UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Energy Storage Association v. PJM Interconnection, L.L.C.	)	Docket No. EL17-64-000
Renewable Energy Systems Americas and Invenergy Storage Development LLC v. PJM Interconnection, L.L.C.	)	Docket No. EL17-65-000

COMMENTS OF THE INDEPENDENT MARKET MONITOR FOR PJM

Pursuant to Rule 211 of the Commission's Rules and Regulations,[1] Monitoring Analytics, LLC, acting in its capacity as the Independent Market Monitor for PJM[2] ("Market Monitor"), submits these comments responding to the complaints against PJM Interconnection, L.L.C. ("PJM") submitted by Energy Storage Association on April 13, 2017, ("ESA"), and by Renewable Energy Systems Americas and Invenergy Storage Development LLC on April 14, 2017 ("RESA-ISD").

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1 18 CFR § 385.211 (2016).

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

I. BACKGROUND

A. The Regulation Market Is Flawed.

Regulation is an ancillary service procured by PJM from system resources to correct for Area Control Error (ACE), or differences between expected load plus exports and expected generation output plus imports. By correcting any short term imbalance between expected load and generation, regulation maintains system frequency and stability.

Since 2012, PJM has maintained regulation service based on resources following a RegA signal and resources following a RegD signal. The objective of PJM's regulation market design is to minimize the cost to provide regulation from a combination of resources following two different signals (RegA signal and RegD signal) in a single market.

The RegA signal is designed for resources (for example, thermal resources) with slower ramping speeds than RegD resources. The RegD signal is designed for resources (for example, batteries) with faster ramping speeds.[3] While specific design criteria were the basis for the RegA signal and RegD signal, there are no resource/technology specific requirements to qualify to supply RegA or RegD service. A resource need only prove the ability to follow the RegA or RegD signal to offer the service. Some resources (combustion turbines and hydro resources) have qualified and successfully performed as both RegA and RegD. The original RegA and RegD signal controls were not coordinated, but responded separately to ACE.

When solving for the least cost combination of RegA and RegD MW to meet the effective regulation requirement, the regulation market substitutes RegD MW for RegA

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[3] RegD resources are at times referred to as energy limited resources. The amount of energy that can be produced before recharging is a function of the offered capability relative to the capacity of the resource, e.g. a battery. The amount of energy that can be produced continuously by a storage resource in a defined time period is a function of the capacity offered relative to the total storage capacity. The energy capability is a choice of the resource owner. The lower the capacity offered relative to the total storage capacity, the longer the time that the resource can provide the associated energy to the system.

MW so long as it is economic to do so (reduces total cost while maintaining a fixed level of control). Correctly implemented, the engineering based rate of substitution defines the marginal rate of technical substitution (MRTS) between RegA and RegD, which is called a marginal benefit factor (MBF) in the regulation market.[4] Problems arise when the MBF is not identical to the MRTS, e.g. when the MBF is modified from the actual, engineering based MRTS.

The MBF is used to convert incremental additions of RegD MW into incremental effective MW. Correctly implemented, the total effective MW for a given amount of RegD MW is the sum of the incremental effective MW contributions, which equals the area under the MBF function. This conversion into a common unit of measure, effective MW, allows a direct comparison of RegA and RegD offers. In a correctly implemented market design, all resources, either RegA or RegD, would be paid the same price per effective MW provided.

To meet the objective of minimizing cost, the marginal benefit factor (MBF) function must be correctly defined and consistently applied throughout the market design, from optimization to settlement. Consistently applying the MBF from optimization to settlement is the only way to ensure that the engineering relationship is reflected in the relative value of RegA and RegD resources in the market price signals. Consistently applying the MBF is the only way to ensure that PJM efficiently procures the optimal combination of RegA MW and RegD MW needed to provide a target level of regulation service. Consistently applying the MBF is the only way to ensure that you get what you pay for.

The MBF was not, and is not, correctly defined in the current PJM market rules and is not correctly or consistently implemented in the optimization, clearing and settlement of the regulation market. The result has been perverse economic incentives and PJM

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[4] MRTS is a standard concept in economics. *See, e.g.,* Michael Katz and Harvey Rosen, *Microeconomics*, Richard D. Irwin, Inc. (1991) at 264–275. The Market Monitor will use the term MBF in this document because that terminology has been used by PJM and others in the discussion to date. MRTS would also be correct.

operational problems. The Market Monitor brought these fundamental implementation flaws to the attention of PJM and a stakeholder process was started to develop a comprehensive fix to the market design. In the interim, while waiting for the lengthy stakeholder process to run its course, PJM addressed the immediate operational problems caused by the design flaws by adjusting the MBF function and modifying the RegA and RegD signals.

In 2015, PJM observed operational problems associated with RegD resources following the RegD signal in some hours. The problems were directly related to an incorrectly defined and implemented MBF function that both consistently overvalued RegD relative to RegA and caused too much RegD to clear the market. The result was that RegD actually hurt rather than helped ACE control.

A fundamental issue with PJM's initial and current MBF function is that it is incorrectly defined as the RegD MW as a percentage of the effective MW target requirement, rather than as the RegD MW as a percentage of the total regulation MW cleared (total of RegA and RegD combined). The KEMA study defined the effective MW target requirement as the RegD percentage of total regulation MW.[5] PJM's approach is inconsistent with the tradeoff between RegA and RegD defined in the KEMA study. The incorrectly defined MBF causes a mismatch between intended and realized proportions of RegD in the market clearing.

The current market clearing is done without confirming that the resulting combinations of RegA and RegD are consistent with the proportions incorporated in the MBF curve and therefore consistent with feasible market solutions. This approach clears RegD MW as long as it appears to be a cheap source of effective regulation MW regardless

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[5] KERMIT Study Report: To determine the effectiveness of the AGC in controlling fast and conventional resources in the PJM frequency regulation market (Dec. 13, 2011) ("KEMA Study") <http://www.pjm.com/~/media/committees-groups/committees/oc/20150701-rpi/20150701-kema-study-report.ashx>.

of whether it is feasible. The result of the market design is that the market clears too much RegD relative to RegA MW. The problem is exacerbated by an increasing proportion of RegD offering at an effective price of zero,

The MBF related operational issues with the regulation market were raised in the PJM Operating Committee on May 26, 2015, by PJM. On October 22, 2015, the PJM Markets and Reliability Committee approved changes to Manual 11 that introduced an interim, partial fix to the operational problems associated with the relative and absolute over procurement of RegD in the regulation market.[6] The interim fix, implemented on December 14, 2015, was designed just to reduce the purchase of RegD to a manageable level in order to reduce the operational issues associated with the over procurement of RegD.[7] The goal was not to correct the structure of the MBF function and the broader issues in the market design, but to reduce the purchases of RegD MW in all hours, based on the relative value of RegD, and to cap purchases of RegD MW during critical performance hours, when the relative and absolute over procurement of RegD caused the most severe operational issues. The interim fix included a revised MBF function that reflected zero marginal benefit from RegD MW when RegD made up 40 percent (instead of the 62 percent under the initial MBF) of the effective regulation requirement.

In addition to the modification of the MBF function, the December 14, 2015, interim fix implemented by PJM defined, based on analysis of historic operational data, a subset of

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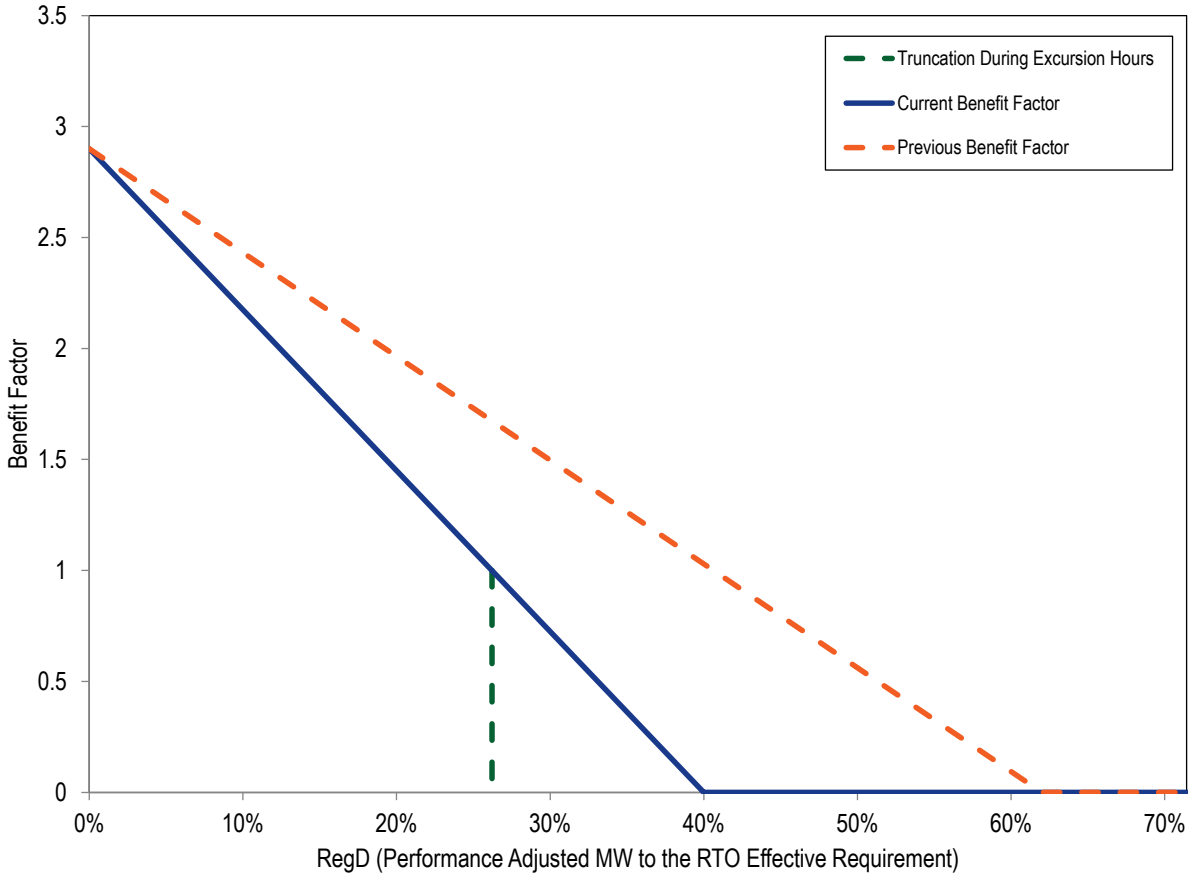
[6] Regulation Performance Impacts, PJM Markets and Reliability Committee (Oct. 22, 2015) <http://www.pjm.com/~/media/committees-groups/committees/mrc/20151022/20151022-item-05-regulation-performance-impacts-presentation.ashx> and <http://www.pjm.com/~/media/committees-groups/committees/mrc/20151022/20151022-item-05-regulation-performance-impacts-draft-manual-11-revisions.ashx>.

[7] The operational issues were the need for RegA pegging and the need for manual override of the RegD signal caused by an over procurement of RegD. Pegging a regulation signal means that 99 percent or more of the regulation following the signal is moving entirely in either a positive or negative direction.

critical control hours when RegD was determined, on the basis of operational analysis, to be even less valuable as a replacement for RegA. These hours were called excursion hours (HE7, HE8, HE18, HE19, HE20, and HE21). During those excursion hours, the new MBF function was defined to end at an MBF value of 1.0 at 26.2 percent RegD (when 183.4 performance adjusted RegD MW clear). During these hours PJM would not clear any RegD in excess of 26.2 percent of the total regulation requirement in order to reduce operational issues.

Figure 1 Marginal benefit factor curve before and after December 14, 2015 revisions by PJM



After implementing the interim fix, PJM began a review of the regulation signal design. As a result of this review, on January 9, 2017, PJM introduced new signal designs

and regulation requirements intended to further improve system performance.[8] These modifications included changing the definition of off-peak and on-peak hours, adjusting the currently independent RegA and RegD signals to be interdependent, and changing the 15-minute energy neutrality requirement of the RegD signal to a 30-minute conditional energy neutrality requirement.

Rather than using off-peak hours and on-peak hours to define regulation requirements, the January 9, 2017, changes redefine hours as nonramp and ramp with specific time periods based on the season. PJM also increase the regulation requirement from 700 MW to 800 MW for ramp hours (Table 1). The set of excursion hours (HE7, HE8, HE18, HE19, HE20, and HE21), where the MBF is capped at 1 at 26.2 percent RegD remained.

Table 1 Seasonal Regulation Requirement Definitions

Season	Dates	Nonramp Hours	Ramp Hours
Winter	Dec 1 - Feb 28(29)	00:00 - 03:59 09:00 - 15:59	04:00 - 08:59 16:00 - 23:59
Spring	Mar 1 - May 31	00:00 - 04:59 08:00 - 16:59	05:00 - 07:59 17:00 - 23:59
Summer	Jun 1 - Aug 31	00:00 - 04:59 14:00 - 17:59	05:00 - 13:59 18:00 - 23:59
Fall	Sep 1 - Nov 30	00:00 - 04:59 08:00 - 16:59	05:00 - 07:59 17:00 - 23:59

B. PJM and the Market Monitor Have Developed a Proposal to Correct the Regulation Market Flaws That Will Be Filed with the Commission.

The December 14, 2015, and January 9, 2017, changes do not address the fundamental market design issues in the regulation market. PJM and the Market Monitor have recognized that correcting these problems will require substantive changes to the

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[8] Implementation and Rationale for PJM's Conditional Neutrality Regulation Signals, PJM white paper, January 2017 (Feb. 3, 2017) <http://www.pjm.com/~/media/committees-groups/task-forces/rmistf/postings/regulation-market-whitepaper.ashx>.

tariff. PJM and the Market Monitor have created a joint proposal to address these issues. The PJM/Market Monitor joint proposal was approved by the Regulation Market Issues Senior Task Force ("RMISTF") on February 27, 2017, with 75 percent of participants voting in favor.[9] The PJM/Market Monitor joint proposal will be filed at the Commission after review at the June 22, 2017, Markets and Reliability Committee and the June 22, 2017, Members Committee.

II. COMMENTS

A. Changes to the Regulation Signals Were Needed to Maintain System Reliability.

ESA (at 18) and RESA-ISD (at 3) complain that PJM's modifications to the MBF function on December 14, 2015, and PJM's changes to the regulation signals on January 9, 2017, constituted substantive changes to PJM's filed rate that should require a change in PJM's tariff and should not be left to the operational discretion of PJM. ESA argues (at 24) that PJM's change to the MBF function significantly affected the rates, terms and conditions of regulation service for RegD resources. ESA and RESA-ISD request (*id*.) that "PJM should be required to justify the reasonableness of its benefit factor calculations with an analysis that meaningfully considers the impact of the regulation resource commitments on system control metrics used to monitor compliance with NERC reliability standards." ESA argues (*id*.) that "PJM should not be allowed to continue tweaking supposedly objective engineering measures in order to achieve desired outcomes in the Regulation market."

ESA and RESA-ISD mischaracterize the nature of the changes. The issue at present is not how to properly house rules under the rule of reason. The Commission decided that

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[9] RMISTF Vote Results, RMISTF Committee Meeting (February 27, 2017) <http://www.pjm.com/~/media/committees-groups/task-forces/rmistf/20170227/20170227-rmistf-vote-results.ashx>.

issue in the Order No. 755 compliance proceeding.[10] In addition, PJM did exactly the analysis complainants ask for. PJM analyzed the impact of its regulation market design and determined that operational reliability required a redefinition of the MBF function. PJM needed to make the referenced changes to maintain system reliability while tariff revisions to correct the fundamental market flaws are developed. The PJM/Market Monitor joint proposal was approved by the Regulation Market Issues Senior Task Force ("RMISTF") and will be filed soon after review in the senior stakeholder committees is completed on June 22, 2017.

B. ESA's Request for Interim Relief Should Be Denied.

ESA (at 3) seeks an order directing PJM to include in the tariff the method for calculating the benefits factor and parameters governing the design of its RegD signal. PJM, the Market Monitor and stakeholders have been working since May 2015, on a package of reforms for the PJM Regulation Market, which would address ESA's issues and other flaws in the PJM Regulation Market design. PJM's filing would have already been filed with the Commission, but for the delay in the stakeholder process sought by complainants and their allies at the April 27, 2017, meeting of the MRC. Setting aside what the rule of reason requires, and setting aside differences on the substance of the reforms needed, the Market Monitor supports including as much of the rules in the tariff as possible.

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[10] *See PJM Interconnection, L.L.C.*, 141 FERC ¶ 61,134 at P 30 (2012) ("PJM provides sufficient information as to how the benefits factor will be calculated.[footnote omitted] For example, PJM proposes to calculate both a unit-specific benefits factor and a marginal benefits factor for the fast responding and traditional regulation signals.[footnote omitted] Under PJM's proposal, each resource will be assigned a unit-specific benefits factor based on its order in the merit stack for the applicable regulation signal. PJM's proposal also provides that the unit-specific benefits factor is the point on the benefits factor curve that aligns with the last MW, adjusted by historical performance that a given resource will add to the fast-responding resource stack.[footnote omitted] We also find that the use of the benefits factor in market clearing allows PJM to minimize the total capability it needs to procure, while maintaining its compliance with NERC's Control Performance Standard 1.[footnote omitted]").

ESA has requested as interim relief, that the Commission direct PJM (i) to return to the prior, pre January 2017, RegD signal and (ii) and eliminate the December 2015 RegD cap (26.6 percent). There is no tariff provision addressing these issues now because the Commission expressly declined to require such a provision.[11] There will there be no tariff provisions in place during the interim period under any scenario. No issue ripe for resolution implicates the rule of reason. The issue is whether ESA has met its burden to require nontariff rule changes during the interim period.

ESA fails to demonstrate that the current RegD signal, as revised, is unjust and unreasonable. ESA does not address PJM's point. The revised rules were needed for reliability because the prior signal was creating operational problems, and detracting from rather than enhancing reliability. If purchasing too much RegD was creating operational issues and purchasing the correct level of RegD resolves the operational issues, any financial impact on RegD resources is appropriate.

C. PJM's Signal Design Should Be Evaluated Based on Support for Least Cost System Control and Nothing Else.

RESA-ISD claim (at 15) to "have experience[d] significant reduction in their compensation" and to have incurred financial harm due to changes in signal design. RESA-ISD provide no evidence of financial harm. RESA-ISD do not even attempt to show that alleged financial harm is the result of the revisions to the market design. RESA-ISD do not address the fact that RegD resources are being overpaid under the current market design and the PJM's revisions further increased performance payments to RegD resources.

The objective of PJM's regulation market design is to minimize the cost to provide regulation via a combination of resources following two different signals (RegA signal and RegD signal) in a single, competitive and efficient market.

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[11] *Id.*

RESA-ISD complain that it makes less money under the new rules. The claim has not been supported. Even if the result were reduced payments for RESA-ISD, this does not mean that such a market result is unjust and unreasonable.

There is no evidence to support the claim that the change in signal design has caused financial harm to the RegD suppliers.

D. The Revised Regulation Signals Are Consistent with the Physical Limits of RegD Resources.

RESA-ISD assert (at 11), with no evidence, that PJM's new RegA and RegD signals result in market requirements that exceed the physical limitations of the energy storage resources. The assertion is false. The new regulation signals do not require resources to exceed their physical limits. In general, RegD resources have either adapted to the changes in the market by modifying their offer parameters (reductions in bid in capability to support longer duration injections and withdrawals) to improve their performance and/or have proven capable of longer duration operation.[12] In either case, RegD resources continue to successfully participate in the market.

E. The Better Approach to Ensure Accurate RegD Procurement Is to Adjust, Rather Than Cap, the MBF function.

ESA claims (at 25–26) that limiting the MBF value to 1.0 during some hours (and thereby limiting RegD to 26.2 percent of the effective MW target) violates the tariff and has caused them harm, because demand for RegD resources was artificially truncated at an inefficient level. ESA argues (*id*.) that additional RegD MW should be allowed to clear in

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[12] RegD resources are at times incorrectly referred to as energy limited resources. The amount of energy that can be produced before recharging is a function of the offered capability relative to the capacity of the resource, e.g. a battery. The energy capability (the amount it can discharge or charge) of a storage resource within a given period of time is a function of the offered capability relative to the resources total storage capacity, which is a choice of the resource owner. The lower the offered capability relative to the total storage capacity of the resource the greater the length of time that the resource can provide that capability to the system.

excursion hours (HE7, HE8, HE18, HE19, HE20, and HE21) because the MBF of these resources would still be positive. ESA argues that "tariff provisions specifically direct PJM to apply the benefits factor to the capability and performance offers of each resource when clearing the Regulation market…[t]his allows a resource with a benefits factor of less than 1.0 to clear the market if, after taking into account the resource's benefits factor and historical performance, it is still a lower cost resource."(*id.*) According to this argument the floor on the MBF value during excursion hours should be removed and RegD resources should be allowed to clear until it is no longer economic to do so (or the MBF value reached zero).

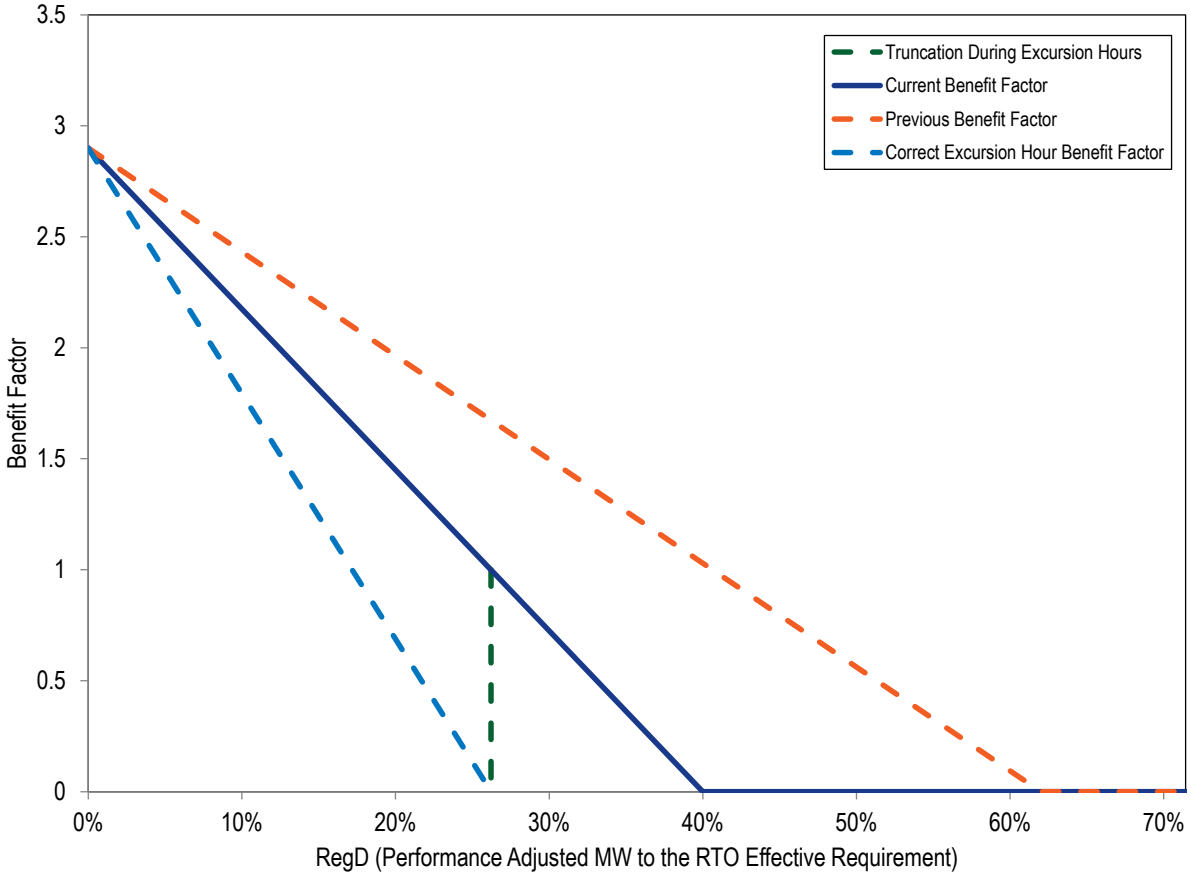
The Market Monitor agrees in part. To the extent that the MBF does not reflect the relative value of RegA and RegD during excursion hours, PJM should propose a MBF that does reflect the relative value of RegA and RegD during those hours and make changes to its manuals to reflect that new MBF. The correct value is 0.0 and not 1.0. PJM's actual rule, as applied, correctly reflects that value of 0.0. PJM's revised rule is correct and the practical effect of the revised rule is correct and the revised rule should be retained until a complete solution can be implemented. An incorrectly defined MBF does not allow the regulation market to provide a least cost solution to its regulation service needs.

PJM has explained that it faces operational issues when there is more than 26.2 percent RegD during excursion hours. In other words, PJM has indicated that from an operational perspective, RegD in excess of 26.2 percent has no value as a substitute for RegA. The actual MBF value is therefore not 1.0 at 26.2 percent RegD during excursion hours. The actual MBF value is 0.0, as PJM has indicated that additional MW of RegD beyond 26.2 percent has no value as a substitute for RegA MW.

As a result, PJM's current interim MBF is overvaluing RegD relative to RegA from zero to 26.2 percent RegD during excursion hours and the MBF value should be 0.0 at 26.2 percent RegD. Figure 2 shows the MBF function (Correct Excursion Hour Benefit Factor) that would reflect these values.

ESA is correct that the MBF is incorrect at 26.2 percent but ESA draws the wrong conclusion. The correct value of the MBF at 26.2 percent is 0.0.

Figure 2 Marginal benefit factor curve before and after December 14, 2015, with revised excursion hours marginal benefit factor curve



Contrary to ESA claims that limiting the MBF value to 1.0 (thereby limiting RegD to 26.2 percent of the effective MW target) harms ESA providers, limiting the MBF value to 1.0 has caused RegD resources to be overvalued in the regulation market clearing during excursion hours.

III. CONCLUSION

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

Respectfully submitted,

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Dated: May 24, 2017

CERTIFICATE OF SERVICE

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

Dated at Eagleville, Pennsylvania,
this 24th day of May, 2017.

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