California Independent
System Operator Corporation

Issue Paper

Parameter Tuning for Uneconomic Adjustments in the MRTU Market Optimizations

May 6, 2008

Department of Market and Product Development

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1. Introduction

This issue paper and the stakeholder process it initiates have several objectives:

1. To describe the nature and role of a special class of parameters known as “penalty prices,” which are used in conjunction with “uneconomic adjustment” in the market optimization algorithms central to the CAISO’s new spot markets being implemented under the Market Redesign and Technology Upgrade (MRTU) project;
2. To describe the CAISO’s analytical process for “tuning” these parameters in order to determine initial values for the required parameters to be utilized in ongoing market simulation activities and upon MRTU start-up;
3. To discuss in detail a special case of uneconomic adjustment in the day-ahead market known as “LAP demand clearing,” for which the CAISO is required to file additional tariff language in compliance with FERC’s June 25, 2007 order in response to the CAISO’s compliance to the earlier September 21, 2006 order on the CAISO’s February 9, 2006 MRTU tariff filing (see MRTU tariff section 31.3.1.3);
4. To provide a list of the initial parameter values that have been determined for the day-ahead and real-time markets based on the analysis performed to date and are being incorporated into the current market simulation software, and to describe the basis for these particular values;
5. To explain the CAISO’s proposal for ongoing updating of these market parameters and for keeping market participants apprised of the current values at all times; and
6. To develop any additional tariff language that may be needed in conjunction with uneconomic adjustment. Such tariff language would be submitted to FERC in July, 2008 in conjunction with the CAISO’s compliance with the “LAP demand clearing” issue noted above. Prior to making the July FERC filing, CAISO management will seek the approval of its Board for any policy changes associated with any proposed tariff changes beyond straightforward fulfillment of the existing compliance requirement.

As discussed later in this issue paper, the CAISO expects that the July FERC filing will involve some specific policy-related tariff changes in two areas. First, the existing MRTU tariff requires that the market optimization software utilize *all* Economic Bids submitted to the market before it adjusts Self Schedules (Section 31.3.1.1). This issue paper will describe situations in which this requirement will lead to solutions that are both operationally and economically unreasonable. The CAISO believes therefore that it is appropriate to modify the existing requirement to allow Self Schedules to be adjusted or certain other constraints to be relaxed before exhausting all Economic Bids in order to avoid such extreme, unreasonable outcomes. Second, there are certain supply shortage situations for either Energy or Ancillary Services for which the MRTU tariff has not yet specified the associated pricing provisions. The appropriate pricing rules for these uneconomic adjustment situations will be developed as part of the parameter tuning effort and included in the July FERC filing.

2. Proposed Process and Timetable

The following table summarizes the key steps and dates in the stakeholder process leading to the July Board decision and FERC filing. The CAISO will augment this schedule in the near future to include dates for stakeholder review of draft tariff language.

Date	Activity
Tu. May 6	CAISO posts Issue Paper
Tu. May 13	Stakeholder meeting
Tu. May 20	Written stakeholder comments due
Th. June 5	CAISO posts Draft Final Proposal
Th. June 12	Stakeholder meeting or conference call
W. June 18	Written stakeholder comments due on Draft Final Proposal
M. June 23	MSC posts Draft Opinion
F. June 27	MSC adopts formal Opinion
M. June 30	CAISO posts Board documents, including Final Proposal
W.-Th. July 9-10	Board meeting
F. July 18 (approx.)	FERC filing

3. Uneconomic Adjustment and Penalty Prices

3.1. Overview

A fundamental market design principle behind the CAISO's MRTU project is to rely as far as possible on submitted Economic Bids to clear each market with respect to Energy, congestion management and Ancillary Service (AS) procurement. In the course of developing the MRTU design, it was always recognized that in some instances using Economic Bids alone would not yield a complete and feasible solution, in which case the MRTU market software would resort to "Uneconomic Adjustments" to arrive at a solution. Such Uneconomic Adjustments could consist, depending on the specific market conditions, of adjustments to submitted Self Schedules in accordance with the scheduling priority hierarchy specified in the MRTU Tariff, or the relaxation of certain constraints.[1]

From the perspective of the optimization software, the process for performing Uneconomic Adjustments in accordance with the required priority hierarchy is managed through the specification in the software of certain parameters generally referred to as "penalty factors" or

1 The MRTU Tariff provisions regarding Uneconomic Adjustment are found in Sections 31.4 and 34.10.

"penalty prices."[2] These parameters are associated with each of the different categories of Self Schedules and other constraints, and their role is effectively equivalent to the role that submitted bids prices play in arriving at an optimal solution based on Economic Bids. A key difference, however, is that the Uneconomic Adjustment parameters are set to artificial extreme values outside the range of acceptable Economic Bids (that is, outside the range between the applicable Bid Cap and Bid Floor) to preserve the principle of relying first on Economic Bids to arrive at a market solution. These artificial extreme values are not suitable for determining the prices to be used in settling the market, however, which gives rise to the need to structure each market process as a sequence of two market runs: a scheduling run which includes extreme penalty prices for determining energy schedules and AS procurement, and a pricing run which determines appropriate settlement prices to be associated with the energy and AS schedules that result from the scheduling run.

The primary purpose of the Parameter Tuning effort discussed here is to determine the values for the various Uneconomic Adjustment parameters – i.e., the penalty prices – to be used in the MRTU market software at the start-up of the MRTU markets and in the final phase of Market Simulation leading up to the market start-up. There are several ways to classify the various penalty prices to be studied in this effort: (a) scheduling run parameters and pricing run parameters; (b) Self Schedule parameters and constraint parameters; and (c) Day Ahead Market parameters and Real Time Market parameters. The distinctions and interrelationships among these types of parameters will be explained in the course of this paper.

As a result of the parameter tuning effort the CAISO anticipates making a filing at FERC in July to amend certain related provisions of the MRTU Tariff. The tariff changes will cover two areas. First, general changes are needed to reflect an important shift of emphasis regarding how scheduling priorities are treated in uneconomic adjustment. Current MRTU tariff language states that all available Economic Bids will be exhausted before the optimization adjusts Self Schedules to achieve a feasible solution (e.g., Sections 31.3.1.1, 31.4 and 34.10). Test cases run to date in this effort have shown that this rule, if followed without exception in all cases, will in certain situations lead to solutions that vary severely from both sound operational practice and reasonable economic outcomes. To illustrate, consider a situation in which a transmission constraint is violated and the only effective economic decremental bid ("DEC bid") is from a distant generator whose effectiveness on the constraint is very low. If the provision of section 31.3.1.1, for example, is followed to the letter, the optimization must utilize *all* available Economic Bids before adjusting a Self Schedule. The optimization would utilize this relatively ineffective DEC bid, decrement a large number of MW of the generator's output to obtain a small MW flow reduction on the constrained line, and create an extreme congestion price differential between the generator and the other side of the constraint. But such an outcome, based on an inflexible interpretation of section 31.3.1.1, would not be consistent with sound operational practice – operators would not relieve a constraint in one area of the grid by making a large adjustment to a distant generator that had very low effectiveness. Rather, it would be appropriate to set a threshold effectiveness level for Economic Bids to be used to relieve such a constraint, and when Economic Bids are not available above threshold, to decrement a smaller number of MW from a more effective nearby generator Self Schedule. Such a threshold would be set in the optimization software as a type of Uneconomic Adjustment parameter, as discussed in this issue paper. With regard to the tariff provision in question, the shift of

[2] The term "penalty factor" or "penalty price" is a conventional technical term used in the vocabulary of optimization algorithms and software to refer to tunable parameters that are specified by the user to implement relative priorities for enforcing various constraints or categories of constraints. Contrary to the more common use of the word "penalty," these parameters have nothing to do with the concept of enforcing market participant compliance with market rules, penalizing non-compliance, etc.

emphasis would be to describe Self Scheduling priorities so as to allow the optimization to achieve operationally sound and economically reasonable solutions in cases where following a strict requirement to utilize all Economic Bids first would lead to an unsound solution. This will be one of the matters submitted to FERC in the CAISO's July 2008 filing.

The second area to be addressed in the July FERC filing will be the CAISO's compliance with FERC's June 25, 2007 order to clarify the methodology for resolving the "LAP Clearing" problem. This problem is a special case of Uneconomic Adjustment within the broader scope of the present effort, but it is the one that was addressed in the CAISO's original February 9, 2006 MRTU Tariff filing and was determined by FERC to require greater clarification.

As mentioned above, under the MRTU market design each market process (e.g., the IFM and the RTED) consists of two runs: a scheduling run and a pricing run. The scheduling run first determines the MW Energy schedules of supply and demand resources and designates MW quantities of resources to provide ancillary services. The pricing run then determines the locational marginal prices (LMPs) for energy and the ancillary service marginal prices for each ancillary service product. The next two sub-sections discuss the scheduling run and the pricing run in greater detail.

To summarize, the overall objective of the parameter tuning analysis is to determine, for the various MRTU market optimization processes, appropriate penalty prices for scheduling runs and pricing parameters for pricing runs to:

1. Observe the desired priorities for self-scheduling and constraint relaxation in the scheduling runs of each market process, consistent with the fundamental MRTU design principles;
2. Provide efficient economic signals in the form of large magnitude (positive or negative) prices when warranted, in particular to link settlement charges to cost causation and avoid creating incentives for participants to schedule and operate in a manner that undermines the operational and efficiency objectives of the MRTU design;
3. Prevent "unreasonable" price outcomes in the pricing runs, which may occur if curtailment priorities are enforced inflexibly even under the most extreme circumstances; and
4. Achieve scheduling and pricing outcomes that are consistent with good operational practice and support reliable operation of the CAISO transmission system.

3.2. The Scheduling Run

In the scheduling run, the current MRTU Tariff states that the optimization software will try to achieve a solution (which includes system energy balance, congestion management and procurement of AS requirements) utilizing Economic Bids as far as possible, and will resort to "uneconomic adjustment" – i.e., adjustments to Self Schedules or relaxation of constraints – only when a solution based entirely on Economic Bids is not achievable (see Section 31.3.1.1). Allowing the curtailment of Self Schedules and relaxation of constraints will ensure that the optimization will achieve a solution in the scheduling run.

The MRTU Tariff also specifies a set of priorities whereby certain types of Self Schedules are adjusted before others when Uneconomic Adjustments are necessary (see Sections 31.4 and 34.10). For example, "generic" Self Schedules are adjusted before ETC Self Schedules, which are in turn adjusted before TOR Self Schedules. Similarly, different types of constraints – including the transmission constraints, nomogram constraints, AS requirement constraints, and the energy balance constraint – are assigned different levels of priority for enforcement, and the order of enforcement can differ between different market processes. The modeling of priorities for Self Schedule protection and constraint enforcement in the scheduling run is carried out through the use of penalty prices with extreme values, which are applied to slack variables representing the curtailment of the Self Schedule and the relaxation of the constraints. The penalty prices for Self Schedule curtailment, for example, have negative values and are much lower than the Energy Bid floor. For transmission constraint relaxation, penalty prices are positive and much higher than the Energy Bid cap. For violation of the energy balance constraint, a very large positive value is used for the penalty price. The penalty prices are intentionally set at values that are out of the range of Economic Bids so that all Economic Bids will be utilized to the extent possible to avoid Self Schedule curtailment and constraint relaxation. Similarly, the penalty prices of different priority levels are sufficiently far apart from each other to ensure that adjustments of lower priority are activated prior to higher priority ones as the optimization searches for a solution. The larger the magnitude of the penalty price, the higher will be the priority for Self Schedule protection and constraint enforcement. The optimization process of the scheduling run will minimize the total bid cost of the scheduled resources, including the costs associated with the slack variables based on the assigned penalty prices, subject to various constraints.

When Self Schedule curtailment or transmission constraint relaxation occurs in the scheduling run solution, some of the Energy LMPs and AS Marginal Prices (ASMPs) that result from this scheduling run are determined by the CAISO-assigned extreme penalty prices. Hence the scheduling run prices are inappropriate for use in settlements because the CAISO assigned penalty prices are only intended as an optimization tool and are not economically meaningful. Moreover, the LMPs and ASMPs determined based on scheduling run penalty prices will typically not reflect the values specified in the CAISO tariff for the determination of market prices under uneconomic adjustment. One of the functions of pricing run, therefore, is to determine prices as specified in the CAISO tariff that can be used for settlement in such circumstances.

3.3. The Pricing Run

The pricing run retains the slack variables associated with self-schedules that were curtailed and transmission constraints that were relaxed in the scheduling run. Since the values of slack variables determined in the scheduling run reflect the amount by which the corresponding self schedule was adjusted or the constraint was relaxed, the slack variables that appear in the pricing run are those having non-zero values in the scheduling run solution. Each such slack variable is modeled in the pricing run with a small range (referred to as "*epsilon*") beyond the level determined in the scheduling run. This design guarantees that a solution will exist in the pricing run. Further, the prices associated with the slack variables are not the extreme penalty prices used in the scheduling run. Instead, the prices of the slack variables will be set to the appropriate multiple of the bid cap or bid floor of the associated commodity as specified in the CAISO tariff. For example, the price for a self-schedule curtailment slack variable is currently set to the bid floor for a curtailed generating resource and to the bid cap for curtailed load.[3] The price for a transmission relaxation slack variable is currently set to 3 times the bid cap.[4] Because the required priority order among the various Self Schedule types and constraints has been observed in the scheduling run, the prices associated with the slack variables in the pricing run do not need to be as extreme as their corresponding values in the scheduling run, but instead can reflect the pricing policy as specified in the CAISO tariff. (Sections 31.4 and 34.10)

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3 See Sections 39.6.1.4 and 39.6.1.1.

4 See Sections 39.6.1.1 and 31.3.1.3. These values are configurable parameters that can be modified in accordance with future tariff changes.

The pricing run is formulated to determine the Energy and AS prices of the physical schedule produced in the scheduling run, taking into account the costs associated with the slack variables, i.e. including the cost assigned in the tariff to curtailing Self Schedules or violating the corresponding constraints.[5] The prices determined in the pricing run will have the following characteristics:

- LMPs, ASMPs and constraint shadow prices that resulted from the scheduling run and were not calculated through slack variable penalty prices in the scheduling run, i.e., those that were not affected by uneconomic adjustment in the scheduling run, will have nearly identical values in both the scheduling run and the pricing run.
- For those LMP, ASMP and constraint shadow prices that were calculated through slack variables in scheduling run, the pricing run prices are determined by both the Economic Bids of market participants and the pricing run penalty prices for the slack variables. For example, suppose that a self-schedule of a generating resource was curtailed in the IFM scheduling run solution. In the pricing run, the LMP at the resource's location would be determined by several factors including the bid floor value used for the slack variable and the price determined by the marginal bids of generation resources, imports, loads and exports.

To illustrate the above, consider the following conditions:

1. System-wide shortage of generating capacity to meet system load and/or system reserve requirement;
2. Regional shortage in AS bids to meet AS requirement but no shortage of Energy Bids to meet load.

In each case the scheduling run will produce schedules that violate the corresponding constraints. For a violation of the system-wide energy balancing equation, the pricing run will determine the energy clearing price to be the penalty price of the associated slack variable used in the pricing run. Similarly, for the violation of the AS minimum requirement, the AS clearing price determined by the pricing run is the slack variable penalty price of this constraint in the pricing run. In either scenario, the energy price and the AS price will be limited in accordance with the Tariff to a small multiple of the bid cap based on the pricing parameters for the pricing run currently set in the application software. Developing the policy for these clearing prices as well as setting the slack variable penalty prices to be used in the pricing run are key objectives of this initiative, and will comprise an element of the CAISO's July 2008 FERC filing.

3.4. Extreme Energy and Ancillary Service Prices

While the approach of protecting self-schedules and enforcing transmission constraints with extreme penalty prices in the scheduling run works well in a radial network model under the current zonal market design, it could have unintended consequences under the LMP design utilizing the full network model in MRTU. During the previous testing of application software with realistic data, LMP prices with extreme values, i.e., very large positive or negative prices, were observed in the pricing run from time to time. Extreme LMP prices can occur in those situations where resource self-schedules are curtailed or transmission constraints relaxed in the scheduling run solution, but they can also occur in other circumstances. There are two main causes of extreme LMP values in the scheduling run.

[5] In addition, a cost is assigned to not meeting economic demand bids which is equal to the value placed on meeting that demand by the demand bid price.

- Large numbers of resources are self-scheduled and modeled as inflexible in the scheduling run. As a result, the amounts of Economic Bids that can be used to resolve transmission congestion may be limited and, if the Economic Bids are not sufficient, Uneconomic Adjustment will be required.
- Transmission constraints in the scheduling run are enforced as even harder constraints (i.e., having higher penalty price values) than self-schedules.[6]

For example, suppose a particular transmission constraint is congested. Depending on the network configuration, injecting additional power at one source while reducing the injections of power at other sources could be very efficient (i.e., low re-dispatch cost per megawatt of congestion relief) in solving congestion, or very inefficient (i.e., high re-dispatch cost per megawatt of congestion relief). If there are insufficient Economic Bids from resources having a material impact on a transmission constraint to solve transmission constraint violations, then ineffective resources with Economic Bids will be utilized to solve the congestion. This means that in order to solve a very small violation of a transmission constraint, very large amounts of economic adjustment from some ineffective resources (e.g., resources with a high cost per megawatt of congestion relief) are needed, resulting in extremely large shadow price of the transmission constraint and extreme LMP prices at locations near the transmission constraint. Moreover, large adjustments of ineffective resources to relieve a constraint are generally inconsistent with good grid operating practice. High LMP prices for energy are also sometimes accompanied by high AS prices due to the opportunity cost of using capacity to provide AS when the generating capacity could be providing high priced energy.

Thus the high penalty values set on transmission constraints and self-schedules in the scheduling run, which are appropriately intended to ensure that Economic Bids are fully utilized before self schedules are curtailed or constraints are relaxed, can have unintended consequences in extreme cases. In the scenario described here, an inflexible rule that requires utilizing *all* Economic Bids before adjusting self schedules or relaxing constraints would lead to extreme scheduling run and pricing run results. Through this parameter tuning effort the CAISO is assessing ways to tune the penalty prices so as to avoid the unintended consequences that result in these extreme cases. Several alternatives are described below to illustrate the tradeoffs and potential issues that arise with different approaches to setting penalty price values.

Alternative 1. In this alternative, the slack variables representing the relaxation of transmission constraints are modeled with lower penalty prices in the scheduling run, while the penalty prices on self-schedules are kept at a high level. Large economic adjustments by ineffective resources to solve congestion will therefore not result in the scheduling run solution. Instead, the optimization process will choose to relax transmission constraints rather than attempting to solve the constraints using ineffective resources at very high cost.

Determining the appropriate penalty price for constraint relaxation is discussed later in this paper. Setting too small a value would have potentially severe adverse effects. If the penalty price is too low, effective resources with high cost bids would not be scheduled or even committed to solve violated transmission constraints, and the scheduling run solution could involve large amounts of relaxation in constraints. This solution could compromise system

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[6] Although the existence of self-schedules can increase the frequency of Uneconomic Adjustment and extreme prices, particularly in the IFM, the existence of hard transmission constraints (i.e. constraints with very high penalty prices) in the scheduling run is sufficient to give rise to extreme prices. The NYISO has encountered such extreme prices from time to time simply as a result of attempting to solve transmission constraints at any cost, particularly in real-time operation with short-term ramp constraints.

reliability by requiring re-dispatch in real time to relieve the overloaded constraints, which could be particularly challenging if resources that will be needed in real time to manage congestion are not committed.

Another important consideration is that this approach would depress the cost impact of having insufficient Economic Bids to manage congestion. If the cost of submitting high volumes of self-schedules is understated, market participants will have greater incentives to submit inflexible self-schedules for resources that are not really inflexible. A particular concern is to avoid situations in which the charges for infeasible self-schedules are predictably modest in the IFM, but because harder transmission constraints must be enforced in real-time, the infeasible day-ahead schedules can be sold back at much more negative prices in real-time, creating a profit opportunity analogous to the "DEC game" which the MRTU markets were designed to eliminate. The Alternative 1 approach would thus give rise to large constrained off payments in real-time if the transmission limits that were relaxed in the IFM scheduling run cannot be relaxed in real-time operation.

For this approach to work it would be necessary to determine an appropriate upper bound on the amount of constraint relaxation that would be acceptable. On one hand, allowing too much constraint relaxation could compromise system reliability, as discussed above. On the other hand, by allowing only a very small amount of relaxation, the problem of extreme pricing which this solution was intended to address may occur anyway.

Finally, it should be noted that this approach would reverse the priority order specified in the current MRTU tariff, which provides that self-schedules would be adjusted before transmission constraints are relaxed. (See Sections 31.3.1.1, 31.4 and 34.10.)

Alternative 2. Under this alternative, in addition to lowering the penalty value for constraint violations as under Alternative 1, we would also lower penalty prices on self-schedule curtailment in the scheduling run.[7] At one extreme, we could model all self-schedules using the minimum Economic Bid as does the NYISO. (See discussion in Section 7.) In such modeling approach, we would increase the amount of Economic Bids that can be adjusted for resolving transmission congestion. Thus, the amount of constraint relaxation that would be needed would likely also be reduced. Of course, this approach would not distinguish self-schedules from Economic Bids at the bid floor price, which would weaken the priority structure for self-schedules under uneconomic adjustment. This approach could also result in reducing self-schedules instead of accepting incremental Economic Bids whose price exceeds $30, which could be similarly effective in relieving a transmission constraint by providing a counterflow to the self-schedule, but would not be utilized because it would be less costly to decrement a bid at -$30 than to increment a bid at more than $30.

Other Alternatives. One of the reasons for the extreme LMP prices in the pricing run is that the current design only relaxes the transmission constraint or curtails the self-schedule for the exact amount needed to clear the scheduling run. If the marginal cost of the Uneconomic Adjustment to resolve the constraint is extremely high in the scheduling run, it will still be high in the pricing run. This outcome could be avoided without the need for changes to the scheduling run if the violation costs of the transmission constraints and self-schedules were set to their tariff values for their entire range in the pricing run (i.e., -$30 for supply self-schedules and $500 for demand self-schedules). This would result in pricing run schedules that differ from those resulting from the scheduling run, but that might not necessarily matter if the pricing run schedules were not used as final schedules. It would also, however, result in prices that would not reflect actual

7 A variation of this approach could be to continue to use extreme penalty prices in the scheduling run for TOR and ETC self-schedules but to use the -$30 bid floor price for all other self-schedules.

incremental costs in the scheduling pass, so some market participants would not be charged the full cost of accommodating their self-schedules or of relieving a transmission constraint. Although it may seem desirable to avoid high LMPs, as noted earlier it would defeat the MRTU market design by hiding the true cost impacts that result when large amounts of self-schedules require the optimization to resort to uneconomic adjustment, which would in turn create strong incentives for participants to submit inflexible self-schedules for resources that are actually flexible.

An intermediate way of reducing the magnitude of the infeasibilities that could be used as a variation of the approach just described would be to reduce the penalty price for normal generation self-schedules in both the scheduling run and the pricing run, but not all the way to the bid floor price, i.e., set the penalty price to -$50 rather than either -$3,000 or -$30. At the same time, maintain the high positive penalty price on demand self-schedules. This would avoid incurring extreme costs to accommodate self-schedules that would not be recovered in the pricing pass.

3.5. The LAP Demand Clearing Problem

The Load Aggregation Point ("LAP") clearing problem is specific to the IFM; it does not arise in either the RUC or the RTM because there is no bidding or scheduling of demand using LAPs in these market processes.

In the MRTU design, one important principle embodied in the mechanism for clearing Demand Bids (including Self Schedules) submitted at the LAP level is that the load distribution factors (LDFs) used to distribute the submitted LAP Demand Bids to PNodes should be preserved in the clearing of Demand against Supply for the LAP. This is a necessary feature for obtaining internally consistent prices in the IFM, because it ensures that nodal LMPs and cleared nodal Demand quantities will aggregate to a LAP price and quantity that is on the LAP Demand curve.[8] This same feature has a potential to lead to undesirable consequences, however, under certain conditions, which are expected to be rare. Essentially, if there is internal congestion within the LAP that creates a load pocket and there is a shortage of supply within the load pocket, constraining the LDFs to remain fixed so that LAP Demand clears at a point on the LAP Demand curve can result in (a) a large volume of LAP Demand Bids being curtailed in the IFM, which shifts that Demand out of the IFM and into Real-Time and leads to a higher level of RUC procurement, or (b) extremely high Day-Ahead LMPs within the load pocket, or (c) both.

In general this problem is avoidable with an effective Resource Adequacy (RA) program that requires well-specified local capacity requirements, combined with clear, effective obligations on RA capacity under the CAISO market rules to make itself available in the IFM. Such obligations ensure that local supply scarcity – a key condition for the above scenario to occur – will be uncommon, limited to situations where facility outages or derates severely constrain the supply into a load pocket.

It is important to note that even if the CAISO were not to use LAP Demand Bids in the IFM, high LMPs in a load pocket can occur when supply into that area is severely constrained, for which the MRTU design includes effective local market power mitigation to minimize the impacts of such conditions on Demand. Another point to keep in mind is that even though LMPs in the load pocket may be high, the LAP Demand is settled at a LAP price which corresponds to a point on the LAP Demand curve and thus will still be a price that the LAP Demand is willing to pay based

8 Indeed, this feature was incorporated to address the number one issue that LECG identified in their February 2005 report assessing the overall MRTU market design, which is available at: http://www.caiso.com/docs/2005/02/23/200502231634265701.pdf.

on its submitted LAP Demand Bids, even though a few of the individual LMPs that comprise the LAP price may be high.

The other consequence of a local-scarcity condition – the potential for severe curtailment of LAP Demand in the IFM – is a direct consequence of holding the LDFs fixed in all circumstances. From the perspective of economic consistency this is the correct thing to do because, as noted above, it ensures that the cleared nodal Demand and LMPs aggregate up to a point on the LAP Demand curve. But in practical terms the LDFs are statistically derived and as such will deviate randomly from the true distribution of Demand in any given hour. With a sound methodology for estimating the LDFs, the LDFs will be reliable and the random deviations should be small, but even so it should be recognized as a strong presumption to insist that the LDFs be fixed under all circumstances. Moreover, although high LMPs in load pockets are appropriate when those areas are constrained and supply is scarce, it is less desirable to curtail IFM Demand across an entire LAP when a local constraint is binding. Such curtailment is purely an artifact of the fixed LDFs, which is why this is an IFM problem only. Demand in RUC and in Real-Time is modeled nodally; absent a fixed distribution of Demand, a local constraint will not force Demand to be curtailed pro rata across the LAP.

Based on the scenarios described above, the CAISO included in the filed MRTU tariff certain provisions to address the local scarcity circumstances described here, to mitigate what would otherwise be highly artificial scheduling or pricing outcomes. The most current version of these tariff provisions is contained in section 31.3.1.3.[9]

FERC's September 21, 2006 Order on the February 2006 MRTU Tariff filing discussed the CAISO's proposal for addressing the LAP Demand Clearing scenario and concluded with the following compliance requirement.

> 618. We agree with PG&E that the parameters that govern the CAISO's use of MRTU Tariff section 31.3.1.2 could significantly impact rates and find that the CAISO should provide further details on those parameters in MRTU Tariff section 31.3.1.2. This section currently states that "the CAISO will evaluate the validity of the binding constraints and if it is determined that the constraint can be relaxed based on the operating practices, will relax the constraint consistent with operating practices" and "the CAISO may 'soften' the Load Distribution Factor constraints on a node or sub-LAP basis, i.e., adjust load at individual nodes or, in aggregate, a group of nodes to relieve the constraint in such a way that minimizes the quantity of load curtailed." While the CAISO anticipates using these provisions only under rare conditions, the provisions must be fully developed and transparent. Thus, the CAISO must revise this section to include the parameters that would govern its use of MRTU Tariff section 31.3.1.2. Accordingly, we direct the CAISO to file a compliance filing within 60 days of the date of this order reflecting this change.

The CAISO revised section 31.3.1.2 in compliance with the above order, and in response FERC issued further compliance requirements in its June 25, 2007 order on the CAISO's compliance filing.

> 162. We agree with parties' contention that the proposed tariff language is unclear and requires further clarification. For example, several parties raised concerns on the use of

9 The material now in Section 31.3.1.3 was originally in Section 31.3.1.2. In response to requests by participants to add additional detail from BPMs into the Tariff and by the CAISO's own initiatives in the BPM MRTU proceeding, the CAISO has proposed to add language to Section 31.3.1.2 to more clearly state how Ancillary Services will be treated in the IFM. The material on LAP Demand Clearing was therefore placed into Section 31.3.1.3.

> penalties for constraint violations. We share those concerns. While the CAISO attempts to explain the penalty as a mathematical device for relaxing constraints, we believe the CAISO should give further details about the impact of the proposed penalty levels in the IFM.
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> 163. In addition, we note that the CAISO has failed to respond to certain issues raised by commenting parties. For example, the CAISO's answer does not address Six Cities or SoCal Edison's concerns relating to how the rules will function, who are the affected parties, how they are affected, or the impact it will have on market prices. We believe the parties raise legitimate concerns that the CAISO must address in a subsequent compliance filing directed in this order. Accordingly, we direct the CAISO to resubmit revised tariff language that clearly indicates that the penalty is not a financial penalty in the traditional sense and clarify what constitutes an effective economic bid. In addition, we direct the CAISO to clearly articulate in the compliance filing transmittal letter: (1) what the revised provision does; (2) how the provision works in practice; (3) the practical and financial effect of the provision on the market participants; and (4) detailed answers to the questions raised by commenters.
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> 164. We hereby direct the CAISO to resubmit revised tariff sheets in conjunction with the compliance filings it will make on or before August 3, 2007. We also accept the CAISO's commitment to conduct the market simulation which will better inform us on the performance of the proposed penalty and direct the CAISO to propose modifications if necessary.

The CAISO subsequently filed a series of motions for extension of time to allow for thorough testing and analysis of the proposed procedures using the market simulation software. The CAISO filed the last of these motions on January 31, 2008, wherein it described the further testing it intends to complete and committed to file in compliance with the above order as soon as such testing and analysis were completed but no later than sixty-two days prior to the start-up of the MRTU markets. FERC approved this motion, and on that basis the CAISO is including the analysis associated with the LAP Demand Clearing scenario in this parameter tuning effort and will incorporate its compliance on this matter into the planned July filing.

4. Parameter Tuning Analysis – Description

4.1. Relationship to Analysis Track Testing

The Analysis Track Testing[10] effort was primarily intended to: 1) verify that the prices calculated from the SCUC are correct, and 2) validate that Energy and Ancillary Service schedules determined by SCUC are consistent with (i) calculated prices, (ii) submitted Bids, and (iii) market rules per the CAISO MRTU Tariff. As such Analysis Track Testing examines the performance and results of the optimization algorithms, taking the penalty prices and other pricing parameters as given inputs. In contrast, the parameter tuning analysis is intended to fine-tune the values of the penalty prices and pricing parameters, with the objective of ensuring that priorities and pricing rules established in the tariff for cases of uneconomic adjustment and constraint relaxation are appropriately applied. Thus, although the parameter tuning analysis

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10 On April 16, 2008, the CAISO posted the preliminary LECG report on Analysis Track Testing: http://www.caiso.com/1fab/1fabe05421e10.pdf

effort is different from the Analysis Track Testing effort, the parameter tuning effort does build upon the validation results of Analysis Track Testing and therefore the two efforts have been coordinated.

4.2. Overview of the Analysis

The parameter tuning analysis described here focuses on the IFM and RUC market process of the Day Ahead Market, and the RTUC and RTD market processes of the Real Time Market. Although certain specific situations were described above to illustrate the importance of properly tuning the penalty prices used in Uneconomic Adjustments (i.e., the use of a distant ineffective generator Economic Bid to relieve a transmission constraint, and the LAP demand clearing problem), the analysis addresses the parameters needed for uneconomic adjustment in a comprehensive manner and is not limited to those situations only.

The overall objective of the parameter tuning analysis is to determine, for the IFM, RUC, RTUC and RTD market processes, appropriate penalty prices for scheduling runs and pricing parameters for pricing runs to:

1. Observe the desired priorities for self-scheduling and constraint relaxation in the scheduling runs of each market process, consistent with the fundamental MRTU design principles;
2. Provide efficient economic signals in the form of large magnitude (positive or negative) prices when warranted, in particular to link settlement charges to cost causation and avoid creating incentives for participants to schedule and operate in a manner that undermines the operational and efficiency objectives of the MRTU design;
3. Prevent “unreasonable” price outcomes in the pricing runs, which may occur if curtailment priorities are enforced inflexibly even under the most extreme circumstances; and
4. Achieve scheduling and pricing outcomes that are consistent with good operational practice and support reliable operation of the CAISO transmission system.

The following cases were identified for analysis (M = Medium, H = High priority).

Scenario	Pre-IFM	IFM	RUC	HASP	RTPD (RTUC)	RTID (RTED)
Extreme prices resulting from a resource with low effectiveness used to relieve constraint	M	H	M	M	M	M
LAP demand clearing large MW reduction due to binding transmission constraint	H	H				
Energy balance constraint violation	M		H	M	M	M
AS procurement constraint violation	M	H		H	H	
Export priority		M		M		

The following sub-sections describe the particular optimization cases the CAISO has identified for purposes of the parameter tuning analysis. At the present time the CAISO has not yet been able to work with and analyze all these cases, but they are all described here to provide a sense of the direction of further efforts on this project.

1. **Day-Ahead Pre-IFM LAP Load Reduction (2 cases)**

The cases of interest here are those where short of other actions (explained in (a) and (b) below) LAP load would have been curtailed at some LAP.

The optimization software will produce a message when the scheduling run of the Pre-IFM All Constraints Run cannot fully meet the CAISO demand forecast plus AS requirements and will automatically take one of the following actions:

a. release some Energy from otherwise conditionally accepted self provided AS capacity, or

b. relax some transmission constraints.

The two cases of interest – involving load curtailment in the PG&E and SCE default LAPS – can be identified by the occurrence of the message noted above, or by the reduction of conditionally accepted self-provided AS. Both Pre-IFM and IFM results will be analyzed for each of the two LAP cases.

2. **Use of Bids with Very Low Effectiveness (8 cases)**

The cases are of interest are those where large volumes of economic (as distinct from self-scheduled), but relatively ineffective, bids are used to resolve a transmission constraint. The main symptoms of such cases are high shadow prices of transmission constraints. The analysis will utilize four cases in this category from IFM and four cases from RTM. The cases of interest are:

- Shadow price of a Competitive Path (a Tie, Path 15, or Path 26) exceeding $5,000/MWh
- Shadow price of a Competitive Path (a Tie, Path 15, or Path 26) exceeding $1,500/MWh but not greater than $5,000/MWh
- Shadow price of a Non-competitive Path (any path other than a Tie, Path 15, or Path 26) exceeding $3,000/MWh
- Shadow price of a Non-competitive Path (any path other than a Tie, Path 15, or Path 26) exceeding $1,500/MWh but not greater than $3,000/MWh

3. **"Energy" Imbalance (2 cases)**

Two cases are of interest here: a RUC case and an RTM (HASP or RTD) case. Each case is characterized by a shortage of market-wide supply, and would be identified by either a reduction of the load forecast used as the CAISO demand, or a non-zero Energy Balance slack variable.

4. **AS Constraint Violation (2 cases)**

Two cases are of interest here: an IFM case and an RTPD case.

- The IFM case is characterized by relatively large Ancillary Service Marginal Prices (ASMPs).

  Note: The IFM case does not have to exhibit procurement less than the requirement as described next for the RTPD case of interest. Once an IFM case with high ASMPs is identified, the AS constraints can be varied in the analysis to generate variants that trigger system-wide or AS Regional constraint violations.

- The RTPD case is characterized by one of the upward AS procurement requirements not being fully met (i.e., Regulation plus Spin plus Non-spin, or Regulation plus Spin, or just Regulation), when self-provided AS are included. If such a case is not available, then an RTPD case featuring high ASMPs would be suitable, as described for IFM in the previous bullet.

5. **Export Priority (2 cases)**

Two cases are of interest here: an IFM case and a HASP case.

- The IFM case is characterized by reduction of a self-scheduled export on a non-congested tie in IFM.
- The HASP case is characterized by reduction of a self-scheduled export on a non-congested tie in HASP.

5. Parameter Tuning Analysis – Initial Results

5.1. Day Ahead Market Discussion

The initial parameter values recommended for the IFM based on the parameter tuning effort to date implement a priority order that is consistent with the MRTU tariff, particularly sections 31.3.1.3 (Reduction of LAP Demand) and 31.4 (Uneconomic Adjustments in the IFM). Section 31.4 lists the scheduling priorities in IFM as follows:

1. Reliability Must Run (RMR) Generation pre-dispatch reduction;
2. Day-Ahead TOR Self-Schedules (balanced demand and supply reduction);
3. Day-Ahead ETC Self-Schedules (balanced demand and supply reduction); different ETC priority levels will be observed based upon global ETC priorities provided to the CAISO by the Responsible PTOs;
4. Other Self-Schedules of CAISO Demand reduction subject to Section 31.3.1.3, exports explicitly identified in a Resource Adequacy Plan to be served by Resource Adequacy Capacity explicitly identified and linked in a Supply Plan to the exports, and Self-Schedules of exports at Scheduling Points explicitly sourced by non-Resource Adequacy Capacity;
5. Self-Schedules of exports at Scheduling Points not explicitly sourced by non-Resource Adequacy Capacity, except those exports explicitly identified in a Resource Adequacy Plan to be served by Resource Adequacy Capacity explicitly identified and linked in a Supply Plan to the exports as set forth in Section 31.4(d);
6. Day-Ahead Regulatory Must-Run Generation and Regulatory Must-Take Generation reduction;
7. Other Self-Schedules of Supply reduction; and
8. Economic Bids of Demand and Supply.

Section 31.3.1.3 further specifies the priority process for resolving situations where the IFM cannot resolve a non-competitive transmission constraint utilizing effective Economic Bids, such that load at the LAP level would otherwise be adjusted to relieve the Constraint, of which the first two steps are summarized as follows:[11]

> Step 1: Schedule the Energy from Self-Provided Ancillary Service Bids from capacity that is obligated to offer an Energy Bid under a must-offer obligation such as from an RMR Unit or a Resource Adequacy Resource.
>
> Step 2: Relax transmission constraints, subject to provisions including applying a penalty price for pricing transmission constraints at three times the Energy Bid cap, and this penalty price being less than the penalty price for curtailing firm, price-taker load.

The recommended scheduling run and pricing run penalty price values for the Day Ahead Market based on the CAISO's parameter tuning analysis to date are summarized in the following tables, with brief comments explaining the rationale for these values.

5.2. Integrated Forward Market (IFM) Parameter Values

Penalty Price Description	Scheduling Run Value[12]	Pricing Run Value	Comment
Market energy balance	45,000	1500, 5000	In the scheduling run, it is essential to produce supply matching demand plus losses. In the pricing run, the penalty price is the same as for transmission constraints to ensure that LMPs remain within a reasonable range. This is relevant to the MPM and RUC passes in which the objective is to meet CAISO Forecast Demand.
Transmission constraints: Intertie scheduling	30,000	30,000	Intertie scheduling constraints are explicitly excluded from the LAP clearing mechanism described in section 31.3.1.3.
Reliability Must-Run (RMR) pre-dispatch curtailment (supply)	-6000	-30	The CAISO considers transmission constraints when determining RMR scheduling requirements. However, for this and other parameters listed below, bid prices are limited to between -$30 and $500 in the pricing run, as described earlier in this paper.
Pseudo-tie layoff energy	-6000	-30	Pseudo-tie layoff energy is scheduled under contractual arrangements with the Balancing Authority in whose area a pseudo-tie is located.
Transmission constraints: branch, corridor, nomogram (base case and contingency	5000	1500, 5000	In the scheduling run, the guideline applied to transmission constraints is that an Economic Bid should be accepted if it

[11] In the tariff there is a Step 3 identified in which load distribution factors would be adjusted. At this point it appears unnecessary and impractical to execute this step. Therefore the parameter tuning is not relying on Step 3 for analysis.

[12] Penalty values are negatively valued for supply reduction and positively valued for demand reduction.

analysis)			is priced at the bid cap and is at least 10% effective in relieving a transmission constraint. In the pricing run, two penalty price segments are available: one is priced at three times the Energy Bid cap pursuant to section 31.3.1.3, extending from the original limit to any constraint relaxation resulting from the scheduling run, minus a small amount called "epsilon", then the second of "epsilon" around the relaxed limit must equal the penalty price of the scheduling run in order to ensure reasonable LMPs.
TOR self schedule	4500, -4500	500, -30	A TOR Self-Schedule would only be adjusted if it has very high effectiveness in relieving a constraint that cannot otherwise be enforced.
ETC self schedule	3200, -3200	500, -30	An ETC Self-Schedule would only be adjusted if it has high effectiveness in relieving a constraint that cannot otherwise be enforced. The typical value is set at 200% of the generic self-scheduled demand, but different values from $3400 to $4500 are possible if differential priorities are established among ETC rights.
CVR self schedule	3200, -3200	500, -30	A CVR Self-Schedule is assigned the same priority as the typical value for ETC Self-Schedules.
Ancillary Service Region Minimum Requirements	2000	250	In the event of bid insufficiency, AS minimum requirements would be honored in priority to serving generic Self-Scheduled demand, but not at the cost of overloading transmission into AS regions.
Ancillary Service Region Maximum Limit on Upward Services	1500	50	In the event of multiple AS regional requirements having bid insufficiency, it is undesirable to have the multiple constraints produce AS prices significantly exceeding the AS bid cap. An alternative for enforcing sub-regional AS requirements is to enforce a maximum AS requirement on other AS regions, thereby reducing the AS prices in the other regions without excessive AS prices in the sub-region with bid insufficiency.
Perfect hedge without scheduling priority (lowest ETC priority level)	1600, -1600	500, -30	Some merchant transmission may receive "perfect hedge" settlement treatment but not high scheduling priority, and a resource associated with such would thus be priced the same as generic self-schedules for demand.
Self-scheduled CAISO	1600	500	Pursuant to section 31.3.1.3, the

demand and self-scheduled exports using identified non-RA supply resource			uneconomic bid price for self-scheduled demand exceeds the penalty price for relaxed transmission constraints in the pricing run.
Self-scheduled exports not using identified non-RA supply resource	800	500	Self-scheduled exports using RA capacity would be priced at 50% of generic self-schedules for demand.
Regulatory Must-Run and Must Take supply curtailment	-750	-30	Regulatory must-run and must-take supply received priority over generic self-schedules for supply resources.
Price-taker supply bids	-550	-30	Generic self-schedules for supply receive higher priority than Economic Bids at the bid cap, and would be priced 10% higher in the scheduling run.
Conditionally qualified Reg Up or Down self-provision	285	285	Conversion of AS self-schedules to Energy pursuant to section 31.3.1.3 will give higher priority to maintaining the availability of regulation, over spinning and non-spinning reserve.
Conditionally qualified Spin self-provision	280	280	Conversion of AS self-schedules to Energy pursuant to section 31.3.1.3 will give higher priority to maintaining the availability of spinning reserve, over non-spinning reserve.
Conditionally qualified Non-Spin self-provision	275	275	The CAISO has determined this penalty price for conversion of self-provided non-spinning reserves through empirical testing, as a value that balances the maintenance of AS self-schedules with ensuring that the conversion to energy occurs before transmission constraints are relaxed.
Conditionally unqualified Reg Up or Down self-provision	75	75	In instances where AS self-provision is not qualified pursuant to the MRTU tariff, the capacity can still be considered as an AS bid, along with regular AS bids. The price used for considering unqualified AS self-provision is lower than the AS bid cap, to allow it to be considered as an Economic Bid.
Conditionally unqualified Spin self-provision	50	50	Same as above.
Conditionally unqualified Non-Spin self-provision	35	35	Same as above.

5.3. Residual Unit Commitment (RUC) Parameter Values

At the time this issue paper is being prepared, the CAISO has not yet performed sufficient parameter tuning analysis to recommend initial parameter values for RUC. The CAISO expects to provide these values in the revised version of this paper on May 29.

5.4. Real Time Market Discussion

In most cases the Day Ahead and Real Time market processes (RTUC and RTD) will utilize the same penalty price values for the corresponding Self Schedule types and constraints. There are some design differences between Day Ahead and Real Time, however, that are implemented through different values for the parameter settings.

One key difference between the IFM and the Real Time Market processes is that Demand can be bid in with Economic Bids and Self Schedules in the IFM, whereas internal Demand is essentially fixed at the CAISO Forecast of CAISO Demand in the RTUC process, and is determined to maintain Real Time balance in the RTD. In particular, there is no Self Scheduling of internal Demand in the RTM, though there is Self Scheduling of export Demand in the HASP run of the RTUC. Thus penalty price associated with Self Scheduled internal Demand in the IFM corresponds to the CAISO Forecast of CAISO Demand in the RTUC.

Another key difference is that in the IFM a higher priority is assigned to meeting AS minimum requirements than to scheduling energy to supply load if there is shortage in generating capacity, whereas in the RTM the market will utilize AS capacity to provide energy if needed to serve load, even if this means falling below required AS quantities. Under this AS priority in the IFM both economic and Uneconomic Adjustments of demand would be utilized to obtain a solution prior to any violations of AS minimum requirements. In contrast, in the RTM market applications, system load has the highest priority, so that minimum AS requirements could be violated in order to dispatch energy from unloaded capacity to meet system load.

Finally, among the RTM market applications, the RTPD (RTUC) co-optimizes energy and AS, whereas the RTD optimizes energy only. Therefore, scheduling run penalty prices and pricing run pricing parameters associated with AS requirements are not relevant in the RTD.

At this point in the parameter tuning analysis, the CAISO has not completed sufficient test cases to provide a basis for definitive recommendations for the Real Time market processes. The values listed in the following tables are therefore mostly the same as their corresponding values in the IFM, with only certain differences based on the considerations noted above. The CAISO intends to complete additional test cases and provide additional rationale for the Real Time penalty price values in the next version of this paper on May 29.

5.5. Real Time Pre-Dispatch (RTPD) Parameter Values

The basis of the Real-Time priorities is established in the MRTU Tariff in Sections 34.10.1 and 34.10.2.

Penalty Price Description	Scheduling Run Value	Pricing Run Value	Comment
Energy balance/Load curtailment	45,000	1500, 5000	In the scheduling run, it is essential to produce supply matching demand plus losses. In the pricing run, the penalty price is the same as for transmission

			constraints to ensure that LMPs remain within a reasonable range.
Transmission constraints: Intertie scheduling	30,000	30,000	Intertie scheduling constraints are explicitly excluded from the LAP clearing mechanism described in section 31.3.1.3.
Reliability Must-Run (RMR) pre-dispatch curtailment (supply), and Exceptional Dispatch Supply	-6000	-30	The CAISO considers transmission constraints when determining RMR scheduling requirements. However, for this and other parameters listed below, bid prices are limited to between -$30 and $500 in the pricing run, as described earlier in this paper.
Pseudo-tie layoff energy	-6000	-30	Pseudo-tie layoff energy is scheduled under contractual arrangements with the Balancing Authority in whose area a pseudo-tie is located.
Transmission constraints: branch, corridor, nomogram (base case and contingency analysis)	5000	1500, 5000	In the scheduling run, the guideline applied to transmission constraints is that an Economic Bid should be accepted if it is priced at the bid cap and is at least 10% effective in relieving a transmission constraint. In the pricing run, two penalty price segments are available: one is priced at three times the Energy Bid cap pursuant to section 31.3.1.3, extending from the original limit to any constraint relaxation resulting from the scheduling run, minus a small amount called "epsilon", then the second of "epsilon" around the relaxed limit must equal the penalty price of the scheduling run in order to ensure reasonable LMPs.
Real Time TOR Self Schedule	4500, -4500	500, -30	A TOR self-schedule would only be adjusted if it has very high effectiveness in relieving a constraint that cannot otherwise be enforced.
Real Time ETC Self Schedule	3200, -3200	500, -30	An ETC self-schedule would only be adjusted if it has high effectiveness in relieving a constraint that cannot otherwise be enforced. The typical value is set at 200% of the generic self-scheduled demand, but different values from $3400 to $4500 are possible if differential priorities are established among ETC rights.
Ancillary Service Region Minimum Requirements	2000	250	In the event of bid insufficiency, AS minimum requirements would be honored in priority to serving generic self-scheduled demand, but not at the cost of overloading transmission into AS regions.
Ancillary Service Region	1500	50	In the event of multiple AS regional

Maximum Limit on Upward Services			requirements having bid insufficiency, it is undesirable to have the multiple constraints produce AS prices significantly exceeding the AS bid cap. An alternative for enforcing sub-regional AS requirements is to enforce a maximum AS requirement on other AS regions, thereby reducing the AS prices in the other regions without excessive AS prices in the sub-region with bid insufficiency.
Perfect hedge without scheduling priority (lowest ETC priority level)	1600, -1600	500, -30	Some merchant transmission may receive "perfect hedge" settlement treatment but not high scheduling priority, and a resource associated with such would thus be priced the same as generic self-schedules for demand.
Forecast CAISO demand and self-scheduled exports using identified non-RA supply resource	1600	500	Self-Scheduled exports that are explicitly supported by non-RA capacity (Tariff Section 30.5.3)
Self-scheduled exports not using identified non-RA supply resource	800	500	Self-scheduled exports using RA capacity would be priced at 50% of generic self-schedules for demand.
Regulatory Must-Run and Must Take supply curtailment	-750	-30	Regulatory must-run and must-take supply received priority over generic self-schedules for supply resources.
Final IFM Supply Schedule	-650	-30	
Price-taker supply bids	-550	-30	Generic supply self-schedules receive higher priority than Economic Bids at the bid cap, and would be priced 10% higher in the scheduling run.
Conditionally qualified Reg Up or Down Real Time self-provision	285	285	Conversion of AS self-schedules to Energy pursuant to section 31.3.1.3 will give higher priority to maintaining the availability of regulation, over spinning and non-spinning reserve.
Conditionally qualified Real Time Spin self-provision	280	280	Conversion of AS self-schedules to Energy pursuant to section 31.3.1.3 will give higher priority to maintaining the availability of spinning reserve, over non-spinning reserve.
Conditionally qualified Real Time Non-Spin self-provision	275	275	The CAISO has determined this penalty price for conversion of self-provided non-spinning reserves through empirical testing, as a value that balances the maintenance of AS self-schedules with ensuring that the conversion to energy occurs before transmission constraints are relaxed.
Conditionally unqualified Reg	75	75	In instances where AS self-provision is not

Up or Down Real Time self-provision			qualified pursuant to the MRTU tariff, the capacity can still be considered as an AS bid, along with regular AS bids. The price used for considering unqualified AS self-provision is lower than the AS bid cap, to allow it to be considered as an Economic Bid.
Conditionally unqualified Spin Real Time self-provision	50	50	Same as above.
Conditionally unqualified Non-Spin Real Time self-provision	35	35	Same as above.

5.6. Real Time 5-Minute Energy Dispatch (RTD) Parameter Values

At the time this issue paper is being prepared, the CAISO has not yet performed sufficient parameter tuning analysis to recommend initial parameter values for RTD. The CAISO expects these values to be similar to RTPD, but will provide these values in the revised version of this paper on May 29.

6. Updating of Parameter Values

The CAISO's parameter tuning effort is still ongoing at the time of the release of this issue paper. Moreover, although this effort will provide initial parameter values to be used in the continuing market simulation process, the CAISO expects that the experience gained in market simulation will enable some finer tuning prior to MRTU Go Live. The simple fact is that more experience with the market optimizations through a greater variety of test cases will allow the CAISO to adjust the parameters to better achieve the objectives stated in Section 3.1 of this paper.

In order to keep market participants apprised of any adjustments to the parameters discussed in this paper, the CAISO proposes the following approach:

1. During market simulation the CAISO will issue update information in a timely fashion whenever parameter values are changed in the market simulation software.
2. Prior to MRTU Go Live the CAISO will create and publish an Operating Procedure that contains the parameter values to be used upon market launch.
3. For the first 12 months of operation of the new markets, the CAISO will issue revisions of the Operating Procedure as needed to keep market participants fully informed of the current values of the parameter settings in the market software.
4. After 12 months of operation, the CAISO will incorporate the parameter values into a Business Practice Manual, and will utilize the BPM Change Management process to make any changes to the parameters that may be needed subsequently.

The CAISO would like to receive comments from stakeholders on this proposed approach.

7. Related Practices of Other ISOs

The general desire to avoid the operationally unreasonable dispatch results or uneconomic, extreme LMPs that can result from overly strict adherence to ineffective, yet technically "economic" bids appears to be consistent with the practices of the Eastern RTOs.

Most directly relevant to this paper, the NYISO recently pursued and received FERC approval of tariff changes to address what its Independent Market Monitor called "costly re-dispatch in situations where there is little or no reliability benefit." The NYISO described the problem this way:

> The NYISO has found, however, that these dispatch solutions may be inefficient in meeting transmission constraints when compared to established operating practices. That is, the dispatch produced by NYISO's software, under certain circumstances, may be one that a system operator would not pursue. This can happen, for instance, when efficient dispatch options in response to an unexpected operational condition are unavailable because of generator ramp rates or the time required for additional resource commitments. If the Shadow Price has not yet reached its upper bound in these circumstances, the scheduling and dispatch software will use whatever dispatch options are available even if they are, in fact, inefficient in meeting the transmission constraint(s) at issue.

To solve this problem, the NYISO proposed to lower the Shadow Price used to calculate LMPs in that market. This change would effectively lower the threshold at which the market optimization algorithm is permitted to call on "economic" bids to solve for a constraint during certain market conditions. The effects of this change, much like the changes to penalty prices the CAISO is considering, are to "(i) reduce inefficient dispatch; (ii) produce more accurate prices; (iii) reduce the need for operator intervention; and (iv) reduce price corrections." (See generally FERC Docket No. ER07-720-000.)

More generally, the Eastern RTOs do not appear to follow the strict rule that is currently contained in the CAISO's MRTU tariff that lies at the core of this issue – i.e. the rule that all Economic Bids must be fully exhausted before changes to self-schedules are considered to relieve the constraint. For example, ISO-New England's tariff states that "This calculation [of LMPs] shall be made by applying an incremental linear optimization method to minimize energy, Operating Reserve, congestion and transmission loss costs, **given actual system conditions**, a set of energy offers and bids, and **any binding transmission and Operating Reserve constraints that may exist**." (ISO-NE Market Rule 1, Sheet Nos. 7132-7133) Notably, PJM's tariff contains the same exact phrase in describing its optimization. (PJM Tariff, Sheet No. 373) Stated differently, this rule appears on its face to differ from a strict direction to the algorithm to solve for given demand and resource inputs using only Economic Bids, regardless of their impact on the problematic constraint. Indeed, as discussed above, to achieve true least-cost dispatch, constraints must be solved economically, even when the solution is not the next "economic" bid.

Further, setting penalty factors at such levels at to induce the dispatch algorithm to adjust a self-schedule rather than taking a less effective bid, albeit a bid next in merit order, is also in use elsewhere. ISO-New England uses such a procedure when its reserve requirement is not met:

> If there is insufficient Operating Reserve available to meet the Operating Reserve requirements for the system and/or any Reserve Zone or sufficient Operating Reserve is not available at a redispatch cost equal to or less than that specified by the Reserve Constraint Penalty Factors, the applicable Real-Time Reserve Clearing Prices shall be set based upon Reserve Constraint Penalty Factors. **The Reserve Constraint Penalty Factors are inputs into the linear programming algorithm that will be utilized by the linear programming algorithm when Operating Reserve constraints are violated, requiring that the constraints be relaxed to allow the LP algorithm to solve.** (ISO-NE Market Rule 1, Sheet No. 7149D)

In addition, ISO-NE's tariff permits self-schedules to be modified by the ISO if necessary to procure sufficient operating reserves or maintain voltage support. (ISO-NE Market Rule 1, Sheet Nos. 7179-7180). These rules taken together appear to permit ISO-NE's market optimization algorithm to implement penalty factors that will alter self-schedules to maintain the appropriate levels of operating reserves.