UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

PJM Interconnection, L.L.C.	)	Docket No. ER19-2722-005

COMMENTS OF THE INDEPENDENT MARKET MONITOR FOR PJM

Pursuant to Rule 211 of the Commission's Rules and Regulations,[1] Monitoring Analytics, LLC, acting in its capacity as the Independent Market Monitor ("Market Monitor") for PJM Interconnection, L.L.C. ("PJM"),[2] submits these comments responding to the compliance filing submitted by PJM Interconnection, L.L.C. ("PJM") on July 16, 2021 ("July 16th Filing"). The July 16th Filing was submitted in compliance with the order issued June 22, 2021.[3] The July 16th Filing includes the changes to the PJM Operating Agreement that PJM previously filed and that the Commission previously approved for implementation on July 1, 2021. The new implementation date is September 1, 2021.

The software and business rules that PJM plans to implement on September 1 do not price synchronized reserves in a manner consistent with the filed Operating Agreement incorporating the fast start changes (July 16th Filing).

The purpose of these comments is to explain why PJM's planned implementation is not consistent with the filed tariff (OA) or with the Commission's orders. The Market

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1 18 CFR § 385.211 (2020).

2 Capitalized terms used herein and not otherwise defined have the meaning used in the PJM Open Access Transmission Tariff ("OATT"), the PJM Operating Agreement ("OA") or the PJM Reliability Assurance Agreement ("RAA").

3 *See PJM Interconnection, L.L.C.*, 175 FERC ¶ 61,240 (2021) ("June 22nd Order").

Monitor requests clarification that PJM's planned implementation is not consistent with the filed Operating Agreement (July 16th Filing) or with the Commission's orders. The Market Monitor requests that the Commission direct PJM to implement fast start pricing only in a manner consistent with the Commission's orders.

I. BACKGROUND

On December 21, 2017, the Commission found PJM's treatment of fast start resources may be unjust and unreasonable because it did not automatically reduce (relax) the value of the economic minimum MW output limit ("Eco Min") of a fast start resource so that it would be eligible to set the energy market price ("LMP").[4] Units that cannot increase/decrease output are not eligible to set price. PJM's February 2018 Initial Brief asserted that a process known as integer relaxation would accomplish the same goal, to reduce/relax the Eco Min so that the fast start resource could set LMP. [5] But integer relaxation is not the same as reducing the Eco Min. Integer relaxation reduces both the Eco Min and the Eco Max limits of fast start resources.[6]

By order issued April 18, 2019, the Commission accepted the use of integer relaxation for LMP based on ease of implementation as argued by PJM, but the April 2019 Order did not address the differences in pricing that result from using integer relaxation rather than the relaxation of the Eco Min alone. In fact, the Commission explicitly stated that, in the Commission's interpretation of PJM's filing, fast start units would be dispatchable from zero to their economic maximum operating limit for the purpose of setting prices but does not state that the economic maximum would be reduced. [7]

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4 *PJM Interconnection, L.L.C.*, 161 FERC ¶ 61,295 at PP 1, 30–31.

5 Initial Brief of PJM Interconnection, L.L.C., Docket No. EL18-34 (February 12, 2018) at 7–9.

6 *See* PJM Initial Brief, Attachment A, Giacomoni Affidavit at P. 7.

7 *PJM Interconnection, L.L.C.*, 167 FERC ¶ 61,058 at PP 17, 53 ("April 2019 Order"). "While we recognize the PJM Market Monitor and Joint Commenters' argument that PJM's software already

Operating Agreement Schedule 1, Section 3.2.3A(d) states that the synchronized reserve market clearing price ("SRMCP") includes two components: the reserve offer price and the lost opportunity cost.[8] To the extent that the LMP is incorporated in the synchronized reserve market clearing price ("SRMCP"), through the lost opportunity cost ("LOC") component, a higher SRMCP is expected to result from application of fast start pricing to the LMP and is consistent with the OA.

The July 16th Filing does not include any changes to the definition of the SRMCP, so when the LOC is zero, fast start pricing should not affect the calculation of the SRMCP. As described in the PJM Operating Agreement, when LOC is zero, the SRMCP equals the reserve offer of the marginal resource for synchronized reserve.

II. COMMENTS

A. PJM Plans to Apply Fast Start Pricing to Reserve Prices in Some Circumstances.

PJM's planned implementation of fast start pricing for September 1, 2021, will, under certain circumstances, include a component in the SRMCP that is not defined in the OA, the amortized start up and no load of the marginal resource for reserves.[9] The planned implementation will set the SRMCP equal to the sum of the reserve offer and the amortized start up and no load for a marginal reserve resource with an Eco Max that exceeds its Eco

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allows some degree of economic minimum operating limit relaxation, we find that PJM has adequately explained why integer relaxation will be easier to implement. Accordingly, we direct PJM to implement its proposed integer relaxation approach for fast-start resources so that fast-start resources are able to set prices similar to how they would if the resources were considered dispatchable from zero to their economic maximum operating limit for the purpose of setting prices."

8 OA Schedule 1 § 3.2.3A(d).

9 PJM's Initial Brief proposed applying integer relaxation to block loaded reserve units, like synchronous condensers. The April 2019 Order rejected this proposal as out of scope. PJM does not plan to implement fast start pricing for block loaded reserve units.

Min when it clears the pricing run at a MW less than its Eco Max. The addition of the amortized start up and no load to the reserve offer is not required for fast start pricing. The impact on reserve prices is the result of using integer relaxation rather than relaxing only the Eco Min. Integer relaxation reduces both the Eco Min and the Eco Max of the fast start resource, but the only requirement for fast start pricing is the reduction of the Eco Min.

1. Mathematical Explanation

The mathematical method used by integer relaxation introduces a commitment variable that can take on any fractional value between zero and one, instead of being restricted to the integer values of zero and one. In reality, the resource commitment decision is an integer decision. The resource is either committed, and the commitment variable equals one, or the resource is not committed, and the commitment variable equals zero. This is how the commitment variable works under the current PJM market design and in the dispatch run under fast start pricing. The following constraint must hold:

$$Commit * EcoMin \leq Energy\ MW + Reserve\ MW \leq Commit * EcoMax$$

where *Commit* is the commitment variable. For the dispatch run and the current market design, *Commit* takes on one of two integer values (either 0 or 1):

$$\text{Dispatch Run: } Commit \in \{0,1\}$$

For the pricing run, *Commit* can vary from zero to one:

$$\text{Pricing Run: } 0 \leq Commit \leq 1$$

The commitment variable for eligible fast start resources is determined by the market cost minimizing optimization in the pricing run, as are the energy MW and reserve MW.

In the pricing run solution, the optimization solves such that the commitment variable equals the share of Eco Max MW cleared for energy and reserves for the fast start unit that is marginal for reserves:

$$Commit = \frac{Energy\ MW + Reserve\ MW}{EcoMax}$$

To increase energy or reserve MW, the commitment variable must be increased.

In the formulation of the system production cost objective function, the commitment variable is multiplied by the commitment cost. When the commitment variable is between zero and one for a fast start unit that is marginal in the energy market, the commitment cost divided by the eco max (amortized start up and no load) is added to the LMP:

$$LMP = \frac{Commitment\ Cost}{EcoMax} + Incremental\ Energy\ Cost$$

This is the result intended by FERC's order. When the commitment variable is between zero and one for a fast start unit that is marginal in the reserve market, the commitment cost divided by the eco max (amortized start up and no load) is added to the synchronized reserve market clearing price (SRMCP):

$$SRMCP = \frac{Commitment\ Cost}{EcoMax} + Reserve\ Offer + LOC$$

This result was not intended by FERC's order. This result was not included in PJM's compliance filings.

In the case where the commitment variable is less than one, lost opportunity cost is zero:

$$\text{If } Commit < 1, LOC = 0.$$

In fact, *LOC* can only be positive when the commitment variable is equal to one:

$$If\ LOC > 0, Commit = 1.$$

This is because an LOC greater than zero means there is a tradeoff between energy and reserves for the marginal resource such that the resource must reduce a MW of energy to provide another MW of reserves. This only occurs when the resource clears its full Eco Max between energy and reserves, which requires a commitment variable equal to one.

The amortized commitment cost is added to the SRMCP when the commitment variable is less than one because the pricing run must increase the commitment variable to clear an additional MW of reserves from the resource. When the commitment variable increases, the pricing run objective function increases by the amortized commitment cost of the marginal resource for reserves. Typically, this will be a resource that PJM deselected

from providing tier 1 reserves that is clearing tier 2 reserves. The same issue may affect regulation market clearing prices.

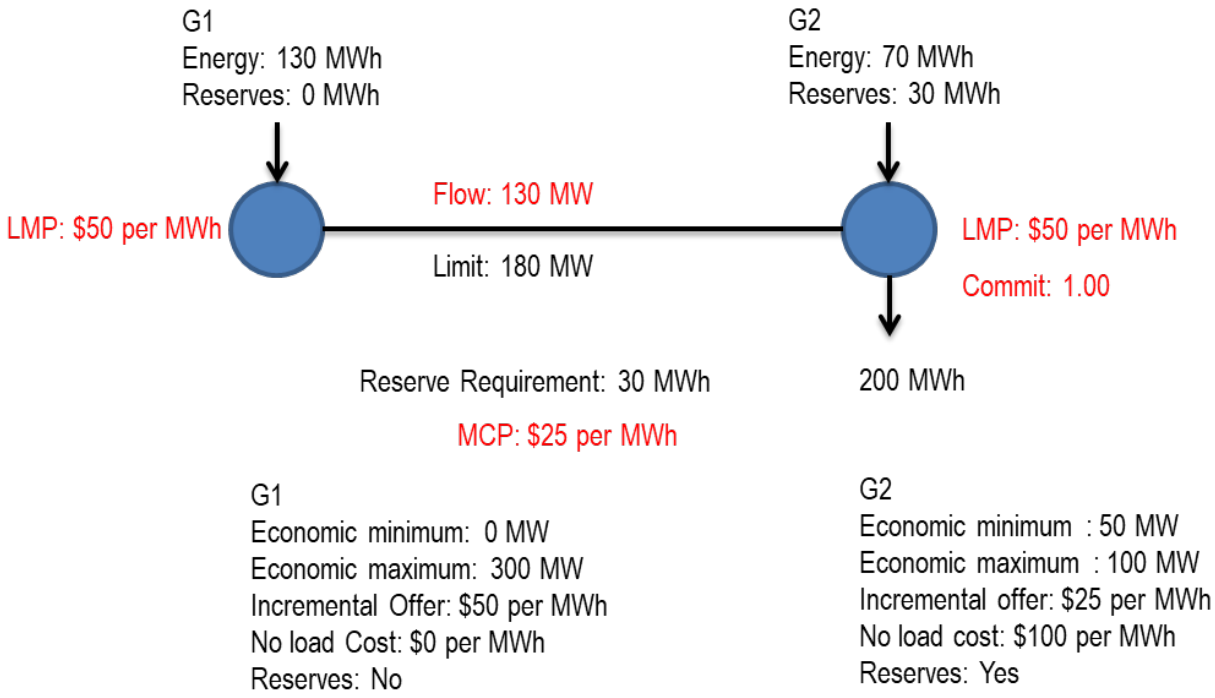
B. Examples

1. Fully Committed Fast Start Unit, Reserve Price Includes Lost Opportunity Cost

Consider, for example, a two bus model shown in Figure 1. Generator G1 can provide 300 MW at a price of $50 per MWh. G1 has no commitment costs and cannot provide reserves. Generator G2 lies at the opposite end of a transmission constraint with a limit of 180 MW. All of the 200 MW of load is at the location with G2. G2 is a fast start unit that can provide a minimum of 50 MW and a maximum of 100 MW at an incremental energy offer of $25 per MW. G2 also has a $100 per hour no load cost. G2 provides both energy and reserves. The less expensive G2 cannot meet the 200 MW of load and a reserve requirement of 30 MW alone.

In this case, the fast start unit is the less expensive generator for energy, even including the amortized no load cost. As a result, the constraint does not bind, and LMP equals the marginal cost of G1, which is $50 per MWh. The market uses G2 to meet the 30 MW reserve requirement and its other 70 MW for least cost energy. The fast start resource is fully committed, so the commitment variable equals one. The reserve market clearing price equals G2's lost opportunity cost, the $50 per MWh LMP minus the $25 per MWh incremental cost, which is $25 per MWh. This market outcome is consistent with PJM's OA.

Figure 1 Two bus model example fast start unit with lost opportunity cost



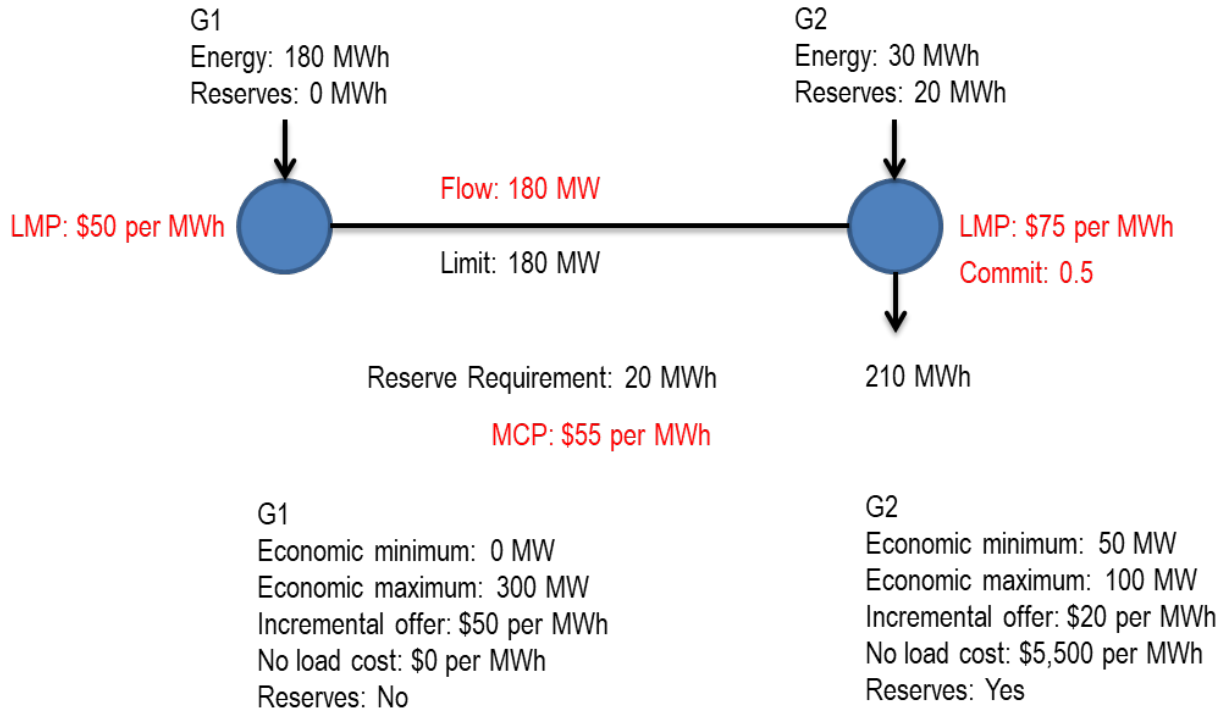
2. Partially Committed Fast Start Unit, Reserve Price Includes Amortized Commitment Costs

Now consider a more expensive fast start resource, higher load, and a lower reserve requirement as shown in Figure 2. If G2 has an incremental energy offer of $20 per MWh and a no load cost of $5,500 per hour, the pricing run will not fully commit it. In this example, load is 210 MW and the reserve requirement is 20 MW. All other market inputs remain the same.

The pricing run adds the amortized no load cost, $5,500 per hour divided by the 100 MW Eco Max ($55 per MWh), to the incremental energy cost of G2. With the more expensive G2, the pricing run will use all the energy from G1 until the constraint is binding at 180 MW. G2 will clear 50 MW, 30 MW for energy and 20 MW for reserves. The commitment variable equals 0.5. On the margin, an additional MWh of energy requires increasing the output of G2, which means increasing the commitment variable and incurring the amortized no load cost along with the incremental energy cost. Therefore, LMP at G2 equals $20 per MWh plus $55 per MWh, which is $75 per MWh. The same

applies to reserves. On the margin, an additional MW of reserves requires increasing the commitment variable and incurring the amortized no load cost along with the reserve offer price, which is zero in this case. Therefore, the SRMCP equals $55 per MW. G2 has no lost opportunity cost because it can increase reserve MW without reducing energy MW. Instead, the price is determined by the application of integer relaxation to the Eco Max of the resource. This market outcome is not consistent with PJM's OA.

Figure 2 Two bus model with partially committed fast start unit



C. Fast Start Pricing Would Not Apply to Reserve Prices Under the Commission's Original Fast Start Pricing Proposal.

In the December 2017 Order, the Commission preliminarily found that PJM should relax the Eco Min of fast start resources.[10] With relaxation of only the Eco Min, the amortized commitment costs would not be added to the SRMCP. It is the relaxation of the

[10] December 2017 Order at PP 14-15.

Eco Max due to integer relaxation that causes this to occur. In requesting that the Commission approve its use of integer relaxation for fast start pricing, PJM did not explain that this would have a significantly different impact on pricing than just relaxing the Eco Min.[11] The PJM Initial Brief referenced MISO's use of integer relaxation, which is well defined in MISO's tariff and explicitly explains that integer relaxation applies fast start pricing to reserve prices.[12] The July 16th Filing does not include such an explanation. PJM did not explain to the Commission that its use of integer relaxation would have any pricing affects other than those resulting from the reduction of the Eco Min of eligible fast start resources. PJM did not file changes to the OA to add a new component to the SRMCP.

Therefore, the Market Monitor requests clarification that PJM's planned implementation is not consistent with the filed Operating Agreement (July 16th Filing) or with the Commission's orders.

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11 PJM Initial Brief at 5-9.

12 MidContinent ISO, "ELMP for Energy and Operating Reserve Market: Ex-Post Pricing Formulations," OATT Schedule 29-A, accessed August 5, 2021, <https://docs.misoenergy.org/legalcontent/Schedule_29-A_-_ELMP_for_Energy_and_Operating_Reserve_Market.pdf>.

III. CONCLUSION

The Market Monitor respectfully requests that the Commission afford due consideration to these comments as it resolves the issues raised in this proceeding.

Respectfully submitted,

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Dated: August 6, 2021

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 6th day of August, 2021.

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