2.15</td>
<td>-0.01</td>
<td>400.00</td>
<td>34.91</td>
</tr>
<tr>
<td>Non-Spinning</td>
<td>DAM</td>
<td>4.23</td>
<td>1.22</td>
<td>0.00</td>
<td>400.00</td>
<td>18.74</td>
</tr>
<tr>
<td>Non-Spinning</td>
<td>HAM</td>
<td>2.70</td>
<td>1.28</td>
<td>-0.01</td>
<td>399.99</td>
<td>9.34</td>
</tr>
</tbody>
</table>

From Figure 1 and Table 2 we can see that the highest market clearing price of all four A/S reached $400/MWh in both DA and RT in the three years although more than 99% of the time the prices stayed below $200/MWh. The historical price distribution indicates that the value of A/S resources of different quality. Although the level of specific SRDCVs will be determined through judgment, like other ISOs did as noted above, the ranking of the SRDCVs and expected market clearing prices for each A/S (reflecting co-optimization) should reflect their relative quality and hence value to the system. Since there will be a Bid Cap on reserve under MRTU,

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the SRDCV for the lowest quality reserve should be greater than or equal to the Bid Cap. Otherwise there could be circumstances of economic scarcity in which some economic bid prices are higher than the SRDCV. Historically each A/S has reached the Bid Cap in some peak hours and hence for the market to provide added value for each A/S, the SRDCV or expected market clearing price would have to exceed the Bid Cap.

Figures 2 and 3 provide a view of the system from supply side. In the charts are DA supply curves of Non-Spinning and Regulation Down Reserves of two typical hours, one in February and the other in July of 2007.

**Figure 2. Typical Hourly Supply Curves of Non-Spinning**

![Typical Hourly Supply Curves of Non-Spinning](image)

The supply curves of both Non-Spinning and Regulation Down, in both February and July, reached the A/S bid cap, $400/MWh. The last portion of each of the supply curves is very steep. All that suggests that in order to make use of all in-market resources and attract out-of-market resources when Scarcity Pricing is triggered, the scarcity price should be at least as high as the bid cap. It is consistent with what we learned from the historical A/S market clearing prices. The SRDCVs of higher quality A/S should be incrementally set between the starting scarcity price and the energy bid cap to ensure that market clearing prices during reserve shortages will reflect the value ranking of the A/S.

In the Draft Proposal, the CAISO proposed a Scarcity Reserve Demand Curve with a single SRDCV for each A/S regardless of the level of A/S deficiency. Stakeholders suggested that the CAISO consider a tiered demand curve with which the scarcity price increases with the severity of shortage. The CAISO believes that this is a reasonable suggestion and proposes a demand curve that has Non-Spinning divided into three segments with three different SRDCVs. When the shortage in Non-Spinning is smaller than certain value, there will be one SRDCV. When the shortage is greater than that value, the demand curve has another higher SRDCV.
Figure 3. Typical Hourly Supply Curves of Regulation Down

The CAISO conducted analysis in order to determine the breaking points of the segments of the Non-Spinning in the Scarcity Reserve Demand Curve. The analysis uses hourly Non-Spinning bid deficiency (when bid-in supply is less than requirement) data of year 2006 and 2007 to examine the volume of bid deficiency. The results show the 33rd percentile value of Non-Spinning bid deficiency of about 69 MW and 67th percentile value of 210 MW. This 33rd percentile value means that for 33% of the hours the bid deficiency is less than 69 MW (see Figure 4). The CAISO, therefore, proposes to break the Non-Spinning section of the Scarcity Reserve Demand Curve at 70 MW and 210 MW respectively.

Based on the analyses and the references from the reserve demand curves of NYISO and ISO-NE, the CAISO proposes the SRDCVs of the CAISO Scarcity Reserve Demand Curve as listed in Table 3. The SRDCVs are defined as percentages of energy bid cap since energy bid cap will change in the first three years of MRTU operation, as discussed in Section 2.4.2 of this proposal. In this way, the values of SRDCVs can change automatically with the energy bid cap.
Figure 4. Distribution of CAISO Non-Spinning Bid Insufficiency
(DAM and HAM, 2006-2007)

Table 3. CAISO Scarcity Reserve Demand Curve Value

<table>
<thead>
<tr>
<th>Reserve</th>
<th>Percent of Energy Bid Cap</th>
<th>Bid Cap = $750/MWh ($/MWh)</th>
<th>Bid Cap = $1000/MWh ($/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CAISO</td>
<td>Local</td>
<td>CAISO</td>
</tr>
<tr>
<td>Regulation Up</td>
<td>20%</td>
<td>10%</td>
<td>$150</td>
</tr>
<tr>
<td>Spinning</td>
<td>10%</td>
<td>10%</td>
<td>$75</td>
</tr>
<tr>
<td>Non-Spinning Shortage &gt; 210 MW</td>
<td>70%</td>
<td>25%</td>
<td>$525</td>
</tr>
<tr>
<td>Shortage &gt; 70 &amp; ≤ 210 MW</td>
<td>60%</td>
<td>50%</td>
<td>$450</td>
</tr>
<tr>
<td>Shortage ≤ 70 MW</td>
<td></td>
<td></td>
<td>$750</td>
</tr>
<tr>
<td>Sum</td>
<td>100%</td>
<td>45%</td>
<td>$750</td>
</tr>
<tr>
<td>Regulation Down</td>
<td>60%</td>
<td></td>
<td>$450</td>
</tr>
</tbody>
</table>

Non-Spinning Reserve is first on the demand curve. It has three segments and three SRDCVs. They are set by the following guidelines: the starting SRDCV has to be higher than the A/S bid cap and the middle section of SRDCV should be able to trigger Demand Response resources. The SRDCVs are set by looking at the third year of MRTU from where the energy bid...
cap reaches the maximum currently contemplated by the MRTU tariff. So when shortage in Non-Spinning is less or equal to 70 MW, the SRDCV is $500/MWh (when energy bid cap is $1000/MWh) that is above the A/S bid cap ($250/MWh). For shortage between 70 MW and 210 MW, the SRDCV is set at $600/MWh, which is the equivalent trigger of Interruptible Load Demand Response. When the shortage is greater than 210 MW, the SRDCV is increased to $700/MWh.

For the reasons noted above, CAISO has proposed that Spinning Reserve has a relatively low SRDCV based on the consideration of possible more frequently “ramp constraint” caused scarcity. However, when both Spinning and Non-Spinning Reserves are in shortage, the market clearing price of Spinning Reserve will be the sum of the SRDCVs of Spinning and Non-Spinning Reserves, that is $800 ($700+$100) when the energy bid cap is $1000. As shown in Table 3, with the three-segment pricing of Non-Spinning Reserves, the sum of the scarcity prices for each individual reserve, as determined by the Bid Cap, will only equal the Bid Cap when Non-Spinning Reserves are in shortages greater than 210 MW.

The SRDCVs in Sub-Regions are set based on the considerations that when Scarcity Pricing is triggered only in a Sub-Region, the A/S market clearing price should be at least as high as the A/S bid cap. The scarcity price signal should be able to attract additional needed resources to the Sub-Region.

Regulation-Down Reserve should be always procured at the CAISO control area level. It does not have SRDCV in Sub-Region. At the CAISO control area level, Regulation-Down Reserve has a separate Scarcity Reserve Demand Curve from the other three upward A/S reserves.

### Table 4. CAISO Scarcity Reserve Market Clearing Prices

<table>
<thead>
<tr>
<th>Reserve</th>
<th>Bid Cap = $750/MWh ($/MWh)</th>
<th>Bid Cap = $1000/MWh ($/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CAISO</td>
<td>Local</td>
</tr>
<tr>
<td>Regulation Up</td>
<td>$750</td>
<td>$1088</td>
</tr>
<tr>
<td>Spinning</td>
<td>$600</td>
<td>$883</td>
</tr>
<tr>
<td>Non-Spinning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortage &gt; 210 MW</td>
<td>$525</td>
<td>$713</td>
</tr>
<tr>
<td>Shortage &gt; 70 &amp;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 210 MW</td>
<td>$450</td>
<td></td>
</tr>
<tr>
<td>Shortage ≤ 70 MW</td>
<td>$375</td>
<td></td>
</tr>
<tr>
<td>Regulation Down</td>
<td>$450</td>
<td></td>
</tr>
</tbody>
</table>

According to the price cascading rule, assuming that the supplies of all A/S reserves are short in both the CAISO control area and in Sub-Regions, the market clearing prices of the scarcity reserves can be calculated based on the SRDCVs in Table 3. The market clearing prices calculated are listed in Table 4.

The scarcity price of the lowest quality reserve, that is, the SRDCVs of Non-Spinning Reserves, are higher than the highest historic A/S bid and market clearing price, even when the A/S price cap was $400/MWh. The market clearing prices under scarcity situation should also be sufficient to provide the needed incentives to price responsive demand and supply resources.
when scarcity reaches to the second or third tier. The highest market clearing price, when supply of all A/S reserves are short, can get as high as the energy bid cap.

3 Other Related Issues

There are some other issues closely related to the Scarcity Pricing design that have been raised by stakeholders. These issues may have significant impacts on the design and implementation of Scarcity Pricing mechanism. The CAISO would like to take this opportunity to discuss these issues with stakeholders.

3.1 Day-Ahead RA Resources A/S Must-Offer Requirement

Under the MRTU Tariff, RA resources must offer their capacity in the form of energy, A/S or a combination there-of, into the DAM. If a RA resource fails to make 100% of its capacity available, the CAISO will insert Energy Bids, but not A/S Bids, in the DAM. Accordingly, there is no express requirement for RA resources to submit A/S Bids for 100% of their A/S certified RA capacity in the DAM. Since FERC directed the CAISO to implement a Scarcity Pricing mechanism in the DAM, the fact that RA resources are not required to offer A/S in the DAM for any certified A/S capacity may create opportunities for market manipulation. For example, RA resources could withhold A/S capacity to cause scarcity in the DAM or in the RTM in order to benefit from the energy prices driven up by the scarcity prices of reserves. Because the CAISO will attempt to procure 100% of its A/S requirements in the DAM, economic or physical withholding in the DAM would have the most impact on consumer A/S costs.

The CAISO, therefore, proposes to extend the current must-offer requirement to requiring RA resources to offer 100% of their A/S certified RA capacity in the form of A/S Bids into the DAM. If a RA resource fails to do so, the CAISO will insert a zero ($0/MWh) A/S Bid into the DAM for any A/S certified RA capacity.

The majority of stakeholders support this proposal. Some stakeholders have also suggested the CAISO consider exemption for some RA contracts, such as existing RA contracts and RA resources self-scheduled for energy. However, due to the potential market ramifications from A/S withholding, the CAISO strongly believes that it should have the capability of co-optimizing all RA capacity regardless of when an RA contract was entered into. Therefore, the CAISO proposes the following revisions:

1) All RA resources must submit A/S bids for 100% of their A/S certified RA capacity into the DAM, even if the RA capacity has been self-scheduled for energy. Otherwise, a zero ($0/MW) bid will be inserted;

2) All RA resources with A/S certified capacity, with the exceptions as discussed below, will always be considered for energy and A/S in the DAM IFM energy and A/S co-optimization.

3) RA capacity DAM energy self-schedules will be honored except in situations when an A/S scarcity could be triggered after all other available resources.

4) Hydro RA resources are subject to the DAM A/S must-offer requirement for the expected available Energy or the expected as-available Energy according to their annual Use Plan and monthly Resource Adequacy Plan. Hydroelectric Generating Units and Pumping Load will be able to update use plans intra-monthly as necessary.

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20 MRTU Tariff Section 40.6
to reflect evolving hydrological and meteorological conditions.\textsuperscript{21} They may offer as Contingency-Only A/S.

5) Non-Dispatchable Use Limited RA Resources will be exempted from the DAM A/S must-offer requirement.\textsuperscript{22}

According to the MRTU Tariff, short-start RA units are also required to offer into RTM if not selected in the DAM or RUC.\textsuperscript{23}

Some stakeholders expressed concerns that the A/S must-offer requirement may hurt RA resources financially. The CAISO studies show that there is no negative financial impact on the RA resources by requiring the RA resources offer A/S in DAM. In fact RA resources offering A/S may be rewarded financially more than the resources not offering A/S. Three scenarios are analyzed in document “A Financial Analysis on RA Resource A/S Must Offer Requirement” that is posted together with this proposal.

3.2 A/S Cost Allocation

With strong support from stakeholders, the CAISO proposes a methodology of locational A/S cost allocation. That is the A/S cost will be allocated to A/S Sub-Regions according to their shares of net A/S obligations. The methodology and two examples are discussed in the document “A Methodology for A/S Cost Allocation by Location” that is posted together with this proposal.

3.3 Energy Price in Case of Reserve Scarcity

When there is a reserve supply shortage, the Scarcity Pricing mechanism will be triggered and the reserve market clearing prices will be set by the SRDCVs. At the same time, energy prices may either rise together with the reserve prices, or may be unaffected by the increase in reserve prices.

If a generation unit has to back down generation in order to provide one additional MW of scarcity reserve, the price of energy at the location of this generation unit could include the opportunity cost of the capacity (the shadow price of the capacity constraint) as well as the offer price of the incremental energy. On the other hand, if the incremental energy dispatched to meet load cannot be used to provide reserves due to ramp rate or other constraints, the price of energy at this location may not be directly affected by the reserve scarcity prices. The energy and reserve co-optimization models will determine the market clearing reserve prices and energy prices simultaneously.

Under MRTU the Integrated Forward Market (IFM) model performs energy and A/S co-optimization for the DAM, in which A/S has priority over energy. In RTM, energy has priority over A/S. The A/S procurement quantities and scarcity prices determined in the Hour-Ahead Scheduling Process (HASP) and Real-Time Unit Commitment (RTUC) processes will be carried over to the Real-Time Dispatch (RTD) process to optimize the procurements of energy. The opportunity costs of capacity will be reflected in the prices of A/S and energy from the co-optimization.

\textsuperscript{21} It is consistent with the MRTU Tariff Section 40.6.4.2.
\textsuperscript{22} It is consistent with the MRTU Tariff Section 40.6.4.3.2.
\textsuperscript{23} MRTU Tariff Section 40.6.3
The “Revised Scarcity Pricing Design Numerical Examples” provides several examples covering different situations of reserve shortage. The energy price varies depending on situations of capacity shortage. They are based on a simplified energy and reserve co-optimization model, as described in the document.\(^{24}\)

### 3.4 Interaction between Demand Response and Scarcity Pricing

#### Key Points

- **Simultaneous Roll-Out of Scarcity Pricing and Dispatchable Demand Response**
  Stakeholders support the simultaneous roll out of Scarcity Pricing and Dispatchable Demand Response under the Markets and Performance (formerly known as Release 1A) Demand Response initiative. Dispatchable Demand Response provided by Participating Load can be a very effective way to relieve reserve shortage conditions, and price responsive demand provided by Non-Participating Load can also contribute to the relief of a reserve shortage condition.

- **Emergency Triggered Interruptible Load**
  Stakeholders support modifying the existing Emergence Triggered Interruptible Load programs administered by the utilities so that these programs can be made available to the CAISO markets to help mitigate scarcity events. In its February 27, 2008 Ruling, the CPUC provided guidance to the IOUs on their 2009-2011 DR portfolio, emphasized the importance of demand response as Participating Load, and encouraged the IOUs to consider ways to incorporate the attributes of Participating Load into the design of their DR programs, including Emergency Triggered programs.

  This section discusses the details of the types of DR programs and how they interact with Scarcity Pricing.\(^{25}\)

#### Types of Demand Response Programs

Twelve months after MRTU startup, there will be three broad categories of demand response programs including the Dispatchable Demand Response and pre-existing programs. These programs are,

- Participating Load – Dispatchable Demand Response
- Non-Participating Load – Price Responsive Demand Response
- Emergency Triggered Interruptible Load

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\(^{24}\) The model was initially developed by Benjamin Hobbs.

\(^{25}\) The Demand Response programs are developed through the Demand Response Release 1 initiative and the Demand Response Post Release 1 initiative. This section only briefly discusses these programs and how they interact with Scarcity Pricing. For more information on Demand Response, market participants should refer to the Demand Response initiatives on the CAISO website at [http://www.caiso.com/1893/1893e350393b0.html](http://www.caiso.com/1893/1893e350393b0.html).
Table 5. Summary of the CPUC/CAISO Demand Response Programs

<table>
<thead>
<tr>
<th>Types of Demand Response Programs</th>
<th>Participating Load – Dispatchable DR</th>
<th>Non-Participating Load – Price Responsive DR</th>
<th>Emergency Triggered DR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market</td>
<td>DAM, RTM</td>
<td>DAM</td>
<td>No direct participation</td>
</tr>
<tr>
<td>Product</td>
<td>Energy, A/S, RUC</td>
<td>Energy</td>
<td>No direct participation</td>
</tr>
<tr>
<td>Able to Set Market Clearing Price?</td>
<td>DA &amp; RT Nodal Prices</td>
<td>DA LAP Prices</td>
<td>No</td>
</tr>
<tr>
<td>Can be Used to Relieve Shortage?</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Demand Response Provided by Participating Load

Under Release 1A Demand Response initiative, the CAISO proposes enhanced functionality which effectively provides demand resources with full comparable functionality to that of a generator in the CAISO’s market. The proposed design provides considerable flexibility for demand resources, allowing Participating Loads to (1) bid into the CAISO Markets with a forward energy bid; (2) provide optional bid components about the operating characteristics of the demand resource such as Minimum Load Reduction (minimum MW of demand response), Minimum and Maximum Load Reduction Time, and Minimum Load Reduction Cost in addition to the energy bid, etc. The availability of these bid components provides Participating Load with essentially the same flexibility that generators have in the CAISO Markets to ensure that the CAISO’s dispatch recognizes limitations in their availability; (3) provide optional capacity products for Residual Unit Commitment (RUC) and A/S.

At the same time the CAISO will be implementing Scarcity Pricing, it will also be implementing Demand Response enhancements. A Participating Load will be able to submit energy bids in both DA and RT at a nodal level or custom Load Aggregation Points (Custom LAPs), and settle at its location’s LMP. Therefore, a Participating Load will be able to set DA and/or RT nodal LMPs.

Figure 5 illustrates how a Participating Load can provide demand response by load reduction. The economic range of a Participating Load’s Energy Bid Curve is determined by its Minimum Load and Base Load, i.e., the maximum consumption as bid in the CAISO Markets. When the market clearing price is higher than its willingness to pay, the Participating Load’s consumption will be reduced accordingly from its Base Load, and the resulting MW amount of load reduction (Load Curtailment) represents the demand response MW.

Besides participating in Energy markets in the DAM, a Participating Load, like a generator, can optionally choose to provide RUC and/or A/S capacity. The amount of A/S capacity that can be offered is the Load reduction the Participating Load can deliver within 10 minutes. The co-optimization function in the CAISO’s market software will determine the final DA load schedule and/or A/S award. In the hour(s) DA A/S is awarded, the CAISO can dispatch the A/S capacity for energy (i.e., curtail the load supplying the A/S capacity) in RT in those

More information about the CAISO Post Release 1 Demand Response straw proposal can be found at [http://www.caiso.com/1c91/1c919e0e11c30.pdf](http://www.caiso.com/1c91/1c919e0e11c30.pdf).
hours if needed during normal operating conditions, except for those reserves designated as Contingency Only.\textsuperscript{27} If the A/S capacity awarded in a given hour is not fully curtailed in RT, any residual load schedule could still provide additional A/S and load reduction in RTM, up to the awarded A/S capacity amount in that hour.

**Figure 5. Energy Bid by Participating Load**

![Energy Bid by Participating Load Diagram]

Given Participating Loads and generators are equivalent resources for providing energy and A/S to the CAISO, Participating Loads can be an additional and effective way to relieve reserve shortage conditions.

**Price Responsive Demand Provided by Non-Participating Load**

Non-Participating Load can participate in the CAISO DAM by submitting a price-sensitive demand curve in the DAM at any of the three Default Load Aggregation Points (Default LAPs). The DAM energy bid represents a downward sloping demand curve reflecting the Load’s diminishing willingness to pay as consumption increases, or reduced consumption as price increases. In RT, a load can choose to over or under-consume in RT by having actual demand that differs from the load’s DAM Schedule. In RT, the load can adjust its consumption based on HASP advisory prices or RT interval prices to either reduce usage during high-cost intervals or purchase additional energy during low-cost intervals. The use of an hourly DA energy bid, and the opportunity to adjust demand in RT based on the market price of energy, constitute Price-Responsive Demand.\textsuperscript{28}

\textsuperscript{27} Contingency Only reserves are Operating Reserve capacity that have been designated, either by the Scheduling Coordinator or the CAISO, as available to supply Energy in the RT only in the event of the occurrence of an unplanned Outage, a Contingency or an imminent or actual System Emergency (Tariff Section 34.8). Resources must specify through a contingency flag whether their Spinning and Non-Spinning awards are to be treated as contingency reserve, i.e., whether they will be available for Real-Time Dispatch under contingency conditions only, or whether they can be dispatched optimally in RT under all conditions.

\textsuperscript{28} There are no penalties in Release 1A of the CAISO Markets that limit the ability of Price-Responsive Demand to select its level of consumption in the DAM or to adjust its consumption in the RTM: (1) whereas section 11.23 of the MRTU tariff provides Uninstructed Deviation Penalties that may be
Non-Participating Load can only bid into the DA Energy market at the Default LAP; therefore, it can only set the DA LAP energy price. In addition, since Non-Participating Load is not location-specific, it cannot provide location-specific information in its bids, as a result, Non-Participating Load cannot bid to provide A/S or capacity for RUC, thus it cannot directly relieve a reserve shortage condition. However, it can indirectly contribute to the relief of a reserve shortage condition by reducing load and, thus potentially reducing the CAISO’s A/S requirement. In addition, when scarcity pricing is triggered, Non-Participating Load can respond to price signals and reduce the amount of load exposed to high energy prices.

Load reduction provided by Day-Ahead and Day-of Non-Participating Load Demand Response programs will also be able to relieve reserve shortages. The CAISO is considering to factor load reduction cleared DA into the CAISO’s load forecast, which may reduce A/S requirements in RT and lower the chances of triggering scarcity pricing in RT.

Some stakeholders also suggest that the CAISO provide shortage signals to end users to notify them of impending shortages in the A/S market, and allow them to respond to shortage signals. Since the CAISO intends to procure 100% of the projected A/S requirement in DAM, the CAISO cannot know if there is a shortage until DAM runs. End users can respond to potential shortages by becoming Participating Loads and bid A/S into the DAM. When A/S bids are accepted in the DAM, the end-use customers can then know with day-ahead notification whether their capacity may be needed in RT.

Emergency Triggered Interruptible Load

There is currently approximately 1,700 MW Interruptible Load that is outside of the CAISO market, and is called upon during a CAISO declared Stage 2 and Stage 3 Emergency. These programs, which are administrated by the utilities and approved by the CPUC, generally provide a rate reduction to the enrolled participants.

Since Scarcity Pricing is triggered in the market clearing process, i.e. in the IFM in the DAM and in the HASP and/or RTUC in the RTM, Interruptible or Non-firm Load could end up paying the scarcity price for A/S up and until a Stage 2 Emergency is declared, assuming sufficient Interruptible Load drops that alters the underlying cause of the Scarcity Price condition.

Certain stakeholders have recommended that the CAISO trigger Scarcity Pricing only after the CAISO has declared an Emergency. In this way, Interruptible Load will have already

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imposed, subject to additional FERC Order, on generators and Interchange transactions with other Control Areas, these provisions do not apply to Load or Curtailable Demand, and (2) provisions that are currently being developed for MRTU Release 1 to ensure sufficient DA scheduling of Load terminate with the implementation of Convergence Bidding in Release 1A.

The CAISO has been working through the MRTU Release 1 working group to establish a mechanism for LSEs to inform the CAISO about their operation of demand response programs that use Non-Participating Load, and for the CAISO to use this information to adjust capacity procurement in the RUC process.

CAISO declared Emergency notices specifically related to deficiencies in Regulation or Operating Reserves are issued by the CAISO based on the severity of the deficiency:

- **Stage One**: Actual or anticipated Operating Reserves are less than the WECC Minimum Operating Reliability Criteria (typically between 6-7%);
- **Stage Two**: Actual or anticipated Operating Reserves are less than or equal to five percent (5%).
been curtailed prior to the triggering of Scarcity Pricing, thus preventing the Scarcity Pricing condition from either materializing or, at minimum, from exposing the Interruptible Load to the Scarcity Price.

As discussed above, this notion is inconsistent with the fundamental construct of a Scarcity Pricing mechanism that is triggered based on the CAISO’s inability to procure its minimum A/S requirements in the DA Market and/or RT Market, i.e. when the CAISO is planning and procuring the resources necessary to meet the applicable reliability criteria for a given operating hour. A Scarcity Pricing mechanism that is triggered only after the CAISO system has gone “critical” and is in an emergency state in RT is too late and does not send the appropriate incentive to market participants to make resources available to the CAISO during the CAISO’s DA and RT planning and procurement timeframes.

For instance, during a CAISO declared Stage 2 Emergency, when many of the Interruptible Load programs are dispatchable, the CAISO’s actual or anticipated reserve margin is less than or equal to 5%. This is far below the accepted WECC Minimum Operating Reliability Criteria. For these reasons, the CAISO believes it would be unreasonable to base the Scarcity Pricing trigger on an emergency trigger, such as a CAISO declared Stage 1, 2 or 3 Emergency.

Many of these concerns can be ameliorated by configuring, where possible, demand response resources that can actively bid into the wholesale markets and respond to price signals. If the existing Interruptible Load programs were modified to provide bids into the CAISO Markets, then the bids could be dispatched by the CAISO, and these resources could help to reduce or avoid scarcity situations. Even if these programs could not be operated in a way that meets the technical requirements (e.g., constant visibility to the CAISO of the availability of each load for dispatch) for providing Non-Spinning Reserve, having these programs available to provide Real-Time Energy would allow the CAISO to reserve A/S capacity to maintain system reserves. This will bring greater overall depth to the CAISO’s energy and A/S capacity markets.

Per written comments received in February 2008, stakeholders support modifying the existing Interruptible Load programs administered by the utilities so that these programs can be made available to the CAISO markets to help mitigate scarcity events. In its February 27, 2008 Ruling, the CPUC also provided guidance to the IOUs on their 2009-2011 DR portfolio, emphasized the importance of demand response as Participating Load, and encouraged the IOUs to consider ways to incorporate the attributes of Participating Load into the design of their DR programs, including Emergency Triggered programs.

3.5 Scarcity Pricing and Capacity Payments

Some stakeholders raised the concern that suppliers might be overcompensated for their fixed costs when both a Scarcity Pricing mechanism and a capacity market are implemented. Some stakeholders suggested that generators receiving capacity payments should be disqualified from Scarcity Pricing.

The capacity market focuses on long-term supply sufficiency. LSEs need to secure sufficient capacity to meet the long-term resource adequacy requirements. The capacity price is based in part on expected revenues of resources in the energy and ancillary service markets.

- **Stage Three:** Actual or anticipated Spinning Reserves are less than or equal to the Spinning Reserve Requirement defined in the WECC Minimum Operating Reliability Criteria (typically between 1.5% and 3%). Reserve scarcity pricing will be triggered before the CAISO must declare a Stage 1, 2 or 3 Emergency.
Sufficient supply will stabilize the market price in the long run and minimize the chances of scarcity. The capacity price is thus important guidance for long-term generation investments.

Scarcity Pricing, on the other hand, is a solution for short-term resource shortage while also making more explicit the reliability value of energy and A/S. It provides incentives for loads to improve price responsiveness and for existing generation owners to make more generation capacity available during the peak demand periods. The price signal will further attract supply from outside of the CAISO control area. The increased price volatilities in spot markets will encourage LSEs to pursue long-term bilateral contracts in order to hedge the wholesale price risks. Scarcity Pricing does let generation owners, especially the owners of flexible generation units, recover a portion of their investments.

It is therefore clear that capacity markets and Scarcity Pricing do not overlap, but rather complement each other. Implementing both will let the ISO make best use of all available resources according to market demand.

Currently, in California, capacity is procured through the CPUC administrated Resource Adequacy (RA) program. RA contracts are negotiated bilaterally and their prices are non-transparent. RA resources are paid to show up in the CAISO markets, just like non-RA resources receiving Residual Unit Commitment (RUC) payments that have to show up in RTM. As proposed in this proposal, RA resources will be subject to both energy and A/S must-offer requirements, which may reduce energy and A/S price spikes and the chances of Scarcity Pricing being triggered. The CAISO does not believe it is appropriate for the CAISO Tariff to exempt RA resources from receiving scarcity rents. Instead, the sellers and buyers should take into account the revenue from Scarcity Pricing in the negotiation of RA contracts.

On the other hand, capacity revenue adjustment could be done more explicitly with the implementation of a centralized capacity market (if the CPUC determines to pursue such a design). For example, ISO-NE, which has a scarcity pricing mechanism similar to the one being proposed here, will implement an ex post revenue adjustment based on Peak Energy Rent with the implementation of the Forward Capacity Market in 2010.31

Therefore, the CAISO proposes that the Scarcity Pricing design not disqualify bilateral RA resources from receiving scarcity prices, nor to adjust capacity payments to RA resources before the implementation of a centralized capacity market. Capacity payment adjustment could be implemented with a centralized capacity market, as a part of capacity market design. The CAISO will review the performance of the Scarcity Pricing mechanism after the capacity market is implemented.

### 4 Past Activities and Next Steps

The following is a summary of the past activities in the Scarcity Pricing stakeholder process and proposed schedules for future events.

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<tr>
<th>Date</th>
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<tr>
<td>May 31, 2007</td>
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<tr>
<td>June 6, 2007</td>
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<tr>
<td>September 5, 2007</td>
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The CAISO will discuss this Revised Draft Proposal with stakeholders on a conference call on May 27, 2008. Stakeholders are welcome to submit written comments to SPComments@caiso.com by close of business on June 3, 2008. The CAISO will post a template for stakeholder comments to its website at http://www.caiso.com/1bef/1bef12b9b420b0.html. The CAISO anticipates posting a Final Proposal on June 16 which will be presented to the CAISO Board of Governors on July 8-9, 2008.