California Independent

Convergence Bidding:
Market Monitoring and Mitigation Issues

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1. Introduction

Convergence bidding (also known as “virtual bidding”) offers potential for improved market efficiency under the type of two-settlement energy market being implemented under MRTU. However, if not carefully designed, convergence bidding may also create the potential for market manipulation through exploiting market design or modeling flaws to the detriment of market efficiency and other participants. This paper focuses on market design, mitigation and monitoring options that may allow the benefits of convergence bidding to be realized, while avoiding or mitigating potential uses of convergence bidding that may be detrimental to market efficiency.

The first section of this paper provides results of a benchmarking review of market design, mitigation and monitoring features and practices at three other ISOs that have implemented virtual bidding (New York, PJM, and New England).

The final section provides a discussion highlighting some of the concerns with implementing convergence bidding after the release of MRTU from a perspective of market monitoring and mitigation of the potential problems associated with convergence bidding.

2. Benchmarking

As the CAISO and stakeholders consider various design elements of convergence bidding that may pose market manipulation concerns, it is useful to draw from the tools and practices developed by other ISOs to address such concerns. This section describes the monitoring tools and practices they use.

2.1 Market Design Rules

Spatial Granularity

Both PJM and ISO-NE have implemented a nodal convergence bidding scheme, whereas the NYISO limits virtual bidding to demand zones. Although the spatial granularity of convergence bidding in the NYISO market is less than that of the PJM and ISO-NE markets, the NYISO design consists of fifteen zones that has proven sufficient for price convergence and has provided participants with hedging opportunities.

The NYISO's zonal design of convergence bidding is most like Option 1a from the CAISO white paper on convergence bidding, which would limit virtual bidding to LAPs, while the nodal spatial granularity of PJM and ISO-NE is most like Option 3.

Flagging of Convergence Bids

PJM and the NY-ISO require that convergence bids be flagged to differentiate these bids from "physical" supply and demand bids. This enables these ISOs to better monitor the effects of convergence bidding on market outcomes, and to evaluate the need for additional resources in real time to meet expected demand. ISO-NE does not require convergence bids to be flagged as "virtual" bids.

Limits of Convergence Bid Volumes/Segments

None of the ISOs limit the total quantity of convergence bid volumes or convergence bid segments as a means to mitigate any potential abuses of convergence bidding. NYISO believes that the $200/MWh collateral requirement for convergence bids – and the potential losses associated with the volatility of price differentials – effectively limit convergence bid volumes for individual participants such that position limits are not necessary. The PJM Market Monitor has indicated that the concept of position limits for convergence bidding is under consideration.

Although none of the ISOs has implemented position limits to mitigate potential manipulative bidding practices, each has implemented some features that serve to limit the burden of large bid volumes or numbers of bid segments on the market information system and optimization routines.

- The NYISO uses a $200/MWh collateral requirement to help prevent submission of large volumes of convergence bids/offers at extremely high/low prices that have little chance of being accepted.
- Both the ISO-NE and NYISO allow bids in whole MWh increments only.
- ISO-NE enacted a small transaction charge per convergence bid which was successful in incenting participants to submit fewer bids with more segments, thus eliminating bid "spamming" on the market optimization routines.

Treatment of Uninstructed Deviations and Forced Outages

Participants with physical generation assets may have the ability to affect real-time prices in a manner that cannot be predicted by other participants through means such as sudden forced outages and uninstructed deviations. For example, a generator may take a position in the Real Time Market and then seek to utilize its generation resources to raise or depress the real-time price in order to profit from their convergence bidding position.

Uninstructed Deviation Penalties (UDPs) could deter such gaming. The NYISO does have a UDP such that, if a participant is 3% over their schedule, they are not paid for that excess, and if a participant is 3% under their schedule, they are assessed a penalty that is tied to the price of energy reserves. ISO-NE does not have a UDP, though a participant's failure to notify the ISO before real time may result in uplift charges. Like ISO-NE, PJM does not have explicit UDPs, but supply that does not generate in real time may incur uplift costs.

2.2 *Mitigation Measures*

CRR Settlement Rule

One of the major concerns about convergence bidding is that it may be used by a market participant to manipulate Day Ahead Market prices in order to increase revenues from the market participant's Congestion Revenue Rights (CRRs). For example, a participant owning CRRs that sink to a demand node or zone may submit virtual demand bids at this location to create or increase congestion. Although the participant may lose money on the virtual bid itself, the resulting increase in CRR revenues could make this strategy profitable.

The mitigation measures that have been adopted by other ISOs to address the potential use of virtual bidding to manipulate market prices and CRR revenues have been determined, in large part, by the spatial granularity of the convergence bidding market design. ISOs with convergence bidding at a nodal level (PJM and ISO-NE) have adopted a special rule to mitigate potential use of convergence bidding to increase CRR payments, while ISOs with zonal level convergence bidding (NYISO) have not adopted any such settlement rules.

Both PJM and ISO-NE have established a settlement rule that deters market participants from using convergence bids to increase DA congestion in order to earn additional profits from the Congestion Revenue Rights. In PJM and ISO-NE, this settlement rule is triggered if:

1. The participant has convergence bids accepted at one of the nodes for which it owns a CRR, or at nearby nodes, that could increase the participant's CRR payments by increasing the price difference between the two nodes defining the CRR; and

2. The difference between the DA MCPs at the source and sink nodes of the CRR is greater than the difference between the MCPs for these same nodes in the Real Time Market.

If the conditions above exist, the participant's CRR payments are then limited to be no greater than the average hourly cost of the CRR paid by the participant (e.g., in the monthly or annual auction for CRRs).

Attachment A provides a more detailed description of how this settlement rule works in a fully nodal convergence bidding design, and how this settlement rule would need to be applied to the type of convergence bidding design described under Option 2 of the CAISO white paper.

In the PJM system, this settlement rule is automatically applied as part of the settlement system since virtual bids are explicitly differentiated from "physical" bids in the PJM system. Based on discussions with ISO-NE Market Monitoring staff, it is unclear whether this settlement rule is automatically applied as part of their settlement system, or is an option that may be applied on a case-by-case basis if the Market Monitor determines that a participant's convergence bidding may have affected its CRRs revenues. In fact, since "virtual" bids are not explicitly differentiated from "physical" bids in the ISO-NE system, it is unclear how this rule could be applied automatically by ISO-NE.

The NYISO has not adopted explicit settlement rules relating to the linkage of virtual bids to CRR holdings. This is because congestion revenue rights, as well as convergence bids, are at such large geographical areas that any attempt to use convergence bids to impact congestion would be very diluted across many transmission paths. It would therefore take a tremendous volume of convergence trades to create appreciable congestion between the locations for which a participant owns CRRs. The NYISO Market Monitor has found that the collateral requirement of $200/MWh for all convergence trades and the fact that it is very difficult to impact prices in a zonal convergence bidding design sufficiently address this concern.

Ability to Limit or Suspend Trading

As previously noted, none of the ISOs have limits on the total quantity of convergence bid volumes or convergence bid segments. However, both the NYISO and ISO-NE Market Monitoring units have the authority to suspend or limit trading based on their analyses of market participant behavior. Specifically, the ISO-NE Tariff states that,

> [t]he ISO, will restrict the Market Participant for a period of 6 months from submitting any virtual transactions at the same Node(s), and/or electrically similar Nodes to, the Nodes where it had submitted the virtual transactions

> that contributed to the unwarranted divergence between the LMPs in the Day-Ahead and Real-Time Energy Markets.[1]

The ISO-NE Market Monitor indicates that it has used this authority, although on a very limited basis. The NYISO Tariff provides that

> [i]f the ISO determines that the conditions specified in Section 4.5.2 exist, the ISO may limit the hourly quantities of Virtual Bids for supply or load that may be offered in a zone by a Market Participant whose Virtual Bidding practices have been determined to contribute to an unwarranted divergence of the LBMPs between the Day-Ahead and Real-Time Markets. Any such limitation shall be set at such level that, and shall remain in place for such period as, in the best judgment of the ISO, would be sufficient to prevent any unwarranted divergence between Day-Ahead and Real-Time prices.[2]

The NYISO Market Monitor has indicated that it has never had to use the authority to suspend trading and considers this a “circuit breaker” provision of their Tariff. PJM does not have Tariff authority to suspend trading.

2.3 Monitoring Tools

Ability to Track Convergence Bidding Profits and Losses

The NYISO Market Monitor has the ability to track each participant’s profits and losses from virtual bidding with relatively little time lag, and indicates that this is one of the key sources of information for monitoring and investigating convergence bidding behavior. Behavior of participants with significant and systematic losses or profits may be flagged for review. Sustained losses may indicate that a participant is seeking to profit indirectly from CRRs or other contracts that may be tied to LMP prices. Conversely, significant and sustained profits may indicate that a participant is able to influence real-time prices in a way that enables them to profit from convergence bidding (such as having knowledge or ability to create unit outages, uninstructed deviations, etc.).

The PJM Market Monitor appears to have the ability to determine profits and losses from convergence bidding, but it is unclear to what extent this is monitored and investigated, as the PJM Market Monitor believes that the CRR settlement rule mitigates most of the concern about potential abuses of convergence bidding.

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[1] http://www.iso-ne.com/regulatory/tariff/sect_3/mr1_appendix_a.pdf

Market Rule 1, Appendix A, Section III.A.8.2.2. iii. (page 41 of 65 in the document at the above link, Tariff Sheet 7438)

[2] http://www.nyiso.com/public/webdocs/documents/tariffs/market_services/att_h.pdf
Attachment H, Section 4.6.3 a. (page 24 of 29 in the document at the above link, Tariff Sheet 476A)

Since "virtual" bids are not explicitly differentiated from "physical" bids in the ISO-NE system, it is unclear how ISO-NE would track profits and losses from convergence bidding activity of individual participants.

Ability to Simulate Impact of Convergence Bids on Market Prices

In order to evaluate the impact of convergence bidding on converging day-ahead and real-time prices, Market Monitors need the ability to rerun the market excluding convergence bids. Both NYISO and PJM have the ability to do this, and do so routinely. NYISO and PJM both use a software package called PROBE,[3] and indicate that this software has been configured to replicate the actual production system with a very high level of accuracy, but requires much less computational time.

Because convergence trades are not labeled as such in the ISO-NE market, this process is more difficult. However, ISO-NE prepares an annual report analyzing the impacts of convergence trading in their market as directed by the FERC. For purposes of these reports, ISO-NE Market Monitoring staff identify "virtual" bids based on the participants' physical load and generation compared to their total bid quantities. ISO-NE uses an in-house software market model that appears to include both the day-ahead and Real Time Markets, but is more simplified.

Ability to Assess Impact of Market Behavior on Participant's Total Portfolio

In addition to rerunning the Day Ahead Market excluding convergence bids, the PROBE software used by PJM and the NYISO also has the ability to show changes in the entire settlement for each participant's total portfolio of resources and loads. This helps to identify situations in which participants may seek to utilize convergence bidding to increase profits from other elements of their portfolios.

2.4 *Summary Matrix of Convergence Bidding Benchmarking*

Table 1 summarizes the key convergence bidding market design, mitigation and monitoring features in PJM, NYISO, and ISO-NE discussed above. Additional mitigation measures and monitoring tools are discussed in more detail in the following section.

[3] PROBE stands for PoRtfolio Ownership Bid Evaluation, and is specialized software developed by PowerGem.

Table 1 - Comparison of Convergence Bidding Mitigation Features

	NYISO	PJM	ISO-NE
Spatial Granularity	Zonal (15 zones)	Nodal	Nodal
Flagging of Convergence Bids	Yes	Yes	No
Congestion Revenue Rights	Monitor using Re-Runs of the DA Market	Automated Settlement Rule	Settlement Rule (May not be Automated)
Bid Segments	VB in Whole MWh Only	(unable to determine)	None
Collateral & Charges	Collateral $200/MWh	(unable to determine)	Small Charge per Convergence Bid
Ability to Limit or Suspend VB	Yes – Unused "Circuit Breaker" Provision	No	Yes – Limit or Suspend < 6 months
Ability to Re-Run DA Market	SCUC and PROBE	SCUC and PROBE	Estimates effects of Convergence Bidding on an Annual Basis

3. Discussion of Market Mitigation and Monitoring Issues

This section discusses some of the key convergence bidding market design issues, with particular emphasis on mitigation and monitoring issues.

3.1 Spatial Granularity

The spatial granularity at which convergence bidding is allowed (LAP or nodal) represents the most important market design element relating to mitigation of potential adverse impacts or abuses of virtual bidding. The three major spatial granularity options that have been under consideration for the CAISO market are:

1) **Convergence demand and convergence supply bids at Load Aggregation Points (LAPs).** With this option, both virtual demand and supply bids would only be allowed at the LAP level. Under this design, virtual supply bids are, in effect, negative virtual demand bids (i.e., they simply have the effect of reducing LAP demand bids). This option is most equivalent to the zonal model adopted in the NYISO, except that the three LAPs that will exist in the CAISO market under MRTU are a somewhat higher level of aggregation than the zones in the NYISO system.

2) **Convergence supply and demand bids at all Pnodes**. With this approach, participants would be allowed to submit convergence demand and supply bids at any pricing node in the network. This option is essentially equivalent to the nodal model adopted in PJM and ISO-NE.

3) **Convergence demand bids at Load Aggregation Points (LAPs), convergence supply bids at generation PNodes**. This approach parallels the manner in which bids for physical demand and supply can be submitted under the current MRTU design. Under MRTU, the majority of physical demand can only submit demand bids at a LAP level, with distribution factors being used to model how load is distributed at different nodes within each LAP, and physical supply bids are submitted and modeled at the node at which the supply resource is actually located. This option represents somewhat of a hybrid of the nodal models implemented in other ISOs.

The Department of Market Monitoring supports the CAISO's straw proposal of limiting convergence bidding to the LAP (Option 1). Allowing virtual bidding at the LAP only (virtual demand and supply bids at a LAP) will provide most of the potential benefits of convergence bidding, while avoiding most of the potential detrimental impacts of convergence bidding. After significant experience is gained under MRTU with LAP convergence bidding, a more granular virtual bidding design can be considered that would include additional monitoring and mitigation rules.

DMM believes that convergence bidding at a nodal level may require significant additional market mitigation and monitoring safeguards than would be required under zonal level convergence bidding. DMM offers the following rationale for preferring to limit virtual bidding at the LAP-level as an initial design approach under MRTU:

- **Underscheduling.** The primary immediate goal of convergence bidding is to prevent any potential monopsony power in the day-ahead energy market of large buyers or LSEs at the LAPs. Option 1 will certainly address this first issue by providing a mechanism for participants – including marketers and generators – to prevent underscheduling or mitigate any potential monopsony power at the LAPs. Options 2 and 3 do not appear to provide any significant additional benefits than Option 1 in this respect.

- **Mitigating Supplier Market Power.** A second – often cited – potential benefit of convergence bidding is that it may mitigate market power of suppliers – particularly at individual supply nodes – in the Day Ahead Market by allowing other participants to submit virtual supply bids. However, under the MRTU local market power mitigation design, virtual bidding at individual supply nodes may actually exacerbate local market power, depending on whether virtual supply bids are considered in the local market power mitigation procedures or not. If they are considered but are also exempt from mitigation, virtual supply bids might be used to undermine the local market power mitigation procedures.[4] Alternatively, if they are excluded from the local market power mitigation procedures, their exclusion could result in inaccurate bid mitigation of physical generator bids since ultimately all bids (virtual and physical) are considered in the day-ahead energy market. Given these complexities and potential for nodal virtual bids to undermine local market power mitigation procedures, DMM believes limiting virtual bids to LAPs, as an initial design approach, is prudent.

- **Eliminating Implicit Virtual Bids.** Another potential benefit of convergence bidding is that it may reduce or eliminate the incentive for "implicit" virtual bidding through under or overscheduling of load or submitting bids or schedules from physical resources that, once accepted in the Day Ahead Market, are withdrawn in real-time. Since actual load is required to schedule at the LAP level only, Option 1 should largely eliminate the incentives to engage in implicit convergence bidding through under or over scheduling of load. It should also help to reduce any implicit virtual bidding at individual supply nodes since there is likely to be a strong correlation between price convergence at the LAP level and at individual supply nodes. Though Options 2 and 3 might be more effective in reducing implicit virtual bidding at individual supply nodes, the additional benefit of this has to be weighed against the potential market power issues noted in the previous bullet.

- **Increase Market Liquidity.** Another potential market benefit of virtual bidding is a general increase in market liquidity. Again, Option 1 seems to allow significant benefits from increased market liquidity. Under this option, all virtual supply and

[4] For example, under the local market power mitigation procedures, only resources that are dispatched up to relieve congestion on non-competitive transmission paths are subject to mitigation. If virtual supply bids are considered in the mitigation runs but not subject to being mitigated they may displace physical supply bids and set very high LMPs. Subjecting virtual supply bids to bid mitigation is problematic because, unlike physical resources, there is no meaningful cost-basis for these bids.

demand bids and all physical demand will form a single market at each LAP. These LAPs also correspond closely with generation trading hubs, which provides the opportunity to create significant liquidity at the LAP/trading hub level. Options 2 and 3 do not appear to provide any significant additional benefits than Option 1 in this respect, since it is unclear that the volume of virtual bids at individual nodes would be so significant as to create a highly liquid market at a nodal level.

- **Hedging Mechanisms for Generation Owners.** Other frequently cited benefits of convergence bidding is that it provides generators with a mechanisn for (1) hedging outage risks, and (2) offering and scheduling supply in the Day Ahead Market, while still being able to earn the real-time price if they believe this price will exceed the day-ahead price. While limiting virtual demand bidding at LAP level (Options 1 and 3) does not provide as targeted a mechanism for these purposes as nodal virtual demand bidding (Option 2), LAP level virtual demand bidding should still provide an effective tool for these purposes due to the high correlation of LAP and Pnode prices. In addition, since Option 1 allows arbitrage bidding from a wide pool of participants to limit or eliminate any systematic difference in day-ahead and real-time prices, this improved price convergence should reduce the rationale for generators to avoid scheduling supply in the Day Ahead Market or to hedge the financial risk associated with forced outages at units after they are scheduled to operate through the Day Ahead Market.

- **Gaming of Congestion Revenue Rights.** Most importantly, allowing convergence bidding only at LAPs limits the ability of participants to exercise market power, and to game Congestion Revenue Rights. Under this approach, convergence demand bids, which would only be submitted at LAPs, would be blunt instruments for creating congestion between specific nodes. This is because convergence demand bids would be distributed across many nodes using Load Distribution Factors (LDFs) so it would not be possible for a participant to target the specific nodes for which it owns CRRs. Conversely, allowing convergence bidding at individual nodes (Options 2 and 3) could certainly increase day-ahead congestion between specific nodes, so a settlement rule similar to the one adopted by PJM and ISO-NE described above would need to be developed and applied to convergence supply bids under these options.[5] Some significant operational experience under the LMP market would help the CAISO and DMM in determining appropriate settlement and monitoring approaches for addressing this potential concern. Starting with a simple convergence bidding design that limits virtual bids to the LAPs would provide time to assess the need for more granular virtual bidding and time to develop the appropriate safeguards required to address potential CRR gaming issues.

- **Monitoring and Mitigating of Generation Outages, Deviations and Other Factors Affecting Real-time LMPs.** DMM believes that under Option 2 – which allows demand bids at supply nodes – it may be particularly important to monitor and

[5] For more detail on the settlement rule required for this option, see Attachment A.

have some market rules to mitigate the potential ability of participants controlling generation assets to profit from virtual bidding by utilizing their ability to affect real-time prices in ways that would be highly unpredictable for other market participants. Examples of such mechanisms include forced outages, uninstructed deviations, and other ways of affecting real-time LMP. Specific events that may be subject to scrutiny under Option 2 would be if a generation owner took a significant position through virtual bids, which was correlated with events (such as forced outages or generation deviations) that had the effect of increasing the generator's profits from these virtual bids. Again, Option 1 (and Option 3) largely avoid this issue since participants cannot submit virtual demand bids at individual supply nodes – where real-time prices may be highly sensitive to factors within a generators control.

Additional Market Design Issues

Load Distribution Factors

DMM supports the CAISO's straw proposal that the Load Distribution Factors (LDFs) used for physical bids also be used for convergence bids. Minimizing differences between convergence and physical trades with respect to settlements will limit the incentive to game one against the other.

3.2 Mitigation Measures

This section describes the various market power mitigation measures that DMM believes would be needed under each of the spatial granularity options being considered for convergence bidding.

Congestion Revenue Rights

As discussed above, under Options 2 and 3, it would be necessary to implement a settlement rule that automatically limits revenues from CRRs that have been increased by the strategic use of convergence bids.

DMM believes that while the settlement rule used by PJM and ISO-NE may mitigate much of the concern about use of virtual bids to mitigate gaming of CRRs, further refinements of this type of settlement rule may be warranted under Options 2 or 3. Option 1, recommended by DMM, does not require the implementation of such a settlement rule.

Position Limits

Credit and collateral requirements may provide *de facto* position limits for many participants. However, it may be prudent to have the ability to impose some position limits in the event that a participant may still qualify for an excessive amount of virtual bidding after meeting credit and collateral requirements.

Limitation or Suspension of Convergence Bidding

As noted above, the Eastern ISOs generally do have provisions to limit or suspend convergence bidding for any particular SC or group of SCs that are exercising market power. ISO-NE Market Monitoring has used this authority on rare occasions. The NYISO has not.

For the stability of the market and to protect compliant participants, it is important to react quickly to any abuse of convergence bidding and therefore have an ability to quickly suspend an entity's ability to submit virtual bids if they are found to have used that bidding to exercise market power. DMM believes that in order to quickly identify and report potential market abuses to the FERC – or exercise any authority the CAISO may have to limit or suspend trading – it will be critical that DMM has the ability to routinely re-run the market with and without virtual bids to assess their impact on price convergence and portfolio effects. Such routine assessments will require a highly automated set of modeling and monitoring tools.

Local Market Power Mitigation and Price Caps

Since there would be no basis for establishing Default Energy Bids for virtual bids to be used in market power mitigation (MPM), applying MPM to virtual bidding is problematic. However, DMM believes it is important that virtual bids be subject to the same $500-$1,000 maximum bid cap that is scheduled to be in effect for physical bids under MRTU.

A separate but related issue is how virtual bids should be treated in pre-IFM MPM runs. Initially, pre-IFM MPM will be applied based on CAISO forecasted load, rather than bid in load. However, FERC's September 21 Order directs the CAISO to examine the issue of whether pre-IFM MPM should be based on total bid in demand in future releases of MRTU. DMM believes that the implications of including virtual supply and demand bids in the pre-IFM MPM needs further review.

Flagging of Convergence Bids

The DMM agrees that convergence bids should be submitted explicitly, and that they should be flagged so that they are distinguishable from physical bids. This is important for effective market monitoring and assessment of the impact of virtual bidding, and may have reliability implications as well.

Bid Price-Quantity Pairs

DMM does not believe that limiting the convergence bids with respect to the number of segments, or number of bids per participant represents effective or significant mechanism for mitigating potential inefficiencies or abuses of convergence bidding. However, such restrictions may be beneficial from the perspective of information systems design and maintenance, and the efficiency of market operations and software. In addition to limiting the number of segments or number of virtual bids per participant, a transaction fee for each virtual bid or a minimum bid quantity threshold may also help to reduce virtual bid volumes.

3.3 Monitoring Tools

Ability to Re-Run the Day Ahead Market

Under virtual bidding, it is vital that the CAISO market software include a routine, daily counterfactual run that calculates Day Ahead Market prices excluding convergence bids. Without this capability, Market Monitoring will not be able to routinely evaluate the effects of convergence bidding, that is, the extent to which virtual bidding leads to the convergence (or divergence) of day-ahead and real-time prices.

In addition to examining price convergence, having the ability to calculate each individual virtual bidder's impact on prices, congestion and their net market profits is critical for monitoring.

Finally, if there are significant differences in the spatial granularity, cost allocations, uplift charges, bidding rules *et cetera* between the convergence and physical market rules, DMM will also need the ability to run the settlement outcomes in both scenarios to ensure that these differences are not being gamed.

Attachment A

Example of Congestion Revenue Credit Calculation for Spatial Granularity Option 3

The specific language in the PJM Tariff limiting a participant's CRR payments in cases where the participant's virtual bids may have otherwise increased CRR payments reads as follows:

> 5.2 Transmission Congestion Credit Calculation.
>
> (b) If a holder of a Financial Transmission Right between specified delivery and receipt busses acquired the Financial Transmission Right in a Financial Transmission Rights Auction (the procedures for which are set forth in Part 7 of this Schedule 1) and (i) had an Increment Bid and/or Decrement Bid that was accepted by the Office of the Interconnection for an applicable hour in the Day-ahead Energy Market for delivery or receipt at or near delivery or receipt busses of the Financial Transmission Right; and (ii) the result of the acceptance of such Increment Bid or Decrement Bid is that the difference in locational marginal prices in the Day-ahead Energy Market between such delivery and receipt busses is greater than the difference in locational marginal prices between such delivery and receipt busses in the Real Time Energy Market, then the Market Participant shall not receive any Transmission Congestion Credit, associated with such Financial Transmission Right in such hour, in excess of one divided by the number of hours in the applicable month multiplied by the amount that the Market Participant paid for the Financial Transmission Right in the Financial Transmission Rights Auction.

PJM extends the CRR settlement rule described above to busses "nearby" the delivery or receipt busses specified by the CRR. The Tariff defines busses that are "at or near" each FTR delivery or receipt Location as follows:

> [a] Location shall be considered at or near the FTR delivery or receipt Location if seventy-five % or more of the energy injected or withdrawn at that Location and which is withdrawn or injected at another Location is reflected in the constrained path between the subject FTR delivery and receipt Locations that were acquired in the FTR Auction

The ISO-NE Tariff incorporates virtually the same language.

DMM staff found this Tariff language ambiguous,[6] and sought to clarify how it is actually applied. The following example demonstrates how DMM believes this settlement rule used by PJM and also adopted by ISO-NE is applied.

[6] For example, the requirement that "the result of the acceptance of such Increment Bid or Decrement Bid is that the difference in locational marginal prices in the Day-ahead Energy Market between such delivery and receipt busses is greater than the difference in locational marginal prices between such

Example 1: Congestion Revenue Credit Calculation

for Spatial Granularity Option 3 (Full Nodal)

In this example, the transmission congestion occurs from Zone A to Zone B, so the Participant owning CRRs from Zone A to Zone B will receive the difference between the Locational Marginal Prices (LMPs) at those two zones. Increasing congestion will increase the price at Zone B, so Market Participants might try to create congestion by bidding convergence demand at B, or convergence supply at A.

Figure A-1 - Two-Node Example

The settlement rule adopted by PJM and ISO-NE to address such situations essentially consists of three steps, which are described below.

1. If the participant has an accepted inc bid (convergence supply bid) at A or an accepted dec bid (convergence demand bid) at B, then a potential adjustment to participant's Congestion Revenue Rights (CRR) payments (also called Financial Transmission Rights (FTR)) would be based on Steps 2 and 3 described below.

2. A test of whether the difference between the Market Clearing Prices (MCPs) in the two zones in the Day Ahead Market is greater than the difference between the MCPs in real time,[7] which can be expressed as:

   Is $(MCP_{DA,B} - MCP_{DA,A})$ greater than $(MCP_{RT,B} - MCP_{RT,A})$?

   If this condition is not true, no adjustment is made, as depicted in Cases A and B in Table A-1. If this condition is true, an adjustment is made to limit the CRR revenues received by the participant, as described in Step 3 below. Case C in Table A-1shows a case in which this condition is true. In this scenario, the Participant's accepted inc bid at A or accepted dec bid at B may have contributed to a $10 price differential between points A and B. Without a settlement rule, the

delivery and receipt busses in the Real-time Energy Market" seems to imply that some analysis must be done to determine the impact of the participant's virtual bids on the day-ahead and real-time price at both nodes. However, DMM does not believe that, in practice, such analysis is done.

[7] While this doesn't necessarily mean that gaming of CRRs using convergence trading occurred, it is as good a measure as can be obtained without rerunning the market without convergence bids. Note that rerunning the market would show the day-ahead results without convergence trades, but these results would still have to be compared to the RT market that ran after the DA market including convergence trades. For this and other reasons, even rerunning the DA market would produce an imperfect test of the gaming of CRRs using convergence bidding.

Participant would collect $10 of congestion revenue[8] for each MW of CRRs owned, while the RT market results show that only a $5/MW differential between Nodes A and B.

Table A-1 - Summary of Settlement Scenarios

	Day Ahead Market			Real Time Market			CRR Settlement Adjustment
Case	MCP at Zone B	MCP at Zone A	MCP_B – MCP_A	MCP at Zone B	MCP at Zone A	MCP_B – MCP_A	
A	$50	$45	$5	$50	$45	$5	None
B.	$50	$45	$5	$55	$45	$10	None
C.	$55	$45	$10	$50	$45	$5	See 3. below

Note: All prices are per MWh.

3. In Case C, the following adjustment would be made as part of the settlement process:

$$CRR = (DA_B - DA_A) * Q_{CRR} - Q_{CRR} * [(DA_B - DA_A) - avg(P_{CRR})]$$

where Q_{CRR} is the quantity in MWh of CRRs owned along the path from Node A to Node B, and the average CRR price (P_{CRR}) is the price the Participant paid for the monthly CRR divided by the number of hours in the month.[9]

For example, if a participant's monthly CRR of a 100 MW cost $600, and there were 720 hours in the month, the following would be the revenue calculations for the CRRs in the above three scenarios:

a. ($50 - $45)*100 = $500

b. ($50 - $45)*100 = $500

c. ($55 - $45)*100 – 100*[($55 - $45) - $600/720]

= $1,000 – $917 (payment on CRRs – adjustment)

= $83

[8] For simplicity, we assume the marginal loss component of the LMPs at A and B are the same and therefore the price differential is assumed to reflect only congestion.

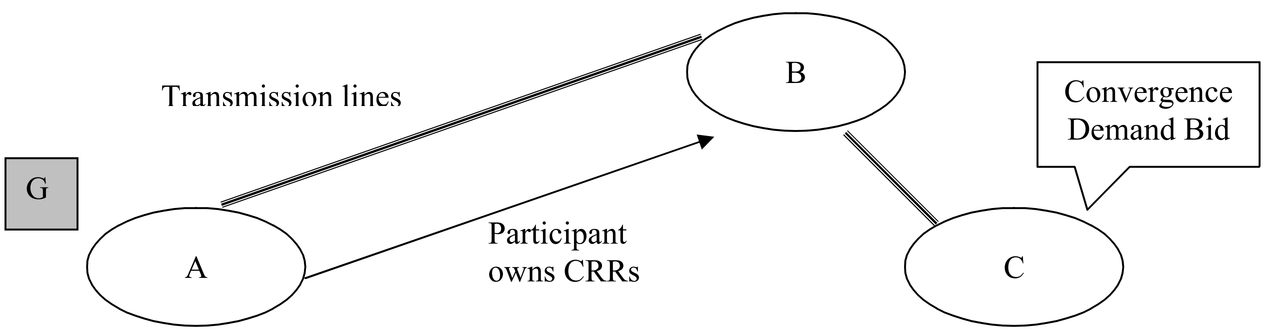
[9] Note that, in the event that the difference between the MCPs is less than the average hourly price of the CRRs, no adjustment would be made.

Definition of "Nearby" Nodes:

In a nodal virtual bidding scenario, it is important to consider that congestion might occur between Nodes A and B if the Participant strategically places convergence bids at nearby nodes. For example, say a Participant owning CRRs from Node A to Node B places a convergence demand bid (also known as a dec bid) at Node C. Depending on the transmission system and the location of generating plants, congestion may well be increased between Nodes A and B.

Below is a diagram of a situation in which a node, Node C, is isolated such that a convergence demand bid at Node C can only be met by additional generation from Node A, which will increase flows on the path between Nodes A and B. In this case, convergence demand bids at Node C could create congestion between Nodes A and B, thereby increasing the difference between the MCPs at Nodes A and B, and increasing CRR revenues.

Figure A-2 - Three-Node Example



In order to deter this sort of gaming, PJM extends the CRR settlement rule described above to busses "nearby" the delivery or receipt busses specified by the CRR. PJM Market Monitoring staff has clarified that busses that are "nearby" the delivery or receipt busses are identified based on "Shift Factors" or "Power Transfer Distribution Factors" (PTDFs).

Specifically, if there is congestion between a CRR's source and sink, and the owner of those Rights places a virtual supply bid on the low priced or unconstrained side, it is then paired with another location where a withdrawal occurred (by the CRR owner or any market participant). This reference location is the withdrawal location with the minimum Shift Factor. If the difference between the Shift Factor at the location of the virtual supply bid and the Shift Factor of the reference location is greater than or equal to +/- 75%, the location is considered near the constraint.

For example, if a virtual supply bid is placed at Node A, which has a 20% Shift Factor, and a withdrawal occurred in Node C, which has a the lowest Shift Factor of -55%, then difference between the two is 75%. This would trigger the application of the above-described settlement rule.

Conversely, if a virtual demand bid is placed on the high priced or constrained side, it is paired with the location with the maximum Shift Factor where an injection occurred (again, by the CRR owner or any other market participant). If the difference between the Shift Factor at the bid location and the Shift Factor at the reference injection location is greater than or equal to +/- 75%, the location is considered near the constraint.

For example, if a virtual demand bid is placed at Node C, which has a -55% Shift Factor, and an injection occurred at Node A, which has the maximum Shift Factor of 20%, the difference between the two is -75%. Again, this would trigger the application of the above-described settlement rule.

DMM believes the basic settlement rule described above could be applied to Option 3, with some modications to account for the fact that, under Option 3, virtual demand bids would be at a LAP level while virtual supply bids would be at a nodal level.