Issue Paper

Modeling of Multi-Stage Generating Units

November 7, 2008

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Prepared for Discussion on a Stakeholder Call – November 14, 2008

1 Introduction

Due to their technology, multi-stage generating units have Forbidden Regions in which they cannot operate. That is, between their minimum and maximum operating levels, there are output levels at which the units cannot be dispatched, but rather must be transitioned through. The reason for this is that Multi-Stage Generating resources are actually comprised of multiple generators, often termed "embedded generating units."

For example, consider a "1 x 1 Combined Cycle" power plant that is comprised of two embedded generators: a Gas Turbine with a maximum output of 200 MWh and a Steam Turbine with a minimum operating level of 50 MWh and maximum output of 150 MWh. The Gas Turbine unit must be started first, and ramps up to 200 MWh. The next upward dispatch of this Combined Cycle plant must be directly to 250 MWh because the Steam Turbine will need to be started and it has a minimum operating level of 50 MWh. Thus, for this resource, the range from 200 MWh to 250 MWh is "forbidden" in that this Combined Cycle unit can be transitioned through the range, but not dispatched to – or held at – an operating level within this 200 to 250 MWh range.

There are currently about 85 multi-stage generating units in the California ISO control area. Of these, 34 are Combined Cycle units. The remaining multi-stage generating units are composite Constrained Output Generating units and pumped storage hydro units. All of these units have at least one Forbidden Region.

The Market Redesign and Technology Upgrade (MRTU) design has Forbidden Regions captured in the Master File data set by which the ISO records critical operating and business information for each generating unit. The ISO Integrated Forward Market and Real Time Market software was designed to uphold the Forbidden Region constraints so that multi-stage generating units are not infeasibly dispatched. It is important to note, however, that while the enforcement of the Forbidden Region constraints keeps units from being dispatched at infeasible output levels, it does not economically optimize the dispatch of multi-stage generating units. That is to say, simply forbidding the software from certain dispatch ranges for specific units does not optimize that dispatch with respect to costs, the various operating configurations of multi-stage generating units, and other resources in the market.

It is for this reason that the Federal Energy Regulatory Commission mandated[1] that the ISO modify the software used to reach an economic dispatch solution to explicitly account for the operating constraints of multi-stage generating units.

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1 Paragraph 573 of FERC's September 21, 2006 Order on MRTU "direct(s) the ISO to continue working with software vendors to develop an application that will accurately detail the constraints of combined cycle units, and to file tariff language" for implementation of such improvements no later than three years after MRTU start up.

Recently, the market simulation efforts involving the ISO and market participants have revealed stability and performance issues regarding the enforcement of the Forbidden Region constraints within the Real Time Market software. These issues were reviewed during the October 28th meeting of the ISO Board of Governors, and the Board approved a recommendation to defer the functionality for enforcing Forbidden Operating Regions from the Real Time Market optimization.[2]

Thus, for MRTU *go live* the ISO software will not automatically dispatch multi-stage generating units through their Forbidden Regions. As a result, the ISO now proposes to expedite the design and implementation for the explicit modeling of multi-stage generating units into the market software. Specifically, the ISO is targeting resolution of policy issues associated with the explicit modeling of multi-stage generating units to go before the ISO Board of Governors for approval in early 2009, so that implementation of these modeling features could be implemented within 6-9 months of MRTU *go live*.

Starting with this *Issue Paper*, the ISO is initiating a short stakeholder process to review policy issues related to the modeling of multi-stage generation units, and to solicit feedback and suggestions from interested stakeholders. The outcome of this process should determine the key policy features for modeling and dispatching multi-stage generating unit models, as well as any implications or related concerns such as Bid Cost Recovery for embedded generating units.

2 Process and Timetable

The purpose of the present *Issue Paper* is to initiate a discussion process with stakeholders to determine the best approach for resolving the issues described above. As such, this paper does not offer ISO recommendations for how to resolve the issues. Rather, it aims to provide the background and description of the issues, to identify key criteria and objectives to be considered in evaluating potential solutions, and to describe some candidate solutions to be considered.

Ultimately the ISO intends to identify appropriate changes to its MRTU market software to address the multi-stage generating unit modeling issue described here, to submit the proposed changes to the ISO Board of Governors and to file them at FERC. The ISO will strive to implement the changes to the MRTU model within the first year or MRTU *go live*.

The table below summarizes the key steps in the stakeholder process on multi-stage generating unit modeling, starting with the release of this issue paper and ending with submission of the ISO management proposal to the Board. The ISO invites stakeholder input on any and all topics discussed in this issue paper.

[2] The explanatory memorandum and presentation to the ISO Board of Governors and the approved Board motion to defer this functionality is located at: http://www.ISO.com/2067/2067aeac40f40.html

November 7	Post Issues paper
November 14	Stakeholder conference call
November 21	Stakeholder comments due *
December 5	Post Straw Proposal
December 9	Stakeholder conference call
December 15	Stakeholder comments due *
December 19	Post Final Proposal
January 26-27, 2009	Presentation to ISO Board of Governors

* Please e-mail comments to Gillian Biedler at gbiedler@ISO.com

3 Description of the Issues

Multi-stage generating units in general (and Combined Cycle units specifically) are characterized by a panoply of embedded operating configurations. For this reason, having these units bid and be dispatched as one resource poses some significant difficulties:

3.1 Inaccurate reflection of operating characteristics

Much of the inherent flexibility of multi-stage generating units goes unused by the optimization which can lead to suboptimal dispatch and thus higher costs. In addition to the multi-stage generating units' flexibility that is foregone due to software limitations, multi-stage generating unit owners and operators limit the flexibility they offer into the market in order to protect against uneconomic or infeasible dispatches.

Specifically, operators of multi-stage generating units will face difficulties in protecting infeasible operating ranges particularly given limitations on ramp rates and the suspended functionality of Forbidden Regions upon MRTU *go live*. As a result, operators of multi-stage generating units, to avoid dispatches that are infeasible, will have the incentive to deviate from such dispatches or to bid so as to operate at their preferred configurations. Once in the preferred and stable operating configuration, the owner of a multi-stage generating unit will need to manually adjust the unit's dispatch range (via unit de-rates, for example) in order to eliminate the possibility that the ISO would dispatch the unit between configurations.

This poses an operational burden in that more operator management of the resource is required. Comments from Market Participants on the nature and extent of this operational burden would be appreciated.

3.2 Bid structure inadequate to capture unit flexibility

It is difficult and potentially misleading to create a continuous, monotonically non-decreasing bid curve that represents the full range of embedded operating configurations of a multi-stage generating unit. Further, submitting a curve that cannot accurately reflect operating constraints

might expose operators of multi-stage generating units to infeasible or costly dispatches. As mentioned above, this will leave those operators to bid and/or re-rate their units in order to force the dispatch of their units to be within specific operating ranges or configurations. Again, this impedes the inherent flexibility of the multi-stage generating units from being realized by the market.

The addition of software functionality to richly model the characteristics of multi-stage generating units will enable the market to benefit from their flexibility. While the Forbidden Region functionality simply moves units through their Forbidden Operating Regions, modeling of multi-stage units will capture the operating parameters that vary with output levels. These parameters would include operating and start-up costs, hold times, nuances in ramping capabilities, varying heat rates and energy costs, and dual regulating ranges. Multi-stage unit modeling can optimize with respect to these output-varying parameters because it relieves the constraint that these resources must submit a monotonically increasing bid curve.

In addition, there may be other groups of units with unique constraints which could also be accommodated through the multi-stage unit model. Stakeholder input on this would be much appreciated.

3.3 Multi-Stage Modeling and Forbidden Operating Region Functionality

The need for both the Forbidden Operating Region functionality and the multi-stage unit modeling is not clear at this time. In theory, the multi-stage modeling would supplant the need for Forbidden Region as the modeling would be a more sophisticated implementation of these constraints. Once there are software options to evaluate for the multi-stage modeling, more robust analysis of the need for maintaining the Forbidden Region functionality will be possible.

3.4 Bid Cost Recovery

The current structure of Bid Cost Recovery (BCR) is based on the cost components of a resource's bid. The ISO uses resource-specific Start-Up and Minimum Load costs for this calculation. Under MRTU as currently designed, one value for each of these costs is recorded for each resource. The stakeholder process will evaluate the concept that multi-stage generating resources, which are comprised of multiple embedded generators, might be better served by a more tailored calculation of BCR. In particular, a BCR calculation that uses the output-varying values for costs such as Start-Up and Minimum Load for each of the embedded generators rather than for the composite unit as a whole may be preferable to the calculation currently in place. The potential benefits of such a change, as well as the feasibility of it from an implementation standpoint, are to be evaluated.

4 Key Criteria for Evaluating Potential Solutions

This section provides some key evaluation criteria the ISO believes are important. Stakeholders are invited to identify other criteria that should be considered in assessing potential solutions.

- Any policy that is developed should achieve the objective of more accurately incorporating the operating parameters of multi-stage generating units so that the units will be economically and feasibly dispatched, and so that the market can benefit from their full participation.

- Any policy that is developed should address the need for Bid Cost Recovery for the embedded generators, i.e. operating configurations, of multi-stage generating units.

- Policy and design options should be evaluated for implementation feasibility and costs for both the ISO Stakeholder and for the ISO. This evaluation should be done keeping in mind (1) the magnitude of the potential issue, and (2) work that has already been done on multi-stage modeling for other markets.

5 Conclusion

The focus of this *Issue Paper* and the ensuing stakeholder discussion is on the policy implications for the ISO's modeling of generators that have Forbidden Operating Regions. The ISO is initially targeting the 6-9 month period after MRTU start-up for incorporating such modeling within the ISO market systems.

The ISO suggests greater benefit will be reached by evaluating the overall impact of enhanced modeling of multi-stage generators, rather than just examining software impacts related to dispatch through Forbidden Regions which do not assess all costs or options for optimal dispatch. Thus this stakeholder process will consider a broad range of issues related to modeling various operating configurations of resources – within a future operating state where such enhanced modeling is in place. This stakeholder discussion generally will *not* review issues related to the market operations process for handling Forbidden Regions after MRTU *go live*, but prior to the incorporation of this modeling feature.

The ISO invites stakeholder comments and discussion on the issues raised within this paper as well as other issues that should be examined. Initial comments should be sent to GBiedler@caiso.com by close of business on November 21st.

The ISO will conduct an initial conference call to review this Issue Paper on November 14th from 1:00 pm to 2:00 pm.