Draft Final Proposal

Multi-Stage Generator Unit Modeling Enhancements

September 9, 2011

MSG Enhancements

Prepared for Discussion on a Stakeholder Call – September 16, 2011

1   Introduction

In December 2010, the ISO implemented modeling functionality that optimizes the commitment and dispatch of generating units that, by their physical nature, have multiple operating configurations. The MSG functionality is designed to take advantage of the inherent flexibility of these resources while respecting their operating characteristics and the costs of their operation. The ISO has identified potential refinements to the MSG functionality through experience gained since deployment of MSG, the analysis of commitment, dispatch, and market outcomes for MSG resources, and with the help of stakeholder feedback.

Through this stakeholder process the ISO has developed proposals for potential refinements to the modeling of multi-stage generation units, and incorporated feedback and suggestions from interested stakeholders. The MSG modeling enhancements in this proposal will be taken to the ISO Board of Governors for approval in October 2011.

2   Process and Timetable

The purpose of the present revised straw proposal is to provide stakeholders with a description of the suite of near-term improvements to MSG modeling identified by the ISO. This paper offers refined ISO recommendations for the design of these enhancements.

Date	Activity
June 24, 2011	Post issue paper / straw proposal
July 1, 2011	Stakeholder conference call
July 14, 2011	Stakeholder comments due *
August 5, 2011	Post revised straw proposal
August 12, 2011	Stakeholder conference call
August 19, 2011	Stakeholder comments due *
September 13, 2011	Post draft final proposal
September 16, 2011	Stakeholder conference call
September 26, 2011	Stakeholder comments due *
October 27–28, 2011	CAISO Board of Governors meeting

   * Please e-mail comments to msg-enhance@caiso.com

3   Description of the Issues & Proposed Resolutions

Following implementation of the MSG modeling functionality in December 2010, the ISO and stakeholders have identified several enhancements that can improve modeling to allow better real-time operation and MSG participation in light of the characteristics typical of MSG resources. In doing so, this list also addresses several stakeholder concerns. The issues and proposed resolutions

are described below along with the ISO's assessment of the next steps in this stakeholder effort that will be required to implement these changes.

3.1   Limitations on MSG configurations and paths in real-time

Issue

The current limitation in the number of MSG configurations in real-time is three plus the day-ahead and/or RUC committed configuration. Production experience indicates that the number of alternative transition paths among configurations in combination with the number of configurations themselves impacts the performance of the MSG algorithms and not just the number of configurations bid into the real-time market. As configurations and paths submitted to the market increase in number, there is a corresponding increase in permutations that the optimization software must evaluate. To make these evaluations, the optimization must calculate and compare costs along each path requiring more iterations through the optimization decision algorithm.

While the ISO would ideally not have any limitations on configurations and paths, some limits are in fact required to ensure that the software can perform as required in the real-time. The ISO anticipates that the need for such limitations will wane over time as the software is continually tuned.

Proposed resolution

In response to stakeholder feedback, the ISO is modifying its initial proposal that would have allowed ten configurations to be bid into real time, and limit the number of transition paths between any two configurations to two. The ISO is now proposing to allow MSG resources to bid up to six configurations (plus the day-ahead and/or RUC committed configuration) into the real-time market. This will increase the number of biddable configurations from today from three to six, and note that the ISO proposes to maintain the current practice of inserting - as applicable - a bid for the default RA configuration and for the configuration that supports any RUC schedule or award. Being able to bid in more configurations will give market participants more flexibility in bidding in their MSG units. Additionally, having more bid-in configurations will aid the real-time market in optimizing the dispatch of MSG resources in situations of under- and over-generation.

By changing its proposal from ten real-time configurations to six, the ISO can loosen the proposed limitation on the number of paths between configurations. For resources with six or fewer registered MSG configurations, we propose no limit on the number of paths a resource can register between configurations.

The ISO also proposes to provide an option for market participants that prefer to have more biddable configurations and are not as constrained by the path requirements. Specifically, for resources with seven or more registered MSG configurations, the ISO proposes to limit the number of transitions paths between any two configurations to two. Please note that there are no limitations on the number of transition paths "hard-coded" into the MSG algorithms. Rather, this limitation of paths will be done as part of the process of registering the MSG resource. By not including the limitation of paths directly in the market systems, we maintain the option to ease the limits as continued fine-tuning improves the performance of the MSG algorithms.

The following table illustrates the number of possible <u>upward</u> transition paths between configurations for an MSG resource with six configurations. Note that no limitation on the number of paths (upward or downward) is proposed for MSG resources with six or fewer configurations.

Table 1: Transition paths for a 6-configuration MSG resource

From C-1	From C-2	From C-3	From C-4	From C-5	From C-6
1 to 2					
1 to 3	2 to 3				
1 to 4	2 to 4	3 to 4			
1 to 5	2 to 5	3 to 5	4 to 5		
1 to 6	2 to 6	3 to 6	4 to 6	5 to 6	
1 to 7	2 to 7	3 to 7	4 to 7	5 to 7	6 to 7

MSG resources with seven, eight, nine or ten registered configurations will be subject to the proposed limitation on the number of transition paths. The following table provides an example of the proposed limitation on <u>upward</u> transition paths for an MSG resource with ten configurations.

Table 2: Transition paths for a 10-configuration MSG resource

From C-1	From C-2	From C-3	From C-4	From C-5	From C-6	From C-7	From C-8	From C-9
1 to 2								
1 to 3	2 to 3							
1 to 4	2 to 4	3 to 4						
1 to 5	2 to 5	3 to 5	4 to 5					
1 to 6	2 to 6	3 to 6	4 to 6	5 to 6				
1 to 7	2 to 7	3 to 7	4 to 7	5 to 7	6 to 7			
1 to 8	2 to 8	3 to 8	4 to 8	5 to 8	6 to 8	7 to 8		
1 to 9	2 to 9	3 to 9	4 to 9	5 to 9	6 to 9	7 to 9	8 to 9	
1 to 10	2 to 10	3 to 10	4 to 10	5 to 10	6 to 10	7 to10	8 to 10	9 to 10

Limit to 2 from each of these columns

An analogous table could be constructed for all the possible <u>downward</u> transition paths. For MSG resources with seven or more registered configurations, the proposed limitation would be applied to the downward paths as well. We propose that the limitations on <u>upward</u> and <u>downward</u> paths be imposed independently of each other. That is to say, the two "to-from" configuration pairs

specified in the <u>upward</u> direction need not be the same as the two "to-from" configuration pairs specified in the <u>downward</u> direction.

As noted above, the ISO and stakeholders alike would prefer not to have limitations on real-time configurations, or on registered transition paths. The aim of this proposal is to strike a balance that meets participants' needs for flexibility without compromising the performance of the MSG algorithms in real time.

Stakeholder feedback
All stakeholder were either supportive or silent on the proposal to increase the number of biddable configurations in real-time, and to restrict the number of paths that can be registered.

PG&E expressed support for the limitation of paths for MSG resources with six or more registered configurations. In addition, PG&E suggested that the transition path limitation be a "configuration parameter" so that it could readily be changed as the optimization's performance is improved. PG&E also requested clarification as to the applicability of the path limitation to downward transitions. The ISO has provided responses to both those questions in the section above.

3.2   Bidding requirements on lower configurations

Issue
Current bidding requirements allow an MSG resource to bid in any start-able configuration. This leaves the capacity below the minimum operating level of that configuration unavailable to the market optimization. This is not consistent with the treatment of non-MSG resources for which the optimization can consider the operating levels from the plant-level Pmin up to the maximum bid-in capacity. As a consequence, the market solution may not have the option to dispatch resources at their lower capacity levels when the resource is bid into the market at its highest resource adequacy capacity requirement. This can result in the inability to make use of an MSG resource's resource adequacy capacity.

Proposed resolution
The ISO proposes that MSG resources be required to offer the entire capacity range between the maximum bid-in energy MW and the higher of self scheduled energy MW and resource level Pmin on a MSG plant level in real-time market. Note that the enhancement to enable resources to bid up to six configurations (plus the day-ahead and/or RUC committed configuration) in real-time will make this possible without limiting participants' ability to supply other real-time bids. This will improve the market solution by giving it additional flexibility, and it will also ensure that all resource adequacy capacity is bid in as required.

The requirement to fully bid in resource adequacy capacity would not also impose a downward capacity must-offer requirement. As is consistent with requirements for non-MSG resource adequacy resources, a downward capacity must-offer requirement is not proposed as part of this initiative.

Stakeholder feedback
SCE expressed support for this change.

PG&E requested clarification that the ISO will create a default bid for the resource's default resource adequacy configuration. The ISO clarifies that this is the case. In addition, PG&E requested clarification as to whether or not "there is any requirement to bid additional configurations beyond the RA path and the newly required configuration which includes Pmin." The ISO clarifies that we will require the configurations between Pmin and the RA capacity to be offered and will insert default bids in the event that the configurations necessary for this whole range are not bid in.

3.3   Transition cost validation rules

Issue
In the initial straw proposal, the ISO proposed a change to the validation rules currently applied to the MSG transition cost registration. It was our understanding that the current rules, though originally intended to provide market participants with flexibility, have proved too limiting. However, stakeholder feedback indicates that this is not the case. As a result, the revised straw proposal reflected our recommendation to keep the current transition cost validation rules in place.

Proposed resolution
The ISO maintains the recommendation to leave the current transition cost validation rules in place as they are at this time. The ISO has added further evaluation of transition cost validation rules to the Market Design Initiatives Catalog.[1]

Stakeholder feedback
The Department of Market Monitoring submitted comments on the initial straw proposal supporting moving to a proxy costs calculation for transition costs. In response to the revision of the proposal to maintain the existing two validation rules, DMM states in their comments that "[w]hile DMM does not oppose the transition cost validation rules, we do favor a proxy based approach and encourage the ISO to consider this alternative in future related market initiatives."

CDWR, PG&E, SCE and SDG&E support (or do not oppose) the proposal to keep the current transition cost validation rules in place.

PG&E "urges the CAISO to continue a stakeholder process on improvements to transition cost validation rules, or at least to incorporate consideration of these rules in the more general discussion of further changes to constraints on bidding start-up and minimum load costs." As noted above, such reevaluation has been added to the Market Design Initiatives Catalog.

3.4   Limitation on the number of ramp-rates for each MSG configuration

Issue
The current MSG functionality allows only one ramp-rate to be defined and bid-in per configuration. This creates limitations for some resources. Some combined cycle units can ramp

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[1]   The catalog is prepared as part of the market design initiatives process. More on this process as well as the catalog itself can be found at the following link:
http://www.caiso.com/informed/Pages/StakeholderProcesses/MarketDesignInitiativesProcess.aspx

from, for example, one configuration that can operate in two modes: 2x1, and 2x1 plus duct firing. These two modes have largely different ramp-rates

Proposed resolution
The ISO maintains its initial proposal to allow two ramp-rates per MSG configuration.

Stakeholder feedback
PG&E, SCE, and CDWR supported the change from one ramp rate per configuration to two ramp rates for each configuration.

PG&E requested clarification that the number of allowable ramp rates be limited through the registration process and not "hard-coded" in SIBR. That is the case – in other words, the limitation to two ramp rates per configuration is imposed in the registration process and not in the software rules.

Further, PG&E requested clarification "as to the limitations on the allowable differences between ramp rates within and between MSG configurations" especially given issues encountered in the past with large differences between ramp rates for one resource presenting non-convexity of the optimization solution. The ISO concurs that whenever more than one ramp rate is given the issue of non-convexity in the market solution can arise. However, the ISO feels that offering two ramp rates per MSG configuration is an important enhancement because there can be different ramp rates within a combined cycle unit's 2x1 configuration (for example) when it moves into its duct firing range.

3.5 Flexibility with respect to the self-scheduled real-time configuration to support the energy schedule or A/S award from the day-ahead market

Issue
Currently, if an MSG resource has a day-ahead energy schedule or ancillary service award in one configuration, then the resource can only self-schedule in real-time in that configuration. In actuality, there can be more than one configuration able to support that day-ahead schedule and ancillary service award.

Proposed resolution
The ISO proposes to enable market participants to self-schedule in real-time into a configuration different from that scheduled in the day-ahead so long as the real-time configuration can support the same awarded ancillary service and/or Residual Unit Commitment capacity. A configuration is considered to be able to support the A/S and/or RUC award if (1) the range of the configuration is such that the self-schedule can be met and while reserving enough capacity ("head room") to respond to the A/S award if needed, and (2) the configuration be certified to an capable of providing the ancillary service.

Note that, while the ISO allows energy self schedule and ancillary service self provision to be in different configurations, we will continue to treat energy self schedule and ancillary service self-provision at the plant level.

SCE, CDWR, and PG&E support this enhancement.

PG&E had several clarifying questions with respect to implementation details:

1. "Does this solution [enhancement] allow for incremental ancillary services to be procured from an MSG resource whose energy and ancillary service configurations do not match?"
   a. Yes. This is done by observing both the energy self-schedule and the ancillary service self-provision at a plant level.
2. "If incremental ancillary services can be procured, which configuration is used to determine how much incremental ancillary service can be procured the energy configuration, or the awarded configuration?"
   a. The decision will be based on economics with combined energy and ancillary service bid costs. Again, all bid-in configurations will be considered and the energy self-schedule and ancillary service self-provision are observed at the plant level.
3. "Does a RUC award constrain the ability to self-schedule in a configuration other than the day-ahead awarded configuration?"
   a. No. It does not constrain that because a RUC award may not be binding on that configuration. We will include appropriate changes in the SIBR rule design.
4. "What if the RUC award is in a lower configuration, and a self-schedule, although it exceeds the RUC award, reduces the upward dispatch capability of the resources versus its RUC award?"
   a. This can occur. However a RUC award only obligates the unit to participate in real-time at least to that capacity. In the event that the unit has a self schedule in real-time higher than the RUC award, it has fulfilled that requirement. That is consistent with the CAISO policy regarding RUC capacity at this point.

3.6   Minimum Load Costs and Bid Cost Recovery calculation

Issue
Under the current rules, if an MSG resource is committed by the ISO to a higher configuration, its minimum load costs will be included in the Bid Cost Recovery calculation provided that the meter is within the 3 percent Tolerance Band of the Pmin.[2] If the resource falls short of the 3 percent Tolerance Band, no minimum load costs are considered in the Bid Cost Recovery calculation for that interval. However, the resource in this case may still be operating above the minimum load of a lower configuration and would be operating above the plant-level minimum load. There is therefore the concern that this rule be revised to align the BCR calculations for MSG resources with the BCR calculation for non-MSG resources.

Proposed resolution
The ISO maintains its proposal to use the second of the three options described in the original issue paper/straw proposal on this policy initiative. Specifically, the ISO proposes that the calculation of the minimum load costs for the highest configuration be equal to or lower than the qualified BCR configuration for which the meter is within or above the 3% (or 5MW) Tolerance Band of its Pmin.

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[2]   The Tolerance Band is calculated as the maximum of 5 MW or 3 percent of the plant-level Pmax.

As an example, consider a two-configuration MSG resource that is dispatched up from its lower configuration (C1) to the pmin of its higher configuration (C2). The current rules specify that if, for a particular interval, the resource does not come within 3% (or 5 MW) of the Pmin of C2 then no minimum load costs are considered for that interval. However, the resource is in fact supplying energy at a level above its plant-level pmin, in this case the pmin of C1. Thus, the ISO proposes that for such intervals, the minimum load costs of C1 be included in the BCR calculation (provided that there is not an energy self-schedule or ancillary services self-provision in C1). In general terms, the minimum load costs associated with the configuration with the highest pmin that is below the pmin of the target configuration will be included in the BCR calculation for such intervals.

In both of the following graphical depictions, the resource would be eligible for minimum load costs for configuration 1.

Figure 1: Non-overlapping MSG configurations, upward dispatch
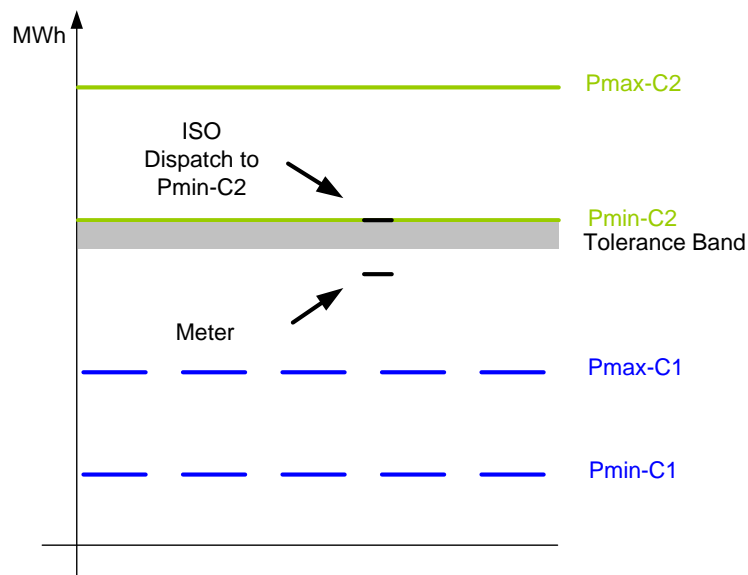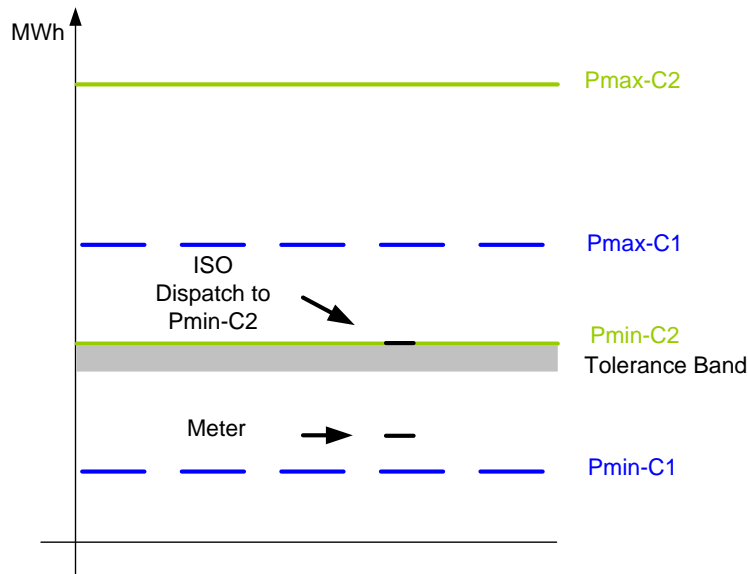

Figure 2: Overlapping MSG configurations, upward dispatch

In the case of a decremental dispatch, a resource dispatched into a lower configuration that consequently moves below the tolerance band of its current configuration is eligible for the minimum load costs of the next highest configuration Pmin.

Again, in both the following graphical depictions, the resource would be eligible for minimum load costs associated with configuration 1.

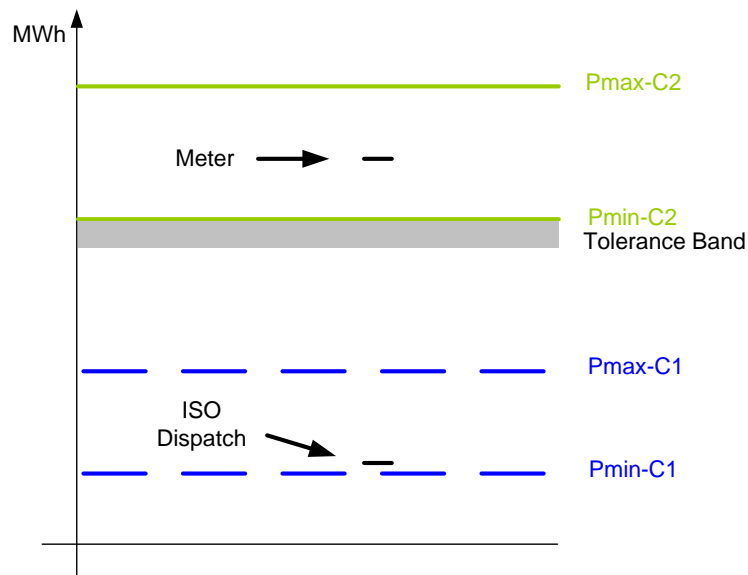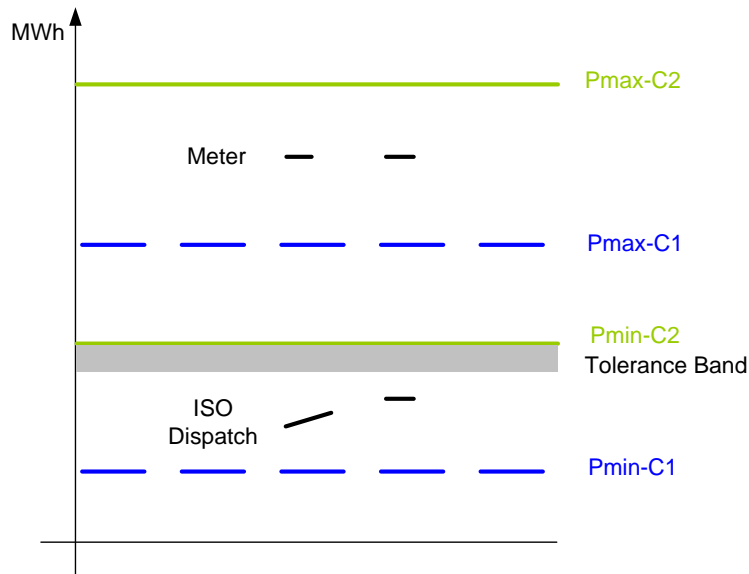**Figure 1: Non-overlapping MSG configurations, downward dispatch**

Figure 2: Overlapping MSG configurations, downward dispatch

MWh

Pmax-C2

Meter

Pmax-C1

Pmin-C2
Tolerance Band

ISO
Dispatch

Pmin-C1

Stakeholder feedback

The ISO DMM, PG&E, SCE and SDG&E support (or do not oppose) this element of the MSG Enhancements proposal.

On the "Tolerance Band Limitation" CDWR states that "The Tolerance Band is the amount of MWh that Generation Units can deviate from a dispatch instruction without incurring Uninstructed Deviation Penalty." The ISO clarifies that the market design does not currently include uninstructed deviation penalties. The tolerance band precludes resources that do not come within 3% of the resource's Pmax or 5 MW of their Pmin (specifically the maximum of these two values) when dispatched are not eligible for minimum load costs for that interval. The policy recommendation in this proposal is simply to not disqualify MSG resources from any minimum load costs because they don't reach the tolerance band of a configuration's Pmin when that configuration's Pmin is above the plant-level Pmin. The ISO recommends that the resource be eligible for the minimum load costs associated with the "next-highest" configuration Pmin. Since the resource is in fact on-line and above its plant-level Pmin, the ISO proposes that it is eligible for some minimum load costs to be included in its real time cost calculation.

With respect to CDWR's concern about a "Bid Cost Recovery Increase" the ISO reiterates that the current accounting of minimum load costs for MSG resources does not consider legitimate costs associated with the ISO's dispatch of the resource. This proposal helps bring the compensation of MSG resources' costs in line with the methodology of calculating costs for non-MSG resources.

PG&E points out that
> The current proposal appears to be based on the assumption that a resource's value is instructed energy only, and hence that it should receive bid cost recovery at least up to the configuration it is able to achieve, to be consistent with non-MSG resource treatment. It isn't clear that the analogy holds when the value of the MSG resource is strongly dependent on its configuration because of its ability to provide ancillary services, or not, in the given configuration.

The ISO concurs with PG&E's point that the resource would not receive payment for ancillary services in such a case. In general we are trying to align treatment of non-MSG resources and MSG resources with respect to cost accounting. The ISO does recognize that, for a non-MSG resource, the ability to provide ancillary services is perhaps not as dependent on its operating range as for an MSG resource.

The DMM helps clarify that this rule should apply in the downward direction as well. That is to say, if a resource is dispatched into a lower configuration, it is eligible only for the minimum load costs of that target configuration once it moves below the tolerance band of the higher configuration.

4   Conclusion

The ISO invites stakeholder comments and discussion on the draft final proposal provided in this paper. The ISO will conduct a conference call to review this document on September 16, 2011 from 10:00 a.m. to 11:00 a.m. Comments should be sent to msg-enhance@caiso.com by close of business on September 23, 2011.