Regulation Market Issues Senior Task Force Final Report

Final Report

February 22, 2018

Contents

Executive Summary **2**
Issue Charge and Problem Statement **3**
Education Provided **3**
Vote Results **4**
Final Packages **4**
PJM/IMM 4
Beacon 6
ESA 9
Steel Producers 12
Mosaic/A.F. Mensah 12
NextEra 13
ESA Compromise 16
Conclusion **17**
Appendix **18**
The FERC Material 18
Meeting Materials 18
Supporting Documentation 29
Stakeholder Participation 29

Executive Summary

The PJM Interconnection Markets and Reliability Committee formed the Regulation Market Issues Senior Task Force to examine the problem statement initiated by Monitoring Analytics that found market and operational issues associated with the application of the marginal benefit factor in pricing and settlement in the PJM Regulation Market. Discussions at the RMISTF were a continuation of the Regulation Performance Impacts group reporting to the Operating Committee.

Stakeholders in the RMISTF met 18 times from September 2015 through February 2017. They developed seven proposals, including a joint PJM/IMM proposal, to address the problem statement. The PJM/IMM joint proposal received the most votes and was endorsed by the Markets and Reliability Committee on June 22, 2017

In addition, through PJM signal and design analysis, in support of the RMISTF, a new regulation signal design and regulation requirement was implemented into PJM operations on January 9, 2017.

In line with the proposal, revisions were proposed at the March 16, 2017, Markets & reliability Committee to Manual 11, Manual 12, Manual 28 and the Tariff and Operating Agreement. Changes were filed with the FERC on Oct. 17, 2017 in Docket No. ER18-87-000.

Item 11 - Regulation Market Issue Senior Task Force

Item 11 - Regulation Market Issue Senior Task Force - Draft Manual 11 Revisions

Item 11 - Regulation Market Issue Senior Task Force - Draft Manual 12 Revisions

Item 11 - Regulation Market Issue Senior Task Force - Draft Manual 28 Revisions

Item 11 - Regulation Market Issue Senior Task Force - Draft Tariff & OA Revisions

The summary of the joint PJM/IMM proposal follows.

Benefit Factor - Application and clearing

- Replace Benefit Factor with Regulation Rate of Technical Substitution
- Effective MW calculation will be area under the Regulation Rate of Technical Substitution curve

Performance Scoring

- Precision only calculation
- Minimum allowable participation threshold to be raised from status quo 40 percent to 50 percent

Settlements

- Replace Mileage Ratio from the Regulation Performance Credit with Marginal Rate of Technical Substitution
- Marginal Rate of Technical Substitution will be added to the Regulation Capability Credit

Transition Plan

- The first 12 months of the 24-month transition period will have a minimum (floor) Regulation Rate of Technical Substitution value of 0.65.
- The last 12 months of the 24-month transition period would have a minimum (floor) Regulation Rate of Technical Substitution value of 0.50.

Issue Charge and Problem Statement

Monitoring Analytics, the Independent Market Monitor, brought forth this issue due to observed market and operational issues in the Regulation Market associated with the definition and inconsistent application of the marginal benefit factor in the Regulation Market construct.

IMM also brought forth the problem statement:

- The marginal benefit function is not correctly defined and it is not consistently applied throughout market construct.
- This problem warrants consideration in the PJM stakeholder process as it is has contributed to known operational and market issues.
- The use of the marginal benefit function in the regulation market optimization should be reviewed and revised as appropriate.
- The application of the marginal benefit function in pricing and settlement should be reviewed and revised as appropriate.

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Education Provided

At the first RMISTF meeting on September 16, 2015, PJM provided an inventory of education materials for stakeholders.

Inventory of Education Materials

Additional education materials that were requested by stakeholders, and subsequently presented at RMISTF meetings, are captured in the Education Requests & Action Items tracking sheet.

Vote Results

On February 15, 2017, members of the RMISTF used the online voting tool to vote on the RMISTF proposals. There were seven proposals. The joint PJM/IMM proposal received the most votes and was endorsed by the Markets and Reliability Committee on June 22, 2017.

Figure 1: RMISTF Vote Results

RMISTF Vote Results

Total Unique Responders	29				
Total Companies	159				
Voting Members	52				
Affiliates	107				
Question	Yes	No	Abstain	#	%
1. Do you support Package E – PJM/IMM? -- Response	114	39	6	159	75%
2. Do you support Package F - Beacon? -- Response	23	118	18	159	16%
3. Do you support Package G - ESA? -- Response	33	108	18	159	23%
4. Do you support Package H – Steel Producers? -- Response	11	106	42	159	9%
5. Do you support Package I – Mosaic & A.F. Mensah? -- Response	33	108	18	159	23%
6. Do you support Package J – NextEra? -- Response	23	117	19	159	16%
7. Do you support Package K – ESA Compromise? -- Response	39	107	13	159	27%
	Make a Change	Retain the Status Quo	Abstain	#	%
8. Do you prefer to make a change to Regulation Market regarding performance score, clearing, and settlements, or retain the status quo? -- Response	126	19	14	159	87%

Final Packages

The information below is copied from the executive summaries of the proposals as provided by the stakeholders in the RMISTF and as previously published on the RMISTF page of stakeholder materials on pjm.com.

PJM/IMM

Through PJM signal and design analysis, in support of the Regulation Market Issues Senior Task Force (RMISTF), a new regulation signal design and regulation requirement will be implemented into PJM operations in January 2017. The regulation signal design introduces a Regulation D signal that is conditional neutral over a 30-minute period; the signal will try to respect the energy limitation of Regulation D resources, but, when required, the Regulation D signal will still dispatch resources outside of their anticipated energy capabilities. The regulation requirement will be updated from its current definition (700 MW on-peak and 525 MW off-peak) to 800 MW ramp and 525 MW non-ramp. This will allow for more regulation on the system when more variability in control is observed.

Following the signal and requirement implementation, the system and resource performance will be evaluated to determine a Marginal Rate of Technical Substitution (MRTS) curve definition. The MRTS curve definition will describe the trade-off between Regulation A and Regulation D MWs to provide regulation service.

In support of the regulation signal redesign, regulation requirement update and MRTS curve definition, PJM and IMM have developed a package of updates to the design components of the Regulation Market to ensure the redesign allows for efficient and proper market, settlements and operation structures. A summary of the key design components in the PJM/IMM package is as follows:

10. Effective MW calculation - MRTS Application: Area under the MRTS curve Calculate the effective MW as the area under the MRTS curve (vs. MRTS*MW*PS) to capture the full benefit of the resource providing regulation and effectively meeting the regulation requirement.

16: Components of performance scoring and weighting: precision only calculation

$$Performance\ Score_{10sec} = 1 - MIN_{t0-t10}\left(\frac{Response - Signal}{0.5 * ABSHourlyAvgSignal + 0.5 * AREG}\right)$$

$$Performance\ Score_{hourly} = Average\ (PerfromanceScore_{10sec})$$

16A: Accuracy Calculation: NA

16B: Delay Calculation: NA

16C: Precision Calculation: The lowest of the absolute error between the signal at t0 and the response at t0 and t10. The denominator in the precision calculation will be an average of the regulation award and the absolute average hourly signal.

17: Minimum allowable participation threshold: Threshold to be raised from status quo 40% to 50%. It is important to maintain a minimum allowable participation threshold to ensure we are not committing (Self Scheduling) poor performing resources for regulation that are not helping system control or providing adequate regulation service. Given the new regulation signals, performance scoring and other regulation market changes, PJM/IMM propose to raise the minimum allowable participation threshold to 50%, and evaluate during quarterly reviews for any additional adjustments.

19. Application of a substitution factor: Replace Mileage Ratio from the Performance Credit with Marginal Rate of Technical Substitution. Add MRTS to the Capability Credit.

The new settlements equation will be: Credit = CCP*MW*PS*MRTS + PCP*MW*PS*MRTS

The new proposed settlements will ensure that the resources are settled on the effective MW they are providing to the regulation service. This change will provide consistency between the market clearing and settlements, and provide the correct financial signals to the marketplace.

Transition Plan: Implement conditional neutrality and requirement Q1 2017. Transition MRTS over 24-month period.

Implemented conditional neutrality signals and new regulation requirement on Jan. 9, 2017.

Implement a 24-month transition period on MRTS: The first 12 months of the 24-month transition period will have a minimum (floor) MRTS value of 0.65. This means that the maximum amount of Reg D MW (performance adjusted mw) that could clear in this period would be at the point where the MRTS value = 0.65. The last 12 months of the 24-month transition period would have a minimum (floor) MRTS value of 0.50. This means that the maximum amount of Reg D MW (performance adjusted MW) that could clear in this period would be at the point where the MRTS value = 0.50. At the end of the 24-month transition period, the minimum MRTS (floor) can go to 0.

11. Procurement floor: Floor at 0 for all hours (following transition)

13. Schedule used for LOC: Use the schedule the resource is committed on

14. Qualification testing: Up-rate testing once per month. Up-rate testing is categorized as two attempts at an updated capability (one failed test and one re-test) per month

18A. Change in cleared commitment- performance score: Self de-selection results in zero score for remainder of hour. PJM dispatcher de-selection does not impact performance.

21. Calculation of mileage: Status Quo

Beacon

Beacon Power (Beacon) appreciates the opportunity to provide comments to PJM Staff and stakeholders in the Regulation Market Issues Senior Task Force (RMISTF) and to fully expand on the proposed market solutions set forth in its package proposal before the RMISTF. By way of background, Beacon operates a 20 MW flywheel-based energy storage facility in the PJM footprint. In response to PJM's development of a regulation market specifically designed to incent entry of dynamic, fast-responding resources, the Beacon facility entered the PJM space. Since the time of market entry, Beacon has consistently provided the desired quality of frequency regulation service. While Beacon commends the staff of PJM and the Independent Market Monitor for their level of engagement, their willingness to respond to stakeholder concerns, and their efforts to develop solutions to address the existing operational concerns within the PJM regulation market, some elements of PJM's solution package provide Beacon with significant concern.

PJM has engaged stakeholders over the last eighteen months and through two committees to help identify the operational and market-based issues negatively impacting the effectiveness of its regulation market. Through these processes, PJM has identified a number of factors that contribute to the diminution in regulation market performance. Significantly, PJM and the IMM have stated the shape of the existing Benefits Factor (BF) Curve is likely incorrect and does not appropriately represent the trade-off value between the Reg A and the Reg D MWs. At times, this has led PJM to procure too much Reg D and an insufficient amount of Reg A and has caused and continues to cause operational issues when ACE persists in one direction for an extended period of time. Further, PJM has found the current Reg A and Reg D signals fail to optimize the potential benefits offered to the system by those respective resource types. Taken together, these factors occasionally leave PJM in a situation where there is an insufficient volume of regulation MWs to appropriately balance ACE.

Any potential solution to address the operational and market-based issues recently seen in PJM's regulation market should align with the existing market structure to avoid undue and significant market disturbance and comply with the rulings central to Federal Energy Regulatory Commission (FERC) Order 755.1 Order 755 requires that all resources providing regulation service be fairly compensated for the service provided based on the amount of work performed. Accordingly, Order 755 directs that all resources be compensated for the work performed through an evaluation of movement or mileage. ("A mileage-based performance payment component … will provide compensation that appropriately recognizes a resource's actual ramp rate capability." Order 755 at P 177). This requirement recognizes the benefits offered to the system by dynamic resources that can respond to PJM's regulation signal more quickly and accurately than their more traditional counterparts, and the need for those resources to be compensated fairly. Any proposed solution that seeks to require existing PJM-committed dynamic resources to ramp faster and more frequently than their more traditional counterparts, while ensuring that dynamic resources are compensated less is plainly unfair, unreasonable, and counter to the explicit directives contained in Order 755.

Beacon recognizes that PJM has the authority, through its reliability directives, to modify the regulation signals and the shape of the BF Curve, and has a timeline in place to implement various changes to those items. PJM's optimization of the regulation signals through the implementation of its proposed 30-minute conditionally neutral signal and PJM's modification of the BF curve to address resource procurement issues could very likely improve the operation and effectiveness of its regulation market. While Beacon will address additional items below, it is significant to flag PJM's proposed modification to settlements that would eliminate the inclusion of the mileage ratio in favor of the Marginal Rate of Technical Substitution (MRTS) value but will have no positive impact on market operations or resource performance.

With regards to the regulation signal itself, Beacon highlights the importance of state of charge management. It is essential to the energy-limited resources that PJM attracted to the market through this neutrality function that neutrality is maintained. Any proposal to eliminate neutrality would be uniquely targeted at energy-limited resources participating in the regulation market and would punish such resources for having operational limits. To address any operational issues PJM has attributed to neutrality, such as signal pegging and the need for manual operator intervention, PJM should focus on procuring the appropriate balance of energy-limited resources and ramp-limited resources. PJM designed a regulation market around the operational limits of its resources such that Reg D resources respond to ACE quickly, while Reg A resources respond more slowly to carry the signal for a prolonged period of time and to support the regulation signal's neutrality function. By securing the proper mix of Reg A and Reg D resources, PJM will be able to avoid the operational issues associated with procuring too many Reg D MWs and too few Reg A MWs.

Related to securing a proper mix of Reg A and Reg D resources, PJM has indicated that they occasionally experience times where too few Reg A MWs are secured. PJM's proposal to modify the way in which the BF curve is used in market clearing exacerbates this issue. At present, PJM clears "blocks" of Reg D MWs under the BF curve that are in the shape of a rectangle. PJM is proposing to now clear the entire area under the BF curve, rather than relying on the unit-specific block shape. The effect of this administrative change is that the Reg D MWs that clear the market will count as a greater quantity of effective MWs, thus reducing the quantity of Reg A resources that clear the

market. As a result, PJM's proposed solution to market clearing could worsen the existing issues in procuring the proper mix of resources by limiting market space for Reg A MWs, and negating any potential benefits associated with adjusting the BF curve. Also, in order to limit the potential impact of additional Reg D resources, PJM should cap the amount of performance adjusted Reg D capacity procured. Otherwise, the newly proposed MRTS curves could significantly expand the allowable Reg D capacity procurement, further reducing the quantity of Reg A capacity procured.

Shifting gears to resource performance and performance scoring, Beacon agrees with PJM that the areas of performance scoring, qualification and the minimum allowable participation threshold need some modification. Beacon agrees with PJM's recommendation to permit uprate testing on a monthly basis. In using PJM's proposed changes to performance scoring as a basis, Beacon also recommends using only the precision score if precision is less than 75% during a scoring interval. However, Beacon recommends calculating such a score as (0*Accuracy + 0*Delay + 1*Precision), rather than PJM's (0*Accuracy + 0*Delay + 1/3*Precision). This adjustment prevents having arbitrary cliffs in performance scoring. Moreover, Beacon recommends a minimum allowable participation threshold of 60% after a 6-month transition period, rather than the PJM-proposed 75%. In light of the sweeping market reforms and changes to the regulation signal, Beacon feels an increase in the threshold from 40% to 60% will incent resources to perform better. But that jumping from 40% to 75% may place well-performing resources at risk of falling out of the market as PJM and market participants gain experience in managing operations under the new signal.

The most significant item on the RMISTF's package matrix to Beacon is PJM's proposal to change the way in which the market is settled. At present, PJM compensates resources based on the sum of Performance Credits and Capability Credits. The Performance component is multiplied by a mileage ratio. The mileage ratio is representative of the amount of movement and work a Reg D resource performs against that of a traditional Reg A resource. Thus, Reg A resources are compensated at a mileage ratio of 1. Reg D resources are compared to Reg A resources and compensated for the additional movement and ramping PJM is requiring from those resources. PJM has proposed to remove the mileage ratio from settlements and to apply the MRTS/BF to both the Performance and Capability portions of settlements. Due to the current level of Reg D market participation, which is the result of PJM's current market design, the MRTS/BF will always be less than one under these conditions. In looking at this change in conjunction with PJM's proposed signal modifications, Reg D resources would be required to ramp more, provide more movement, and perform more work, but would be compensated at a rate less than Reg A resources. This proposed disparate treatment of dynamic resources would make PJM the only RTO/ISO under FERC jurisdiction that fails to compensate for mileage. It should be noted that PJM's previous attempt to exclude mileage from settlements was flatly rejected by the Commission. ("By failing to include actual mileage in the settlement equation, PJM appears to be inconsistent with Order 755." PJM Interconnection, L.L.C., 141 FERC ¶ 61,134 at P 46 (2012)). PJM's proposal to remove mileage from settlements is not only inconsistent with Order 755, but also unrelated to the resolution of PJM's operational issues, and unduly discriminatory against dynamic resources providing regulation service in the PJM region.

ESA

The key elements of the ESA proposal are:

1. Use PJM's proposed Reg D signal, but place the signal definition in the Tariff. As a threshold issue, we propose that the regulation signal definitions be moved to the tariff. For all intents and purposes, the regulation products are defined by the Reg A and Reg D signals. Those signals are not currently set in the tariff or manuals. This allows PJM to materially change the regulation products without FERC review. We believe that this violates the plain language of the Federal Power Act. It also inappropriately places PJM staff in the position of making competitively significant changes to Reg A or Reg D suppliers' obligations without any external review as to if those changes are unduly discriminatory against one resource type or another.

That said, we believe PJM's proposed conditionally neutral signal is well designed and appropriate, and include it in our proposal, subject to it being paired with an MRTS curve that accurately reflects its benefits. One of the attractive features of the conditional neutral signal is that it automatically adapts to the level of Reg D on the market—because the signal sacrifices energy neutrality as needed to maintain system control, the new signal optimally controls ACE even with 100% Reg D. This observation informs much of our proposal.

Our proposed tariff definition of the regulation signals is:

The control signal sent to traditional Regulation resources will be optimized to minimize ramp rate, as further set forth in PJM Manuals. The control signal sent to dynamic Regulation resources will be optimized to minimize net energy demands, as further set forth in PJM Manuals.

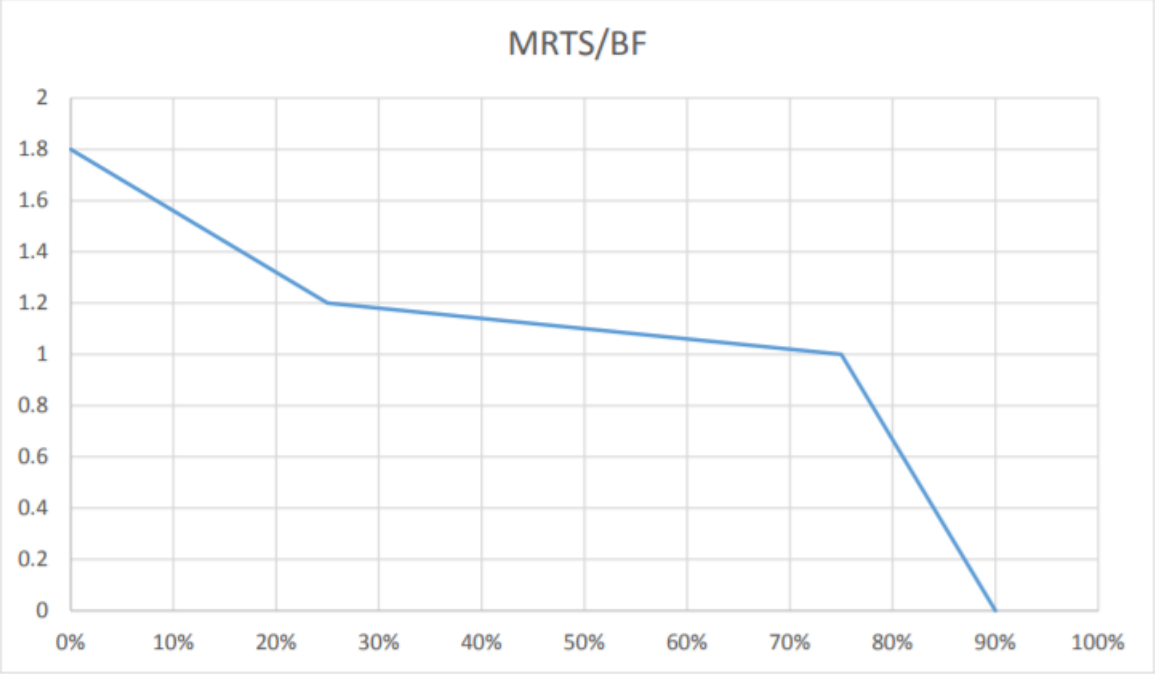
2. Calculate the Benefits Factor/MRTS Curve based on unit obligations, not predictions of class average performance. Place this procedure in the tariff. The BF/MRTS curve, or at least the procedure to generate it, belongs in the tariff. That curve directly affects resource pricing and possibly settlement, and as such is part of a rate by any reasonable definition.

PJM's proposed method for determining the MRTS curve is inconsistent with their proposed regulation signal, and discriminates against Reg D resources. PJM has calculated the MRTS curve under the assumption that Reg D resources are not able to follow the signal. This reduces the compensation received by all Reg D resources, even those that are able to follow the regulation signal perfectly. Further, resources that are not able to follow the signal suffer a reduction in their performance score, effectively penalizing them a second time.

This approach to the MRTS curve sends a perverse investment signal to asset owners. Presumably, the long-term goal is to incent storage resource owners to increase the energy capacity of their units. But because the MRTS is a fleet average, owners who make these investments see no reward.

Our proposal is that the MRTS/BF be calculated based on the signal that Reg D resources are asked to follow, with failures to perform handled on a unit-specific basis through performance scores. This is consistent with all other PJM markets and is the only approach that does not discriminate against well performing units.

In lieu of a BF/MRTS curve derived with this method, we have proposed a fairly flat curve based on our best estimate. We note that under the proposed conditionally neutral signal, Reg D will never move against ACE, even with 100% Reg D. Thus, the benefits factor should never drop below 1.0. However, in the interests of compromise and of making changes in small steps, we propose a curve that does drop off to preserve some role for Reg A resources. Our proposed BF/MRTS curve reflects this:



Our proposed tariff language for the MRTS curve is:

The Office of the Interconnection shall calculate a Marginal Rate of Technical Substitution (MRTS) Curve between the dynamic Regulation signal and traditional Regulation signal. As further detailed in PJM Manuals, the MRTS Curve shall be calculated using engineering models to determine the combinations of the dynamic Regulation signal and traditional Regulation signal that provide equivalent system control, as measured by control metrics to be specified in PJM Manuals.

3. Pay all regulation resources the same price per effective MW. We propose that both Reg A and Reg D receive the same payment for effective MW provided. This is implemented by settling Reg D based on the average effective MW provided per performance adjusted MW—that is, if 200MW of Reg D displaces 300MW of Reg A, Reg D should be paid at 1.5x the rate of Reg A. This construct maintains equal pay for equal service.

4. Scheduling changes to accommodate charge management. The current storage fleet was built to follow a 15-minute energy neutral signal. Moving to the non-neutral signal places asset owners at significant operational risk. To manage this, we propose the package of scheduling reforms listed below. The theme of these reforms is to create ways for storage resources to schedule around their charge limits.

a. Support flexible and inflexible resources: Similar to how the synchronized reserves are scheduled now, we propose that regulation units be divided into inflexible (those that require significant lead time) and flexible units. Just as for SR, PJM can assign some portion of requirements to inflexible units prior to the operating hour, and assign the remainder to flexible units during the hour.

b. Intra-hour drop out: Currently, regulation resources can stop providing regulation during an operating hour with no financial penalty or effect on their performance score. We propose that units retain this right, but be required to 'buy out' of their commitment for the remaining 5-minute intervals they were scheduled for. When this happens, PJM would schedule replacement from the available flexible regulation resources. We are open to discussion of reasonable deviation-like charges in this case.

c. Procure more Reg A when needed: ACE often exceeds the regulation requirement for extended periods of time. During those periods, the entire regulation fleet is pegged at +/-100%, effectively leaving PJM with no regulation control. We propose that once ACE has been at +/-100% for 15 minutes, PJM immediately acquire more Reg A as needed to bring ACE back within the regulation range.

5. Stricter Performance Scoring. Stricter performance scoring is important. In particular, we believe that unit specific performance scores are the correct way for the market to account for energy-limited resources. By design, as the amount of Reg D increases the new signal will become less energy neutral. Proper performance scoring will send the correct signal to asset owners when they need to invest in increased storage capability. We propose using the precision score as the performance score, but are also open to the "cut off at 75% precision" approach in the PJM/IMM package.

6. Keep Mileage Payments. We propose to keep the status quo on performance payments: units make two part offers with capacity and performance components, and Reg D receives performance payments based on the mileage ratio between the Reg D and Reg A signals. Mileage payments are an important part of cost recovery for storage. Most storage technologies are only good for some number of charge/discharge cycles. The mileage payment is a reasonable approximation of these costs. The new conditionally neutral signal appears to push Reg D resources harder, with more up and down motion than the current signal. This will decrease the service life of many deployed units. Keeping mileage payments is an appropriate way to recover those costs in market.

7. Other Items. We also:

a. Have no explicit floor on Reg D, other than where the BF/MRTS curve crosses 0.

b. Keep the status quo for treatment of self-scheduled or zero offers.

c. Agree with the PJM/IMM proposal to calculate LOC based on cheapest of price or most expensive of cost schedule.

d. Keep the status quo on price-setting thresholds.

Steel Producers

Steel Producers' package addresses threshold issues for regulation market participation by load, namely:

- the separation of regulation signals into regulation up and regulation down, and
- directional and asymmetrical products.

Demand side resources are technically feasible and would be a valuable tool for PJM operators.

Steel Producers also prefers shorter scheduling intervals, intra-hour rescheduling, and the automatic increase of regulation intra-hour when needed.

Mosaic/A.F. Mensah

Mosaic Power and A.F. Mensah are generally supportive of the changes in the PJM/IMM package, but note that the package does not address the stated goal of sending appropriate market signals to participants. The IMM has noted that the amount of Reg D resources entering the PJM markets is inconsistent with the PJM marginal benefits curve. However, the proposal to settle on the MRTS is based on an over-simplification of the problem and will not achieve the intended effect.

A clear market signal requires rational price formation. Mosaic Power analysis has shown that the marginal clearing price is considerably below the settled price. The disconnect between bid prices and settled prices is by far more a significant factor than the MRTS at settlement. As demonstrated, the settled price is essentially the result of several randomizing factors and yields a lottery-like marketplace. The MRTS acts like a tax on lottery winnings, which while discouraging over-building, does not contribute to a useful market price signal.

The key factors in the disconnect between the clearing price, which is often zero to a few cents a megawatt, and the settled price, which is typically between $5 and $50 per megawatt are:

1) The inclusion of the LOC in the clearing and settling price. The LOC at clearing time is calculated with the margin between PJM's best estimate of energy costs and the actual energy costs. The LOC at settling reflects the maximum actual difference between the predicted and actual LOC for any node with a regulating resource that is co-optimized with energy. Because of the incentive to bid near zero plus LOC, the regulation settled price is primarily based on the maximum error over a set of pricing points.

2) The distribution of regulation prices is dramatically skewed between the low median price and much higher average price. It is the infrequent "lottery winning" hours that drive the average market returns. Because these winning hours are the result of unforecasted system conditions, they can't be predicted, and resources must be in market to receive these returns, there is a rush to the bottom in bidding. Bids are uniformly far below costs in the expectation that over time the average returns will justify operations. This eliminates any correlation in bidding between normal operation costs and prices of operating regulation resources.

3) The regulation market is small, and of the small number of market participants, most elect to act as price-takers, either by bidding zero, or by self-scheduling. This thinly traded market further obscures the actual costs and inhibits the formation of any broadly meaningful price.

4) The MRTS discounts the offer price by the relative mix of Reg A and Reg D participants in the market. However, the MRTS is not known at the time the regulation bids are submitted, and the bidding parties do not have a means to know how their offer will be valued by PJM. A resource that bids its costs is likely to be discounted on an hour-by-hour basis by a different value depending on the bid stack, and it will be settled at that amount different than it bid. While MRTS is useful for PJM to select an optimal mix of fast and traditional regulation resources, it is a detriment to rational price formation when used in settlement.

As proposed by PJM/IMM, the MRTS would be applied inconsistently between clearing and settlement. In clearing, each unit would clear at a unique MRTS value, but in settlement, as proposed, they would be paid based solely on the market MRTS. This value is less than or equal to the unique values at which every unit cleared. This would result in Reg D resources providing a much larger proportion of effective MW to the market than they would be paid for.

When settling on the MRTS, the resource revenue is double-discounted. The MRTS discounts the value of the resource by applying a valuation based on the class average performance as a key input to the MRTS curve, and again by the individual resource performance through the performance score. This is unjustly against fast regulation resources because traditional resources are not penalized for their average class performance, but are assumed to have a class-wide benefit of 1.

To address these concerns in the limited scope of the RMISTF, Mosaic Power and A.F. Mensah are focused on these specific modifications to the PJM/IMM proposal:

1) Do not include MRTS in settlement. The MRTS curve provides an optimal mix of fast and traditional regulation. The performance score provides the necessary pay-for-performance without penalizing fast resources as a class for the underperformance of a few.

2) Restrict Self-Scheduling to those resources providing for their internal or bilateral regulation needs. This places more resources in the pool for better price formation. Self-Scheduling also results in the selection of low-performing regulation resources when clearing prices are above zero.

3) Resources that fail the TPS, and have excess market power, should not be permitted to drive prices below cost. In such cases, the minimum bid should be the Manual 15 costs.

NextEra

NextEra Energy Resources, LLC (“NextEra”) is submitting this updated alternate proposal in response to proposed changes to the current PJM Regulation market being evaluated by the Regulation Market Issues Senior Task Force (“RMISTF”).

NextEra understands the challenges PJM has experienced related to resource selection and its concerns with respect to accuracy of price signals. NextEra therefore supports some of PJM's proposed changes, including the following aspects:

1) Minimum allowable participation threshold increase from 40% with transition to 55%, and

2) Adoption of the ramping/non-ramping seasonal periods implemented on January 9, 2017.

However, NextEra strongly disagrees with other aspects of PJM's proposal and has provided a package to the RMISTF describing alternate methods to address these items. Below is a summary of NextEra's previously provided package along with additional background related to our opposition of the key components described.

Transition

NextEra's proposal provides for a transition to allow changes to be implemented over time in a manner that is defined and allows stakeholder visibility related to market clearing and settlements. Exhibit 1 provides the transition timing for the key aspects related to signal, performance score, market clearing, and settlements.

Exhibit 1. NextEra Proposed Transition

<table>
<tr><th>Items</th><th>Go-live +1 Year</th><th>Go-live +2 Years</th><th>Go-live +3 Years</th><th>Go-live +4 Years</th><th>Go-live +5 Years</th><th>Go-live +6 Years</th><th>Go-live ongoing</th></tr>
<tr><td>Signal</td><td colspan="7">30 minute conditional neutrality</td></tr>
<tr><td>Participation Threshold Score</td><td colspan="7">0.55</td></tr>
<tr><td>Clear resources down to MRTS =</td><td>0.8</td><td>0.7</td><td>0.6</td><td>0.5</td><td>0.4</td><td>0.3</td><td>0.1</td></tr>
<tr><td>Settlements Calculation Tier 1</td><td colspan="6">MRTS >= 1: [(PCP x mileage ratio)+(CCP x MRTS)] x Performance Score</td><td rowspan="2">Tier 1 Settlements Calculation</td></tr>
<tr><td>Settlements Calculation Tier 2</td><td colspan="6">MRTS < 1: [((PCP x mileage ratio) + CCP) x MRTS] x Performance Score</td></tr>
</table>

NextEra agrees with the changes in the defined periods; however, the adequacy of the MW quantity of regulation procured remains under review and additional procurement may be necessary (winter off-ramp = 525 MW, winter on-ramp=800 MW).

PJM Signal Change

NextEra continues to evaluate the ramifications of the Regulation D signal from the new PJM conditional neutrality controller that was placed into service on January 9, 2017. Regulation D signal pegging is a concern.

Marginal Rate of Substitution ("MRTS") Market Clearing Methodology

NextEra does not support the adoption of the MRTS for market clearing and settlement as proposed by PJM. The proposed MRTS contains a flaw in that it does not consider asset specific performance in an effective and efficient manner. The PJM proposal oversimplifies the relationship between Regulation A ("Reg A") and Regulation D ("Reg D") resources and does not consider each resource's contribution to reliable operations. Although PJM's current proposal adjusts market offers based on performance scores, it leads to a scenario that inappropriately equates two resources that are in fact providing different levels of performance to the system. In NextEra's opinion, this structure would create scenarios that provide incentive to perform ONLY at a minimum level of service. In essence, a race to the bottom for resource providers is created as there is no incentive to be a high performer since those megawatts offered are equated to megawatts offered by a lower performing unit. There would be no incentive for resource owners to design and/or build better performing units, which is the core goal of FERC's pay-for-performance requirements. The Independent Market Monitor ("IMM") has already observed a form of this scenario in the 2016 PJM State of the Market report in which the IMM stated, "when the marginal benefits factor is above one, REG D resources are generally underpaid on a per effective MW basis…and when the marginal benefit factor is less than one, REG D resources are generally overpaid on a per effective MW basis." The scenario in which Reg D resources are not appropriately compensated will only be exacerbated by implementing the MRTS clearing methodology as proposed by PJM. PJM therefore would fail to comply with Order 755's requirement that resources be paid for performance that reflects the quantity of frequency regulation service provided when accurately following the signal.

For the above reasons, NextEra proposes that a phased approach such that the MRTS clearing floor is reduced over time. This proposed phased approach allows a transition the final MRTS floor value of 0.1.

Two Tier Settlement Methodology

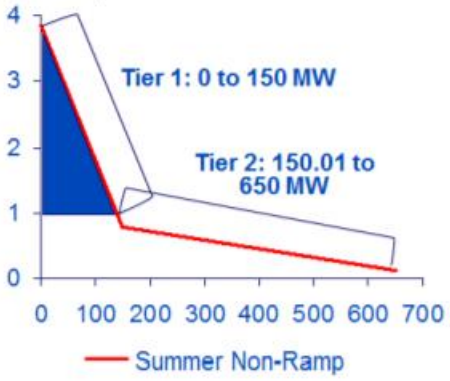
NextEra proposes that a two tiered approach for settlement should be implemented along with PJM's adoption of the MRTS. A two tiered approach allows the market to appropriately consider and incentivize higher performing resources thus improving PJM's system reliability while also communicating an appropriate price signal to market participants. With the proposed two tier approach, resources that clear at MRTS levels greater than or equal to 1.0 would receive the Tier 1 settlement value (see Exhibit 2). PJM continues to propose that resource-specific historical performance scores will be used to rank any resources that offer to provide Reg D at the same bid price. Resources that clear when the MRTS is less than 1.0 will receive Tier 2 compensation. Resources that clear in Tier 1 and Tier 2 would be compensated based on the following formulas:

Tier 1 Settlement Value (MRTS >= 1.0) = [(PCP x Mileage Ratio) + (CCP x MRTS)] x Performance Score

Tier 2 Settlement Value (MRTS < 1.0) = [((PCP x Mileage Ratio)+ CCP) x MRTS] x Performance Score

It is noted that Tier 1 resources would continue to be paid a mileage payment consistent with FERC Order 755, but the MRTS adjustment is only applied to the CCP. Tier 2 offers that clear receive reduced compensation since the MRTS applies to both the PCP and CCP. Resources would thus be incentivized to perform at a higher level and at a lower cost. NextEra believes that the tiered approach to market clearing and settlement should be implemented for a six year transitional period (see Exhibit 2). PJM has a history of implementing changes with transitional periods when changes which have significant stakeholder impact occur. A recent example is the implementation of the PJM capacity market's pay-for-performance provisions which will not be fully implemented until the 2020/2021 capacity period.

Exhibit 2. NextEra Proposed Tier 1 and Tier 2 Market Settlement Example



ESA Compromise

The Compromise proposal is the PJM/IMM package, with the minimum changes to address aspects of that proposal that the storage industry will not be able to support. Those changes are:

- Place the high-level definitions of the Regulation signals and MRTS curve in the tariff.
- Calculate the MRTS based on the characteristics of the regulation signal that resources are obligated to follow rather than modeled responses of a hypothetical regulation fleet.

Our proposed tariff language is:

Regulation Signal, tariff Schedule 3(h) and Attachment K Appendix Sec 1.11.4(c):

The control signal sent to traditional Regulation resources will be constrained by ramping limits, as further set forth in PJM Manuals. The control signal sent to dynamic Regulation resources will be optimized, but not constrained, to minimize net energy demands, as further set forth in PJM Manuals.

MRTS, Att. K Sec 3.2.2(j):

The Office of the Interconnection shall calculate a Marginal Rate of Technical Substitution (MRTS) Curve between the dynamic Regulation signal and traditional Regulation signal. As further detailed in PJM Manuals, the MRTS Curve shall be calculated using engineering models to determine the combinations of the dynamic Regulation signal and traditional Regulation signal that provide equivalent system control, as measured by control metrics to be specified in PJM Manuals.

Conclusion

The PJM/IMM joint proposal garnered the most votes and was presented for endorsement at the June 22, 2017, Markets and Reliability Committee meeting.

Also, through PJM signal and design analysis, in support of the RMISTF, a new regulation signal design and regulation requirement was implemented into PJM operations on January 9, 2017.

The following regulation signal parameters changed effective January 9, 2017:

- The requirement definition changed from off-peak (0000 – 0459) and on-peak (0500 – 2359) to off-ramp and on-ramp period, defined seasonally, to better capture system conditions. The effective requirements on Jan. 9 were the winter requirements, defined as off-ramp (HE1- HE4 and HE10-HE16) and on-ramp (HE5-HE9 and HE17-HE24).
- The effective megawatt requirement changed from 525 MW off-peak and 700 MW on-peak to 525 MW off-ramp and 800 MW on-ramp
- Transitioned to the new signal formation: New Reg A and Reg D signals are interdependent and the Reg D signal has a 30-minute conditional neutrality component

The following is the PJM/IMM package summary.

Benefit Factor - Application and clearing

- Replace Benefit Factor (BF) with Regulation Rate of Technical Substitution (RRTS)
- Effective MW calculation will be area under the RRTS curve

Performance Scoring

- Precision only calculation
- Minimum allowable participation threshold to be raised from status quo 40% to 50%

Settlements

- Replace Mileage Ratio from the Regulation Performance Credit with Marginal Rate of Technical Substitution
- Marginal Rate of Technical Substitution will be added to the Regulation Capability Credit

Transition Plan

- The first 12 months of the 24-month transition period will have a minimum (floor) RRTS value of 0.65. The last 12 months of the 24-month transition period would have a minimum (floor) RRTS value of 0.50.

PJM filed manual updates, as well as Tariff and Operating Agreement updates, with the FERC on Oct. 17, 2017, in Docket No. ER18-87-000.

Item 11 - Regulation Market Issue Senior Task Force

Item 11 - Regulation Market Issue Senior Task Force - Draft Manual 11 Revisions

Item 11 - Regulation Market Issue Senior Task Force - Draft Manual 12 Revisions

Item 11 - Regulation Market Issue Senior Task Force - Draft Manual 28 Revisions

Item 11 - Regulation Market Issue Senior Task Force - Draft Tariff & OA Revisions

Appendix

The FERC Material

Oct. 17, 2017 - Docket No. ER18-87-000

Meeting Materials

Final Matrix - RMISTF Options & Packages Matrix

Sept. 11, 2015

Agenda

Item 02A - Regulation Performance Impacts

Item 02B - Problem Statement Issue Charge Overview

Item 03 - RMISTF Draft Charter

Item 04 - Inventory of Educational Materials

Item 05 - Draft RMISTF Work Plan

October 16, 2015

- Agenda
- Minutes
- Item 01 - Draft Minutes - RMISTF - 9.16.2015
- Item 02 - Draft Charter
- Item 03 - Regulation Market Overview
- Item 04 - Details of Benefits Factor Calculation
- Item 05 - A.F Mensah Inc. Best Least Cost Solutions
- Item 05 - Regulation Market Issues
- Item 07 - PJM Regulation Study

November 11, 2015

- Agenda
- Minutes
- Item 01 - Draft Minutes - RMISTF - 10.16.2015
- Item 02 - RMISTF Charter
- Item 03 - Regulation Market Issues
- Item 04 - Benefits Factor - Additional Information
- Item 05 - Performance Based Regulation Concepts
- Item 06 - Regulation Study
- Item 07 - Regulation Three Pivotal Supplier Test & Lost Opportunity Cost

December 10, 2015

- Agenda
- Minutes
- Item 01 - Draft Minutes - RMISTF - 11.11.2015
- Item 02 - Regulation Lost Opportunity Cost
- Item 03 - Regulation Signal Pegging
- Item 04 - Regulation Study Update
- Item 05 - Providing Regulation
- Item 06 - Consensus-Based Issue Resolution Process
- Item 07 & 08 - Options Packages Matrix
- Educational Items
- Post Meeting - Options & Packages Matrix XLS

January 13, 2016

- Agenda (DOC)
- Minutes
- Draft Minutes - RMISTF - 12.10.2015
- Item 02 - Education Requests & Action Items
- Item 02A - Regulation-Synch Reserve Overview
- Item 02B - Performance Score Delay Issues
- Item 03 - 04 - Options Packages Matrix

- Item 05 - ASO Real Time Regulation MCP Differentiation
- Item 06 - ISO/RTO Regulation Market Comparison
- Reg D Signal with No Neutrality - 10 Second Data
- Reg D Signal With No Neutrality - 2 Second Data
- Post Meeting – Options & Packages Matrix

Febuary 12, 2016

- Agenda
- Minutes
- Item 1 - Draft Minutes - RMISTF - 1.13.2016
- Item 2 - ISO/RTO Regulation Market Comparison
- Item 3 - Regulation Performance Impacts Regulation Changes Status
- Item 4 - Performance Score Analysis
- Item 4 - Scoring Experiments - Part 2
- Item 4 - Scoring Experiments
- Item 5 - Options & Packages Matrix
- Item 7B - A. F. Mensah, Inc. - Regulation Market Proposal
- Item 7 - Energy Storage Association Design Components
- Post Meeting - Options & Packages Matrix
- Education Requests & Action Items

March 23, 2016

- Agenda
- Minutes
- Item 1 - Draft Minutes - RMISTF - 2.12.2016
- Item 2 - Education on Communications Latency
- Item 3 - Update RTO/ISO Benchmarking
- Item 4 - Reference Guide for Design Components Dependencies
- Item 5 - Regulation Study
- Item 6 - Regulation Performances Impact Updates
- Item 7 - Options & Packages Matrix
- Post-Meeting Matrix
- Education Requests & Action Items
- Energy Storage Association Presentation

April 13, 2016

- Agenda
- Agenda
- Minutes
- Item 1 - Draft Minutes - RMISTF - 3.23.2016
- Item 2 - Communication Timing & Performance Scoring
- Item 3 - RTO/ISO Regulation Market Comparison
- Item 6 - Options & Packages Matrix
- Post-Meeting Options & Packages Matrix

June 1, 2016

- Agenda
- Minutes
- Item 1 - Draft Minutes - 4.13.2016
- Item 2 - Regulation Signal Saturation Analysis
- Item 3 - Concept of Flexible & Inflexible Resources in the Synchronized Reserve Market
- Item 4 - PJM Regulation Study Update
- Item 5 - Regulation Performance Impact Updates
- Item 6 - Options & Packages Matrix
- Reg A and Reg D Signals for Sample Week Winter 2015
- Reg A and Reg D Signals for Sample Week Winter 2015 (Updated With Current Signals)
- Education Requests/Action Items
- Post Meeting - Options & Packages Matrix

June 22, 2016

- Agenda
- Minutes
- Draft Minutes - RMISTF - 6.1.2016
- Item 2 - RPI Changes
- Item 4 - Regulation Market Optimization
- Item 5 - Options & Packages Matrix
- Item 5 - Regulation Dependencies Matrix

- Item 5 - ESA RMISTF Proposal
- Proposed Package Matrix (Beacon)
- Education Requests & Action Items
- Post-Meeting Options & Packages Matrix
- Reg A and Reg D Signals for Sample Week Winter 2015

July 19, 2016

- Agenda
- Agenda
- Minutes
- Item 1 - Draft Minutes - RMISTF - 6.22.2016
- Item 2 - Regulation Study Update
- Item 3 - MRTS Development Flow Chart
- Item 4 - Performance Score Update
- Item 4 - RMISTF Options & Packages Matrix
- Regulation Performance Updates
- Regulation Signal Sample Data 4 Weeks New Signals
- Executive Summary of Dominion Package
- Post Meeting - Options & Packages Matrix

August 30, 2016

- Agenda
- Minutes

- Item 1 - Draft Minutes - RMISTF - 7.19.2016
- Item 2 - PJM Regulation Study Update - Requirement & MRTS
- Item 3 - Conditional Neutrality
- Item 4 - Performance Scoring
- Item 5 - RMISTF Options & Packages Matrix
- Post Meeting Matrix

September 27, 2016

- Agenda
- Minutes
- Item 1 - Draft Minutes - RMISTF - 8.30.2016
- Item 2 - PJM Regulation Study Update - Control Metric & MRTS
- Item 3 - Performance Score
- Item 4 - Mosaic – Regulation Price Formation
- Item 5 - Review of Regulation Price Formation
- Item 6 - NextEra Presentation
- Item 6 - RMISTF Beacon Package
- Item 6 - RMISTF Options & Packages Matrix
- Item 6 - RMISTF Executive Summary - Dominion Package
- Item 7 - ESA Proposal Updates
- 5 Minute Regulation Price Data - 8.23 to 9.3

RMISTF Post-Meeting Matrix

October 25, 2016

Agenda

Agenda

Minutes

Item 1 - Draft Minutes - RMISTF - 9.27.2016

Item 2 - RMISTF Transition Proposal

Item 3 - RMISTF Options & Packages Matrix

Mosaic Performance Score Study

NextEra Proposed Transition Plan

ESA Proposal

AF Mensah Settlement Changes Concerns

Post-Meeting Matrix

November 16, 2016

Agenda

Minutes

Item 1 - Draft Minutes - RMISTF - 10.25.2016

Item 2 - Regulation Study Update - New MRTS Curves

Item 3 - Regulation Market Optimization

Item 4 - RMISTF Timeline

Item 4C - Dominion Proposed Performance Scoring Changes

Item 4C - RMISTF Options & Packages Matrix

Precision Check Scoring Template

Regulation Signal Sample Data 4 Weeks 15 & 30 CN

Options & Packages Matrix - Post-Meeting

December 8, 2016

Agenda

Minutes

Item 1 - Draft Minutes - RMISTF - 11.16.2016

Item 2A - RMISTF Transition Plan

Item 2B - ESA Transition Plan

Item 3A - Options & Packages Matrix

Item 3B - AF Mensah RMISTF Package Presentation

Item 3C - Beacon RMISTF Proposal

Mosaic Power Executive Summary

MRTS Curve Points

NextEra Executive Summary

PJM IMM RMISTF Executive Summary

Dominion Executive Summary

Steel Producers Executive Summary

AF Mensah Executive Summary

Beacon Executive Summary

ESA Proposal Executive Summary - Draft

Post-Meeting Matrix

January 24, 2017

- Agenda
- Minutes
- Item 1 - Draft Minutes - RMISTF - 12.8.2016
- Item 2 – FERC NOPR Presentation
- Item 4 – Signal Implementation Review
- Item 5 - MRTS Clearing Simulation
- Item 6 - RMISTF Options & Packages Matrix
- Item 6 - ESA Compromise Proposal
- MRTS Clearing Simulation - Updated
- Performance Score Template Precision Update

Febuary 27, 2017

- Agenda
- Minutes P
- Item 1 - Draft Minutes - RMISTF - 1.24.2017
- ESA Compromise Proposal Executive Summary
- ESA Proposal Executive Summary
- Mosaic & A.F. Mensah Executive Summary
- NextEra Executive Summary of Proposal PJM Reg Market Changes
- PJM IMM RMISTF Executive Summary
- RMISTF Options & Packages Matrix
- RMISTF Vote Results

Supporting Documentation

KEMA Regulation Study 2011
RTS Curve Points Updated
Implementation & Rationale for PJM's Conditional Neutrality Regulation Signals (Regulation Market Whitepaper)
Performance Scoring Design Component
Performance Score Template Precision Update
MRTS Clearing Simulation – Updated
MRTS Curve Points
Precision Check Scoring Template
Regulation Signal Sample Data 4 Weeks 15 & 30 CN
Regulation Signal Sample Data 4 Weeks New Signals
Reg A & Reg D Signals for Sample Week Winter 2015
Reg A & Reg D Signals for Sample Week Winter 2015 (Updated With Current Signals)

Stakeholder Participation

The following is a sampling of frequent attendees at the RMISTF meetings.

Last Name	First Name	Company
Ainspan	Malcolm	NRG
Anders	David	PJM Interconnection, LLC
Benchek	Jim	FirstEnergy Solutions Corp.
Benner	Scott	PJM Interconnection, LLC
Berlinski	Mike	Customized Energy Solutions, Ltd.
Bolan	Martin	FirstEnergy Solutions Corp.
Borgatti	Michael	Gabel and Associates
Bonner	Charles	Dominion
Boyle	Glen	PJM Interconnection, LLC
Burwen	Jason	Energy Storage Association
Carmean	Gregory	OPSI
Copeland	Doug	EDF Renewable Energy
Coyle	Billy	Dominion Virginia Power

Croop	Danielle	PJM Interconnection, LLC
Dugan	Chuck	EKPC
Endress	Eric	PJM Interconnection, LLC
Fereshetian	Damon	PJM Interconnection, LLC
Filomena	Guy	Customized Energy Solutions, Ltd.
Fitch	Neil	NRG
Foladare	Ken	Tangibl
Ford	Adrien	PJM Interconnection, LLC
Gallagher	William	A.F. Mensah, Inc.
Guo	JJ	AEP
Haas	Howard	Monitoring Analytics, LLC
Hamilton	Brian	Infinite Consulting
Hebert	Christopher	Beacon Power, LLC
Hitt	Carrie	NextEra
Hoatson	Tom	LS Power
Hoffman	Jeff	PJM Interconnection, LLC
Horstmann	John	Dayton Power & Light Company (The)
Hsia	Eric	PJM Interconnection, LLC
Jia	Wufan	Mobility House
Johnson	Carl	Customized Energy Solutions, Ltd.*
Keech	Adam	PJM Interconnection, LLC
Kilgallen	Kevin	Iberdrola
Kumaraswamy	Kiran	AES
Libbos	Robin	First Energy Corp.

Lowe	Benjamin	Alevo
Lowe	Connie	Dominion Virginia Power
Mabry	Dave	McNees Wallace & Nurick LLC
Morelli	Lisa	PJM Interconnection, LLC
North	Phillip	AES
Olaleye	Michael	PJM Interconnection, LLC
Ondayko	Brock	Appalachian Power Company
Pilong	Chris	PJM Interconnection, LLC
Pratzon	Dave	GT Power Group
Reed	Paul	Viridity
Rutigliano	Tom	ESA
Sasser	Jonathan	Customized Energy Solutions, Ltd.
Scarpignato	David	Calpine Energy Services, L.P.
Scornavacca	Kristian	NextEra Energy Power Marketing, LLC
Sillin	John	FERC
Shparber	Steve	PJM Interconnection, LLC
Smith	Melissa	PJM Interconnection, LLC
Stewart	Travis	Gabel Associates
Vaudreuil	Greg	Mosaic Power
Volinsky	Sheila	PJM Interconnection, LLC
Wang	Ting Ting	AEP
Wheeler	John	Fermata Energy
Whitehead	Jeff	Direct Energy
Xenopoulos	Damon	SMXB Law