



Ohio Legislature

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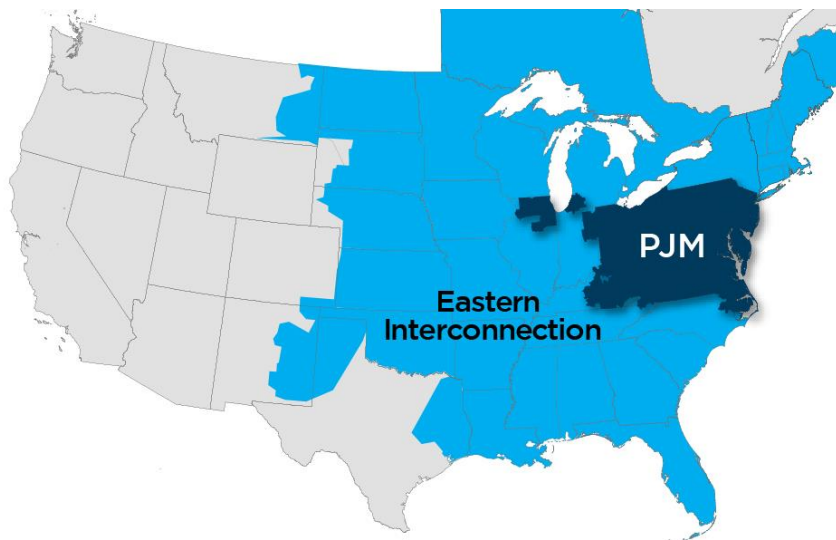
## Introduction

I am Asim Haque, Vice President – State and Member Services of PJM Interconnection. On behalf of PJM, it is a pleasure to share PJM's perspective on the reliability, resilience and affordability of the bulk power grid with the Ohio legislature.

Based in Valley Forge, Pennsylvania, PJM Interconnection ensures the reliable flow of power to 65 million customers in 13 states and Washington, D.C. As such, we're responsible for ensuring reliable and efficient delivery of electricity over the bulk electric system to one-fifth of the nation.

The PJM grid consists of 85,103 miles of transmission lines and approximately 1,200 generation sources, along with more than 500 demand response and energy efficiency providers. We are interconnected with our neighboring systems in the Eastern Interconnection, which geographically includes over two-thirds of the United States and Canada. PJM delivers power from the high-voltage transmission grid to local distribution utilities, who then are responsible for delivery to end-use customers.

**Figure 1.** PJM Service Territory



PJM utilizes markets to reinforce grid reliability by ensuring that, in addition to our reliability requirements on generators, market signals work in tandem with those requirements to support reliable operations. For example, our capacity market is designed to procure resources available to meet projected peak demand and other contingencies three years ahead of time. Through our Day-Ahead and Real-Time markets, we produce a security-constrained economic dispatch across our footprint, ensuring that the most efficient and cost-effective mix of resources are called on each hour of each day to achieve reliability at the least cost to customers. In addition, in any given hour we either export excess power supplies to our neighbors or import needed power from those neighbors, which helps support reliable and cost-effective operations throughout the Eastern Interconnection.

## Executive Summary

My testimony addresses the three key foundations which are the subject of this hearing – reliability, resilience and affordability. Relative to these three guiding principles, a few key points are central:

- Reliability and security of the bulk power grid is our first priority and our organization’s driving purpose.
- Our grid is strong, with a set of diverse generation resources, healthy reserves, a robust transmission system that is interconnected with our neighbors, and a transparent planning process – each of which helps maintain reliability in adverse conditions. Nevertheless, ensuring the continued strength and reliability of the grid requires our constant attention. We meet this challenge with the strong and helpful support of our transmission and generation owners, our states, our large and diverse stakeholder community, and industry partners such as the natural gas pipeline companies that support gas-fired generators in our footprint. The Federal Energy Regulatory Commission (FERC) and the North American Electric Reliability Corporation (NERC) are important overseers in this effort.
- PJM prepares for threats to the bulk power system by stress testing the system and analyzing literally millions of possible contingencies. This contingency analysis includes analysis of planned as well as unplanned transmission and generation outages, impacts of extreme weather, fuel shortages and other scenarios. Additionally, because it is impossible to foresee every possible contingency, PJM and its members expend considerable effort preparing for unforeseen disturbances on the grid.
- PJM’s markets exist to deliver reliability at the lowest cost over time. Our capacity market is designed to procure adequate resources, three years forward, to be available to cover projected peak demand as well as a reserve for contingencies. Our energy and ancillary services markets perform a security-constrained unit commitment and dispatch to ensure selection of the lowest-cost resource mix to serve customers while respecting the physical limits of the grid.
- In addition to reliability, affordable electric service has been one of the bedrock principles since the early development of electricity to light our homes and businesses. Our markets, in combination with our operations and planning functions, are estimated to deliver \$3.2 billion to \$4 billion in annual efficiencies for customers. As we prepare for the grid of the future, we need to continue to ensure that affordability remains a key component of our collective thinking.
- For 15 years, PJM has managed a changing resource mix by using advanced technology and appropriate generation forecasting to improve reliability during the transition. We will continue to foster deliberate and thoughtful partnership among multiple parties, including PJM, our states, our transmission and generation owners and other stakeholders, and regulators such as FERC and NERC going forward.

## Reliability: Job #1

At PJM, reliability is our top priority. We understand the profound implications of what we do and how important electricity is to daily life. We understand that we must prove ourselves every day by ensuring the reliable delivery of electricity that is so central to the economy and health and well-being of the 65 million Americans in our footprint.<sup>1</sup>

PJM has been ensuring reliability at the bulk power level to our region going back to 1927, when three utilities recognized the synergies of sharing power and created the first continuous power pool.

That value proposition endures today: Both in areas with regional transmission organizations (RTOs) and those without RTOs, the industry has a long history of mutual support. However, PJM's regional approach, operating across a very large footprint with many more resources and tools available, ensures a stronger grid than might exist if every utility in our system had to ensure reliability solely on their own. PJM's rigorous planning process ensures a reliably planned system for the long term over a wide range of operating conditions.

Ensuring reliable operations of the grid is complex, involving multiple layers of protection. It involves 24/7 system monitoring and dispatch by trained operators, coordination with other operating entities and industry sectors in real time, markets that support reliability and resource adequacy over the long term, and extensive regional transmission planning to ensure the grid is equipped to serve future needs.

### ***Stress Testing and Planning: A Key Component of Reliable Operations***

Analyzing different scenarios and stress testing the system is an integral part of both daily operations and our long-term planning. We analyze changes to the expected load forecast due to weather conditions, the effect of the pandemic, and other near-term events, including: extreme weather, unexpected fuel shortages and unexpected reduction in generation.

We also conduct long-term scenario forecasting. Our forecasts incorporate factors such as changing weather patterns, different levels of economic growth, and customer-driven energy efficiency and demand response actions that impact electricity demand.

We utilize this forecasting for a number of our operations, including procurement of sufficient excess generation reserves and the building of sufficient transmission resources.

### ***Addressing Extreme Weather Conditions***

I wish to address the issue of preparation for temperature extremes – with a focus on recent extreme winter weather – both from the point of view of PJM operations and, in the separate section below, from the point of view of how PJM's market design reinforces reliable operations.

Although I cannot guarantee we would not face challenges during extreme weather conditions (indeed, no one can), PJM has a large, multi-state geographic footprint, a diverse fuel mix, a robust reserve margin and strong

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<sup>1</sup> I am attaching to this testimony the white paper "Reliability in PJM: Today and Tomorrow," which provides additional explanation of how PJM addresses reliability through our markets, planning and operations functions.

interconnections with our neighboring systems, all of which help keep the power flowing. Most generating resources in our footprint are built with freezing temperatures in mind, and our members prepare and winterize, in part, because of the nature of the region, which covers much of the Atlantic seaboard and upper Midwest.

PJM and its member companies plan throughout the year for winter – and summer – conditions. We have incorporated into our manuals an extensive pre-winter preparation checklist. This checklist, directed to generators, covers a variety of winterization actions to be undertaken. Even though the reporting is voluntary today, we have received a high level of generator compliance, particularly from those units that otherwise could face the most weather-related impacts. In addition, at the start of the summer and winter season, we conduct emergency response drills with our members and natural gas pipeline operators, and survey generators regarding their fuel inventory.

We saw this during the severe weather in mid-February of this year that impacted much of the country. Although the weather was not as cold in most of our region (although we did see extremely cold temperatures in the western portion of our region around Chicago), PJM generators demonstrated high availability to operate reliably under winter conditions. That, combined with a strong transmission system, enabled us to export as much as 15,700 MW of electricity – a record amount – to support our neighbors who were experiencing extreme weather conditions. This was more than three times the megawatts we would export on an average day.



The entire Eastern Interconnection, although stressed in the southwest, was certainly stronger as a result of this massive level of exports and support by PJM to neighboring systems. And, as noted previously, our neighbors have provided us support at times when system conditions in PJM could be alleviated with imports from our neighbors.

## Resilience: Beyond Reliability

PJM defines resilience as: “preparing for, operating through, and recovering from events that impose operational risk, including but not limited to, high-impact, low-frequency events that today are not typically addressed by industry reliability standards.”

With this in mind, PJM ensures that the grid is resilient in the face of extreme conditions while monitoring and adapting to situations in real time.

Perhaps as a prime example: We are in the middle of a high-impact, and hopefully low-frequency, event in the form of the COVID-19 pandemic. And while PJM has had a pandemic response plan in place since 2006, this event has demonstrated how we need to “expect the unexpected” and ensure that the system is resilient to withstand those unexpected events.

PJM has responded to this challenge by staying focused on building resilience to the impacts of the pandemic into our operations, remaining flexible and learning as we go. We have successfully run our operations, planning and markets with 90 percent of our workforce working remotely. Operators on campus are now in their second round of sequestration to ensure continued operation of the grid. We improvised a third control room as a backup to our two existing control rooms, which normally support each other. And we have managed to conduct about 400 meetings with our stakeholders, all remotely.

## ***Learning From Extreme Events***

PJM has an established track record of learning from extreme grid events, whether these occur in our region or elsewhere, and using these lessons learned to improve the reliability and resilience of our system. Some examples include:

- Review of Southwest 2011 Winter Event: PJM established winterization steps to be taken by generation unit owners and established a reporting system to PJM, as well as provisions to secure additional reserves to address both winter and summer stressed conditions.
- 2014 Polar Vortex Event: PJM made changes to its capacity market design to provide significant penalties for poor generator performance and payments for superior generating performance during identified stress conditions.
- Gas/Electric Coordination: PJM established protocols with natural gas pipelines serving our region to ensure real-time communication and contingency analysis during times of stressed conditions on the interstate pipeline system.

We welcome continued coordination among PJM, generation, transmission and distribution owners, FERC, NERC, the gas industry, states and other stakeholders to this end.

## **PJM Markets Reinforce Reliability & Support Affordability**

PJM administers several markets to efficiently reinforce reliable grid operations, including: capacity, energy and ancillary services.

Our primary markets are the energy and capacity markets. Each market serves a separate function, but they work in tandem.

I will describe the capacity market first, because although it represents about 20 percent of our total market, it is squarely aimed at maintaining reliability. PJM's capacity market was implemented to secure enough power supplies at locations they are needed to make sure that sufficient supply is available to meet peak demand three years into the future, taking into account anticipated outages of individual resources and required reserves for other contingencies. Under a normal schedule, we hold a three-year-forward auction in May. That is extremely valuable from a reliability perspective.

The capacity market also helps provide an investment signal to attract new efficient generation and to retire older, less efficient generation. It can help to avoid some of the volatility we would otherwise see in an energy-only market. The design of the capacity market also results in the purchase of resources beyond the minimum reliability requirement, providing additional reliability for unforeseen events, with each megawatt of reliable supplies beyond the minimum being procured at a declining cost to the customer.

As a result of extreme weather conditions our region realized during the Polar Vortex of 2014, we made notable changes to our market design to ensure that the market both rewards superior generator unit performance and penalizes poor generator unit performance. During the 2014 Polar Vortex, up to 22 percent of generators in our footprint were unavailable as a result of forced outages.



As a result of the winterization procedures, which I described above, along with the incentive and penalty reforms we instituted in 2016, we have seen a notable improvement in generator performance including during periods of extreme weather. Forced outages during the recent cold weather in the PJM region peaked at 9.8 percent during the coldest weather of Feb. 15–17, compared with the 22 percent during the 2014 Polar Vortex, as noted above. Nevertheless, we are not resting on these past achievements but looking forward to ensure that grid reliability is maintained under a paradigm of more extreme weather and a changing generation portfolio. I address this further in The Energy Transition section.

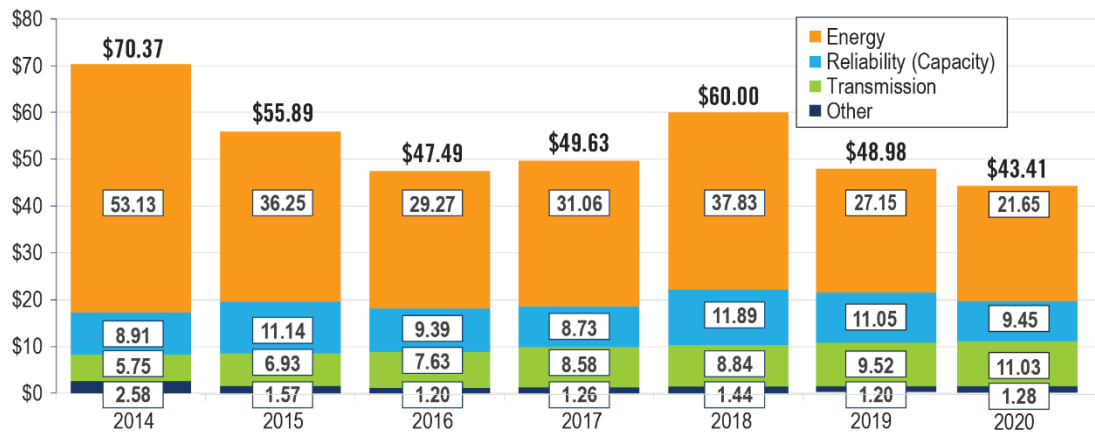
The largest of the PJM markets is the Energy Market, making up the majority of wholesale electricity costs. While the capacity market prepares for the future, the Energy Market addresses near-term need. Energy prices are produced on average every five minutes, as the most cost-effective resources across the PJM region are dispatched to serve ever-changing demand.

PJM believes that our markets should be designed to accommodate state policies related to the generation resource mix, while also ensuring that we have the products (and adequate compensation to providers) in place, in a timely manner, to meet the reliability needs of the system going forward. We are presently involved in a series of workshops with our stakeholders on these very issues, and it will take continued federal leadership, coordination with our members, states and other stakeholders to accomplish this goal.

### Available & Affordable Electricity

In aggregate, our markets have helped support an overall decline in total wholesale costs in recent years. Total wholesale prices were \$43.41 in 2020, down 38 percent from 2014. PJM’s wholesale prices have been essentially flat for two decades and are competitive with other regions of the country. The Energy Market, which is about 60 percent of the PJM markets, saw historic low prices in 2020.

**Figure 2. Total Wholesale Cost (2014–2021)**

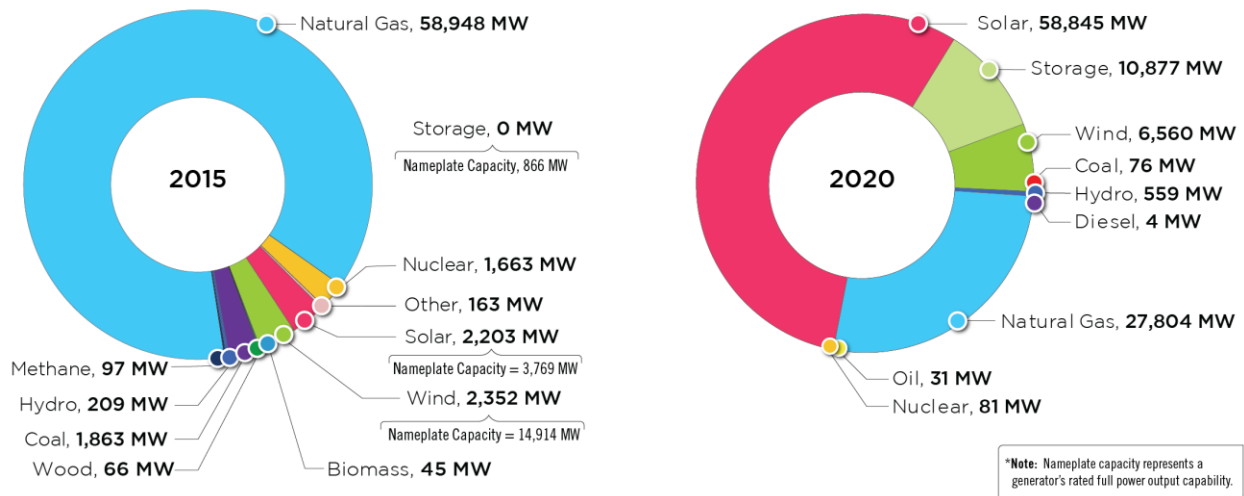


I should also note that wholesale costs are just one component of the overall customer bill. Customer bills include generation and transmission charges for services that flow through PJM as well as distribution-level charges of each utility and, in some cases, additional charges from competitive retailers. Those distribution charges are determined by each state public utility commission.

## The Energy Transition

PJM has managed continual changes in the fuel mix for the last 15 years and, as a result of advancements in technology, this trend appears to be accelerating. Today, PJM’s interconnection queue, consisting of generator projects studying the possibility of development and interconnection into PJM’s grid, has expanded significantly and is dominated by wind, solar, battery or hybrid projects.

**Figure 3.** Profile of New Generation Seeking to Interconnect Onto the PJM Grid



As the grid continues to evolve, PJM is committed to help facilitate advancements in the energy economy in a manner that ensures grid reliability and uses our regional scale and competitive markets, wherever possible, to deliver efficiency for customers.

Nevertheless, ensuring grid reliability through this transition will drive PJM and our stakeholders to consider a number of overarching issues, including:

- As we see an increasing level of intermittent resources in the supply portfolio serving PJM customers, we could face energy prices falling significantly, due to declining marginal costs and the fact that these resources using the wind or sun to generate power effectively have no fuel costs. At the same time, we will need to ensure adequate compensation mechanisms for back-up dispatchable generation – be it fossil generation or batteries – that will be needed given the intermittent nature of renewables. This may make the capacity market even more important in ensuring that we have adequate reserves. As an alternative, RTOs and ISOs could develop and provide compensation mechanisms for new flexible ancillary services. PJM has begun this process with FERC’s approval last year of our proposal to improve our overall pricing of reserves needed to maintain reliability each day.
- While the output of intermittent resources is less predictable on an individual unit basis, a substantial portfolio of such resources across a wide, diversified geography can contribute to the capacity needs of the system during peak periods. Along with our stakeholders, PJM is in the process of adopting a more accurate approach, called effective load carrying capability, to calculate the capacity value of intermittent

resources during periods of peak demand. This will be an important component of our approach to reliability in coming years.

- In today's paradigm, we set reliability requirements to avoid a triggering event that could occur in the loss of load under a "one day in ten years" standard. However, as we have seen in many past situations, events such as extreme temperatures don't often occur as simple stand-alone events. Rather, there are often coincident events, such as extremely cold temperatures coupled with ice storms, or the potential for multiple cybersecurity intrusions, for which we need to plan. Great strides have been made in how we drill and plan for these multiple events all hitting us at once, as I noted above.

I present these not as insurmountable challenges, but as illustration of the need to coordinate the timing and substance of policymaking, industry evolution and technological development, so as to ensure that we continue to maintain a reliable power grid as we transition to a more modern grid.

With an eye to the future, PJM is committed to working with our stakeholders to ensure reliability remains the top priority and driving mission of our organization. Based on our conversations with industry leaders, stakeholders and policymakers, we see three items that will be critical to that pursuit:

- Communication between policymakers and grid operators will be key to crafting workable goals and laws going forward.
- On the markets side, there will need to be regulatory support for accommodating state policies regarding the generation resource mix while also ensuring that we have the products (and adequate compensation to providers) in place, in a timely manner, to meet the reliability needs of the system going forward. We are presently involved in a series of workshops with our stakeholders on these very issues.
- Modernizing the existing transmission system will provide a multitude of benefits, including designs that can withstand more extreme events, lower frequency and shorten duration of outages, reduce public and employee safety risks, and use advanced technology to improve system operability, efficiency and security.

## In Conclusion

Thank you again for the opportunity to share PJM's perspectives on these important issues that face Ohio and our nation.

In closing, I want to reiterate that the reliability and security of the bulk power system continues to be PJM's top priority.

As a large, interconnected grid, we ensure reliability through our markets, operations and regional transmission planning and through the significant efforts of our member companies. PJM is committed to accommodating state policy choices, and as we progress toward the Grid of the Future together, we must do so with reliability at the core of our common purpose and with careful consideration of the costs customers will be asked to pay.

And we look forward to working further with members of Ohio's legislature and our partners across the energy industry, as well as other states and stakeholders, on additional actions to ensure reliability, affordability and resilience in a changing world.