Electric System Reliability and EPA's Clean Power Plan: The Case of PJM

Analysis Group

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Acknowledgments

This report provides an assessment of various reliability issues facing the PJM Regional Transmission Organization, as it looks ahead to implementation of the Clean Power Plan, proposed by the U.S. Environmental Protection Agency on June 2, 2014.

This report is the second in a series of reports, and supplements analyses we presented in our first report (February 2015) on EPA's Clean Power Plan. In that report, we assessed the readiness of the nation to ensure a reliable electric system while moving to reduce carbon pollution from existing power plants.

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Executive Summary

This report reviews electric reliability issues in the multi-state region where the grid operator is the PJM Interconnection ("PJM"), and supplements analyses we presented in our February 2015 report on the Environmental Protection Agency's ("EPA") Clean Power Plan.[1] In that report, we assessed the readiness of the nation to ensure a reliable electric system while moving to reduce carbon pollution from existing power plants. Looking across the nation as a whole, we found that there is a compelling case that carbon pollution can be controlled at existing power plants without adversely affecting electric system reliability.

Here we focus on PJM. PJM is an interesting case to analyze for a number of reasons:

- It is the largest competitive wholesale electricity market region in the U.S., touching 13 states and the District of Columbia.
- It is an integrated power system that faces complicated compliance issues due to: the sheer size and economic diversity of the region (extending from Chicago to the East Coast); the number of states; the mix of industry players that will be involved in Clean Power Plan planning and compliance; and perhaps most importantly, the region's heavy reliance on coal-fired power plants.
- It is actively engaged with states and others to examine how controlling carbon pollution might impact the region's electric system.
- And it has six years of experience operating an electric system where some (but not all) of the PJM states participate in a multi-state carbon-reduction program: the Regional Greenhouse Gas Initiative ("RGGI").

Our review concludes that:

- ***PJM is already adapting to changes underway in the electric industry, and doing so successfully from a reliability point of view.*** As a region with electric capacity totaling approximately 200 gigawatts ("GW"), PJM has seen some 12.5 GW of mostly aging, coal-fired resources retire during the 2010-2014 period, due largely to economic and regulatory factors. Another 7.6 GW is expected to be retired over the next 3-4

[1] Susan Tierney, Paul Hibbard, and Craig Aubuchon, "Electric System Reliability and EPA's Clean Power Plan: Tools and Practices," Analysis Group, February 19, 2015. http://www.analysisgroup.com/article.aspx?id=15856.

years. These plants are being replaced with new resources – primarily natural gas-fired and wind projects – and there is a deep queue of additional new proposed projects in line to meet future needs. PJM has effectively administered processes to manage this transition in a way that meets both reliability and efficiency objectives.

- ***PJM's analysis of compliance options demonstrates that regional, market-based approaches can meet Clean Power Plan goals across PJM states at lowest cost, with retirements likely spread out over a number of years.*** PJM's recent modeling, performed at the request of the Organization of PJM States ("OPSI"), evaluates a wide array of potential compliance approaches and identifies capacity at risk of retirement. In addition to stressing the benefits of a flexible and collaborative approach, the results indicate that expansion of energy efficiency and renewable resources can reduce the quantity of existing coal-fired units at risk of retirement. Also important, PJM's analysis only reflects adding capacity from proposed projects already in PJM's interconnection queue (totaling 14.5 GW); the total quantity of new projects is likely to be much higher over the full time frame of Clean Power Plan implementation.

- ***PJM and the PJM states have extensive authorities and experience with administrative mechanisms to address – and successfully resolve – potential reliability violations associated with the retirement of power plants.*** These mechanisms include extending unit operations through "reliability must run" contracts, accelerated procurements of demand and supply resources, temporary waivers of regulatory requirements if or when reliability is an issue, and fast-tracking resource siting and permitting when needed to meet short-run reliability challenges.

- ***PJM has demonstrated success with reliability challenges in the past, including retirements related to low natural gas prices and the Mercury Air Toxics Standard ("MATS"), and stresses on the fleet during the winter 2014 Polar Vortex.*** In the case of the Polar Vortex, some stakeholders have claimed that operating conditions during early 2014 prove that the Clean Power Plan could be a threat to reliability. In fact, for PJM, the Polar Vortex is a case study of how numerous planning, operational, and market tools can be (and are) deployed to ensure reliability in response to unexpected events. Moreover, during the more recent harsh 2015 winter when new record-breaking peak loads occurred, we note that PJM's "reliability tool kit" has functioned nicely and possibly even improved over the past year.

- ***Given the robustness of existing reliability tools and the flexibility in the Clean Power Plan, we are not convinced that a Reliability Safety Valve, as proposed by PJM, is either needed or practically workable.*** If EPA wishes, however, to include some sort of reliability "back stop" mechanism in the final carbon rule, we think EPA should design it in a way that creates appropriate incentives for reliance upon normal reliability tools and thus makes it unlikely that a waiver will need to be called upon.

- To avoid unintended consequences, any such back-stop reliability waiver/ mechanism should be accompanied with a requirement to offset any emissions associated with implementation of the reliability mechanism.
- More specifically, the design of any such reliability mechanism should ensure that any requested waiver is approved only if it is:
  - Appropriate: The need for the waiver is demonstrated through standard industry tools, and alternatives are comprehensively reviewed;
  - Transparent: Compliance waiver requests are evaluated through public processes with stakeholder input;
  - Equitable: The waiver mechanism should not create advantages to asset owners, and should apply equally across asset owners and across states;
  - Equivalent: A waiver request and/or approval should include compensatory actions to ensure the cumulative carbon-pollution reductions through 2030 are maintained; and
  - Cost-Effective: Mitigation solutions should receive full credit for the value of incremental and/or avoided carbon pollution.

- **PJM is well positioned to lower carbon pollution from existing power plants while relying on the reliability tools and operating procedures it uses with great success.**

This paper is designed to:

- Put a spotlight on the PJM region, by describing the characteristics of its power plant mix, its reliance on coal-fired generating units, and the evolving conditions on the system as some units retire and other resources enter the market.
- Provide context on how PJM routinely navigates changing system conditions.
- Summarize the results of PJM's analyses of the impacts of alternative Clean Power Plan approaches on the PJM system, along with PJM's request to EPA that it include a Reliability Safety Valve provision as part of the final rule;
- Explain the tools available to PJM to ensure reliability.
- Describe the design elements that we think are appropriate if the EPA and other stakeholders consider incorporating some kind of reliability waiver provision as part of Clean Power Plan implementation.

Overview and Background

In our February 19, 2015 report, "Electric System Reliability and EPA's Clean Power Plan: Tools and Practices," we examined concerns raised by stakeholders across the country about whether the EPA's proposed rule would jeopardize electric system reliability. Looking across the nation as a whole, we found that there is a compelling case that carbon pollution can be controlled at existing power plants without adversely affecting electric system reliability, in consideration of the following factors:

- ***Since the EPA proposed its Clean Power Plan last June, many observers have raised concerns that its implementation might jeopardize electric system reliability.*** Such warnings are common whenever there is major change in the industry and play an important role in focusing the attention of the industry on taking the steps necessary to ensure reliable electric service to Americans.

- ***Given the significant shifts already underway in the electric system, the industry would need to adjust its operational and planning practices to accommodate changes even if EPA had not proposed the Clean Power Plan.*** As always, grid operators and utilities are already looking at what adjustments to long-standing planning and operational practices may be needed to stay abreast of, understand, and adapt to such changes in the industry.

- ***The standard reliability practices that the industry and its regulators have used for decades are a strong foundation from which any reliability concerns about the Clean Power Plan will be addressed.***

- ***As proposed by EPA, the Clean Power Plan provides states and power plant owners a wide range of compliance options and operational discretion (including various market-based approaches, other means to allow emissions trading among power plants, and flexibility on deadlines to meet interim targets) that can prevent reliability issues while also reducing carbon pollution and compliance costs.*** Experience has shown that such approaches allow for seamless, reliable implementation of emissions-reduction targets.

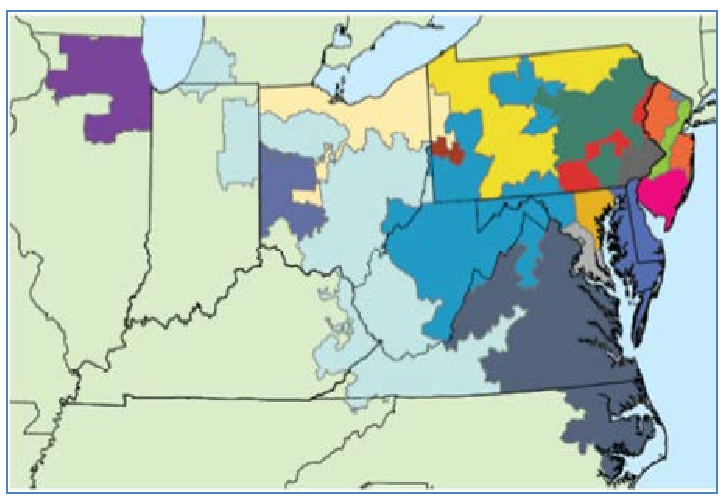
- ***Some of the reliability concerns raised by stakeholders about the Clean Power Plan presume inflexible implementation, are based on worst-case scenarios, and assume that policy makers, regulators, and market participants will stand on the sidelines until it is too late to act.*** There is no historical basis for these assumptions. Reliability issues will be solved by the dynamic interplay of actions by regulators, entities responsible for reliability, and market participants with many solutions proceeding *in parallel*.

- ***There are many capable entities focused on ensuring electric system reliability, and many things that states and others can do to maintain a reliable electric grid.*** We identify a number of actions that the Federal Energy Regulatory Commission ("FERC"), grid operators, states, and others should take to support electric system reliability as the electric industry transitions to a lower-carbon future. We summarized our recommendations for these various parties in tables in our report.

- ***In the end, the industry, its regulators and the States are responsible for ensuring electric system reliability while reducing carbon emissions from power plants as required by law. These responsibilities are compatible, and need not be in tension as long as all parties act in a timely way and use the many reliability tools at their disposal.*** We observe that, too often, commenters make assertions about reliability challenges that really end up being about cost impacts. Although costs matter in this context, we think it is important to separate reliability considerations from cost issues to avoid distracting attention from the actions necessary (and feasible) to keep the lights on.

After writing that report, we wanted to test whether there might be particular circumstances in some specific parts of the country that would cause us to reach different conclusions than the ones we reached in the national report. So, we are focusing here on such questions in one part of the country: the multi-state electric system served by PJM.

Figure 1: PJM Territory, Showing Zones



Source: PJM

As we describe further below, PJM is an interesting case study for several reasons: its significant historical dependence on coal for power generation; its large and relatively well-functioning wholesale power market made up of hundreds of participants, including power generating companies, electric delivery utilities and many others; the active role of state regulators in the region; and an interesting set of developments (e.g., asset retirements, new build proposals, long-term capacity markets, analyses of potential solutions, and so forth) underway, as the region transitions toward greater diversity in its power supply.

Looking at PJM's situation and how the players in that region are going about planning for potential responses to EPA's proposed Clean Power Plan provides a rich target for analysis and for potential lessons learned that may be helpful to others around the country. The region has recently faced reliability challenges during the Polar Vortex in January 2014, and yet continues to attract investment interest and creative problem-solving approaches. In spite of cold winter weather and record peak loads in 2015, PJM's reliability has held up nicely even as the region has seen more power plant retirements.[2] PJM has worked with its states to identify potential compliance options to be explored through system modeling analyses and collaborative discussions. And PJM has offered a point of view about how the combination of reliability tools and market mechanisms can adapt to changes being introduced by the Clean Power Plan while minimizing overall costs to ratepayers.

This paper focuses on PJM to explore: the trends underway in the region (including many changes in the electric power system); PJM's recent experience in adapting to unit retirements that have arisen as a result of market fundamentals, environmental regulations, and other factors; the results of PJM's analyses of the implications of different types of Clean Power Plan compliance approaches that might be adopted by states in the PJM footprint; and the 'reliability safety valve' idea that PJM has put forward with other regional grid operators. We also examine the broader range of reliability tools available to the industry (including PJM) at present and in the context of the proposed Clean Power Plan, and suggest principles that policy makers should take into account in considering whether a reliability 'waiver' mechanism is needed and – if so – how it should be designed.

[2] Nine out of the top ten winter peaks in PJM history occurred in January 2014 and February 2015, with the record peak load occurring on February 20, 2015 (at 143,826 MW), followed by the second highest on January 7, 2014 (142,863 MW, including demand response), and the third-highest on February 19, 2015 (at 140,860 MW). PJM, February Cold Weather Review, March 3, 2015, presentation to the March 5th, 2015, PJM Operating Committee Meeting (Item 03). http://www.pjm.com/committees-and-groups/committees/oc.aspx.

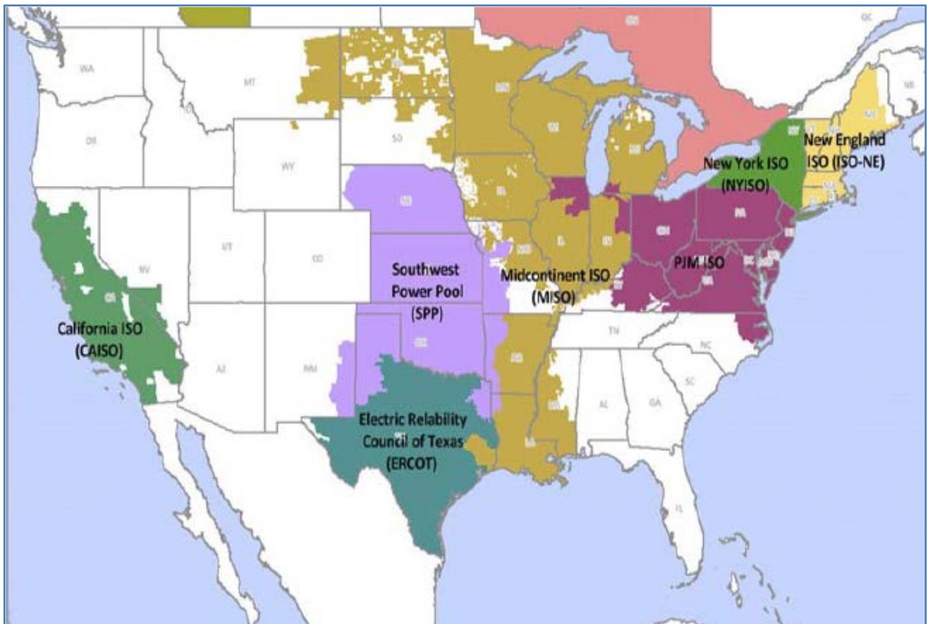
Spotlight on PJM

What is particularly interesting about the PJM context that caused us to focus on this region?

A Large, Integrated Power System

First, in terms of the size of its overall electric system, PJM is the largest of the nation's Regional Transmission Organizations ("RTOs") that administer an "organized" wholesale market (as shown in Figure 2). Although covering a smaller geographic area than the Midcontinent Independent System Operator ("MISO") and a physical area comparable in size to the Southwest Power Pool ("SPP"), PJM is the largest RTO in terms of the amount of megawatts ("MW") of generating capacity and the size (in MW) of the system's peak load.[3] An RTO covering such a large percentage of the nation's electric generating units and consumer demand creates an

Figure 2: Regional Transmission Organizations



Source: FERC

[3] Comparison of the size of the various RTOs:

Regional Transmission Organizations (2014)							
	CAISO	ERCOT	ISO-NE	MISO	NYISO	PJM	SPP
Population served	30 million (consumers)	24 million (consumers)	14.5 million (people)	42 million (people)	20 million (people)	60 million (people)	15 million (people)
Summer Peak Load (GW)	44.67	66.73	24.39	114.86	29.78	141.67	46.14
Winter Peak Load (GW)	33.19	58.37	21.37	109.61	25.74	140.47	36.43
Operating Capacity (GW)	70.09	99.43	36.06	199.71	43.51	202.42	73.05
Actual Net Energy for Load (GWh)	232,696	341,311	128,651	685,593	160,028	797,648	62,390
Source: SNL Financial for electric industry facts; population and customer information from each RTO.							

opportunity to understand the reliability implications of different Clean Power Plan approaches.

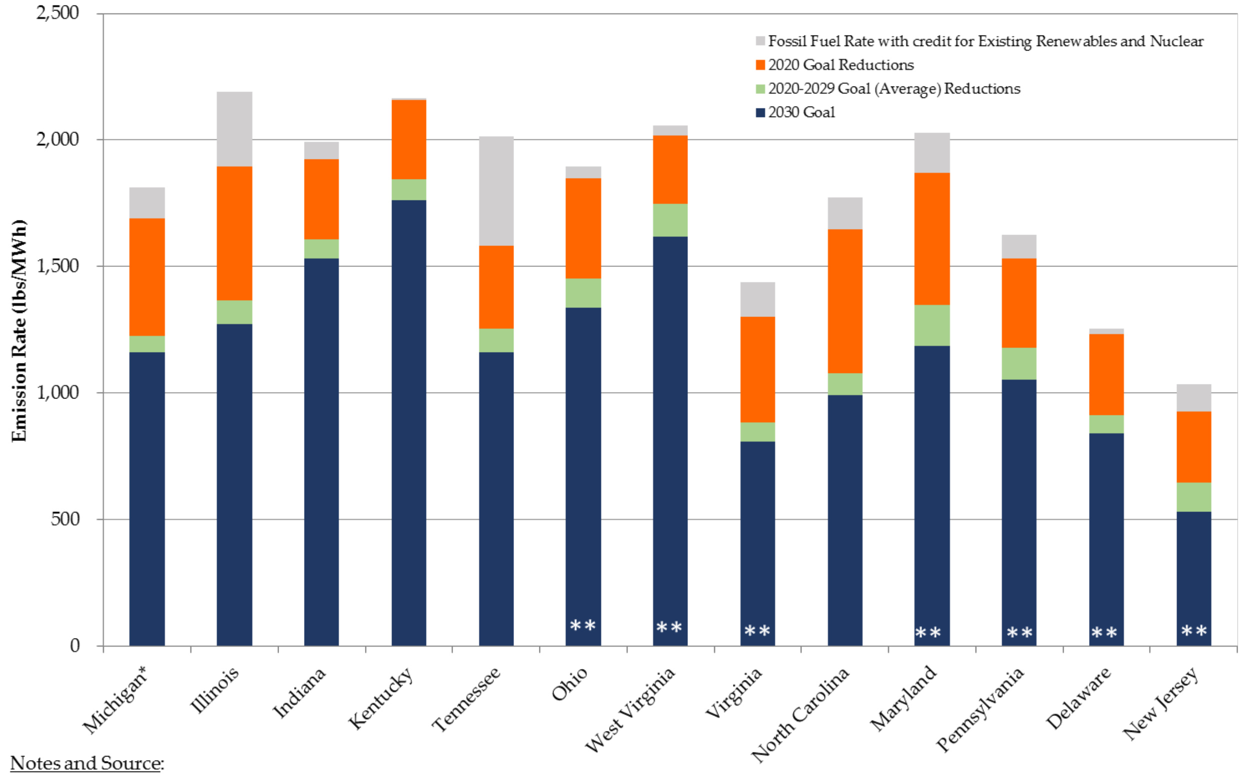
A Multi-State Footprint

Second, although not the only multi-state RTO, PJM serves a region touching 13 states plus the District of Columbia. This means that the PJM electric system operates as an integrated, rather than state-specific or single-utility system. By contrast, EPA's proposed regulatory framework under Section 111(d) of the Clean Air Act ("CAA") provides for state-specific CO_2-emission reduction targets for the 49 states that have power plants covered by the proposed regulation.[4] Of necessity, this creates a complicated set of potential compliance design options and challenges for adjoining states, and for power plant owners within those states. For one thing, the proposed emission-reduction targets vary considerably from one state to the next, and contiguous states within PJM have different emission targets (in terms of pounds of CO_2 per MWh), as shown in Figure 3, below. (In Figure 3, states are listed in terms of their approximate geographic order from west to east.) Under the EPA proposal, each state will have the option to decide whether to prepare a State Plan for its state alone or as part of a multi-state program in conjunction with one or more states. Some of the states in PJM (such as Illinois, Kentucky, Indiana, and North Carolina, for example) have generating units in that RTO as well as generating units in either another RTO or altogether outside of an RTO region.[5] In theory, the power plants participating in PJM's wholesale market could end up being covered by as many as 13 different state plans, or a single regional design coordinated across states (in the event that all 13 states adopted the same approach in their separate plans and/or in a common multi-state plan), or some different mixture of approaches.

[4] There are fossil-fuel power plants covered by the Clean Power Plan in all states/districts except for Vermont and the District of Columbia.

[5] Illinois has generating units in both PJM and MISO, as do Indiana and Michigan. Kentucky has generating units in two different RTOs (PJM and MISO), and in areas without an RTO (e.g., power plants owned by the Tennessee Valley Authority). North Carolina has generating units in PJM as well as in areas without an RTO.

Figure 3:
Proposed Carbon Pollution Reduction Levels under the Clean Power Plan:
CO_2 lbs/MWh by State
(2012 levels, 2020 Goal Reductions, 2020-2029 Goal Reductions, and 2030 Goal)



Notes and Source:
* Michigan only has nuclear and NGCC within its PJM service territory.
** States with all or the majority of their coverage in the PJM region.
The top bar indicates the 2012 fossil fuel rate, with credit for 2012 renewables and at-risk nuclear generation.
Source: EPA, Technical Support Document for the CAA Section 111(d) Emission Guidelines for Existing Power Plants, Goal Computation Technical Support Document. Docket ID No. EPA-HQ-OAR-2013-0602.

Active Involvement of State Regulators

Third, representatives from state public utilities commissions ("PUC") from states served by PJM work together through an active association – called the Organization of PJM States, Inc. – that has been in place for several years. Through OPSI, the states discuss a variety of topics of interest and relevance to the states, including wholesale market rules, transmission planning assumptions, and other things, including emerging regulatory requirements such as the Clean Power Plan. OPSI sometimes takes positions in formal regulatory proceedings (e.g., at the FERC) or in the PJM stakeholder context. This helps to make PJM an interesting case study from the perspective of a potential multi-state collaborative effort.

Significant Non-Utility Ownership of Generating Units

Fourth, most of the 1,400 power plants in PJM are owned by competitive power producers whose revenues result principally from participation in FERC-regulated wholesale markets, as opposed to operating under rate-regulation subject to decisions of a state PUC. Thus, the continued operations and actual performance of these power plants is fundamentally driven by regional power plant economics and regional electric system reliability considerations.

Of course, there are many variations in state policies affecting the cost and operations of different power plants, including state-specific land-use and taxation policies, environmental protection requirements (e.g., air-permit conditions, water-discharge regulations), cost of doing business (e.g., labor-related policies), and other factors (e.g., the willingness of a state to site new transmission facilities that affect power plant economics). Even with these variations, these plants compete with one another in a multi-state region where the terms and conditions of operations are routinely affected by state and local considerations and driven financially by federally determined wholesale market rules. This state-by-state federal jurisdictional patchwork exists today, and is an important consideration related to Clean Power Plan compliance options and costs. PJM operates the system reliably today, even with these public policies affecting the plants in the integrated system.

Deep Reliance on Coal – A Carbon-Intensive Fuel

Fifth, with PJM spanning a region in close proximity to (or on top of) Eastern and Midwestern coal-production basins, the PJM states have relied quite heavily on significant coal-fired generating capacity and generation.[6] This disproportionate dependence on the historically cheapest but most carbon-intensive fuel has alerted many observers to the potential that the PJM region could be substantially affected by the Clean Power Plan. Although PJM's overall reliance on coal for electricity generating capacity (at 40 percent) is only somewhat higher than that in the U.S. as a whole (29 percent) as of 2012, several of the PJM states have much higher percentages of their generation output in their states from coal-fired power plants. (See Table 1.) In 2012, for example, Kentucky, West Virginia, and Indiana had at least 80 percent of their in-state generation from coal-fired power plants. Given the carbon intensity of coal, this lack of fuel diversity exposes these states to potentially greater amounts of retirements, more significant fleet turnover, and changes in the system's capacity mix and system operations under the Clean Power Plan.

From 2010 through 2014, PJM saw the retirement of roughly 12,500 MW of coal-fired power plant capacity – more than any other region in terms of absolute amounts of retirements. (See Figure 4.) Given that those retirements occurred before 2015, most of them can be considered driven largely by economic factors, such as competitive pressures arising from relatively low natural gas prices, sluggish load growth, and other considerations relating to

[6] Capacity (MW) and generation (MWh) are for 2012. During 2013-2014, several regions saw coal-fired power plant retirements (PJM – 4,749 MW; NYISO - 74 MW; ISO-NE – 295 MW; and MISO – 410 MW). SNL Financial.

Percent of Generating Capacity (MW) by Fuel (2012)								
Generating Asset by Fuel Type	CAISO	ERCOT	ISO-NE	MISO	NYISO	PJM	SPP	USA
Coal	3%	20%	7%	39%	6%	40%	36%	29%
Nuclear	12%	5%	13%	7%	12%	16%	4%	9%
Natural Gas	54%	62%	45%	39%	52%	30%	43%	41%
Hydro, Wind, Biomass, Solar, Geothermal	30%	12%	13%	12%	17%	7%	15%	16%
Other	1%	0%	22%	3%	12%	6%	3%	5%
Total	100%	100%	100%	100%	100%	100%	100%	100%
Percent of Generation Output (MWh) by Fuel (2012)								
Generating Asset by Fuel Type	CAISO	ERCOT	ISO-NE	MISO	NYISO	PJM	SPP	USA
Coal	5%	31%	4%	56%	3%	44%	60%	38%
Nuclear	23%	11%	32%	14%	29%	33%	6%	19%
Natural Gas	48%	50%	55%	23%	45%	18%	25%	30%
Hydro, Wind, Biomass, Solar, Geothermal	23%	8%	9%	6%	21%	3%	9%	11%
Other	0%	0%	1%	1%	2%	1%	0%	1%
Total	100%	100%	100%	100%	100%	100%	100%	100%
Source: SNL Financial								

the relative inefficiencies of smaller, older coal-fired generating units.[7] Owners of an additional 7,461 MW of coal-fired capacity in PJM have announced their intention to retire them in 2015 and 2016, likely in response to the combination of those same factors as well as incremental investment requirements that would otherwise have been needed to bring aged coal-plant capacity into compliance with the Mercury and Air Toxics Standard.[8]

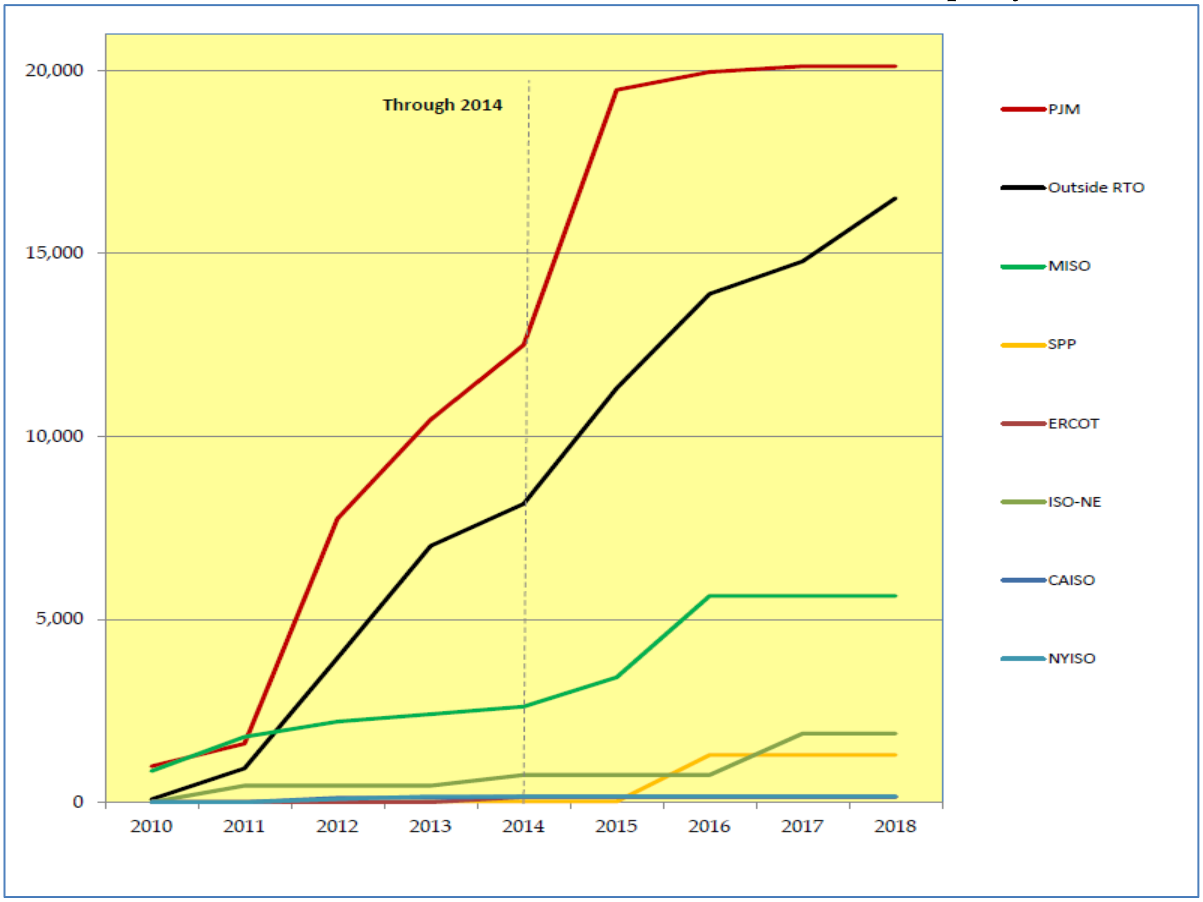
Table 1
Percent of Generation by Fuel (2012): US, PJM and the States in PJM
(Ranked by Dependence on Coal as a Share of Total Generation)

	Coal	Nuclear	Natural Gas	Hydro, Wind, Biomass, Solar, Geothermal	Other
West Virginia	96%	0%	0%	4%	0%
Kentucky	94%	0%	3%	3%	0%
Indiana	82%	0%	12%	4%	3%
Ohio	67%	13%	17%	2%	0%
Michigan	47%	25%	21%	6%	0%
Tennessee	45%	32%	10%	12%	0%
PJM	44%	33%	18%	3%	1%
North Carolina	44%	34%	17%	5%	0%
Maryland	44%	36%	5%	7%	8%
Illinois	41%	49%	6%	4%	0%
Pennsylvania	39%	33%	24%	4%	0%
USA	38%	19%	30%	11%	1%
Virginia	17%	38%	33%	11%	1%
Delaware	17%	0%	79%	1%	3%
New Jersey	4%	50%	41%	3%	1%
District of Columbia	0%	0%	87%	0%	13%
Source: SNL Financial					

[7] More than two-thirds (or 7,754 MW out of 12,500 MW) that had retired in the PJM region by October 2014 had retired during the 2010-2012, the period when natural gas prices were dropping significantly in relation to coal prices. See: Susan Tierney, "Why Coal Plants Retire: Power Market Fundamentals as of 2012," March 2012.

[8] These statistics are from SNL Financial for the PJM region.

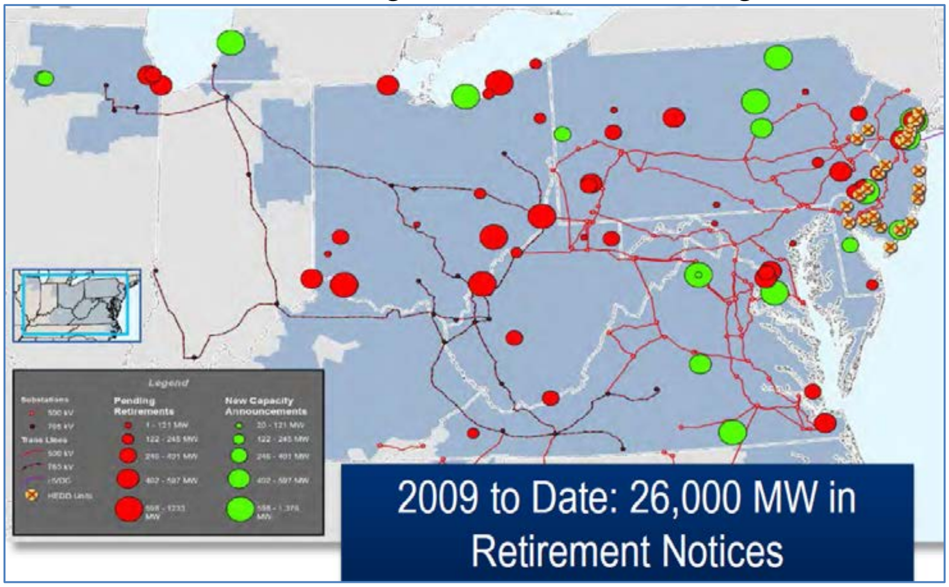
Figure 4:
Retirements of Coal-Fired Generating Capacity by RTO:
2010-2014 (Actual) & 2015-2018 (Announced) - Cumulative MW of Capacity Since 2010



An Evolving Resource Mix

In parallel with these coal-plant retirements, the PJM region has also experienced a large quantity of proposals to construct new gas-fired and other generating capacity additions. There have also been many proposals to repower (or fuel-switch) existing coal-fired facilities with natural gas. (See Figure 5.)

Figure 5
PJM: Fuel Switching in the Overall Generating Fleet



Source: PJM, Evolution of Supply: Managing the Evolving Fuel Mix in Markets and Operations, February 2015.

Intersecting with these trends are the results of PJM's long-term capacity auctions, which identify the capacity resources that are cleared to receive capacity payments (and capacity obligations) in future years. The effects of economic pressure on coal plants started to show up in the 2011 results of PJM's Base Residual Auction ("BRA"), for capacity in service in the years 2014/2015 and beyond. For the BRA for the year 2015/2016 (completed in 2012), generators received specific guidance that they should include the costs of environmental regulations (including MATS compliance) in their capacity offers. Figure 6 shows the changing set of resources (including gas-fired generators, renewable resources, and demand-side resources) that has cleared the future capacity auctions in PJM.

There have also been other economic pressures on PJM's generating fleet: For example, PJM has more nuclear generating capacity than any other RTO.[9] Taking both coal-fired and nuclear capacity into account, PJM relies more on these traditionally base-loaded technology/fuel types and less on natural gas capacity than any other region of the country.[10] Some of these nuclear plants have also been experiencing price pressures, and several units

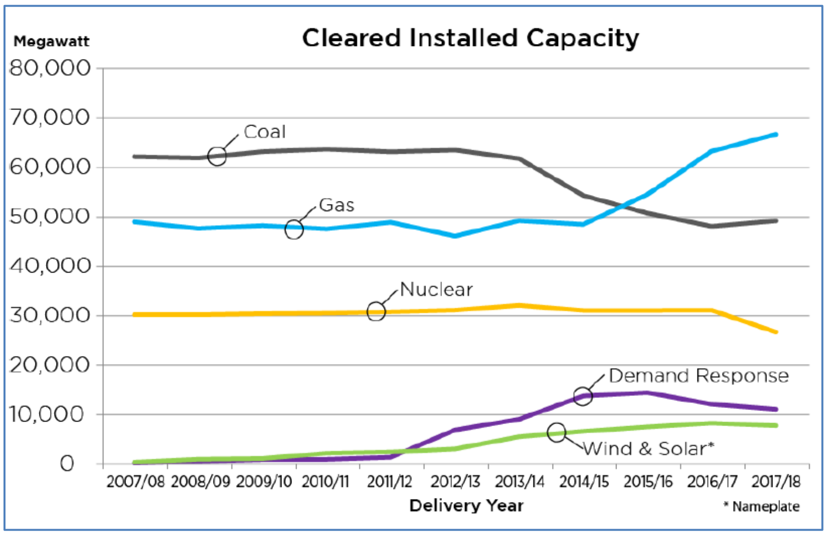
[9] See footnote 7, above.

[10] See footnote 7, above.

did not clear in PJM's most-recent capacity auction (held in the summer of 2014) for the one-year period from June 2017 to May 2018.[11]

Like other regions, PJM also has seen growth in renewable energy projects and demand-side resources participating in the wholesale (and retail) markets. Most reliability concerns tied to the Clean Power Plan (and to the economic and other factors in play) focus on the potential reliability impacts of these ongoing changes in PJM's resource mix, with many units retiring at the same time that many new assets come on line.

Figure 6



Source: PJM, Evolution of Supply: Managing the Evolving Fuel Mix in Markets and Operations, February 2015.

But recent history demonstrates that it is overly simplistic to conclude that a lower-carbon electric system leads to unreliable operations. Market structure, operational practices and other factors can maintain reliability during periods of change. For example, when PJM experienced unexpected reliability challenges last winter during the "Polar Vortex" (in January 2014) and during this past winter's harsh weather conditions (in January and February 2015), reliable service was maintained. This occurred even though PJM hit new record-breaking winter-time peak demand, and in 2014 did so with 22 percent of its generating capacity (including coal, nuclear and natural-gas capacity) being unavailable.[12] PJM has observed that "[a]lthough operational conditions were tight during the Polar Vortex, some variables exceeded PJM's expectations in real-time: the availability and response of

[11] See, for example, Comments of the Pennsylvania Public Utility Commission, filed December 1, 2014, EPA-HQ-OAR-2013-0602, page 53. Exelon has said that its Quad Cities and Byron nuclear plants in Illinois and its Oyster Creek nuclear plant in New Jersey are not obtaining sufficient revenues in PJM's markets to remain open in future years. http://www.nei.org/News-Media/News/News-Archives/Exelon-on-the-2014-PJM-Capacity-Market-Auction.

[12] PJM, "Analysis of Operational Events and Market Impacts During the January 2014 Cold Weather Events," May 8, 2014, page 4.

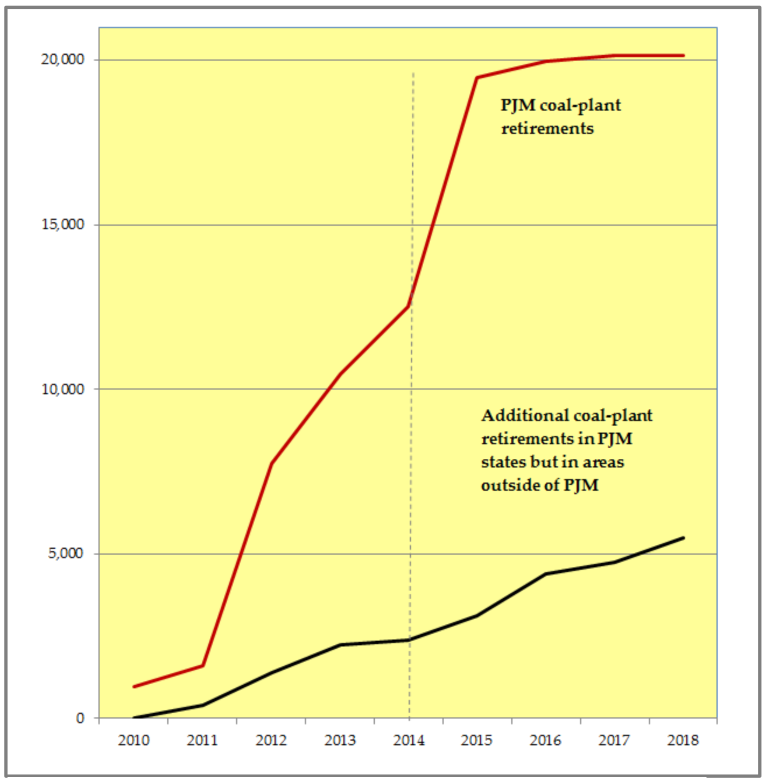
voluntary demand response, the response of the stakeholders to the public appeal for conservation, and the performance of wind-powered generation."[13]

Many Seams with Neighboring Electrical Areas

PJM also provides an interesting case study because it has lots of boundaries with other RTOs and non-RTO regions, thus creating some potentially challenging issues associated with "seams" in the context of Clean Power Plan implementation and electric system reliability. There are several factors that complicate the seams issues: (a) that the PJM states have differing CO_2 emissions rates and targets (Figure 3) due to the different carbon-intensities of their generation mixes (reflected in Table 1); and (b) that the borders of PJM's territory do not match up with states' own borders (Figure 1) and vice versa. These factors mean that individual PJM states will have to consider whether to develop State Plans with different approaches for their power plants in PJM and for their other power plants, and PJM will have to incorporate reliability practices (and potentially other actions) to accommodate different conditions at the boundaries of its system with neighboring systems.

Note that in the states where some but not all of the in-state generating units are in PJM, there have been other coal-plant retirements in addition to the amounts previously identified for PJM as a whole. These other retirements (shown in Figure 7) affect the character of the overall fleets in the PJM states and how those states will plan to comply with the Clean Power Plan while also assuring reliability.

Figure 7
Retirements in PJM states:
Retirements Inside Versus Outside of PJM
(Actual (2010-2014) and Announced (2015-2018)
(Cumulative MW)



Source: SNL Financial

[13] PJM Interconnection, "Analysis of Operational Events and Market Impacts During the January 2014 Cold Weather Events," May 8, 2014, page 20.

Experience Implementing the Regional Greenhouse Gas Initiative

In 2009, ten Northeastern/Mid-Atlantic states began RGGI, the country's first market-based program to reduce carbon pollution from power plants. At that time, three states in PJM (Delaware, Maryland and New Jersey) were members of RGGI, along with New York and the six New England states. (New Jersey withdrew from the program in 2011.) The owners of power plants in the RGGI states must purchase CO_2 allowances equivalent to their emissions, with the total amount of allowances capped at a level that is declining over time.

RGGI touches three RTO regions (PJM, NYISO and ISO-NE), with only some of the PJM states participating in the program. Before RGGI implementation began in 2011, many parties (including the grid operators themselves) debated whether there would be reliability problems associated with dispatching a system where some power plants (e.g., fossil generators in the RGGI states) faced a carbon price but others (non-fossil plants in the RGGI states and all plants in the portions of PJM not covered by RGGI) did not.

In practice, however, RGGI was implemented seamlessly from the very beginning, and without any reliability problems.[14] And over this time period, these PJM states that participate in RGGI have successfully handled coal-fired deactivations at the same rate than the non-RGGI states.

Recent Experience with Reliability Challenges Associated with MATS Compliance

Given the significant amount of coal-fired generating capacity in the PJM footprint, the price pressure from natural gas, and a timeline for compliance with MATS rule starting in April 2105, PJM has had an active role in assuring reliable outcomes of the transitions already underway (and described above).

Notably, leading up to the EPA's announcement of the final MATS rule at the end of 2011, there was significant debate in the industry regarding the electric-system reliability implications associated with the timing of MATS compliance, and the manner in which the CAA required the MATS program to limit emissions at affected generating stations without much flexibility in implementation approaches. Reliability concerns focused on the fact that such a large portion of the nation's generating fleet would be affected, and on whether the systems in which those plants were located could respond appropriately (and reliably) given

[14] Paul Hibbard, Susan Tierney, Andrea Okie, Pavel Darling, "The Economic Impacts of the Regional Greenhouse Gas Initiative on Ten Northeast and Mid-Atlantic States: Review of the Use of RGGI Auction Proceeds from the First Three-Year Compliance Period," November 22, 2011.

those regions' heavy reliance on coal-fired generation. PJM, along with the other RTOs, urged the EPA to incorporate a 'reliability safety valve' into the regulatory compliance framework.[15]

To address such concerns, EPA's December 2011 regulatory package related to MATS included a specific statement of enforcement policy to explain that, "…where there is a conflict between timely compliance with a particular requirement and electric reliability, the EPA intends to carefully exercise its authorities to ensure compliance with environmental standards while addressing genuine risks to reliability in a manner that protects public health and welfare."[16] To provide the electric industry and its regulators greater assurance of the agency's intention to support reliable electricity supply while also reducing toxic air emissions, the EPA incorporated into the MATS rule a reliability safety valve, allowing the owners of particular generating units an opportunity to request a one-year extension in the compliance time lines if the unit could not meet the deadlines in EPA's regulations and the unit was needed for electric system reliability.[17]

Since EPA issued that guidance, affected power plant owners in PJM and elsewhere have been taking steps either to bring their generating units into compliance or to plan for their retirements. So far, very few owners of power plants (and RTOs, in support of them) have requested a waiver for reliability purposes.[18]

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[15] See Testimony of Michael Kormos before the FERC, Reliability Technical Conference, Docket No. AD12-1-000. http://www.ferc.gov/CalendarFiles/20111208072454-Kormos,%20PJM.pdf.

[16] EPA December 2011 MATS Enforcement Response Policy. http://www2.epa.gov/enforcement/enforcement-response-policy-mercury-and-air-toxics-standard-mats

[17] The extra year potentially available under the MATS "reliability safety valve" would be in addition to an extra year available to companies making good-faith efforts to comply but needing additional time beyond the April 2015 deadline. Note that MATS includes a 3-year compliance period, with an extension of the compliance deadline for a 4th year for units able to demonstrate to state permitting authorities that additional year is needed for installing technology. In some cases a 5th year may be allowed, in light of EPA's intention to allow use of administrative orders "…with respect to sources that must operate in noncompliance with the MATS for up to a year to address a specific and documented [electric] reliability concern." EPA December 2011 MATS Enforcement Policy Letter. This would extend MATS compliance deadlines from April 2015 to April 2016 for certain units.

[18] On December 24, 2014, PJM made two filings (Docket Nos. ER15-738-000 and ER15739-000) with the FERC requesting a waiver to retain approximately 2,000 MW of capacity that was scheduled for release (i.e., allowed to retire and thus withdraw from future capacity obligations) in its Third Incremental Auction for the 2015/16 delivery year. PJM sought to maintain this capacity, in part, due to concerns over expected retirements related to the MATS rule and the uncertainty of demand response pending judicial review of FERC Order 745. (Federal Energy Regulatory Commission v. Electric Power Supply Association, before the Supreme Court of the U.S.) PJM also proposed changes to its Tariff, allowing it to recover the costs of any capacity agreements secured outside of its capacity auction. The FERC noted that these contracts differed from current reliability must-run agreements, which are intended to address transmission reliability issues and not resource adequacy issues. On February 20, 2015, the FERC accepted PJM's waiver request and denied the request for Tariff revisions. PJM has since stated

Reliability and Other Implications of the Clean Power Plan in PJM

With all of this in mind, we decided to look at the prospects for how a large, multi-state and highly coal-dependent region like PJM might fare, from a reliability point of view, when implementing the Clean Power Plan in the areas (states) where PJM administers the market.

PJM's Analysis of Clean Power Plan Impacts

PJM and its stakeholders have already been examining potential answers to that and other questions.[19] Of course, PJM has had experience in addressing reliability risks associated with the changes already underway in its system. PJM's typical stakeholder processes (relating to transmission planning and market efficiency, for example) have examined many "what if" questions associated with policy-driven and market-driven changes underway.

Over the past half year, PJM has undertaken a set of analyses of the potential impacts of the Clean Power Plan at the request of OPSI in September 2014. The OPSI Board asked PJM to carry out modeling of future conditions on the system under a variety of assumptions and cases. Starting with a case intended to portray 'business as usual' for 2020, 2025, and 2029 in the absence of the Clean Power Plan, OPSI asked PJM to model other scenarios reflecting a common region-wide compliance approach versus a state-by-state approach, as well as other assumptions about PJM's resource mix and load.[20]

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that it will not re-file its Tariff revision, noting that it expects additional capacity from 2016/17 units that are anticipated to be online earlier than expected and the extension of a large generator slated for deactivation in 2015/16.

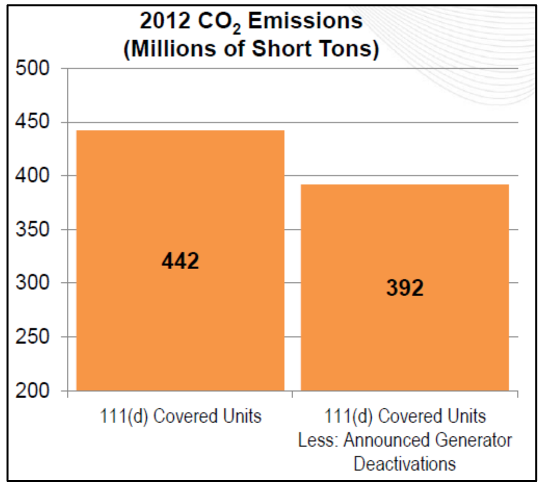
[19] PJM released its final economic analysis of the EPA Clean Power Plan on March 2, 2015 ("PJM Interconnection Economic Analysis of the EPA Clean Power Plan Proposal, March 2, 2015," hereafter "Economic Analysis"). During its assessment, PJM shared its preliminary modeling results with stakeholders on an ongoing basis. See, for example, PJM's November 11-2014 presentations to its Members Committee on the analyses it had underway on the carbon rules (see Item 03). Later updates included: Paul Sotkiewicz and Muhsin Abdur-Rahman, "EPA's Clean Power Plan Proposal: Review of PJM Analyses Preliminary Results," presented to the Members Committee Webinar, November 17, 2014 (hereafter, "PJM Preliminary Analyses"); Transmission Expansion Advisory Committee, January 7, 2015 (hereafter, "PJM Transmission Committee Analyses"); Muhsin K. Abdur-Rahman and Paul Sotkiewicz. "PJM's Economic and Reliability Analysis of the EPA's Clean Power Plan (CPP)," presented to the Members Committee Webinar, January 20, 2015 (hereafter, "PJM At-Risk Analysis").

[20] September 2, 2014 letter from L. Ann McCabe, President, Organization of PJM States, Inc., to Terry Boston, CEO of PJM. http://www.pjm.com/~/media/documents/reports/20140905-opsi-data-request-for-section-111d-modeling.ashx OPSI's September 2, 2014 letter made the following modeling requests:

- "Case 1: Base Case/ Business as Usual: This case would examine outcomes assuming no 111(d) regulation. This case would use the same variable values and input assumptions as used in PJM's market efficiency analysis….
- Case 2a. PJM 111d Regional Compliance Case: Roll up the PJM state emissions targets, as proposed by EPA (and make adjustments for states at the seam based on resources only within PJM). This case would result in a single price across PJM for CO_2 emissions. …PJM would take as given the energy

PJM noted early on that "[s]ustained low natural gas prices combined with sluggish load growth exert economic pressure on less efficient coal units to retire independent of 111(d) policy. PJM-announced deactivations mitigate impacts of 2020 emissions target and provide some margin for output increases consistent with load growth."[21] These actual and announced unit retirements mean that the states in PJM already will have made progress toward meeting the emission reductions targets since the base year of 2012, as shown in Figure 8.

Figure 8:
CO_2 Emissions from Power Plants in PJM (taking into account retirements)



Source: PJM Preliminary Analyses

PJM released its first economic modeling results in mid-November, 2014, later updated these results in January 2015 to quantify the total amount of capacity at risk under different scenarios, and released its final economic assessment in March 2015. As part of its analysis, PJM only included known existing and planned fossil resources, based on projects that have already filed in its interconnection queue. These projects represent an additional 14,470 MW of new gas-fired capacity that is ready to come online.[22] Over the full compliance period, PJM will likely experience new entry in addition to this capacity, as new projects are developed closer to a potential time of need.

efficiency targets being met…, and adding renewables to meet the known state RPS targets for each year run.

- Case 2b. PJM Regional Compliance Case Scenarios: …model the system the same as in 2a however incorporate the following assumptions:
  - Case i: only include renewables currently in the queue
  - Case ii: only model 50% of the EPA assumed energy efficiency achievement
  - Case iii: assume natural gas price 50% greater than used in Case 2a
  - Case iv: assume a 50% reduction in nuclear as compared to that used in Case 2a.
- Case 3. State by State Compliance Case: For 2020 perform regional dispatch, but each state with a compliance obligation under the EPA 111(d) proposal (12 in PJM) would be modeled with a separate CO_2 price that reflects the separate state targets assigned by USEPA."

[21] PJM Preliminary Analysis, page 12.

[22] PJM Economic Analysis, Appendix A1, page 99. Specifically, PJM included resources with a completed Interconnection Services Agreement and/or Facilities Services Agreement. PJM notes that the commercial likelihood of these projects is greater than 70 percent and 50 percent, respectively. PJM Risk-Analysis, page 20.

Across the full range of scenarios (including others beyond those requested by OPSI), PJM found that:[23]

- CO_2 prices increase and compliance costs increase as pollution-reduction targets decline over time and/or natural gas prices increase.
- The total amount of at-risk capacity increases over time; that is, not all retirements happen at once.
- Increased energy efficiency and renewable energy result in less capacity at risk for retirement, because these other resources have the effect of lowering the region-wide CO_2 price, allowing coal resources to be dispatched more frequently.
- Meeting current state renewables policies can lower CO_2 compliance costs. However, individual state-by state-compliance (as opposed to a regional plan) both increases the amount of capacity at-risk for retirement and results in higher CO_2 prices and compliance costs.
- Compared to a mass-based approach, rate-based compliance goals result in higher CO_2 prices.
- Some states (Pennsylvania, West Virginia, Kentucky and Illinois) are net exporters in the multi-state common market and, under an individual state compliance approach, may export less to other states with the result that net importing states will have to dispatch less-efficient or more-expensive in-state resources.[24]

As part of its economic analysis, PJM quantified the amount and location of capacity at risk of retirement. At risk generation is measured using the expected annual revenue requirements of existing plants relative to the cost of entry for a new gas-fired power plant, with existing plants at "very high" or "high" risk of retirement if their net revenue requirements were above the cost of new entry under a range of modeling assumptions.[25]

PJM found that "some of the units [approximately 3,500 MW] designated as at-risk in 2020 would be [even] in the absence of the policy based on continuation of existing market trends…"[26] PJM also found that most of the new gas capacity is located in the East (while most of the de-activation requests were in the western part of PJM, as shown in Figure 5), resulting in east to west power flows. Because most of the at-risk resources are outside of the

[23] See broadly, PJM Economic Analysis, pages 6 – 7.

[24] PJM At-Risk Analysis, page 8.

[25] PJM At-Risk Analysis, page 113. In its final Economic Analysis (page 93), PJM focused on generators that fail to meet 0.5 x net Cost of New Entry ("CONE") criterion across: 1) all scenarios, 2) 50% of scenarios, 3) Worst Case Scenarios, 4) High Renewable/EE Scenarios, and 5) Low Renewable/EE Scenarios.

[26] PJM Transmission Committee Analyses, page 40.

"gas rich areas," congestion revenues could increase to existing steam resources, mitigating some retirement risk.[27]

PJM is now conducting a set of follow-on reliability analyses, using the detailed location information of at-risk generation in a set of generator and load deliverability tests.

PJM's Request for a Clean Power Plan Safety Valve

As part of the group known as the ISO/RTO Council, PJM joined with other RTOs in submitting comments to the EPA on the proposed Clean Power Plan in December 2014.[28] These comments included four recommendations, one of which was for EPA to include a Reliability Safety Valve ("RSV") provision in its final rules:

> The RSV process, through a petition to EPA, should be available to identify and respond to state, multi-state, and/or regional reliability issues that: (1) are unforeseen; (2) arise during implementation of approved State Plans; (3) are fully identified; (4) have been independently verified by ISOs/RTOs in market areas and the NERC-registered entities responsible for reliability in the state and/or region, *e.g.*, reliability coordinator, planning coordinator, etc., with independent review by NERC or the Regional Entity in non-market areas; and (4) cannot be addressed through a State Plan modification that would allow the state to return to compliance with its existing, approved compliance schedule and/or State Plan goals or performance expectations.[29]

Clearly, this recommendation does not only reflect these grid operators' laudable focus on having adequate tools to assure reliable electric service; it also seems to build off of their prior request to EPA that its MATS rule incorporate a safety valve. As we note above, the final MATS rule did provide for a longer compliance timeline for plants needed to remain in service (e.g., prior to retirement, or during an outage period for installation of pollution-control measures) for reliability purposes.

PJM officials have expressed confidence that its market will be able to adapt to the requirements of the future carbon rule.[30] But they have also raised questions about reliability

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[27] PJM Transmission Committee Analyses, page 65.

[28] Comments of the ISO/RTO Council, December 1, 2014, EPA-HQ-OAR-2013-0602.

[29] Comments of the ISO/RTO Council, December 1, 2014, EPA-HQ-OAR-2013-0602, page 16.

[30] Statement of Michael J. Kormos, Executive Vice President – Operations, PJM Interconnection, before the Federal Energy Regulatory Commission, Technical Conference on Environmental Regulations and Electric Reliability, Wholesale Electricity Markets, and Energy Infrastructure, Docket No. AD15-4-000, February 19, 2015:

concerns in the event that the individual PJM states adopt a wide variety of approaches in their State Plans:

> Clearly if there were an explicit price on carbon dioxide or another regional parameter that would be reflected in the dispatch, the market can produce efficient results inclusive of that constraint. …. The more problematic issue arises if individual states adapt different compliance approaches which lead to different implicit carbon dioxide prices either at the state or by individual generating unit. That being said, individual states could effectuate their plans by placing state-directed run-time limitations on individual units just as they do today for Title V air permits or local ozone and NO_x rules in non-attainment areas. These limitations to individual units within a state would be respected in the dispatch but potentially would lead to a less optimal result than if all plants were subject to a uniform constraint.
>
> Furthermore, there would need to be a reliability safety valve that would provide for the ability to violate these constraints if an RTO found itself in a situation where the unit was need for reliability but did not have any "run-time" left.

In a nutshell, the market is a tool which can be utilized to ensure efficient competitive outcomes in response to a particular set of state or federal policies. The markets do not drive policy outcomes but have proven resilient enough to respond to different policy initiatives. In that sense, they have proven successful in producing a diverse and competitively priced set of resources that are compliant with that policy. Whether it is the Sulfur Dioxide Trading Program of the 1990's, the MATS rule or individual state RPS initiatives, the markets have been able to send the appropriate price signals that produce competitive outcomes.

In some ways, the Clean Power Plan can be seen as another policy choice to which the markets will react. Just as with the MATS rule and state RPS rules, the EPA Clean Power Plan will adjust the type of resources that bid into the market but will not require wholesale market redesign. In this way, the markets provide an important role in revealing the least cost compliance options while also facilitating innovation by allowing new ideas to be tested and monetized if successful (or replaced if unsuccessful).

The markets are also able to quickly internalize the costs of compliance and respond to any implicit or explicit price on carbon dioxide emissions. Whether a cap and trade system is developed on a regional basis or units simply have to bid their individual compliance costs, the market provides a sorting function that allows the least cost solutions to emerge. Finally, the market provides a source of transparency, independence and neutrality in revealing the true cost of compliance. By providing the sort function referenced above, the market reveals the least cost compliance plan that is consistent with the Clean Power Plan and all reliability requirements. For all these reasons, the markets that this Commission has helped craft since at least the inception of RTOs, represents a valuable tool that can absorb and respond to the changes brought about by the Clean Power Plan without any wholesale revisions needed.

> Absent an explicit price, it is unclear how an RTO would be able to allocate available run hours of units to when they are needed most.[31]

We support this concern for ensuring reliable electricity service as part of the transition to an electric system with lower carbon emissions. But we think that PJM's position that a reliability safety valve is needed reflects a view that the Clean Power Plan needs to be – or will be – implemented in inflexible ways. Using Section 111(d) of the Clean Air Act, the EPA's proposal offers a much-wider and more flexible set of approaches than was possible in other recent air regulation programs, like MATS.[32]

We have described this flexibility in our prior report on reliability and the Clean Power Plan,[33] and simply note here that each state will have flexibility to propose its preferred actions that accomplish the targeted reductions. If a state has concerns about the reliability implications of potential temporary or permanent outages of units needed to respond to EPA guidance, the state can take that fact explicitly into account as it designs its State Plan. Additionally, grid operators (like PJM) have extremely strong and standard reliability practices that the industry and its regulators have used for decades. These are a strong foundation from which any reliability concerns about the Clean Power Plan will be addressed.

Addressing Reliability Issues: Existing Approaches and Tools

How will such practices enable PJM to support reliability through the implementation period of the Clean Power Plan? Given the significant changes underway in that region, with its recent and upcoming announced unit retirements and additional potential generating units

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[31] Statement of Michael J. Kormos, Executive Vice President – Operations, PJM Interconnection, before the Federal Energy Regulatory Commission, Technical Conference on Environmental Regulations and Electric Reliability, Wholesale Electricity Markets, and Energy Infrastructure, Docket No. AD15-4-000, February 19, 2015.

[32] "In the recent MATS rule, for example, EPA set uniform national standards to reduce emissions from different categories of existing coal- and oil-fired power plants. No trading or averaging is allowed across different generating stations. There is no possibility of purchasing credits resulting from over-compliance at other sources, or to credit emissions reductions resulting from end-use efficiency or zero-carbon energy sources. By contrast with MATS, Section 111(d) inherently allows greater opportunities for different pathways to compliance." Susan Tierney, Greenhouse Gas Emission Reductions From Existing Power Plants Under Section 111(d) of the Clean Air Act: Options to Ensure Electric System Reliability," May 8, 2014, pages 16-17.

[33] AG 2015 Report on Reliability and the Clean Power Plan.

that might be "at risk," how well is PJM positioned through its current planning, market, and operational processes to address the need to ensure a reliable transition?

PJM in the Context of the Electric Industry's Standard Reliability Tools

In our earlier Report,[34] we described the wide range of planning and operational tools used by system operators, regulators, and other entities to maintain power system reliability. These tools are well-established, but (as always) grid operators and utilities are already looking at what adjustments to long-standing planning and operational practices may be needed to stay abreast of, understand, and adapt to changes underway in the industry. Given the significant shifts already underway in the electric system, the industry would need to adjust its operational and planning practices to accommodate changes even if EPA had not proposed the Clean Power Plan.

Our prior report also discussed the different goals of reliability planning and operations: namely, *resource adequacy* and *system security*. And we described how reliable electric system operations are preserved in many ways, with contributions from many actors from local utilities to national regulatory organizations and international reliability entities.

For the most part, changes to electric systems are gradual over time, and effective planning and market structures allow for the orderly replacement and addition of transmission and generation infrastructure (and demand-side resources) to address evolving needs. But this is not always the case. Situations arise in all regions of the country where a sudden event, or a proposed near-term change in the system, requires stepping outside of the standard planning and market procedures that are normally relied on to meet reliability needs. Examples include the sudden loss of a power plant (or transmission facility) due to a catastrophic event (e.g., when damage from a storm or equipment failure ends up taking a plant out of service due to significant damage to the facilities); or a decision by one or more asset owners to shut down facilities for economic (or other) reasons with limited notice.

This, of course, is one of the key reliability concerns associated with the Clean Power Plan that has been raised by entities with respect to PJM operations – namely, that carbon-control compliance costs could over a relatively short time cause the retirement of many power plants within the PJM footprint, including units that, if not replaced, are needed to maintain reliability. This might be the case, for example, if a unit needed to support transmission system voltage and frequency in a local area provided notice of deactivation or retirement with little advance warning. Or it could arise simply if owners of many resources in a

[34] AG 2015 Report on Reliability and the Clean Power Plan.

transmission-constrained zone or region were to decide to deactivate their assets all at approximately the same time. In either case, deactivation could lead the system to have a reliability "hole" that needs to be addressed through the additional of new generating resources and/or transmission upgrades.

The retirement of generating units that play important reliability functions has been, and always will be, a fact of life in the electric industry – one that is assumed, expected, and prepared for in numerous ways, by every system operator and state and federal regulators. It is a continuous fiduciary obligation of asset owners to evaluate the benefits and costs of continued power plant operations, and retire assets that no longer provide sufficient value to the owner. Ultimately, retirement decisions can happen on short notice, since the evaluation of asset value is based on factors that can change in unpredictable ways, and very quickly. After all, many things affect those decisions: how well the plant is operating; how its economics are affected by the relative prices of competing fuels or the need for major repairs or upgrades; how costly it might be to comply with new regulations; and so forth.

Every region – including PJM -- has shown time and again the resilience of processes in place to maintain system reliability in the face of major resource changes, and the ability of power systems to absorb and process such changes in a way that meets efficiency and reliability objectives. Generally these changes are processed in an orderly fashion; but the tools available to maintain reliable system operations in the face of short-notice retirement decisions or loss of resources extends – *when needed* – well beyond the "normal" planning and market structures that govern most outcomes.

As we noted above, the PJM region has already experienced significant amounts of unit retirements and expects to experience more over the coming decade. It is managing to integrate increasing amounts of intermittent supplies and rely upon them during extremely cold winter conditions. It is overseeing reliability as the industry responds to a much-more restrictive set of air-pollution-control mechanisms under MATS (as compared to the Clean Power Plan), and has not had to lean on the EPA's MATS reliability safety valve except rarely.[35]

[35] It is our understanding that PJM has not had to formally request a waiver from the EPA under the MATS safety valve. However, PJM recently sought and received approval from the FERC to retain additional capacity for the upcoming 2015/2016 delivery year, in part, due to concerns about MATS related retirements (see footnote 21). Similarly, PJM expressed its support to the Kentucky Department for Environmental Protection for East Kentucky Power Cooperative's request of a one-year extension of the MATS-related deactivation of the 196 MW Dale Units 3 and 4. See Michael J. Kormos, Letter to Kentucky Department for Environmental Protection, December 16, 2014. Yorktown Units 1 and 2 in Virginia also elected to stay in-service through March 31, 2016 to support transmission upgrades.

In all cases, PJM has resolved these reliability challenges using its current set of operating procedures and planning tools, including its annual Regional Transmission Expansion Planning ("RTEP") process. Figure 9 shows the total quantity of generator retirements and additions by state for the period 2010 to 2018. (States are listed in terms of their reliance on coal for electricity generation, as in Table 1.) Many reports of activity surrounding changes in power plant conditions focus primarily on the retirement side of the picture. The additions slated for 2010-2018 include plants actually added up through 2014, as well as plants under construction or in advanced development with an in-service date between 2014 and 2018. Across the PJM states, the retirements roughly equal the additions, with state-by-state variation.

Figure 9

Generator Retirements, Additions, and Reliability Planning, by State, 2010-2018

	Retirements (MW)					Additions (MW)				
State	Coal	Oil	Gas	Other	Total	Gas	Solar	Wind	Other	Total
West Virginia	2,820	-	-	-	2,820	-	-	351	2	354
Kentucky	996	-	-	-	996	214	-	-	59	273
Indiana	1,510	-	-	-	1,510	670	1	703	5	1,379
Ohio	6,274	108	730	-	7,112	2,735	47	834	216	3,832
Michigan	-	-	-	-	-	-	-	-	-	-
Tennessee	-	-	-	-	-	-	-	-	-	-
North Carolina	-	45	-	-	45	901	590	-	-	1,491
Maryland	126	115	85	154	480	2,887	82	238	221	3,427
Illinois	1,440	2	11	20	1,473	571	22	1,329	26	1,948
Pennsylvania	4,395	478	-	-	4,874	3,765	41	596	161	4,562
Virginia	1,999	105	-	-	2,104	4,056	-	-	164	4,220
Delaware	365	7	84	-	456	447	30	2	5	484
New Jersey	113	1,339	2,283	21	3,756	1,853	368	25	15	2,260
Total	*20,038*	*2,199*	*3,193*	*195*	*25,625*	*18,098*	*1,182*	*4,078*	*873*	*24,231*

Notes and Sources:

All Resource Retirements and Additions (including planned units in advanced development or under construction) reflect operating capacity, using SNL Financial data.

Figure 10 shows the total quantity of coal-fired deactivation requests (i.e., retirement requests) to PJM for the same period. In all but a few instances, these units have been able to deactivate on time and as scheduled – meaning that PJM was able to determine that any reliability issues had been addressed in that time frame. In other instances, PJM has been able to quickly identify and resolve known reliability problems through transmission upgrades, operating procedures, and in some instances, reliability must run agreements. At times, these challenges have included large quantities of resources retiring *at the same time*, as anticipated by some commenters of the Clean Power Plan.[36]

Figure 10

Generator Retirements, Additions, and Reliability Planning, by State, 2010-2018

State	Coal-Related Retirement (Deactivation) Requests: Unit Count	MW	Average Time to Completion (months) (*On-Time* and *Reliability Extension*)**	Transmission Projects Driven by "Deactivation" ***: Count	Cost ($million)	All Transmission Projects: Count	Cost ($million)
West Virginia	18	2,687	100%	8	$160	37	$237
Kentucky	5	993	100%	0	$0	4	$13
Indiana	6	1,503	100%	2	$0	10	$3
Ohio	37	6,012	83%	32	$134	134	$296
Michigan	0	-		0	$0	2	$44
Tennessee	0	-		0	$0	1	$1
North Carolina	0	-		0	$0	7	$61
Maryland*	7	1,339	100%	4	$63	94	$612
Illinois	7	1,408	79%	0	$0	56	$694
Pennsylvania*	33	5,056	91%	22	$234	195	$1,021
Virginia	10	1,937	92%	5	$62	104	$1,352
Delaware	3	349	100%	0	$0	16	$100
New Jersey	1	129	100%	8	$9	173	$1,947
Total	*127*	*21,413*	*91% Weighted Average On-Time Requests*	*81*	*$661*	*833*	*$6,380*

Notes and Sources:

* SNL and PJM retirement capacities may differ, with SNL potentially a smaller number; SNL only considers future retirements with State approval and owner announcement, in addition to PJM deactivation approval.

** Time to Completion represents the average time (in months) between a deactivation filing, the requested date, and the actual date. Deactivations that occur at the requested date, or are extended without a reliability need are highlighted in dark blue; the average extension period for deactivations that are extended for reliability upgrades or operating procedures is highlighted in light blue. Due to averaging, the total sum of on-time deactivations (dark blue) and deactivation extensions (light blue) may not add up to the total time for an *individual* unit whose deactivation was extended for reliability reasons. There are five RMR units in Ohio that have an average time of 40 months between deactivation filing and actual deactivation date, indicated in grey. Deactivation dates represent the most recent filing on the PJM deactivation list.

In considering the potential inclusion of an administrative-waiver mechanism as part of EPA's final rule (and/or in State Plans), it is helpful to review the *similar* mechanisms and actions that have been and currently are relied on to maintain reliability in the face of changes to the power system. For example:

[36] For example, in February 2012, FirstEnergy submitted a deactivation request for 14 units representing 2,705 MW in Ohio, Pennsylvania, and Maryland. This represents one of the largest single deactivation requests, and PJM identified more than 190 reliability violations. Transmission solutions were immediately identified, and PJM determined that it needed to retain in service five units totaling 885 MW. These units include: Ashtabula 5, Eastlake 1-3, and Lake Shore 18. See: http://www.pjm.com/planning/generation-deactivation/gen-deactivation-rmr.aspx. These remained on Reliability Must Run ("RMR") contracts, for the period through April 15, 2015. Transmission projects were put in place ahead of schedule, and the RMR contracts for all but one generator (Ashtabula) were ended on September 15, 2014. These units have elected to remain in operation as market participants until their scheduled deactivation. The strength of the RTEP process is precisely that it focuses on specific regional and sub-regional issues in the planning effort, and considers impacts across and within different planning zones. The success of this project is evident by the distributed nature of these deactivation requests, which cover nearly every state in the PJM footprint. Note that as illustrated in Figures 5 and 7, several states (such as Michigan, North Carolina, and Tennessee) face similar retirement challenges with resources that are outside of the PJM footprint.

- ***Planning and market/regulatory outcomes will address most resource retirements.*** As discussed in our earlier Report,[37] regions, states and utilities conduct comprehensive planning and, in many cases, perform "what-if" analyses of potential resource changes based on industry forecasts and individual unit economics. The failure of a unit to clear in a forward capacity auction,[38] or formal requests or notices to deactivate/retire a unit, spur immediate system studies to evaluate reliability impacts. In some cases these studies are tied to the overall level of resources on the system ("resource adequacy"); in others, they focus on the impact of the loss of a generating source on local and regional system operations ("system security"). Market outcomes or utility resource planning/procurement requirements then typically cause the development and operation of new resources as needed to meet resource adequacy and system security needs. If the loss of a resource is found to cause security violations on the transmission system that are not or cannot be addressed through resource additions, regional planning processes are initiated for the development and construction of transmission system upgrades to eliminate the reliability issues. Normal planning and market/ procurement processes are conducted with sufficient lead time to cause the development of replacement resources or transmission upgrades prior to the shutting down of the resource.

- ***With short-notice retirements, resources may be retained for an interim period through a number of mechanisms until reliable solutions are developed***. On occasion, changes on power systems can occur without sufficient notice for typical planning and market procedures to cause timely replacement (see Figure 10). Certain losses of resources cannot be delayed (e.g., due to safety considerations, or other factors we discuss further below). But the request by an asset owner to promptly deactivate or retire a resource for economic reasons triggers an immediate review of system impacts, and in most cases the deactivation of the unit is delayed if the shutdown of the unit would cause violation of reliability standards. The impact analysis reviews not just whether there will be sufficient resources to meet peak load, but more importantly whether the loss of the unit on local and regional transmission system flows would violate transmission-security standards. The rejection of a deactivation request triggers (1) entering into an RMR contract with compensation based on the cost of continued operation of the unit, with the contract and the allocation of contract

[37] AG 2015 Report on Reliability and the Clean Power Plan.

[38] As a relevant example, a power plant owner may determine the costs it will incur to comply with the Clean Power Plan, and include such costs in its offer to take on a capacity supply obligation in PJM's forward capacity market. If the potential compliance costs are high enough to cause the unit to fail to clear in the forward auction, it will no longer be assumed as an in-service capacity resource in the year in question.

costs to loads reviewed and approved by FERC; and (2) identification of system upgrades needed to eliminate the need to keep the unit to in service, as well as initiation of processes to get the upgrades in place as soon as feasible (in order to minimize the term of the RMR contract). Importantly, if a unit remains operational through an RMR contract, contract costs approved by FERC generally include the costs to comply with environmental requirements during continued operation. Thus, PJM has in place existing FERC-approved provisions in its tariff that provide for maintaining operation of units needed for reliability, and accelerating the entry of system resources needed to allow for retirement of the unit as soon as feasible.

- ***Even in rare cases where a short-notice loss of resource cannot be delayed, system operators and utilities have tools to maintain reliability until replacement resources or upgrades are in place***. While in most cases a power plant owner that seeks to retire a unit has the opportunity to do so well in advance of when the unit would need to close, this is not necessarily always the case. Major failures of the power plant's equipment (e.g., due to an accident) can lead to the immediate shut down of a unit, and the owner may decide to not bring the unit back in service if, for example, the cost of repair is too high. In practice, we are aware of very few examples where an asset owner shut down operation of an otherwise safely operating unit that was deemed needed to maintain power system reliability.[39] However, it is more ambiguous as a legal matter exactly what is the expectation/obligation of an asset owner once retirement notice is given, particularly if remaining in operation would require violation of another regulatory standard. In PJM, resources need only provide 90-day notice of deactivation.[40] Even in these unlikely or infrequent situations, the industry has access to a number of tools to fill in the gap left by the sudden loss of a resource on the system that is needed for reliability. System operators can take emergency actions as needed to protect system security, including operating procedures that provide for accessing in-region and neighboring regions' reserves, posturing units to manage flows on the transmission system, demand response and voluntary curtailments, emergency involuntary voltage reduction (brownouts) and curtailments (blackouts). In addition, there are a number of steps

[39] The only instance that we identified was the deactivation of Titus Units 1-3, a 243 MW coal plant in Pennsylvania. Initially, operators filed notice for a deactivation of April 2015. PJM found that necessary reliability upgrades could be completed on time. Following the GenOn-NRG merger, the plant's owner announced its intent to deactivate the unit early (i.e., by September 2013). PJM noted that upgrades could not be completed in time. Titus officially deactivated in September 2013. See PJM Generator Deactivations, available: http://www.pjm.com/planning/generation-deactivation/gd-summaries.aspx.

[40] PJM, Manual 14D: Generator Operational Requirements, Revision 33, Effective Date: February 5, 2015, page 68.

and stop-gap measures system operators and utilities have taken or can take to address a reliability need that is immediate, and will not have a permanent solution for an extended period of time. For example, these may include: (a) solicitation of additional energy efficiency, load curtailment and/or demand response; (b) installation of moveable generation as needed to support system operations; (c) immediate development of temporary generation through utility self-build projects or fast-track solicitations (e.g., "gap RFPs"); and (d) altered operating procedures that provide relief from system contingency coverage practices.

- ***Federal and state energy and environmental regulators allow specific emergency actions and/or temporarily waive requirements when power system reliability is in question.*** Power system outages represent a major public health, safety and economic risk to cities and states, and are viewed as such by state officials. The authority to build administrative flexibility into regulatory or permitting frameworks to address threats to public health and safety exists throughout the framework of state and federal laws and regulations. This includes state compliance programs, air permits, siting and permitting laws and decisions, and the authority to take specific actions as needed in emergency situations. Examples include (a) emergency-out clauses built into permits' fuel restrictions (i.e., allowing the combustion of fuel oil beyond permit limits if needed for reliability); (b) temporary waivers from air permit requirements under system emergency conditions; (c) accelerated zoning, permitting and siting processes to provide for rapid advancement of needed generation or transmission projects;[41] (d) general emergency action authority vested in the President, the Department of Energy, governors, and other federal and state entities; and (d) in regulated states, the granting of utility-specific capital cost recovery allowances or mechanisms to facilitate accelerated investment in needed infrastructure.

As described in detail in our prior Report, power system reliability remains a high priority, given its importance to public health and safety, and economic productivity. This is clearly evident in EPA's proposal, the intent of the President and EPA, and in the vast structure of state and federal agency rules and authorities. The flexibility that EPA granted states in designing Clean Power Plan implementation plans leaves the door very wide open for states to propose in their plans the specific mechanisms needed to ensure that Clean Power Plan

[41] For example, following the California Energy Crisis in the early 2000's, the state added thousands of MWs of new generation using a set of emergency 21-day, 4-month, and 6-month citing procedures. These emergency responses helped establish a set of best practice siting procedures that can be used by other states in similar situations. Susan F. Tierney and Paul J. Hibbard, "Siting Power Plants: Recent Experience in California and Best Practices in Other States," Hewlett Foundation Energy Series, February 2002.

compliance does not compromise system reliability. And the current structure of power system operator market rules, planning processes, and operating procedures, along with the existing authorities of state and federal agencies, provide a deep set of tools to take specific action if and as needed to meet resource adequacy and system security requirements throughout the period leading up to, and during the 2020-2030 compliance window.

Administrative Waiver / Reliability Backstop Mechanisms

As noted above, PJM – along with other members of the ISO/RTO Council and other commenters – have recommended that EPA allow or require the availability of an administrative waiver process (a reliability safety valve) that would apply only if and when compliance obligations would otherwise cause the retirement of a generator that is needed for system or local reliability.

We note that there are potential variations on proposed administrative waiver mechanisms that reflect differences in the form of and entity responsible for the mechanism: Is it an EPA requirement? Would FERC be involved? Does the mechanism need to be detailed in state plans? Is it an obligation on states or on compliance entities? Variations also focus on the period of concern: Is it a resource/capacity issue, tied to the need *for a particular unit* to always be available to support system reliability, and thus not allowed to retire? Or is it a periodic issue, related to the need to allow units to exceed permitted emission or operational limits if needed in *specific dispatch circumstances*? In this Report, we refer to all proposals allowing for variations, exemptions, waivers, or deferrals of compliance obligations as "administrative waiver mechanisms."

As described above, we believe that the electric industry already has the tools in place to keep units operational when needed for reliability, and the Clean Power Plan has inherent flexibility. Consequently, we are skeptical that an administrative reliability waiver is needed as part of the EPA's final Clean Power Plan rule – especially one that is administratively complex.

That said, if designed well, some form of administrative waiver included in EPA's final rule could create clarity around waiver standards and expectations, and thus provide a degree of assurance to the industry and public officials. Such an administrative waiver provision might specifically detail the expected limitations in granting compliance waivers, the reporting requirements and standards, and supplemental obligations on states and compliance entities involved in compliance waiver activities. In this way, EPA's expectations around the limitations of an administrative waiver mechanism could encourage consistency across states.

In our view, if EPA were to decide to incorporate some form of reliability provision in its final rule, we strongly encourage EPA to design it in a way that creates appropriate incentives for reliance upon normal reliability tools and thus makes it unlikely that a waiver will need to be called upon.

- First, its design should avoid unintended consequences; any such back-stop reliability waiver/ mechanism should be accompanied with a requirement to offset any emissions associated with implementation of the reliability mechanism.
- More specifically, the design of any such reliability mechanism should ensure that any requested waiver is approved only if it is:
  - ***Appropriate*** – Any administrative mechanism providing for relief from compliance obligations should contain specific obligations on the petitioning entity to demonstrate:
    1. The unit in question is needed to maintain reliable system operations (wherever possible through standard reliability modeling conducted by the system operator or consistent with system planning standards);
    2. Every effort was made to pursue compliance plans in a timely fashion in order to minimize the potential need to request relief from compliance obligations (e.g., the filing of deactivation notices as soon as feasible and a complete evaluation of compliance alternatives);
    3. The timely administration of regulatory or market activities to provide solutions that eliminate the need for the unit at the earliest possible date, and the timeframe for such solutions; and
    4. The request includes specific plans and commitments to offset the CO_2 emission impact from application of the proposed compliance relief.
  - ***Transparent*** – Proposals for applicability of the relief mechanism should be available to the public, and filed and deliberated through a state process providing the opportunity for comment by industry stakeholders and the public.
  - ***Equitable and Competitively Neutral***– The relief mechanism should be designed so as to not confer any market advantage on any participant in wholesale electricity

markets. The mechanism should apply equally across entities within a state, and similarly not confer advantages on compliance entities in one state over competitors in a neighboring state.

- ***Equivalent*** – The relief mechanism should include provisions by which the state would take steps to reduce CO_2 emissions through other means in an amount equal to the cumulative quantity of increased CO_2 emissions resulting from granting compliance relief. Specifically, states will need to identify how the EPA CO_2 emission standards for the state through the relevant averaging period (e.g., 2020-2029) will be met despite the granting of compliance relief. In decisions granting waivers, exemptions or deferrals from compliance requirements, state implementing agencies should specifically identify how the Equivalent standard will be met.

- ***Cost Effective*** – The relief mechanism should consider and include the full value of incremental and/or avoided CO_2 emissions when evaluating reliability mitigation solutions.

Table 2:
Evaluation Criteria for a Reliability Waiver Program

A Waiver Program Should Ensure that any Requested Waiver is Approved Only if it is:	
Appropriate	Need is demonstrated through standard industry tools, and alternatives are comprehensively reviewed
Transparent	Compliance waiver requests are evaluated through public processes with stakeholder input
Equitable	The waiver mechanism should not create advantages to asset owners, and should apply equally across asset owners and across states
Equivalent	A waiver request and/or approval should include compensatory actions to ensure the cumulative CO_2 standard through 2030 is maintained
Cost-Effective	Mitigation solutions should receive full credit for the value of incremental and/or avoided CO_2 emissions

A formal administrative waiver mechanism to ensure power system reliability throughout the period of Clean Power Plan compliance may not be necessary – the industry and governmental authorities have demonstrated the ability and willingness to do whatever it takes to maintain reliability when facing the retirement of existing power plants. However, if EPA wishes to include an administrative waiver mechanism in the Clean Power Plan, or require it of states, it should be consistently applied, and designed to meet appropriate, transparent, equitable, equivalent, and cost-effective standards.

Conclusion

Our review concludes that:

- ***PJM is already adapting to changes underway in the electric industry, and doing so successfully from a reliability point of view.*** As a region with electric capacity totaling approximately 200 gigawatts ("GW"), PJM has seen some 12.5 GW of mostly aging, coal-fired resources retire during the 2010-2014 period, due largely to economic and regulatory factors. Another 7.6 GW is expected to be retired over the next 3-4 years. These plants are being replaced with new resources – primarily natural gas-fired and wind projects – and there is a deep queue of additional new proposed projects in line to meet future needs. PJM has effectively administered processes to manage this transition in a way that meets both reliability and efficiency objectives.

- ***PJM's analysis of compliance options demonstrates that regional, market-based approaches can meet Clean Power Plan goals across PJM states at lowest cost, with retirements likely spread out over a number of years.*** PJM's recent modeling, performed at the request of the Organization of PJM States ("OPSI"), evaluates a wide array of potential compliance approaches and identifies capacity at risk of retirement. In addition to stressing the benefits of a flexible and collaborative approach, the results indicate that expansion of energy efficiency and renewable resources can reduce the quantity of existing coal-fired units at risk of retirement. Also important, PJM's analysis only reflects adding capacity from proposed projects already in PJM's interconnection queue (totaling 14.5 GW); the total quantity of new projects is likely to be much higher over the full time frame of Clean Power Plan implementation.

- ***PJM and the PJM states have extensive authorities and experience with administrative mechanisms to address – and successfully resolve – potential reliability violations associated with the retirement of power plants.*** These mechanisms include extending unit operations through reliability must run contracts, accelerated procurements of demand and supply resources, temporary waivers of regulatory requirements if or when reliability is an issue, and fast-tracking resource siting and permitting when needed to meet short-run reliability challenges.

- ***PJM has demonstrated success with reliability challenges in the past, including retirements related to low natural gas prices and the MATS, and stresses on the fleet during the winter 2014 Polar Vortex.*** In the case of the Polar Vortex, some stakeholders have claimed that operating conditions during early 2014 prove that the Clean Power Plan could be a threat to reliability. In fact, for PJM, the Polar Vortex is a case study of how numerous planning, operational, and market tools can be (and are) deployed to ensure reliability in response to unexpected events. Moreover, during the more recent harsh 2015 winter when new record-breaking peak loads occurred, we note that PJM's "reliability tool kit" has functioned nicely and possibly even improved over the past year.

- ***Given the robustness of existing reliability tools and the flexibility in the Clean Power Plan, we are not convinced that a Reliability Safety Valve, as proposed by PJM, is either needed or practically workable.*** If EPA wishes, however, to include some sort of reliability "back stop" mechanism in the final carbon rule, we think EPA should design it in a way that creates appropriate incentives for reliance upon normal reliability tools and thus makes it unlikely that a waiver will need to be called upon.
    - To avoid unintended consequences, any such back-stop reliability waiver/ mechanism should be accompanied with a requirement to offset any emissions associated with implementation of the reliability mechanism.
    - More specifically, the design of any such reliability mechanism should ensure that any requested waiver is approved only if it is:
        - Appropriate: the need for the waiver is demonstrated through standard industry tools, and alternatives are comprehensively reviewed;
        - Transparent: compliance waiver requests are evaluated through public processes with stakeholder input;
        - Equitable: The waiver mechanism should not create advantages to asset owners, and should apply equally across asset owners and across states;
        - Equivalent: A waiver request and/or approval should include compensatory actions to ensure the cumulative carbon-pollution reductions through 2030 are maintained; and
        - Cost-Effective: Mitigation solutions should receive full credit for the value of incremental and/or avoided carbon pollution.

- **PJM is well positioned to lower carbon pollution from existing power plants while relying on the reliability tools and operating procedures PJM uses with great success.**