Stepped Constraint Parameters

Issue Paper

May 5, 2016

Table of Contents

1. Introduction

The Security Constrained Unit Commitment (SCUC) and Security Constrained Economic Dispatch (SCED) optimization software for the ISO markets utilize a set of configurable scheduling parameters which specify the criteria for the software to adjust non-priced quantities when necessary to reach a feasible solution. The pricing parameters also specify the criteria for establishing market prices in instances where one or more non-priced quantities are adjusted by the market clearing software.

In some instances, adjusting a non-priced quantity may be more effective at resolving some constraints and less costly than procuring large quantities of energy from a minimally effective resource that happens to bid into the market. Costs are deemed excessive in instances when the adjustment of a non-priced quantity can resolve the constraint at a lower system cost. This design ensures the optimization software can achieve solutions that represent sound economics and good utility practice.

This initiative will consider the appropriate configurations for market scheduling and pricing parameters and related design decisions. These market parameters are associated with optimization constraints and govern conditions which may set market prices and/or relax constraints. The magnitude of such market parameter values reflect the hierarchical priority order in which the associated constraint may be relaxed in that market by the market software. The ISO tariff specifies several levels of scheduling priority for different types of non-priced quantities in the integrated forward market (IFM) and real-time market (RTM).

The proposed scope of this initiative is to explore modifications to:

- Transmission constraint scheduling parameter;
- Shift factor effectiveness threshold;
- Power balance constraint pricing parameter;
- EIM transfer limit when the hourly resource sufficiency evaluation is not passed;
- Lowering the energy bid floor; and,
- Other items based upon stakeholder comments regarding this issue paper.

2. Plan for Stakeholder Engagement

The ISO plans to present its proposal developed through this initiative at the October 2016 Board of Governors meeting. The current schedule for the policy stakeholder process leading up to this Board of Governors meeting is below.

Item	Date
Publish Issue Paper	May 5, 2016
Stakeholder call	May 12, 2016
Issue paper comments due	May 26, 2016
Publish Straw Proposal	June 14, 2016
Stakeholder meeting	June 21, 2016
Stakeholder comments due	July 7, 2016
Publish Draft Final Proposal	July 21, 2016
Stakeholder call	July 28, 2016
Stakeholder comments due	August 4, 2016
Board of Governors Meeting	October 26-27, 2016

3. Transmission constraint relaxation parameter

The transmission constraint relaxation parameter establishes the cost threshold at which the market software will relax an internal transmission constraint in order to avoid expensive and ineffective market solutions. In the pricing run, the pricing parameter is set to the lesser between the bid cap and scheduling run penalty price associated with the relaxation level of the market solution.

Under the previously completed initiative of Transmission Constraint Relaxation Parameter Change[1], the ISO recommended lowering real-time scheduling run transmission constraint relaxation penalty price parameter for the real-time dispatch (RTD) from $5000 to $1500. The reduction of this scheduling run penalty price parameter was implemented to address the high real-time congestion offset (RTCO) uplift occurring throughout the months from July to October 2012. The lower relaxation parameter was implemented on May 10, 2013.

On May 1, 2014, the ISO commenced the FMM (15-minute market). Since then, the energy deviations from day-ahead to FMM for internal generations are settled at the FMM market prices and the energy deviation from FMM to RTD for internal resources is settled at RTD market prices. Loads are settled based upon an hourly price calculated using the weighted average of the load imbalance cleared to meet the ISO demand forecast in each market run interval of FMM and RTD. Since FMM LMPs have settlement implication to the RTCO to ensure that the resulting shadow prices from the FMM run is consistent with RTD, the $1500 transmission constraint relaxation parameter is used for FMM also.

In order to further improve the dispatch efficiency the ISO is considering a tiered approach for relaxing transmission constraints. This approach avoids utilizing large ineffective re-dispatch for small amounts of congestion flow relief without material degradation to system reliability. The ISO contemplates a two-level approach for the transmission constraint relaxation with penalty price parameters for the scheduling run based on the transmission constraint kV level and the % amount of relaxation.

The ISO proposes to relax the transmission constraints based upon the magnitude of the violation and voltage level:

1. 230kV and above
    a. $750 scheduling parameter for below 2% in exceeding the original limit
    b. $1500 scheduling parameter for 2% or more in exceeding the original limit
2. 115kV and lower
    a. $500 scheduling parameter for below 2% in exceeding the original limit
    b. $1000 scheduling parameter for 2% or more in exceeding the original limit

[1] Transmission Constraint Relaxation Parameter Change Revision, ISO Draft Final Proposal http://www.caiso.com/Documents/DraftFinalProposal-TransmissionConstraintRelaxationParameterChange.pdf

The justification of lowering the parameter is that effective adjustments for resolving congestion for low voltage level are comparatively less available than those at the high voltage level. In conjunction, transmission constraints at low voltage level tend to be non-competitive and bids at these voltage levels are likely subject to market power mitigation. Therefore, high bids are unlikely. As such, for some flow relief cost within the range between $1000/MW and $1500/MW, the effectiveness of adjustments available at the low voltage level is less than those at the high voltage level; hence this justifies a lower parameter value for the low voltage level

The intent of setting the price curve's first tier at $500 for 115kV and lower levels and at $750 for 230kV and higher levels is to further promote efficient RTM dispatch for small amounts of limit violation in the market outcome. The length of the segment at 2% of the limit for the first tier considers the operational margin, which is normally set to 3 to 5% below the actual limit by the system operators.

Past experience suggests that high cost congestion in RTM is mostly a fleeting event for 1 to 2 intervals due to shortage in ramping capability and such congestion can be managed over longer period of time. Allowing a small amount of relaxation over a short duration could avoid the market outcome of large movements in some generators from one RTD interval to the next. For the more severe congestion, the second segment relaxation with higher parameter will take effect after exhausting the entire 2% relaxation amount from the first tier.

With the introduction of the FMM, the RTCO from infeasible day-ahead schedules due to modeling issues has been reduced. This is because more effective lower cost options are available for resolving congestion prior to constraint relaxation as the last resort. Under FMM, flow limits and the modeled transmission constraints between the FMM and RTD should not differ significantly. Therefore the RTCO resulting from the re-dispatch of infeasible FMM schedule in RTD is expected not to be large.

Though the role of mitigating RTCO is diminished after the implementation of FMM, the lowering of the relaxation parameter can be a viable mechanism for efficient dispatch by filtering out large ineffective re-dispatch of resources. However, we don't want a lower constraint relaxation parameter to result in market solutions that overly rely on transmission constraint relaxation to resolve congestion. As a result, legitimate economic commitments and/or dispatching of the effective economic bids of interties could be forgone, jeopardizing system reliability. It is important that the level of the relaxation parameters balance these competing objectives.

4. Shift factor effectiveness threshold

In order to ensure the market optimization can solve within market timelines, the software includes an effectiveness threshold setting which governs whether the software will consider a bid "effective" for managing congestion on a binding transmission constraint. The current threshold excludes shift factors with an effectiveness less than 2%. Market efficiency is improved if the threshold is reduced because there are more potential economic bids and thus, solutions to resolve congestion. However, if the market is unable to reach a solution due to the increase number of potential market solutions, market efficiency will be reduced because the a

prior market run may need to be used because a there is not a solution available for the current market run.

In Table 1 below, the ISO analyzed the difference in market solve times for lower thresholds for the IFM on December 1, 2014.

Effectiveness Threshold	2%	1%	0.1%
# of occurrences of resources with shift factors exceeding the effectiveness threshold that are reported for movement in resolving constraint violations in the final iteration	1127	1015	1945
# of occurrences of resources with shift factors exceeding the effectiveness threshold but below 2% that are reported for movements in resolving constraint violations in the final iteration	0	0	542
IFM run execution time (Maptest)	58min	1hr1min	1hr4min
# of binding internal flowgate constraint interval in pricing run	50	55	52
# of binding inter-tie constraint interval in pricing run	45	46	45

Table 1 - Market outcome using different effectiveness thresholds

The analysis demonstrates that improved computational power allows the market optimization to solve with a lower effectiveness threshold and still maintain the currently market timelines. Thus, the market efficiencies from using a lower effectiveness threshold can be achieved without the risk of the market not solving in time. The ISO believes that it would be appropriate to reduce the threshold from 2% to 0.1%.

5. Power balance constraint

After the implementation of the Energy Imbalance Market, the ISO observed instances in which the power balance limit had to be relaxed because of insufficient economic bids which resulted

in prices being set at the power balance constraint relaxation parameters[2]. However, since the EIM entity maintains balancing authority responsibilities, the EIM entity had available resources to meet its load. The market optimization was not able to recognize that this available capacity that is manually dispatched to maintain system balance within the balancing authority area. If the market optimization could recognize this capacity and include it in the economic dispatch, prices would be set based upon the last economic energy bid[3] instead of the relaxation parameter.

In March 2015, the ISO implemented its available balancing capacity design which allows the market to recognize the additional resources the EIM entity uses to meet its balancing authority responsibilities. The design ensures that this capacity is only included in the bid stack in the event that the balancing authority area's individual power balance constraint is being violated because of insufficient economic bids from participating resources within its balancing authority area. When the available balancing capacity is deployed, these resources are included in the bid stack allowing the LMP within the balancing authority area to be set by the marginal economic bid and not the power balance constraint relaxation parameter.

When developing the available balancing capacity design, the ISO reviewed approaches developed by other ISO/RTOs. Power balance constraint infeasibilities between half of a percent to 1 percent of intervals are not unusual. To mitigate instances of small power balance constraint infeasibilities triggering extreme prices, other ISOs have recognized that for small infeasibilities of a transient nature, the ISO was not in true scarcity because it had sufficient operating reserves that could be utilized without negatively impacting reliability. Other ISOs rationally relate prices in these intervals to the practices which resolve the imbalance. In the NYISO for instance, a system of penalty prices allows the operator to balance the system, which includes releasing up to 25 MW at a penalty price of $25/MWh and 55MW at $400/MWh. Over the years, they have evolved at which price based on the amount ratepayers spend for extra regulation capacity[4].

A stepped relaxation approach uses predetermined tiers MW quantities and prices. In the event the power balance shortfall is within a tier, the additional MWs are released to resolve the power balance constraint even if there are higher priced economic bids still available because the tier prices are set below the bid cap pricing levels. For example, assume the ISO had a 40MW tier which was released at $25/MWh. The system has transmission limits binding: therefore, no bids are mitigation because there is no congestion. If there were three resources bidding: (1)

[2] The relaxation parameters are a function of the bid cap and the bid floor. The upward power balance constraint is relaxed at $1000/MWh and the downward power balance constraint relaxation is ($155)/MWh.

[3] If a resource bid $1000/MWh and was not mitigated, the last economic bid would equal the current $1000/MWh relaxation parameter. Under the available balancing capacity design, if the transfer limit into the balancing authority area is binding, local market power mitigation rules will be in effect and since all bids within that balancing authority area are effective address the transfer limit congestion, all internal resources' bids will be mitigated.

[4] The actions of other ISO/RTO was discussed at the April 17, 2015 Market Surveillance Commitment meeting by Dr. Scott Harvey. The presentation is available at http://www.caiso.com/Documents/Discussion_EnergyImbalanceMarketPotentialPricingSolutions-MSC_Presentation-April2015.pdf

100MW @ $15/MWh, (2) 200MW @ $30/MWh, and (3) 50MW @ $1000/MWh. If load was 330MW, the price would be set at $30/MWh. It is important to note that there was a total of 350MW of economic bids. However, the bid of resource (3) is not used because the infeasibility is small and does not cause a reliability concern. It is appropriate not to accept this bid because it is not indicative of the value to meeting system needs.

The ISO seeks stakeholder input on the appropriateness of implementing a similar approach for address small infeasibilities of the power balance constraint in addition to the available balancing capacity proposal already implemented. The ISO believes that if a tier relaxation approach is developed, the approach should apply to both upward and downward power balance constraint violations. The discussion of the bid floor level discussed in section 7 will impact the setting of tiers for downward power balance constraint violations.

6. EIM transfer limit when resource sufficiency evaluation is failed.

The EIM does not include forward resource adequacy requirements or obligations for resources to submit bids. However, elements are included to ensure each EIM balancing authority has sufficient resources to serve its load while still realizing the benefits of increased resource diversity. On an hourly basis, a resource sufficiency evaluation[5] is performed for each balancing authority area in the EIM area. The evaluation has three related tests: balance, capacity, and ramping. If the resource sufficiency evaluation is failed, incremental EIM transfer into and out of that balancing authority area are restricted to the last FMM schedule from the previous operating hour. When the EIM transfers are frozen, this will impact LMPs within that balancing authority area.

In addition, the EIM design includes under-scheduling and over-scheduling penalties in the event imbalance requirement exceed certain thresholds. If the scheduling penalties are incurred, this will not impacts LMPs within that balancing authority area, but will result in uplift revenues that are allocated to balancing authority areas in the EIM that passes the resources sufficiency evaluation over this trade date.

Upon reflection, the ISO believes that a penalty approach may be more appropriate than freezing EIM transfers into/out of the offending balancing authority area. This is because there may be market participants in a balancing authority area that have load or generation imbalances that are settled at the LMP, but have sufficient resources to individually meet their imbalance needs. In addition, EIM benefits are the result of maximizing the use of available transfer capability between balancing authority areas. The freezing of transfers, while seeking to address “leaning”, reduced the use of transmission made available to support EIM transfers. Therefore, the ISO recommends implementing a penalty structure similar to the load under-scheduling penalties and over-scheduling penalties.

Under this approach, if an EIM entity fails the resource sufficiency evaluation due to insufficient bid range in the upward direction, the EIM entity scheduling coordinator will be penalized at a percentage of the system marginal energy cost or fixed price adder for each MW of transfers

[5] *See* EIM BPM section 11.3.2

into that balancing authority area. The penalty collected would then be allocated to the other balancing authority areas in the EIM area which did not fail the resource sufficiency evaluation to compensate them for the leaning from insufficient supply which occurred. If an EIM entity fails the resource sufficiency evaluation due to insufficient bid range in the downward direction, the EIM entity scheduling coordinator will be penalized at a percentage of the system marginal energy cost or fixed price reduction for each MW of transfers out of that balancing authority area. The penalty collected would then be allocated to the other balancing authority areas in the EIM area which did not fail the resource sufficiency evaluation to compensate them for the leaning from excess supply which occurred.

The ISO seeks input from stakeholders on the appropriate levels of the penalty for failing the hourly resource sufficiency evaluation. The penalty needs to be sufficiently large as to provide proper incentives for the EIM entity or the ISO to ensure adequate bid range from participating resources. In addition, the ISO will need to determine the allocation of any costs and payments from the new penalty approach.

Similar to the load under/over-scheduling penalty, the EIM entities will determine how the costs are sub-allocated to their customers under their OATT. The ISO will need to also develop a mechanism to sub-allocate both the costs and revenues to its market participants. The ISO would like to leverage the existing settlement of over/under scheduling penalties to minimize implementation costs for both the ISO and market participant and welcomes stakeholder comments regarding the appropriate sub-allocation approach.

7. Lowering bid floor

In the absence of sufficient supply bids, the ISO must issue non-economic instructions (instructions not based on energy bids) to manage over-supply conditions, real-time congestion and system ramping needs. On, December 19, 2013 FERC accepted the ISO's proposal to lower the bid floor from negative $30/MWh to negative $150/MWh under the notion of facilitating increased real-time economic bidding by variable energy resources. Lowering the bid floor would cover the opportunity costs of not producing for many variable energy resources. The deeper pool of economic bids, which could result in decremental dispatches would allow the ISO to rely more on market-based curtailment in periods of over-supply. During the stakeholder initiative, it was contemplated that a further reduction to negative $300/MWh would occur at some later date.

The ISO has identified that as the supply fleet evolves toward a 50% renewable portfolio standard for California, that there will increased instances of over-supply which may necessitate the cutting of self-schedules at the power balance constraint violation price versus through economic bids. If resources continue to self-schedule during periods of over-supply, this indicates that the existing bid floor may be insufficient to cover out of market opportunity costs.

Previously, stakeholders had expressed concerns that the transient nature of extreme prices increased risk to resource from being dispatched in one interval only to have price switch direction and the resource to have insufficient ramping capability respond to the updated dispatch. In section 5 above, the ISO discussed the potential for using a tiered approach to

relaxing the power balance constraint. In addition, the ISO will be implementing the flexible ramping product in Fall 2016 to address the concerns previously raised regarding spurious price spikes. Thus, the need to mitigate extreme low prices by having a higher bid floor is reduced.

Currently, the bid floor (-$150/MWh) and bid cap (+$1000/MWh) are not symmetrical. This results in a market wide bias to overschedule demand in the day-ahead market because in the real-time market if there is insufficient supply it can trigger $1000/MWh prices to serve demand, but is there is excess supply the load must buy back at $150/MWh. The ISO seeks stakeholder input on the appropriate level of the bid floor and the need for symmetrical bid caps and bid floors.

8. Next Steps

The ISO plans to discuss this issue paper with stakeholders during a stakeholder conference call to be held on May 12th. The ISO requests comments from stakeholders on the proposed scope of this initiative to review the stepped constraint parameters. Stakeholders should submit written comments by May 26th to intitiativecomments@caiso.com.