California ISO Draft Proposal

Reserve Scarcity Pricing Design

February 6, 2008
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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. Properly designed scarcity prices should stimulate demand response, draw supply from outside of the CAISO control area, create incentives for generators to make more resources available during peak load periods, promote long-term contracting, and attract investment in new generation resources.

The Federal Energy Commission directed the CAISO to file tariff language and to implement a reserve shortage Scarcity Pricing mechanism within 12 months after MRTU Release 1 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) the design and operation experiences of other ISOs; and 3) the interaction between Scarcity Pricing and other MRTU components.

Since the Issue Identification Paper for Scarcity Pricing Design was posted on May 31, 2007, the CAISO has: (1) hosted three stakeholder meetings discussing the CAISO Scarcity Pricing design; (2) held a panel discussion stakeholder conference call on the Scarcity Pricing designs of NYISO and ISO-NE; and (3) posted a Straw Proposal for Scarcity Pricing Design. The CAISO has also requested and now received stakeholder comments on both papers. The purpose of this Revised Straw Proposal is to advance the discussion of Scarcity Pricing design, building on the Straw Proposal, focusing on specific solutions for the following design issues.

1) Scope of Scarcity Pricing: Based on stakeholder feedback, the CAISO proposes the zonal pricing scope using the A/S Regions and Sub-Regions as defined in the MRTU Tariff.

2) A/S Reserves in Scarcity Pricing: The CAISO proposes a joint scarcity demand curve for Regulation Up, Spinning, and Non-Spinning Reserves, the three upward A/S

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2 September 21 Order at PP 1077, 1079.
3 Id. at P 1079.
4 Issue Paper (http://www.caiso.com/1bef/1bef12e2453e90.pdf) was posted on May 31, 2007 and Straw Proposal (http://www.caiso.com/1c51/1c51b3ab4fea0.pdf) was posted on Sep 5, 2007.
reserves, for Scarcity Pricing. Regulation Down Reserve will have a separate scarcity demand curve, as suggested by stakeholders.

3) Triggers of Scarcity Pricing: The MRTU Tariff defines A/S Regions (the CAISO system) and Sub-Regions and indicates that the CAISO may set maximum and minimum A/S requirements for the Regions and Sub-Regions to ensure appropriate dispersion of A/S. The CAISO proposes to use the minimum requirements as the triggers of Scarcity Pricing within an A/S Region or Sub-Region. That is, if a minimum requirement is established in an A/S Region or Sub-Region and there is a shortage in that region, Scarcity Pricing will apply in that A/S Region or Sub-Region. On the other hand, if no minimum requirement is established the Scarcity Pricing will not be triggered.

4) Scarcity Reserve Demand Curve: Based on the analysis of CAISO historical A/S prices and the experience of NYISO and ISO-NE, and due to the fact that the energy bid cap will change over the first three years of operation of MRTU, the CAISO proposes to set the Scarcity Reserve Demand Curve Values of Non-Spinning, Spinning, and Regulation Up Reserves to 70%, 10%, and 20% of energy bid cap respectively at the CAISO control area level and 6% of energy bid cap for each of the three A/S reserves at Sub-Region level. So the highest A/S market clearing price, when supply of all A/S reserves are short, can get as high as 118% of the energy bid cap in an A/S Sub-Region. Regulation Down will be procured only at the CAISO control area level and has a Scarcity Reserve Demand Curve Value of 50% of energy bid cap. The scarcity price should reward price responsive demand and provide additional incentives for supply of energy.

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.

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. However, the CAISO proposes that RA contracts signed before Jan. 1, 2009 and RA capacity self-scheduled for energy should be exempted from the A/S offer requirement but nevertheless be required to make their A/S available in the event the CAISO is unable to procure 100% of its A/S requirements in the DAM. In this 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: Under MRTU, the allocation of A/S costs is based on A/S responsibility of individual Scheduling Coordinators system-wide. Paragraph 309 of the September 21 FERC MRTU Order accepts this system-wide A/S cost allocation methodology. Stakeholders are again advocating that A/S costs be allocated on an A/S Regional or Sub-regional basis. For the near term, including the first year that enhanced Scarcity Pricing is in effect, the CAISO proposes to keep the system-wide
A/S cost allocation mechanism that has been accepted by FERC. At the end of the first year that Scarcity Pricing is in effect, the CAISO will consider whether a change in cost allocation is appropriate in light of an overall assessment of the costs and benefits.

8) Demand response: 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 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 RA resources, which have received capacity payment through RA contract, be disqualified from receiving scarcity prices. The CAISO believes that is inappropriate for the CAISO to disqualify RA contract holders from receiving scarcity prices or to adjust capacity payment. Parties to bilateral RA contracts are, of course, free to negotiate how any scarcity rents may be factored into the price of capacity.

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

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 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. Any increased price volatility in the wholesale spot market arising from shortage pricing can be avoided by load serving entities (LSEs) that enter into long-term bilateral contracts to hedge the price of power.

Under MRTU Release 1, the CAISO has proposed a limited scarcity pricing mechanism that raises energy bids to the bid cap when there are insufficient energy bids in Real-Time Market 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 Release 1. 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”.\(^5\) 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.\(^6\)

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.”\(^7\)

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.\(^8\) 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.

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

There were two options for the scope of Scarcity Pricing proposed in the Straw Proposal: system-wide only or system-wide and zonal. The majority of stakeholders, based on their written


\(^6\) September 21 Order, at P1077.

\(^7\) September 21 Order at P1079.

and verbal comments, support system-wide and zonal pricing scope using the A/S Regions and Sub-Regions defined in the MRTU Tariff.

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

With a system-wide and zonal pricing scope, scarcity is measured at both system level and a finer spatial granularity compared to the system-wide only approach. When a shortage in a Sub-Region occurs despite sufficient reserves system wide, Scarcity Pricing will be triggered only in that Sub-Region but not for the whole CAISO system. ISO-NE, NYISO, and PJM have all implemented system-wide and zonal reserve Scarcity Pricing.

2.2 A/S Reserves in Scarcity Pricing Mechanism

There are four types of A/S reserves under MRTU: Regulation Up, Regulation Down, Spinning, 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.

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

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

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

(c) 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;

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

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9 MRTU Tariff Section 8.3.3
(e) 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

(f) 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:**

\[ RegUp \geq RegUp_{MinReq} \]

**Spinning Reserve Requirements:**

\[ RegUp + Spin \geq RegUp_{MinReq} + Spin_{MinReq} \]

**Non-Spinning Reserve Requirements:**

\[ RegUp + Spin + Non-Spin \geq RegUp_{MinReq} + Spin_{MinReq} + Non-Spin_{MinReq} \]

where, \( RegUp_{MinReq} \), \( Spin_{MinReq} \), and \( Non-Spin_{MinReq} \) 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 Straw Proposal that these three types of reserves be considered jointly for Scarcity Pricing. Stakeholders support the 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 shortage of supply for Regulation-Down Reserve. It could become more challenging in the near future since California is moving forward to meet the Renewable Portfolio Standards. Connecting more renewable resources (primarily wind generations) to the CAISO grid will increase the demand for Regulation Reserves. The CAISO therefore propose 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.

Based on the comments by stakeholders, the CAISO proposed in the Revised Straw Proposal to include Regulation Down Reserve in the Scarcity Pricing mechanism. The feedback is positive. All stakeholders submitted comments support the proposal.

The ISO-NE has implemented a joint Operating Reserve Demand Curve for 10-minute Spinning Reserve, 10-minute Non-Spinning Reserve, and 30-minute Operating Reserve. Regulation Reserve is not included in Scarcity Pricing. The NYISO has implemented a Reserve Demand Curve for the same operating reserves, as well as a separate Demand Curve for Regulation Reserve.

### 2.3 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 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.”¹⁰

“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.”¹¹

“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.”¹²

“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

¹⁰ MRTU Tariff Section 8.2.3.1
¹¹ MRTU Tariff Section 8.2.3.2. The WECC/NERC new paradigm does not require the exporting control area to back firm energy interchanges with Operating Reserves.
¹² MRTU Tariff Section 8.3.3.1
procured within a Sub-Region count toward satisfying the Ancillary Service requirements for the System Region or the Expanded System Region..”¹³

“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 6:00pm 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.”¹⁴

The CAISO proposes 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 those 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.

**Stakeholder Comments and the CAISO Responses**

Some stakeholders asked for clarification concerning how the CAISO will apply these reliability criteria.

The application of these criteria set forth in the MRTU Tariff section 8.3.3 and in Section 4 of the Market Operations BPM will be documented in an Operating Procedure. Currently, the CAISO has a team working on developing the Operating Procedure, which will be posted for notice and comment prior to MRTU Go Live. In the development process, the CAISO will conduct technical analysis on the reliability requirement criteria and determine what additional market power mitigation measures are needed.

Some stakeholders have also raised concerns about the CAISO Operators’ out-of-market activities, particularly that Operators may dispatch out-of-market resources to prevent triggering Scarcity Pricing., which could severely distort the price signals that Scarcity Pricing is intended to convey.

In fact, if the triggers proposed above are implemented, scarcity prices will be determined in the DAM and RTM market clearing processes through the energy and A/S co-optimization models. Although the CAISO has authority to issue Exceptional Dispatches to commit or dispatch resources prior to the running of the IFM, such use of ED should be strictly limited to resources that require a longer lead time to start and the CAISO determines they are necessary pursuant to its tariff authority (and not to prevent triggering of scarcity). Absent such a need the CAISO would wait until after the IFM and RUC has run to determine whether any additional resources are required. Consequently, use of ED should rarely have any effect in the triggering of Scarcity Pricing.

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¹³ MRTU Tariff Section 8.3.3.2
¹⁴ MRTU Tariff Section 8.3.3.3

Other stakeholders have suggested that the CAISO link Scarcity Pricing with the issuance of a Staged Emergency. That is, Scarcity Pricing should be triggered only after a Staged Emergency has been declared such that the emergency-only Demand Response (Interruptible Load) can be accessed to prevent triggering of Scarcity Pricing.

This suggestion appears to be based on the assumption that all supply resources are in the market. In fact, even with the proposed RA resources DAM A/S must-offer requirement (see Section 3.1 of this proposal), there are still some non-RA resources that are not subject to any must-offer requirement. These non-RA resources may chose not to bid into the market for various reasons. The CAISO operators will try to deploy these out-of-market resources whenever they are needed in order to maintain the reliability of the system. The deployed out-of-market resources may prevent declaring a Staged Emergency, but would and should not prevent triggering of scarcity pricing nor should the CAISO change its definition of a Staged Emergency. This is a practice also conducted by other ISOs, such as NYISO.

Moreover, Interruptible Load programs are designed for maintaining operational reliability purpose. These Interruptible Loads are not in the market nor triggered by a price. Scarcity Pricing, however, is a market mechanism intended to send price signal for incenting short-term supply and price responsive demand resources when they are needed. It is determined in the market clearing (i.e., energy and A/S co-optimization) process and will be automatically triggered. Staged Emergency, and use of out-of-market resources, is evaluated after that.

The CAISO, therefore, believes that there should be no specific linkage between Scarcity Pricing and a Staged Emergency and proposes to use the minimum A/S requirements as the triggers of Scarcity Pricing.

**Table 1. Summary of Use of Out-Of-Market Resources**

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th></th>
<th>2007</th>
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<tbody>
<tr>
<td>Month</td>
<td>Called Times</td>
<td>Average MW</td>
<td>Called Times</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>1</td>
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<tr>
<td>3</td>
<td></td>
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<td>12</td>
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<td>Annual</td>
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<td>85</td>
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<tr>
<td></td>
<td>9</td>
<td>95</td>
<td></td>
</tr>
</tbody>
</table>

To get a sense how frequently out-of-market resources will be used, stakeholder have asked the CAISO to provide some operational information. Table 1 lists the number of times the CAISO called up incremental out-of-market resources in year 2006 and 2007 and the average
MWs used each time. Please note that during this time period the CAISO operated Day-Ahead and Hour-Ahead A/S Markets but only a Real-Time Imbalance Energy Market. Today’s markets are likely to be less liquid when compared to MRTU; ith the MRTU system, which includes proposed RA resources energy and A/S offer requirement, the CAISO anticipates that the reliance on out-of-market resources should be reduced.

In addition, some stakeholders have asked whether the CAISO could provide an estimate of the frequency of the occurrence of scarcity. Bishu Chatterjee of the CPUC and Keith Collins of FERC did some research of the instances of scarcity in all the ISOs. Mr. Chatterjee presented their research results at the August 10, 2007 CAISO MSC-Stakeholder meeting. Table 2 is an excerpt from his presentation showing historical records of A/S scarcity for the other ISOs and Staged Emergency information for the CAISO, due to the fact that the CAISO does not have Scarcity Pricing yet. The CAISO data are provided for reference only since they do not necessarily reflect the reality under MRTU. With the current proposal, the CAISO believes that the instances of Scarcity Pricing being triggered could be slightly higher than a Staged Emergency being declared under MRTU due to the use of out-of-market resources.

Table 2. Historical Record of Scarcity by ISO

<table>
<thead>
<tr>
<th>Year</th>
<th>PJM</th>
<th>MISO</th>
<th>NYISO</th>
<th>ISONE</th>
<th>CAISO</th>
<th>ERCOT</th>
</tr>
</thead>
</table>
| 2005 | July 26 – 5 h  
July 27 – 4.5 h | None | Aug 27 – 4 h | None | 9.9 h |
| 2006 | None | None | July 18 – 9h  
July 19 – 9h  
Aug 1 – 5h  
Aug 2 – 11h  
Aug 3 – 6h | Aug 1 – 40 m  
Aug 2 – 4 h  
45 m | 24.8 h |
| 2007 | June 15-15m  
June 20 – 30 m | | | | April 3 – 7 fifteen minute intervals |

Finally, some stakeholders have suggested the CAISO use static numbers of MWs for A/S minimum requirements within the A/S Regions and Sub-Regions, as is done in the NYISO and ISO-NE. This would not be appropriate for the CAISO as the A/S minimum requirements are set by the WECC MORC and NERC control performance criteria as percentages of load. The A/S minimum requirements can and do change from hour to hour.

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15 When out-of-market resources are called up, the resources may be used for longer than one settlement interval.

16 Bishu Chatterjee and Keith Collins, “Some issues on Scarcity Pricing,” August 2007, [http://www.caiso.com/1c33/1c33c3c43dbd0.pdf](http://www.caiso.com/1c33/1c33c3c43dbd0.pdf).

17 The CAISO data are the number of hours declared Staged Emergency. For some of the hours, only Southern California had a Staged Emergency.
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 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 the two 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 3 lists the equivalent terminologies describing the reserve demand curves used by the three ISOs.

Table 3. Equivalent Terminologies

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

2.4.1 Overall Considerations

The CAISO, per 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 nature of CAISO's system and its nested 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 larger system region to its more granular sub-regions.

In addition, the CAISO mechanism will be different because of the integration of Regulation Up with Spinning and Non-Spinning Reserves in Scarcity Pricing. This is because, 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 whereas the NYISO chose to implement a separate demand curve for Operating Reserve and Regulation because not all capacity able to provide operating...
reserves can provide Regulation Up or Down. One additional difference is that the CAISO does not have a reserve product to meet 30-minute contingencies as the other two ISOs do.

### 2.4.2 Benchmark Price for Scarcity Reserve Demand Curve

Based on these considerations, the CAISO proposed in the Straw Proposal to link the maximum A/S scarcity price (Benchmark Price) to the energy bid cap under MRTU, the approach NYISO, ISO-NE, and PJM took. The other option considered was to base the A/S scarcity price on the Value of Lost Load (VoLL).\(^\text{18}\) Stakeholders are divided on this issue. The CAISO conducted further research and communicated with other ISOs in regard to the selection of Benchmark Price and is in agreement with ISO-NE that

“The RCPFs 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.”\(^\text{19}\)

The CAISO, therefore, proposes to link the Benchmark Price for the Scarcity Reserve Demand Curve to the energy bid cap under MRTU.

According to the MRTU Tariff, the CAISO will have an energy bid cap of $500/MWh for the first year, $750/MWh for the second year, and $1000/MWh thereafter. The Benchmark Price will therefore change accordingly, at least once (based on the assumption that Scarcity Pricing will be in operation one year after the start of MRTU).

### Stakeholder Comments and the CAISO Responses

Some stakeholders have suggested the CAISO use VoLL as the Benchmark Price since “Scarcity Prices in the range of $500/MWh are too low to reimburse an owner for the cost of peaking capacity and they are too low to make large commercial and industrial customers financially indifferent toward curtailing load.”\(^\text{20}\)

The CAISO believes this suggestion is based on the assumption of an energy-only market (no capacity market). VoLL represent the costs caused by involuntary load curtail. In California, the current RA program provides participating generation and loads capacity payments. The CPUC and the CAISO are working together on the design of future capacity market. Scarcity Pricing is not the main source for investment recovery. Instead, it is aimed at short-term supply and demand response and is only a supplement to the payments from the RA program or capacity market. Also, the Benchmark Price is set only for the scarcity prices of A/S. Energy prices will most likely set on top of the A/S price. In a scarcity situation, the energy price could be much higher than the benchmark Price of A/S. The CAISO therefore believes that it is reasonable to link the energy bid cap to the Benchmark Price of the Scarcity Reserve Demand Curve. ISO-NE, NYISO, and PJM all took this approach. MISO uses VoLL as the high end of its Scarcity Reserve Demand Curve because MISO will not have a capacity market.

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\(^{18}\) MISO, which does not have a capacity market, filed its Scarcity Pricing design using a combination of energy bid caps and VoLL.

\(^{19}\) Rationale and Derivation of proposed Real Time Reserve Constraint Penalty Factors, ISO-NE, April 29, 2005, pp. 4.

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 more likely to have supply deficiency. For example, during the morning ramping up period, load picks up more quickly than generators can ramp up. Spinning Reserve could face supply shortage during this time. To minimize the cost of serving the demand, it may be appropriate to set the SRDCV for Spinning Reserve at a moderate level.

For example, the ISO-NE set 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 may need to consider the same issue.

3) The SRDCVs should be set to reflect the cost the ISO will pay to obtain additional supply at different levels of reserve shortage.

ISO-NE used the following rationales for setting their RCPFs. “The $100/MW TMOR RCPF value is calibrated to all for re-dispatch of the system to create reserve under the majority of system condition.” “Shortages of system TMNSR 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. The price cascading rule exists in the Scarcity Pricing design of both ISO-NE and NYISO.

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 close to the Benchmark Price set for the Scarcity Reserve Demand Curve.

Besides the factors above, the analysis of historical A/S market clearing prices can also provide guidance for determining the SRDCVs. Figure 1 shows the distributions of SP15 Regulation Up Reserve market clearing prices based on the hourly prices from Jan. 1 2004 to

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21 Direct Testimony of Marc D. Montalvo, ISO-NE, February 3, 2006, pp. 44.
22 Direct Testimony of Marc D. Montalvo, ISO-NE, February 3, 2006, pp. 41-44.
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**

Table 4 is a more comprehensive summary of the statistic analysis of the CAISO SP15 A/S market clearing prices.

<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>RTM</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>RTM</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>RTM</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>RTM</td>
<td>2.70</td>
<td>1.28</td>
<td>-0.01</td>
<td>399.99</td>
<td>9.34</td>
</tr>
</tbody>
</table>

Taking into account all the factors and based on the statistic analyses of historic A/S prices 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 5. 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.
Table 5. 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>Reg Up</td>
<td>20%</td>
<td>6%</td>
<td>$150</td>
</tr>
<tr>
<td>Spinning</td>
<td>10%</td>
<td>6%</td>
<td>$75</td>
</tr>
<tr>
<td>Non-Spinning</td>
<td>70%</td>
<td>6%</td>
<td>$525</td>
</tr>
<tr>
<td>Sum</td>
<td>100%</td>
<td>6%</td>
<td>$750</td>
</tr>
<tr>
<td>Reg Down</td>
<td>50%</td>
<td>18%</td>
<td>$375</td>
</tr>
</tbody>
</table>

Non-Spinning Reserve is first on the demand curve. It has the largest value of SRDCV among all A/S reserves. 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 $600 ($525+$75) when the energy bid cap is $750.

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 6. 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>Reg Up</td>
<td>$750</td>
<td>$885</td>
</tr>
<tr>
<td>Spinning</td>
<td>$600</td>
<td>$690</td>
</tr>
<tr>
<td>Non-Spinning</td>
<td>$525</td>
<td>$570</td>
</tr>
<tr>
<td>Reg Down</td>
<td>$375</td>
<td>$375</td>
</tr>
</tbody>
</table>

All SRDCVs are much higher than the 99.5th percentile value of the historic A/S prices, even when the price cap was $400/MWh. The market clearing prices under scarcity situation should be sufficient to provide the needed incentives to price responsive demand and supply resources.

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 5. The market clearing prices calculated are listed in Table 6.

The highest market clearing price, when supply of all A/S reserves are short, can get as high as 118% of the energy bid cap in an A/S Sub-Region.
Stakeholder Comments and the CAISO Responses

Stakeholders have asked whether in the CAISO’s Revised Straw Proposal the scarcity prices increase with more severe shortages. Since the CAISO is capable of converting Non-Spinning to Spinning Reserve when Spinning is expected to have a shortage of supply, generally Non-Spinning will be the first to trigger Scarcity Pricing. When the shortage becomes more severe, it will expand into Spinning. There is an increment in scarcity price (SRDCV) from Non-Spinning to Spinning.

As for the stakeholder suggestion of using a tiered approach for the SRDCV like what NYISO has for its 30-min Reserve, the CAISO believes that approach is appropriate for some systems, like ISO-NE and NYISO, which have fixed MWs as A/S minimum requirements. The CAISO does not believe this is the ideal way for the CAISO where the A/S minimum requirements are set as percentages of load of each hour. The MWs of the tiers vary from hour to hour. For some hours the MWs could be small, which could result in scarcity price jumping up and down significantly just because of small changes in supply. That could cause unnecessary price volatilities and reduce the predictability of the markets.

Finally, stakeholders have asked questions about the price cascading rule. One is about how the prices of higher quality A/S are set when there is only one lower quality A/S in shortage. The other is about how the prices of higher quality A/S are set when they have lower bid prices than a lower quality A/S. The CAISO has created some examples about the two cases. The examples are presented in the document “Revised Scarcity Pricing Design Numerical Examples,” which has been posted together with this proposal.

2.5 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.

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NYISO implemented a tiered demand curve for its 30-min Reserve: $50/MWh for the first 200MW shortage, $100/MWh for the next 200MW, $200/MWh thereafter.
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 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.25 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 recourses 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, proposed in the Straw Proposal 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. Based on this feedback, 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/MWh) 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) If not voluntarily offered, RA contracts signed before January 1, 2009 will not be considered for A/S in DAM unless it is necessary to avoid or reduce A/S scarcity. This is based on the suggestion by stakeholders that the existing RA contracts were negotiated without the knowledge and consideration of Scarcity Pricing mechanism.

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24 The model was initially developed by Benjamin Hobbs.
25 MRTU Tariff Section 40.6
4) 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, including the RA contracts signed before January 1, 2009, have been exhausted.

5) 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. They may offer as Contingency-Only A/S.

6) Non-Dispatchable Use Limited RA Resources will be exempted from the DAM A/S must-offer requirement.⁶

According to the MRTU Tariff, short-start RA units are also required to offer into RTM if not selected in the DAM or RUC.⁷

Stakeholder Comments and the CAISO Responses

Based on the feedback from stakeholders, there are two issues that need further clarification regarding the RA resources DAM A/S must-offer. One is about A/S certified capacity and the other is about curtailing energy self-schedules.

The proposed DAM A/S must-offer does not require any change to the current RA program or RA product. The CAISO proposal allows the CAISO to co-optimize energy and A/S certified capacity of any RA resource in the DAM. If only a portion of a generation unit’s capacity is sold as RA resource, the A/S certified capacity under the RA contract should be in the same proportion as the total capacity of the generation unit.

The proposal to allow the CAISO to curtail RA resources energy self-schedules if it is necessary is based on the consideration of preventing A/S capacity withholding while allowing the resource to be used exclusively for Energy to the extent possible. The energy self-schedules on behalf of RA resources, just like other energy self-schedules under MRTU, will have a higher priority than economic bids so that they will not be adjusted unless all economic bids are exhausted. On the other hand, because energy self-schedules could be used by RA resource providers to withhold capacity from A/S markets in order to trigger Scarcity Pricing and benefit from the high prices, without the authority to curtail RA resource energy self-schedules the CAISO will be unable to mitigate market power in this respect.

3.2 A/S Cost Allocation

With the implementation of Scarcity Pricing on a zonal basis, the costs of A/S in some A/S Sub-Regions could be higher than in other Sub-Regions due to unbalanced distribution of resources and transmission constraints.

Under MRTU, the allocation of A/S costs is based on A/S responsibility of individual Scheduling Coordinators. A system-wide user rate is computed for each service across all regions (resources) and markets (Day-Ahead, HASP, and Real-time) for each hour. Paragraph 309 of the September 21 FERC MRTU Order accepts this system-wide A/S cost allocation methodology.

Stakeholder Comments and the CAISO Responses

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²⁶ It is consistent with the MRTU Tariff Section 40.6.4.3.2.
²⁷ MRTU Tariff Section 40.6.3
Stakeholders commented on the “Revised Straw Proposal for Scarcity Pricing Design” all support more granular A/S cost allocation. The CAISO proposes to maintain the FERC approved system-wide A/S cost allocation mechanism for the first year after the implementation of Scarcity Pricing. At the end of the first year the CAISO will review this A/S cost allocation mechanism and financial impacts on market participants and then determine whether it is cost effective to change it. Based on the past experience, changes of such settlement rules would incur significant implementation costs that may not be justified by the benefits associated with more granular cost allocation.

3.3 Demand Response and Scarcity Pricing

Types of Demand Response Programs

Once MRTU Release 1A is in operation, there will be three broad categories of demand response programs including the enhancements proposed under the MRTU Release 1A Demand Response initiative and the programs pre-existing prior to Release 1A. These programs are,

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

This section briefly discusses these programs and how they interact with Scarcity Pricing.28

Table 7. 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

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28 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.
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.

Figure 2. Energy Bid by Participating Load

A Participating Load can 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 is able to set DA and/or RT nodal LMPs.

Figure 2 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 hours if needed during normal operating conditions, except for those reserves designated as

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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).
Contingency Only. 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.

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.

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, Non-Participating Load cannot bid into the A/S markets, 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. Load reduction cleared DA will be factored 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

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.

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 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.
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.\textsuperscript{32} In this way, Interruptible Load will have already 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

\textsuperscript{32} 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%);
- **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.
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.

3.4 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. Sufficient supply will stabilize the market price in the long run and minimize the chances of scarcity. The capacity price is the guidance for long-term generation investments.

Scarcity Pricing, on the other hand, is a solution for short-term resource shortage. It provides incentives for loads to improve price response and for existing generation owners to make more generation capacity available during the peak demand periods. The price signal will 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 price risks in wholesale spot electricity markets. 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. They 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. 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 with the implementation of a centralized capacity market (if CPUC decides to go with it). For example, ISO-NE will implement an ex post revenue adjustment based on Peak Energy Rent with the implementation of the Forward Capacity Market in 2010.\footnote{ISO-NE, “Forward Capacity Market: Payments, Performance and Charges”, (http://www.iso-ne.com/markets/othrmkts_data/fcm/pres/fcm_pmnts_prfrmnc_chrgs.pdf).}

Therefore, the CAISO proposes, in Scarcity Pricing design, not to disqualify 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 Next Steps

The following is a proposed schedule of stakeholder activities.

- ISO Issue Paper 5/31/07
- Stakeholder Meeting 6/6/07
- ISO Straw Proposal 9/5/07
- Stakeholder Meeting 9/12/07
- Stakeholder Panel Conference Call 11/1/07
- ISO Revised Straw Proposal 11/19/07
- Stakeholder Meeting 11/26/07
- ISO Draft Proposal 1/29/08
- Stakeholder Meeting 2/13/08
- ISO Final Proposal Early March, 2008
- Stakeholder Meeting or Conference Call Late March, 2008
- Board Decision May, 2008

Stakeholders are welcome to submit written comments on the outstanding issues and proposed solutions raised in this Revised Straw Proposal to SPComments@caiso.com by February 27, 2008. The CAISO will review and incorporate stakeholder comments in the next revision of the proposal.