UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Coordination Across the Midcontinent Independent System Operator, Inc./PJM Interconnection, L.L.C. Seam	)))))	Docket No. AD14-3-000

REPLY TO REPLIES TO RESPONSES TO REQUEST FOR INFORMATION OF THE INDEPENDENT MARKET MONITOR FOR PJM

Pursuant to the notices issued on February 24 and May 19, 2015, and the Commission's Open Meeting convened January 22, 2015, Monitoring Analytics, LLC, acting in its capacity as the Independent Market Monitor for PJM ("Market Monitor"), submits this reply to the replies to the response of the MISO Independent Market Monitor ("MISO IMM") to the Commission's order issued February 24, 2015, requesting further information on interface pricing and other seams issues affecting PJM Interconnection, L.L.C. ("PJM") and the Midcontinent Independent System Operator, Inc. ("MISO").[1] [2]

I. REPLY

The MISO IMM's response addresses issues related to interface pricing: the Market Monitor's view on overpayment or overcharging for congestion on coordinated flowgates and the scaled version of the two-RTO dispatch model developed by the Market Monitor to

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[1] *Coordination Across the Midcontinent Independent System Operator, Inc./PJM Interconnection, L.L.C. Seam*, 150 FERC ¶ 16,132.

[2] *See* Reply of the Midcontinent ISO's Independent Market Monitor to Responses to Request for Information, Docket No. AD14-3 (June 15, 2015).

analyze the complex interaction between scheduled transactions and the interface pricing methodologies proposed by PJM and MISO and MISO IMM.

A. Problem Definition

While the MISO IMM has made general assertions about interface pricing issues (at 2), the MISO IMM has not demonstrated, either analytically or using a model, that the existence of the same coordinated flowgate in both PJM and MISO dispatch models will always and necessarily result in duplicative congestion settlements.

The central assertion made by the MISO IMM (at 3) is that the "expected congestion effect," which is the congestion component of LMP (CLMP) of the monitoring RTO's interface price for a coordinated flowgate, is the same as the "expected congestion effect," which is the congestion component of the LMP of the non-monitoring RTO's interface price, for the same coordinated flowgate.[3] This means, according to the MISO IMM, that the congestion is counted twice. This mathematical equivalency can only be established if the interface definition used by the monitoring RTO for its interface is identical to the non-monitoring RTO's load-weighted reference bus and shadow prices for the coordinated flowgate calculated by PJM and MISO are equal.[4] The MISO IMM recognizes this underlying principle, although the MISO IMM states (at 3) that "we have not made this assumption and it is in any case irrelevant." However, the MISO IMM states (at 5–6) that "We have proposed the monitoring RTO use an interface definition equal to the load-weighted reference bus of the non-monitoring RTO." This is an assumption of the MISO IMM and it is relevant.

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3 *See* Potomac Economics Joint and Common Market Update: Interface Pricing Flaw, Docket No. AD14-3 (January 22, 2015). The MISO IMM uses the term expected congestion effect as a synonym for congestion component of LMP.

4 *See* Technical Appendix.

The MISO IMM's proposal is to redefine the interface for both MISO and PJM to be as close as possible to the load-weighted reference bus of the neighboring RTO.[5] If the shadow prices of the coordinated flowgate calculated by both MISO and PJM also converge, the MISO IMM's definition of the interface ensures that the mathematical equivalency is fulfilled and is therefore the basis for the argument that there are duplicative congestion settlements.[6]

However, absent that definition of the interfaces, the equivalency does not exist and the basis for the assertions about duplicative settlements is not correct.

The MISO IMM argues (at 3) that the congestion LMPs calculated by both RTOs represent the "expected congestion effects" of transferring power from one RTO to the other and "if both RTOs are populating their interface price with the expected congestion effects on the same transaction," they result in duplication and hence result in inefficient incentives for transactions. However, the Market Monitor has shown that this is an oversimplification of the dispatch models.[7] The "expected congestion effect," which is the congestion component of the LMP (CLMP), can be expressed mathematically in terms its underlying components which include shadow prices and distribution factors. As shown in the attached Technical Appendix, the congestion effects are not the same as a result of the interface definitions that are currently implemented. The MISO interface definition is equally weighted PJM generation buses and is not the PJM load weighted reference bus.

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5 MISO presentation at PJM/MISO Joint and Common Market Initiative Meeting, Carmel IN, May 27, 2015, "Item 04 MISO Interface Pricing Approach Whitepaper," which can be accessed at: <*http://www.pjm.com/committees-and-groups/stakeholder-meetings/stakeholder-groups/pjm-miso-joint-common.aspx>.*

6 *See* the Technical Appendix.

7 *See* Response of the Independent Market Monitor to Request for Information, Docket No. AD14-3 (May 15, 2015).

The PJM interface definition is ten equally weighted buses close to the seam and is not the MISO load weighted reference bus.

The MISO IMM states (at 4) that the "points raised by PJM IMM seem to be intended to cast doubt on the existence of the interface pricing problem." The Market Monitor recognizes that the existing interface pricing approaches adopted by PJM and MISO can be improved. The Market Monitor continues to recommend that the long term solution reflect the locational marginal pricing that would result from a single LMP dispatch over the entire multi-RTO/ISO area. In the short term, the Market Monitor recommends PJM and MISO adopt PJM's proposal to redefine the MISO and PJM interfaces to a common set of buses close to the border between PJM and MISO.

B. PJM IMM Model

The Market Monitor believes that a comprehensive analysis of historical data would not be sufficient to analyze interface pricing issues. The prices at any given time reflect one distinct realization of various constantly changing variables including load, generators' ramp constraints, transmission outages, generator outages and operator actions. It is important to control for all the variables in order to assess the impact of interface definitions on prices and incentives. It is for this reason that the Market Monitor developed the scaled two-RTO dispatch model, which allows for isolating the impact of interface definitions on prices and incentives.

The MISO IMM asserts a number of problems with the model developed by the Market Monitor, none of which are correct:

1. The Model Properly Accounts for Market Flow between PJM and MISO.

The Market Monitor limited the scope of the model to include only two RTOs: PJM and MISO. In the Market Monitor's model, MISO, as the monitoring RTO, explicitly takes into account the power flows associated with PJM generation meeting PJM load (market flow) when managing congestion on the coordinated flowgate.

The MISO IMM claims (at 6) that the loop flows caused by "other systems around the two RTOs is one of the main reasons why the shift factor for a market-to-market constraint can change so significantly as the interface definition (the assumed source of power for an import) moves away from the seam." The MISO IMM provides no support for the claim that the current MISO definition of the PJM interface price, that includes all generation nodes in PJM, is superior in addressing loop flows from neighboring RTOs.

More importantly, the loop flows from other markets should be addressed not through the interface pricing mechanism between PJM and MISO, but through separate interface pricing arrangements between PJM, MISO and the other neighboring markets.

2. The Model Is A Scaled Model.

The PJM IMM model is a *scaled* version of the MISO-PJM region, so the differences will also be scaled, or "understated," as the MISO IMM puts it. Scaled models are a common approach to analyzing complex systems. They are particularly useful for creating controlled experiments that focus and isolate specific aspects of a system. The PJM IMM model is not intended to be used to determine actual prices or an executable dispatch. Its purpose is to identify effects of transaction scheduling and understand the implications of the various proposals under a variety of scenarios.

3. Market to Market Coordination Process is Correctly Modeled.

The market to market coordination process modeled in the Market Monitor's model is exactly as it is defined in the MISO-PJM JOA (2010).[8]

The monitoring RTO accounts for the market flows and determines the relief needed from the non-monitoring RTO. The relief MW and the shadow price determined by the

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8 *See* MISO-PJM Joint Operating Agreement, "Real-Time Energy Market Coordination" at 223–225, which can be accessed at <*https://www.misoenergy.org/Library/Repository/Tariff/Rate%20Schedules/Rate%20Schedule%2005%20-%20MISO-PJM%20JOA%20and%20CMP.pdf*> .

monitoring RTO are passed over to the non-monitoring RTO. The non-monitoring RTO incorporates the relief and shadow price in their dispatch model. This is done by setting the transmission limit of the coordinated flowgate equal to the current flow minus the relief requested from the non-monitoring RTO and allowing the flow on the coordinated flowgate to exceed its limit with a violation penalty equal to the shadow price passed over from the monitoring RTO. The M2M process used in the model is shared with MISO and PJM. The method is also described in the MISO-PJM JOA (2010).[9]

4. The Model Does Not Attempt to Represent Transaction Behavior.

The MISO IMM contends (at 8) that the model does not forecast transaction levels. That is correct. The scaled version of the two-RTO dispatch model developed by the Market Monitor simulates PJM and MISO's dispatch processes, the objective of which is to minimize their respective production costs. Both RTOs take into account offers from their generators, projected load, network conditions and transaction levels within the confines of joint operating rules covering interface management and congestion management of coordinated flowgates. The model does not attempt to model the transaction behavior of market participants.

5. Neither the PJM nor the MISO Market Clearing Processes Are Suitable to Study the Joint Dispatch Issue that the Model Is Designed to Analyze.

Real-time market outcomes are an inadequate basis for analyzing the complex interactions among scheduled transactions, congestion management on coordinated flowgates and interface definitions.[10] The MISO IMM claims (at 9) that the "… [actual

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9 *See* MISO-PJM Joint Operating Agreement, "Real-Time Energy Market Coordination" at 223–225, which can be accessed at <https://www.misoenergy.org/Library/Repository/Tariff/Rate%20Schedules/Rate%20Schedule%2005%20-%20MISO-PJM%20JOA%20and%20CMP.pdf> .

10 *See* Reply of the Midcontinent ISO's Independent Market Monitor to Responses to Request for Information, Docket No. AD14-3 (June 15, 2015).

market outcomes] are far superior because they allow one to directly compare the pricing implication of the PJM proposal versus the MISO IMM proposal." But the market outcomes are conditional on the existing interface definition and real time conditions at the moment. It is not possible to test the counterfactual proposals from MISO and PJM using data from the existing market which is by definition a result of the existing interface definitions.

II. CONCLUSION

The Market Monitor respectfully requests that the Commission afford due consideration to this pleading as the Commission considers the issues raised in this proceeding.

Respectfully submitted,

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Dated: July 2, 2015

CERTIFICATE OF SERVICE

I hereby certify that I have this day served the foregoing document upon each person designated on the official service list compiled by the Secretary in this proceeding.

Dated at Eagleville, Pennsylvania,
this 2nd day of July, 2015.

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TECHNICAL APPENDIX

The MISO IMM claims that the congestion component of LMP (CLMP) of the monitoring RTO's interface price for a coordinated flowgate is same as the congestion component of the LMP of the non-monitoring RTO interface price for the same coordinated flowgate. Therefore, according to this argument, any congestion charge included in the interface price of the non-monitoring RTO's interface price as a result of this constraint is redundant.

This technical appendix details the conditions needed for the above claim to be true.

Suppose MISO is the monitoring RTO for a coordinated flowgate and PJM is the non-monitoring RTO. MISO defines its PJM interface to include a subset of nodes in the PJM footprint.

The following equation defines the CLMP calculated for the MISO's PJM interface with respect to the coordinated flowgate constraint.

$$CLMP^M = \left(\sum_{i=1}^{n} Shift_i^M * w_i\right) * ShadowPrice^M \qquad (1)$$

Where

$i = 1,2 \ldots n$ represents nodes in the PJM footprint that MISO uses to define its PJM interface.

$Shift_i^M$ represents the shift factor for node i calculated by MISO with respect to its load weighted reference bus. For every 1 MW injected at node i, $Shift_i^M$ flows through the coordinated flowgate in the MISO's model.

w_i represents the weight associated with bus i such that $\sum_i w_i = 1$

$ShadowPrice^M$ represents the marginal value of the binding coordinated flowgate constraint, determined within the MISO's dispatch model.

The following equation defines the CLMP calculated for the PJM's MISO interface with respect to the coordinated flowgate constraint.

$$CLMP^P = \left(\sum_{j=1}^{m} Shift_j^P * u_j \right) * ShadowPrice^P \qquad (2)$$

Where

$j = 1,2 \ldots m$ represents the ten nodes in the MISO footprint that PJM uses to define its MISO interface.

$Shift_j^P$ represents the shift factor for node i calculated by PJM with respect to its load weighted reference bus. For every 1 MW withdrawn at node j, $Shift_j^P$ flows through the coordinated flowgate in the PJM's model.

u_j represents the weight associated with bus j such that $\sum_j u_j = 1$

$ShadowPrice^P$ represents the marginal value of the binding coordinated flowgate constraint, determined within the PJM dispatch model.

The MISO IMM argued that the $CLMP^M$ and $CLMP^P$ represent the same congestion effects. In order for the two CLMPs to represent the same congestion effect, the underlying components should be equal as well.

1. Conditions for $ShadowPrice^M$ = $ShadowPrice^P$

   Under the Joint Operating Agreement between PJM and MISO, both RTOs employ a mechanism to converge their shadow prices associated with coordinated flowgates. It should be noted that the convergence mechanism is designed to iteratively reduce the difference between shadow prices. In other words, if all parameters in the MISO and PJM dispatch models are frozen and only allow the shadow price to change using this mechanism, the shadow prices would be equal after multiple iterations. It is unlikely that the shadow prices will be equal at any specific point in time.

2. Conditions for aggregate shift factors to be equal

If the net scheduled transaction flow is from PJM to MISO, in the MISO's network model, the $Shift_i^M$ represents the proportion of the 1 MW injection at node i that flows through the coordinated flowgate and is withdrawn at MISO's load-weighted reference bus.

Similarly, if the net scheduled transaction flow is from PJM to MISO, in the PJM's network model, the $Shift_j^P$ represents the proportion of the 1 MW injected at PJM's load weighted reference bus that flows through the coordinated flowgate and withdrawn at node j, PJM's defined interface buses for MISO.

The conditions for the following to hold,

$$\left(\sum_{i=1}^{n} Shift_i^M * w_i\right) = \left(\sum_{j=1}^{m} Shift_j^P * u_j\right)$$

would require the following.

a. Both PJM and MISO should have identical network model: The shift factors of a network is a function of impedances and reference bus. The lines, connections that define the network and impedances should be identical.[11]

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[11] There is an exception. If MISO is the monitoring RTO for all coordinated flowgates, it would suffice to have only MISO powerflow model include both PJM and MISO networks.

b. The weights assigned to each node in the PJM load weighted reference bus should be the same as the weights assigned to each node in the MISO's PJM interface definition:

$Shift_i^M * w_i$ represents the proportion of the w_i MW injection at node i that flows through the coordinated flowgate and $\sum_{i=1}^{n} Shift_i^M * w_i$ represents the proportion of the total 1 MW of injection distributed across all the nodes $i = 1,2..n$.

$\sum_{j=1}^{m} Shift_j^P * u_j$ represents the proportion of the 1 MW injected at PJM's load weighted reference bus. Accordingly, $\left(\sum_{j=1}^{m} Shift_j^P * u_j\right) * w_i$ represents the proportion of w_i MW injection at node i that flows through the coordinated flowgate.

Therefore for the above aggregate shift factors to be equal, MISO's PJM interface should use exactly same set of nodes and weights used by PJM to define its load weighted reference bus.

Similarly, if PJM is the monitoring RTO for the coordinated flowgate, PJM's MISO interface should use exactly same set of nodes and weights used by MISO to define its load weighted reference bus.

These conditions are not met.