UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

LS Power Development, LLC, **Complainant,** **v.** **PJM Interconnection, L.L.C. and Monitoring Analytics, LLC, as the Independent Market Monitor for PJM,** **Respondents.**	))))))))))))	**Docket No. EL24-____-000**

COMPLAINT OF LS POWER DEVELOPMENT, LLC

Pursuant to Sections 206 and 306 of the Federal Power Act (the "FPA"),[1] and Rule 206 of the Rules of Practice and Procedure of the Federal Energy Regulatory Commission (the "Commission"),[2] LS Power Development, LLC, on behalf of itself and its affiliates and subsidiaries owning or operating generation facilities in the PJM Interconnection, L.L.C. ("PJM") region (together, "LS Power"), files this complaint (this "Complaint") concerning the calculation of opportunity cost adders ("OCAs") under Schedule 2 to PJM's Amended and Restated Operating Agreement (the "Operating Agreement")[3] and provisions of PJM Manual 15.[4] As described herein and in the affidavits of (1) Benjamin W. Griffiths, Vice President, Regulatory Policy, of LS Power

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1 16 U.S.C. §§ 824e, 825e (2018).

2 18 C.F.R. § 385.206 (2023).

3 Capitalized terms not otherwise defined herein have the meaning set forth in the Operating Agreement or if not therein defined, PJM's Open Access Transmission Tariff (the "Tariff").

4 PJM, PJM Manual 15: Cost Development Guidelines (Revision: 44, Aug. 1, 2023) ("Manual 15"), https://pjm.com/-/media/documents/manuals/m15.ashx.

(the "Griffiths Affidavit") (Attachment A), (2) Paul M. Sotkiewicz, Ph.D., President and Founder of E-Cubed Policy Associates, LLC and former Chief Economist in the Market Service Division of PJM (the "Sotkiewicz Affidavit") (Attachment B), and (3) Jeffrey D. McDonald, Ph.D., former Vice President, Market Monitoring at ISO New England ("ISO-NE") (the "McDonald Affidavit") (Attachment C),[5] PJM's current OCA rules fail to provide market participants with necessary transparency and predictability with respect to the calculation of OCAs, or any means of seeking effective and timely relief with respect to erroneous OCAs. This, in turn, can lead (and in LS Power's experience, has led) to inaccurate OCAs that fail to properly reflect the full opportunity costs of generation facilities with run-hour limitations, where operating now means foregoing the opportunity to operate in a future time period when prices are higher. Inaccurate OCAs thus impede price formation, resulting in sub-optimal dispatch of resources, to the detriment not just of individual suppliers but the reliability of the PJM system as a whole.

The Commission should therefore (1) find that PJM's implementation of provisions relating to OCAs under the Operating Agreement is unjust and unreasonable; (2) order PJM and Monitoring Analytics, LLC, the Independent Market Monitor for PJM (the "IMM"), to work with stakeholders to make necessary improvements to the opportunity cost calculator currently used by the IMM to calculate OCAs (the "IMM Calculator" or "Opportunity Cost Calculator"), and (3) require PJM to make and file necessary modifications to the procedures for OCA determinations as set forth in PJM's Operating Agreement and Manual 15 as described herein. In addition, given the serious harm from inaccurate OCAs as discussed herein, LS Power respectfully requests that the Commission act expeditiously on this Complaint.

[5] At the time when the McDonald Affidavit was written and finalized in late February 2024, Dr. McDonald was Vice President with Concentric Energy Advisors ("Concentric"). Dr. McDonald has since left Concentric and assumed a new position.

I.

CORRESPONDENCE AND COMMUNICATIONS

LS Power requests that all correspondence and communications regarding this Complaint be addressed to the following persons, who should be placed on the Commission's official service list in this proceeding:

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II.

DESCRIPTION OF COMPLAINANT AND RESPONDENTS

A. LS Power

Through subsidiaries and affiliates, LS Power develops, owns, and operates independent power projects and merchant transmission projects in the United States, including generation facilities in the PJM market.

B. PJM

PJM is the regional transmission organization ("RTO") for all or part of 13 states and the District of Columbia. PJM operates organized wholesale electricity markets and manages the high-voltage electricity grid to ensure reliability for more than 65 million people.

C. The IMM

The IMM acts as the independent Market Monitoring Unit for PJM under Section 35.28 of the Commission's regulations,[6] and the Market Monitoring Plan set forth in Attachment M of the PJM Tariff.

III.

BACKGROUND

A. Offer Caps in PJM

Under Section 6.4.1 of Schedule 1 to the Operating Agreement and Schedule K – Appendix to the Tariff, PJM will impose offer price caps on a supplier when the "three pivotal supplier" market power test is failed – *i.e.*, "when, for any given hour, the generation supplier is one of three or fewer generation suppliers available for redispatch that are jointly pivotal with respect to a transmission limit."[7] Section 6.4.2 also establishes the relevant offer caps, providing, among other things, that:

> For offers of $2,000/MWh or less, [the offer cap shall be] the incremental operating cost of the generation resource as determined in accordance with Schedule 2 of the Operating Agreement and the PJM Manuals ("incremental cost"), plus up to the lesser of 10% of such costs or $100 MWh, the sum of which shall not exceed $2,000/MWh; and, for offers greater than $2,000/MWh, [the offer cap shall be] the incremental cost of the generation resource.[8]

Schedule 2 to the Operating Agreement, in turn, sets forth the types of costs that may be included in cost-based offers. As relevant here, Schedule 2 expressly states that "Permissible

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[6] 18 C.F.R. § 35.28(b)(7) (2023).

[7] *PJM Interconnection, L.L.C.*, 126 FERC ¶ 61,145 at P 6 (2009) (the "February 2009 Order") (also noting that "[a]nother aspect of this screen is that PJM subjects to mitigation any generation unit whose owner, when combined with the two largest other generation suppliers, is jointly pivotal, not merely the three largest suppliers").

[8] Operating Agreement, Schedule 1, § 6.4.2; Tariff, Attachment K – Appendix, § 6.4.2.

Components of Cost-based Offers of Energy" may include "Opportunity Costs," which, for a generation facility that is subject to operational limitations under applicable laws, are intended to reflect the foregone value of running in one period instead of in a later period with higher energy market prices.[9]

B. Development of Rules Providing for Inclusion of Opportunity Costs in Cost-Based Offers

In 2008, the Commission issued an order addressing PJM's then-effective market power mitigation rules, which established a paper hearing to examine the justness and reasonableness of the three pivotal supplier test and determine whether the three pivotal supplier test "could result in imposing offer caps more often than is justified."[10] As relevant here, various parties submitted evidence in the paper hearing demonstrating that there were problems with PJM's then-effective offer cap rules because they did not provide for the recovery of opportunity costs. For example, a group of suppliers, supported by an affidavit from Scott M. Harvey, Ph.D., explained that PJM's rules resulted in offers being "cost-capped at a price that does not recognize the energy limits" imposed on generation resources by applicable regulations.[11] This "failure to consider run limitations in the mitigated cost of generators could result in the unit being dispatched economically during non-shortage hours," meaning that "run limited units could be dispatched in hours when the resource is not essential for reliability, potentially foreclosing the possibility for such units to be dispatched later, during times of resource scarcity."[12] Moreover, because resources

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9 Operating Agreement, Schedule 2, § 1.1. *See also* Sotkiewicz Affidavit at ¶¶ 13-16.

10 *Maryland Pub. Serv. Comm'n v. PJM Interconnection, L.L.C.*, 123 FERC ¶ 61,169 at P 59, *on reh'g*, 125 FERC ¶ 61,340 (2008).

11 Brief of the Coalition of Indicated PJM Suppliers on the PJM Three Pivotal Supplier Structural Market Power Test at 25, Docket Nos. EL08-34-000, *et al.* (filed Oct. 6, 2008) ("EL08-47 Indicated Suppliers Brief") (footnote omitted).

12 *Id.* (footnote omitted).

with Reliability Pricing Model ("RPM") capacity obligations were (and continue to be) subject to must-offer requirements, "[o]wners of run limited units may then be motivated to remove the generator as a capacity resource, foregoing RPM payments so that the unit might capture peak hour energy rents."[13]

At the conclusion of the paper hearing, the Commission concluded that "there is not sufficient evidence to meet the [FPA] section 206 burden to show that the three-pivotal-supplier test … is unjust and unreasonable as it relates to assessing the structural competitiveness of the PJM energy market."[14] At the same time, the Commission held that "the application of the related price mitigation measures is unjust and unreasonable because the measures do not clearly define and fully account for the inclusion of unit-specific opportunity costs in mitigated offer prices."[15] In particular, the Commission explained that,

> because default bids do not clearly and explicitly provide for the inclusion of opportunity costs, especially for energy and environmentally-limited resources, the mitigation measures related to determining default bids are unjust and unreasonable. With retention of the three-pivotal-supplier test, we agree that it is critical to assure that mitigation measures account for opportunity costs, while not violating the environmental limitations.[16]

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13 *Id. See also id.* at 25-26 (stating that "[t]he incentive to make run limited units into 'energy only' resources could result [in] driving up capacity costs as such units exit the capacity market" (footnote omitted)); *id.*, Affidavit of Scott M. Harvey, Ph.D. on Behalf of the Coalition of Indicated PJM Suppliers at 19-21 (discussing same).

14 February 2009 Order, 126 FERC ¶ 61,145 at P 1.

15 *Id.*

16 *Id.* at P 42. *See also id.* at P 40 ("PJM states that its market rules do not fully account for opportunity costs related to emissions or other environmental limits, and acknowledges that such costs are valid, and are likely to become more significant as generators encounter more operational limits due to environmental constraints. As a result, PJM recommends that the Commission direct the stakeholders to consider possible changes to the PJM Tariff as necessary to reflect opportunity costs, specifically relating to environmental limitations.").

The Commission therefore directed PJM to make a compliance filing providing for "the incorporation of opportunity costs in mitigated offers."[17]

PJM's initial filing to comply with the February 2009 Order was rejected because the Commission found that "PJM's tariff proposal fails to provide sufficient detail to establish a just and reasonable methodology for including opportunity costs in mitigated rates…."[18] The Commission explained:

> PJM's proposed tariff provision provides only for inclusion of a resource's unit-specific opportunity costs, "in accordance with the procedures prescribed in the PJM Manuals." But PJM's Tariff does not describe the methodology for calculating opportunity costs, and the Manuals were not completed at the time of the filing. While relying on Manuals to develop implementation details and mechanics of implementation may be acceptable, the methodology to be applied in determining the relevant opportunity costs needs to be sufficiently described in the tariff.[19]

The Commission therefore directed PJM to make another compliance filing to provide additional details regarding the inclusion of opportunity costs.[20]

In April 2010, PJM made a filing with revisions to Schedule 2 of the Operating Agreement to comply with the March 2010 Order,[21] which included modifications to PJM's Manual 15

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[17] *Id.* at P 48. *See also PJM Interconnection, L.L.C.*, 127 FERC ¶ 61,188 at P 7 (2009) (clarifying that PJM's compliance filing in response to the February 2009 Order should not be "limited to opportunity costs related to energy and environmentally-limited resources," and that, "[a]s PJM recognizes, the references to these two types of cost in the order were by way of example, and PJM needs to consider all legitimate and verifiable opportunity costs as part of its stakeholder process and its compliance filing" (footnote omitted)).

[18] *PJM Interconnection, L.L.C.*, 130 FERC ¶ 61,230 at P 16 (2010) (the "March 2010 Order").

[19] *Id.* at P 17.

[20] *See id.* at Ordering Paragraph (A).

[21] Compliance Filing, Docket No. EL08-47-005 (filed Apr. 22, 2010) (the "April 2010 Filing").

providing certain additional details regarding the calculation of opportunity costs.[22] PJM also stated:

> To assist Market Participants in calculating Energy Market Opportunity Costs, PJM designed a computer based calculator, called the eMKT Opportunity Cost Calculator, that Market Participants will be able to use to compute their opportunity costs associated with an externally imposed run-hour restriction on a generating unit. This calculator may be accessed by logging on to PJM's eTools at the eSuite login….[23]

On October 25, 2010, the Commission issued an order accepting the April 2010 Filing as "provid[ing] sufficient detail to establish a just and reasonable methodology for including opportunity costs in mitigated offer prices…."[24]

With the revisions proposed in the April 2010 Filing and accepted in the October 2010 Order, Schedule 2 to the Operating Agreement expressly states that all generating units are permitted to recover their opportunity costs.[25] Section 5 of Schedule 2 also sets forth certain requirements regarding the determination of the opportunity cost component of a cost-based offer. Among other things, Section 5 recognizes that generators that have restrictions on their hours of operations due to applicable laws should be permitted to reflect their opportunity costs in their offers, stating:

> For a generating unit that is subject to operational limitations due to energy or environmental limitations imposed on the generating unit by Applicable Laws and Regulations, the Market Participant may include a calculation of its "Opportunity Costs" which is an amount reflecting the unit-specific Energy Market Opportunity Costs

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22 *See id.*, Transmittal Letter at 13 ("PJM's extensive stakeholder and PJM Board-approved revisions to Section 8 of PJM Manual 15, reflected in blackline in Attachment C hereto, thoroughly describe PJM's proposed methodology for calculating Energy Market Opportunity Costs."). *See also id.* at 10-13 (explaining that additional modifications to Manual 15 would be required if the Commission approved the April 2010 Filing).

23 *Id.* at 13.

24 *PJM Interconnection, L.L.C.*, 133 FERC ¶ 61,081 at P 1 (2010) (the "October 2010 Order").

25 *See* Operating Agreement, Schedule 2, § 1.1.

> expected to be incurred. Such unit-specific Energy Market Opportunity Costs are calculated by forecasting Locational Marginal Prices based on future contract prices for electricity using PJM Western Hub forward prices, taking into account historical variability and basis differentials for the bus at which the generating unit is located for the prior three year period immediately preceding the relevant compliance period, and subtract therefrom the forecasted costs to generate energy at the bus at which the generating unit is located, as specified in more detail in PJM Manual 15. If the difference between the forecasted Locational Marginal Prices and forecasted costs to generate energy is negative, the resulting Energy Market Opportunity Cost shall be zero. Notwithstanding the foregoing, a Market Participant may submit a request to PJM for consideration and approval of an alternative method of calculating its Energy Market Opportunity Cost if the standard methodology described herein does not accurately represent the Market Participant's Energy Market Opportunity Cost.[26]

For these purposes, the Operating Agreement defines "Energy Market Opportunity Cost" as:

> the difference between (a) the forecasted cost to operate a specific generating unit when the unit only has a limited number of available run hours due to limitations imposed on the unit by Applicable Laws and Regulations and (b) the forecasted future Locational Marginal Price at which the generating unit could run while not violating such limitations. Energy Market Opportunity Cost therefore is the value associated with a specific generating unit's lost opportunity to produce energy during a higher valued period of time occurring within the same compliance period, which compliance period is determined by the applicable regulatory authority and is reflected in the rules set forth in PJM Manual 15. Energy Market Opportunity Costs shall be limited to those resources which are specifically delineated in Operating Agreement, Schedule 2.[27]

C. PJM's Manual 15

As explained above, the Operating Agreement provides that details regarding the calculation of opportunity costs are set forth in Manual 15, and PJM's April 2010 Filing also included revisions to Manual 15 providing information regarding the methodology that PJM

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26 *Id.*, § 5(a).

27 Operating Agreement, § 1, OA Definitions E—F; Tariff, § 1, OATT Definitions E—F.

proposed to use to calculate OCAs. Since the April 2010 Filing, the portions of Manual 15 addressing recovery of opportunity costs have undergone various modifications. While Manual 15 continues to recognize that Energy Market Opportunity Costs may be included in cost-based offers,[28] it now describes two methods for computing opportunity costs: (1) the first method (the "PJM Calculator"), is set forth in Sections 12.3 through 12.6 of Manual 15; and (2) the second method, the IMM Calculator, is described in Section 12.7 of Manual 15.

1. <u>The PJM Calculator and Its Suspension</u>

The PJM Calculator is described in Sections 12.3 through 12.6 of Manual 15 in some detail. These provisions were attached to the April 2010 Filing, and this methodology was employed for about a decade. Although these provisions remain in Manual 15, Section 12.1 makes clear that the PJM Calculator "described in Section 12.3 through 12.6 of this manual is suspended as of June 1, 2020," and that "Market Sellers that wish to include an Opportunity Cost in a unit's cost based offers should use the [IMM Calculator] described in Section 12.7 of this manual."[29] Accordingly, at this time, sellers wishing to include an OCA in their offers do not have the option of using the PJM Calculator and must instead use the IMM Calculator.

2. <u>The IMM Calculator</u>

Section 12.7 of Manual 15 outlines how the IMM will compute OCAs, stating that the IMM Calculator is "a constrained optimization software application independently developed and owned by Monitoring Analytics, LLC."[30] The IMM Calculator attempts to calculate "the marginal

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[28] *See* Manual 15, § 12.2.1 (stating that Energy Market Opportunity Costs are "associated with an externally imposed environmental run-hour restriction on a generation unit. Examples would include a limit on emissions for the unit imposed by a regulatory agency or legislation, a direct run hour restriction in the operating permit, or a heat input limitation defined by a regulatory decision or operating permit.").

[29] *Id.*, § 12.1.

[30] *Id.*, § 12.7.

value of the foregone opportunity to earn higher profits for an environmentally or operationally constrained unit."[31] To perform this calculation, the model "selects the hours of operation that will maximize the generator's energy market revenue net of the generator's short run marginal cost of producing energy, subject to the unit specific environmental or operational limits," and then calculates a "shadow price corresponding to the binding environmental or operational limit," which is "the marginal decrease in the net revenue due to a one hour equivalent decrease in the binding environmental or operational limit."[32]

Manual 15 states that "[i]nputs into the [IMM Calculator] will include unit specific forward LMPs based on futures prices, unit specific forward fuel prices based on futures or contract prices, and unit specific operating parameters."[33] As described in Manual 15 and in the Griffiths Affidavit, some of these inputs are based on publicly available information, and some of these are based on information provided by the seller.[34] The IMM Calculator uses three sets of IMM-estimated forward LMPs and forward delivered fuel prices to calculate the seller's opportunity costs, and then calculates an OCA, which is "the average of the three opportunity cost values corresponding to the three sets of forward LMPs and forward delivered fuel prices."[35]

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31 *Id.*, § 12.7.1 (footnote omitted). *See also id.*, § 12.7.6 ("For resources with a single compliance period (e.g. calendar year), the opportunity cost is the shadow price corresponding to the binding environmental or operational limit. For resources with rolling compliance periods, the opportunity cost is the shadow price corresponding to the earliest binding environmental or operational limit. The shadow price is defined as the marginal decrease in the net revenue due to a one hour equivalent decrease in the binding environmental or operation limit.").

32 *Id.*, § 12.7.1.

33 *Id.*

34 *See id.*, §§ 12.7.2 – 12.7.5; Griffiths Affidavit at ¶ 9.

35 Manual 15, § 12.7.6.

Section 12.7 of Manual 15 indicates that the IMM may make changes to the IMM Calculator at any time, and contemplates only limited review of the IMM Calculator by PJM on an annual basis. Specifically, Section 12.7 provides:

> Any changes to the [IMM Calculator] must be approved by Monitoring Analytics, LLC. The IMM will notify PJM of any significant changes to the [IMM Calculator] and any such changes will be reflected in updates to Manual 15 Section 12.7. PJM will review any such changes to verify that the [IMM Calculator] continues to meet the requirements of Schedule 2 of the Operating Agreement.
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> On an annual basis, PJM will review the inputs and results of the [IMM Calculator] in consultation with the IMM to verify that the [IMM Calculator] continues to meet the documented requirements.[36]

D. LS Power's Experiences with OCAs in PJM

LS Power owns various generating resources in PJM that have RPM capacity obligations and that are therefore required to submit daily offers into the PJM energy market.[37] LS Power's resources are subject to air permit emissions limits and are therefore entitled to include OCAs in their cost-based offers under the Operating Agreement and Tariff. Over the past two years, however, LS Power has repeatedly encountered problems with the OCAs determined using the IMM Calculator and has repeatedly found itself unable to obtain effective and timely relief with respect to those OCAs. As discussed in greater detail below and in the Griffiths and Sotkiewicz Affidavits, while there can be legitimate disagreements about how OCAs should be calculated, there were serious errors in the OCAs generated by the IMM Calculator that took the IMM months to acknowledge, and that resulted in LS Power's units being forced to submit offers that did not properly reflect their opportunity costs for extended periods of time. This caused the units to use

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36 *Id.*, § 12.7.

37 *See* Tariff, Attachment K – Appendix, § 1.10.1A(d).

up their limited run hours when prices were lower and being unable to operate when prices were higher, meaning that LS Power was not just financially harmed but, as Dr. Sotkiewicz explains, that the units were not available when prices indicated a greater system need for them to maintain reliability.

The Griffiths Affidavit discusses at length LS Power's concerns regarding the OCAs determined by the IMM Calculator and the roadblocks LS Power encountered in attempting to resolve such concerns. First, beginning in April 2022, LS Power began to have concerns regarding the IMM's determinations of OCAs for its units in the Commonwealth Edison Company ("ComEd") Zone, which are subject to stringent emissions limits under the Illinois Climate and Equitable Jobs Act ("CEJA"). As relevant here, CEJA limits the emissions of carbon dioxide ("CO_2"), as well as a wide array of other co-pollutants such as carbon monoxide ("CO"), sulfur dioxide ("SO_2"), nitrous oxides ("NOx"), and particulate matter ("PM").

As Mr. Griffiths explains, at that time, there were substantial differences between the IMM's OCA calculations and LS Power's internal estimates, with LS Power's estimates being five times or more higher than the IMM's calculations, a difference of more than $40/MWh. LS Power did not, however, have any insight regarding the cause of these differences. In this respect, it bears emphasis that the IMM Calculator itself is not shared with market participants and, as described in more detail in Section IV.B.1 below, Manual 15 also does not contain adequate information for a market participant to fully understand how the IMM Calculator works.[38] In addition, the IMM does not provide a seller with details on the OCA determinations for the seller's units. Instead,

38 *See* Sotkiewicz Affidavit at ¶¶ 54-67.

sellers like LS Power only receive the IMM's final OCA determination, a single numerical value for each unit, with no way to fully understand how these calculations were derived.[39]

In light of the lack of information regarding the IMM Calculator, Mr. Griffiths created his own model in an attempt to replicate the IMM's calculations and understand how the IMM's OCAs had been derived. Mr. Griffiths explains that, while the Operating Agreement theoretically permits market participants to submit their own OCA-calculation models,[40] his intent in putting together his model was to replicate the IMM's OCA calculations so that LS Power could understand why its internal estimates were so different from the IMM's. To be sure, Mr. Griffiths understood and understands that there may be some variations in an OCA calculation, and he therefore was not seeking to replicate the IMM's calculations perfectly. But the magnitude of the difference between LS Power's internal estimates and the IMM's determinations was nonetheless striking and raised serious concerns at LS Power.

Accordingly, from April through late July 2022, Mr. Griffiths repeatedly attempted without success to come anywhere close to replicating the IMM's calculations. During that time, Mr. Griffiths repeatedly asked the IMM for additional information. However, the IMM would not share additional information regarding the IMM Calculator beyond that in Manual 15, and also did not respond to LS Power's request for results and intermediate calculations from older OCA estimates that could help provide insight into the IMM Calculator.[41] Instead, the IMM insisted that any differentials between the IMM's and LS Power's calculations must be the result of problems with Mr. Griffiths' model.[42] Mr. Griffiths therefore continued to enhance his model to

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39 *See* Griffiths Affidavit at ¶ 11.

40 *See* Operating Agreement, Schedule 2, § 5(a).

41 *See* Griffiths Affidavit at ¶¶ 22-26.

42 *See id.* at ¶¶ 23, 26.

address issues raised by the IMM, including spending thousands of dollars to purchase a commercial optimization solver, but continued to be unable to replicate the IMM's OCA calculations.[43]

It was only at the end of July 2022, after months of fruitless efforts attempting to replicate the IMM's calculations, that Mr. Griffiths began to suspect that the difference between the IMM's calculations and LS Power's own estimates "was likely due to the IMM only tracking a single criteria pollutant …, whereas my own model was tracking all of them…."[44] As Mr. Griffiths explains, the IMM and the LS Power team had previously agreed to minimize administrative burdens by only modeling CO limitations, as these were the most stringent limitations imposed on LS Power's ComEd units. In looking at data for LS Power's Rockford Energy Center ("Rockford"), however, Mr. Griffiths realized that modeling only CO limitations would result in run-hour limits of approximately 2,000 hours a year, while modeling all co-pollutants meant a significantly reduced annual limit of approximately [redacted] run-hours, a value in line with its actual air permit restrictions.[45]

Mr. Griffiths brought the issue to the IMM's attention on July 22, 2022, and again on July 31, 2022.[46] In response to Mr. Griffiths' questions regarding projected run hours under the IMM Calculator, however, the IMM stated that [redacted] and again took the position that any issues identified by Mr.

43 *See id.* at ¶ 27.

44 *Id.* at ¶ 30 (also explaining how this significantly skewed the IMM's OCA calculations).

45 *Id.*

46 *See id.* at ¶¶ 31-32.

Griffiths must result from problems with Mr. Griffiths' model.[47] Facing this impasse with the IMM, LS Power was then forced to reach out to PJM, with the hope that "while the IMM would not disclose any modeling results to us, it might be willing to share intermediate results (including simulated dispatch) with PJM,"[48] and "[o]n August 9, 2022, PJM confirmed to LS Power by phone that the IMM model was simulating far higher levels of dispatch at Rockford than our Title V permit would allow, based on PJM's review of OCA modeling data provided by the IMM."[49] Shortly after that conversation between PJM and the IMM, the IMM raised the OCAs for LS Power's Rockford units by a factor of almost 25, and also significantly increased the OCAs for LS Power's other Illinois units.[50] This change brought the IMM's OCA estimates in line with those Mr. Griffiths had been producing for several months.

LS Power and Mr. Griffiths certainly understand the IMM having initially modeled only one limiting pollutant for Rockford and LS Power's other Illinois units, as both LS Power and the IMM agreed that this was the most administratively efficient approach.[51] The problem was the IMM's continued insistence, even months after LS Power had raised concerns, that there could not be any problems with the IMM Calculator[52] and its refusal to share any data or information that would have helped the parties work together more effectively to identify and resolve the problem.[53]

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47 *See* Griffiths Affidavit, Attachment A-8 (E-mail from Luis Gomez dated Aug. 1, 2022, 10:42 AM) (responding to Mr. Griffiths' statement that modeling just one pollutant resulted in [redacted] and stating that [redacted]).

48 Griffiths Affidavit at ¶ 33.

49 *Id.* at ¶ 35.

50 *See id.* at ¶ 36.

51 *Id.* at ¶¶ 30, 37.

52 *See* Griffiths Affidavit, Attachment A-8 (E-mail from Luis Gomez dated Aug. 1, 2022, 10:42 AM).

53 *See id.*

In particular, and as described above, the IMM did not want to provide the number of run hours that the IMM Calculator was simulating ***for LS Power's own units***.[54] With more timely access to additional information regarding this intermediate output, LS Power could have identified the impermissible run-hours at an earlier date, and would not have had to submit offers with significantly understated OCAs from April through mid-August 2022.

A second (and potentially even more troubling) example involves LS Power's two peaking units at the Chambersburg Generating Facility in Pennsylvania ("Chambersburg"), where the IMM's artificially low OCAs resulted in those units prematurely hitting their permit limits in the middle of a month and therefore being unable to run for the remainder of the month. In that case, the IMM set OCAs of zero for Chambersburg in April and early May 2023, despite the units approaching their permit limit. Setting the OCAs at zero is equivalent to predicting that the Chambersburg units would be dispatched fewer hours than remained on the applicable permit such that there would be no opportunity costs associated from the units being prevented from running in later periods.[55] Responding to LS Power's questions regarding these OCAs of zero in late April, the IMM stated that [redacted][56] Although LS Power pointed out that the Chambersburg units had been running for more hours than in prior years and would soon hit their permit limits, the IMM further took the position that [redacted] and that [redacted]

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[54] *See id.* Despite a follow-up question on this issue, the IMM has to date not identified any basis for withholding this type of intermediate data with the affected seller. *See* Griffiths Affidavit at ¶ 32.

[55] *See* Griffiths Affidavit at ¶ 40; Sotkiewicz Affidavit at ¶ 87.

[56] Griffiths Affidavit, Attachment A-10 (E-mail from Luis Gomez dated Apr. 28, 2023, 2:27 PM).

[redacted][57] The IMM stated that it would [redacted][58] Nevertheless, the zero OCAs persisted and, as a result, the Chambersburg units continued to be dispatched for an average of 19 hours a day in early May 2023, including in many off-peak hours.[59]

Starting in late April 2023, various LS Power representatives reached out to the IMM in an effort to get the IMM to substantively reassess the reasonableness of its OCA results in this period. For example, LS Power's Senior Vice President of Energy Marketing and Trading asked the IMM on April 25, 2023 and April 28, 2023 to share its run assumptions and outputs as well as forward pricing curves.[60] On May 11, 2023, Mr. Griffiths again contacted the IMM, explaining that [redacted] and identifying potential errors in the IMM Calculator.[61] Later that day, the IMM finally raised the OCAs, but this increase was modest and the OCAs remained far below LS Power's estimates.[62] LS Power was only able to use these revised OCAs for one day before the Chambersburg units hit their permit limits on May 13, 2023, and were unable to operate for the remainder of May 2023.[63]

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57 *Id.*

58 *Id.*

59 *See* Griffiths Affidavit at ¶¶ 42-43 & Figure 1.

60 Griffiths Affidavit, Attachment A-10 (E-mail from Marc Kline dated Apr. 25, 2023, 2:41 PM); *id.*, E-mail from Marc Kline, Apr. 25, 2023, 3:13 PM); id. (E-mail from Marc Kline dated Apr. 28, 2023, 1:48 PM).

61 Griffiths Affidavit, Attachment A-11 (E-mail from Benjamin Griffiths dated May 11, 2023, 3:10 PM).

62 *See* Griffiths Affidavit at ¶¶ 44-45.

63 *See id.* at ¶ 46.

As best Mr. Griffiths can tell, the understated OCAs for Chambersburg predominately resulted from errors in the IMM Calculator's treatment of no-load, start-up costs, and emissions rates.[64] Although he raised his concerns with the IMM and notwithstanding the IMM's acknowledgement that there are issues with the IMM Calculator's treatment of no-load costs, the IMM insisted that this had minimal effects on the OCA determinations.[65] The IMM has also provided no follow up information, and to date, LS Power has not been able to determine if any corrections have been made to the IMM's treatment of no-load or start-up costs.[66] Mr. Griffiths also was informed in the course of his review that certain cost data LS Power had inputted in the IMM's Member Information Reporting Application ("MIRA") was not the data that was being used in the IMM Calculator. This was, Mr. Griffiths states, "deeply worrying because it suggested that the only inputs we believed we knew went into the IMM's model – our approved [cost] inputs – might not actually be used by the IMM's model."[67] Mr. Griffiths further explains that "[t]he IMM has confirmed that its model cannot actually assess start-up fuel bought at the market price for the day on which it is used, so the IMM instead creates a lump-sum that seeks to reflect both the fixed and fuel components associated with start-up," but that, "[u]nfortunately, the IMM's conversion of fuel costs fails to accurately reflect actual costs."[68] Thus, the fuel costs used in the IMM Calculator were significantly higher than prevailing market prices at that time.[69] Mr.

64 *See id.* at ¶ 48.

65 *See id.* at ¶ 51.

66 *See id.* at ¶ 52.

67 *Id.* at ¶ 50.

68 *Id.* at ¶ 53.

69 *See id. See also id.* at ¶ 54 (also stating that "[e]ven today, the fuel costs assumed by the IMM are significantly elevated over market prices").

Griffiths also explains that it took the IMM more than two months to correct the emissions rates issues he identified with respect to the OCA calculations for Chambersburg.[70]

As a final example of LS Power's concerns with respect to the IMM's calculation of OCAs, LS Power owns six technologically identical units (GE LM6000s) at the Aurora Generating Station (the "Aurora LM6000s"). Each of the Aurora LM6000s has substantially the same operational parameters, emissions profile, and dispatch history as the others. As a result, it is logical to expect that the Aurora LM6000s would have similar, if not identical, OCAs at any given time. Nonetheless, as Mr. Griffiths explains, during a six-week period from April through June 2022, the IMM-calculated OCAs varied significantly for each of the Aurora LM6000s within each week, and also from week to week.[71] There were also times when the OCAs for the Aurora units inexplicably moved in different directions, with the OCAs increasing for certain units but decreasing for others.[72] As Mr. Griffiths states, the reasons for these erratic and counter-intuitive variations were never clear.[73]

IV.

COMPLAINT

The Operating Agreement and Tariff make clear that generators whose operations are limited as a result of applicable laws have the right to include their Energy Market Opportunity Cost in their cost-based offers, such that their offers will reflect "the value associated with a

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70 *See id.* at ¶ 55.

71 *See* Griffiths Affidavit at ¶¶ 17-18 & Table 1. Mr. Griffiths explains that there were also significant variations in the IMM-calculated OCAs for three GE 7EA simple cycle turbines at the Aurora Generating Station. *See id.* at ¶ 19.

72 *See id.* at ¶ 18.

73 *See id.*

specific generating unit's lost opportunity to produce energy during a higher valued period of time occurring within the same compliance period…."[74] As Dr. Sotkiewicz explains, by permitting the inclusion of these opportunity costs, the Operating Agreement and Tariff seek to ensure that operationally limited resources are dispatched when they are most valuable to the system, thereby maximizing profits for the resource owner and maximizing operational flexibility and reliability for PJM.[75] But as LS Power's experience illustrates, the existing approach to calculating OCAs in PJM is not fulfilling this purpose.

As Mr. Griffiths explains and as Drs. Sotkiewicz and McDonald confirm, the current approach is resulting in OCAs that can be grossly understated and fall well short of any reasonable approximation of a use-limited resource's 's opportunity costs. Moreover, the lack of transparency regarding the IMM Calculator and procedures allowing review and modification of the IMM's OCA determinations have meant that sellers have no way of seeking corrections to inaccurate OCAs, much less ensuring that those corrections are made in an effective and timely manner. The consequence is that LS Power and presumably other sellers are being forced to submit offers with understated OCAs for prolonged periods, not just to their own detriment, but also to the detriment of PJM system reliability. And there is every reason to expect that absent Commission action, these problems will recur and increase as a growing number of resources face significant use limitations.

LS Power thus respectfully requests that the Commission order PJM and the IMM (1) to provide additional transparency regarding the IMM Calculator and work with stakeholders to

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[74] Operating Agreement, § 1, OA Definitions E—F (definition of "Energy Market Opportunity Cost"); Tariff, § 1, OATT Definitions E—F (definition of "Energy Market Opportunity Cost").

[75] *See* Sotkiewicz Affidavit at ¶¶ 27-40.

improve the model, and (2) to improve the procedures for OCA determination and review, as described in more detail in Section V below.

A. The IMM Calculator Has Resulted in Unjust and Unreasonable OCAs that Fail to Reasonably Approximate Opportunity Costs, Resulting in Harm to Individual Sellers and the PJM Market as a Whole

As the February 2009 Order found and numerous other Commission orders have affirmed, competitive offers must reflect a seller's opportunity costs.[76] LS Power's experiences make clear, however, that the IMM Calculator and PJM's procedures relating to OCAs are flawed and have resulted in LS Power being forced to submit offers that did not reasonably approximate its units' full opportunity costs and were therefore below competitive levels for extended periods.

As discussed above, it has become apparent that the IMM calculated OCAs for Rockford based on an erroneous assumption that the facility would be able to run for approximately 2,000 hours per year, almost [redacted] times more than the [redacted] hours actually allowed under its air permit.[77] This error, which also applied to the calculation of OCAs for LS Power's other Illinois units, resulted in OCAs that were far lower than the units' actual opportunity costs. The lack of information regarding the IMM's calculations and simulated run hours meant that it took months for Mr. Griffiths to identify the cause of the problem. And even after Mr. Griffiths raised the issue with the IMM, the IMM would not provide information regarding the run hours used in the IMM

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[76] *See, e.g., Midwest Indep. Transmission Sys. Operator, Inc.*, 109 FERC ¶ 61,285, at P 229 (2004) ("'legitimate risks and opportunity costs' include inter-temporal opportunity costs caused by run-time restrictions, operational risks such as the risks of unit failure (including costs of repairs and costs of foregone sales during the repair period), short-term fluctuations in fuel prices or availability, and possibly, other factors"), *on reh'g*, 111 FERC ¶ 61,053, *reh'g denied*, 112 FERC ¶ 61,086 (2005); *ISO New England Inc.*, 89 FERC ¶ 61,209 at 61,641 (1999) ("A market rule should not require bidders in a competitive market to provide services at a price less than their bid (since, otherwise, the price may not cover the bidder's costs, including opportunity costs)."); *Pennsylvania Elec. Co.*, 60 FERC ¶ 61,034 at n.39 ("Prices in competitive markets reflect opportunity costs."), *reh'g denied*, 60 FERC ¶ 61,244 (1992).

[77] *See* Griffiths Affidavit at ¶¶ 30-35.

Calculator, thereby resulting in further delay as LS Power was forced to obtain the information through PJM.[78] Accordingly, an issue that could have been resolved relatively quickly if LS Power had insight into the modeling process instead dragged on, while the units' energy offers reflected improperly low OCAs for the entire high-value summer season.

Similarly, LS Power struggled to get responses to its concerns regarding the zero OCAs for Chambersburg, even when it warned that the units were fast approaching their permit limits.[79] As the Commission previously recognized, "[a] generating unit with limited run hours should not be forced to run when prices are low and therefore lose its ability to run during periods of higher prices."[80] Yet that is precisely what happened to Chambersburg. As Mr. Griffiths points out, the zero OCAs set by the IMM meant that the Chambersburg units were dispatched in almost all hours in early May 2023, and

> the fact that Chambersburg had to go on outage during a month when it had OCAs of zero shows that the OCAs were inefficient and economically absurd. If nothing else, LS Power would have earned more money by running the unit during on-peak hours throughout the month of May rather than running nearly around-the-clock over the first 12 days of the month.[81]

In fact, even after the IMM increased the OCAs on May 11, 2023, the OCAs were still too low. The Chambersburg units continued to be dispatched at relatively low prices, thereby resulting in the units hitting their permit limits on May 13, 2023, and being unable to operate for the

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78 *See id.* at ¶¶ 33-35.

79 *See* Griffiths Affidavit, Attachment A-10 (E-mail chain including e-mails from LS Power raising concerns regarding OCAs of zero); Griffiths Affidavit, Attachment A-11 (E-mail from Benjamin Griffiths dated May 11, 2023, 3:10 PM).

80 March 2010 Order, 130 FERC ¶ 61,230 at P 23.

81 Griffiths Affidavit at ¶ 47.

remainder of the month when prices were higher. By Mr. Griffiths' estimate, the inaccurate OCAs resulted in substantial losses to Chambersburg, as

> Chambersburg would have earned approximately $159,000 in incremental profits if it could have run optimally across the full month, instead of only running in the first half of the month and not at all in the second half. And this estimate understated the true impact of the inaccurately low OCA: because Chambersburg was forced to run more than it should have in May 2023, it had less MWhs that it could sell in the remaining summer months, where clearing prices would reasonably have been anticipated to be higher.[82]

Dr. Sotkiewicz explains that these types of understated OCAs also result in suboptimal dispatch, to the detriment of the market as a whole and system reliability. As Dr. Sotkiewicz states, failure to properly calculate OCAs will mean that a unit will be dispatched when locational marginal prices ("LMPs") are below the unit's actual marginal costs, including opportunity costs. This not only deprives the seller of revenues, but also means that the unit will "not be available for higher price periods when there is a greater reliability need as evidenced by prices."[83] Inaccurate OCAs therefore limit the number of units that PJM has available when the system is tight and reliability is potentially at risk. For example, when a resource such as Chambersburg is "being used heavily for transmission constraint control and thus subject to market power mitigation," inaccurate OCAs can result in the resource's limited run hours being used up, thereby "not only hurt[ing] the resource owner but also render[ing the] resource[] unavailable for other times when reliability may be compromised…."[84] Indeed, Mr. Griffiths explains that, had PJM experienced a Performance Assessment Interval during the time when Chambersburg's run hours had been

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82 *Id.*

83 Sotkiewicz Affidavit at ¶ 39.

84 *Id.* at ¶ 103.

depleted due to the inaccurate OCAs, LS Power would have been put in the difficult position of having to either incur hefty non-performance penalties or running in violation of its air permit.[85]

While understated OCAs may suppress LMPs when use limited units run at prices below their full costs,[86] Dr. Sotkiewicz explains that they will also result in increased prices in other time periods by limiting the units that PJM may dispatch. Providing an illustrative example, he notes:

> Calling on our hypothetical resource with out-of-pocket costs of \$50/MWh and opportunity costs of \$250/MWh to alleviate transmission constraints (by ignoring or understating opportunity costs) falsely suggests that the cost of transmission constraint control is \$50/MWh, when it is actually much higher (\$80/MWh, in this case). In this instance alone, prices are not consistent with the reliability needs and costs of ensuring reliability, and PJM is ultimately failing to dispatch on a least-cost basis, not just in a single hour, but over multiple hours across the year, given the omission or understatement of opportunity costs. During the lower cost hours, the dispatch of the \$300/MWh resource, albeit only valued at \$50/MWh rather than \$80/MWh due to the omission or understatement of opportunity costs, understates the costs of maintaining reliability. But this inefficient dispatch may also result in costs of maintaining reliability during higher cost hours being overstated, because having run during the lower cost hours, the \$300/MWh resource will be unable to run during the higher cost hours. That may mean that PJM needs to call on a higher cost resource, say \$400/MWh, to maintain reliability.[87]

The Commission has reached the same conclusion, finding that failure to properly recognize opportunity costs creates "inefficient dispatch [that] can lead to increased costs to customers."[88]

Critically, Dr. Sotkiewicz also emphasizes that inaccurate OCAs may have serious, longer-term consequences for reliability and resource adequacy by spurring premature retirements. An affected resource is "denied the opportunity to earn higher net energy market revenues because of

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85 *See* Griffiths Affidavit at ¶ 46.

86 *See* Sotkiewicz Affidavit at ¶¶ 38-40; McDonald Affidavit at ¶ 22.

87 Sotkiewicz Affidavit at ¶ 40.

88 March 2010 Order, 130 FERC ¶ 61,230 at P 23.

the lack or an understatement of opportunity costs due to run-time restrictions."[89] This, in turn, "could lead resources that are needed by PJM for reliability to seek retirement, exacerbating the problem described in PJM's recent report on resource retirements and replacements."[90]

B. It is Unjust and Unreasonable for PJM and the IMM Not to Provide Transparency and Timely Review With Respect to OCA Determinations

As LS Power's experience shows and as Dr. Sotkiewicz confirms, the determination of OCAs involves a highly complex modeling exercise, where seemingly small modeling choices can lead to OCAs that do not accurately reflect opportunity costs. Based on over 20 years of experience as a market monitor, Dr. McDonald explains that collaboration with an asset owner is vital to ensuring that modeling choices produce accurate results, as the asset owner "understands the physical, operating, and regulatory attributes of its assets better than other entities, including PJM and the IMM,"[91] and is thus best positioned to identify needed modifications to OCA calculations. Dr. McDonald also provides examples where his market monitoring team worked with asset owners to arrive at accurate cost calculations and mitigation decisions.[92] By contrast, asset owners in PJM cannot provide meaningful input because they are not given insight into the OCA calculation process. In addition, sellers have no way of obtaining timely review when they suspect there are problems with an OCA determination. The lack of transparency with respect to the IMM Calculator and lack of procedures allowing sellers to obtain timely review of OCA determinations thus directly result in the unjust and unreasonable OCAs discussed above.

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89 Sotkiewicz Affidavit at ¶ 41. *See also* EL08-47 Indicated Suppliers Brief at 25-26 (describing harm from failure to properly reflect opportunity costs in offers).

90 Sotkiewicz Affidavit at ¶ 43.

91 McDonald Affidavit at ¶ 21.

92 *See id.* at ¶¶ 10-11.

1. Sellers Lack Needed Transparency Regarding OCA Determinations and the IMM Calculator

The Commission has long made clear that "[b]oth a formula rate and its inputs must be transparent; it is essential to their being just and reasonable,"[93] and has therefore directed that rate calculations must be "transparent and replicable, consistent with the Commission's standards."[94] As Dr. Sotkiewicz explains, this mandate is consistent with economic theory, as "[t]ransparency is a necessary condition for information to be disseminated to participants in the PJM energy market to ensure outcomes are competitive."[95] Similarly, Dr. McDonald emphasizes the importance of transparency and dialogue in market monitoring and mitigation, stating that "[c]ollaboration and transparency of data, method, and process in a timely fashion help[] … to avert an incorrect mitigated price adversely affecting the participant and price formation in the wholesale markets."[96]

Regrettably, the required and expected transparency with respect to OCA determinations was lost with the transition from the PJM Calculator to the IMM Calculator. In the March 2010

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93 *Midwest Indep. Transmission Sys. Operator, Inc.*, 143 FERC ¶ 61,149 at P 83 (2013) (footnote omitted) (also stating that "formula rate protocols must … provide interested parties with the information necessary to understand and evaluate the implementation of the formula rate for either the correctness of inputs and calculations, or the reasonableness of the costs to be recovered in the formula rate"), *reh'g denied*, 146 FERC ¶ 61,209 (2014). *See also, e.g., Tri-State Generation and Transmission Ass'n, Inc.*, 175 FERC ¶ 61,229 at PP 10-13 (2021) (order to show cause preliminarily finding tariff to be unjust and unreasonable because members could not determine charges that would be assessed); *Monongahela Power Co.*, 162 FERC ¶ 61,129 at P 74 (rejecting a transmission planning process that was so vague or incomplete that it did not allow stakeholders "to replicate the results of planning studies"), *reh'g denied*, 164 FERC ¶ 61,217 (2018); *PJM Interconnection, LLC*, 151 FERC ¶ 61,208 at P 95 (2015) (finding a tariff that is "inappropriately vague" to be unjust and unreasonable because the ambiguity prevented parties from foreseeing the impacts of their actions), *on reh'g*, 155 FERC ¶ 61,157 (2016), *reh'g denied*, 162 FERC ¶ 61,047 (2018); *PJM Interconnection, L.L.C.*, 119 FERC ¶ 61,318 at PP 180-181 (order rejecting a provision of a proposal that would have given the IMM the discretion to set or reset market clearing prices "[b]ecause this discretion would allow the Market Monitor to use its sole judgment to determine inputs that can ultimately set the market clearing price…. Instead of relying on the Market Monitor's discretion, objective criteria should be developed for use in such instances so that predictable results will emerge."), *reh'g denied*, 121 FERC ¶ 61,173 (2007).

94 *Baltimore Gas & Elec. Co.*, 153 FERC ¶ 61,140 at P 7 (2015) ("*Baltimore Gas*") (footnote omitted).

95 Sotkiewicz Affidavit at ¶ 48.

96 McDonald Affidavit at ¶ 12.

Order, the Commission explained that it was rejecting PJM's compliance filing because PJM's filing had not provided sufficient details for the Commission to "understand the methodology [PJM] proposes to employ in determining the relevant opportunity costs."[97] In response, PJM filed its April 2010 Filing, which not only included additional tariff language for inclusion in the Operating Agreement, but also preliminary revisions to Manual 15 that had been discussed at length with stakeholders.[98] At that time, PJM also released a calculator that "Market Participants will be able to use to compute their opportunity costs associated with an externally imposed run-hour restriction on a generating unit."[99]

Since that time, however, the OCA-determination process has become increasingly and unworkably opaque. The PJM Calculator described at length in Manual 15 is no longer in use, and sellers are now only permitted to include OCAs determined using the IMM Calculator.[100] While Dr. Sotkiewicz explains that there are benefits to the concepts underlying the IMM Calculator, there are serious questions regarding the implementation of those concepts.[101] Market participants have never had access to and therefore have not had the opportunity to properly vet the IMM Calculator.[102] Moreover, as Dr. Sotkiewicz states, "the descriptions in Section 12.7 of Manual 15 provide nowhere near enough information to fully understand, much less replicate, the IMM's approach," and "[t]here is not even enough detail to define an optimization problem for maximizing generator net revenues that accurately captures the same problem for defining the

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97 March 2010 Order, 130 FERC ¶ 61,230 at P 19.

98 *See* April 2010 Filing, Transmittal Letter at 6.

99 *Id.* at 13.

100 *See* Manual 15, § 12.1.

101 *See* Sotkiewicz Affidavit at ¶ 58.

102 *See id.* at ¶ 26 (explaining that during the process that led to the adoption of the IMM Calculator, the IMM only shared the model with PJM and not market participants).

OCA that is described in Manual 15."[103] Dr. Sotkiewicz also details at length the gaps in the descriptions of the IMM Calculator in Manual 15, including, but not limited to (1) failure to address the calculation of no-load and start-up costs; (2) failure to discuss the treatment of emissions rates; (3) questions regarding generator constraints; and (4) lack of information regarding the derivation of the applicable shadow price used to calculate OCAs.[104] To make matters worse, and as detailed in the Griffiths Affidavit, the IMM has rejected LS Power's requests for information regarding intermediate results for LS Power's own units, as well as information using vintage data.[105]

The lack of information available to sellers regarding the IMM Calculator and their own OCA determinations is plainly unjust and unreasonable. In a recent order, the Commission rejected a proposal by PJM because it did not "contain[] sufficient transparency for interested stakeholders, including the Market Monitor, sellers, and the Commission,"[106] and further explained that:

> PJM proposes to use a proprietary model and has not offered to make this model available to stakeholders, such as the Market Monitor or sellers, nor has PJM sufficiently explained the assumptions that will be used in the model. Also, PJM does not explain whether PJM will modify its model to account for unit-specific adjustments to accreditation, which may alter a seller's risk exposure, or to accommodate the proposed PAI Obligation Transfer that may reduce a resource's risk exposure. Further, as noted above, PJM does not explain whether, and if so, how, estimates of risk exposure will incorporate actions that sellers take or intend to take to reduce that exposure.[107]

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103 *Id.* at ¶ 60.

104 *See id.* at ¶¶ 58-67.

105 *See* Griffiths Affidavit at ¶¶ 25-26, 32.

106 *PJM Interconnection, L.L.C.*, 186 FERC ¶ 61,097 at P 67 (2024) (the "ER24-98 Order").

107 *Id.* at P 68 (footnote omitted).

As with the model addressed in the ER24-98 Order, the IMM Calculator is not available to market participants, and the Griffiths and Sotkiewicz Affidavits also demonstrate that Manual 15 fails to contain sufficient information to allow market participants to understand and replicate the OCAs determined by the IMM Calculator. For example, LS Power is still not sure if the IMM has made corrections to address the no-load cost and start-up cost issues that Mr. Griffiths identified,[108] and still has no idea why the technologically identical Aurora LM6000s were given very different OCAs.[109] In fact, Mr. Griffiths states that LS Power does not even know what inputs the IMM Calculator is using, since such inputs may apparently differ from the information that the seller has put into MIRA.[110] Clearly, this falls abysmally short of the "transparent and replicable" standards required by the Commission.[111]

To be clear, the fact that the October 2010 Order previously found Schedule 2 to the Operating Agreement to provide sufficient detail regarding the determination of OCAs does not mean that PJM's current OCA procedures are adequate. As an initial matter, the October 2010 Order suggests that PJM was required to file modifications to its Operating Agreement if it wished to make changes to its calculation of opportunity costs. In that order, the Commission explained:

> The PJM IMM states that, while the general approach developed by PJM and PJM stakeholders for calculating opportunity cost-based offers is reasonable, the proposal should include additional, identified enhancements that would produce more accurate results. The PJM IMM has proposed several modifications that it states improves the accuracy of the opportunity cost calculation and would like these modifications to be incorporated into the current PJM proposed revisions. The PJM stakeholders are currently reviewing the PJM IMM's proposed enhancements to the opportunity cost calculation. While the Commission believes that the PJM IMM's

108 *See* Griffiths Affidavit at ¶¶ 52, 54.

109 *See id.* at ¶¶ 18-19.

110 *See id.* at ¶ 50.

111 *Baltimore Gas*, 153 FERC ¶ 61,140 at P 7. *See also supra* note 93.

> proposed modifications may have merit, the Commission will not prejudge them while they are still being vetted through the stakeholder process. ***Any such modifications, though, must be submitted as Tariff revisions.***[112]

PJM has now abandoned the PJM Calculator that was discussed in the April 2010 Filing and moved to a completely different method for calculating OCAs – the IMM Calculator – but did not make any filings with the Commission reflecting that change. To be clear, LS Power recognizes that, under the "rule of reason," PJM is only required to file tariff provisions that "affect rates and service *significantly*, that are realistically *susceptible* of specification, and that are not so generally understood … as to render recitation superfluous."[113] In this case, however, it is notable that PJM itself previously took the position that "PJM is obligated by the tariff to maintain its own calculator,"[114] and PJM also apparently viewed the IMM Calculator as representing a substantial change from the prior PJM Calculator.[115] Accordingly, even if the details of the IMM Calculator can be included in Manual 15, it is hard to believe that such a dramatic change in approach can be implemented without modifications to the Operating Agreement. Nonetheless, the more pressing issue is that LS Power and other market participants do not even have the necessary details

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112 October 2010 Order, 133 FERC ¶ 61,081 at P 24 (emphasis added). *See also id.* at P 11 (explaining that the IMM's proposed "specific enhancements include: more accurate treatment of minimum run time restrictions, fuel procurement options, and operational characteristics" (footnote omitted)).

113 *Cleveland v. FERC*, 773 F.2d 1368, 1376 (D.C. Cir. 1985) (emphasis in original). *See also, e.g., KeySpan-Ravenswood, LLC v. FERC*, 474 F.3d 804, 810-811 (D.C. Cir. 2007).

114 PJM, *MIC Special Sessions: Opportunity Cost Calculator*, at 4 (2019), https://www.pjm.com/-/media/committees-groups/committees/mic/20190710/20190710-item-07a-opportunity-cost-calculator.ashx.

115 PJM previously stated that "PJM does not believe the IMM Opportunity Cost Calculator directly adheres to the methodology for calculating Energy Market Opportunity Costs as documented in PJM Manual 15, Section 12," and identified various differences between the PJM Calculator and IMM Calculator. PJM, Letter to Market Sellers Using an Opportunity Cost Adder in Cost-Based Energy Market Offers re: Re: PJM Approval of IMM Opportunity Cost Calculator as an Alternative Method at 2 (Oct. 24, 2018, reissued Aug. 27, 2019), https://www.pjm.com/-/media/etools/markets-gateway/pjm-approval-of-imm-opportunity-cost-calculator-as-an-alternative-method.ashx.

regarding the IMM Calculator to properly evaluate whether PJM should have made a filing with the Commission under the "rule of reason."

Even assuming, for argument's sake, that changes to the Operating Agreement did not have to be filed in light of the adoption of the IMM Calculator, PJM is still obligated to ensure that it has provided sufficient information for market participants to fully understand and replicate the applicable rates.[116] The Commission's fundamental concern when it rejected PJM's initial filing in compliance with the February 2009 Order was that PJM had not provided sufficient detail about the PJM Calculator in either the Operating Agreement or its manuals.[117] Moreover, the Commission made clear that "the methodology to be applied in determining the relevant opportunity costs needs to be sufficiently described in the tariff," even as it acknowledged that "relying on Manuals to develop implementation details and mechanics of implementation may be acceptable…."[118] Consistent with that guidance, PJM's further compliance filing included revisions to Manual 15 that provided considerable detail about the PJM Calculator.[119] Yet no similar detail about the IMM Calculator has ever been provided in the Operating Agreement, Manual 15, or anywhere else, with the result that market participants and the Commission have none of the visibility into the process that the Commission demanded in the March 2010 Order.

This lack of visibility flies in the face not only of the March 2010 Order but also other Commission orders. In a case challenging the market power mitigation rules of New York Independent System Operator, Inc. ("NYISO"), the Commission found that NYISO had already filed tariff revisions "to increase transparency and provide potential new entrants with greater

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116 *See supra* note 93.

117 *See* March 2010 Order, 130 FERC ¶ 61,230 at PP 16-21.

118 *Id.* at P 17.

119 *See* April 2010 Filing, Attachment C.

certainty."[120] Nevertheless, the Commission agreed with the complainants in that case that "developers would benefit from examples of how the mitigation and offer floor rules will be applied because increased clarity and a better understanding of how the rules will be applied benefit both new entrants and existing market participants."[121] The Commission thus required NYISO to "provide examples on its website to clarify, in general, how the mitigation exemption test and offer floor calculations are implemented," and stated that "[t]he examples should use hypothetical data coupled with detailed narratives explaining how NYISO performs each of the required mitigation tests as well as how it determines and applies the offer floors for non-exempt projects."[122] In another case involving a proprietary model owned by a third-party vendor, the Commission made clear that PJM was required to disclose to market participants "detailed information regarding how the LP model operates … including a description of the price optimization formula, which PJM characterizes as the 'core' of the model, together with numerical examples of how that formula works…."[123] By contrast, and as explained previously, the IMM did not respond to LS Power's requests for examples using historic data or for information regarding the intermediate results produced by the IMM Calculator regarding LS Power's own units. The IMM has also never publicly released examples depicting how the IMM Calculator would evaluate sample, hypothetical resources.[124]

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[120] *Astoria Generating Co. L.P. v. New York Indep. Sys. Operator, Inc.*, 139 FERC ¶ 61,244 at P 46 (2012) ("*Astoria*").

[121] *Id.* at P 50.

[122] *Id.*

[123] *PJM Interconnection, L.L.C.*, 94 FERC ¶ 61,081 at 61,370 (2001) (the "ER99-2028 Clarification Order").

[124] *See* Griffiths Affidavit at ¶ 10.

2. Sellers Lack the Ability to Obtain Timely Relief for Inaccurate OCAs

While LS Power fully understands that there is no "perfect" way to calculate OCAs, there are clearly "wrong" ways to do so, and any approach that produces inaccurate OCAs must be promptly identified and corrected. This is precisely why it is important for market participants to be able to work with PJM and the IMM in a collaborative manner and to have avenues for seeking effective and timely review of mitigation determinations that are believed to be erroneous.[125] But as Dr. McDonald observes, while LS Power repeatedly flagged concerns with the OCAs generated by the IMM Calculator, "the primary causes of the[] delays in correcting the inaccurate [LS Power] OCAs were twofold: the IMM's unwillingness to communicate transparently and completely with LS Power, and the IMM's unwillingness to collaboratively remedy identified issues in a timely manner."[126] In fact, even in a case where Mr. Griffiths identified needed changes with respect to certain OCA calculations using a methodology previously approved by the IMM, it took the IMM over two months to make those corrections.[127] At the same time, LS Power had no other options for obtaining relief, as the current rules leave sellers little or no recourse if they are dissatisfied with the results of the IMM Calculator. This is inconsistent with the Operating Agreement and is otherwise unjust and unreasonable.

As approved by the Commission in the October 2010 Order, Schedule 2 to the Operating Agreement states that "a Market Participant may submit a request to PJM for consideration and approval of an alternative method of calculating its Energy Market Opportunity Cost if the standard methodology described herein does not accurately represent the Market Participant's Energy

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125 *See* McDonald Affidavit at ¶¶ 18-21.

126 *Id.* at ¶ 17.

127 *See* Griffiths Affidavit at ¶ 55.

Market Opportunity Cost."[128] The IMM objected to this provision, claiming that it represented "an unnecessary and subjective administrative loophole providing PJM with discretion to override the new rules defining opportunity cost."[129] The Commission accepted this provision over the IMM's objection, finding that:

> providing a method for a resource to propose an alternative method for determining opportunity costs as set forth in the proposed Schedule 2 is reasonable, because some resources may have energy and environmental limitations that do not fit into the standard methodology…. PJM states that it supports a role for the PJM IMM with regard to an alternative method for determining opportunity costs and a proposal to provide for the PJM IMM's input as part of PJM's Manual 15 is being considered through the stakeholder process. With regard to the participation of the PJM IMM in providing input into such determinations, Order No. 719 permits the PJM IMM to have a role in providing the inputs for such a process as long as PJM retains the ultimate decision making authority. As the Commission stated in Order No. 719, this would enable PJM to utilize the expertise and software capabilities that the PJM IMM can provide.[130]

Notwithstanding the language of the Operating Agreement and the Commission's determinations in the October 2010 Order, PJM and the IMM appear to have *sub silentio* eliminated a seller's right to propose an alternative methodology for calculating its OCAs. In particular, Section 12.1 of Manual 15 now states that "Market Sellers that wish to include an Opportunity Cost in a unit's cost based offers should use the IMM Opportunity Cost Calculator described in Section 12.7 of this manual."[131] LS Power's third-party energy manager expressly asked the IMM the following question:

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[128] Operating Agreement, Schedule 2, § 5(a).

[129] October 2010 Order, 133 FERC ¶ 61,081 at P 21.

[130] *Id.* at P 22 (footnotes omitted).

[131] Manual 15, § 12.1. While Section 12.3 of Manual 15 continues to state that a seller may request approval of an alternative opportunity cost calculator, Section 12.1 also states that "[t]he Opportunity Cost Calculator described in Section 12.3 through 12.6 of this manual is suspended as of June 1, 2020." *Id.*

[redacted][132]

In response, the IMM stated: [redacted][133]

In addition to effectively eliminating a seller's right to propose the use of a different opportunity cost calculator, PJM and the IMM have also given the IMM sole discretion to determine OCAs and therefore, permissible cost-based energy offers, in violation of the Commission's regulations[134] and Order No. 719.[135] The April 2010 Filing and October 2010 Order contemplated that PJM would be performing the OCA calculation.[136] The October 2010 Order also recognized that the IMM could provide inputs to mitigation, "as long as PJM retains the ultimate decision making authority."[137] Importantly, however, PJM has now assigned responsibility for calculating OCAs to the IMM but there are no provisions in the Tariff or Operating Agreement expressly providing for PJM to review the IMM's OCA determinations. In LS Power's experience, PJM has also never indicated a willingness to make final determinations

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132 Griffiths Affidavit, Attachment A-10 (E-mail from Brian Sinclair dated Apr. 28, 2023, 5:57 PM).

133 *Id.* (E-mail from Luis Gomez dated Apr. 28, 2023, 6:12 PM).

134 *See* 18 C.F.R. § 35.28(g)(3)(iii)(A) (2023) (providing that "[a] Commission-approved independent system operator or regional transmission organization may not permit its Market Monitoring Unit, whether internal or external, … to conduct prospective mitigation"); 18 C.F.R. § 35.28(g)(3)(iii)(B) (2023) (providing that "[a] Commission-approved independent system operator or regional transmission organization may permit its Market Monitoring Unit to provide the inputs required for the Commission-approved independent system operator or regional transmission organization to conduct prospective mitigation").

135 *Wholesale Competition in Regions with Org. Elec. Mkts.*, Order No. 719, 125 FERC ¶ 61,071 (2008) ("Order No. 719"), *on reh'g*, Order No. 719-A, 128 FERC ¶ 61,059, *on reh'g*, Order No. 719-B, 129 FERC ¶ 61,252 (2009).

136 *See, e.g.*, April 2010 Filing, Transmittal Letter at 13 (discussing "PJM's proposed methodology for calculating Energy Market Opportunity Costs" and the PJM Calculator).

137 October 2010 Order, 133 FERC ¶ 61,081 at P 22 (footnote omitted).

with respect to OCA levels. For example, after LS Power raised questions regarding the IMM's OCA determinations for Rockford with PJM, PJM confirmed that the IMM Calculator was simulating dispatch hours that far exceeded Rockford's permit limits.[138] Nonetheless, PJM did not modify the OCAs or otherwise provide relief to LS Power, and LS Power instead had to wait for the IMM to modify the relevant OCAs.[139] As a result, the IMM now effectively has final authority to determine OCAs. Commission precedent makes clear that this is not permitted. Indeed, the Commission previously found that a provision of PJM's Tariff had to be modified because it:

> vests final authority in the MMU to determine the EFORd for a generator, which is used to determine the sell offer a mitigated generator may submit. This provision therefore is at odds with Order No. 719 because it involves the MMU in tariff administration, by influencing a necessary determination establishing the offer a seller may bid and ultimately processed by PJM to clear the market. It also directly involves the MMU in prospective mitigation, since the EFORd determines the mitigated rate the seller may bid into the market. While Order No. 719 permits the MMU to provide inputs into this calculation, it requires that the RTO make the final determination regarding offers and rates.[140]

Similarly, OCAs "determine[] the mitigated rate the seller may bid into the market,"[141] and the IMM's calculations must therefore be subject to review by "PJM, the entity responsible for making the final determination."[142]

Finally, while Manual 15 states that PJM will conduct an annual review of the IMM Calculator, what little PJM does in furtherance of this requirement provides little, if any, comfort

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[138] *See* Griffiths Affidavit at ¶ 35.

[139] *See id.* at ¶ 36.

[140] *PJM Interconnection, L.L.C.*, 129 FERC ¶ 61,250 at P 150 (2009) (footnote omitted). *See also id.* at P 161 (rejecting proposal that would "remove[] PJM as the entity that would administer its tariff and provide[] the MMU with such authority," where, for example, "the MMU, not PJM would have the final determination of whether or not a generator can delist").

[141] *Id.* at P 150.

[142] *Id.* at P 148.

to sellers. To begin with, Manual 15 only provides for PJM review of the IMM Calculator "to verify that the IMM … Calculator continues to meet the documented requirements."[143] And there is no evidence PJM has closely examined the reasonableness of OCAs determined by the IMM Calculator, rather than simply rubber-stamping the IMM's approach. For example, PJM's letter to market participants regarding its 2023 review of the IMM Calculator stated:

> Throughout the course of 2023, PJM monitored the level of units' [Opportunity Cost Calculator] adders as calculated by Monitoring Analytics. The trending of adder values corresponded to what one would expect to see based on the units' remaining run hours as well as natural gas and electricity forward prices.
>
> Additionally, the Market Monitor made changes to their calculation methodology in 2022, updating the minimum run time logic. Section 12.7.9 was added to Manual 15 in August 2023 to document these changes. The Market Monitor confirmed that no additional changes to the calculator have been made in 2023.[144]

PJM's vague reference to "[t]he trending of adder values" hardly provides any meaningful assurance that the OCAs produced by the IMM Calculator reasonably approximate a seller's opportunity costs. Similarly empty is PJM's conclusion that "PJM has no concerns with the IMM's Opportunity Cost Calculator."[145] PJM was privy to communications between LS Power and the IMM regarding flaws in the model,[146] but PJM's letters to market participants regarding PJM's

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143 Manual 15, § 12.7.

144 PJM, Letter to Market Sellers Using an Opportunity Cost Adder in Cost-Based Energy Market Offers re: IMM Opportunity Cost Calculator – Annual Review (Dec. 12, 2023) ("2023 Review Letter"), https://www.pjm.com/-/media/etools/markets-gateway/2023-annual-review-of-imm-opportunity-cost-calculator-methodology.ashx. *See also* PJM, Letter to Market Sellers Using an Opportunity Cost Adder in Cost-Based Energy Market Offers re: IMM Opportunity Cost Calculator – Annual Review (Dec. 21, 2022) ("2022 Review Letter") (same), https://www.pjm.com/-/media/etools/markets-gateway/2022-annual-review-of-imm-opportunity-cost-calculator-methodology.ashx.

145 2023 Review Letter. *See also* 2022 Review Letter (same).

146 *See* Griffiths Affidavit, Attachment A-13 (E-mail from Glen Boyle dated June 2, 2023, 9:37 AM); Griffiths Affidavit, Attachment A-15 (E-mail from Benjamin Griffiths dated July 14, 2023, 12:24 PM) (recipients including Glen Boyle and Frederick (Stu) Bresler of PJM).

review do not even hint at the existence of any such problems. To make matters worse, market participants are afforded no opportunity to provide input or ask questions in the review process, and therefore cannot know if flaws in the IMM Calculator are being properly identified and addressed. The PJM review process thus suffers from the same lack of transparency as the OCA calculations themselves.

V.

RELIEF REQUESTED

The Commission should grant this Complaint and find that PJM and the IMM have violated provisions in the Operating Agreement relating to the determination of OCAs and have otherwise determined OCAs in an unjust and unreasonable manner, and require PJM and the IMM to make necessary improvements in their procedures. To be clear, LS Power is not requesting refunds or other relief with respect to any past OCAs; rather, LS Power is only asking the Commission to require prospective improvements in the OCA-determination process, which should be implemented as quickly as possible given the serious market and reliability ramifications of inaccurate OCAs as identified by Dr. Sotkiewicz. In particular, given the rapidly approaching, high value summer season, the Commission should act expeditiously to grant this Complaint and, at a minimum, require the following:

A. PJM and the IMM Should be Required to Provide Additional Transparency with Respect to the IMM Calculator

In the past, the IMM emphasized the importance of transparency in the OCA determination process, stating:

> The objective should be to have the best possible opportunity cost calculations for any unit that requests evaluation of its opportunity costs and that participants understand the basis for those calculations. The goal is to have a pragmatic and workable approach

> to calculating opportunity costs that makes sense to participants. The goal is not to make opportunity costs high or low, but to make them as accurate as possible based on all the detailed and corroborated facts of each unit and accurate details about the PJM market. That is the best way to ensure competitive market outcomes.[147]

Regrettably, however, the reality has fallen far short of the IMM's stated goals of ensuring that "participants understand the basis for [the OCA] calculations" and to "have a pragmatic and workable approach to calculating opportunity costs that makes sense to participants."[148] Indeed, Mr. Griffiths, Dr. Sotkiewicz and Dr. McDonald each state that PJM and the IMM have failed to provide market participants with adequate information regarding the IMM Calculator.[149] Based on his experiences as a market monitor, Dr. McDonald also addresses the steps that PJM and the IMM should take to provide additional transparency, which are similar to the remedies required by the Commission in *Astoria*[150] and the ER99-2028 Clarification Order.[151] Specifically, Dr. McDonald recommends that the IMM "be required to post a public document that fully describes the mathematical model and algorithm used to calculate OCAs, as well as the application of all aspects of the calculation including variable and parameter definitions, such that the model can be replicated by participants."[152] Dr. McDonald also explains that "[m]odel inputs and outputs for fictitious generation assets with different characteristics should also be provided so that the model can be calibrated and verified by participants," and that this would not require "producing

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147 Monitoring Analytics, LLC, Opportunity Cost Calculations at 2 (Sept. 16, 2018), https://www.pjm.com/-/media/committees-groups/committees/mic/20180925-special-occ/20180925-item-02b-imm-response-to-pjm-re-opportunity-cost-20180916.ashx.

148 *Id.*

149 *See* Griffiths Affidavit at ¶¶ 10-11; Sotkiewicz Affidavit at ¶¶ 54-67; McDonald Affidavit at ¶ 15.

150 *See Astoria*, 139 FERC ¶ 61,244 at P 50.

151 *See* ER99-2028 Clarification Order, 94 FERC ¶ 61,081 at 61,370.

152 McDonald Affidavit at ¶ 23.

proprietary software or code."[153] Dr. Sotkiewicz likewise recommends the publication of "a full analytical expression of the entire optimization problem including all constraints such as the full expression of the rolling 12-month compliance periods for emissions limits."[154]

B. The IMM Should be Required to Provide Market Participants Additional Information Regarding Their Unit-Specific OCA Determinations

As discussed herein, one of the principal roadblocks LS Power encountered in attempting to resolve concerns regarding the OCAs for its units has been the IMM's unwillingness to provide even unit-specific information on the inputs and intermediate results of the IMM Calculator. Consistent with his explanation of the need for collaboration and dialogue between market participants and market monitors, Dr. McDonald states that the IMM should be required to "fully disclose to [a] participant all asset-specific inputs, all intermediate calculations (e.g. price projections, simulated dispatch), and all final results in addition to the resulting OCA for that specific participant," which should not raise any confidentiality or competitive concerns because "the IMM would only be disclosing information relating to the participant's own assets."[155]

C. The Commission Should Reaffirm Market Participants' Right to Propose Alternative Methods or Calculators for Determining OCAs

The Operating Agreement expressly states that "a Market Participant may submit a request to PJM for consideration and approval of an alternative method of calculating its Energy Market Opportunity Cost if the standard methodology described herein does not accurately represent the

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[153] *Id.* at ¶ 24.

[154] Sotkiewicz Affidavit at ¶ 96. *See also id.* at ¶ 97 (stating that "[t]here is nothing proprietary about any analytical expressions of the IMM OCA optimization problem or conceptual descriptions of the algorithms used to solve the problem in a manner comparable to the description of PJM's opportunity cost calculator in PJM Manual 15").

[155] McDonald Affidavit at ¶ 25.

Market Participant's Energy Market Opportunity Cost."[156] The Commission specifically addressed this provision, finding that "providing a method for a resource to propose an alternative method for determining opportunity costs as set forth in the proposed Schedule 2 is reasonable, because some resources may have energy and environmental limitations that do not fit into the standard methodology."[157] Similarly, Dr. McDonald explains, that "[t]here can be multiple variants of a model or even different models that can produce reasonable estimates of the OCA," and that a custom model can be "especially useful" in certain circumstances, including "when the standard model does not capture material aspects of an asset's attributes, fuel and environmental limitations, fuel market, or other issues that would cause the standard model to miscalculate the OCA for that asset."[158] As explained above, however, PJM and the IMM have apparently eliminated the right of market participants to propose their own OCA calculators, with the IMM stating that [redacted][159] Given that "a custom OCA model will likely produce a more accurate OCA and may reduce the frequency of disputes,"[160] the Commission should reaffirm that market participants have the right to propose and use their own OCA calculators, subject to PJM review and approval.

In addition, the Commission should confirm that sellers do not have to affirmatively prove that the IMM Calculator "does not accurately represent the [seller]'s Energy Market Opportunity Cost" prior to proposing the use of an alternative methodology. Absent such clarification, the right to propose an alternative methodology would be effectively eliminated because, as discussed

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156 Operating Agreement, Schedule 2, § 5(a).

157 October 2010 Order, 133 FERC ¶ 61,081 at P 22.

158 McDonald Affidavit at ¶ 26.

159 Griffiths Affidavit, Attachment A-10 (E-mail from Luis Gomez dated Apr. 28, 2023, 6:12 PM) (emphasis added).

160 McDonald Affidavit at ¶ 26.

herein, sellers lack the information necessary to understand how the IMM Calculator is deriving OCAs, much less to prove definitively that the IMM Calculator is inappropriate for the seller's particular facility or circumstances. Alternatively, to the extent that the Commission is of the opinion that the existing language of the Operating Agreement does, in fact, require such a showing as a prerequisite to using an alternative OCA-calculation methodology, the Commission should find that the language in the Operating Agreement is unjust and unreasonable because it would impermissibly place precedence on the IMM Calculator over sellers' proposals.[161]

D. PJM Should Put in Place Procedures Governing the Annual Review of the IMM Calculator

At this time, PJM is only obligated to review the IMM Calculator under Section 12.7 of Manual 15, which states that "[o]n an annual basis, PJM will review the inputs and results of the IMM Opportunity Cost Calculator in consultation with the IMM to verify that the IMM Opportunity Cost Calculator continues to meet the documented requirements."[162] This provision, at least as interpreted by PJM, is sadly lacking. As an initial matter, the language implies that PJM should focus its review on whether the IMM Calculator comports with the "documented requirements," which could be read to mean simply ensuring that the IMM Calculator comports with the descriptions in Section 12.7 of Manual 15, rather than attempting to ensure that the IMM Calculator provides for reasonably accurate OCAs.[163] Accordingly, to "help improve the model

161 *See Vistra Corp. v. FERC*, 80 F.4 302, 317-319 (D.C. Cir. 2023) (explaining that the IMM's proposal should not "receive[] 'precedence' if the [IMM] disagrees with a supplier's offer," and finding the rule in question in that case to be permissible because "suppliers do not play second fiddle when their proposed offers deviate from that of the [IMM]").

162 Manual 15, § 12.7.

163 PJM's letters describing its annual reviews also suggest that PJM's review focuses on documentation regarding the IMM Calculator in Manual 15. *See* 2023 Review Letter (stating that "the Market Monitor made changes to their calculation methodology in 2022, updating the minimum run time logic" and that "Section 12.7.9 was added to Manual 15 in August 2023 to document these changes"); 2022

and build market confidence in the resulting OCA values," Dr. McDonald recommends that the PJM annual review process be formalized in the Operating Agreement (or PJM Tariff), and that market participants be given greater insight into this review, including being permitted to provide input and raise concerns regarding the IMM Calculator.[164]

E. Procedures Should be Put in Place to Allow Market Participants to Seek Review of OCA Determinations

As discussed in Section IV.B.2 above, market participants currently have no way to seek effective and timely review of OCAs derived by the IMM Calculator. Consistent with the Commission's holding that the IMM may "provid[e] inputs … as long as PJM retains the ultimate decision making authority,"[165] and with PJM's procedures with respect to other mitigation determinations by the IMM,[166] the Operating Agreement should be modified to provide that, in cases where a market participant and the IMM are unable to reach agreement after a certain period of time,[167] the market participant may request that PJM review and make "the ultimate decision"

Review Letter (stating that "the Market Monitor confirmed that they have made changes to their calculation methodology in 2022 to account for difference in emissions limits on units that are subject to CIJA regulations" and that "PJM is currently evaluating those changes to determine what, if any, changes will be made to Manual 15 to document these changes").

164 McDonald Affidavit at ¶ 27.

165 October 2010 Order, 133 FERC ¶ 61,081 at P 22 (footnote omitted).

166 *See* Tariff, Attachment DD, § 5.14(h-1)(3)(B) ("the Capacity Market Seller may request that the Market Monitoring Unit, subject to acceptance by the Office of Interconnection, produce a resource-specific Energy & Ancillary Services Offset value"); *id.*, § 5.14(h-1)(3)(F) ("the Office of the Interconnection [shall] determine[] with the advice and input of Market Monitor, the acceptable minimum Sell Offer"); *id.*, § 6.4(b) (providing that the Market Monitoring Unit shall make a determination with respect to the Market Seller Offer Cap but that "the Office of the Interconnection will make the determination of the level of the Market Seller Offer Cap, which shall be deemed to be final"); *id.*, § 6.6 ("After the Market Monitoring Unit has made its determination of whether a resource may be removed from Capacity Resource status, or whether the resource meets one of the exceptions thereto, and has notified the Capacity Market Seller and the Office of the Interconnection of the same pursuant to Tariff, Attachment M-Appendix, section II.C.4, the Office of the Interconnection shall approve or deny the request.").

167 Dr. Sotkiewicz emphasizes the need for prompt resolution of disputes regarding OCAs and thus suggests that market participants be permitted to seek a determination from PJM if the dispute between the

regarding permissible OCAs. In addition, while a market participant always has the right to file a complaint with the Commission under Section 206 of the FPA, the Operating Agreement should also expressly give market participants that do not agree with PJM's and the IMM's OCA calculations the right to make a filing with the Commission seeking review of such determinations.[168] These modifications will ensure that individual sellers have the ability to obtain timely relief, and prevent the PJM market as a whole from being adversely affected by inaccurate OCAs for prolonged periods.

VI.

REQUEST FOR PRIVILEGED TREATMENT

Pursuant to Section 388.112 of the Commission's regulations,[169] LS Power requests privileged treatment of portions of this Complaint and the Griffiths Affidavit, including the attachments thereto, which contain competitively sensitive and proprietary materials that are treated as private by LS Power and that would, therefore, be exempt from disclosure under the Freedom of Information Act.[170] Public disclosure of this information would result in severe and

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market participant and the IMM cannot be resolved within seven days. *See* Sotkiewicz Affidavit at ¶¶ 101-103.

168 *See, e.g.*, Tariff, Attachment DD, § 5.14(h-1)(3)(F) ("A Capacity Market Seller that is dissatisfied with any determination hereunder may seek any remedies available to it from FERC…."); *id.*, § 5-14(h-1)(9)(A) (same); *id.*, § 6.5 (providing for Sell Offers to be rejected "unless the Capacity Market Seller obtains approval from FERC for use of such offer"); *id.*, § 6.6(e) ("nothing in this section precludes the Capacity Market Seller from filing a petition with FERC seeking a determination of whether the EFORd complies with the requirements of the Tariff").

169 18 C.F.R. § 388.112 (2023).

170 5 U.S.C. § 552 (2018). *See also Food Mktg. Inst. v. Argus Leader Media*, 139 S.Ct. 2356, 2364-66 (2019) (rejecting the "substantial competitive harm" requirement articulated in *National Parks & Conservation Ass'n v. Morton*, 498 F.2d 765 (D.C. Cir. 1974), and stating that, "where commercial or financial information is both customarily and actually treated as private by its owner and provided to the government under an assurance of privacy, the information is 'confidential'" and thus exempt from disclosure under FOIA).

irreversible competitive harm to LS Power, because it would give competitors access to information regarding LS Power's costs and could thereby impede competition in the PJM energy markets.

In accordance with Section 388.112 of the Commission's regulations, LS Power has provided, in Attachment D hereto, a proposed form of protective agreement (the "Protective Agreement") pursuant to which other parties will have access to the non-public materials. The proposed Protective Agreement is a modified version of the Commission's Model Protective Order incorporating provisions, consistent with those in protective orders employed in other Commission proceedings,[171] which provide additional protection for highly sensitive materials.[172]

LS Power will promptly provide the non-public version of this Complaint to eligible "Reviewing Representatives" (as defined in paragraph 3.E of the proposed Protective Agreement) of PJM, the IMM, or any person who has filed a motion to intervene or a notice of intervention after receiving a written request that includes (1) an executed Protective Agreement, (2) executed non-disclosure certificates for each such Reviewing Representative and, (3) in the case of persons other than the IMM or PJM, a copy of the motion to intervene or notice of intervention. Such written requests should be directed to: Neil L. Levy (nlevy@mwe.com) and Stephanie Lim (slim@mwe.com). Because all of the non-public materials submitted as part of this Complaint are

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171 *See, e.g., Astoria Generating Co., L.P. v. New York Indep. Sys. Operator, Inc.*, 136 FERC ¶ 61,155 (2011) (setting forth a protective order that restricted access to "Highly Sensitive Protected Materials").

172 LS Power has modified the Model Protective Order by (1) attaching a separate "Non-Disclosure Certificate for Competitive Duty Personnel" and expanding the definition of "Non-Disclosure Certificate" in Section 3.D accordingly; (2) adding a new subparagraph (ii) to paragraph 3.E in order to specify that only those persons qualifying as "Highly Confidential Reviewing Representatives" may have access to Highly Confidential Privileged Materials; and (3) including defined terms for "Competitive Duties" (new paragraph 3.F) and "Competitive Duty Personnel" (new paragraph 3.G). The other changes to the Model Protective Order involve deleting or modifying provisions addressing oil pipeline proceedings, or are non-substantive.

Highly Confidential Privileged Materials, the non-public version of this Complaint will only be provided to individuals who are eligible Reviewing Representatives under paragraph 3.E.ii of the proposed Protective Agreement.[173]

Notwithstanding the proposed Protective Agreement, LS Power wishes to make clear that the non-public materials, including those designated as Highly Confidential Privileged Materials, should be treated as privileged materials reviewable by Commission Staff.

The non-public materials are marked "CONTAINS PRIVILEGED INFORMATION" and "DO NOT RELEASE." In addition, in accordance with the Commission's notice on labelling of non-public information,[174] each page of the non-public version of this filing is marked "CUI//PRIV." The highly sensitive, non-public materials not available for review by Competitive Duty Personnel are also marked "CONTAINS HIGHLY CONFIDENTIAL PRIVILEGED MATERIALS."[175]

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[173] LS Power will provide the non-public version of this Complaint to inside employees of non-governmental entities other than PJM and the IMM pursuant to paragraph 3.E.ii.e of the Protective Agreement as mutually agreed by the requesting entity and LS Power. Requests to designate inside employees as Highly Confidential Reviewing Representatives pursuant to paragraph 3.E.ii.e should be made by e-mail to the same individuals identified above and should include an executed non-disclosure certificate and the following information:

(1) The name and e-mail address of the individual;

(2) The name of the party requesting the designation;

(3) The employer of the individual;

(4) The individual's title and a brief description of the individual's job description and responsibilities; and

(5) Whether the individual is directly involved in, or has direct or supervisory responsibilities over, the purchase, sale, or marketing of electricity (including transmission service) at retail or wholesale, the negotiation or development of participation or cost-sharing arrangements for transmission or generation facilities, or other activities or transactions of a type with respect to which the disclosure of Highly Confidential Privileged Materials may present an unreasonable risk of harm.

[174] *See* Notice of Document Labelling Guidance for Documents Submitted to or Filed with the Commission or Commission Staff, 83 Fed. Reg. 28,631 (June 20, 2018).

[175] All of the non-public materials submitted as part of this Complaint are designated as Highly Confidential Privileged Materials.

VII.

OTHER MATTERS

A. Other Proceedings

Pursuant to Rule 206(b)(6) of the Commission's Rules of Practice and Procedure,[176] LS Power states that the issues presented in this Complaint are not pending before the Commission in any other proceeding.

B. Negotiations among the Parties

As described herein, LS Power has discussed its concerns regarding the OCA determinations for various LS Power resources with PJM and the IMM and was eventually able to reach agreement with the IMM regarding certain of the OCA determinations. However, LS Power has not been able to reach agreement with the IMM regarding certain aspects of the IMM Calculator, including, for example, with respect to the treatment of no-load and start-up costs. Discussions with PJM and the IMM have also not addressed LS Power's concerns regarding the lack of transparency and PJM's procedures with respect to the calculation of OCAs. Accordingly, LS Power does not believe that further informal discussions provide a means of addressing the concerns that have prompted this Complaint in a timely way.

In accordance with Rule 206(b)(9) of the Commission's Rules of Practice and Procedure,[177] LS Power states that it has not discussed the subject matter of this Complaint with the Commission's Office of Enforcement. While LS Power believes that PJM and the IMM have violated requirements of the Operating Agreement, it does not believe that the nature of these violations lend themselves to resolution by the Office of Enforcement.

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[176] 18 C.F.R. § 385.206(b)(6) (2023).

[177] 18 C.F.R. § 385.206(b)(9) (2023).

C. Financial Impact

While the financial impact cannot be estimated with precision, the erroneous OCAs derived by the IMM Calculator have, as discussed in the Griffiths Affidavit, resulted in significant financial harm by forcing LS Power to submit energy offers that fail to reflect its opportunity costs and by causing LS Power's units to deplete their limited run hours in lower-priced periods and therefore be unable to operate when prices are higher. In addition, Dr. Sotkiewicz further explains that the financial harm is not limited to LS Power but extends to other market participants and the PJM region as a whole.

D. Service and Form of Notice

In accordance with Rule 206(c) of the Commission's Rules of Practice and Procedure,[178] LS Power is serving a copy of this Complaint on the respondents, PJM and the IMM.

In accordance with Rule 206(b)(10) of the Commission's Rules of Practice and Procedure,[179] a form of notice suitable for publication in the Federal Register is provided in Attachment E.

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[178] 18 C.F.R. § 385.206(c) (2023).

[179] 18 C.F.R. § 385.206(b)(10) (2023).

VIII.

CONCLUSION

WHEREFORE, for the foregoing reasons, LS Power respectfully requests that the Commission issue an order granting this Complaint and ordering the relief requested herein.

Respectfully submitted,

LS POWER DEVELOPMENT, LLC

By: *__/s/ Neil L. Levy__*

Neil L. Levy
David G. Tewksbury
Stephanie S. Lim
McDermott Will & Emery LLP
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500 North Capitol Street, NW
Washington, DC 20001

Marjorie Rosenbluth Philips
Senior Vice President, Wholesale Market Policy
Benjamin Griffiths
Vice President, Wholesale Market Policy
LS Power Group
1700 Broadway, 35th Floor
New York, NY 10019

On behalf of **LS Power Development, LLC**

Dated: March 20, 2024

CERTIFICATE OF SERVICE

I hereby certify that I have this day served the foregoing document on the respondents, PJM Interconnection, L.L.C. and Monitoring Analytics, LLC.

Dated at Washington, D.C., this 20th day of March, 2024.

/s/ Stephanie S. Lim
Stephanie S. Lim

Attachment A

The Griffiths Affidavit

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

LS Power Development, LLC,	)	
	)	
Complainant,	)	
	)	
v.	)	
	)	**Docket No. EL24-__-000**
PJM Interconnection, L.L.C. and Monitoring Analytics, LLC, as the Independent Market Monitor for PJM,	)	
	)	
Respondents.	)	

AFFIDAVIT OF BENJAMIN W. GRIFFITHS
<u>ON BEHALF OF LS POWER DEVELOPMENT, LLC</u>

<u>I. INTRODUCTION</u>

1. My name is Benjamin W. Griffiths. I am Vice President, Wholesale Market Policy, of LS Power Development, LLC and its subsidiaries and affiliates (together, "LS Power"). My business address is 1700 Broadway, 35th floor, New York, NY 10019.

2. I am providing this affidavit in support of LS Power's complaint concerning opportunity cost adders ("OCAs") for emissions-limited units calculated by Monitoring Analytics, LLC, the Independent Market Monitor for PJM ("IMM"), under the process approved by PJM Interconnection, L.L.C. ("PJM"). I have firsthand experience of the problems LS Power has identified with the OCAs calculated by the IMM, and with the process by which LS Power has attempted to address those problems with the IMM and PJM.

3. The purpose of this affidavit is to discuss LS Power's concerns regarding the IMM's OCA calculations and process for determining OCAs in PJM. LS Power has harbored concerns about the accuracy of the IMM's OCA estimates for some time, and as I explain herein, I

began looking in depth at the IMM's OCAs beginning in April 2022, after observing particularly dramatic differences between our internal expectations and the IMM's posted values. This led to a two-year attempt to address our concerns regarding the IMM's OCAs. However, LS Power (and presumably other market participants) have little, if any, insight into the OCA calculation process and therefore little recourse if they suspect there is a problem with the IMM's calculations. Accordingly, over the past two years, I have spent hundreds of hours trying to ensure that OCAs for LS Power's units properly reflect their opportunity costs but have repeatedly encountered problems because of the lack of transparency with respect to the IMM's OCA calculations. As a result of this lack of transparency, I have been repeatedly forced to attempt to replicate the IMM's results, and to guess at the inputs and approach employed by the IMM in its calculations. During that process, I repeatedly attempted but failed to obtain additional information from the IMM regarding its calculations. It was only after months of these efforts (and PJM's input) that I was able to identify errors in the IMM's modeling and inputs with respect to the OCAs for certain of LS Power's units, but we continue to have substantial questions and concerns regarding the IMM's OCA calculations. The delays in resolving these issues have meant that LS Power's OCAs remained unreasonably low for months on end, and continue to remain unreasonably low, which has harmed LS Power and, in all likelihood, the market as a whole.

II. QUALIFICATIONS

4. I have spent the past decade working in the electric power industry and the past five years working on wholesale power markets in eastern regional transmission organizations ("RTOs") and independent system operators ("ISOs"). At LS Power, I provide qualitative

and quantitative analysis of issues involving the market rules of RTOs and ISOs like PJM and ISO New England Inc. ("ISO-NE").

5. Before joining LS Power in 2021, I worked for the Massachusetts Attorney General as an energy analyst focusing on matters relating to ISO-NE, the Federal Energy Regulatory Commission, and the Massachusetts Department of Public Utilities. Earlier, I was employed by Resource Insight, Inc., a Massachusetts-based consulting firm specializing in the regulation of electric and gas utilities, focusing on resource planning and rate design. I hold an M.S. in Energy & Earth Resources from the University of Texas at Austin and a B.A. in Classics from Boston University. I have taken coursework in statistics, probability, numerical modeling and techniques, and decision analysis. I have also testified before state and federal regulators and authored or co-authored reports, whitepapers, and a peer-reviewed journal article on various electricity-related topics. Of particular interest here, I have developed numerous techno-economic optimization models focusing on various aspects of the power sector.

6. My complete curriculum vitae is attached to this affidavit as Appendix A.

III. THE CALCULATION OF OCAS IN PJM

7. Through subsidiaries and affiliates, LS Power develops, owns, and operates independent power projects and merchant transmission projects in the United States, including generating facilities in the PJM market. These units are subject to environmental permits that limit how, when, and how much such units can be used to produce electricity. For example, air permits can limit the quantity of certain pollutants emitted by a unit or by a group of units that comprise a single facility over a specified period. These types of permits can curtail otherwise profitable dispatch. For example, it may be profitable for a peaking facility to run in 15% of hours over the course of the year, based purely on its operating

costs and market prices, but the facility is limited to operating in just 10% of hours under its air permit. An efficiently dispatched unit will want to run in the 10% of hours that are most profit maximizing and forego generation in the other 5% of hours that are less profitable. The problem is, however, that resources with PJM capacity obligations are required to submit daily offers into the day-ahead market, meaning that resources cannot simply "opt out" of the market so that they will be available on days with expected higher prices. PJM and other RTOs therefore rely on OCAs to "price in" the expected value of high value generation at a future point in time.

8. Dr. Paul M. Sotkiewicz is providing a separate affidavit addressing the importance of ensuring that sellers are able to fully reflect their marginal costs in their cost-based offers, including the opportunity costs associated with not being able to sell power in other time periods. Dr. Sotkiewicz also provides a history of the development of PJM's rules relating to OCAs.

9. PJM's current rules now require any market participants that want to include an OCA component in their offers to request an OCA from the IMM.[1] Under the process described in Section 12.7 of PJM's Manual 15, the IMM uses a proprietary and confidential model (referred to as the "Opportunity Cost Calculator" or "OCC") to simulate how a power plant would operate in the future based on expected future market prices and environmental permit limitations.[2] In doing so, Manual 15 states that the IMM's Opportunity Cost

[1] *See* PJM, *PJM Manual 15: Cost Development Guidelines* (Revision 44, Aug. 1, 2023) ("Manual 15"), Section 12.1.

[2] Manual 15 states that, for purposes of calculating the OCA:

> The Opportunity Cost Calculator selects the hours of operation that will maximize the generator's energy market revenue net of the generator's short run marginal cost of producing energy, subject to the unit specific

Calculator relies on the following inputs: "unit specific forward [Locational Marginal Prices ("LMPs")] based on futures prices, unit specific forward fuel prices based on futures or contract prices, and unit specific operating parameters."[3] Based on Manual 15 and my experience, the IMM uses the following forecasts in its OCA calculations:

- A forecast of future hourly power prices over the next year. For these purposes, future power prices are computed on an hourly basis by pairing historic hourly nodal pricing patterns with monthly futures contract prices at Western Hub, adjusting for the basis differential between the unit's node and the hub.[4] In order to reflect the fact that different historical periods have different pricing patterns, the IMM computes three sets of forward prices, based on the three most recent years of historical data.
- A forecast of what it would cost to produce electricity at the unit, on an hourly basis (including fuel costs, start-up costs, and operating costs), based on a mixture of forecasts and observed costs. Fuel costs are based on a forecast, which is computed

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> environmental or operational limits. The duration and structure (i.e. rolling compliance periods or a single compliance period) of the optimization period will be as specified in an environmental permit for environmental limitations, or as specified by the original equipment manufacturer or insurance carrier for physical equipment limitations….
>
> Inputs into the Opportunity Cost Calculator will include unit specific forward LMPs based on futures prices, unit specific forward fuel prices based on futures or contract prices, and unit specific operating parameters.

Id., Section 12.7.1.

3 *Id.*

4 *Id.*, Section 12.7.2. This section includes significant ambiguity including with respect to the potential to rely on future contracts for a "frequently traded PJM hub" other than Western Hub, the treatment of leap-days, how historic periods are "mapped" to future ones, and how basis adjustments and volatility scalers are computed. This stands in contrast to the formulaic precision offered in the older PJM forecasting methodology articulated in Section 12.5 of Manual 15.

using the same basic approach used for power prices: applying future contract prices to historic, observed gas prices. Unit operating parameters, such as start-up costs, variable operation and maintenance costs ("O&M"), heat-rates, and the like are IMM-approved values based on observation.[5] In addition, market participants provide emission rates to the IMM, which reflect, for each monitored pollutant, the emissions produced per start and per MMBtu of gas consumption. The IMM must also approve these emission rates for use in the OCA calculations.

- An assessment of how much the unit can run in the future period while complying with the terms of its air permit, based on how much it has run in the past. Emissions history is based on run-data submitted on a weekly basis to the IMM by the market participant, and the IMM relies on this emissions history to compute the quantity of emissions remaining on each of the period periods.[6]

The IMM's Opportunity Cost Calculator then simulates how a unit should run based on these prices, costs, and limits. This Opportunity Cost Calculator is intended to "select[] the hours of operation that will maximize the generator's energy market revenue net of the generator's short run marginal cost of producing energy, subject to the unit specific environmental or operational limits."[7] The IMM describes the Opportunity Cost Calculator as using "an integer programming solver that finds the maximum energy market revenue net of the generator's short run marginal cost of producing energy while simultaneously

5 *Id.*, Section 12.7.4.

6 *Id.*, Section 12.7.5.

7 *Id.*, Section 12.7.1.

satisfying all generator parameter limits (e.g. minimum run time, economic minimum economic maximum) and environmental or operational limits."[8]

10. To my knowledge, the IMM has never provided market participants with any details about how this model works "under the hood" – no formal mathematical formulation of optimization's objective function or the various constraints limiting operation; no executable code to allow for reproducing results; no numerical examples that describe how it works. Based on the limited information in Manual 15, my understanding is that the IMM uses this model to compute OCAs in four steps. First, the IMM runs its optimization model to simulate a unit's optimal dispatch over the next year, subject to operational limitations and environmental permit limits (the "Base Case"). Second, the IMM then investigates this Base Case dispatch to identify the "earliest binding" permit period, if any – i.e., the first month when the unit is anticipated to hit its emissions limit. The IMM decrements this environmental permit limit by the equivalent of 1 MWh, then reruns the optimization model holding all else equal, ignoring dispatch after this earliest binding constraint (the "Alternative Case"). Third, the IMM subtracts the profits in the Alternative Case from the profits in the Base Case, between the first day of the model period and the "earliest binding" constraint, to estimate the foregone value of a 1 MWh reduction in output. This change in profit is the OCA for one pricing scenario. Fourth, to account for natural variations in pricing patterns, the IMM runs Steps 1-3 on each of the three different sets of forward prices, based on the three most recent years of pricing data. The IMM's

8 *Id.*, Section 12.7.6, footnote 2.

final OCA for a given week equals the simple average of the OCAs in those three scenarios.[9]

11. OCAs are calculated by the IMM for market participants on a weekly basis (more often if a unit is approaching a permit limit). The only information released to the market participant from this process is the final OCA, which is a single dollar-per-MWh value. In my experience, the IMM will not provide to market participants any "intermediate" results, such as the forward prices or simulated unit operation.

IV. LS POWER'S EXPERIENCE WITH OCAS FOR ITS PEAKING FACILITIES IN COMED

12. LS Power owns 31 peaking units, spread across four facilities, in the ComEd zone in Illinois. Each of these 31 units is subject to strict emissions limits under the Climate and Equitable Jobs Act ("CEJA") passed by the Illinois legislature in September 2021. Under CEJA, all privately-owned combustion turbines ("CTs"), like LS Power's peaking units, are required to reduce all carbon dioxide ("CO_2") and copollutant emissions[10] to zero by January 1, 2030 or January 1, 2035, depending on location. CEJA also imposes decreasing, year-over-year limits on emissions from CO_2 and other co-pollutants in the intervening years.

13. Under PJM's rules, LS Power's Illinois units are subject to cost-based energy offer caps, which include OCAs calculated using the IMM's Opportunity Cost Calculator. Although LS Power has had questions regarding the IMM's OCAs for a while, elevated power market prices in 2022 amplified our concerns and drove us to focus a lot more closely on the

[9] *Id.*, Section 12.7.6 ("The opportunity cost adder is calculated as the average of the three opportunity cost values corresponding to the three sets of forward LMPs and forward delivered fuel prices.").

[10] In addition to CO_2, Illinois criteria pollutants include carbon monoxide ("CO"), nitrogen oxides ("NO_x"), sulfur dioxide ("SO_2"), particulate matter ("PM"), and volatile organic compounds ("VOC").

OCAs. Starting in April 2022, LS Power's Energy Management and Trading team became especially concerned about the IMM-generated OCAs being imposed on LS Power's ComEd peakers because there was a significant difference between the values computed by the IMM and the values LS Power was estimating internally. Having had experience developing OCAs in another wholesale market, I was asked to see if I could reconcile the two OCA estimates. In my experience, when estimates for the same notional thing are dramatically different there must be a cause, such as a difference in methodology or a difference in forward expectations. Through careful evaluation of models and their inputs and outputs, it should generally be possible to get the two values to converge, or at least understand what assumptions keep the values from converging. I think of this process as a form of spelunking – poking around in the inner recesses of a model to identify potential issues that might yield inaccurate results.

14. An example from early May 2022 shows the magnitude of the gap between the IMM's and LS Power's estimates. LS Power indirectly owns the Aurora Generating Station ("Aurora"), which has a set of six LM6000 aero-derivative peakers (Units 5 through 10). For the one-week period from May 2, 2022 through May 8, 2022, the IMM was calculating individual OCAs for each of the six Aurora units ranging from \$1.94/MWh to \$9.74/MWh. At the same time, however, I estimated OCAs for these same units to be in the range of \$50/MWh, roughly five-times higher.

15. My OCA estimate of around \$50/MWh was based on a very simple analysis. First, I used publicly-available data to estimate LMPs and gas costs for the next year.[11] I then subtracted

[11] More specifically, I created forward hourly LMPs by taking historic LMPs for the Northern Illinois Hub and then scaling each hour's price by the ratio of the forward price for the relevant month, year, and period and the historic price for that same month, year, and period. Aurora LMPs were very similar to the

expected hourly operating costs, including amortized start costs, from the forward LMPs to compute margin for each hour of that year. Finally, I sorted these hourly margin estimates from most profitable to least. From this basic approach, I found that there were 4,869 hours where the LMP was expected to exceed the cost to dispatch the unit over the next year. At the same time, based on their emissions limitations under CEJA, each of the Aurora LM6000 units were expected to have run-hour limits of approximately [redacted] hours per rolling year. Because there were many more profitable hours than the permit would allow, this meant that the OCA must be higher than zero. But how much? To find out, I looked at the expected profit from the [redacted] most valuable hour – that is, the least valuable hour in which the unit would still want to run – and found that the profit margin was $47.25/MWh. Adjacent hours had the same sort of margin, so this estimate was not particularly sensitive to different run hour limitation assumptions. From my analysis, I concluded that OCAs for the Aurora LM6000 units should have been in the $47/MWh range.

16. I will be the first to admit that this analysis was relatively simple and did not factor in some operational limitations that might reduce the level of profitable dispatch and reduce OCAs.[12] On the other hand, this analysis also did not account for the fact that the unit had already used up some of its emissions for the year, which would tend to increase OCAs.

Northern Illinois Hub, so I did not attempt to make a basis adjustment to reflect pricing differences between the Aurora node and this hub. For natural gas prices, I relied on the monthly price for Chicago Citygate, and assumed that the price of gas was constant for each day of the month. Forward prices for power and gas were sourced from the Intercontinental Exchange ("ICE").

[12] As discussed below, we remedied these shortfalls over the summer of 2022 with increasingly sophisticated forecasts and dispatch models.

Nonetheless, it was concerning that there was such a large difference (dozens of dollars, not a few cents) between my estimate and the IMM's OCA calculations.

17. Around this same time, I also observed IMM-generated OCAs that did not seem to align with economic theory or underlying facts. For example, the table below depicts OCAs for Aurora Units 5 through 10 for a six-week period from April-June 2022. Each of these technologically identical units (GE LM6000s) has the same basic operational parameters, same basic emissions profile, and same basic dispatch history. For this reason, I had expected similar OCAs at each of these Aurora units. In addition, I expected that the OCAs would increase over the course of the month as the units were dispatched and therefore remaining run hours under their permits decreased. As shown in Table 1 below, however, those two expectations did not hold.

Table 1: Aurora 5-10 OCAs by Calculation Date, May 2022 ($/MWh)

OCA Valid Period (for DA Offers)	IMM OCA ($/MWh) Facility	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
5/2/2022 through 5/8/2022	$16.31	$6.12	$3.94	$9.74	$1.94	$3.86	$7.94
5/9/2022 through 5/15/2022	$33.61	$22.05	$8.17	$32.30	$8.76	$10.67	$20.45
5/16/2022 through 5/22/2022	$15.66	$6.25	$9.69	$28.83	$6.77	$9.70	$18.03
5/23/2022 through 5/29/2022	$22.67	$6.20	$3.66	$21.67	$19.20	$22.61	$13.46
5/30/2022 through 6/5/2022	$8.81	$7.46	$3.81	$19.22	$4.72	$7.05	$4.93

18. Contrary to expectations, values between the Aurora LM6000 units varied widely within weeks and between weeks. For example, in the first week of May 2022, there was a five-fold difference in the OCA between the LM6000 at the site with the highest OCA and the LM6000 with the lowest (Unit 7 had an OCA of $9.74/MWh while Unit 8 had an OCA of

$1.94/MWh). The facility-wide OCA for this same week was even higher: $16.31/MWh.[13] There were also baffling changes in OCA values between weeks. Unit 5, which had a middle-of-the-road OCA in this first week, saw its OCA increase by 260% the following week (from $6.12/MWh to $22.05/MWh) only to fall again by 72% the week after that (back to $6.25/MWh). While some units followed this low-high-low pattern in the first half of May 2022, not all did. For example, Unit 6 saw its OCA increase week-over-week-over-week in that same period. Later, between the third and fourth weeks of May 2022, four of the six units saw their OCAs decrease while the OCAs for Units 8 and 9 more than doubled. The reason for these divergences was never clear, and this raised a number of other questions. For example, what could account for these big week-over-week swings? If the forward curve had shifted down due to more bearish market expectations, why didn't *all* of the OCAs drop commensurately?

19. During this same timeframe, a different set of units at Aurora (three GE 7EA simple cycle turbines) had similarly erratic OCAs. One of the three units saw its OCA drop from $102/MWh to $39/MWh and then increase back to $91/MWh over three successive weeks, while the other two units maintained relatively stable values. Again, there was no clear explanation for this.

20. In light of these issues, beginning in mid-May 2022, I began trying in earnest to reconcile our OCA estimation approach with that of the IMM. My goal was to refine my modeling

[13] At Aurora, LS Power was allowed to rely on the higher of the unit-specific OCA or the facility-wide OCA. The former was computed based on specific run-limits of each individual turbine while the latter aggregated emissions onto a facility-wide level. The unit-specific estimates, at least in theory, should have been the more precise OCA values.

with the hope of closing the gap between our respective estimates and better understanding of the week-to-week variations in the IMM's results.

21. My first step in trying to reconcile our results was to shift to a more sophisticated dispatch model that could better reflect unit offer costs and the matrix of the overlapping permit constraints. To do so, I created a linear programming ("LP") based optimization model which dispatched a unit against hourly, forward-adjusted prices and accounted for unit costs. I attempted to mimic the IMM's approach to estimate forward prices (though, as discussed below, I later made subsequent changes based on the IMM's input). This LP model focused on limiting run hours rather than limiting emissions explicitly, but these are closely correlated for LS Power's units, which are peaking units that tend to run near full output or not at all. The simple model could not track start-up emissions either, but I amortized these costs to ensure that they were reflected. While this model did not have all the bells and whistles of more precise models, it did capture the most salient features – hourly price curves, unit dispatch, start-up cost tracking, rolling 12-month permit limits, and the like.[14] My LP model suggested that the OCAs for Aurora should be in the $39.31/MWh to $48.67/MWh range – just slightly lower than the simple rank-based approach I initially employed.[15] These new optimization-based results were *still* an order

[14] I described this model in a memorandum that I provided to the IMM. *See* E-mail from Benjamin Griffiths (May 18, 2022, 4:47 PM) (provided as Attachment A-1); Memorandum from LS Power to Monitoring Analytics re: Proposed Opportunity Cost Adder for Aurora (May 18, 2022) (provided as Attachment A-1.1).

[15] Conservatively assuming that none of the unit's run hours had been used to date, the LP model estimated that Aurora 8 should have an OCA of $40/MWh if scheduled optimally, or $31.26/MWh if it could only be dispatched in eight-hour blocks. In reality, the unit had exhausted about half of its emissions limit from prior generation, so the OCA was likely higher.

of magnitude higher than what the IMM was estimating. It was therefore clear that I needed additional information to understand how the IMM was calculating the OCAs.

22. Given the gap between LS Power's estimated OCAs and those generated by the IMM, as well as the perplexing OCAs shown above, LS Power decided to reach out to the IMM. At that time, we thought the most productive path forward would be to share all of our work so that we could discuss those discrepancies with the IMM. On May 18, 2022, I provided the IMM with our basic OCA model, including all data inputs, executable code to run the optimization, and a memo explaining how the model was formulated.[16]

23. A week later, on May 25, 2022, the IMM returned with its review of my LP model and identified 11 differences between my approach and the IMM's.[17] The differences identified by the IMM included [redacted]. The IMM offered no discussion about whether any of these modeling differences were material, merely that they existed.

24. Based on the IMM's response, I then modified my model to account for and eliminate each of the differences identified by the IMM. However, even with these adjustments, I found that there were still significant differences between my OCA calculations and those of the IMM. Accordingly, I then sent the IMM two memorandums explaining that none of the 11 methodological differences identified by the IMM explained the gap between our

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16 *See* E-mail from Benjamin Griffiths (May 18, 2022, 4:47 PM) (provided as Attachment A-1); Memorandum from LS Power to Monitoring Analytics re: Proposed Opportunity Cost Adder for Aurora (May 18, 2022) (provided as Attachment A-1.1).

17 *See* Memorandum from Monitoring Analytics to LS Power re: LS Power Opportunity Cost Calculator (May 25, 2022) (provided as Attachment A-2).

calculations and those of the IMM.[18] At that time, I again provided the IMM with our working model so that the IMM could verify our findings. We also asked the IMM for more information regarding its model and the calculation of OCAs. These included questions like: [redacted][19] The IMM did not respond to our questions.

25. Towards the end of June 2022, LS Power called PJM staff about the large gap between our calculations and those of the IMM and explained that the IMM had not sufficiently explained why its results differed so dramatically from ours. I also provided a memorandum explaining that there was a large, persistent gap in our results and those of the IMM, and requested disclosure of intermediate outputs of the IMM model to help us align on accurate results.[20]

26. On July 6, 2022, we had a follow-up phone call with both PJM and IMM staff where we asked the IMM if it could provide its Opportunity Cost Calculator model, or at least the inputs and outputs from its model, so that we could see how the model was arriving at its results. The IMM refused to provide any supplemental information on how its model worked beyond what was written in Manual 15. The IMM also refused to provide any

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[18] *See* E-mail from Benjamin Griffiths (May 31, 2022, 5:20 PM) (provided as Attachment A-3); Memorandum from LS Power to Monitoring Analytics re: IMM Identified Differences in OC Methodology do not explain the Gap (May 31, 2022) (provided as Attachment A-3.1); E-mail from Marjorie Philips (June 8, 2022, 11:43 AM) (provided as Attachment A-4); Memorandum from LS Power to Monitoring Analytics re: Proposed Opportunity Cost Adder for Aurora using Basis-Adjusted Western Hub Forwards and Three Study Periods (June 8, 2022) (provided as Attachment A-4.1).

[19] E-mail from Benjamin Griffiths (May 31, 2022, 5:20 PM) (provided as Attachment A-3).

[20] *See* E-mail from Benjamin Griffiths (June 24, 2022, 4:00 PM) (provided as Attachment A-5); Memorandum from LS Power to PJM re: Calculating Opportunity Costs adders for LS Assets (June 24, 2022) (provided as Attachment A-5.1).

historical results that could provide insight into how OCAs were generated, even using "stale" data. Instead, the IMM focused on certain methodological choices in my modeling. In particular, the IMM expressed concern that the LP model used by LS Power could not fully capture start-up dynamics because of its linear programming formulation.[21] PJM asked follow-up questions around details about price forecasting and emission rate estimation, to which I responded a couple of days later with a memorandum detailing my calculations.[22]

27. To address the IMM's modeling concerns, later that week, LS Power spent more than $10,000 for an expensive commercial optimization solver to improve my model and address the minimum runtime and start-up differences identified by the IMM, again with the goal of trying to replicate the IMM's calculations. This enhanced model was a mixed integer programming ("MIP") model that would allow me to mirror the IMM's modeling process as described in Section 12.7.6 of Manual 15. Accordingly, my MIP model reflected commitment and dispatch logic, tracked emissions from start-up and operating hours, tracked all criteria pollutants assessed by CEJA, included min-run and min-down times, and computed OCAs across three "base" pricing years. Based on the description in Manual 15,[23] I also attempted to mimic the IMM's forecasting methodology for power and

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21 In the real world there can be certain variables that exist only in certain states. For example, a unit is either committed to run or it is not; a unit is either "starting up" or "not starting up." There is no "sort of starting up". Integer variables like those allowed in a mixed *integer* model models can reflect these discrete states of the world. Linear programs, which can only express *continuous* variable, cannot.

22 *See* E-mail from Benjamin Griffiths (July 8, 2022, 1:00 PM) (provided as part of e-mail chain in Attachment A-6); Memorandum from Benjamin Griffiths on Calculating Input LMPs for OCA Modeling (July 6, 2022) (provided as Attachment A-6.1).

23 *See* Manual 15, Sections 12.7.2 and 12.7.3.

gas prices to ensure that my model's inputs matched those of the IMM and would provide an apples-to-apples comparison to the IMM's results.

28. Again, my goal with the MIP model was to recreate the IMM's results, so that I could better understand the IMM's process and have better insight on why our estimations were so different from the IMM's. However, Manual 15 Section 12.7.6 does not provide nearly enough detail to ensure a 1-for-1 replica of the IMM's approach. All models – including the IMM's OCA optimization model – are full of dozens, perhaps hundreds, of distinct methodological choices. The current version of LS Power's OCA model is several thousand lines of code long, and I assume the IMM's is in that same range. Each line of that code reflects a choice about how to implement the broad goal outlined in Section 12.7.6 of Manual 15.[24]

29. While I attempted to replicate the IMM's model, it became clear that I had not succeeded because my new MIP model continued to produce significantly higher OCAs compared to those of the IMM. This was true not only for the Aurora units. I also applied this new MIP model to look at other units in the LS Power fleet. At each facility I modeled, I found a significant gap in my results and those of the IMM.

30. Finally, in late July 2022, three months after I had started looking at the issue, I discovered what I believed was the cause of the discrepancy between our results and those of the IMM. Specifically, in going through our model results for LS Power's units at the Rockford Energy Center ("Rockford") in Rockford, Illinois, and others in the state with a fine-tooth

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24 To name just a few choices: (a) How should various aspects of a unit's cost-based offer be reflected, including start-up costs, variable O&M costs, no-load costs? (b) How should various aspects of a unit's operational characteristics such as eco-max, eco-min, min-run and min-down time be incorporated? (c) What kind of optimization solver should be used? (d) How precise should the dispatch results be (i.e., the tightness of the mixed-integer program gap)?

comb, I realized that the discrepancy in results was likely due to the IMM only tracking a single criteria pollutant (CO), whereas my own model was tracking all of them (CO, CO_2, SO_2, NO_x, PM). Upon further inquiry with our internal LS Power team, it turned out that members of LS Power's team previously agreed with the IMM that it made sense to only model CO to limit the administrative burden, because CO limitations are the most stringent ones our units face in the real world. Unfortunately, by exclusively focusing on CO, the IMM's optimization model yielded dispatch that was "feasible" within the context of the model but would have been illegal in the real world. All else equal, an OCA model only factoring CO restrictions into dispatch would dispatch our Rockford units about 2,000 hours per year. However, in the real world, our Rockford units are subject to multiple criteria pollutants – CO, CO_2, SO_2, NO_x, and PM 2.5 – and are therefore limited to approximately only [redacted] hours of dispatch per year. This is because CO emissions are very high on start-up but very low during normal operations, so the IMM's model would rarely turn the unit on but then leave it on for a long time once started because an incremental run hour was nearly "costless" from a CO emissions standpoint. In the real world, however, that same extra hour would be "costly" from a CO_2, NO_x or SO_2 standpoint because for those pollutants, the more the unit is run, the more emissions are produced. As a result, CEJA limited the Rockford units to about [redacted] hours of run-time, and were LS Power to run any of the Rockford units for 2,000 hours per year as modeled by the IMM, it would be in violation of its Title V air permit. A unit which has a stricter permit should have a higher OCA, all else equal. In my estimate, accounting for all criteria pollutants rather than just CO would increase the Rockford OCA from the IMM's estimate of $0.59/MWh to $38.40 – a 65-fold increase.

31. On July 22, 2022, I passed this information to the IMM, including a simple way to diagnose the problem: if the IMM's model was indicating that Rockford could run for approximately 2,000 hours per year – then it was in error.[25] However, the IMM did not respond.

32. To follow up, on July 31, 2022, we asked the IMM: [redacted][26] The IMM responded [redacted][27] I subsequently asked the IMM [redacted][28] but the IMM did not respond.

33. Given the lack of a response from the IMM, we again reached out to PJM staff to discuss the problem. Our hope was that, while the IMM would not disclose any modeling results to us, it might be willing to share intermediate results (including simulated dispatch) with PJM.

34. Around the same time we were talking with PJM staff about these issues, we also continued our discussions with IMM staff. On August 2, 2022, the IMM noted: [redacted]

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25 *See* E-mail from Benjamin Griffiths (July 22, 2022, 4:25 PM) (provided as Attachment A-7).

26 E-mail from Benjamin Griffiths (July 31, 2022, 10:24 PM) (provided as part of e-mail chain in Attachment A-8).

27 E-mail from Luis Gomez (Aug. 1, 2022, 10:42 AM) (provided as part of e-mail chain in Attachment A-8).

28 *See* E-mail from Benjamin Griffiths (Aug. 1, 2022, 11:23 AM) (provided as part of e-mail chain in Attachment A-8).

[redacted][29]

35. On August 9, 2022, PJM confirmed to LS Power by phone that the IMM model was simulating far higher levels of dispatch at Rockford than our Title V permit would allow, based on PJM's review of OCA modeling data provided by the IMM.

36. A couple of days later, on August 11, 2022, the IMM apparently updated its Rockford model to track other copollutants (which were also added to the Member Information Reporting Application ("MIRA"), which is the IMM's data input website) and OCAs increased 25-fold. Before the change, units at Rockford had OCAs in the range of $0 to $2.47/MWh; after the change, they ranged from $48.94-$53.85/MWh, just a little higher than my estimate from several weeks before. Over the next few weeks, the IMM made the same change to LS Power's other units in Illinois, which also resulted in significantly higher OCAs for each of those units.

37. To be clear, I am not arguing that it was unreasonable for the IMM to have only used a single pollutant (CO) in its modeling. To the contrary, LS Power's team and the IMM both originally believed that this was the most administratively efficient approach. However, the problem is that once I raised the issue of the large gap between our OCAs and those of the IMM, it took over four months to identify the cause of the discrepancy because the IMM was not willing to work cooperatively in the process. Had the IMM been willing to share with us any of the intermediate results from its model or been more willing to take our concerns seriously, the problem could have been identified and resolved much sooner.

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[29] E-mail from Luis Gomez (Aug. 2, 2022, 11:57 AM) (provided as part of e-mail chain in Attachment A-9).

As it stood, LS Power had to devote hundreds of hours of staff time to this problem and spend thousands of dollars on software. While debugging a model can be difficult, it should not have been hard to see that, in the case of Rockford, the IMM's 2,000 simulated run hours was [redacted] times more than the unit had run historically, [redacted] times more than would be allowed to run under the terms of its air permit, and [redacted] times more than the OCA model I developed indicated. Moreover, even when I identified the cause of the problem, the IMM refused to address our concerns, and instead, we had to reach out to PJM to get information regarding the run hours used by the IMM and get the IMM to modify its modeling.

38. Today, the Illinois peakers have OCAs that fall in a more reasonable range, though there are still unexplained results from time to time. But by refusing to work with LS Power, the IMM perpetuated obviously incorrect OCAs for months. This artificially suppressed our cost-based energy market offers for most of the high-value summer season, and quite possibly LMPs for other market participants as well.

V. <u>LS POWER'S EXPERIENCE WITH OCAS FOR ITS CHAMBERSBURG FACILITY</u>

39. LS Power owns two identical peakers at its Chambersburg Generating Facility ("Chambersburg") in Pennsylvania. The Chambersburg facility is subject to a 12-month rolling NO_x limit under its Title V air permit.[30] In practice, the facility-wide 97.7 ton NO_x limit means each unit can run approximately [redacted] hours per year under its air permit. At the same time, Chambersburg is located in an area with transmission constraints and is

[30] *Chambersburg Energy LLC,* Title V/State Operating Permit No: 28-05028, (Mar. 27, 2019) https://files.dep.state.pa.us/Air/AirQuality/AQPortalFiles/Permits/PermitDocuments/1364323[28-05028]_Issued_v2.pdf.

therefore often subject to cost-based mitigation. For example, each of the Chambersburg units was mitigated in about [redacted] of all hours from January 1, 2023 through June 30, 2023.

40. Starting in the spring of 2023, LS Power's energy managers for Chambersburg reached out to me to discuss the OCAs set by the IMM for this facility. The unit was close to its permit limit at the end of April 2023, and the LS Power team was concerned that Chambersburg would hit its limit in May 2023. At that time, the IMM was generating OCAs of zero – meaning that under the IMM's modeling, there was no opportunity cost associated with making sales from Chambersburg because it was expected that there were fewer profitable simulated run hours than hours of permissible generation on the permit.

41. In late April 2023, LS Power asked the IMM questions about how the IMM arrived at the zero OCA for Chambersburg. In response, the IMM took the position that Chambersburg hitting a permit limit was [redacted] and that the [redacted][31] As a result, each day in late March through early May 2023, the Chambersburg units were mitigated and forced to participate in the energy market using a cost-based offer with an IMM-determined OCA of zero until May 12, 2023, as shown in Table 2 below.

Table 2: Chambersburg OCAs by Calculation Date

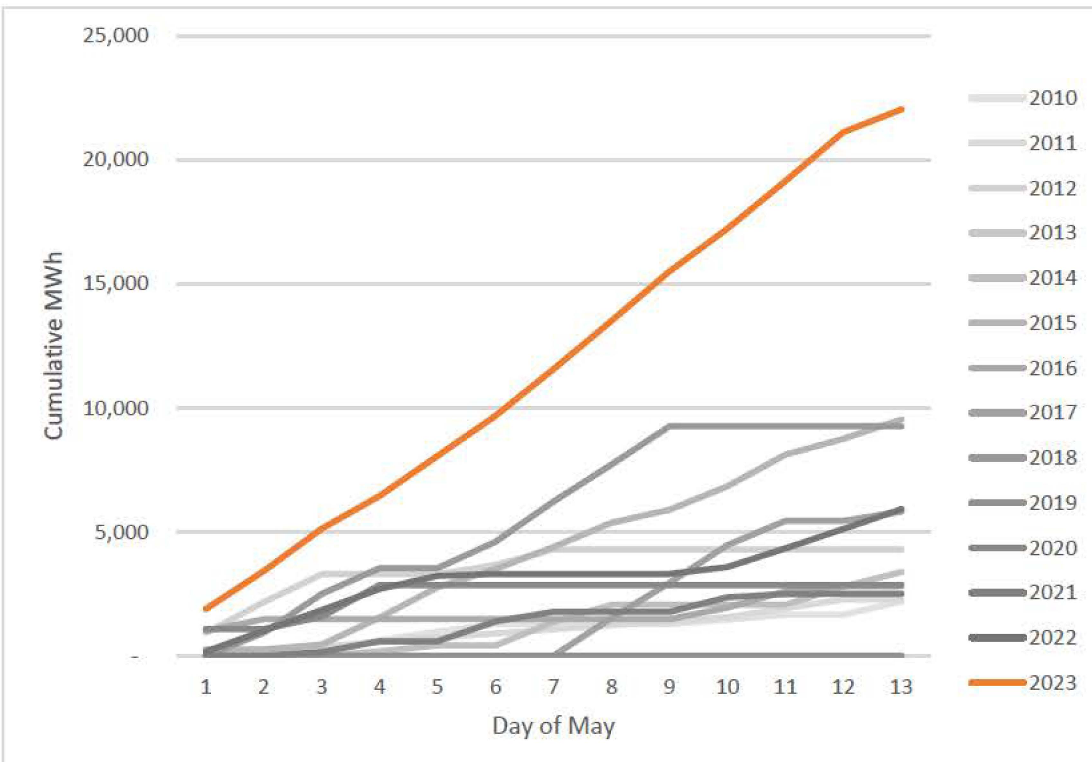
IMM OCA Calc Date	**OCA Valid Period (for DA Offers)**	**IMM OCA ($/MWh)**
3/23/2023	3/27/2023 through 4/2/2023	$0
3/30/2023	4/3/2023 through 4/9/2023	$0
4/6/2023	4/10/2023 through 4/16/2023	$0
4/13/2023	4/17/2023 through 4/23/2023	$0
4/20/2023	4/24//2023 through 4/30/2023	$0
4/27/2023	5/1/2023 through 5/7/2023	$0

[31] E-mail from Luis Gomez (Apr. 28, 2023, 2:27 PM) (provided as part of e-mail chain in Attachment A-10).

5/4/2023	5/8/2023 through 5/14/2023	$0
5/11/2023[32]	5/12/2023 through 5/21/2023	$6.94

42. As a result of the zero OCAs, over the first 13 days in May, the Chambersburg units ran an average of 19 hours per day. This was five times more than typical dispatch looking over the past 13 years, and more than twice as much than the previous record for the same period (see figure below).

<u>Figure 1: Chambersburg Cumulative Generation, May 1-May 13, 2023</u>



43. As the permit limit neared, LS Power repeatedly contacted the IMM trying to get OCAs more in line with our internal modeling,[33] which indicated that Chambersburg's OCAs

[32] The May 11, 2023 OCA was a special OCA run issued after day-ahead offers were submitted for May 12, 2023. Accordingly, LS Power was not able to utilize this OCA until its day-ahead offer for May 13, 2023.

[33] *See* E-mail chain provided in Attachment A-10; E-mail from Benjamin Griffiths (May 11, 2023, 3:10 PM) (provided as Attachment A-11).

should have been in the $10/MWh range in early May 2023 and in the $30 range by mid-month. While these OCAs may not seem particularly high, they would have kept the units from running in most of the lower-value off-peak hours, which would have resulted in the units being able to run in at least some hours that were expected to be higher priced later in the month.[34]

44. Finally on May 11, 2023, after LS Power had submitted its day-ahead offers for May 12, the IMM raised Chambersburg's OCAs to $6.94/MWh but we could only use this for a single day on May 13, 2023 before hitting Chambersburg's permit limit. This $6.94/MWh value itself was itself likely far too low because, at that time, the Chambersburg units only had a few remaining run hours on their permit and it was likely that there would be at least a few hours over the rest of the month with an energy margin of more than $6.94/MWh.[35]

45. That same day, I provided the IMM with my view on two issues that were likely yielding the inaccurately low OCAs: the first related to the IMM's treatment of start-up costs, and the second related to the emissions rates used by the IMM to compute emissions in the dispatch model.[36] In the same message, I estimated Chambersburg's OCA at $23.20/MWh – more than three times the IMM's value.

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[34] At Chambersburg (Node: "GUILFORD138 KV GEN12"), prices for May 1 through May 13, 2023 averaged $33.71/MWh in off-peak hours and $49.41/MWh in on-peak hours – a peak/off-peak spread of $15.70/MWh. An OCA of $6.94/MWh would therefore not have been high enough to have the unit clear only in on-peak hours, because the OCA was less than the typical spread between the off-peak and on-peak periods.

[35] The $6.94/MWh OCA was less than the spread between contemporaneous on-peak and off-peak forwards, meaning that the Chambersburg units would still have run in off-peak hours, rather than more optimally during peak hours. Specifically, forwards settling on May 10, 2023 had on-peak Western hub prices for the balance of May at $36.8/MWh (ICE code "PJM") and off-peak prices for the same hub at $27.72/MWh – a $9.08/MWh difference. Because the IMM-determined OCA was less than the average peak/off-peak spread, it is unsurprising that the Chambersburg units were again dispatched on many hours on May 12, 2023 and May 13, 2023 and hit their permit limit on May 13, 2023.

[36] *See* E-mail from Benjamin Griffiths (May 11, 2023, 3:10 PM) (provided as Attachment A-11).

46. Before the IMM responded to my concerns and even with the increased OCA of \$6.94/MWh in place for May 13, 2023, Chambersburg hit its permit limit at 1:28 PM on May 13, 2023, and went on Max Emergency outage for the rest of the month, making it unavailable to PJM for the 18 remaining days of May 2023, before being able to operate again in June 2023 when emissions from the previous June rolled-off. Had the unit faced a Performance Assessment Interval ("PAI") in this period, it would have been forced to make one of two bad choices: remain on Max Emergency and be subject to a substantial non-performance penalty, or run in the PAI and exceed the air permit limit.

47. While I readily acknowledge that a unit may hit its permit limit under optimal dispatch, the fact that Chambersburg had to go on outage during a month when it had OCAs of zero shows that the OCAs were inefficient and economically absurd. If nothing else, LS Power would have earned more money by running the unit during on-peak hours throughout the month of May rather than running nearly around-the-clock over the first 12 days of the month. To get a sense of the inefficiency of the actual outcome, I estimated how Chambersburg should have run in May based on actual market prices for power and gas, limiting emissions to the level the facility actually produced in May 2023, using the same dispatch model I developed to compute OCAs. This backwards looking model indicated that Chambersburg would have earned approximately \$159,000 in incremental profits if it could have run optimally across the full month, instead of only running in the first half of the month and not at all in the second half. And this estimate understated the true impact of the inaccurately low OCA: because Chambersburg was forced to run more than it should

have in May 2023, it had less MWhs that it could sell in the remaining summer months, where clearing prices would reasonably have been anticipated to be higher.[37]

48. Based on my more fulsome examination of the Chambersburg OCAs, my understanding is that there were at least three problems with the IMM's model, which I shared with the IMM as I discovered them from May through July of 2023: the first related to the treatment of start-up costs computed by the IMM, the second related to the treatment of no-load costs in the IMM's OCC dispatch model, and the third related to the emissions rates used to compute emissions in the dispatch model.[38]

Errors in the Treatment of No-Load Costs

49. No-load costs are a long-standing component of a resource's three-part energy offer. No-load costs reflect the cost to have a generator running at any level. In hours when the generator is online, no-load costs are incurred at a fixed dollar-per-hour rate. In hours when the generator is offline, no-load costs are not incurred. The quantity of generation when online is irrelevant. No load costs are separate and distinct from variable O&M costs, which are a function of how much a unit is generating.

50. The IMM must approve Chambersburg's no-load costs as part of Chambersburg's annual Fuel Cost Policy.[39] LS Power inputted separate no-load costs and variable O&M costs for Chambersburg in MIRA. However, as I looked into the OCAs for Chambersburg, I learned

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[37] Under its permits, Chambersburg is subject to emissions limitations on a staggered rolling basis, so if Chambersburg ran in a given hour today, it simultaneously affects not just how it can run between today and the end of the current month, but also between today and the end of the next month, between today and 12 months from now, and all other periods in between.

[38] *See* E-mail from Benjamin Griffiths (May 11, 2023, 3:10 PM) (provided as Attachment A-11); E-mail from Benjamin Griffiths (May 24, 2023, 9:19 AM) (provided as Attachment A-12); E-mail from Benjamin Griffiths (July 14, 2023, 12:24 PM) (provided as Attachment A-15).

[39] PJM, *Fuel Cost Policy Guidelines* (Version 3, May 3, 2023), https://www.pjm.com/-/media/markets-ops/energy/fuel-cost-policy/fuel-cost-policy-guidelines.ashx.

that certain inputs visible to the market participant are *different* from inputs relied on by the IMM to compute OCAs. Specifically, LS Power had assumed that the IMM would use the approved fuel cost values that LS Power reported in MIRA. However, PJM staff reported to us (and the IMM) that: [redacted][40] This comment was deeply worrying because it suggested that the only inputs we believed we knew went into the IMM's model – our approved inputs – might not actually be used by the IMM's model.

51. As I continued to dig, I learned that the erroneous variable O&M costs resulted from the fact that the IMM's model is unable to reflect no-load costs accurately. Instead, the IMM amortizes no-load costs and converts it into a $/MWh alternative that it then adds to the variable O&M cost.[41] While the IMM initially suggested that this translation of no-load costs from a dollar-per-hour rate into a dollar-per-MWh would not affect the OCA, I provided simple numerical examples to the IMM to demonstrate this was not the case. This is because the IMM's OCA model treats no-load costs as avoidable when they are not.[42] A one MWh reduction in output at a facility (between the OCA "base case" and "alternative case") would have no effect on that unit's no-load costs in the real-world, but in the IMM's OCA model, it would reduce generation costs by the amortized amount and suppress the

[40] E-mail from Glen Boyle (June 2, 2023, 9:37 AM) (provided as Attachment A-13).

[41] *See* E-mail from John Hyatt (June 5, 2023, 6:10 PM) (provided as part of e-mail chain in Attachment A-14) (stating that [redacted]).

[42] *See* E-mail from Benjamin Griffiths (July 14, 2023, 12:24 PM) (provided as Attachment A-15).

resultant OCA by the same quantum. The IMM confirmed that its model suffered from this flaw, although the IMM disputed the magnitude of the problem.[43]

52. I remain unclear about how *exactly* the IMM is computing no load costs and questions to the IMM on this issue remain unanswered.[44] To this day, I am unable to reproduce the IMM's results, and to my knowledge, the IMM has not corrected its model to accurately reflect no-load costs.

Errors in the Treatment of Start-up Costs

53. Some generators, including Chambersburg, have two-part start-up costs: one part is a fixed dollar-per-start charge, the second is a volume of gas bought at the prevailing market rate. The IMM has confirmed that its model cannot actually assess start-up fuel bought at the market price for the day on which it is used, so the IMM instead creates a lump-sum that seeks to reflect both the fixed and fuel components associated with start-up.[45] Unfortunately, the IMM's conversion of fuel costs fails to accurately reflect actual costs. For example:

- On January 27, 2023, the IMM was assuming that our start-up costs were [redacted]/start, which implies an average start-up fuel cost of $17.10/Dth – at a time when the forward strip over the next 12 months was averaging just $3.84/Dth (ICE code "FQT").

[43] *See* E-mail from John Hyatt (July 21, 2023, 3:39 PM) (provided as part of e-mail chain in Attachment A-16) (stating that [redacted]).

[44] *See* E-mail from Benjamin Griffiths (July 31, 2023, 9:24 AM) (provided as part of e-mail chain in Attachment A-17).

[45] *See* E-mail from John Hyatt (June 5, 2023, 6:10 PM) (provided as Attachment A-14) (noting that, [redacted]).

- On April 28, 2023, the IMM was assuming that our start-up costs were [redacted]/start, which implies an average start-up fuel cost of $7.02/Dth – at a time when the forward strip over the next 12 months was averaging just $3.78/Dth.

54. I do not know how the IMM ended up with these artificially high fuel prices, but they did not align with contemporaneous market expectations. Even today, the fuel costs assumed by the IMM are significantly elevated over market prices. These unreasonably high fuel costs resulted in reduced dispatch in the IMM's model and a resulting lower OCA. While LS Power flagged this issue to the IMM, to my knowledge, the IMM has not corrected its model to accurately reflect start-up costs. Instead, the start-up cost values in MIRA periodically change, but we have no insight on how the IMM calculates these values. This is true not only for Chambersburg but also for other LS Power units.

Delays in the Implementation of Changes and Corrections to Emission-Related Inputs

55. Aside from the issues identified above, my experiences indicate that even basic corrections to OCA inputs can take weeks to get implemented. For example, in early May 2023, I noticed Chambersburg's per-MMBtu and per-Start emission rates were inaccurate for reasons similar to what we had experienced with our Illinois peakers. To address this issue for our Illinois peakers, I had developed an approach to partition observed historical emissions compiled by the EPA into start-up related and operations-related rates, and the IMM had approved this methodology for our Illinois peakers in the summer of 2022. Using this exact same approach, data sources, and workbooks, I computed updated start-up and operations emission rates for the Chambersburg facility and provided them to the IMM for review and adoption on May 11, 2023. Despite repeated queries, it took until July 21, 2023 – *i.e.*, 71 days – to get the correct values adopted. Accordingly, Chambersburg was forced

to use inaccurate OCAs for more than two months due to a lack of timely updates by the IMM.

VI. CONCLUSION

56. One important point I wish to emphasize is that I am not arguing that the IMM's OCA model must be "perfect." Instead, it is foreseeable that OCA models will have to be adjusted, corrected, and enhanced on an ongoing basis to make them as accurate as possible. That is precisely why it is important for the IMM to work collaboratively with market participants to identify problems and make necessary changes. LS Power has been ready and willing to collaborate with the IMM on remedying the infirmities of its OCA work for the better part of two years. However, it is hard for LS Power and other market participants to feel confident that the IMM's approach makes sense because much of the IMM's modeling is hidden. In addition, the IMM's defensive stance about its own modeling work creates an unnecessarily antagonistic process for affected market participants to remedy mistakes and ensure that detailed and corroborated facts are reflected in the IMM's model in a timely manner. There is no way for a market participant to ensure that the IMM's model includes the detailed facts that it should, and no way to ensure that the model simulates the market participant's resources with fidelity. There is no timeline for correcting mistakes or recourse if the IMM fails to make updates based on detailed and corroborated facts. Taken together, all these issues have resulted in numerous LS Power OCAs being estimated inaccurately for months on end.

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

LS Power Development, LLC,	)	
	)	
Complainant,	)	
	)	
v.	)	
	)	**Docket No. EL24-__-000**
PJM Interconnection, L.L.C. and Monitoring Analytics, LLC, as the Independent Market Monitor for PJM	)	
	)	
Respondents.	)	

AFFIDAVIT

I, Benjamin W. Griffiths, hereby state, under penalty of perjury, that the statements contained in the foregoing Affidavit of Benjamin W. Griffiths on behalf of LS Power Development, LLC are true and correct to the best of my knowledge and belief.

Benjamin W. Griffiths

Appendix A

Benjamin W. Griffiths

Updated March 2024

Professional Experience

LS Power | Boston, MA, *Vice President, Wholesale Market Policy* (January 2024 – Present); *Senior Director, New England Regulatory Policy* (January 2023 – January 2024); *Director, New England Regulatory Policy*, (November 2021 – January 2023)
I lead the firm's market policy and regulatory affairs for the New England region, focusing on proposals before ISO New England and the Federal Energy Regulatory Commission.

MA Attorney General's Office | Boston MA, *Energy Analyst* (November 2018 – November 2021)
The AGO is the statutory ratepayer advocate for the Commonwealth. I provided qualitative and quantitative analysis of cases before the Massachusetts Department of Public Utilities, as well as proposals before ISO New England and the Federal Energy Regulatory Commission.

Independent Consultant | Austin, TX and Boston, MA (September 2017 – November 2018)
I developed policy insights and numerical models for projects related to distributed energy resources, energy efficiency, and retail rate design.

Resource Insight Inc. | Arlington, MA Research Analyst (May 2012 – June 2015)
I analyzed electric utility resource planning, ratemaking, cost-of-service, and power procurement issues at an economic consultancy.

Education

University of Texas at Austin, Jackson School of Geosciences | Austin TX
Master of Science, Energy & Earth Resources. Graduated: May 2017.

- Coursework: Decision Analysis, Systems Modeling, Probability, Mathematical Statistics, Energy Law, Electrochemical Materials, &c.
- Thesis: "Finding Carbon Breakeven: Induced Emissions from Economic Operation of Energy Storage in Renewables-Heavy Electricity Systems." Co-winner of the program best thesis award.

Harvard University, Harvard Extension School, Cambridge MA | Boston MA
Non-degree coursework in Economics, Finance, & Statistics. Enrolled: January 2014 – May 2015.

Boston University, College of Arts and Sciences | Boston MA
Bachelor of Arts., magna cum laude, Classics and History. Graduated: January 2010.

Comments, Expert Testimony & Affidavits

4. **FERC ER21-1637**: ISO-NE Cost of New Entry / Offer Review Trigger Price Update. Affidavit of B.W.Griffiths in Support of the NEPOOL-Approved Proposal; Report on revenues available to energy storage on behalf of the MA AGO and filed as part of NEPOOL comments (April 7, 2021).

3. **MA DPU 20-120**: National Grid Gas Distribution Rate Case. Direct testimony on behalf of the MA AGO on the calculation of marginal costs (March 26, 2021); Surrebuttal testimony (April 30, 2021).

2. **FERC ER20-1567**: ISO-NE Energy Security Improvements (ESI). Affidavit on behalf of the MA AGO and filed as part of NEPOOL Comments (April 15, 2020). Answer of the MA AGO (June 16, 2020).

1. **FERC ER19-1428**: ISO-NE Inventoried Energy Program (IEP). Affidavit on behalf of the MA AGO (March 25, 2019).

Publications (Articles, Whitepapers, Reports, &c.)

11. **B.W. Griffiths**, 2023, "Gas-Only Resource Availability Modeling & Possible Integration into ISO-NE's RCA Project." Available at: https://www.iso-ne.com/static-assets/documents/2023/02/a07e_mc_2023_02_07-09_ls_power_unit_specific_gas_modeling_memo.pdf.

10. **B.W. Griffiths**, 2020, "Algorithmically Developing Efficient Time-of-Use Electricity Rates." Available at: https://papers.ssrn.com/abstract=3732850.

9. **B.W. Griffiths**, 2020, "Revenue for Energy Storage Participating in ISO-NE Energy and Reserves Markets: Alternative ORTP EAS Offset Estimates." Presented to NEPOOL Markets Committee. Available at: https://www.iso-ne.com/static-assets/documents/2020/11/a4_b_xii_ma_ago_memo_re_alternative_eas_energy_storage.pdf.

8. **B.W. Griffiths**, 2020, "Expensive, Ineffective, & Occasionally Counterproductive: Clean Peak Standards Simulation Results for New England" Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3560193.

7. Mass AGO (M. Hoffer, R. Tepper, **B.W. Griffiths**, &c.) and Regulatory Assistance Project, 2020, "Wholesale Electric Market Design for a Low/No-Carbon Future: Report on the October 2019 Symposium & Proposed Next Steps". Available at: https://www.mass.gov/doc/wholesale-electric-market-design-for-a-lowno-carbon-future/.

6. **Griffiths, B.W.**, "Reducing emissions from consumer energy storage using retail rate design." *Energy Policy* (Volume 129, June 2019, Pages 481-490). Available at: https://www.sciencedirect.com/science/article/abs/pii/S0301421519300679.

5. Synapse Energy Economics (P. Knight, M. Chang, D. White, N. Peluso, F. Ackerman, J. Hall), Resource Insight (P. Chernick, **B.W. Griffiths**), etc. 2018. *Avoided Energy Supply Components in New England: 2018*. Synapse Energy Economics and others for Avoided Energy Supply Component (AESC) Study Group.

4. **B.W. Griffiths**, 2017, "Finding Carbon Breakeven: Induced Emissions from Economic Operation of Energy Storage in Renewables-Heavy Electricity Systems." Available at: https://repositories.lib.utexas.edu/handle/2152/61660.

3. **B.W. Griffiths.,** C.W. King, G. Gülen, J.S. Dyer, D. Spence, and R. Baldick, "State Level Financial Support for Electricity Generation Technologies" White Paper UTEI/2018-1-1, 2018, available at: http://energy.utexas.edu/policy/fce.

2. **B.W. Griffiths**, G. Gülen, J.S. Dyer, D. Spence, and C.W. King, "Federal Financial Support for Electricity Generation Technologies" White Paper UTEI/2016-11-3, 2017, available at: http://energy.utexas.edu/the-full-cost-of-electricity-fce.

1. Hornby, R., P. Chernick, D. White, J. Rosenkranz, R. Denhardt, E. A. Stanton, J. Gifford, B. Grace, M. Chang, P. Luckow, T. Vitolo, P. Knight, **B.W. Griffiths**, B. Biewald. 2013. *Avoided Energy Supply Costs in New England: 2013 Report.* Synapse Energy Economics for Avoided Energy Supply Component (AESC) Study Group.

Comments

7. **FERC ER24-275:** ISO-NE Revisions to Establish a Jointly Optimized Day-Ahead Market for Energy and Ancillary Services. Comments on behalf of LS Power Development, LLC (November 21, 2023).

6. **FERC AD22-9:** New England Winter Gas-Electric Forums. Comments on behalf of LS Power Development, LLC (November 7, 2022). Comments on behalf of LS Power Development, LLC (August 24, 2023).

3. **FERC EL22-42**: RENEW & ACP Complaint on New England Gas Accreditation. Protest of LS Power Development, LLC (April 14, 2022).

2. **N.S.UARB Matter No. M08349**: Review of NS Power Compliance Filing on its Proposed AMI Opt-Out Charge, On behalf of the Nova Scotia Consumer Advocate, P. Chernick and B.W. Griffiths, (October 26, 2018).

1. **EPA R09-OAR-2012-0021**: Affordability of Pollution Control on the Apache Coal Units: Review of Arizona Electric Power Cooperative's Comments on Behalf of the Sierra Club, P. Chernick and B.W. Griffiths (2012).

Presentations

8. B.W. Griffiths, 2023-24, "[Forward Reserve Market] Offer Cap Amendment". Successive Presentations to NEPOOL Markets Committee: November 7-8, 2023, December 12-14, 2023 and January 9-11, 2024.

7. B.W. Griffiths, 2023, "Mechanism for Repowered Resources to Unwind FCM Obligations". Successive Presentations to NEPOOL Markets Committee: April 11-13, 2023 and April 25, 2023.

6. B.W. Griffiths, 2022-24, "Thoughts on the Treatment of Gas Availability in RCA". Successive Presentations to NEPOOL Markets Committee: July 12-14, 2022, December 6, 2022, February 7-9, 2023, March 7-9, 2023, April 11-13, 2023, and March 13, 2024.

5. B.W. Griffiths, 2020, "A (Gentle) Introduction to Wholesale Markets". Presented as part of the Mass AGO's Teach-in on ISO-NE, NEPOOL, and wholesale power markets on December 9, 2020.

4. B.W.Griffiths, 2020, "Value of Electric Vehicle Time-of-Use Retail Rates for Massachusetts Customers". Presented as part of the DPU Docket 20-69 Tech Sessions on December 3, 2020.

3. B.W.Griffiths, 2020, "Mass AGO Alternative Storage Energy & Ancillary Services Revenue Estimates for ORTP Reset", Successive Presentations to NEPOOL Markets Committee: September 8-10, 2020, October 6-8, 2020, and, November 9-10, 2020.

2. B.W.Griffiths and C.Belew, 2019-20. "Amendments to the ISO-NE Energy Security Improvements Proposal" to (1) Elimination of the Replacement Energy Reserve; (2) Add a Lookback Provision. Successive Presentations to NEPOOL Markets Committee on September 3-4, 2019, January 14, 2020, February 14, 2020, March 11, 2020, and March 24, 2020.

1. London Economics International and the Mass AGO, 2019, "Chapter 3 Preliminary Proposal", Presentation to NEPOOL Markets Committee on March 6, 2019.

Attachment A-1

Highly Confidential Privileged Materials Removed

Attachment A-1.1

Highly Confidential Privileged Materials Removed

Attachment A-2

Highly Confidential Privileged Materials Removed

Attachment A-3

Highly Confidential Privileged Materials Removed

Attachment A-3.1

Highly Confidential Privileged Materials Removed

Attachment A-4

Highly Confidential Privileged Materials Removed

Attachment A-4.1

Highly Confidential Privileged Materials Removed

Attachment A-5

Highly Confidential Privileged Materials Removed

Attachment A-5.1

Highly Confidential Privileged Materials Removed

Attachment A-6

Highly Confidential Privileged Materials Removed

Attachment A-6.1

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Attachment A-9

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Attachment A-13

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Attachment A-14

Highly Confidential Privileged Materials Removed

Attachment A-15

Highly Confidential Privileged Materials Removed

Attachment A-16

Highly Confidential Privileged Materials Removed

Attachment A-17

Highly Confidential Privileged Materials Removed

Attachment B

The Sotkiewicz Affidavit

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

LS Power Development, LLC,	)	
	)	
Complainant,	)	
	)	
v.	)	
	)	**Docket No. EL24-__-000**
PJM Interconnection, L.L.C. and Monitoring Analytics, LLC, as the Independent Market Monitor for PJM	)	
	)	
Respondents.	)	

AFFIDAVIT OF PAUL M. SOTKIEWICZ, PH.D.
ON BEHALF OF LS POWER DEVELOPMENT, LLC

I. INTRODUCTION

1. My name is Dr. Paul M. Sotkiewicz. I am the President and Founder of E-Cubed Policy Associates, LLC ("E-Cubed") and formerly served as the Chief Economist in the Market Service Division of PJM Interconnection, L.L.C. ("PJM"). I have been retained by LS Power Development, LLC to submit this affidavit in support of its complaint regarding the opaque and flawed calculation of opportunity cost adders ("OCAs") to mitigated energy offers for emissions-limited units.

2. As the former Chief Economist at PJM, I have firsthand knowledge of the origins and history behind the opportunity cost calculations as they were derived starting in 2009 and

first appearing in PJM Manual 15: Cost Development Guidelines ("Manual 15")[1] in 2010.[2] I, along with other PJM staff, developed the concept and the data inputs and formulations behind these historical calculations of the OCA.

3. Following the statement of my qualifications in Section II, the remainder of my affidavit is organized as follows. Section III provides a short history of the OCA. The OCAs and what is known as PJM's opportunity cost calculator were developed in response to Federal Energy Regulatory Commission ("FERC") directives in a proceeding on energy market mitigation using the "Three Pivotal Supplier" test.[3] In its February 2009 Order in that proceeding, the Commission found that the then-effective market power mitigation measures the PJM Energy Market were unjust and unreasonable[4] because the mitigated offer prices "fail[ed] to fully account for opportunity costs, particularly for energy- and environmentally-limited resources."[5] I discuss how PJM responded to that and subsequent FERC directives on OCAs and how the approach has changed since then.

4. I also cover more recent opportunity cost discussions from 2017-2020, and the switch to the opportunity cost calculator developed by the Independent Market Monitor for PJM

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[1] The most recent version of Manual 15 is Revision 44, effective as of August 1, 2023 and available at https://www.pjm.com/-/media/documents/manuals/m15.ashx. At various points in my affidavit, I refer to earlier versions of Manual 15. When I do so, I provide the relevant Revision designation.

[2] Specifically, these calculations appeared in Revision 15, effective as of October 27, 2010, according to the revision history in PJM Manual 15.

[3] *See Maryland Pub. Serv. Comm'n v. PJM Interconnection, L.L.C.*, 123 FERC ¶ 61,169 (granting and dismissing complaint in part and establishing paper hearing procedures), *on reh'g*, 125 FERC ¶ 61,340 (2008); *PJM Interconnection, L.L.C.,* 126 FERC ¶ 61,145 (2009) ("February 2009 Order") (order following stakeholder process and PJM's submission of a report).

[4] *See* February 2009 Order, 126 FERC ¶ 61,145 at P 1.

[5] *Id.* at P 28 (footnote omitted). *See also id.* at P 47 (finding the mitigation measures to be unjust and unreasonable "because they do not clearly and systematically provide for the inclusion of opportunity costs").

("IMM") in Section III.

5. Section IV provides the rationale for including opportunity costs for energy and environmental limits that may be imposed on generators from both a generator financial perspective and a system reliability perspective. Regarding reliability, I point out the issues with both short-term operational reliability and longer-term resource adequacy implications tied to getting the OCA determination right.

6. Section V explains why full information and transparency is consistent with competitive market outcomes, and how a lack of transparency leads to sub-optimal, non-competitive market outcomes. Section V also explains how there was previously greater transparency into the OCA calculations than exists today.

7. Section VI discusses some technical, mathematical, and computational concerns that go to the core of the IMM opportunity cost calculator and that call into question the accuracy and validity of the IMM methodology, as best it can be understood from the limited available documentation. Such details, while seemingly arcane, are essential to understanding and trying to replicate and understand the IMM's methodology.

8. Finally, Section VII provides four recommendations that follow from my analysis herein and relate in particular to the IMM OCA optimization method. I recommend that FERC order the following: (1) an expedited PJM stakeholder process to be conducted over a period of days or weeks (not months or years) to fully vet and flush out the details of the IMM OCA calculator so that it can be replicated by market participants; (2) PJM to file any necessary changes to Schedule 2 of the Operating Agreement ("OA") to correspond to the IMM OCA optimization model; (3) PJM to institute annual audits that require reporting to the PJM membership what they have found in the audit as well as memorializing this

audit responsibility in Schedule 2 of the OA; and (4) PJM to be empowered to serve as a back stop to the IMM if the market participant and the IMM cannot come to agreement on an OCA value, since PJM notionally has this ability in the OA today and since PJM should have knowledge of the IMM's optimization calculation.

II. QUALIFICATIONS

9. Prior to founding E-Cubed, I worked as a contractor and directly for PJM in Audubon, Pennsylvania from February 2008 until October 2016. In my time at PJM, I first served as a Senior Economist until March 2010 and subsequently as the Chief Economist in the Market Service Division until June 2015. From July 2015 until October 2016, I worked as a contractor for PJM under the title of Senior Economic Policy Advisor. Prior to joining PJM, I served as the Director of Energy Studies at the Public Utility Research Center, University of Florida from August 2000 until February 2008 and I was an Economist at FERC from September 1998 until August 2000. I have a B.A. in History and Economics from the University of Florida (1991), and an M.A. (1995) and Ph.D. (2003) in Economics from the University of Minnesota.

10. I have over 25 years of experience in matters at the intersection of utility regulatory policy, power system economics, and environmental economics. In my current role, I advise private- and public-sector clients on a range of economic issues related to electricity market design and performance, power generation economics, utility regulatory policy, and the economic impacts of state and federal environmental policies. At PJM I provided expert analysis, advice, and support for PJM initiatives related to market design changes in, and performance of, PJM's energy, ancillary service, and capacity markets. As an economist at FERC, I worked on market design issues and filings related to the newly formed independent system operator/regional transmission organization ("RTO") markets

concentrating primarily on the New York Independent System Operator, Inc. and the California Independent System Operator Corporation markets.

11. Relevant to this complaint, as noted in my introduction, I led the initial development of PJM's opportunity cost calculator to determine OCA adders in response to the February 2009 Order. Furthermore I have particular experience in analyzing the impact of environmental policy on the electricity industry including: (1) my doctoral dissertation on the Title IV Sulfur Dioxide Trading Program under the 1990 Clean Air Act Amendments; (2) serving as a consultant to the Florida Department of Environmental Protection on its Clean Air Interstate Rule State Implementation Plan; (3) co-leading or leading the PJM analyses of the Waxman-Markey climate change bill, Mercury and Air Toxics Standards, and Clean Power Plan on PJM's markets; (4) serving as an invited peer reviewer by the United States Environment Protection Agency on the Integrated Planning Model it uses to analyze policies;[6] and (5) serving as a consultant to gas-fired generation in obtaining a Title V air permit in Pennsylvania[7] and navigating the recently implemented Climate Equitable Jobs Act ("CEJA") emissions restrictions in Illinois.[8] This experience over time has given me the expertise to read and understand Title V air permits and generation operation to determine the kinds of run-time limitations generators face which is the foundation of the

[6] Integrated Planning Model (IPM) Base Case Version 5.13 Peer Review, Peer Review Report, October 2014 (prepared for U.S. Environmental Protection Agency Clean Air Markets Division by Anthony Paul, Chair, Meghan McGuinness, Walter Short, Paul Sotkiewicz, John Weyant through RTI International).

[7] Rebuttal Report Regarding the Review and Evaluation of Alternatives and Benefit Cost Analysis Prepared for Renovo Energy Center in Clean Air Council et al. v. Pennsylvania Department of Environmental Protection, Environmental Hearing Board Docket No. 2021-055, May 2, 2022; Affidavit Prepared for Renovo Energy Center, Department of Environmental Protection, Environmental Hearing Board Docket No. 2021-055, July 18, 2022.

[8] Affidavit in Support of Protest of J-Power USA Development Co. Ltd. in PJM Interconnection, L.L.C., Docket No. ER22-2984-000.

need for the OCA.

12. Additionally, as relevant to this complaint, I have worked on integer programming and mixed integer programming models going back to my doctoral dissertation, and I have published peer reviewed work with respect to mixed integer programming as it relates to unit commitment models.[9] I have also published general formulations of mixed integer programs that once solved, can be converted back to linear or concave programming models to derive shadow prices on integer constraints that otherwise are unavailable in mixed integer programs alone.[10] As the PJM Chief Economist, I also advised and oversaw the Cost of New Entry ("CONE") studies used in the PJM Capacity Market in 2011 and 2014, which are now performed on a quadrennial basis, and as a consultant I am advising natural gas combined cycle and combustion turbine owners and developers in PJM and thus have detailed knowledge of the costs, operating characteristics, and emissions profiles of these technologies as well as other fossil fueled technologies. More details on my experience and work history can be found in my CV attached as Attachment 1.

III. BRIEF HISTORY AND RELEVANT BACKGROUND TO THE OPPORTUNITY COST ADDER AND CALCULATOR

A. Run-Limited Opportunity Costs Explained

13. The costs of operating a resource go beyond fuel, variable operation and maintenance ("O&M"), and emissions allowance costs. Resources often face a trade-off between running now and running later due to a variety of factors, including environmental permit

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[9] O'Neill, Richard P., Helman, Udi, Sotkiewicz, Paul M., Rothkopf, Michael H., and Stewart, William R. Jr., "Regulatory Evolution, Market Design, and the Unit Commitment Problem" *The Next Generation of Unit Commitment Models*, B. Hobbs, M. Rothkopf, R. O'Neill, and H.P. Chao editors. 2001.

[10] O'Neill, Richard P., Sotkiewicz, Paul M., Hobbs, Benjamin F., Rothkopf, Michael H., and Stewart, William R. Jr., "Efficient Market Clearing Prices in Markets with Non-Convexities," European Journal of Operational Research, Volume 164, Issue 1, 1 July 2005, Pages 269-285.

limits, limited quantities of stored fuel, and manufacturer-prescribed run hour limits.

14. When running now prevents a resource from running later, the resource may incur very real opportunity costs, representing the cost of the lost opportunity to run later and earn higher net energy market revenues. For example, consider a resource with a two-hour run limit, marginal costs of \$40/MWh (inclusive of fuel, variable O&M, and emissions allowances).

15. Further consider three consecutive hours with LMPs of \$50/MWh, \$70/MWh, and \$90/MWh respectively for hours 1, 2, and 3. Higher prices should reflect greater reliability need and consistent with reliability, the run-limited resource should operate in the higher priced hours when it is needed most, which also coincides with maximizing net energy market revenues.

16. Absent opportunity costs reflecting the run time limit, the resource in this example would be operated in hours 1 and 2 at LMPs of \$50/MWh and \$70/MWh but would not be available in hour 3 when the LMP is \$90/MWh. Such an outcome is inconsistent with reliability and with maximizing net revenues. However, an opportunity cost of \$30/MWh added to the \$40/MWh marginal cost, reflecting the difference between the margin if the run limit were reduced by 0.01 hours,[11] would ensure the run-limited resource is operated in the highest price hours where LMP is \$70/MWh and \$90/MWh respectively,[12] consistent with reliability needs and maximizing generator net revenues.

[11] While the prices are expressed in \$/MWh, using an interval shorter than an hour will come closer to capturing the actual shadow price as well as the reality that run time restrictions derived from emissions limits that could imply run limits that end at any time during a clock hour. Indeed mathematically, the shorter the interval, the closer the calculation will come to the actual shadow price that would be derived from properly defined optimization problem as explained below.

[12] If the run time constraint is reduced by 0.01 hours, then the resource gives up the margin of running at \$70/MWh at a running cost of \$40/MWh for 0.01 hours.

B. The Commission Recognizes Run-Limited Opportunity Costs Must be Included in Mitigated Offers Resulting From Market Power Mitigation

17. Almost 15 years ago, FERC recognized the importance of ensuring mitigated offer prices captured opportunity costs, stating:

> We find that, because default bids do not clearly and explicitly provide for the inclusion of opportunity costs, especially for energy and environmentally-limited resources, the mitigation measures related to determining default bids are unjust and unreasonable. With retention of the three-pivotal-supplier test, we agree that it is critical to assure that mitigation measures account for opportunity costs, while not violating the environmental limitations.[13]

18. In response, PJM made a compliance filing to add provisions to its Tariff and OA relating to energy and environmentally limited resources' opportunity costs, specifically providing for the inclusion of such opportunity costs in offers in Schedule 2 of the OA.[14] While providing the inclusion of such opportunity costs, PJM's compliance filing did not set forth any methodology or formula for calculating opportunity costs or otherwise provide a detailed explanation as to how the opportunity costs associated with energy or environmental limits would be calculated or determined.

19. FERC rejected PJM's compliance filing as "too incomplete and unspecified[.]"[15] FERC explained:

> [W]e find that PJM's tariff proposal fails to provide sufficient detail to establish a just and reasonable methodology for including opportunity costs in mitigated rates…. PJM's Tariff does not describe the methodology for calculating opportunity costs, and the Manuals were not completed at the time of the filing. While relying on Manuals to develop implementation details and mechanics of implementation may be acceptable, the methodology to be applied in determining the relevant opportunity costs

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[13] February 2009 Order, 126 FERC ¶ 61,145 at P 42.

[14] PJM Interconnection, L.L.C., EL08-47-004 (Compliance Filing), July 31, 2009.

[15] *PJM Interconnection, L.L.C.*, 130 FERC ¶ 61,230 at P 1 (2010) ("March 2010 Order").

needs to be sufficiently described in the tariff.[16]

20. Because PJM's filing provided insufficient detail for FERC to "understand the methodology it proposes to employ in determining the relevant opportunity costs,"[17] FERC directed PJM to make a further compliance filing.

21. In its subsequent compliance filing, PJM provided a more fulsome description of the opportunity cost methodology in Schedule 2 of the OA and included in the filing the then-current version of PJM Manual 15, which provided the full-blown methodology.[18] FERC approved this compliance filing on October 25, 2010,[19] and the approved member and PJM changes to Manual 15 went into effect.[20]

22. The bottom line from the early history of the opportunity cost calculator is that FERC has insisted that it be well defined and explained. That is, the Commission, as well as the mitigated sellers, ought to be able to "understand the methodology…employ[ed] in determining the relevant opportunity costs…."[21] As will be discussed below, changes since these earlier orders have made it difficult, if not impossible, to understand the methodology now being used to calculate OCAs.

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[16] *Id.* at PP 16-17.

[17] *Id.* at P 19.

[18] PJM Interconnection, L.L.C., EL08-47-005 (Compliance Filing), April 22, 2010 ("April 2010 Compliance Filing"). The member- and PJM Board-approved modifications to Manual 15 were included as Attachment C to this compliance filing.

[19] *PJM Interconnection, L.L.C.*, 133 FERC ¶ 61,081 (2010) ("October 2010 Order").

[20] The Manual 15 changes went into effect as Revision 15, October 27, 2010.

[21] March 2010 Order, 130 FERC ¶ 61,230 at P 19.

C. <u>Subsequent Changes to and Suspension of the PJM Opportunity Cost Calculator</u>[22]

23. Other than a handful of changes to account for start-up costs, inclusion of minimum runs times, dual fuel capabilities, and allowing for physical limitations, the methodology for the opportunity cost calculator remained nearly constant from 2010 through June 1, 2020, when PJM's opportunity cost calculator was suspended in favor of only using the IMM's opportunity cost calculator methodology.[23]

24. The lead up to the suspension of PJM's OCA calculator method and adoption began in 2017 with a Problem Statement and Issue Charge approved by the PJM Markets and Reliability Committee ("MRC") and assigned to the Market Implementation Committee ("MIC")[24] that was intended to address comparability issues between the PJM OCA methodology and the IMM's more recently developed OCA optimization method.[25]

25. The earliest documentation of the IMM OCA calculation method was presented on May 23, 2017 at a Special MIC meeting and also provided a comparison to the PJM OCA

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[22] The entire history of the opportunity cost calculator discussion from 2017 to 2020 can be found at https://pjm.com/committees-and-groups/issue-tracking/issue-tracking-details.aspx?Issue=%7b867315DA-0DED-4A9A-B571-DE4B2C8BF80E%7d. What follows in this subsection is abridged by necessity but nonetheless illustrates the comparative lack of documentation for the IMM OCA optimization method.

[23] *See* "Minutes to the 197th PJM Member's Committee Meeting March 26, 2020," posted May 4, 2020, available at https://pjm.com/-/media/committees-groups/committees/mc/2020/20200504/20200504-item-06a-draft-minutes-mc-20200326.ashx. This suspension was reflected in Revision 35 to Manual 15, effective as of April 24, 2020 and available at https://www.pjm.com/-/media/documents/manuals/archive/m15/m15v35-cost-development-guidelines-04-24-2020.ashx.

[24] Draft Minutes to the April 12, 2017 Market Implementation Committee, May 3, 2017, available at https://pjm.com/-/media/committees-groups/committees/mic/20170503/20170503-item-02-draft-minutes-mic-20170412.ashx.

[25] PJM, Problem Statement and Issue Charge Opportunity Cost Calculator, May 23, 2017 MIC Special Session, available at https://pjm.com/-/media/committees-groups/committees/mic/20170523-special/20170523-item-02-opportunity-cost-calculator-problem-statement-issue-charge.ashx.

methodology that existed within PJM Manual 15.[26] More than a year later, PJM issued an advisory to market participants stating that the IMM OCA optimization was not an approved method for calculating the OCA and that only the PJM OCA method or other PJM approved method could be used.[27]

26. Following exchanges of letters between PJM and the IMM, the IMM agreed to share the workings of its model with PJM but there was no full sharing with the PJM market participants. The IMM again provided a high-level overview of its method compared to the PJM members on September 25, 2018,[28] but there was still not enough information provided for anyone to replicate its method. Indeed, if anything, this presentation was less detailed than the overview provided in May 2017. On October 24, 2018, PJM approved the use of the IMM OCA optimization method.[29] While PJM highlighted key differences between the two calculation methods, it did not provide sufficient information for others to replicate the IMM's methodology.

IV. SHORT-TERM AND LONG-TERM RELIABILITY IMPLICATIONS OF IGNORING OR UNDERSTATING OPPORTUNITY COSTS IMPLIED BY RUN TIME LIMITATIONS

27. The prime directive of power market and system operation is that prices must be

[26] Monitoring Analytics, "Opportunity Cost Calculator," May 23, 2017 MIC Special Session, available at https://pjm.com/-/media/committees-groups/committees/mic/20170523-special/20170523-item-04-opportunity-cost-calculator-imm-education-session.ashx ("2017 IMM OCA Presentation").

[27] PJM, Letter Re: Approved Opportunity Cost Calculators, August 7, 2018, available at https://pjm.com/-/media/committees-groups/committees/mic/20180824-special-occ/20180824-item-02-opc-calculator-market-seller-notice.ashx.

[28] Monitoring Analytics, "Opportunity Cost Issues," September 25, 2018 MIC Special Session, available at https://pjm.com/-/media/committees-groups/committees/mic/20180925-special-occ/20180925-item-03b-imm-opportunity-cost-presentation.ashx ("2018 IMM OCA Presentation").

[29] PJM, Letter Re: PJM Approval of IMM Opportunity Cost Calculator as an Alternative Method, October, 2018, available at https://pjm.com/-/media/committees-groups/committees/mc/20190124/20190124-item-04b-october-2018-opc-calculator-market-seller-notice.ashx.

commensurate with the reliability and operational needs of the system. In the PJM energy market this means that transmission constraints must reflect the costs of redispatch to ensure transmission security so that the system operates within the thermal limits of transmission assets, voltage levels are maintained, and any transient stability limits are observed. This also means that if reserve levels are short of their requirements, both energy and reserve prices should reflect these shortages.

28. From a resource adequacy perspective, energy and reserve prices should reflect times when PJM is approaching a capacity emergency, with higher prices signaling that more available resources are needed to maintain energy balance and reserves. That is, rising prices are a signal regarding the reliability status of the PJM system, all things equal.

29. A corollary to the prime directive that prices must reflect system conditions and operational needs is that prices must reflect the costs of resources needed to operate the system reliably. This is especially true when market power mitigation is applied on the premise that there may be structural market power for alleviating transmission constraints as determined by the Three Pivotal Supplier Test in the PJM energy market, because failing accurately to reflect resources' costs in offers will prevent the market from accurately reflecting the costs of redispatch.

30. The costs of operating a resource go beyond the out-of-pocket fuel, variable operation, and maintenance ("O&M"), and emissions allowance costs. When running now prevents a resource from running later, the resource may incur very real opportunity costs, representing the cost of the lost opportunity to run later and earn higher net energy market

revenues.[30] This trade-off between running now and running later can arise from a variety of factors, including environmental permit limits, limited quantities of stored fuel, and manufacturer-prescribed run hour limits. Increasingly, generators are facing run time limitations due to emissions permit limits that have been statutorily determined through state policy or through limitations on emissions in a resource's air permit pursuant to Title V of the Clean Air Act. These emissions limitations prevent a generator from operating in all hours when it may be economic based solely on out-of-pocket costs, and thus create opportunity costs reflecting the foregone opportunity to run during hours when prices may be higher thus leading to high net energy market revenues.

31. The opportunity costs associated with a resource's use-limits must be accounted for in its offer not only for the owner's financial health, but also for the reliability of the PJM system from both a real-time operations and resource adequacy perspective.

A. Reliability in Real-time Operations for Transmission Constraints or Capacity Emergencies

32. Consider a simple example with a 100 MW resource with out-of-pocket marginal costs (inclusive of fuel, variable O&M, and emissions allowances) of $50/MWh[31] that can run for no more than 200 hours over the next 1,000 calendar hours under its air permit.

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[30] The PJM OA defines the term "Energy Market Opportunity Cost" as "the difference between (a) the forecasted cost to operate a specific generating unit when the unit only has a limited number of available run hours due to limitations imposed on the unit by Applicable Laws and Regulations and (b) the forecasted future Locational Marginal Price at which the generating unit could run while not violating such limitations. **Energy Market Opportunity Cost therefore is the value associated with a specific generating unit's lost opportunity to produce energy during a higher valued period of time occurring within the same compliance period**, which compliance period is determined by the applicable regulatory authority and is reflected in the rules set forth in PJM Manual 15. Energy Market Opportunity Costs shall be limited to those resources which are specifically delineated in Operating Agreement, Schedule 2." OA, Section 1 (OA Definitions E-F) (emphasis added).

[31] For ease of explanation assume no start-up costs and no minimum run time.

33. To keep the example simple, assume that for each of first 200 calendar hours, locational marginal prices ("LMPs") are \$30/MWh; for the next 200 hours, LMPs are \$45/MWh; for the next 200 hours, LMPs are \$60/MWh; for the penultimate 200 hours, LMPs are \$75/MWh; and for the final 200 hours, LMPs are \$300/MWh, due to the system being close to entering a capacity emergency.

34. Absent any run-time restriction (and associated opportunity costs), this resource would operate for the last 600 hours out of the 1,000 total hours anytime when the LMP was greater than its marginal cost of \$50/MWh. But with the run time limitation, this resource can only run 200 hours. That means it will be unable to operate in 400 hours when it would be economic based solely on out-of-pocket costs.

35. An efficiently dispatched unit will want to run in 200 hours that are most valuable to the resource owner and for system reliability needs, while foregoing generation in the other 400 hours that are less valuable. In this example, the unit will want to run in the 200 hours where LMPs are \$300/MWh.

36. If the generator were free to choose when to run and had perfect foresight about market prices and operating costs over the duration of its permit limitations, it would not operate during the first 800 hours of the 1,000-hour period in order to be available to run during the last 200 hours, when LMPs were highest. This would not only be the most financially advantageous use of the limited hours but would also use those limited hours when it is most needed for reliability needs as the higher prices reflect greater reliability needs. The problem is, however, that resources with capacity obligations are required to submit daily offers into the day-ahead market, meaning that a resource cannot simply "opt out" of the market and save its limited run hours for days when prices are expected to be highest. To

the extent a resource is not subject to market power mitigation in the energy market, a resource can incorporate this run-limited opportunity cost in its market-based offers. The issue is when a resource is subject to market power mitigation under the Three Pivotal Supplier test and is therefore required to submit cost-based offers. PJM and other RTOs and generation owners therefore rely on OCAs to "price in" the expected value of high value generation at a future point in time which are also consistent with reliability needs.

37. Accounting for opportunity costs resulting from run time restrictions within energy offers ensures that system reliability needs, and resource owner net revenue maximization coincide, and that the unit can submit daily energy market offers in line with expectations of future market conditions. In this example, the opportunity cost is $250/MWh, equal to the hourly profit (LMP minus out-of-pocket marginal costs) associated with running in the 200 hours when prices are $300/MWh. That represents the cost of the foregone opportunity to run during one of those last 200 hours incurred by running during any of the first 800 hours, when LMPs are lower.

38. If this $250/MWh opportunity cost is not included in the unit's offer, suboptimal dispatch results. Recall that in this example, LMPs rise over time. If the unit runs based on its original $50/MWh offer, it will be run to exhaustion in the $60/MWh block of hours that precedes the $75/MWh and $300/MWh LMP blocks. If the run-time limited resource has hit its permit limit prematurely, then the unit would not be available when it would be needed most for reliability when the system is facing $300/MWh prices, which could be indicative of PJM nearing a capacity emergency. This underscores how failure to fully account for opportunity costs is harmful not only to the resource owner but also to the system: the $300/MWh LMPs signal a greater system need for the resource's output but,

absent an adequate OCA, the resource will have used up its limited run hours during the 200 hours when LMPs of $60/MWh signaled a lesser system need.

39. This inefficient dispatch dynamic can also occur any time the resource is mitigated to its cost-based offer. Absent the reflection of the resource's opportunity costs, if it is run for transmission constraint control when prices are $60/MWh, it will not be available for higher price periods when there is a greater reliability need as evidenced by prices. Moreover, the presence of opportunity costs in this example means that for the hours in which this resource is run, this action does not reflect the true cost of transmission constraint control.

40. For example, there may be other generators able to alleviate the transmission constraint, albeit with different offer profiles. While the unit throughout this example has out-of-pocket costs of $50/MWh and opportunity costs of $250/MWh, a different unit behind the transmission constraint may have total costs of $80/MWh. Calling on our hypothetical resource with out-of-pocket costs of $50/MWh and opportunity costs of $250/MWh to alleviate transmission constraints (by ignoring or understating opportunity costs) falsely suggests that the cost of transmission constraint control is $50/MWh, when it is actually much higher ($80/MWh, in this case). In this instance alone, prices are not consistent with the reliability needs and costs of ensuring reliability, and PJM is ultimately failing to dispatch on a least-cost basis, not just in a single hour, but over multiple hours across the year, given the omission or understatement of opportunity costs. During the lower cost hours, the dispatch of the $300/MWh resource, albeit only valued at $50/MWh rather than $80/MWh due to the omission or understatement of opportunity costs, understates the costs of maintaining reliability. But this inefficient dispatch may also result in costs of

maintaining reliability during higher cost hours being overstated, because having run during the lower cost hours, the $300/MWh resource will be unable to run during the higher cost hours. That may mean that PJM needs to call on a higher cost resource, say $400/MWh, to maintain reliability.

B. <u>Long-Term Reliability Implication for Resource Adequacy</u>

41. In addition to creating reliability issues in the operational timeframe, inaccurate OCAs can result in premature retirement and long-run reliability challenges. The run-time restricted resource in this example is denied the opportunity to earn higher net energy market revenues because of the lack or an understatement of opportunity costs due to run-time restrictions. Continuing with the previous example, if the run-limited resource is run when prices are $60/MWh, it only earns net energy market revenues of $10/MWh, or $200,000 for the 1,000-hour period ([$60/MWh - $50/MWh] * 100 MW * 200 hours). Yet, if opportunity costs are properly accounted for in this example, the run-limited resource would earn $250/MWh or $5,000,000 over this 1,000-hour period ([$300/MWh - $50/MWh] * 100 MW * 200 hours). There is a significant discrepancy in energy market net revenue depending on whether run-time limited opportunity costs are fully included.

42. Continuing forward with this example, assume that for the delivery period the going forward cost (avoidable cost rate in PJM parlance) of the run-limited resource is $85,000/MW-period but that the capacity price was only $65,000/MW-period.[32] Absent the use of opportunity costs to allocate limited run hours to when they are most valuable to the resource owner and for reliability, it is possible that the run-limited resource will be

[32] I am abstracting away from the PJM convention of expressing RPM prices in $/MW-day for the ease of example. It is helpful to think of a $/MW-period as being analogous to a $/MW-year.

unable to cover its going forward costs and seek to retire.

43. In this example, not reflecting run-limited opportunity costs would lead to a period loss of $18,000/MW-period for the resource owner (costs of $85,000/MW-period less the capacity price of $65,000/MW-period and the net energy revenues of $2,000/MW-period absent the application of the OCA). If such a situation continues over years where opportunity costs are consistently understated, or there is a continued expectation of this under-estimation, this could lead resources that are needed by PJM for reliability to seek retirement, exacerbating the problem described in PJM's recent report on resource retirements and replacements.[33]

44. If, by contrast, the run-limited resource could reflect opportunity costs accurately, in this example the resource would earn sufficient revenues to remain in operation and continue to provide reliability to the PJM system. Reflecting opportunity costs in this example, the run-limited resource would cover its $85,000/MW-period going forward costs with the energy revenues earned plus capacity payment resulting in a positive margin of $30,000/MW-period (revenues of $50,000/MW-period from energy plus $65,000/MW-period from capacity less $85,000/MW-period in going forward costs).

45. In both the operational and investment timeframes, incorrect OCAs can yield inefficient system operation, heightened risk of premature retirement, and increased long-run system stress. To be sure, the IMM is calculating OCAs, so the issue is generally not whether opportunity costs are reflected at all but instead whether they are fully and correctly reflected. But an inadequate OCA is only marginally better than no OCA at all. If in the

[33] PJM, Energy Transition in PJM: Resource Retirements, Replacements & Risks (Feb. 24, 2023), available at https://www.pjm.com/-/media/library/reports-notices/special-reports/2023/energy-transition-in-pjm-resource-retirements-replacements-and-risks.ashx.

example above, the resource's offers included an OCA of $20/MWh, that would have pushed its 200 run hours into the penultimate 200-hour period when LMPs were $75/MWh and increased its energy revenues for the 1,000-hour period correspondingly. Importantly, however, the resource still would have used up its 200 run hours before the last period when LMPs hit $300/MWh. Mr. Griffiths' affidavit describes real-world examples in which the IMM-calculated and PJM-approved OCAs were inadequate, and there were delays in correcting OCAs because of the lack of transparency about the methodology. It is better to stave off operational limitations or retirements by ensuring that resources are fairly compensated within the energy market rather than rely on out of market solutions. Getting OCAs "right" is a critical part of that effort.

V. POWER MARKETS REQUIRE TRANSPARENCY OF ALL AVAILABLE INFORMATION TO ENSURE COMPETITIVE AND RELIABLE OUTCOMES

46. All students of economics learn that one of the key underlying assumptions/characteristics of a perfectly competitive market is there is perfect information. That is: all market participants are aware of the underlying rules and the fundamentals of the market, including the means of production, costs of production, and any possible restrictions that may exist.

47. Traditional commodity markets come about as close to achieving the ideal of perfect information as one is going to find: these markets involve the trading of a homogeneous product (*e.g.*, corn, soybeans, wheat, natural gas), where there are institutional or regulatory requirements for reporting, where the requirements are known to all, and where the reported information is publicly available. Additionally, there are entire industries that focus on providing as much information as possible to market participants as possible. Power markets such as those administered by PJM should be no different in this respect.

48. Transparency is a necessary condition for information to be disseminated to participants in

the PJM energy market to ensure outcomes are competitive. However, unlike traditional commodity markets, PJM's energy market contains provisions for market power mitigation that are supposed to operate in a manner that ensures competitive outcomes when there are only a limited number of resources that can solve reliability problems such as alleviating transmission constraints. While the resource-specific inputs to the mitigation calculations are often competitively sensitive, the rules and calculation methodologies can and should be transparent to all market participants, especially those whose resources are subject to market power mitigation measures.

A. The PJM Opportunity Cost Calculator Methodology in PJM Manual 15 is Well-Defined, Transparent, and Can be Replicated by Market Participants

49. The PJM opportunity cost calculator has been described in Manual 15 since 2010 with relatively few changes. The current version of Manual 15 provides, in Sections 12.7.3 through 12.7.6, a step-by-step guide to how to determine the OCA using PJM's opportunity cost calculator, as it has since Revision 15, excerpts of which were submitted to the Commission as part of the April 22, 2010, compliance filing[34] approved by the Commission on October 25, 2010.[35]

50. As of June 1, 2020, the PJM opportunity cost calculator was suspended, but the detail on the calculator remains in PJM Manual 15. The PJM methodology for all cases covers 20 pages and outlines how to develop forward energy and fuel prices applicable to a resource facing energy and/or environmental limits, how to determine daily and hourly volatility,

[34] April 2010 Compliance Filing, Attachment C. The excerpts showed member and PJM Board approved revisions to Manual 15 in redline that were implemented on October 27, 2010 as Revision 15 with an effective date of October 27, 2010. *See* https://web.archive.org/web/20101221040135/http://pjm.com/~/media/documents/manuals/m15-redline.ashx.

[35] *See* October 2010 Order, 133 FERC ¶ 61,081.

unit costs by day including forward emissions allowance prices, and how to calculate the generator margins in each hour.

51. PJM's opportunity cost calculator methodology accounts for start-up costs and minimum run times by looking at the energy/environmentally limited resource in blocks of run time and subtracts out start-up costs. The PJM opportunity cost calculator methodology then ranks the blocks by margins from highest to lowest, where the OCA will be the lowest ranked margin just before the limited resource hits its emissions or run-time limit.[36]

52. The PJM opportunity cost calculator is not a perfect methodology. It omits start-up related emissions, no-load costs, and to some extent limits the size of the blocks in which a unit can run, does not account for trade-offs between continuing to operate and at minimum run levels rather than incur start-up and shut down costs, and is unclear how rolling 12-month limits would work or be modeled. However, the PJM methodology is transparent, detailed, and can be replicated by market participants.

53. Furthermore, the PJM methodology is entirely consistent with the language in Schedule 2 of the OA as the OA language was designed to track the PJM opportunity cost methodology approved in 2010.

B. The Current IMM Opportunity Cost Calculator is Absent from Schedule 2 of the OA and not Transparent or Well-defined in PJM Manual 15

54. Schedule 2 of the OA provides only very high-level guidance on how opportunity costs should be computed, stating:

> [U]nit-specific Energy Market Opportunity Costs are calculated by forecasting Locational Marginal Prices based on future contract prices for electricity using PJM Western Hub forward prices, taking into account historical variability and basis differentials for the bus at which the

[36] Given the emissions profiles of resources.

> generating unit is located for the prior three year period immediately preceding the relevant compliance period, and subtract therefrom the forecasted costs to generate energy at the bus at which the generating unit is located, as specified in more detail in PJM Manual 15.[37]

55. The language in Schedule 2 of the OA is entirely consistent with PJM opportunity cost calculator methodology defined in Sections 12.3 through 12.6 of PJM Manual 15, though the details in PJM Manual 15 are much more detailed as described in subsection A above.

56. However, PJM Manual 15, Section 12.7 describing the IMM OCA optimization methodology provides a different description of how the OCA is calculated with only slightly greater detail, stating:

> The Opportunity Cost Calculator selects the hours of operation that will maximize the generator's energy market revenue net of the generator's short run marginal cost of producing energy, subject to the unit specific environmental or operational limits. The duration and structure (i.e. rolling compliance periods or a single compliance period) of the optimization period will be as specified in an environmental permit for environmental limitations, or as specified by the original equipment manufacturer or insurance carrier for physical equipment limitations. In the case of a fuel supply limitation, the duration of the optimization period must be approved by PJM and the MMU.[38]

57. Unlike the description of PJM's opportunity cost calculator, the foregoing description of the IMM's opportunity cost calculator does not track the guidance in Schedule 2 of the OA. That is because when the IMM's opportunity cost calculator supplanted PJM's calculator, there was no corresponding revision to the OA. As a result, the IMM's methodology is not congruent with what is reflected in the OA as filed with and approved by FERC.

58. That is not to say that the underlying ideas and concept are necessarily wrong. The idea of using an optimization-based approach to compute OCAs is reasonable, as such an approach

[37] OA, Schedule 2, Section 5.

[38] Manual 15, Section 2.7.1.

has the **potential** to better reflect a unit's operational characteristics and economic decisions. At the same time, however, defining any kind of optimization problem and properly expressing the constraints to that problem, such as environmental limits on a rolling 12-month basis, or modeling the relationship between emissions and start-up or shut down sequences, and the different kinds of emissions that are tracked and when they occur during generator operation, are challenging and must be done correctly if this approach is going to work.

59. Furthermore, accounting for discontinuities such as start-ups, shut down, minimum run times and down times, minimum run levels that differ from zero, and trade-offs between continuing to operate when prices are less than running costs versus incurring costs with repeated start-up and shut down cycles makes this optimization problem difficult to solve, because standard linear and concave programming techniques cannot be used.

60. Unfortunately, the descriptions in Section 12.7 of Manual 15 provide nowhere near enough information to fully understand, much less replicate, the IMM's approach. There is not even enough detail to define an optimization problem for maximizing generator net revenues that accurately captures the same problem for defining the OCA that is described in Manual 15. There is no meaningful discussion of other generator operations constraints such as minimum down time, capacity limits, start-up costs, or no-load costs as discussed in the previous two paragraphs. A few of these unit limitation constraints are mentioned in passing in a footnote, in a different subsection of Section 12.7,[39] but that description is far from the sort of complete or robust definition of the problem being solved that one would need to understand what the IMM is doing. Certain kinds of costs, like no-load and

[39] *Id.*, Section 12.7.6, footnote 2.

start-up costs – approved by the IMM as part of a standard 3-part energy offer – are simply omitted from discussion in the Manual. And as discussed by Mr. Griffiths in his affidavit, it appears that the way the IMM is reflecting those costs is inconsistent with how market participants would expect them to be modeled.

61. Additionally, there is no discussion on how **emission rates** are, or should be, modeled. Emission rates reflect the relationship between unit emissions and generator output, which will include start-up, shut down, economic minimum operation and maximum output. For emissions limited resources, these factors are important as they determine which pollutant constraint will be the most binding. The description in Section 12.7.1 of Manual 15 only mentions environmental permit limitations but does not provide important details in the description of the opportunity cost calculator. Incorrect emission rate estimates can overstate or understate how much energy an emissions-limited resource can run and significantly affect the resultant OCA.

62. All that Manual 15 has to say about emissions data is the following:

> Up to date emissions totals, hours of operations, or number of starts are critical inputs into the Opportunity Cost Calculator. Market Participants are required to provide these values on a routine basis and as requested by the MMU. If Market Participants fail to provide emissions data at the required temporal granularity, actual generation history and the generator's **emissions rates** and heat rate will be used to calculate daily emissions.[40]

63. There is nothing in the foregoing description about how this data will be used to calculate start-up or shut down sequence emissions or how this data will be used to calculate emissions during a run hour, nor does it provide the same detail as the PJM methodology which has suspended since June 1, 2020.[41] For criteria pollutants such as sulfur dioxide

[40] Manual 15, Section 12.7.5 at 105. (emphasis added)

[41] Manual 15, Sections 12.3 through 12.6.

("SO_2"), nitrogen oxides ("NO_x"), and for climate pollutants such a carbon dioxide ("CO_2"), these data are reported on an hourly basis through EPA Continuous Emissions Monitoring System ("CEMS") data, but the reported data do not disentangle emissions associated with the start-up or shut down portion of generator operation from other emissions associated with generator output. Generation owners monitor other pollutants associated more with start-up and shut down sequence such as carbon monoxide ("CO") and volatile organic compounds ("VOC") that are not reported in the publicly posted CEMS data.

64. Furthermore, the IMM's opportunity cost calculator methodology contains descriptions that are mathematically at odds with each other. First, footnote 2 to Section 12.7.6 of PJM Manual 15 describes the optimization methodology as an integer programming ("IP") problem maximizing net energy market revenue subject to generator parameter constraints. Mathematically speaking, an IP implies all variables are integer or discrete variables (*e.g.*, 0, 1, 2, etc.), but it is clear from the descriptions earlier in Section 12.7 that the IMM's methodology also includes continuous variables (*i.e.*, there are an infinite number of real values within a given interval) such as generator output. A more accurate mathematical description is to say the optimization is a mixed integer program ("MIP"), which contains both continuous variables and integer variables. This distinction may seem to be arcane and nitpicky, but it matters as it informs market participants about the underlying structure of the model and facilitates attempts to replicate the model for the purposes of understanding how the OCA will be determined when a run-limited resource is mitigated for structural market power.

65. Second, none of the so-called generator constraints enumerated in footnote 2 are described

as being either continuous variables constraints or integer constraints. This lack of transparency makes it difficult, if not impossible, for market participants to understand whether the IMM's opportunity cost calculator is modeling certain generator constraints as either continuous or as integer constraints.

66. Third, Section 12.7.6 describes the OCA as the shadow price on the binding environmental constraint. If, as described in footnote 2, the optimization is an IP or MIP, the concept of a shadow price simply does not exist as part of the solution to any IP, MIP or combinatorial optimization problem.[42] The concept of "shadow prices," which are the dual variables or Lagrange multipliers on constraints, only exists in what are known as linear programs ("LP") or concave programs in which all variables and constraints are continuous and the underlying constraint set is convex.[43] Consequently, the description of the optimization algorithm in Section 12.7.6 as calculating a shadow price makes no sense where, as here, an IP or MIP is involved and makes it impossible to replicate or understand without making additional assumptions about how the IMM's opportunity cost calculator works. The only possibility for obtaining meaningful shadow prices in this setting is to solve the MIP to optimality, and then insert the optimal integer variables in as equality constraints and resolve the problem as a conventional linear or concave program to derive the set of shadow

[42] *See* Geoffrion, A.M, and Nauss, R. "Parametric and Postoptimality Analysis in Integer Linear Programming," *Management Science* 23(5), 1977, pp. 453-466 as cited by O'Neill, Richard P., Sotkiewicz, Paul M., Hobbs, Benjamin F., Rothkopf, Michael H., and Stewart, William R. Jr., "Efficient Market Clearing Prices in Markets with Non-Convexities." *European Journal of Operational Research*, Volume 164, Issue 1, 1 July 2005, Pages 269-285. "As an example, Geoffrion and Nauss (1977) state, 'integer linear programming models have no shadow prices or dual variables with an interpretation comparable to that in linear programming.'"

[43] *See* Akira Takayama, *Mathematical Economics,* second edition, Cambridge University Press, 1985, Chapter 1: Developments of Nonlinear Programming. *See also* Avinash K. Dixit, *Optimization in Economic Theory,* second edition, Oxford University Press, 1990.

prices that are consistent with all the constraints in the optimization problem.[44] This methodology is consistent with how LS Power is determining their OCAs.[45] However, there exists no documentation to show whether the IMM's opportunity cost calculator applies the same methodology in any meaningful way.

67. This lack of transparency makes it impossible for market participants to understand how they may be mitigated by the IMM and what the OCA might be. The best a market participant can do is to make assumptions on how the opportunity cost calculator works, how the optimization is set up, what are or are not integer constraints, what data is used, how data inputs are transformed, and so on. But I can see no valid justification for requiring such guesswork.

C. The Description of the IMM's Opportunity Cost Calculator Indicates that the Maximization of Net Energy Revenues Cannot Be Guaranteed to be Solved to Optimality Based on the Description of the Rolling 12-month Restriction

68. Section 12.7.6 of Manual 15 describes how a rolling 12-month compliance period is modeled in the IMM's opportunity cost calculator as follows: "For resources with rolling compliance periods, the opportunity cost is the shadow price corresponding to the **earliest binding** environmental or operational limit." [emphasis added] Even leaving aside, for the

[44] O'Neill, Richard P., Sotkiewicz, Paul M., Hobbs, Benjamin F., Rothkopf, Michael H., and Stewart, William R. Jr., "Efficient Market Clearing Prices in Markets with Non-Convexities." *European Journal of Operational Research*, Volume 164, Issue 1, 1 July 2005, Pages 269-285. This paper developed this concept and derived mathematical proofs to show that such prices form a competitive equilibrium and also is Pareto optimal.

[45] The LS Power methodology adds an extra step in that it takes the shadow prices from inserting the optimal integer variables as equality constraints and then uses these to solve the dual problem that reduces the run time or environmental constraints by one MW in an attempt to be consistent with the IMM methodology as it is understood.

moment, the issues regarding shadow prices described above, this "earliest binding" cut-off of the optimization is arbitrary and ignores other, more binding constraints that may occur further into the rolling 12-month compliance period.

69. For example, suppose that given forward power and fuel prices over the rolling 12-month period into the future, the emission limits of a resource bind in the fourth, eighth, and eleventh months looking into the future. That is, the unit would have wanted to run more in each of these months but will be prevented from doing so by the emissions limit applied over a rolling 12-month period. To maximize net energy market revenues subject to the environmental constraints, each one of these binding constraints must be met and examined. Again, putting aside that shadow prices do not exist in IP or MIP, the IMM's approach, as I understand it from the narrative explanation in Section 12.7.6 of Manual 15, would still be flawed in that it would fail to examine all binding constraints beyond the first one encountered. In this example, it would instead set the OCA based on the fourth month, even if opportunity costs would be substantially higher in the eighth and eleventh months. Assume, for example, OCAs of $20/MWh for the fourth month, $50/MWh for the eight month, and $35/MWh for the eleventh month. The "earliest binding" language in Section 12.7.6 suggests that the opportunity cost calculator would ignore the higher values for the eighth and eleventh months and assign an arbitrarily low OCA of $20/MWh. In reality, the IMM should be looking across all of these different binding permit limits **simultaneously** to find the true marginal period block – *i.e.*, the period when dispatch would actually be reduced – and set OCAs based on that period. In this case, the OCA should be set to $50/MWh, while the IMM's approach understates it at $20/MWh.

70. The IMM opportunity cost calculator description of cutting off the OCA at the earliest

binding constraint is quite different from the PJM methodology that ranks the blocks of energy margin from highest to lowest which would imply that most restrictive constraint would be binding for the opportunity cost, rather than the earliest constraint.

71. The above example also shows that it is not clear at all how a rolling 12-month environmental restriction would be modeled, as the IMM's opportunity cost calculator is silent on this matter. This modelling choice matters. How far into the future is the look ahead? Is it 12 months forward from the date of the OCA calculation? Is it 24 months to account for "run out" issues? Neither choice would necessarily be incorrect, but it must be well-defined, and the optimization must be solved to optimality rather than cutting it off at the earliest binding constraint as the IMM's opportunity cost calculator apparently does.

72. It seems reasonable and logical to model a rolling 12-month emissions limit at least 12 months forward consistent with the rolling average permit restriction. This would imply 12 different environmental constraints within the model in which each successive rolling 12-month environmental constraint would be dependent upon the choices made by the optimization problem in previous months. But we do not know if this is how the rolling 12-month compliance is modeled in the IMM's calculator.

D. The Description of the IMM's Opportunity Cost Calculator Indicates that the Maximization of Net Energy Revenues Cannot Be Guaranteed to be Solved to Optimality Based on the Description of the Start-Up and Minimum Run Time Logic

73. Section 12.7.9 of Manual 15 provides a narrative description of the start-up and minimum run time logic: "For a generator with a minimum runtime of one hour or less, the Opportunity Cost Calculator will commit the unit only in the case that the revenue net of

startup and hourly operating cost for the first hour is greater than \$0 or the revenue net of startup and hourly operating cost for the first hour plus the next hour is greater than \$0."[46]

74. On its face, this language is problematic in that it implies a deterministic model: if it would be profitable to start and only run one or two hours, the IMM's opportunity cost calculator will commit that resource to run regardless of what future hours may appear to have higher net revenues. The opportunity cost calculations given the run time logic as written are "path dependent" in that if a resource is committed in the first month, under the logic of the IMM's opportunity cost calculator, it may be foregoing more profitable opportunities in future months because of this deterministic start-up and run time logic.

75. Consider a simple example with a 100 MW resource that has a 1-ton emissions restriction and a 1-hour minimum run time. Each start results in 0.1 tons of emissions and costs \$1,000/start and marginal cost inclusive of fuel, variable O&M, and emissions allowances of \$50/MWh. Running at a full load of 100 MW results in 0.3 tons each hour. Intuitively, it would make sense to minimize the number of starts and maximize generator output consuming emissions.

76. Further assume there would only be three time periods in which this unit may possibly find it profitable to run. In the first month of a restriction, it is a one-hour period in which the LMP is \$70/MWh. In the second month, it is a period of three consecutive hours of LMP of \$80/MWh. In the third month, there is a three-hour stretch of LMP at \$100/MWh.

77. By the deterministic language of the start-up and minimum run-time logic, the resource would be committed in the first month to start-up and run for one hour, incur a start cost of \$1,000 and variable costs of \$5,000 (\$50/MWh x 100 MW) for a cost of \$6,000 and earn

[46] Manual 15 at 106.

$7,000 (100 MW x $70/MWh). This first month would use up 0.4 tons of emissions and result in net energy revenue for this block of $1,000.

78. Then in the second month, with only 0.6 tons of emissions remaining, the resource would be committed for the block of energy when LMP is $80/MWh. The unit with start-up can now only run 1.67 hours (1 hour, 40 minutes) of the three-hour block because of the previous commitment. If the resource had not been previously committed, it could run the entire three-hour block, incurring $1,000 in start costs and variable costs of $15,000 ($50/MWh x 100 MW x 3 hours) for a total cost of $16,000 while earning $24,000 ($80/MWh x 100 MW x 3 hours). This would have resulted in net energy revenue of $8,000.

79. Instead in the second month, because of the deterministic minimum run time logic, the resource incurs $1,000 in start costs and $8,350 in variable costs ($50/MW x 100 MW x 1.67) while earning $13,360 ($80/MW x 100 MW x 1.67) for net energy revenues of $5,010. When added to the $1,000 of net energy revenues from the first month, the net energy revenue totals $6,010, still materially less than the $8,000 it would have earned running the full three-hour block at $80/MWh.

80. Given the run time logic when combined with the logic of the earliest binding constraint, Manual 15 indicates that the IMM's opportunity cost calculator would determine an OCA of $30/MWh (the forgone LMP in the second month block of LMP at $80/MWh less the $50 MWh running costs).

81. To make matters worse, there is the third month when energy prices would be $100/MWh. This month would not even be considered under the IMM's opportunity cost calculator run time logic and earliest binding constraint logic. If the deterministic run time logic and

earliest binding constraint logic were relaxed, the optimization algorithm would pick the third month block that would earn the resource $14,000 in net energy revenues, yet the IMM's opportunity cost calculator run time logic and earliest binding constraint logic as articulated in Section 12.7 of Manual 15 would prevent this more efficient outcome.

82. Thus, if the combinatorial optimization (MIP) were to be solved to optimality, the OCA would be $50/MWh in this example rather than $30/MWh as would be the case under the stated run time logic in Section 12.7.9. Because the IMM's opportunity cost calculator appears to fail to solve to optimality given what is known about the IMM's opportunity cost calculator, it is almost certain that the OCAs are likely understated which can lead to reliability problems in both the short-term and long-term.

<u>VI. TECHNICAL, MATHEMATICAL, AND COMPUTATIONAL CONCERNS REGARDING THE IMM OPPORTUNITY COST CALCULATOR</u>

A. <u>From the Available Documentation, the IMM's Opportunity Cost Calculator Methodology Does Not Result in Shadow Prices for the OCA as Understood in Optimization Models</u>

83. Putting aside all the concerns about ambiguity in data and methods, there is reason to believe that the IMM's model may also consistently generate inaccurate results because of how the opportunity cost model attempts to solve its underlying dispatch optimization to reveal the OCA "shadow price." Manual 15 suggests that the IMM's opportunity cost calculator attempts to maximize net energy revenues for a selected resource using the stated IP/MIP logic. Next, the IMM's opportunity cost calculator the uses the same IP/MIP logic to recompute those net energy revenues assuming slightly lower permit limits.[47] In this

[47] *See* Manual 15, Section 12.7.1 ("The opportunity cost is the shadow price corresponding to the binding environmental or operational limit. The shadow price is defined as the marginal decrease in the net revenue due to a one hour equivalent decrease in the binding environmental or operational limit.").

way, the opportunity cost calculator is estimating the OCA based on very small changes in annual (or monthly) net energy revenues using two separate IP/MIP solutions with only a slight difference in the permitted output limits.

84. This interpretation of the Manual 15 language for the IMM's opportunity cost calculator is not consistent with the language presented by the IMM in 2017.[48]

> • Step 1: Optimize w/o environmental/equipment limitation constraints
> • Step 2: Optimize with environmental/equipment limitation constraints
> > • If the objective function value in Step 2 is less than the objective function value in Step 1, then continue to Step 3; otherwise OCC Adder = 0
>
> • Step 3: Determine the earliest compliance period that is binding in Step 2 and restrict the run time hours for that compliance period to be 1 hour less than the previous solution. Resolve the optimization."

The Manual 15 language for the IMM opportunity cost calculator is missing the first two steps as stated in the 2017 IMM OCA Presentation, so it is not clear exactly what is happening in the IMM's calculator. Moreover, if the IMM opportunity cost calculator does include the first two steps, the difference between the objective function without output limitations and the objective function with output limitations should provide a value of the opportunity cost without having to use the step that looks at the earliest binding constraint. As discussed above, that earliest-binding constraint step truncates the problem and potentially underestimates the opportunity cost.

85. Furthermore, there are well established methods to accurately compute small changes of this sort from MIP optimization models as outlined in peer reviewed work almost 20 years ago.[49] As already explained earlier in this affidavit, deriving shadow prices in a MIP

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[48] 2017 IMM OCA Presentation.

[49] O'Neill, Richard P., Sotkiewicz, Paul M., Hobbs, Benjamin F., Rothkopf, Michael H., and Stewart, William R. Jr., "Efficient Market Clearing Prices in Markets with Non-Convexities." *European Journal of Operational Research*, Volume 164, Issue 1, 1 July 2005, Pages 269-285.

framework requires solving the MIP to optimality with all run-time and output constraints in place, not three times as the IMM 2017 OCA Presentation would indicate. A second run inserts the optimal integer variables in as equality constraints and resolves the problem as a conventional linear or concave program to derive the set of shadow prices that are consistent with all the constraints in the optimization problem. This methodology is computationally far simpler, and there are true shadow prices that can be derived from this method. There is no reason to believe that the IMM's opportunity cost calculator is using the above method given the current written documentation.

86. The only other documentation, scant as it is, is from the IMM 2018 OCA Presentation.[50] This presentation provided examples that only examine a single hourly limit yet skip the first step as stated in the 2017 IMM OCA Presentation and solve successive IP/MIP problems with the restriction reduced by one hour. Again, there is lack of complete documentation to understand the IMM methodology so it can be replicated.

87. Mathematically, economically, and intuitively an OCA should never be negative. Yet, the IMM's methodology can result in negative OCAs for any specific year of the three previous years accounting for the basis differential and variability. If a generator's out-of-pocket variable costs are such that it would always run fewer hours than its permit, even a very restrictive emissions permit would allow, its OCA will be exactly zero. An OCA of zero reflects the fact that running now will not prevent the unit from running later, and that the opportunity cost of running now is, therefore, zero. Put differently, notwithstanding its permit restrictions, the unit can run in all the hours in which it is profitable. Intuitively and economically, a negative OCA implies that a unit would be dispatched on a cost-based

[50] IMM 2018 OCA Presentation at 8-13.

offer that is below its out-of-pocket costs. This is obviously an absurd outcome. This is why Schedule 2 of the OA states, “If the difference between the forecasted Locational Marginal Prices and forecasted costs to generate energy is negative, the resulting Energy Market Opportunity Cost shall be zero.”[51]

88. However, the language is Schedule 2 is silent on whether this is for the total calculated Energy Market Opportunity Cost, or applied to each of the three preceding years for which an opportunity cost is calculated with forward energy prices but the basis differential and volatility in the three previous years are then averaged to get the Energy Market Opportunity Cost.[52] Manual 15 offers no information about how it avoids or resolves these spuriously negative OCA estimates. While the OA requires that “negative OCAs” be set to zero, it is not clear whether the IMM’s opportunity cost calculator sets each individual negative OCA to zero before averaging over three years or if it allows negative OCAs to be included within the three-period average. It is unclear how often the IMM’s model does generate spurious results. Nor is it clear whether the IMM’s opportunity cost calculator does anything to ensure negative values cannot be generated in the first place, by, for example, solving the unit commitment MIP to optimality, inserting the optimal integer variables in as equality constraints, and then resolving the problem as a conventional linear or concave program that are consistent with all the constraints in the optimization problem.[53] On all these issues, Manual 15 is silent, even though nuanced modeling choices can have significant economic consequences, with poor choices

[51] OA, Schedule 2, Section 5.

[52] *Id.*

[53] *See supra* ¶ 66.

generating results that are economically nonsensical.

89. Mathematically, when solving linear or concave programming problems, the shadow prices/Lagrange multiplies/dual variables **cannot** be less than zero. The methodology of solving the MIP to optimality and then inserting the integer variable solution as equality constraints ensures that the shadow prices on the run-time or output limits of resources are never less than zero. In contrast, the IMM's methodology as stated in Manual 15 does not rule out negative OCAs for any of the three years of estimates going into the calculator, stating, "The opportunity cost adder is calculated as the average of the three opportunity cost values corresponding to the three sets of forward LMPs and forward delivered fuel prices."[54]

90. The only documentation of the minimum for an OCA being zero appears in the 2017 OCA Presentation, but this is not memorialized in Manual 15 or the Schedule 2 of the OA. However, in the subsequent 2018 IMM OCA Presentation, the IMM documents the notion there may be negative opportunity costs, but there is no context provided.[55] At best, this is an area in which more clarity is needed. At worst, the IMM's methodology is working with fundamentally illogical and nonsensical negative OCAs that could bias the average of three years of OCAs downward.

B. <u>The IMM's Opportunity Cost Calculator Has Not Been Vetted Regarding the Optimality of Its Solutions With Respect To Computational Algorithms</u>

91. MIP models, like the ones that the IMM relies on to solve unit commitment and dispatch, can generate dispatch results that are very close to optimal, but there is no way to prove

[54] Manual 15 at 105.

[55] 2018 IMM OCA Presentation at 7.

that the results from a MIP model are the most optimal (or most profitable). MIP models provide results within a pre-specified level of precision, known as the MIP gap.[56] Unlike linear programs, which can be mathematically proved to yield the most optimal results, MIPs will provide optimal results, plus or minus a small level of uncertainty. In this way, MIP models provide solutions for optimal dispatch but within a tolerance margin from the optimal solution as a user defined input as a trade-off between achieving the optimal solution and computational clock time to explore all branches of the tree of possible solutions.[57]

92. This feature of IP/MIP models leads to a problem with how the IMM's opportunity cost calculator attempts to estimate the OCA by subtracting one solution from another. While the result from either one of these dispatch solutions may be within a user determined tolerance margin to use on its own, comparing one IP/MIP solution to another also may be solved within a tolerance margin leads to a greater chance of error in computing the OCA. Based on available documentation from stakeholder presentations from more than six years ago, this is what the IMM appears to be doing. Thus, subtracting one solution with a tolerance margin from a second solution with a tolerance margin to compute the OCA can result in spurious results such as negative OCAs.

93. For example, consider a case where a unit produces 5,000 MWh over a permit period and earns $50/MWh in profit for each MWh sold, earning it $2,500,000. If we were to have

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[56] *See* Matthias Miltenberger, Gurobi Optimization, "What is the MIP Gap?", available at https://support.gurobi.com/hc/en-us/articles/8265539575953-What-is-the-MIPGap.

[57] *Id*. "Moreover, for real-world applications, it is always sensible to set a positive MIP Gap tolerance to manage the tradeoff between having a feasible solution that is good enough for the use case and the computation time required to explore the branch-and-bound tree (many times it's prohibitive to exhaust that search)."

the unit run one hour less, it would earn period revenues of $2,499,950 – $50 less. A model specified with a tolerance margin or MIP gap of 0.01%[58] means that it would provide a solution guaranteed within one-hundredth of 1% of optimal, however, would be satisfied with a result that is within $250 of the optimal solution. **The error bars of the MIP are, in effect, five times larger than the OCA itself,** which means that the MIP model could imply that the unit could actually earn up to $2,500,250, when the emissions limits were decremented. That, in turn, would incorrectly suggest an OCA of -$250/MWh instead of the "true" OCA of +$50/MWh. Again, this negative OCA does not represent anything economically meaningful but may be an artifact of the user defined MIP gap tolerance margin to shorten computational clock time inherent to IP/MIP models. Even if the IMM calculator resets all negative OCAs to zero, the subtraction of one MIP gap solution from another MIP gap solution can still significantly misstates the resource's OCA: here, setting it at $0/MWh when it should have been then the true OCA of $50/MWh.

94. Given the trade-offs between computational clock time and optimality as represented by the chosen MIP gap tolerance margin, the solution discussed above where the IP/MIP is solved only once, rather than two or three times as it seems the IMM does, and then the integer solutions are inserted as equality constraints allows the IP/MIP to be solved to optimality (or much closer) by defining an even smaller MIP gap tolerance margin by using the saved computational clock time of avoiding more IP/MIP solutions. Moreover, the use of the same solution to solve the linear or concave program enhances the consistency of the solution by avoiding introducing additional error in the OCA calculation.

[58] Two common MIP solvers, Gurobi and CPLEX, both use this 0.01% threshold as the default value. *See* https://www.gurobi.com/documentation/current/refman/mipgap2.html and https://www.ibm.com/docs/en/icos/12.9.0?topic=parameters-relative-mip-gap-tolerance.

VII. RECOMMENDATIONS AND CONCLUSIONS

95. Given the ambiguity and uncertainty regarding the workings of the IMM's opportunity cost calculator/optimization program and the many inherent problems that I have shown within this affidavit, there is a need to better define the IMM's optimization program and make the entire process as transparent as possible given the benefits of transparency as discussed herein. In this spirit I offer the following recommendations.

96. *Recommendation 1*: FERC should order PJM to launch a stakeholder process to fully vet the IMM OCA optimization problem to make this market mitigation mechanism as transparent as possible so that market participants can gain a full understanding of the IMM's OCA optimization mechanism, the required inputs, and how the inputs are used to determine the OCA. This would look like a FERC Technical Conference in spirit but ought to be conducted at PJM over a period of **days or perhaps weeks** and not months or years. A start to this would be for the IMM and PJM, as the auditor of the IMM mechanism as articulated in PJM Manual 15, to provide a full analytical expression of the entire optimization problem including all constraints such as the full expression of the rolling 12-month compliance periods for emissions limits.

97. I note that this first recommendation does not call for the IMM to release its computer code or any commercial software code that might be proprietary. There is nothing proprietary about any analytical expressions of the IMM OCA optimization problem or conceptual descriptions of the algorithms used to solve the problem in a manner comparable to the description of PJM's opportunity cost calculator in PJM Manual 15.

98. It is also possible, and maybe even likely, that with PJM stakeholder and member input there will be improvements to the IMM OCA optimization. These could be observations to ensure the accuracy of inputs, consider different operational constraints such as those

imposed by natural gas pipelines such as 24-hour ratable takes, and different algorithms to sharpen the optimization and reach a more optimal solution to the objective function of maximizing net revenue. This in turn will lead to an accurate OCA that will help preserve operational reliability while mitigating structural market power.

99. *Recommendation 2*: The current Schedule 2 OA language regarding opportunity costs was tailored to the PJM OCA methodology that was suspended June 1, 2020, and has not been updated to account for the IMM´s OCA optimization methodology that is now the only OCA methodology that can be used. FERC should order PJM to file any necessary revisions to Schedule 2 of the OA related to opportunity costs to reflect the IMM OCA methodology now in use. This would be informed by the information coming out of my first recommendation where there would be greater transparency provided regarding the IMM methodology so that the OA language will provide an accurate expression of the IMM OCA optimization methodology.

100. *Recommendation 3*: Currently, Manual 15 charges PJM with auditing the IMM OCA methodology. FERC should order PJM to set forth in Schedule 2 of the OA PJM's duty to conduct an annual audit of the IMM OCA optimization methodology including inputs, and for PJM to report the results of that audit to the PJM membership. Such an audit should include the number of occurrences of disagreements between the IMM and market participants over the value of the OCA determination, the number of times these disagreements were the result of errors, and the nature of the errors either by the IMM or market participants. Such reporting will help both the IMM and market participants going forward to avoid repeating past errors and to improve the OCA calculations to the benefit of market participants and the market alike. Given the increasing environmental

restrictions placed on fossil resources, it is increasingly imperative to ensure the fidelity of the IMM OCA as the reliability implications will only increase while also ensuring just and reasonable market power mitigation.

101. *Recommendation 4*: FERC should allow market participants that disagree with an IMM OCA determination to seek redress with PJM as the entity administering its Tariff and OA within seven days of a disagreement that cannot be resolved. Currently there is no formal process to handle disputes over the level of the OCA between the IMM and market participants as is clearly evidenced in the affidavit provided by LS Power's Benjamin Griffiths. As Mr. Griffiths outlines, it took months of back and forth between LS Power and the IMM before getting PJM involved to come to a resolution. Unfortunately, in the case of LS Power's Chambersburg units, this was too late, as at one point they ran out of available hours because of incorrect OCA calculations. This is the kind of reliability problem that can arise if the OCA is understated as I explained above.

102. As the administrator of the Tariff and OA, and as the auditor of the IMM OCA optimization methodology, PJM is best positioned to help resolve any disputes to ensure the OCA is correctly determined to ensure reliable operations.

103. The short time period in the fourth recommendation is needed to avoid circumstances in which relief from an understated OCA is only obtained when it is too late. That was exactly what occurred in Chambersburg's case. It was being used heavily for transmission constraint control and thus subject to market power mitigation, and its limited run hours were used up before its OCAs were corrected. This not only hurts the resource owner but also renders resources unavailable for other times when reliability may be compromised as I showed through examples above in Sections IV-A and V-D.

104. Finally, all the above recommendations once enacted, should all be memorialized in PJM Manual 15 with the degree of detail that is currently in place for the PJM OCA methodology, but applied to the IMM OCA optimization methodology.

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

LS Power Development, LLC,	)	
	)	
Complainant,	)	
	)	
v.	)	
	)	**Docket No. EL24-__-000**
Monitoring Analytics, LLC, as the Independent Market Monitor for PJM, and PJM Interconnection, L.L.C.,	)	
	)	
Respondents.	)	

AFFIDAVIT

I, Paul M. Sotkiewicz, Ph.D., hereby state, under penalty of perjury, that the statements contained in the foregoing Affidavit on behalf of LS Power Development, LLC are true and correct to the best of my knowledge and belief.

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Paul M. Sotkiewicz, Ph.D.

Dated: March 18, 2024

Attachment 1

E-Cubed Policy Associates, LLC
www.e-cubedpolicy.com | Gainesville, Florida

Paul M. Sotkiewicz, Ph.D.

President and Founder, E-Cubed Policy Associates, LLC

Paul M. Sotkiewicz, Ph.D. is the President and Founder of E-Cubed Policy Associates, LLC ("E-Cubed"), an energy and environmental economic consultancy based in Gainesville, Florida that started in 2016. Dr. Sotkiewicz brings more than 25 years of experience across parts of three decades at the intersection of utility regulatory policy, power system economics, and environmental economics to provide analysis and advice to private and public sector clients on a range of economic issues related to electricity market design and performance, power generation economics, market power mitigation, utility regulatory policy, distributed energy resources and the economic impacts of state and federal environmental policies on the power and gas industries. Dr. Sotkiewicz also supports law firms in litigation proceedings including rate cases, need determinations, rate design and market power/manipulation cases.

<u>Clients have included:</u>

Market and system operators
- Alberta Electric System Operator
- New York Independent System Operator
- Electric Reliability Council of Texas.

Trade associations such as the
- Electric Power Supply Association
- New England Power Generators Association
- PJM Power Providers Group
- American Petroleum Institute
- Industrial Power Consumers Association of Alberta
- Dual Use Customers of Alberta

Merchant generation and transmission developers in North American power markets
- ITC Holdings,
- JPower USA Ltd.
- Panda Power Funds
- Vistra Energy
- ENMAX
- Rockland Capital
- Kalina Distributed Power
- Capstone Infrastructure Corporation

- Pine Gate Renewables
- NextEra Energy Resources
- PVOne
- Bechtel
- Tenaska
- Earthrise Energy, PBC
- LS Power
- Coalition of PJM Capacity Resources which included resources owned by GenOn, Talen Energy, Tyr Energy, Clean Energy Futures, and Competitive Power Ventures among others.

Generation and transmission cooperatives

- Intermountain Rural Electric Association
- Buckeye Power
- East Kentucky Power

Non-Governmental Entities

- Natural Resources Defense Council
- Southern Environmental Law Center

Regulatory Agencies/Governmental Entities

- Delaware Public Service Commission
- US Department of State (via Lawrence Berkeley National Laboratory)
- Government of Vietnam
- Florida Department of Environmental Protection
- Belize Public Utilities Commission

Natural Gas Industry Customers

- Blue Racer Midstream

Prior to founding E-Cubed, Dr. Sotkiewicz worked for PJM Interconnection, LLC in the role of Chief Economist and as a Senior Economic Policy Advisor. At PJM, Dr. Sotkiewicz provided analysis and advice regarding all aspects of PJM's markets and supported regulatory filings and implementation of market design changes. At PJM Dr. Sotkiewicz led initiatives related to shortage pricing and real-time dispatch co-optimization of energy and reserves, integration of demand response in PJM's markets including price formation and compensation of demand resources. At PJM Dr. Sotkiewicz supported PJM's regulatory position with respect to the application of the Three Pivotal Supplier Test supplier market power, helped develop an opportunity cost calculator for run-limited resources used for market mitigation purposes, and administered implementation of the minimum offer price rule (MOPR) to curb buyer-side market power in the PJM capacity market. Dr. Sotkiewicz also authored or co-authored a series of policy analyses and whitepapers on ranging from transmission cost allocation to gas-electric coordination to the effects of environmental rules on PJM's markets. While at PJM, Dr. Sotkiewicz was a frequent speaker at FERC Computation Technical Conferences related to advances in unit commitment models and computation methods that could be applied in ISO/RTO markets.

As an economist at the United States Federal Energy Regulatory Commission (FERC) in the Office of Economic Policy and later, on the Chief Economic Advisor's staff at Dr. Sotkiewicz conducted research and provided analysis and advice on market design issues related to the ISO/RTO markets, in particular the California ISO and New York ISO, as they were being formed and implemented and worked on merger cases to analyze any potential for market power. As part of this work, Dr. Sotkiewicz has co-authored peer review articles related to unit commitment models and price formation to account for discrete decisions related to start-up, shut-down, and minimum run conditions.

Dr. Sotkiewicz is the author or co-author of multiple book chapters and publications related to wholesale market design and policy including price formation in unit commitment models, the integration of demand response and distributed energy resources in markets and operations environmental economic policy, distribution rate design, economic decisions for nuclear resource build decisions, and renewable resource integration. In addition to his tenures at PJM and FERC, Dr. Sotkiewicz served as the Director of Energy Studies at the Public Utility Research Center (PURC), University of Florida, and he was an Instructor in the Department of Economics at the University of Minnesota where he earned the Walter Heller Award for Outstanding Teaching of Economic Principles four times.

Dr. Sotkiewicz holds a Bachelor of Arts in history and economics from the University of Florida (1991) with High Honors, a Master of Arts (1995) and Doctorate in Economics from the University of Minnesota (2003). Dr. Sotkiewicz is also a member of Phi Beta Kappa academic honor society and a former Fulbright Scholar.

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EDUCATION

PhD, Economics, University of Minnesota, 2003
M.A., Economics, University of Minnesota, 1995
B.A. (High Honors), History/Economics, University of Florida, 1991

PROFESSIONAL AND ACADEMIC EXPERIENCE

2016- President and Founder, E-Cubed Policy Associates, LLC, Gainesville, FL

- Founded to provide expert advice, testimony, and policy research to private sector and government clients at the intersection of energy, environmental, and economic policy, and regulation.
- Supporting litigation defending market participants against accusations of market manipulation in PJM's markets
- Worked with the Ontario Independent System Operator (IESO), in conjunction with the Brattle Group, to help implement new settlement logic and protocols in their move to LMP-based market design.
- Assisted Brattle Group and NYISO in developing strategies and analysis to move the NYISO markets toward a less carbon intensive future in response to state climate change initiatives
- Conducting analysis of recent past and future expected profitability of nuclear power plants under consideration for state subsidies to keep these facilities in commercial operation and providing reports and testimony in front of state legislative bodies.
- Provide capacity market design and expertise to the ENMAX Corp. in Calgary, AB regarding the AESO capacity market proposal filed in late 2018
- Supported rate case litigation for a reactive power rate case for Panda Stonewall explaining the history behind markets and that the filed rate from Panda Stonewall was consistent with precedent and lost market opportunities
- Providing PJM expertise to JPower USA Ltd in its development of new combined cycle gas facilities in PJM and help move the project through the PJM interconnection processes as well as advising on existing facilities in the PJM and NYISO market.
- Provided capacity market design expertise to the Alberta Electric System Operator in 2017 as they started their transition from an energy-only market to a combined energy and capacity market.
- Supporting the Greek Electricity Market authoring, through ECCO International, a whitepaper on market power mitigation with a special look at buyer side market power mitigation in the energy market with the different indices that could be indicative of buyer market power.
- Authored a Meter Data Study for the NYISO encompassing a survey of metering requirements for demand resources and distributed energy resources in key ISO/RTO markets, the current use of demand response baseline methodologies and use of such baselines for distributed energy resources in the context of REV in New York.
- Work with clients in generation and merchant transmission development projects in various parts of PJM related to helping them through the interconnection process, understanding market rules, and regulatory policy and economic advice in the face of changing market rules.
- Supporting clients in docketed proceedings at FERC and at the Florida Public Service Commission providing expert testimony and analysis used in regulatory proceedings. These proceedings include need determinations, rate filings, RTO market design changes, and policy related proceedings.
- Supporting US government initiatives in exporting knowledge and experience regarding US electric power market and gas market development to the Chinese and Indian governments as they

undertake green energy initiatives and look to improve the overall efficiency of the power system.

2015-2016 Contractor, YOH Inc. and working under the title of Senior Economic Policy Advisor, PJM Interconnection, L.L.C., Audubon, PA
2010-2015 Chief Economist, Market Services Division, PJM Interconnection, L.L.C., Audubon, PA
2008-2010 Senior Economist, Market Services Division, PJM Interconnection, L.L.C., Audubon, PA

- Provide analysis and advice with respect to the PJM market design and market performance including demand response mechanisms, intermittent and renewable resource integration, market power mitigation strategies, capacity markets, ancillary service markets, and the potential effects of environmental policies on the PJM markets.
- Co-authored papers related to effects of the proposed Waxman-Markey climate change bill in 2009, the implementation of the Mercury and Air Toxics Standards (MATS) and Cross State Air Pollution Rule in 2011, and the potential effects of the EPA-proposed Clean Power Plan in 2015.
- Led the Stakeholder Process to implement reserve shortage pricing in PJM in 2009-2010 and provided expert testimony associated with FERC filings in 2010.
- Co-authored paper to explain various market and policy concepts for PJM and its stakeholders including a paper explaining generator costs and compensation in 2010, a paper on alternatives for transmission cost allocation in 2010, and a whitepaper on capacity market issues in 2012.
- Advised PJM executives on market power mitigation issues related to the Three Pivotal Supplier test and cost-based offers used for market power mitigation in the PJM Energy Market in 2008-2009
- Advised PJM executives and Board of Managers on demand response compensation prior to the issuance of FERC Order 745.
- Supported and advised the Capacity Market Operations staff and PJM executives on all matters related to the Reliability Pricing Model (RPM) capacity market including implementation of the Minimum Offer Pricing Rule in its various iterations, administered determinations and/or reasonableness of Market Seller Offer Caps during disputes between Capacity Market Sellers and the Independent Market Monitor.
- Provided advice to Capacity Market Operations staff and PJM executives on the RPM Triennial Parameter Review Process in 2011 and in 2014 including supporting legal staff in making filings, providing expert testimony, and providing expert advice during the 2011 and 2012 hearing and settlement process at FERC.
  Supported and provided advice to Capacity Market Operations staff and PJM executives on Capacity Performance through stakeholder presentations, regulatory filings, and working jointly with the IMM in developing the ideas and concepts taken from ISO New England's Pay for Performance design for us in PJM.
- Supported the Federal State Government Policy outreach through by providing subject matter expertise during one-on-one meetings with regulatory staff and Commissioners related to any issues of mutual interest and import between PJM and state commission, state environmental regulators, FERC staff, and EPA staff as needed.
- Co-authored and co-led PJM's responses to the Independent Market Monitor's (IMM's) *State of the Market Reports* as well as remaining in communication with the IMM on various matters of concern and interest related to PJM market performance and design.
- Led technical and non-technical external outreach efforts to promote PJM markets or explain PJM positions on policy or market design issues of current interest to industry stakeholders including academic audiences and invited presentations at industry sponsored events.
- Provided support in gas/electric coordination discussions within PJM and the between the power and gas industries, as well as operations support during critical operating periods in January 2014 through calls and inquiries to PJM generators and pulling environmental permits to better understand generator operating limitations on back-up fuel.
- Provided periodic reports on market performance and the state of PJM's markets to the PJM Board of Managers Competitive Markets Committee including the relationship between PJM's markets and

major fuel market, environmental policy, and macroeconomic trends.

- Acted in the role of an internal consultant and advisor to all PJM departments and divisions, as needed, to address any questions or concerns surround market performance, market design, and general economic or environmental policy questions.
- Supported development and issuance of the PJM Renewable Integration Study by outside vendors.

2000–2008 Director of Energy Studies, Public Utility Research Center and Lecturer, Department of Economics, University of Florida, Gainesville, FL

- Designed and delivered executive education and outreach programs in electric utility and regulatory policy and strategy for professionals in government, regulatory agencies, and industry primarily for developing countries.
- Created and delivered electricity regulatory policy curriculum for the *PURC/World Bank International Training Program on Utility Regulation and Strategy* offered twice per year for 65 to 95 industry and regulatory professionals in each course.
- Served as the electricity expert and liaison to the Florida electric utilities who were contributing members of PURC.
- Developed electricity related topics and obtained speakers for the PURC Annual Conferences held each February on matters related to environmental policy, wholesale market restructuring, so-called "hurricane hardening" of power systems after the 2004-2005 hurricane seasons, and other policy related matters of interest to the state of Florida.
- Served the PURC liaison to the consultants retained by PURC to evaluate the hardening of electricity infrastructure in the wake of the 2004 and 2005 hurricane seasons.
- Conducted original academic research related to electricity regulation and policy and published in peer reviewed academic and policy journals
- Developed customized regulatory training courses or sessions jointly prepared with other organizations for on-site delivery in Panama, Trinidad & Tobago, Brazil, Mexico, Peru, Bolivia, Argentina, Grenada, South Africa, Zambia, Namibia, and Cambodia
- Served as an advisor and subject matter expert on wholesale restructuring and market issue to Florida Governor Jeb Bush's *Energy 2020 Study Commission* 2000-2001.
- Taught classes as needed in the Economics Department on environmental economics, regulatory economics, and a large lecture class of managerial economics

1999–2000 Economist, Office of Markets, Tariffs, and Rates, United States Federal Energy Regulatory Commission, Washington, DC

1998–1999 Economist, Office of Economic Policy, United States Federal Energy Regulatory Commission

- Provided analysis and research related to filings made by ISO/RTO markets as they commenced operations as centralized wholesale power markets.
- Led the economic analysis and evaluation of the NYISO wholesale power market in its initial filings of its market design and subsequent filings after operations commenced.
- Led economic analysis and evaluation of multiple filings by the California ISO related to requested market design changes filed after starting operations in 1998.
- Supported analysis and evaluation of other ISO/RTO markets as needed.
- Supported and provided analysis on merger applications as needed.
- Conducted original research while on the staff of the Chief Economic Advisor in the Office of Markets, Tariffs, and Rates related to unit commitment models used in day-ahead electricity markets and pricing in the presence of lumpy decisions and operational characteristics (technically known as non-convexities).

1992–1998 Instructor, Department of Economics, Augsburg College, Minneapolis, MN

- Taught small classes of introductory microeconomics, labor economics, money and banking, and environmental economics

1992–1998 Instructor, Department of Economics, University of Minnesota, Minneapolis, MN

- Taught large lecture classes of primarily introductory microeconomics to classes of up to six hundred students three times per year, managing a staff of teaching assistants and graders and developing curriculum and exams.
- Taught smaller classes of introductory microeconomics as well as environmental economics.

PUBLICATIONS AND BOOK CHAPTERS

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Vignolo, Jesus Mario and Sotkiewicz, Paul M., “Towards Efficient Tariffs for Distribution Networks with Distributed Generation,” *Cogeneration and On-site Power Production*, November-December 2006, pp. 67-75.

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Sotkiewicz, Paul M. and Vignolo, Jesus Mario “Nodal Pricing for Distribution Networks: Efficient Pricing for Efficiency Enhancing DG.” *IEEE Transaction on Power Systems*, Vol. 21, No. 2, May 2006, pp. 1013-1014.

Sotkiewicz, Paul M. and Vignolo, Jesus Mario “Allocation of Fixed Costs in Distribution Networks with Distributed Generation,” *IEEE Transaction on Power Systems*, Vol. 21, No. 2, May 2006, pp. 639-652.

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Evolution, Market Design, and the Unit Commitment Problem" The Next Generation of Unit Commitment Models, B. Hobbs, M. Rothkopf, R. O'Neill, and H.P. Chao editors. 2001.

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SELECTED WORKING PAPERS AND UNPUBLISHED MANUSCRIPTS

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O'Neill, Richard P., Sotkiewicz, Paul and Rothkopf, Michael. "Equilibrium Prices in Exchanges with Non-convex Bids." PURC Working Paper, January 2006, updated September 2007.

Sotkiewicz, Paul M. "Cross-Subsidies That Minimize Electricity Consumption Distortions" University of Florida, Department of Economics, PURC Working Paper, 2003.

CONSULTING AND ADVISING EXPERIENCE PRIOR TO JOINING PJM IN 2008

2007 Advisor to the Government of Vietnam regarding the design and experience of wholesale electricity markets as Government looked at the creation of US style ISOs to attract investment in generation assets for IPPs

2007 Independent Expert in the Matter of the Public Utilities Commission of Belize Initial Decision in the 2007 Annual Review Proceeding for Belize Electricity Limited

2006 Advisor to the Division of Air Resource Management, Florida Department of Environmental Protection (FDEP) Regarding Implementation the Clean Air Interstate Rule (CAIR)

HONORS AND AWARDS

2007	Fulbright Senior Specialist Grant in Economics with a specific request for expertise in electricity markets, electricity regulation, and distribution tariff design, Universidad de la República, Montevideo, Uruguay.
2007	Principal Investigator, PPIAF/World Bank Grant to conduct two on-site training courses on the regulation of the electric power sector and on independent power producers and power purchase agreements for the Electricity Authority of Cambodia. Grant award $59,900.
2006	"Efficient Market Clearing Prices in Markets with Non-Convexities" published in *European Journal of Operational Research* received New Jersey Policy Research Organization Bright Idea Research Award in Decision Sciences.
2003	Transportation and Public Utilities Group, Ph.D. Utilities Dissertation Award for "The Impact of State-Level Public Utility Commission Regulation on the Market for Sulfur Dioxide Allowances, Compliance Costs, and the Distribution of Emissions"
1992-97	Distinguished Instructor, Department of Economics, University of Minnesota
1995-96 1994-95 1993-94 1992-93	Walter Heller Award for Outstanding Teaching of Economic Principles, Department of Economics, University of Minnesota
1991-92	Distinguished Teaching Assistant, Department of Economics, University of Minnesota
1991	Phi Beta Kappa, University of Florida

Referee and Review Experience

IEEE Transactions on Power Systems

Integrated Planning Model (IPM) Base Case Version 5.13 Peer Review, Prepared for US EPA Clean Air Markets Division, October 2014, prepared by Anthony Paul, Chair, Meghan McGuinness, Walter Short, Paul Sotkiewicz, John Weyant through RTI International.

Determining the Economic Value of Coastal Preservation and Restoration on Critical Energy Infrastructure, prepared for The Economic and Market Impacts of Coastal Restoration: America's Wetland Economic Forum II, September 28, 2006, Washington, DC

National Research Council of the National Academy of Sciences report entitled "Changes in New Source Review Programs for Stationary Sources of Air Pollutants," February 2006

Ecological Economics

Environmental Science and Technology

California Energy Commission (CEC) Energy Innovations Small Grant (EISG) Program

Energy Journal

Journal of Environmental Economics and Management

IEEE PES Letters

IASTED International Journal of Power and Energy Systems

The Next Generation of Unit Commitment Models B. Hobbs, M. Rothkopf, R. O'Neill, and H.P. Chao editors

2001.

<u>Professional Affiliations</u>

American Economic Association
International Association for Energy Economics
Association of Environmental and Resource Economists
IEEE Power and Energy Society
Energy Systems Integration Group (ESIG)

EXPERT TESTIMONY

***PJM Interconnection, L.L.C.* FERC Docket No. ER09-1063-004, Affidavit in Support of PJM's Compliance Filing with Order No. 719 and Order on Compliance Filing *PJM Interconnection, L.L.C.*, 129 FERC ¶ 61,250 (2009). June 18, 2010**
In support of its compliance filing to establish a mechanism that ensures appropriate pricing during periods of operating reserve shortages, as required by Commission Order No. 719, I provided the following: 1) A high-level overview of PJM markets, planning, and operations, including a description of what is meant by an operating reserve shortage, and how such shortages arise; 2) An overview of PJM reserve requirements, current reserve market structure, and data on PJM's prices and operations at times when the grid it manages has experienced operating reserve shortages; 3) A showing why PJM's then current scarcity pricing not satisfy the Commission's Order No. 719 criteria for operating reserve shortage pricing mechanisms; 4) Description of the main elements of PJM's proposal to comply with Order No. 719's shortage pricing policy, and how PJM's proposal satisfies the six criteria for reserve shortage pricing set by Order No. 719.

***PJM Interconnection, L.L.C.* FERC Docket No. ER09-1063-004, Affidavit in Support of Answer to Comments and Motion for Leave to Answer to Protests, August 23, 2010.** The purpose of this affidavit is to provide the following regarding PJM's proposed shortage pricing mechanism: 1) The complementary relationship between capacity adequacy in the Reliability Pricing Model ("RPM") and shortage pricing; 2) Additional evidence showing why PJM' shortage pricing proposal leads to energy prices that reflect the cost and/or value of energy, allocates energy to those who value it most, enhance operational reliability, and leads to efficient market outcomes while the alternate proposal from the Independent Market Monitor (IMM) fails to achieve any of these goals; 3) An explanation of how the proposed mechanism is consistent with shortage pricing mechanisms in the New York Independent System Operator ("NYISO") and ISO New England ("ISO-NE") that the Commission has already approved as Order 719 compliant.

***PJM Interconnection, L.L.C.* FERC Docket No. ER12-513, Affidavit in Support of Filing to Update its RPM Auction Parameters (aka Triennial Review) December 1, 2011.** This affidavit was submitted in support of three aspects of PJM's proposed changes related to PJM's capacity market, known as the Reliability Pricing Model ("RPM") including: 1) the continued use of a nominal levelized approach to calculating the estimated Cost of New Entry ("CONE") that is used in RPM's Variable Resource Requirement ("VRR") Curve; 2) retention of a combustion turbine ("CT") as the Reference Resource.

***PJM Interconnection, L.L.C.* FERC Docket No. ER-14-2490, Affidavit in Support of Filing to Update its RPM Auction Parameters (aka Quadrennial Review) September 25, 2014** This affidavit was submitted in support of five aspects of PJM's proposed changes related to PJM's capacity market, known as the Reliability Pricing Model ("RPM"): 1) adoption of The Brattle Group's ("Brattle") recommended VRR Curve shape right shifted by 1% of the Installed Reserve Margin ("IRM"); 2) continued use of a nominal levelized approach to calculating the estimated Cost of New Entry ("CONE") that is used in RPM's Variable Resource Requirement ("VRR") Curve; 3) retention of a combustion turbine ("CT") as the Reference Resource: 4) use of a composite of Bureau of Labor Statistics ("BLS") indices to adjust Gross CONE estimates in between periodic VRR parameter reviews; and 5) adoption of the labor estimates provided by the PJM Independent Market Monitor ("IMM") to determine Gross CONE values.

***Grid Reliability and Resilience Pricing* FERC Docket No. RM18-1, Affidavit in Support of the Electric Power Supply Association (EPSA), October 23, 2017**. This affidavit provides evidence the Department of Energy Notice of Proposed Rulemaking ("NOPR" or "Proposal") released on September 28, 20171 and appearing in the Federal Register on October 2, 2017, does nothing to enhance reliability or "resiliency" of the bulk power system and will only succeed in distorting wholesale power markets while also raising costs. Consequently, my affidavit supports EPSA's contention the NOPR should be rejected outright by the Commission.

***ISO New England Inc. and New England Power Pool Participants Committee*, FERC Docket No. ER18-620-000, Affidavit in Support of the Protest of the New England Power Generators Association, Inc. January 29, 2018.** In summary, my affidavit explains that the proposed updated DDBT from $5.50/kW-month to $4.30/kW-month: 1) Relies on a flawed and logically inconsistent methodology that differs from the DDBT methodology approved by the Commission three years ago; 2) Sets a dangerous precedent in ISO-NE taking a position on the direction of its Forward Capacity Market ("FCM") in terms of supply-demand balance and expected market prices that could anchor expectation of market participants. The anchoring of such expectations can change FCA bidding and operational behavior that could harm reliability; 3) The previous methodology approved by the Commission of using Static De-List Bids from oil steam and oil combustion turbine generators remains the appropriate methodology for determining the DDBT; and 4) The cost-based DDBT is likely higher than for FCAs 10-12 given that net going forward costs for oil steam and oil combustion turbine units has likely increased given their age, and other risks and opportunity costs that may be coming into play. My affidavit concludes that retaining the current DDBT until such time as a new DDBT threshold can be determined using the current Commission-approved methodology following the discovery of the actual costs and risks faced by oil units.

Petition for Determination of Need for Seminole Combined Cycle Facility in Docket No. 20170266-EC and Joint Petition for Determination of Need for Shady Hills Generating Facility in Docket No. 20170267-EC, January 29, 2018. Testimony and Exhibits on Behalf of Quantum Pasco Power, LP, Michael Tulk, and Patrick Daly. My testimony supports the notion that there is no need for either combined cycle facility as Seminole Electric has consistently over-forecast its load growth since the "great recession" and that once correcting for these large errors, there is no need to build two new combined cycle facilities when there were other lower cost merchant generator facilities that offered their capacity to Seminole.

***PJM Interconnection, L.L.C.* FERC Docket No. E18-34, Affidavit in Support of EPSA's Filing and Comments in PJM's Fast Start Pricing Proposal, March 14, 2018** My affidavit in this proceeding provides support for PJM's desire to allow resources with up to two-hour start up times to be considered "fast start" resources and to set price in accordance with the fast start pricing principles the Commission has enumerated in its Fast Start Pricing NOPR. I explain PJM's use of IT SCED and request to allow two-hour start time resources to set prices as fast start resources are entirely consistent with the ideas the Commission has enumerated with respect to fast start pricing.

***PJM Interconnection, L.L.C. Capacity Repricing or in the Alternative MOPR-Ex Proposal: Tariff Revisions to Address Impacts of State Public Policies on the PJM Capacity Market*, FERC Docket No. ER18-1314-000, Affidavit is Support of Comments of American Petroleum Institute, JPower USA Development, Ltd., and Panda Power generation Infrastructure Fund, LLC May 7, 2018.** My affidavit provides evidence that 1) The PJM Capacity Repricing Proposal is not just and reasonable and is unduly discriminatory and results in an inefficient commitment of resources; 2) The alternative proposal from PJM, MOPR-Ex, is just and reasonable and results in the most efficient and cost-effective se of resource commitments; and 3) The current and previous iterations of the MOPR are not just and reasonable and are unduly discriminatory because they do not apply to existing resources and they only apply to gas-fired resources. Furthermore, my affidavit provides evidence that MOPR has always been viewed as a market power mitigation mechanism that was originally intended to thwart or mitigate the exercise of buyer-side market power. I show in this affidavit that MOPR and MOPR-Ex are still powerful market power mitigation tools that mitigate the exercise of supplier market power facilitated by the current round of state subsidies to generation. Moreover, I show that Capacity Repricing helps facilitate the exercise of supplier market power through three different means.

***Grid Resilience in Regional Transmission Organizations and Independent System Operators,* FERC Docket No. AD18-7-000, Affidavit is Support of Comments of the American Petroleum Institute, May 9, 2018. T**his affidavit focuses of the comments submitted by PJM and: 1) Supports the idea that in the context bulk power system markets and operation resilience and reliability are indistinguishable and that markets and well-designed incentives are the best avenue to achieve a resilient and reliable bulk power system; 2) Explains why market mechanisms rather than suspension of market and command and control regimes are better at achieving resiliency/reliability even during emergency conditions and that PJM has not made a case for being given the authority to suspend markets; 3) That PJM has not made the case that price formation through integer relaxation is linked to resilience/reliability while other price formation that are crucial to reliability/resilience, such as shortage pricing and fast start pricing, be considered concurrently; and 4) So-called "fuel security" is only a minimal contributor to resilience/reliability while transmission and distribution assets are the leading causes for shedding firm load and outages of gas-fired units are not the leading category of generation outages. With respect to generator reliability/resilience, simply providing additional compensation (or minimize penalties) to generators in wholesale markets, without any ties to generator performance, does nothing to enhance reliability/resilience of generators to withstand or minimize the impact of adverse events on the bulk power system. Experience in PJM prior to and following the discussion and implementation of capacity performance has shown this to be the case as generator performance has improved even in the face of lower energy market prices.

***New England Power Generators Association, Complainant v. ISO New England Inc., Respondent*. FERC Docket No. Docket No. EL18-154-000, Affidavit in Support of Complaint and Request for Expedited Consideration of the New England Power Generators Association, Inc. May 24, 2018.** This affidavit in support of NEPGA's complaint shows the impact of treating Mystic Units 8 and 9 as a price taker on the ISO-NE markets as well as NEPGA's proposed alternative to accommodating the participation of the Mystic units. Discussions include: 1) treating Mystic and other resources retained for fuel security as price takers will do significant harm to the competitiveness of the FCM market and is inconsistent with the first principles of capacity markets articulated by the Commission; 2) the proposal to insert an above market cost resource into the FCM as a price taker does exactly the same harm as an exercise of buyer-side market power, which he Commission has found to be unjust, unreasonable, and unduly discriminatory; and 3) the proposed remedy offered by NEPGA does not distort the results of the Forward Capacity Auction, results in competitive pricing outcomes in FCA, does not displace otherwise economic resources, and provides better reliability outcomes for ISO-NE load than the current ISO-NE proposal.

***New England Power Generators Association, Complainant v. ISO New England Inc., Respondent*. FERC Docket No. Docket No. EL18-154-000, Affidavit in Support of the Motion for Leave and Answer of the New England Power Generators Association, Inc. June 19, 2018.** This affidavit in support of NEPGA's answer refutes the answer of ISO-NE and protesters and responds that nothing in ISO-NE's answer to the Complaint or the protests to the Complaint provides a basis for ignoring that treating the Mystic Units as price takers would suppress prices below competitive levels and inefficiently displace otherwise economic resources in a manner that is observationally equivalent to the harm done by an exercise of buyer-side market power.

***Panda Stonewall, LLC.* FERC Docket No. ER17-1821-002, Testimony is Support of Panda Stonewall, LLC Reactive Power Filing, July 2, 2018.** This testimony supports Panda Stonewall's reactive power rate case that has gone to hearing and supports the inclusion of firm gas pipeline transportation, the use of proxy cost of capital values from the PJM CONE study and supports the inclusion of other administrative and overhead costs consistent with fixed, going forward costs incurred by Panda Stonewall to remain in commercial operation. Furthermore, the testimony puts the costs of reactive power into the context of the wider PJM market and other opportunities for compensation and well as providing historical context around the Commission-approved AEP Methodology for reactive power rates.

***ISO New England Inc.* FERC Docket No. ER18-2364-000, Affidavit in Support of the Protest of the New England Power Generators Association, Inc. September 21, 2018.** This testimony supports NEPGAs protest that the proposed ISO-NE treatment of resources held for winter fuel security as price takers in the FCA makes no sense since winter fuel security is not associated with overall resource adequacy which is based on the summer peak. Moreover, the testimony clearly shows the artificial price suppression that would occur based on ISO-NE proposed treatment of resources held for winter fuel security in the FCA.

Calpine Corporation v. PJM Interconnection, L.L.C. Docket No, EL16-49; PJM Interconnection L.L.C. Docket No. ER18-1314-000, ER18-1314-001, EL18-178 **Affidavit in Support of the Electric Power Supply Association, October 2, 2018.** This testimony refutes the idea that the Commission proposed remedy a resource specific FRR Alternative equally removes both demand and supply from the market and therefore does no harm. Such a mechanism is the equivalent of an exercise of buyer side market power, artificially reduces price below competitive levels, inefficiently displaces lower cost, economic resources with higher cost resources, shifts cost and benefits between market participants, and reduces overall market efficiency. Additionally, PJM market simulations for scenarios from the 2020/2021 auction show the kind of damage that done to the market through the proposed remedy or equivalently buyer sider market power by showing prospective price decreases and generation displacement, and the level of subsidy that could facilitate a successful exercise of buyer-side market power.

Panda Stonewall, LLC. **FERC Docket No. ER17-1821-002, Rebuttal Testimony is Support of Panda Stonewall, LLC Reactive Power Filing, October 12, 2018.** This rebuttal testimony supports Panda Stonewall's reactive power rate case responding to interveners and FERC staff and supports the inclusion of firm gas pipeline transportation, the use of proxy cost of capital values from the PJM CONE study and supports the inclusion of other administrative and overhead costs consistent with fixed, going forward costs incurred by Panda Stonewall to remain in commercial operation. Furthermore, the testimony puts the costs of reactive power into the context of the wider PJM market and other opportunities for compensation and well as providing historical context around the Commission-approved AEP Methodology for reactive power rates.

In the Matter of the Implementation of L. 2018, c. 16 Regarding the Establishment of a Zero Emission Certificate Program for Eligible Nuclear Power Plants, New Jersey Board of Public Utilities, **BPU Docket No. EO 18080899**, **Testimony in Support of PJM Power Providers, October 22, 2018.** This testimony responds to questions posed by the BPU in this docket and provides analysis showing that the nuclear units in New Jersey seeking ZECs are not in need of them to remain in commercial operation. The testimony shows that these resources, given know forward prices for energy and capacity prices can cover their going forward costs in the absence of subsidies in the form of ZECs and will remain in commercial operation despite warnings these resources will retire in the absence of ZEC payments.

Calpine Corporation v. PJM Interconnection, L.L.C. Docket No, EL16-49; PJM Interconnection L.L.C. Docket No. ER18-1314-000, ER18-1314-001, EL18-178 **Affidavit in Support of the Electric Power Supply Association, November 6, 2018.** This testimony responds to the Illinois Commerce Commission's protest that suggests eliminating the RPM Capacity Market and replacing it with an energy-only market construct because the capacity market is not a market at all. It also responds to the notion that markets should account directly for environmental policy and because they do not, it justifies Illinois zero emission credit program for nuclear resources. The testimony refutes these ideas by describing in detail that all markets have administrative rules, and those markets can account for environmental policies when properly formulated to put a price on emissions rather than subsidizing resources out-of-market. Moreover, this testimony provides evidence of the need for the RPM Capacity Market to maintain resource adequacy as an energy only construct would not result in sufficient resources covering going forward costs in the energy market alone.

Alberta Utilities Commission, Consideration of ISO Rules to Implement and Operate the Capacity Market, Proceeding No. 23757, **Evidence in Support of ENMAX Corporation, February 28, 2019.** This evidence outlines the elements of the Alberta Electric System Operator (AESO) proposed capacity market framework that require changes to make align the capacity market with fair, efficient, and openly competitive market principles. The evidence addresses the resource adequacy model, capacity value of resources, penalties and bonuses, market power mitigation, Net CONE determination, and interactions with the energy market framework. The evidence also provides a high-level overview of the objectives of a capacity market and how it should interact with the energy and retail markets in Alberta.

In the Matter of the Implementation of L. 2018, c. 16 Regarding the Establishment of a Zero Emission Certificate Program for Eligible Nuclear Power Plants, New Jersey Board of Public Utilities, **BPU Docket No. EO 18080899**, **Response to Staff Questions on Accounting for Risk in Support of PJM Power Providers, March 8, 2019.** This is a response to BPU staff questions regarding market risk. This response discusses the mitigation of overall market risk based on changing conditions, optimal energy market offers and mitigation of energy market operational risk, and optimal offers and risk mitigation in the capacity market that are available to all generation resources including nuclear resources.

In the Matter of the Implementation of L. 2018, c. 16 Regarding the Establishment of a Zero Emission Certificate Program for Eligible Nuclear Power Plants, New Jersey Board of Public Utilities, **BPU Docket No. EO 18080899**, **Reply Testimony in Support of PJM Power Providers, March 19, 2019.** This reply testimony responds to PSEG comments regarding the need for ZECs for New Jersey's nuclear units. This reply testimony updates the economic analysis showing New Jersey nuclear units are currently profitable and expected to remain profitable in the future. Furthermore, this reply points out that PSEG did not dispute the costs used in the initial analysis or the idea that new entry of combined cycle gas generation can reduce emissions at zero cost at the margin given these resources will enter the market absent subsidies. The reply argues, contrary to PSEG's position, the threat to retire is not credible given the statements and evidence provided by PSEG in its Securities and Exchange Commission (SEC) filings. This reply also provides evidence that it would be infeasible for PSEG to buy out of its capacity commitments in Incremental Auctions (IAs) given the supply and demand conditions present in IAs to date.

Alberta Utilities Commission, Consideration of ISO Rules to Implement and Operate the Capacity Market, Proceeding No. 23757, **Reply Evidence in Support of ENMAX Corporation, April 4, 2019.** This evidence replies to the comments of other interveners regarding various elements of the Alberta Electric System Operator (AESO) proposed capacity market framework. The reply evidence responds to intervener comments on elements of the Net CONE determination, capacity and energy market power mitigation, the capacity value of resources inconsistencies between the resource adequacy model and offered supply, and penalties and bonuses.

PJM Interconnection, L.L.C. **FERC Docket Nos. ER19-1486 and EL19-58, Affidavit in Support of EPSA's Filing and Supporting Comments in PJM's Enhanced Price Formation in Reserve Markets Proposal, May 15, 2019.** This affidavit supports PJM's proposed extension of the ORDC concept to the Day-ahead Energy Market and further refinements to the ORDC construct that employs methods of using history of reserve levels, load forecast error, and generation output and reserves to determine an ORDC based on a loss of load probability. The affidavit also explains and supports other refinements proposed by PJM such as explicitly pricing what was known as Tier 1 reserves to accurately reflect the value those reserves provide to the system. Finally, I argue reserve pricing and the ORDC must explicitly account for operator discretion in making reliability commitments outside of the market framework.

PJM Interconnection, L.L.C. **FERC Docket Nos. ER19-1486 and EL19-58, Supplemental Affidavit in Support of EPSA's Reply Comments in PJM's Enhanced Price Formation in Reserve Markets Proposal, June 26, 2019.** This supplement affidavit rebuts assertions made during the initial comment period. First, positive reserve prices do not imply reserve shortage or scarcity conditions, but the price of reserves based on the value reserve provides beyond the Minimum Reserve Requirement. Second, that PJM's proposed ORDC appropriately accounts for out of market operator actions that would otherwise result in the wrong price signal to the market regarding reserve position and system needs. Third, that the proposed claw back of any revenues earned under the PJM proposal is inefficient and not just and reasonable and confuses capacity market concepts with short-term operational needs.

Colorado Public Utilities Commission in the Matter of the Commission's Implementation of §§ 40-2.3-101 and 102, C.R.S. The Colorado Transmission Coordination Act, PROCEEDING NO. 19M-0495E, in Support of the Intermountain Rural Electric Association, November 15, 2019. This evidence provides the Colorado Commission with an overview of the benefits of RTO markets for electric cooperatives.

American Transmission Systems Incorporated, Docket No. ER20-1740 **Affidavit is Support of Buckeye Power Inc. Counter the Capacity Market Benefits of ATSI Moving from MISO to PJM and Recovery of Transition Costs, May 29, 2020**. This affidavit provides empirical evidence and theoretical support that load connected to the ATSI transmission system paid more in capacity costs in PJM than they would have paid had ATSI stayed in MISO to counter ATSI's argument that ATSI connected load would have paid more for capacity had ATSI remained in MISO.

***Alberta Utilities Commission ("AUC") Distribution System Inquiry Proceeding 24116*, Response from Kalina to AUC Information Request Round 2, Jointly with Regulatory Law Chambers, Terradigm Energy, Inc, and Nican International Consulting, Ltd on Behalf of Kalina Distributed Power, June 17, 2020.** This response to information requests provides support for an optimal distribution tariff design that rewards resources that reduce the need for additional upgrades and reduce line losses and send price signals regarding the optimal location on the distribution system. This response also argues against tariff policies that would inefficiently charge such resources for costs they do not cause to either the distribution system or the transmission system and argues that efficient pricing is consistent with the competitive objectives of the Alberta energy market.

***Investigation into Resource Adequacy Alternative, New Jersey Board of Public Utilities,* BPU Docket No. EO 20030203, Prepared Comments in Support of PJM Power Providers, June 24, 2020.** These prepared comments address the benefits of Reliability Pricing Model (RPM) Participation for New Jersey customers and the additional costs of moving to a Fixed Resource Requirement (FRR) Plan as proposed by PSEG and Exelon in earlier comments. These comments note the extra costs could be over $700 million per year for New Jersey customers and would facilitate the exercise of market power by a small set of generation owners.

***American Transmission Systems Incorporated, Docket No. ER20-1740* Reply Affidavit is Support of Buckeye Power Inc. Counter the Capacity Market Benefits of ATSI Moving from MISO to PJM and Recovery of Transition Costs, June 25, 2020**. This reply affidavit supports the previously supplied empirical evidence and theoretical support that load connected to the ATSI transmission system paid more in capacity costs in PJM than they would have paid had ATSI stayed in MISO to counter ATSI's argument that ATSI connected load would have paid more for capacity had ATSI remained in MISO. Additionally, the reply affidavit responds to ATSI critiques of the original affidavit and the ATSI responses to answers.

***Alberta Utilities Commission ("AUC") Distribution System Inquiry Proceeding 24116*, Concluding Remarks of Kalina Distributed Power, Jointly with Regulatory Law Chambers, Terradigm Energy, Inc, and Nican International Consulting, Ltd on Behalf of Kalina Distributed Power, July 15, 2020.** These concluding remarks reiterates support for an optimal distribution tariff design that rewards resources that reduce the need for additional upgrades and reduce line losses and send price signals regarding the optimal location on the distribution system. These concluding remarks provide established economic theory to explain why the current policies that inefficiently charge such resources for costs they do not cause are not in the best interests of Alberta's energy market or Alberta energy customers.

***Investigation into Resource Adequacy Alternative, New Jersey Board of Public Utilities,* BPU Docket No. EO 20030203, "Prospective Minimum Offer Price Rule Price Floors and Cost-Effectiveness of the PSEG/Exelon Fixed Resource Requirement Plan for New Jersey" in Support of PJM Power Providers, July 22, 2020.** This whitepaper responds to the PSEG and Exelon comments submitted on June 24, 2020, and it responds to the report of the PSEG/Exelon Consultant assertions about the alleged cost savings of moving to a Fixed Resource Requirement (FRR) Plan as proposed by PSEG and Exelon in earlier comments. This paper also discusses the Minimum Offer Price Floor levels for various clean energy resources to show they would not be excluded from the RPM capacity market and would clear the market given historic capacity prices.

***PJM Interconnection, L.L.C. FERC Docket No. EL19-58-003 "Forward Looking Energy and Ancillary Service Offset,"* Affidavit in Support of Comments of the Electric Power Supply Association, September 2, 2020.** Supports and explains PJM's forward-looking energy and ancillary service offset filing in the context of Commission approved methods that use the same framework as the energy and environmentally limited opportunity costs which uses forward looking fuel and power prices in the same way as the PJM proposal. The Affidavit also calls for further analysis of the forward-looking methodology once there are realizations of actual power and gas prices compared to the forward prices used in the methodology.

***Alberta Utilities Commission ("AUC") Proceeding 26090 DG Credit Module for Fortis's 2022 Phase II Tariff Application*, Evidence in Support of Kalina Distributed Power and Capstone Infrastructure Corporation, December 14, 2020.** This expert report discusses the economic and electrical equivalence of distribution connected generation (DCG) to reduced load on the distribution level and the resulting effects on transmission rates and cost recovery in the Alberta power system. This report also points out that DCG is not the cause of so-called erosion of billing determinants from the transmission system costs, but those are caused by over-forecasting load and transmission overbuild. The report argues for retention of Fortis's DCG Credit based on cost causation principles given DCG helps reduce loading on the transmission system.

***Alberta Utilities Commission ("AUC") Proceeding 26090 DG Credit Module for Fortis's 2022 Phase II Tariff Application*, Reply Evidence in Support of Kalina Distributed Power and Capstone Infrastructure Corporation, January 27, 2021.** This reply report provides additional detail regarding the subjects discussed in the initial report, responds to intervenor comments, and explains how DCG can enhanced the efficiency of the Alberta Energy Market as well as providing cost-effective reductions in future transmission build out.

Southeast Energy Exchange Market Agreement FERC Docket ER 21-1111, Affidavit is Support of Public Interest Organizations, March 15, 2021. This affidavit points out the market design and market power shortcoming of the proposed Southeast Energy Exchange Market (SEEM) rules and governance structure as well as problems with the supporting benefit/cost analysis supporting the proposed market design. The affidavit highlights transactional complexity, computational complexity, and rules that allow market power exercised through manipulating submitted parameters as why the Commission should not approve the proposed design and set a technical conference to discuss a more robust market for the Southeast.

Jackson Generation, LLC v. PJM Interconnection in FERC Docket No. EL21-062, Affidavit in Support of Jackson Generation's Complaint, March 30, 2021. This affidavit argues that it makes economic sense for PJM and the Independent Market Monitor to consider a longer asset life than 20 years and the consideration of sunk costs in determining the Minimum Offer Price that Jackson could offer into the 2022/2023 Base Residual Auction. Furthermore, I argued that the tariff language is explicitly consistent with the tariff language as well as previous PJM precedent in allowing longer asset lives and sunk costs when I served as PJM's Chief Economist and oversaw making Minimum Offer Price determinations.

Southeast Energy Exchange Market Agreement FERC Docket ER 21-1111, Affidavit is Support of Public Interest Organizations, June 28, 2021. This affidavit responds to the Southeast Energy Exchange Market (SEEM) filing responding the FERC Staff's Deficiency Letter and continues to point out the market design and market power shortcomings of the rules and monopoly position of the filing parties. This affidavit concentrates on data transparency and the lack of truly independent market monitor to guard against market abuses by large participants, uses existing data from Southern Company's auction market to show that market participation in the prosed design will be effectively non-existent and that this is all by design since the incentives of large franchise monopoly supporters of SEEM are to retain their monopoly positions. governance structure as well as problems with the supporting benefit/cost analysis supporting the proposed market design. The affidavit also highlights areas around computational complexity and the ability to foreclose transactions with other parties leads to an inability to run the market in the time allotted and results in de facto market manipulation.

Alberta Electric System Operator Transmission Rate Design, in Alberta Utilities Commission Proceeding 26911, Report in Support of Industrial Power Consumers Association of Alberta (IPCAA) and the Dual Use Customers (DUC), March 28, 2022. Report entitled "Transmission Rate Design and Energy Market Efficiency" shows why the AESO's proposed rate design to shift fixed costs into volumetric charges is inefficient and leads to uneconomic bypass and harms the Alberta Energy Market. This report also shows why a shift to non-coincident peak charges away from peak charges leads to inefficient decision making by customers and violated cost causality principles in rate design. The conclusion is that the optimal rate design for bulk power transmission should be based on coincident peak charges that includes all the fixed costs of the system.

Rebuttal Report Regarding the Review and Evaluation of Alternatives and Benefit Cost Analysis Prepared for Renovo Energy Center in Clean Air Council et al. v. Pennsylvania Department of Environmental Protection, Environmental Hearing Board Docket No. 2021-055, May 2, 2022. This report responds to Appellants refuting statements regarding benefit-cost analyses, facts regarding the PJM and NYISO markets, and assertions emissions increases of the proposed facility.

Department of Environmental Protection, Environmental Hearing Board Docket No. 2021-055 Affidavit Prepared for Renovo Energy Center, July 18, 2022. This responds to Appellants affidavits regarding emissions data, PA DEP not being responsible for generator entry and exit decisions, and logical flaws in Appellants Expert benefit-cost analysis.

PJM Interconnection, L.L.C., Docket No. ER22-2984-000; Periodic Review of Variable Resource Requirement Curve Shape and Key Parameters, Affidavit in Support of Protest of J-Power USA Development Co. Ltd., October 21, 2022. This affidavit explains why PJM's choice of a 20-year asset life for the Reference Resource Net CONE in the ComEd LDA is in error due to the Climate and Equitable Jobs Act (CEJA) that requires all gas resources reach zero net emissions by 2045. Additionally, the affidavit explains that such LDA specific adjustments for the Energy and Ancillary Service Offset and CONE area differences for labor are common, hence reducing the asset life in ComEd would reasonably be accommodated.

PJM Interconnection, L.L.C., Docket No. ER22-2984-000; Periodic Review of Variable Resource Requirement Curve Shape and Key Parameters, Reply Affidavit in Support of Protest of J-Power USA Development Co. Ltd., November 18, 2022. In response to the answers filed by PJM and the Public Interest Entities to explain why their responses are irrelevant and/or fail to address the concerns J-POWER brought up in its protest with regard to the effect of the Illinois Climate and Equitable Jobs Act on the Commonwealth Edison Company Locational Deliverability Area ("LDA") in the PJM capacity market. I explain here that what PJM proposes to do in its filing is a violation of the spirit and intent of PJM's FERC-approved Tariff and Reliability Assurance Agreement if not a direct failure to follow the plain terms of the governing documents and I provided evidence showing the reliability urgency that is forthcoming in the ComEd LDA requires a shorter asset life for the Reference Resource to be used in developing the Variable Resource Requirement Curve used in PJM's capacity auctions.

PJM Interconnection, L.L.C., Docket No. ER23-729 and EL23-19; Protest of PJM's Filing to Change the Locational Deliverability Area Reliability Requirement in the midst of the 2024/2025 BRA in support of the Electric Power Supply Association, January 20, 2023. This affidavit argues PJM's proposed solution is clearly retroactive rather than prospective, upsets settled expectations, introduces unnecessary uncertainty, and is bad market design, creates a false equivalence between physical reliability needs as determined by PJM's own planning methods with its own ideas of economic supply-demand balance, ignores the real reliability problems that exist in DPL-South as evidenced by historically high prices, tight supply-demand conditions, and the auction outcome PJM seeks to avoid, and the market outcome was easily anticipated.

Aurora Generation, LLC, Elwood Energy LLC, Jackson Generation, LLC, Lee County Generating Station, LLC, Lincoln Generating Facility, LLC, LSP University Park, LLC, Rockford Power, LLC, Rockford Power II, LLC, University Park Energy, LLC, Complainants, v. PJM Interconnection, L.L.C., Respondent. Docket No. EL23-54, April 3, 2023. I show throughout Elliott, PJM power prices and underlying transmission congestion and the ComEd supply-demand balance were inconsistent with the idea that PJM was in any kind of emergency condition in ComEd through the December 23 and 24 PAI intervals. ComEd Zone generators would not have been able to deploy reserves to the rest of PJM. During the final 12 hours of the PAI event on December 24, energy and reserve prices were inconsistent with the idea there were emergency conditions. The lack of timely commitments of generation in ComEd, the cost of gas fired generation in ComEd based on intra-day gas prices were inconsistent with economic dispatch of gas fired resources in ComEd to support the rest of PJM or exports out of PJM. I also showed PJM violated its Tariff, Operating Agreement ("OA"), NERC standards, and PJM Manuals by allowing exports to continue while PJM entered reserve shortages, failing to curtail Non-Firm export transactions prior to and during Emergency Actions, and failing to recall exports supported by PJM Capacity Resources, and in effect employing emergency load management to support non-firm exports.

Coalition of PJM Capacity Resources, Complainants, v. PJM Interconnection, L.L.C., Respondent. Docket No. EL23-55, April 4, 2023. In this testimony I showed how PJM lacked situational and operational awareness leading up to and during Winter Storm Elliott and violated its Tariff and operating procedures: 1) Despite the clear and consistent weather forecasts as early as seven days prior to Winter Storm Elliott, PJM's demand forecast failed to account for the impending weather conditions. PJM Day-ahead Energy Market commitments were inconsistent with the impending reliability needs that were being signaled by other factors and that were realized in real-time operations. 3) PJM failed to notice that gas pipelines serving PJM gas-fired generation had issued critical notices asking or ordering shippers to avoid gas imbalances and adhere to nomination and flow times and 24-hour ratable takes and failed to understand the timing of gas nominations and flows on pipelines and how that would affect the intra-day scheduling and commitment of gas fired resources to serve the load which had been grossly under-forecast. 4) PJM, ignoring the weather forecast relative to the load forecast and gas pipeline notices, failed to commit sufficient additional resources per its Emergency Operating Procedures to ensure sufficient generation was available. 5) PJM missed the clear signals from the natural gas markets that showed extremely high gas prices throughout PJM indicating the severity of the cold weather coming, contrary to the PJM load forecast.6) PJM continued to flow non-firm exports and exports that were likely supported by PJM Capacity Resources and while employing emergency load management contrary to the PJM Tariff and emergency operating procedures.

East Kentucky Power Cooperative, Inc., Complainant, v. PJM Interconnection, L.L.C., Respondent. Docket No. EL23-74, May 31, 2023. I supported EKPC's Complaint in an affidavit that builds upon testimony I have already provided in Complaints filed at FERC in Docket Nos. EL23-54 and EL23-55 with the following updates and additions: 1) Identification of 5-minute intervals experiencing Primary or Synchronized Reserve Shortages in which there was also a Maximum Emergency Generation event and/or emergency demand response in place. 2) Matching the identified 5-minute intervals with the volume of Net Scheduled Exports delineated by different levels of transmission service as posted by PJM on its OASIS. 3) A description of why PAIs should not be triggered by a PJM emergency declaration alone such as the call for Pre-Emergency and Emergency Demand Response and/or Maximum Generation Emergency Actions but should also be accompanied by evidence of a Primary and/or Synchronized Reserve Shortages.4) Assessed what Primary or Synchronized Reserve Shortages would have existed had all Non-Firm (on a transmission reservation basis) exports to the Tennessee Valley Authority and Duke Energy Carolinas and Duke Progress been curtailed as is required under NERC EOP 011-12. I also provided a background history regarding PJM's Capacity Performance ("CP") design explaining that CP did not envision or contemplate exports to neighboring control areas because it was assumed PJM, if it were in emergency conditions, would have been a net importer of energy, and why exports to support external loads during a PAI is inconsistent with cost causation principles. I also showed why the current Penalty Charge Rate based on Net CONE results in undesirable reliability outcomes as it can lead to a loss of multiple years of capacity revenue within the span of only two days, and the loss of capacity that occurred during Elliott.

POLICY WHITEPAPERS and Reports

NYISO Meter Data Study-Final Report, December 8, 2017. Available at https://www.nyiso.com/documents/20142/1391862/NYISO-Meter-Data-Study-Report.pdf/db0de386-04b1-8818-3f77-194bc71a8c37. This report examines the meter data policies in the NYISO in comparison to similar polices in PJM, CAISO, and ISO-NE and the role of entities providing meter services for DER as may be required into the future. This report address and provides recommendations on 1) Baselines for DER as required and modification to existing baselines if needed; 2) Potential for the statistical sampling of a subset of DERs for establishing baselines and for market settlement in the energy, capacity, and ancillary services markets; 3) Interactions of baselines and DER aggregation; and 4) Simultaneous participation in both retail and wholesale markets by DERs.

The Market and Financial Position of Nuclear Resources in Pennsylvania, April 5, 2019. Available at https://citizens-against-nuclear-bailouts.prezly.com/new-report-highlights-long-term-profit-projections-for-pennsylvania-nuclear-generators and https://cdn.uc.assets.prezly.com/210b1e76-c577-4ffb-9bb9-c60c1f4299b8/-/inline/no/
This paper shows that nuclear resources in Pennsylvania are profitable historically and going forward and are in no need of any subsides to keep these resources in service.

The Market and Financial Position of Nuclear Resources in Ohio, May 13, 2019. Available at https://img1.wsimg.com/blobby/go/30b6d3a5-dffd-4a1b-9b4d-0bf3451282cd/downloads/OH%20Nuclear%20Analysis%2020190513-final.pdf?ver=1559092681975
This paper shows that nuclear resources in Ohio, Davis-Besse and Perry, are profitable historically and going forward and are in no need of any subsides to keep these resources in service as proposed under House Bill 6.

Economic Benefits to Ohio Electricity Consumers from the Repeal of House Bill 6, September 16, 2020. This paper shows that the Repeal of HB 6 in Ohio would lead to lower electricity bills for Ohio consumers with saving coming from keeping energy efficiency and demand response programs, and the repeal of subsidies for legacy coal units and the Davis-Besse and Perry nuclear units.

Assessment of the Fixed Resource Requirement Option for Delaware, Prepared for the Delaware Public Service Commission, June 29, 2021. Presented to the Delaware Public Service Commission Open Meeting, October 6, 2021. This paper reviews the FRR Rules in PJM and analyzes the trade-offs for Delaware of opting into an FRR Plan with regard to costs, ability to meet RPS requirements, and overall feasibility. The meeting agenda and minutes are available at https://publicmeetings.delaware.gov/#/meeting/67673.

Attachment C

The McDonald Affidavit

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

LS Power Development, LLC,	)	
	)	
Complainant,	)	
	)	
v.	)	
	)	**Docket No. EL24-__-000**
PJM Interconnection, L.L.C. and Monitoring Analytics, LLC, as the Independent Market Monitor for PJM,	)	
	)	
Respondents.	)	

AFFIDAVIT OF JEFFREY D. McDONALD
ON BEHALF OF LS POWER DEVELOPMENT, LLC

I. INTRODUCTION

1. My name is Jeffrey D. McDonald. I am a Vice President with Concentric Energy Advisors ("Concentric"). My business address is 293 Boston Post Road West, Suite 500 in Marlborough, MA 01752.

2. I am providing this affidavit in support of LS Power Development, LLC's ("LS Power's") complaint concerning opportunity cost adders ("OCAs") for emissions-limited resources, as calculated by Monitoring Analytics, LLC under the rules of PJM Interconnection, L.L.C. ("PJM"). Monitoring Analytics serves as PJM's Independent Market Monitor ("IMM"), and is responsible for administering market power mitigation. I have firsthand experience with administering market power mitigation processes during my tenure as Vice President, Market Monitoring at ISO New England Inc. ("ISO-NE") and consulting with market participants on market power mitigation during my tenure in the Market Monitoring Department at the California Independent System Operator ("CAISO").

3. I have reviewed the affidavits of Benjamin Griffiths and Paul Sotkiewicz, as well as the correspondence between LS Power and the IMM with respect to the OCAs applied to LS Power's generation assets. Based on my extensive experience in market monitoring, an effective OCA calculation process requires the IMM to provide sufficient information to the affected market participant in a timely fashion and for the OCA calculation process to allow the market participant to seek effective and timely review of the IMM's OCA determinations. Unfortunately, the OCA process in PJM appears to lack these characteristics. As I discuss in more detail below, the lack of transparency in the IMM's process and the reluctance to share information regarding its calculation of OCAs in a timely manner has resulted in inaccurate OCAs for extended periods of time, to the detriment of LS Power and the PJM market as a whole.

II. QUALIFICATIONS

4. I have over 20 years of direct experience in wholesale electricity markets at two Independent System Operators ("ISOs"). Currently, I am a Vice President at Concentric Energy Advisors and work in practice areas including wholesale electric market design and analysis, renewable resource integration and commercialization, mergers and acquisitions, and utility rate cases. Prior to working at Concentric, I worked for the CAISO and ISO-NE for over 20 years (collectively), and spent the duration of that time in market monitoring. Over the course of my career, I progressed from analyst to Vice President of Market Monitoring at ISO-NE. While at CAISO and ISO-NE, I served functions across market policy assessment and design, and provided in-depth empirical analysis of complex market issues and forensic investigations of anti-competitive behavior. I also routinely supported and submitted regulatory filings and provided expert witness testimony on numerous occasions.

5. I earned a Ph.D. in Agricultural and Resource Economics from the University of California –

Davis, an M.S. in Natural Resource Economics from the University of Massachusetts – Amherst, and a B.S. in Agricultural and Managerial Economics from the University of California – Davis.

6. My complete resume is attached to this affidavit as Appendix A.

III. PURPOSE OF ATTESTATION

7. The purpose of my attestation is to (1) review the shortcomings of the existing process under which the IMM determines OCAs, and (2) describe improvements that can be made to the OCA process that provides for a timely and transparent information exchange between the IMM and participants so that discrepancies and potential errors can be identified and addressed to minimize harm to the participant and the market.

8. In order to fulfill this purpose, I:
    a. Discuss the need for transparency in adjusting participant bids in accordance with market power mitigation provisions;
    b. Discuss my experience working with participants on the application of market power mitigation to their bids; and,
    c. Describe steps for the IMM and PJM to provide additional transparency to the affected participant and options to resolve disputes where there are concerns regarding the accuracy of the IMM's calculations.

IV. THE ROLE OF TRANSPARENCY IN EFFECTIVE MARKET MONITORING

9. The market monitoring function can have significant influence over how market participants participate and commercialize their assets in ISO markets and, ultimately, the prices produced by those markets. Throughout my twenty years in market monitoring, including eight years as the Vice President of the Market Monitoring for ISO-NE, we exercised reasonable efforts to disclose and discuss data and models when working with individual market participants

regarding their mitigated bid prices. The primary goal was to have an accurate estimate of a competitive cost basis, and we understood that transparency and open dialogue would help achieve this goal. While those interactions did not always result in a satisfied market participant, our aim was to have market participants understand the calculation and the reasons for it. Accordingly, we ensured that market participants had opportunities to discuss mitigations with one or more members of the team. Below I discuss two specific examples of the mitigation process under my management where transparency was critical.

10. The first example is the addition of the implied cost of the Massachusetts greenhouse gas limitations on electric generation ("MAGHG"). The MAGHG program incrementally reduced the amount of emissions allowed from electric generation sources in Massachusetts over time. This created potential scarcity and could force generators to reduce output (similar to the environmental permit restrictions addressed in Mr. Griffiths's affidavit), or purchase allocations from other generators so that they could continue to produce at optimal levels. In the beginning of the program there was no reliable data on a transaction price for allocations. My department developed an opportunity cost model that relied on the allocation and historical production and prices for affected generation assets. The model was clearly documented, distributed, and discussed with participants prior to use in production. As this was a new aspect of the mitigated bid price, numerous participants contacted my department directly to discuss the opportunity cost adders calculated for their assets. In these cases, we promptly provided the participant with the data used in the calculations and discussed the calculation process and the result with the participant. The accurate calculation of the cost adder was important, and collaboration with the participant provided a useful process through which the accuracy of calculation could be vetted.

11. The second is specific to the forward capacity market ("FCM") in New England. ISO-NE's market power mitigation process requires considerable detailed input from the participant, a standardized Excel model, and a detailed review from market monitoring staff. Instructions, a data template and training are provided to participants during the mitigation review process. During this process, market monitoring staff communicate with participants regarding the data they provided and any special circumstances they highlighted. At the end of the process, participants are provided a preliminary estimate of the mitigation calculation for their assets and market monitoring staff are available to consult with the participant prior to finalization of the mitigated bid price. These consultations involve data exchange and explanation, discussion of treatment of non-standard situations, and any other aspect the participant would like to discuss or dispute. The financial model that is the basis of the mitigated bid calculation is initially filled out by participants themselves and is therefore available for detailed review. These steps are undertaken, and tools are made available, to participants prior to finalization of their mitigated bid price. Throughout this lengthy process, the openness of data and models along with consultation with the participant serve the purpose of reducing the risk that erroneous mitigated bids are used in the FCM auction and potentially adversely affect price formation.

12. Both processes described above provide a means to identify and correct issues with input data, assumptions, or calculations. Collaboration and transparency of data, method, and process in a timely fashion helped, in these cases, to avert an incorrect mitigated price adversely affecting the participant and price formation in the wholesale markets.

13. The principles of transparency, timeliness, and collaboration were routinely applied in other mitigation processes, often in one-off cases applicable to a generation asset's specific

circumstance that needed to be addressed in order for the resulting mitigated price to be accurate. While collaboration between the market participant and market monitor does not always result in agreement regarding the resulting value, it does support accurate mitigation, accurate price formation and confidence in the markets. With respect to OCAs, I would emphasize that inaccurate OCAs not only harm the affected market participant but the market as a whole, because an OCA that is set too low will adversely affect clearing prices that are paid to all suppliers and could also prevent a resource from being available when it is most needed by the system.

V. THE NEED FOR TRANSPARENCY IN ADJUSTING PARTICIPANT BIDS TO MITIGATE MARKET POWER

14. As described in Mr. Griffiths's affidavit, on at least two occasions LS Power was forced to use inaccurate OCAs in its mitigated bids over considerable periods of time. These errors caused LS Power financial harm and may also have adversely affected price formation in the PJM market.

15. As Mr. Griffiths explains, market participants receive little information regarding the IMM's calculation of OCAs. Without sufficient information from the IMM, in circumstances where LS Power had questions regarding the IMM's OCAs, Mr. Griffiths had no alternative but to create his own model to mimic the IMM's approach based on publicly available information in order to evaluate the reasonableness of the IMM's calculations and assess whether the IMM's calculations were a reasonable reflection of the opportunity costs for LS Power's assets. Mr. Griffiths also notes that after multiple iterations with the IMM, LS Power still was unable to obtain sufficient detail to recreate the IMM's OCA calculations and the OCA values produced by the LS Power model remained materially higher than those produced by the IMM model. As Mr. Griffiths describes, the OCA values produced by the LS Power model were

more in line with expectations given remaining emission quantities allowed by environmental permits and expected dispatch in forward periods.

16. What is especially troubling is the amount of time that Mr. Griffiths had to spend attempting to understand the IMM's OCA calculations and trying to convince the IMM to modify those calculations. In one instance where Mr. Griffiths identified that the OCAs were not consistent with generation asset's permit limits, his effort to understand the discrepancy took roughly four months.[1] In another instance, it took at least two months to correct some issues, while other issues remained unresolved.[2]

17. As Mr. Griffiths documents, the primary causes of these delays in correcting the inaccurate OCAs were twofold: the IMM's unwillingness to communicate transparently and completely with LS Power, and the IMM's unwillingness to collaboratively remedy identified issues in a timely manner. This is evident in the correspondence between Mr. Griffiths and the IMM. For example, the IMM was only willing to provide the end results of its calculations but refused to release intermediate results or discuss the assumptions and analysis that produced these results even though many of the assumptions were based on information provided by LS Power.[3]

18. Calculating a reasonable OCA can be a complex process and it can be expected that diagnosing a potential error would take more time than, say, confirming a start-time or economic

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[1] *See* Affidavit of Benjamin W. Griffiths on behalf of LS Power Development, LLC at Section IV ("Griffiths Affidavit"). As Mr. Griffiths explains, LS Power's issues with the OCAs for their Illinois units related to simplification of environmental constraints specified in the IMM model. LS Power had agreed to this simplification previously; however, because of the lack of transparency on the part of the IMM, it took months for LS Power to determine that this simplification was a causing the OCA calculation to produce inaccurate results.

[2] *See id.* at Section V. Mr. Griffiths notes that in the case of LS Power's Chambersburg unit, some issues such as accurate emission limits and rates were resolved while issues relating to the treatment of no-load and start-up costs remain unresolved.

[3] *See id.*, paragraphs 25-26.

maximum capacity parameter is correctly entered. However, the communications between LS Power, the IMM, and PJM reveal that this process could have taken far less time had there been more transparency with respect to the model and parameters used and more timely responses from the IMM.

19. In my experience in market monitoring, once a potential error in mitigation was identified, we placed a high priority on diagnosing, and if needed, correcting the issue to avoid those errors affecting the markets. In the LS Power case, the errors in the mitigated bids resulted in the LS Power assets being undercompensated for prolonged periods, resulting in lower net revenue for LS Power.[4] In addition, this error likely affected price more broadly in the PJM market, as more fully described by Paul Sotkiewicz.[5]

20. Competitive wholesale markets should be designed to allow generating asset owners (and market participants generally) the opportunity to earn sufficient revenues to recover their costs and earn a profit. The role of the market monitor is critical in ensuring that the true cost of operating generating assets is reflected in price formation in the markets. Notably, however, in order to ensure the accuracy of the market monitor's determinations and install confidence among market participants, the market monitor must, among other things, follow a review process that is both transparent and timely. In my opinion, based on the communications between LS Power and the IMM that I reviewed, the IMM did not work with LS Power in a transparent and timely fashion with regard to evaluating LS Power's OCAs.

21. As a generating asset owner, LS Power understands the physical, operating, and regulatory attributes of its assets better than other entities, including PJM and the IMM. However, as

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[4] *See id.*, paragraph 47.

[5] *See* Affidavit of Paul M. Sotkiewicz, Ph.D. on behalf of LS Power Development, LLC at paragraphs 32-45.

highlighted in this case, the lack of transparency made it impossible for LS Power to understand the assumptions used by the IMM in its final OCA value. To be clear, I fully recognize that the participant and the IMM may not agree on a result for a multitude of reasons and that the IMM may have valid reasons for its assumptions and methodology. However, if the market participant is not privy to the specific process and method through which the result is derived, then errors and resulting inefficient market outcomes are more likely to persist without detection. In this instance, transparency and timely communication could have improved error identification and correction quickly and averted financial harm to LS Power and the broader market.

VI. RECOMMENDATIONS

22. A primary issue in this proceeding is the difficulty LS Power had obtaining sufficient information in a timely fashion to understand how OCAs for its assets were being calculated, and to verify that calculations were done properly. As described in Mr. Griffiths's affidavit, there was insufficient information available from the IMM in advance of mitigation, even after multiple iterations of information requests. LS Power was not able to reproduce or even closely replicate the IMM model for the OCA calculations, and in one case, LS Power was not aware until well after the fact that the inputs it had provided had been modified by the IMM. Another problem is that there is no clear process for a market participant to seek timely relief if it has concerns with the IMM's OCA decisions. In fact, LS Power incurred substantial losses and price formation in the broader wholesale market was adversely impacted for a prolonged period until LS Power was able to convince the IMM to correct the faulty OCAs, but there is no clear process to ensure that these problems do not reoccur. While a market participant always has the option of filing of a complaint with FERC, mitigation determinations occur frequently and regularly, and there should be some formalized process that can provide an avenue for review

and relief outside of what can be a lengthy complaint process. I therefore present four changes that, based on my expertise and experience, can help minimize these problems.

23. First, I recommend that the IMM be required to post a public document that fully describes the mathematical model and algorithm used to calculate OCAs, as well as the application of all aspects of the calculation including variable and parameter definitions, such that the model can be replicated by participants. The current model descriptions in PJM's Manual 15, Section 12.7 are vague and cannot be reliably translated into a working mathematical model. The IMM's approach is unreproducible because the Manual is unreasonably vague about how the OCA calculator is intended to work and how it is structured. There is no formal, mathematical description of how OCAs are computed and no details about the mathematical programing used to define and run the optimization models that underlie the OCA calculations (such as the objective function, constraints for unit commitment and dispatch, and how permit and operational constraints are defined). Treatment of some input parameters, such as no-load and start-up costs, are simply omitted from the Manual altogether.

24. Model inputs and outputs for fictitious generation assets with different characteristics should also be provided so that the model can be calibrated and verified by participants. Note that none of this requires producing proprietary software or code. It is a model *specification* with representative fictitious examples sufficient for others to replicate and validate using their own software. This will allow for faster discovery of potential inaccuracies that could impact price formation in the market.

25. Second, I recommend that the IMM be required to fully disclose to the participant all asset-specific inputs, all intermediate calculations (e.g. price projections, simulated dispatch), and all final results in addition to the resulting OCA for that specific participant. This data should

be available for each run of the OCA (e.g., at least weekly) via the IMM's Member Information Reporting Application ("MIRA").[6] There should not be any concerns here with respect to the disclosure of information because the IMM would only be disclosing information relating to the participant's own assets.

26. Third, I recommend that FERC confirm that market participants are permitted to use alternative OCA calculation models, subject to IMM and PJM review to ensure that the alternate model captures the critical components of the OCA and produces a reasonable OCA estimate. My understanding is that this is currently contemplated under PJM's Operating Agreement, but has not been permitted in practice. OCAs are complicated numerical processes that need to reflect numerous unit-specific characteristics and/or potentially complex permit limitations. There can be multiple variants of a model or even different models that can produce reasonable estimates of the OCA. This could be especially useful, for example, when the standard model does not capture material aspects of an asset's attributes, fuel and environmental limitations, fuel market, or other issues that would cause the standard model to miscalculate the OCA for that asset. In such cases, a custom OCA model will likely produce a more accurate OCA and may reduce the frequency of disputes.

27. Fourth, while Manual 15 currently provides for an annual PJM audit of the IMM's model,[7] I recommend that this process be formalized and strengthened. At this time, it appears that PJM

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[6] Intermediate calculations include price projections, unit characteristics used in the model, fuel and environmental constraints and related parameters, and simulated operation under three scenarios for the base and alternate cases.

[7] Section 12.7 of PJM's Manual 15 reads: "On an annual basis, PJM will review the inputs and results of the IMM Opportunity Cost Calculator in consultation with the IMM to verify that the IMM Opportunity Cost Calculator continues to meet the documented requirements." *See also* https://www.pjm.com/-/media/etools/markets-gateway/2023-annual-review-of-imm-opportunity-cost-calculator-methodology.ashx.

conducts its review without any input from market participants. A review process that is more clearly spelled out in the PJM Tariff or Operating Agreement and that provides an opportunity for market participant input could help improve the model and build market confidence in the resulting OCA values.

28. Finally, I recommend that a dispute resolution process with a set resolution period (e.g., 30 days) be designed and put in place for resolving OCA-related disputes. If model transparency and participant level disclosure are compulsory, issues may be identified and disputes may be resolved more quickly between the participant and the IMM. If the market participant and IMM are unable to resolve their dispute within the stipulated period, PJM or a 3rd party should evaluate and make a final determination on the model inputs, method, and resulting OCA.

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

LS Power Development, LLC,	)	
	)	
Complainant,	)	
	)	
v.	)	
	)	**Docket No. EL24-__-000**
PJM Interconnection, L.L.C. and Monitoring Analytics, LLC, as the Independent Market Monitor for PJM,	)	
	)	
Respondents.	)	

AFFIDAVIT

I, Jeffrey D. McDonald, hereby state, under penalty of perjury, that the statements contained in the foregoing Affidavit of Jeffrey D. McDonald on behalf of LS Power Development, LLC are true and correct to the best of my knowledge and belief.

Jeff McDonald
Jeffrey D. McDonald

Dated: February 16, 2024

Appendix A

JMcDonald@CEAdvisors.com
(603) 481-6390

JEFF MCDONALD, Ph.D.
VICE PRESIDENT

Dr. McDonald has enjoyed a successful career in the economics of wholesale electricity markets for more than 20 years. Experienced in developing and advocating specific market design to executive management, stakeholders, and regulators. Effective communication of complex market issues to audiences of varied backgrounds. Hands-on experience designing, performing, and managing empirical analysis of market performance and complex market issues. He has experienced market analysis and design through two ISOs; in positions from Analyst to Vice President; and functions across market policy assessment and advocacy, regulatory filings and expert witness testimony, in-depth empirical analysis, and building effective teams.

Areas of Expertise

Electric Market Design and Analysis of Market Performance

- Analysis and design of detailed market instruments across the entire process including identification of gap / market inefficiency, initial design concept to meet the objective, discussion in the stakeholder process, board briefing and approval, regulatory filing with expert witness testimony, monitoring and assessment before and after implementation. Advocacy to audiences including internal committees, market participants, Board of Directors, and regulatory bodies through presentations, memos and reports, regulatory filings and one-on one briefings.
- Design, perform, and manage empirical analysis of complex market issues including effective market outcomes and incentives, effectiveness of new market elements / products, and uncompetitive behavior. Leverage extensive understanding of economics, incentives, and price formation. Investigative forensic analysis prepared for oversight agencies with exhibits for purposes of potential regulatory enforcement action.
- Experience working across disciplines and roles, especially in the market design and implementation space.

Communicate Policy and Market Issues

- Presented to various audiences a range of market topics spanning high-level market performance, detailed design proposals, and empirical analysis of complex market issues. Extensive experience presenting informational and decisional items to Board of Directors, executives, and FERC staff and commissioners.
- Authored reports, white papers, and policy positions via written public comments covering a broad range of topics including market performance, detailed analysis of market issues, and positions on market design proposals.

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Regulatory Proceedings

- Provided written expert witness testimony in regulatory proceedings for over a decade advocating for specific market design elements. Testimony has included both qualitative and quantitative analysis with recommendations. Experience being deposed on ISO operation practices and the market impact of those practices, just compensation for generator assets, and appropriate cost allocation.

Develop High Performing Teams

- Extensive experience developing and leading high performing teams. Key factors for success have focused on strategic hands-on development across people, tools, and process. Thoughtful coaching, open discussion of ideas, and maintaining a very positive and collaborative work culture have been critical to success as well.

PROJECT AREAS

Electric Market Design

The wholesale electric market design process spans multiple stages and Dr. McDonald has had the privilege of contributing in each of those stages for over 20 years. Initially, identification of gaps and developing new products or changing existing rules to address the issue is undertaken. A sample of market topics where he has contributed to the development of new design include adding scarcity pricing and ramping products to the real-time market, addressing manipulation issues in real-time reserves and settlement rules, "mileage" pricing in regulation, market power identification and mitigation in both day-ahead and real-time markets, and capacity market rules regarding market power, retirement, and imported capacity. Another aspect of the design process is the stakeholder engagement which requires the ability to present the issue and design, explain details and answer questions in a public forum, and provide follow up with technical detail for more in-depth questions. He has led the stakeholder engagement for multiple rule changes in two different ISOs on topics including simple changes to existing market rules, new products, and broader-ranging mitigation measures that could have a significant impact on participant profitability. A subsequent stage in the design process is the regulatory filing. He has contributed to the general content of dozens of regulatory filings to support the market rules being proposed. Beyond that, he also has filed numerous expert witness testimony with both qualitative and quantitative analysis. In these instances, he has participated in the regulatory process both in support of and in protest of the proposed rules. The content of his testimony generally draws heavily on applying economic principles to evaluate the proposed market rules. The positions he has taken have been in support of robust price formation that promotes a well-functioning market over time.

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(603) 481-6390

Analysis of Market Performance

In addition to foundational performance metrics and analysis for identification and diagnostics, Dr. McDonald has designed, performed, and managed numerous in-depth analyses of aspects of wholesale electricity markets. These analyses were designed to better understand how the market was performing, identify and diagnose inefficiencies, and investigate potential market manipulation. General approaches used in these analyses include bottom-up analysis using granular market and participant data, custom modeling and simulation, and using third-party market simulation models under alternate rules, conditions, and commercialization models. Notable subject areas among these analyses are impact of scheduling practices on price formation, effectiveness of scarcity pricing, market power in imported capacity, errors in the application of market power mitigation, price impact of grid operation actions, and efficiency in an as-bid reliability product auction. In addition, Dr. McDonald has also performed and managed dozens of investigations into potential market manipulation. These required a very structured forensic empirical analysis that was robust enough for regulatory enforcement purposes. The potentially manipulative behavior evaluated in these investigations spanned many strategies including misrepresentation, withholding, various two-product schemes, and manipulating settlement rules. Some of the more notable investigations that have resulted in penalties or sanctions (see the FERC Enforcement web site for details) are Enron, JP Morgan, Deutsche Bank, Etricom, and Salem Harbor / Footprint. This short list has produced hundreds of millions in refunded ill-gotten gains and penalties.

Market Monitoring Systems

Dr. McDonald has designed and built monitoring systems from data layer to interactive monitoring interface, with quality control processes. His roles on these projects have spanned individual contributor, manager of teams performing the work, liaison with IT departments and software vendors for up-stream services for two different US Independent System Operators. The final product in both cases was an automated interactive monitoring platform that provided customizable views of data across products, time horizons, settlement aspects, and market participants. Both systems utilized a combination of custom intermediate data layers and micro-ETL objects. The calculation engine and user interface were built in SAS Enterprise Business Intelligence and R+Shiny. The overall process was built to be “self-service” in that users could introduce new metrics or alter existing metrics without involving the IT department. The interactivity that was built into the system provided both greater efficiency in the monitoring process and increased coverage across markets and products. Both systems are currently in use as cornerstone tools in their respective monitoring departments.

JMcDONALD@CEADVISORS.COM
(603) 481-6390

PROFESSIONAL HISTORY

Concentric Energy Advisors (June 2023 to present)
Vice President

Libertas Market Analysis (2022 to May 2023)
Principal

ISO New England – Department of Market Monitoring (2014-2021)
Vice President

California Independent System Operator (2000-2014)
Manager, Market Analysis and Mitigation
Manager, Market Monitoring and Reporting
Lead Market Analyst

State of California (1998-2000)
Staff Economist, Department of Transportation
Staff Economist, Department of Industrial Relations

EDUCATION

University of California - Davis (2022)
Ph.D. in Agricultural and Resource Economics, emphasis in Microeconomics and Natural Resource Economics

University of Massachusetts - Amherst (1992)
M.S. in Natural Resource Economics

University of California – Davis (1990)
B.S. in Agricultural and Managerial Economics

Attachment D

Proposed Protective Agreement

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

LS Power Development, LLC, **Complainant,** **v.** **PJM Interconnection, L.L.C. and Monitoring Analytics, LLC, as the Independent Market Monitor for PJM,** **Respondents.**	))))))))))))	**Docket No. EL24-____-000**

PROTECTIVE AGREEMENT

This Protective Agreement is entered into this ______ day of ____________, ____, by and between LS Power Development, LLC ("Complainant") and ________________________ ("Respondent/Intervenor"), and shall govern the use of all Privileged Material, as defined herein, submitted by Complainant or Respondent/Intervenor to the Federal Energy Regulatory Commission (the "Commission") in this proceeding. Complainant and Respondent/Intervenor are referred to herein individually as a "Party" and jointly as "Parties."

1. The complaint ("Complaint") filed by Complainant in the above-captioned proceeding included documents that contained Privileged Material. Respondent/Intervenor is a "participant" in such proceeding, as such term is defined in 18 C.F.R. § 385.102(b), or has filed a timely motion to intervene or a notice of intervention in such proceeding. The Parties enter into this Protective Agreement to govern the use of Privileged Material or CEII produced by Complainant or Respondent/Intervenor in the above-referenced proceeding. Notwithstanding any order terminating such proceeding, this Protective Agreement shall remain in effect unless and until specifically modified or terminated jointly by the Parties or by the Commission or a court of competent jurisdiction.

2. The Commission's regulations[1] and its policy governing the labelling of controlled unclassified information ("CUI"),[2] establish and distinguish the respective designations of

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[1] *Compare* 18 C.F.R. § 388.112, *with* 18 C.F.R. § 388.113. This Protective Agreement does not alter the respective requirements imposed by these sections on Privileged Material or CEII.

[2] *Notice of Document Labelling Guidance for Documents Submitted to or Filed with the Commission or Commission Staff*, 82 Fed. Reg. 18,632 (Apr. 20, 2017) (issued by Commission Apr. 14, 2017).

Privileged Material and CEII. As to these designations, this Protective Agreement provides that a Party:

A. *may* designate as Privileged Material any material which customarily is treated by that Party as commercially sensitive or proprietary or material subject to a legal privilege, which is not otherwise available to the public, and which, if disclosed, would subject that Party or its customers to risk of competitive disadvantage or other business injury; and

B. *must* designate as CEII, any material that meets the definition of that term as provided by 18 C.F.R. §§ 388.113(a), (c).

3. For the purposes of this Protective Agreement, the listed terms are defined as follows:

A. Party(ies): As defined above.

B. Privileged Material:[3]

i. Material (including depositions) provided by a Party in response to discovery requests or filed with the Commission, and that is designated as Privileged Material by such Party;[4]

ii. Material that is privileged under federal, state, or foreign law, such as work-product privilege, attorney-client privilege, or governmental privilege, and that is designated as Privileged Material by such Party;[5]

iii. Any information contained in or obtained from such designated material;

iv. Any other material which is made subject to this Protective Agreement by the Commission, any court, or other body having appropriate authority, or by agreement of the Parties;

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[3] The Commission's regulations state that "[f]or the purposes of the Commission's filing requirements, non-CEII subject to an outstanding claim of exemption from disclosure under FOIA will be referred to as privileged material." 18 C.F.R. § 388.112(a). The regulations further state that "[f]or material filed in proceedings set for trial-type hearing or settlement judge proceedings, a participant's access to material for which privileged treatment is claimed is governed by the presiding official's protective order." 18 C.F.R. § 388.112(b)(2)(v).

[4] *See infra* P 11 for the procedures governing the labeling of this designation.

[5] The Commission's regulations state that "[a] presiding officer may, by order …. restrict public disclosure of discoverable matter in order to …. [p]reserve a privilege of a participant…." 18 C.F.R. § 385.410(c)(3). To adjudicate such privileges, the regulations further state that "[i]n the absence of controlling Commission precedent, privileges will be determined in accordance with decisions of the Federal courts with due consideration to the Commission's need to obtain information necessary to discharge its regulatory responsibilities." 18 C.F.R. § 385.410(d)(1)(i).

v. Notes of Privileged Material (memoranda, handwritten notes, or any other form of information (including electronic form) which copies or discloses Privileged Material);[6] or

vi. Copies of Privileged Material.

vii. Privileged Material does not include:

a. Any information or document that has been filed with and accepted into the public files of the Commission, or contained in the public files of any other federal or state agency, or any federal or state court, unless the information or document has been determined to be privileged by such agency or court;

b. Information that is public knowledge, or which becomes public knowledge, other than through disclosure in violation of this Protective Agreement; or

viii. Additional Subcategories of Privileged Material:

a. "Highly Confidential Privileged Material": A Party may use this designation for those materials that are of such a commercially sensitive nature among the Parties or of such a private, personal nature that the producing Party is able to justify a heightened level of confidential protection with respect to those materials.

C. Critical Energy/Electric Infrastructure Information (CEII): As defined at 18 C.F.R. §§ 388.113(a), (c).

D. Non-Disclosure Certificate: The term "Non-Disclosure Certificate" means, as applicable:

i. The certificate attached to this Protective Agreement, by which individuals granted access to Privileged Material, including Highly Confidential Privileged Material, and/or CEII must certify their understanding that such access to such material is provided pursuant to the terms and restrictions of this Protective Agreement, and that such Parties have read the Protective Agreement and agree to be bound by it.

ii. The certificate attached to this Protective Agreement, by which Competitive Duty Personnel granted access to Privileged Material, excluding Highly Confidential Privileged Material, and/or CEII must certify their understanding that such access to such material is provided pursuant to the

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[6] Notes of Privileged Material are subject to the same restrictions for Privileged Material except as specifically provided in this Protective Agreement.

terms and restrictions of this Protective Agreement, and that such Parties have read the Protective Agreement and agree to be bound by it.

E. Reviewing Representative:[7]

i. For purposes of reviewing Privileged Materials not covered by Paragraph 3(B)(viii)(a), a person who has signed a Non-Disclosure Certificate and who is:

a. Commission Trial Staff designated as such in this proceeding;

b. An attorney who has made an appearance in this proceeding for a Party;

c. Attorneys, paralegals, and other employees associated for purposes of this case with an attorney who has made an appearance in this proceeding on behalf of a Party;

d. An expert or an employee of an expert retained by a Party for the purpose of advising, preparing for, submitting evidence or testifying in this proceeding;

e. A person designated as a Reviewing Representative by order of the Commission; or

f. Employees or other representatives of a Party appearing in this proceeding with significant responsibility for this docket.[8]

ii. For purposes of reviewing Highly Confidential Privileged Materials covered by Paragraph 3(B)(viii)(a) (a "Highly Confidential Reviewing Representative"), a person who has signed a Non-Disclosure Certificate and who is:

a. A member or staff of any state or local utilities commission which is a Party;

b. An outside attorney who has made an appearance in this proceeding for a Party;

c. An attorney, paralegal, or other employee of the firm of the outside attorney described in Paragraph 3(E)(ii)(b) working with such outside attorney for purposes of this case;

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7 For Highly Confidential Privileged Materials, there shall also be Highly Confidential Reviewing Representatives subject to the corresponding terms of this definition.

8 An individual that is engaged in Competitive Duties is ineligible to qualify as a Highly Confidential Reviewing Representative.

d. An outside expert or an employee of an outside expert retained by a Party for the purpose of advising, preparing for or testifying in this proceeding who is working under the direction of an attorney described in Paragraph 3(E)(ii)(b) or 3(E)(ii)(c), and who is an unaffiliated expert (or employees thereof) not engaging in Competitive Duties or other activities or transactions of a type with respect to which the disclosure of Highly Confidential Privileged Materials may present an unreasonable risk of harm;

e. If, after a good faith effort, the Parties fail to agree on designating a specifically-named inside employee(s) of a non-governmental Party as a Highly Confidential Reviewing Representative for the review of specific Highly Confidential Privileged Material(s) or all Highly Confidential Privileged Material(s), a Party may request that the Commission so designate such a specifically-named inside employee(s) who, for example, is not directly involved in, or having direct or supervisory responsibilities over, the purchase, sale, or marketing of electricity (including transmission service) at retail or wholesale, the negotiation or development of participation or cost-sharing arrangements for transmission or generation facilities, or other activities or transactions of a type with respect to which the disclosure of Highly Confidential Privileged Materials may present an unreasonable risk of harm; or

f. A person designated as a Highly Confidential Reviewing Representative by order of the Commission specifically ruling on and indicating each such person by name.

F. "Competitive Duties": Involvement in, or direct or supervisory responsibilities over, the purchase, sale, or marketing of electricity (including transmission service) at retail or wholesale, the negotiation or development of participation or cost-sharing arrangements for transmission or generation facilities, or similar activities or transactions.

G. "Competitive Duty Personnel": Persons having Competitive Duties.

4. Privileged Material and/or CEII shall be made available under the terms of this Protective Agreement only to Parties and only to their Reviewing Representatives as provided in Paragraphs 6-10 of this Protective Agreement. The contents of Privileged Material, CEII or any other form of information that copies or discloses such materials shall not be disclosed to anyone other than in accordance with this Protective Agreement and shall be used only in connection with this specific proceeding.

5. All Privileged Material and/or CEII must be maintained in a secure place. Access to those materials must be limited to Reviewing Representatives specifically authorized pursuant to Paragraphs 7-9 of this Protective Agreement.

6. Privileged Material and/or CEII must be handled by each Party and by each Reviewing Representative in accordance with the Non-Disclosure Certificate executed pursuant to Paragraph 9 of this Protective Agreement. Privileged Material and/or CEII shall not be used except as necessary for the conduct of this proceeding, nor shall they (or the substance of their contents) be disclosed in any manner to any person except a Reviewing Representative who is engaged in this proceeding and who needs to know the information in order to carry out that person's responsibilities in this proceeding. Reviewing Representatives may make copies of Privileged Material and/or CEII, but such copies automatically become Privileged Material and/or CEII. Reviewing Representatives may make notes of Privileged Material, which shall be treated as Notes of Privileged Material if they reflect the contents of Privileged Material.

7. If a Reviewing Representative's scope of employment includes any of the activities listed under this Paragraph 7, such Reviewing Representative may not use information contained in any Privileged Material and/or CEII obtained in this proceeding for a commercial purpose (e.g. to give a Party or competitor of any Party a commercial advantage):

   A. Energy marketing;

   B. Direct supervision of any employee or employees whose duties include energy marketing; or

   C. The provision of consulting services to any person whose duties include energy marketing.

8. If a Party wishes to designate a person not described in Paragraph 3(E) above as a Reviewing Representative, the Party must seek agreement from the Party providing the Privileged Material and/or CEII. If an agreement is reached, the designee shall be a Reviewing Representative pursuant to Paragraph 3(E) of this Protective Agreement with respect to those materials. If no agreement is reached, the matter must be submitted to the Commission for resolution.

9. A Reviewing Representative shall not be permitted to inspect, participate in discussions regarding, or otherwise be permitted access to Privileged Material and/or CEII pursuant to this Protective Agreement until three business days after that Reviewing Representative first has executed and served a Non-Disclosure Certificate.[9] However, if an attorney qualified as a Reviewing Representative has executed a Non-Disclosure Certificate, any participating paralegal, secretarial and clerical personnel under the attorney's instruction, supervision or control need not do so. Attorneys designated Reviewing Representatives are responsible for ensuring that persons under their supervision or control comply with this Protective Agreement, and must take all reasonable precautions to ensure that Privileged Material and/or CEII are not disclosed to unauthorized persons.

[9] During this three-day period, a Party may file an objection with the Commission contesting that an individual qualifies as a Reviewing Representative, and the individual shall not receive access to the Privileged Material and/or CEII until resolution of the dispute.

10. Any Reviewing Representative may disclose Privileged Material and/or CEII to any other Reviewing Representative as long as both Reviewing Representatives have executed a Non-Disclosure Certificate. In the event any Reviewing Representative to whom Privileged Material and/or CEII are disclosed ceases to participate in this proceeding, or becomes employed or retained for a position that renders him or her ineligible to be a Reviewing Representative under Paragraph 3(E) of this Protective Agreement, access to such materials by that person shall be terminated. Even if no longer engaged in this proceeding, every person who has executed a Non-Disclosure Certificate shall continue to be bound by the provisions of this Protective Agreement and the Non-Disclosure Certificate for as long as the Protective Agreement is in effect.[10]

11. All Privileged Material and/or CEII in this proceeding filed with the Commission or submitted to any Commission personnel, must comply with the Commission's *Notice of Document Labelling Guidance for Documents Submitted to or Filed with the Commission or Commission Staff*.[11] Consistent with those requirements:

    A. Documents that contain Privileged Material must include a top center header on each page of the document with the following text: CUI//PRIV.[12] Any corresponding electronic files must also include this text in the file name.

    B. Documents that contain CEII must include a top center header on each page of the document with the following text: CUI//CEII. Any corresponding electronic files must also include this text in the file name.

    C. Documents that contain both Privileged Material and CEII must include a top center header on each page of the document with the following text: CUI//CEII/PRIV. Any corresponding electronic files must also include this text in the file name.

    D. The specific content on each page of the document that constitutes Privileged Material and/or CEII must also be clearly identified. For example, lines or individual words or numbers that include both Privileged Material and CEII shall be prefaced and end with "BEGIN CUI//CEII/PRIV" and "END CUI//CEII/PRIV".

12. If any Party desires to include, utilize, or refer to Privileged Material or information derived from Privileged Material in testimony or other exhibits during the hearing in this proceeding in a manner that might require disclosure of such materials to persons other than Reviewing Representatives, that Party first must notify counsel for the disclosing Party, and identify all such Privileged Material. Thereafter, use of such Privileged Material will be governed by procedures determined by the Commission.

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[10] *See infra* P 19.

[11] 82 Fed. Reg. 18,632 (Apr. 20, 2017) (issued by Commission Apr. 14, 2017).

[12] Parties may desire additional protection in their handling of the following types of material as defined in this Protective Agreement: Highly Confidential Privileged Material. Parties may incorporate this descriptive subcategory into their document labels as needed (e.g., CUI//PRIV-HC).

13. Nothing in this Protective Agreement shall be construed as precluding any Party from objecting to the production or use of Privileged Material and/or CEII on any appropriate ground.

14. Nothing in this Protective Agreement shall preclude any Party from requesting the Commission or any other body having appropriate authority to find this Protective Agreement should not apply to all or any materials previously designated Privileged Material pursuant to this Protective Agreement. The Commission or any other body having appropriate authority may alter or amend this Protective Agreement as circumstances warrant at any time during the course of this proceeding.

15. Each Party governed by this Protective Agreement has the right to seek changes in it as appropriate from the Commission or any other body having appropriate authority.

16. Subject to Paragraph 18, the Commission shall resolve any disputes arising under this Protective Agreement pertaining to Privileged Material according to the following procedures. Prior to presenting any such dispute to the Commission, the Parties to the dispute shall employ good faith best efforts to resolve it.

    A. Any Party that contests the designation of material as Privileged Material shall notify the Party that provided the Privileged Material by specifying in writing the material for which the designation is contested.

    B. In any challenge to the designation of material as Privileged Material, the burden of proof shall be on the Party seeking protection. If the Commission finds that the material at issue is not entitled to the designation, the procedures of Paragraph 18 shall apply.

    C. The procedures described above shall not apply to material designated by a Party as CEII. Material so designated shall remain subject to the provisions of this Protective Agreement, unless a Party requests and obtains a determination from the Commission's CEII Coordinator that such material need not retain that designation.

17. The designator will have five (5) days in which to respond to any pleading requesting disclosure of Privileged Material. Should the Commission determine that the information should be made public, the Commission will provide notice to the designator no less than five (5) days prior to the date on which the material will become public. This Protective Agreement shall automatically cease to apply to such material on the sixth (6th) calendar day after the notification is made unless the designator files a motion with the Commission, with supporting affidavits demonstrating why the material should continue to be privileged. Should such a motion be filed, the material will remain confidential until such time as the interlocutory appeal or certified question has been addressed by the Motions Commissioner or Commission, as provided in the Commission's regulations, 18 C.F.R. §§ 385.714, .715. No Party waives its rights to seek additional administrative or judicial remedies after a decision regarding Privileged Material or the Commission's denial of any appeal thereof or determination in response to any certified question. The provisions of 18 C.F.R.

§§ 388.112 and 388.113 shall apply to any requests under the Freedom of Information Act (5 U.S.C. § 552) for Privileged Material and/or CEII in the files of the Commission.

18. Privileged Material and/or CEII shall remain available to Parties until the later of 1) the date an order terminating this proceeding no longer is subject to judicial review, or 2) the date any other Commission proceeding relating to the Privileged Material and/or CEII is concluded and no longer subject to judicial review. After this time, the Party that produced the Privileged Material and/or CEII may request (in writing) that all other Parties return or destroy the Privileged Material and/or CEII. This request must be satisfied with within fifteen (15) days of the date the request is made. However, copies of filings, official transcripts and exhibits in this proceeding containing Privileged Material, or Notes of Privileged Material, may be retained if they are maintained in accordance with Paragraph 5 of this Protective Agreement. If requested, each Party also must submit to the Party making the request an affidavit stating that to the best of its knowledge it has satisfied the request to return or destroy the Privileged Material and/or CEII. To the extent Privileged Material and/or CEII are not returned or destroyed, they shall remain subject to this Protective Agreement.

19. Regardless of any order terminating this proceeding, this Protective Agreement shall remain in effect until specifically modified or terminated by the Commission. All CEII designations shall be subject to the "[d]uration of the CEII designation" provisions of 18 C.F.R. § 388.113(e).

20. Any violation of this Protective Agreement and of any Non-Disclosure Certificate executed hereunder shall constitute a violation of an order of the Commission.

21. Neither Party waives the right to pursue any other legal or equitable remedies that may be available in the event of actual or anticipated disclosure of Privileged Material, including but not limited to indemnification for unwarranted release of Privileged Material and injunctive relief.

IN WITNESS WHEREOF, the Parties each have caused this Protective Agreement to be signed by their respective duly authorized representatives as of the date first set forth above.

By: ______________________________	By: ______________________________
Name: ____________________________	Name: ____________________________
Title: _____________________________	Title: _____________________________
Representing Complainant	Representing Respondent/Intervenor

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

LS Power Development, LLC,	)	
	)	
Complainant,	)	
	)	
v.	)	**Docket No. EL24-____-000**
	)	
PJM Interconnection, L.L.C. and Monitoring Analytics, LLC, as the Independent Market Monitor for PJM,	)	
	)	
Respondents.	)	

NON-DISCLOSURE CERTIFICATE

I hereby certify my understanding that access to Privileged Material and/or Critical Energy/Electric Infrastructure Information ("CEII") is provided to me pursuant to the terms and restrictions of the Protective Agreement in this proceeding, that I have been given a copy of and have read the Protective Agreement, and that I agree to be bound by it. I further certify that my duties and responsibilities do not include "Competitive Duties" as described in the Protective Agreement. I understand that the contents of Privileged Material and/or CEII, any notes or other memoranda, or any other form of information that copies or discloses such materials, shall not be disclosed to anyone other than in accordance with the Protective Agreement. I acknowledge that a violation of this certificate constitutes a violation of an order of the Federal Energy Regulatory Commission.

By: ________________________________

Title: ________________________________

Representing: ________________________________

Date: ________________________________

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

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<tr><td>LS Power Development, LLC,

Complainant,

v.

PJM Interconnection, L.L.C. and
Monitoring Analytics, LLC, as the
Independent Market Monitor for PJM,

Respondents.</td><td>)
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NON-DISCLOSURE CERTIFICATE FOR COMPETITIVE DUTY PERSONNEL

I hereby certify my understanding that access to Privileged Material and/or Critical Energy/Electric Infrastructure Information ("CEII") is provided to me pursuant to the terms and restrictions of the Protective Agreement in this proceeding, that I have been given a copy of and have read the Protective Agreement, and that I agree to be bound by it. I understand that the contents of Privileged Material and/or CEII, any notes or other memoranda, or any other form of information that copies or discloses such materials, shall not be disclosed to anyone other than in accordance with the Protective Agreement. I acknowledge that my duties and responsibilities include "Competitive Duties" as described in the Protective Agreement, and, as such, I understand that I shall neither have access to, nor disclose, the contents of the Privileged Materials that are marked "Highly Confidential Privileged Material," any notes or other memoranda, or any other form of information that copies or discloses Privileged Materials that are marked as "Highly Confidential Privileged Material." I acknowledge that a violation of this certificate constitutes a violation of an order of the Federal Energy Regulatory Commission.

By: ________________________________

Title: ________________________________

Representing: ________________________________

Date: ________________________________

Attachment E

Form of Notice

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

LS Power Development, LLC, **Complainant,** **v.** **PJM Interconnection, L.L.C. and Monitoring Analytics, LLC, as the Independent Market Monitor for PJM,** **Respondents.**	))))))))))))	**Docket No. EL24-____-000**

NOTICE OF COMPLAINT

(March __, 2024)

Take notice that on March 20, 2024, LS Power Development, LLC ("LSP Development"), on behalf of itself and certain of its affiliates and subsidiaries, filed a formal complaint with the Federal Energy Regulatory Commission regarding the calculation of Energy Market Opportunity Costs under Schedule 2 to the Amended and Restated Operating Agreement of PJM Interconnection, L.L.C. ("PJM").

LSP Development certifies that copies of the complaint were served on the contacts for PJM and Monitoring Analytics, LLC, the Independent Market Monitor for PJM, as listed on the Commission's list of Corporate Officials.

Any person desiring to intervene or to protest this filing must file in accordance with Rules 211 and 214 of the Commission's Rules of Practice and Procedure (18 CFR 385.211 and 385.214). Protests will be considered by the Commission in determining the appropriate action to be taken, but will not serve to make protestants parties to the proceeding. Any person wishing to become a party must file a notice of intervention or motion to intervene, as appropriate. The IMM's and PJM's answers and all interventions, or protests must be filed on or before the comment date. The IMM's and PJM's answers, motions to intervene, and protests must be served on LSP Development.

The Commission encourages electronic submission of protests and interventions in lieu of paper using the "eFiling" link at http://www.ferc.gov. Persons unable to file electronically should submit an original and 14 copies of the protest or intervention to the Federal Energy Regulatory Commission, 888 First Street, N.E., Washington, D.C. 20426.

This filing is accessible on-line at http://www.ferc.gov, using the "eLibrary" link and is available for review in the Commission's Public Reference Room in Washington, D.C. There is an "eSubscription" link on the web site that enables subscribers to receive email notification when a document is added to a subscribed docket(s). For assistance with any FERC Online service, please email FERCOnlineSupport@ferc.gov, or call (866) 208-3676 (toll free). For TTY, call (202) 502-8659.

Comment Date: 5:00 pm Eastern Time on (insert date).

Debbie-Anne A. Reese
Acting Secretary