October 31, 2014

PJM Board of Managers
C/o Mr. Howard Schneider, Chairman
PJM Interconnection LLC
2750 Monroe Blvd.
Audubon, PA 19403

Dear Chairman Schneider:

We write to bring the Board’s attention to the serious and urgent reliability issues that prompted PJM’s Capacity Performance Proposal. As detailed below and in the attached brief PowerPoint presentation (hereinafter “Attach.”), capacity market reform is urgently needed. PJM experienced significant operational challenges during the winter of 2014 that, due to the evolution of PJM’s supply mix, will grow exponentially in the next three years if left unaddressed. These challenges confirmed a critical need for PJM to improve RPM to ensure reliable electricity to meet consumer demand during both summer and winter peaks. While, to date, RPM has been successful in attracting and retaining sufficient resources to meet summer peak load, the capacity market is currently signaling that it is acceptable to replace high-availability capacity – such as nuclear units – with cheap, new capacity that has insufficient control over its fuel or through the retention of capital-starved older units. Left unchecked, such market signals will force needed high-availability resources from the market. PJM’s proposed reforms generally provide such checks and should be implemented.

Published PJM data, and analysis of that data presented herein, provide vivid illustrations of the reliability consequences of inaction. Many stakeholders have questioned the sufficiency of PJM’s data or the need for immediate reform. In contrast, Exelon believes that the data speak volumes, compelling both immediate and longer-term reform to assure that RPM successfully yields commitments of sufficient resources to meet consumer demand during all seasons. PJM narrowly averted load shedding on the morning of January 7, 2014. PJM met this period of peak stress with several gigawatts of electricity produced by units – including nuclear units – for which the May, 2014 capacity market auction yielded a retirement signal, in addition to 4.7 gigawatts of uncommitted resources and depletion of Primary Reserves.

According to PJM’s own analysis, while the early evening of January 7 yielded the peak load, the morning of January 7 was the period of peak system stress. During the morning ramp on January 7, nearly a quarter of RPM-cleared capacity resources was unavailable for dispatch – including close to half of all gas resources, over 20% of all coal resources, and over 25% of all oil resources.\(^1\) As a result, real-time energy prices soared, rising to a peak of $1,841 per MWh.\(^2\)

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\(^1\) PJM Interconnection, Response to Committee Questions of U.S. House of Representatives Committee on Energy and Commerce (April 18, 2014) at Figure 4.

Faced with the absence of a large percentage of its RPM-committed resources, PJM narrowly avoided the need to shed load by depleting approximately 500 MW of primary reserves and relying on about 4.2 GW of non-RPM resources that, through good fortune, happened to be available. Specifically, PJM was fortunate that wind over-performed relative to its RPM capacity rating during the hour of peak system stress – generating more than 1 GW in excess of its capacity rating.\(^3\) PJM has no control over whether the wind is blowing, and cannot plan system reliability around the vagaries of whether intermittent resources will be able to perform. In fact, later during January 7, wind underperformed relative to its capacity rating.\(^4\) PJM also issued a voluntary emergency demand response deployment request, to which about 2.1 GW of demand response voluntarily responded and successfully deployed.\(^5\) PJM also relied upon approximately 1.1 GW of voluntary emergency energy imports.\(^6\) Despite the availability of these resources at the peak, future reliance on non-committed resources to meet peak demand is not a good planning practice.

PJM’s analysis of historic outage rates demonstrates that 2014 was not an exception to the poor performance of certain classes of units. Capacity resources – particularly single-fuel gas-fired resources with interruptible gas supply – tend to underperform during very cold weather.\(^7\) Indeed, PJM’s data (spanning the period between 2007 and 2014) demonstrate that when the wind chill approaches -10 degrees Fahrenheit, megawatts forced out for gas-fired resources in Western PJM are three to five times greater than usual.\(^8\) As the wind chill reaches -20 degrees Fahrenheit, the volume of megawatts forced out increases to around eight times the outages that would be expected when wind chill is over 20 degrees Fahrenheit.\(^9\)

The data further show that natural gas interruptions highly correlate to extreme cold weather events. During January 7, approximately 20% of existing gas plants experienced a forced outage due to fuel availability problems.\(^10\) Moreover, PJM’s recent analysis demonstrates that, in Western PJM, when the wind chill is between 0 and 5 degrees Fahrenheit, gas curtailments cause megawatts forced out for peakers to approximately double from 3% to 6% of ICAP on average.\(^11\) And, when the wind chill falls below -10 degrees Fahrenheit, gas

\(^3\) PJM Staff Presentation, *Wind Chill versus Forced Outages*, (September 11, 2014) at slide 11.

\(^4\) Id.

\(^5\) PJM Interconnection, “PJM Demand Response Activity January 7-8, 2014,” (March 26, 2014) slide 3. To the extent that these demand response providers were responding to economic incentives caused by high energy prices provided by PJM, the D.C. Circuit’s recent decision overruling Order No. 745 calls into question whether those demand response providers will respond to future calls for voluntary emergency demand response. See *Elec. Power Supply Ass’n v. FERC*, No. 11-1486 (D.C. Cir. May 23, 2014), reh’g denied (Sept. 17, 2014).

\(^6\) PJM Analysis at 19.

\(^7\) See PJM Staff Presentation, *Wind Chill versus Forced Outages*, (September 11, 2014) at slide 2.

\(^8\) See id. at 2, 10.

\(^9\) See id. at 2, 10.

\(^10\) PJM Analysis at Figure 16. PJM indicates that roughly 24% of outages last January, or about 10 GW, was due to gas supply interruptions. See Attach. at slide 4. Given roughly 50 GW of gas capacity in PJM at the time, this translates to a 20% forced outage for gas capacity due to fuel supply interruptions alone.

\(^11\) PJM Staff Presentation, *Wind Chill versus Forced Outages*, (September 11, 2014) at slide 10.
curtailments increase the volume of megawatts forced out to between 15% and 25% of ICAP.\textsuperscript{12} Moreover, PJM’s data indicate that, absent dual-fuel capability, all types of gas-fired resources that source gas from local distribution companies (“LDCs”) are particularly unreliable during peak winter conditions due to the LDCs’ curtailment of gas supply in favor of residential heating. In zones with a high concentration of gas-fired resources behind LDCs, gas curtailment risk rises markedly at low wind chills.\textsuperscript{13} Indeed, PJM’s analysis indicates that about 50% of forced outage volume in such zones is attributable to gas curtailments.\textsuperscript{14}

The vulnerability of PJM’s system to extreme cold, seen so clearly last winter, will grow rapidly in the near future as natural gas resources replace retiring coal generation. Indeed, 13 GW of capacity with on-site fuel is projected to retire by the end of the 2016/17 Delivery Year. Exelon estimates that an additional 10 GW of capacity with on-site fuel did not clear in RPM for the 2017/18 Delivery Year, and thus may retire. Furthermore, PJM projects that load will continue to grow in the coming years. Between the Winter of 2013/2014 and the Winter of 2017/18, PJM projects that winter peak load will grow by approximately 7 GW,\textsuperscript{15} meaning that \textbf{PJM’s overall winter shortfall will increase by up to 20 GW if no winter-firm resources are added.\textsuperscript{16}}

Retiring coal resources are likely to be replaced largely by new or repowered natural gas plants. Through the 2017/18 Delivery Year, about 16 GW of new or repowered gas plants are expected to come online.\textsuperscript{16} Yet, absent reforms, many of these facilities will lack dual fuel capability and may be susceptible to the interruptions in gas supply described above. The replacement of retiring coal plants with new natural gas plants will increase the vulnerability of PJM’s fleet to fuel interruptions by placing additional strain on the gas infrastructure.

By 2017, the replacement of coal with gas will increase PJM gas demand by almost 2 BCF/day during cold days. Based on this increased demand, the 2014 level of overall gas demand will be reached when temperatures are 5 to 6 degrees warmer than they were on January 7. Thus, if the status quo is maintained, gas interruptions will occur much more frequently in the future. Moreover, these estimated impacts are based only on announced retirements, and do not account for the potential additional retirement of the roughly 10 GW of nuclear and coal plants that did not clear RPM in 2017/18. If these plants retire, then the increase in PJM gas demand will exceed 3 BCF/day, and fuel interruptions will occur at even higher temperatures, and thus even more frequently.\textsuperscript{17}

The result of this change in resource mix, combined with increased winter peak load projections, is that PJM’s ability to avoid load shed will deteriorate significantly over the next few years, even assuming that PJM can preserve all RPM-cleared nuclear, coal, oil, and dual-fuel

\textsuperscript{12} Id. at 10.
\textsuperscript{13} See id. at 11.
\textsuperscript{14} See id.
\textsuperscript{15} PJM Interconnection, “PJM Load Forecast Report,” January 2014, at 52.
\textsuperscript{16} Id.; PJM Interconnection, “2017/18 Base Residual Auction Results,” Table 8.
\textsuperscript{17} This does not consider the growing demand for gas for industrial, heating, and other purposes, all of which will further strain gas infrastructure on peak days.
resources that have not already announced their retirement. While PJM was able to lean on 4.7 GW of uncommitted capacity resources and reserves depletion to avoid load shed in the past winter, if similar winter conditions were to reoccur in the coming years, PJM would need to rely on several times as much uncommitted, voluntary supply to avoid load shed, making a significant loss of load event a virtual certainty. As indicated in the figure below, under January winter conditions, PJM would need to rely on 7 GW of uncommitted resources in 2014/15, 17.5 GW in 2015/16, nearly 20 GW in 2016/17, and almost 16 GW in 2017/18. These figures assume that 10 GW of uncleared nuclear and coal capacity does not retire. If those resources do retire, PJM would need to rely on nearly 25 GW of uncommitted resources to avoid load shed in 2017/18. These looming gaps in PJM’s supply portfolio are far too large to be patched over with voluntary resources and luck, as was the case last winter, or piecemeal improvements to market design.

![Projected PJM Net Shortfall Under Extreme Winter Conditions](image)

Source: The NorthBridge Group analysis for Exelon

In sum, just as Hurricane Sandy demonstrated the need to weather-harden our distribution infrastructure against extreme weather events that will inevitably recur, so too we must weather-harden our supply-side resources to maintain system reliability – not only against peak weather events, but also against the extreme cold that is a regular feature of winter across the PJM region. Indeed, approximately 80% of residential heating units across PJM depend on electricity to function (including direct electric resistance heating as well as gas, oil, and propane forced air systems). The loss of electricity during a winter freeze presents an unacceptable danger to customers’ lives and property.

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PJM’s proposed capacity market reforms will provide effective, directed incentives for investment to retain and attract capacity resources capable of providing energy whether called in the summer or the winter. Incremental improvements – while important – will be of little avail in overcoming reliability consequences of the significant change in the supply mix illustrated above. The concept behind PJM’s Capacity Performance proposal goes far in resolving this threat. Exelon recommends that the Board heed what the substantial data illustrates; namely that there is a significant and urgent reliability matter revealed by the January weather that must be addressed immediately. Exelon agrees with PJM and the Independent Market Monitor that the Capacity Performance concept can remedy the problem.

We look forward to responding to any questions regarding the attached analysis or the Supporting Comments of Calpine, Exelon and PSEG in which we participated and address the specific details of the Capacity Performance proposal.\(^\text{19}\)

Very truly yours,

\[\signature\]

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Attachment

cc: Andy L. Ott, Executive Vice President – Markets  
W. Terry Boston, President and CEO – PJM Interconnection LLC

\(^{19}\) See Supporting Comments of Calpine, Exelon and PSEG Regarding PJM’s Capacity Performance Proposal (filed Oct. 29, 2014).
Reliability Risks and Lessons Learned In The Wake Of The Polar Vortex

Provided to the PJM Board of Managers
October 31, 2014
The Polar Vortex caused extreme stress on PJM's system and exposed weakness of the current RPM capacity product

- The morning hours were a time of higher system stress despite marginally lower load than later in the day because:
  - Generator forced outages were higher
  - Imports collapsed to near zero due to conditions on neighboring systems
  - Real time prices rose considerably
  - Other RTO/ISOs experienced similar system stress and elevated price during the Polar Vortex

Peak stress occurs around 8-9 am
PJM system-wide generator unavailability reached 25% during peak stress conditions

- Generator unavailability (excluding intermittent renewables) in PJM peaked at about 48 GW in the morning of January 7th - an unavailability rate of about 25%.
- This far exceeded the more typical single digit outage rates.
- Gas resources were particularly unreliable.

**Figure 4: January 2014 Unplanned Generation Unavailable in PJM by Fuel Type**

In peak unavailability hour (morning 1/7) during period of maximum system stress, the following amounts were unavailable:
- 24.5 GW of gas (47%)
- 15 GW of coal (21%)
- 3.5 GW of oil (26%)
- 1.5 GW of nuclear (5%)
- 1.5 GW of other (36%)

Plus 1 GW of planned outages (not shown)

For an overall unavailability rate of about 25% (48 GW out of 184 GW of ICAP)

Source: PJM Interconnection, Response to Oversight Questions of U.S. House of Representatives Committee on Energy and Commerce, April 8, 2014, Figure 6
Nuclear generation is uniquely reliable under extreme weather conditions – including the recent Polar Vortex

On January 7 - the height of the Polar Vortex - 40,200 MW of forced outages.

During the Polar Vortex, the nuclear fleet operated at 95% capacity (NEI). Forbes, Polar Vortex - Nuclear Saves The Day, 1/12/2014

During the Polar Vortex, coal, natural gas and oil generator outages were high due to lack of fuel and other issues. Nuclear units have consistent availability and secure fuel supply.

Sources: Terry Boston, President and CEO PJM, MACRUC 6/22/2014, Mike Kormos, FERC Technical Conference (4/1/2014), Monitoring Analytics, SDM 2014q1.
Expected firm-fueled generator retirements are likely to exacerbate the situation

New Resource composition (estimated):
- ~9.5 GW of natural gas projected by PJM through 2016/17, plus
- ~6 GW of new gas and gas repowering cleared in 2017/18 RPM auction

Retiring Resource composition (estimated)
- ~13 GW of capacity with on-site fuel projected to retire by PJM through 2016/17 (10 GW coal, 3 GW oil/dual-fuel)
- ~10 GW of generation with on-site fuel not cleared in 2017/18 RPM auction that has not yet announced retirement, including 4.3 GW of nuclear and 6 GW of coal (in ICAP terms)

- Going forward, PJM projects a cumulative net reduction in generation capacity of about 3.5 GW through 2016/17
- However, the potential reduction in winter reliability is much greater than this:
  - Essentially 100% of the new capacity is gas that largely appears to lack dual-fuel capability. On winter peak days the marginal unavailability of this capacity is likely to be close to 100% without supporting gas infrastructure investments
  - Roughly 10 GW of nuclear and coal capacity that has not yet announced retirement did not clear in the 2017/18 RPM auction and could potentially retire as early as late 2014.
PJM was forced to rely on about 4.7 GW of uncommitted resources and reserves to avoid load shed during peak stress

- In total, PJM was forced to rely on a combination of voluntary resources (demand response and emergency energy imports), intermittent resource luck (excess wind), and risky operations (operating with a reserve shortfall) in order to meet demand during the hour of peak stress on January 7th.
- Without this supply, PJM would have exhausted its primary reserve, and a voltage reduction would not have been sufficient to avoid load shed.
- While PJM was fortunate in this case, reliance on non-firm resources to meet peak demand is not good planning practice.

PJM Reliance on Uncommitted Resources and Reserves to Maintain Reliability During the Polar Vortex (Jan 7th, 8-9 am)

- Emergency Energy Imports
- Voluntary Demand Response Deployments
- Excess Wind Generation
- Primary Reserve Shortfall
- Total Non-RPM Resources Used to Maintain Reliability During Peak Stress
The 4.7 GW winter resource shortfall will expand to about 25 GW by 2017/18 if additional steps are not taken

- The combination of about 6 GW of load growth and a net reduction of about 9 GW of generation capacity under winter extreme conditions added onto the observed deficiency of just under 5 GW leads to a shortfall of just under 20 GW by 2016/17 with just scheduled retirements. Retirement of unneeded capacity could push the 2016/17 shortfall to 23 GW.

- Although pseudo-tie imports and increased annual DR alleviates some of the shortfall in 2017/18, this is more than offset by about 9 GW of nuclear and coal that did not clear the RPM and could retire.

- Going forward, a sound reliability plan must address this shortfall in the coming winters.

### Projected PJM Net Shortfall Under Extreme Winter Conditions

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