UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Grid Resilience in Regional Transmission Organizations and Independent System Operators	)))	**Docket No. AD18-7-000**

COMMENTS OF POTOMAC ECONOMICS, LTD.

Pursuant to the above-captioned proceeding initiated by the Federal Energy Regulatory Commission (the "Commission"), Potomac Economics hereby submits these comments. The Commission opened this docket after closing a related rulemaking on grid resiliency directed by the Department of Energy (RM18-1-000).

Potomac Economics is the Independent Market Monitor ("IMM") for the Midcontinent ISO ("MISO") and the external Market Monitoring Unit ("MMU") for the New York ISO ("NYISO") and ISO New England. In these roles, Potomac Economics is responsible for monitoring and evaluating the performance of each RTO/ISO's energy and operating reserve markets. We also are required to recommend market design changes to improve the performance of the markets and evaluate design changes proposed by the RTOs or market participants, or other parties. The Commission has requested comments from the RTOs that span a wide range of operating, market, and planning issues, many of which are at the core of our responsibilities as market monitors.

I. NOTICE AND COMMUNICATIONS

All communications, correspondence, and documents related to this proceeding should be directed to the following persons and such persons should be placed on the official service list maintained by the Commission's Secretary for this proceeding:

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II. COMMENTS ON DEFINING AND ACHIEVING RESILIENCE

A. Introduction to the Commission's Resilience Initiative

As introduced above, this docket was preceded by a rulemaking proposed by the Department of Energy to address the resiliency of the electricity system under critical contingencies. The proposed rule in that docket was based on substantial out-of-market compensation for a very narrow class of generating resources, mainly coal- and nuclear-powered resources. While this proposal was supported by groups with close economic ties to the nuclear and coal industry, it was broadly opposed and refuted by most commentators. Consistent with the broad opposition the Commission terminated the rulemaking, finding that the proposed rule was not shown to be just and reasonable.

In opening this docket, the Commission directed the RTOs/ISOs to report on resilience issues in three specific area:

(1) A Common Understanding of Resilience;

(2) How RTOs Assess Threats to Resilience; and

(3) How RTOs Mitigate Threats to Resilience.

In this section, we focus on these three points jointly and discuss the importance of utilizing markets to achieve resilience. We specifically recommend a clear process RTO's should use to address these issues. In the next section, we address the RTO's filings on resilience and primarily focus on the pricing proposal advanced by PJM. We explain that the PJM proposal is unnecessary, inefficient, and will undermine the development of multi-lateral RTO market that have come to define the modern electricity industry.

B. Relying on Market-Based Solutions to Achieve Resilience

The Commission invites comments on the understanding of resilience. The Commission propose that resilience means the following:

> The ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such an event.[1]

The definition would reflect a substantial portion of the duties RTOs already perform, for example, the RTOs are already:

- Define system contingencies that the RTOs must be prepared to address;
- Identify the resources and system capabilities needed to address the contingencies;
- Translate these needs into specific reliability requirements (e.g., planning and operating reserves); and

[1] Commission Order Terminating the Rulemaking Proceeding, and Establishing Additional Procedures, Docket Nos. RM18-1-000 and AD18-7-000, at P. 23.

- Define market requirements and products that embody the reliability requirements.

This prevailing approach allows the RTO's to design markets to procure the resources necessary satisfy the system's reliability requirements at the lowest cost, including capacity markets, energy markets, and ancillary services markets. Properly designed, these markets are an effective means of coordinating the myriad of decisions that must be made by market participants to invest in and maintain the resources and network facilities necessary to maintain reliability.

We agree that not all resilience contingencies are currently addressed by the RTOs' markets, e.g., cyber security and fuel-supply contingencies. However, to the extent that these contingencies raise credible concerns, the RTO processes described above or comparable processes should be employed to define the nature of the contingency and specify market requirements to the greatest extent possible. Once credible and well-defined contingencies have been identified, it requires the expertise of planners and reliability analysts to determine the reliability requirements necessary to respond to the contingencies. The market rules and products can then be modified to set prices that reflect these requirements and facilitate market outcomes that satisfy the requirements.

We applaud the Commission for rejecting the out-of-market compensation scheme proposed by DOE, and we support the Commission's intent to carefully define and consider potential resilience issues in this docket. In order to determine whether resilience issues exist and address them efficiently, we recommend that the RTOs:

i. Define the "resilience" contingencies that currently are not considered formally and to address them through their planning processes;

ii. Evaluate whether RTO shortage pricing and other market mechanisms (e.g., pay for performance rules, capacity markets) provide adequate incentives to address these contingencies; and

iii. If the current markets are determined not to provide efficient long-term incentives to maintain the resources and network infrastructure to address the resilience concerns, then the RTOs should rely primarily on additional market requirements to allow their markets and prices to resolve these issues.

III. COMMENTS ON THE RTO'S EFFORTS TO MITIGATE THREATS TO RESILIENCE

A. Resilience Issues Facing the Eastern RTOs

The RTOs have reported a large range of activities that assess and respond to resilience concerns. We have been involved in and are familiar with many of these activities. For the most part, we believe the RTO's are thinking about resilience correctly. Although they have not all evaluated resilience contingencies systematically as we recommend above, it is likely that such concerns are limited in some of the regions, including New York and the MISO region. Some RTOs have already been engaging in the types of analyses that would need to be performed to quantify a resilience requirement. For example, MISO and ISO New England has conducted planning studies related to fuel security. MISO's evaluations of the adequacy of the gas pipeline infrastructure found the MISO North and Central regions to be "favorably located at the crossroads of pipeline corridors extending from many supply basins…with more than 20 interstate pipelines and significant gas storage resources."[2] Hence, MISO potential exposure to natural gas supply contingencies is relatively low.

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[2] Midcontinent ISO Fuel Assurance Report, FERC Docket Nos. AD13-7 and AD14-8, February 18, 2015, p.6.

ISO-New England's filing explains that fuel security is more serious in its region and it is acting to address this. It recently completed its Operational Fuel Security Analysis which sought to quantify its fuel-security risk. ISO-NE reports that in addressing the fuel-security risk it is seeking to develop long-term market solutions and has initiated stakeholder discussion.[3] Although it would be premature to comment on a particular solution, we are encouraged that market-based options are being pursued.

Although NYISO also has fuel-supply vulnerabilities, they are not nearly as severe as those facing ISO-NE. New York has relied on dual-fuel capability (generally the ability to switch from natural gas to on-site oil), which has been a cost-effective means to address natural gas system contingencies. In New York, 84 percent of the natural gas units are duel-fueled units (See Response of New York Independent System Operator, (in this Docket), p. 31).

The one RTO that advanced proposed action that is not a reasonable response to resilience concerns is PJM. PJM has requested the Commission direct PJM to submit certain proposed pricing reforms in a timely manner in order to accelerate its stakeholder process.[4] As we explain herein, that proposed plan is economically unsound, would instead undermine markets by departing from marginal cost pricing principles, and does not address legitimate resilience threats identified by PJM.

B. Comments on PJM's Pricing Reforms

In this subsection, we address PJM's proposal to tie together resiliency issues with a pricing plan PJM has been developing for its energy and ancillary service markets.[5] This plan is

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3 Response of ISO New England, Inc., Docket AD18-7, March 9, 2018, at p. 1-2.

4 Comments and Responses of PJM Interconnection, LLP, Docket AD18-7, March 9, 2018, at p. 80.

5 Comments and Responses of PJM Interconnection, LLP, Docket AD18-7, March 9, 2018, at p. 78, citing PJM, *Proposed Enhancements to Energy Price Formation (Nov. 15, 2017)* on the internet at (https://www.pjm.com/-/media/library/reports-notices/special-reports/20171115-proposed-enhancements-to-energy-price-formation.ashx.) ("PJM White Paper").

a fundamental departure from the efficient locational marginal pricing framework that has been the foundation of all successful wholesale markets in the U.S.

The pricing proposal in PJM's White Paper would allow all PJM units to be eligible to set locational marginal prices (LMPs), essentially proposing to extend to all PJM units the pricing reforms recently encouraged by the Commission for fast-start units.[6] While it may sound like a logical extension of fast-start pricing, it is economically inappropriate because it would allow costs of non-fast start units that are clearly *not* marginal to set the locational marginal prices in PJM. The Commission's reforms in its fast-start pricing docket would increase pricing efficiency when applied to fast-start units because these units are often the marginal source of energy. This is not the case for infra-marginal baseload units. This would move PJM away from efficient marginal-cost pricing and thereby create inefficient short and long-term incentives for PJM's suppliers, but it will also adversely affect the ISO-NE, NYISO, and MISO markets because of the integration of these markets with PJM.[7]

PJM emphasizes a number of factors that leads it to propose the far-reaching pricing reforms, including the penetration of zero-marginal-cost resources, declining natural gas prices, greater generator efficiency, reduced generator margins resulting from low energy prices, and a flattening supply curve.[8] These changes, according to PJM, have led to lower energy market revenues for inframarginal units, like large base load units, that can no longer earn sufficient

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6 Fast-Start Pricing in Markets Operated by Regional Transmission Organizations and Independent System Operators, 81 Fed. Reg. 96,391 (Dec. 30, 2016); New York Independent System Operator, Docket No. EL18-33-000; and PJM Interconnection, LLC, Docket No. EL18-34-000.

7 PJM has Coordinated Transaction Scheduling ("CTS") every 5 minutes with both NYISO and MISO as well as 15- minute transaction scheduling, which may be directly impacted by changes to the PJM price formation proposals.

8 PJM Whitepaper at pp. 5-6.

revenues to drive efficient investment.[9] Besides the fast that none of these reasons appear directly related to resiliency, these reductions in revenues, which has been experienced in all of the eastern RTO markets, reflects the decreasing value of these resources to the system.

1. The Importance of Marginal Cost Pricing

Among the most fundamental axioms of economic theory is that competitive markets for any product will establish clearing prices that reflect the marginal cost of producing the next increment of the good (and the marginal value of the good to the consumer). By charging this price to all buyers and paying this price to all sellers, every participant in the market will be motivated to produce and consume the good efficiently. The design of the wholesale electricity markets is founded on this fundamental economic principle. The LMPs at every location in the RTO markets are intended to reflect the marginal cost of serving the next increment of load at that location, given network losses and constraints.

The PJM pricing proposal would abandon this fundamental economic principle by establishing prices that depart from marginal costs and creating inefficient incentives to its market participants. Although PJM characterizes its proposal as an expansion of the extended LMP methodology proposed by the Commission to price fast-start resources, it is a fundamental and ill-advised change, as we describe below.

2. Fast-Start and Emergency Pricing

Well-designed fast-start pricing rules allow real-time prices to include the cost of committing and running peaking units when they are the marginal source of energy. Hence, fast start pricing is fully consistent with economic principle discussed above that the competitive price for any good should reflect the marginal cost of supplying the good. To understand why

9 *Id.* at p. 1.

this is the case, one must recognize that the commitment of fast-start units is a fundamentally different action than the commitment of other resources.

Most RTOs are dispatched on a time interval of 5 to 15 minutes. In this time horizon, altering the output of online generation is the primary supply action that can be taken by the market to balance supply and demand and manage congestion. However, there is one class of resources that may be started in this time horizon as an alternative to ramping up online resources – fast-starting peaking resources. The costs of utilizing these resources should be reflected in real-time prices because they are marginal costs. Indeed, the Commission has already opined "that given the unique operating characteristics of fast-start resources, their commitment costs, i.e., start-up and no-load costs, should be viewed as marginal costs and, as such, should be included in prices."[10].

This concept may be confusing to some observers because the commitment costs of most resources are not marginal costs. One can define marginal costs as the additional cost incurred to produce additional output. Most units are committed well in advance, particularly baseload units that may be been started many days in advance of the current real-time production interval. Therefore, these units' start-up and minimum generation costs are sunk and are not marginal for providing additional energy. Therefore, only their incremental energy costs can be marginal when they are dispatched between their minimum and maximum output levels.

However, offline resources that can be started quickly (e.g., within 10 minutes) are different. The start-up and minimum generation costs of these resources have not been incurred when they are offline. As load grows or a constraint begins binding, an RTO may incur these costs in the real-time horizon (5 to 15 minutes) as an alternative to ramping up online resources.

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[10] Fast Start NOPR, p. 51

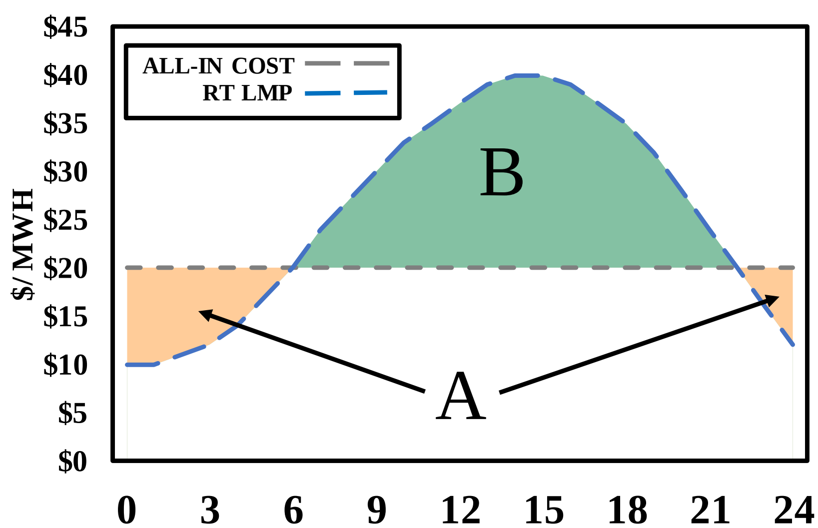
Therefore, the commitment costs of these resources do constitute the marginal costs of satisfying the system's demand, which is the economic rationale for the fast-start pricing that has been implemented by a number of RTOs. This pricing innovation is particularly important because gas turbines constitute most of the resources at the high-priced end of the supply curve – when they do not set price, the prices are often set by a much lower-cost unit. If the portfolio of higher-cost resources included a mixture of flexible and inflexible units, this pricing concern would not be as large because one could expect high-cost flexible units to set prices when the inflexible units could not. Unfortunately, the high-cost supply typically is not sufficiently diverse.

Failure to reflect these costs in real-time prices results in the need to make guarantee payments to these resources to cover their costs, which must be collected from RTO customers through uplift charges. Additionally, the resulting understatement of the real-time prices results in lower day-ahead prices, causing some economic resources to not be scheduled and increasing the need to continue to rely on high-cost fast-starting peaking resources. In MISO this pricing approach has also applied to emergency resources and actions taken by MISO operators to acquire additional supply (or curtail load) under emergency conditions. This is a valuable innovation that should significantly improve price formation.

3. How PJM's Proposed Pricing Differs from Fast-Start Pricing

Although PJM's price formation proposal is superficially similar to fast-start pricing in its mechanics, it is substantively very different. It would, for the first time, introduce fixed costs into real-time pricing that are clearly not marginal in the real-time dispatch horizon. In effect, PJM would be requiring that the average costs of all resources needed to service load be reflected in every five-minute interval. This is fundamentally inconsistent with economic theory and good market design. To understand why, we illustrate in Figure 1 below how baseload resources recover their fixed commitment costs in an efficient LMP market.

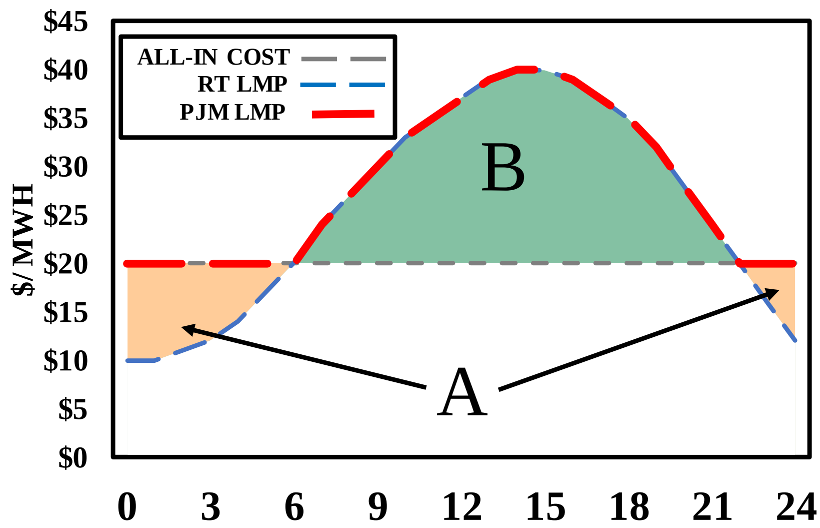
Figure 1 Cost-Recovery for a Baseload Unit



This figure depicts the all-in average cost of a baseload unit (including start-up, no-load and variable energy costs) along with the real-time prices over the day. During the peak hours of the day when load is highest, prices are generally well above the marginal costs of baseload resources. The margins in these hours cover the commitment costs of resources that are economic to commit. In the context of the average costs depicted in this figure, the excess revenues in area B will exceed the amount by which the revenues fail to cover average costs in area A. This is efficient and establishes appropriate economic incentives for the supplier to commit the baseload resource in this example.

Under the PJM proposal, prices must cover the average cost of all baseload resources that are needed to serve load in all intervals. Effectively, this would change the current locational marginal pricing framework to set prices as depicted in Figure 2. This would effective establish a price floor at the average costs of a baseload resource, likely even in cases when the system is over-committed and efficient prices would be very low or negative.

Figure 2: PJM's Pricing Proposal



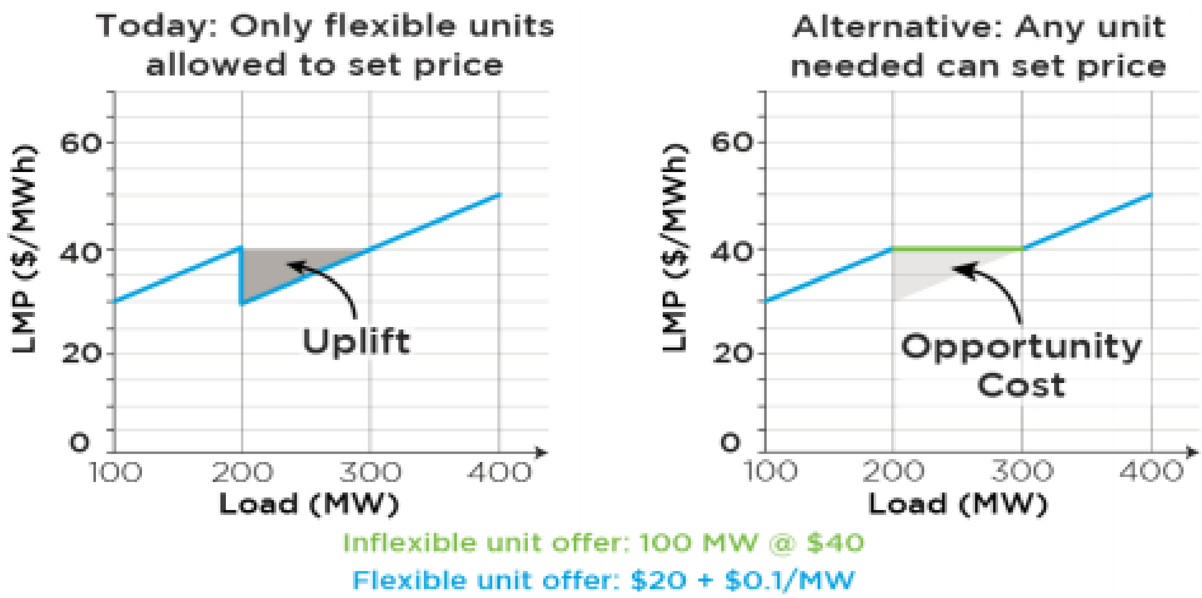
Under this approach, the prices and the dispatch instructions would no longer be consistent. Units with marginal costs of $14 per MWh may be asked to reduce output when prices are set at $30 per MWh. To maintain control of the system, PJM has recognized that it would have to institute opportunity cost payments to guarantee generators the lost profit for economic output they are instructed not to produce. For example, the unit described above would have to receive an opportunity cost payment of $16 per MWh ($30 minus $14) to reduce its output. Absent this payment, it would seek to produce as much output as would be profitable at the $30 per MWh real-time price and the RTO would likely lose its ability to efficiently dispatch the system.

Assuming suppliers would continue to offer resources competitively, we expect that these costs would be enormous. However, this pricing regime would change the offer incentives of the suppliers. For example, it is likely that an inframarginal supplier could earn larger opportunity cost by lowering its offer price. Not only would this further increase the costs to the RTO's consumers, it would also distort the dispatch and commitment of the system.

Finally, we have seen no evidence of significant price formation problems associated with lower-cost baseload or intermediate resources. If the inflexibility of these resources were truly a problem, such that economically committed baseload resources could not cover their full costs, there would be evidence of that problem in the uplift costs.

Figure 3 is reproduced from a previous version of the PJM Whitepaper, which illustrates why they believe that all inflexible resources should set prices.[11] The uplift shown in the left panel would emerge if inflexible units that were needed were not covering their costs. While this is a useful illustration for fast-start peaking resources, this illustration is not accurate for baseload resources. In MISO, although coal and nuclear resources produce roughly two-thirds of all energy, they receive less than one percent of the realtime guarantee payments (uplift) made to ensure that resources cover their full as-offered costs.

Figure 3: PJM's Comparison of Pricing Methods



Hence, there is no support in sound economic theory or market data for PJM's proposed expansion of fast-start pricing to include other types of resources. We urge the Commission to reject the arguments by PJM and the PJM Suppliers to entertain such a proposal in any RTO.

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11 Energy Price Formation and Valuing Flexibility, PJM, June 15, 2017, p. 4.

Effects of PJM's Proposal

To demonstrate the substantial adverse effects of PJM's proposed price formation changes, we estimated the effects of implementing such proposal in MISO, which has a similar portfolio of generating resources to PJM.

We evaluated the real-time prices in MISO and how they would likely be affected by expanding the PJM extended LMP logic to include the startup and no-load costs of long-start resources. This would essentially require the real-time prices to cover the average, all-in cost of any baseload resource that is needed to serve load. In reality, baseload resources are needed in almost all hours. Hence, the PJM pricing proposal would effectively establish a floor price in most hours at the all-in cost of a baseload resource.

We estimated how the market-wide system marginal price (the base energy price at every location) would change under the PJM proposal for the 12 months from November 2016 through October 2017. We found that the system marginal price would increase by roughly 30 percent, demonstrating that the proposal would substantially distort LMPs in MISO.

We also estimated the opportunity cost payments that would be required to ensure that generators have the incentive to follow MISO's dispatch instructions. Given the sizable and inefficient increase in the real-time energy price, one should expect these opportunity cost payments to be sizable. We estimate that the required opportunity cost payments in each 5-minute interval over the 12-month study period by:

- Estimating the difference in the economic output based on each online resource's energy offer curve. The economic output levels are determined at the current price versus the estimated LMP under the PJM proposal.
- Calculating the reduction in the suppliers' net margin (i.e., its opportunity cost). This is the area between the estimated LMP and the offer curve of the resource between the two output levels.

This methodology yielded aggregate opportunity costs in excess of $400 million in the 12 months studied. As mentioned above, this implicitly assumes that generators continue to submit competitive offers in the real-time energy market. We believe such a regime would distort the offer incentives, creating opportunities for generators to alter their offers to increase the opportunity cost payments. Hence, the cost exposure would likely be substantially higher than we estimated. Such pricing incorporates costs into prices that are clearly not marginal in the energy and ancillary service prices. This proposal would likely generate a myriad of other inefficient and unintended results that are difficult to predict in advance.

IV. CONCLUSION

We fully support the Commission's effort to carefully define and consider potential resilience issues in this docket. In order to determine whether resilience issues exist and address them efficiently, we recommend that the RTOs:

i. Define the "resilience" contingencies that currently are not considered formally and to address them through their planning processes;

ii. Evaluate whether RTO shortage pricing and other market mechanisms (e.g., pay for performance rules, capacity markets) provide adequate incentives to address these contingencies.

iii. If the current markets are determined not to provide efficient long-term incentives to maintain the resources and network infrastructure to address the resilience concerns, then the RTOs should develop additional market requirements to allow their markets and prices to resolve these issues.

ISO-NE, MISO, and NYISO have all initiated a large range of activities to assess and respond to resilience concerns and we believe the RTO's are approaching resiliency concerns appropriately.

PJM, however, has proposed to link resiliency to far-reach pricing reforms that would increase energy market compensation to a large range of base-load units. We find these pricing reforms economically unsound and unrelated to true resilience concerns. Therefore, we respectfully recommend that the Commission reject PJM's pricing recommendation.

Respectfully submitted,

/s/ David B. Patton

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CERTIFICATE OF SERVICE

I hereby certify that I have this day e-served a copy of this document upon all parties listed on the official service list compiled by the Secretary in the above-captioned proceeding, in accordance with the requirements of Rule 2010 of the Commission's Rules of Practice and Procedure (18 C.F.R. § 385.2010).

Dated this 8th day of May 2018 in Fairfax, VA.

/s/ David B. Patton