There are distinct moments in an organization’s evolution that determine its future. In 2019, PJM responded with vigor and set its course forward. The ever-changing energy industry landscape refueled PJM’s commitment to its members and core mission. We are adapting PJM’s wholesale markets, enhancing operations and working to forge new consensus for infrastructure planning. PJM, members and other stakeholders refocused efforts to protect PJM’s wholesale markets from risk, explore and support emerging energy policy initiatives, and refine the robust operation of the electricity grid. Assessing the past and anticipating our shared energy future, PJM stands ready to embark with stakeholders on a bright 2020 and beyond.
2019 was a year of strong system performance. It was also the year with the lowest locational marginal prices (LMPs) since the start of PJM LMP markets in 1998. The trend of less variation of LMP, and more consistent energy prices across PJM’s footprint continued. This trend can be attributed to new generation closer to load, generation retirements in lower-priced locations, and further investments in the transmission system, which significantly reduced congestion.

The transmission system is the very foundation of PJM, since the origin of PJM Interconnection in 1927. The Regional Transmission Expansion Planning (RTEP) process is key to ensuring reliability and improving market efficiency. The grid modernization continues also through the supplemental projects by the transmission owners. While there are different views on what is optimal or most cost efficient, we must not lose sight of the high value of PJM’s dense and robust transmission system. Not least, it enabled the unprecedented large and fast energy transition we have experienced in PJM during the last 10 years, from primarily coal to primarily natural gas, while strengthening reliability.

The energy transition will continue, most likely with an increased amount of renewable energy. With more variable resources like wind and solar, the importance of the transmission system will further increase. A special challenge ahead will be the integration of large amounts of offshore wind planned to be built during the coming decade. Taking a comprehensive approach and working together will be crucial.
2019 was also a year of organizational transition. President and CEO Andy Ott retired in June after 22 years at PJM. He was instrumental in developing PJM’s competitive markets. Throughout the balance of 2019, Susan J. Riley served as the interim president and CEO. A longtime Board member, her proactive leadership helped lay a strong foundation for the course ahead.

After a thoughtful and deliberate search, the PJM Board in November was pleased to announce the appointment of Manu Asthana as the new president and CEO, effective Jan. 1, 2020. Asthana brings PJM a wealth of experience across the electric industry, including power generation operations dispatch, competitive retail electricity, electricity and natural gas trading, and risk management, which he acquired in his more than 21 years in the energy industry.

In partnership with stakeholders, PJM vigorously moved forward with the recommendations from the independently produced report after the GreenHat default. As part of a structural change, a chief risk officer, Nigeria Bloczynski, was recruited and joined PJM in July. She reports directly to the Risk and Audit Committee of the Board.

Looking ahead, the PJM Board recognizes a paradigm shift from the common denominator of reliability at least cost to a more complex paradigm, also incorporating very diverse state public policies. In this process, the Board remains committed to reliability and resiliency, fair and non-discriminatory markets and a culture that is open and responsive to members’ and stakeholders’ concerns.

Sincerely,

Ake Almgren, Ph.D., Chair, PJM Board
TO PJM MEMBERS, STAKEHOLDERS & EMPLOYEES

In 2019, PJM Interconnection worked to align itself with the progressive and fast-changing industry we serve. It was a year of reaching out. That is why the theme of this annual report is: Reflect. Refocus. Refine.

During a year of reexamination for PJM, we worked with our members to ensure the reliability of our bulk power system. While fulfilling our critical role, all of us at PJM convened open, innovative and respectful dialogue with our members, state and federal regulators, and our market monitor to move toward solutions and consensus amidst an energy industry undergoing rapid transformation.

While PJM expanded outreach and broadened transparency, we remain proud of our markets and their power to drive innovation, flexibility and reliability. We understand and respect continuing opportunities and challenges posed by lower wholesale energy prices, with more change on the horizon from various carbon reduction objectives. Achieving a necessary balance between environmental initiatives and fair, competitive wholesale markets continues to be at the forefront for PJM. We are committed to preserving the best of what we offer in terms of market solutions in light of capacity changes, the absence of load growth, and the varied interests and perspectives of our members and other stakeholders.

On another vital front, PJM worked closely with stakeholders to collaborate and take the steps required to implement a robust credit risk management framework to protect our members and our markets. The new chief risk officer role reports directly to the PJM Board of Managers and heads the newly formed Enterprise Risk Management Committee at PJM. PJM has collaborated with stakeholders to implement new credit rules within PJM’s governing rules, and we are grateful to our members for their efforts to develop and implement these important credit policy changes.
Highlights of 2019 include:

- Energy production remained significantly cleaner from a carbon emissions perspective than ever before, in part due to PJM’s competitive markets.

- Market reform continued with a commitment to holistically evaluate the effectiveness of the Financial Transmission Rights Market.

- Work continued with the Federal Energy Regulatory Commission on modifications to the construct of the PJM Reliability Pricing Model (capacity market).

- The competitive capacity market provided enough efficient generation to reduce the reserve energy margin.

- The Federal Energy Regulatory Commission issued Order 841, which enabled PJM to propose in a compliance filing to help remove barriers to the participation of electric storage resources in capacity, energy and ancillary markets, which was largely accepted by FERC.

I extend my thanks to Andrew L. Ott, who retired in mid-2019 as PJM president and CEO, following a 22-year career with the organization. For the remainder of 2019, I was privileged to have served as the interim president and CEO. I am very grateful to the committed and talented employees of PJM at all levels for all of the help and support that they gave me during the time that I served in this role. As a director, I had been impressed with PJM employees and am grateful to have had the opportunity to work with them more closely. I am also grateful to our members and regulators for their help and support while I served in the interim role. I hope you will all join me in welcoming Manu Asthana as our new president and CEO. The Board has chosen a leader with varied industry experience in energy and markets – one who will bring fresh perspectives to the team.

We are proud to report that 2019 marked a year when our role as convener and consensus-builder grew in service for our evolving energy industry. Even when issues were complex and controversial, PJM worked to understand what is important to our members, states, the industry as a whole, and FERC, and forged consensus. Looking forward for PJM, a successful 2020 will result in market adaptations serving our mission and our members’ changing needs. We are listening. We are learning. And we are continually seeking a deeper understanding of the concerns of our members, policymakers and other stakeholders.

Thank you for your support.

Susan J. Riley, Interim President & CEO
NEW LEADERSHIP FOR A CHANGING ENERGY FUTURE

As the industry navigated fast-paced change to enter a new decade, senior leadership at PJM Interconnection evolved, too.

Mid-year 2019 marked the retirement of PJM President & CEO Andrew L. Ott following a distinguished 22-year career. During four years as PJM’s president and CEO, Ott was instrumental in developing competitive markets, maintaining system reliability and helping PJM continue its status as an industry leader.

A long-serving member of PJM’s Board of Managers, Susan J. Riley, took the reins as PJM’s interim president and CEO to guide the nation’s largest grid from July 1 through year’s end. PJM, its members and its stakeholders appreciated Riley for refocusing the organization and building engagement between management and members to strengthen our foundation for what lies ahead in 2020 and beyond. To lead PJM into the future, the PJM Board of Managers announced the selection of Manu Asthana as president and chief executive officer, effective in January 2020.

With a wealth of experience from various roles in the electric industry, Asthana brings new and important perspectives to enhance engagement with members and policymakers as PJM remains the reliable, independent operator of the bulk power system, offering innovative responses and solutions for the greater good of our changing industry in 13 states and Washington, D.C.

Letter from Manu Asthana, President and CEO

I am honored to have been selected by the PJM Board of Managers to lead PJM into a new decade while building on its renowned history of leadership and innovation.

During 21 years in the electricity and natural gas industry, my passion has been the formation of world-class teams to deliver transformative growth. From my beginnings in trading and risk management, to a variety of leadership roles in power generation, asset optimization and dispatch, competitive electricity and natural gas retail, and home services across North America, I have gained broad industry perspectives. Experiences like these inform my drive to partner with members, stakeholders and the PJM Board of Managers on creative, principled solutions for the complex energy industry challenges we face.

The remarkable team at PJM already excels at the execution of reliable operations, prudent transmission planning, fair and efficient markets, and innovation. PJM is known for offering crucial, independent perspectives, which will continue to be a focus area for us as we draw on the insights of members and stakeholders to forge consensus whenever possible going forward.

Respectfully,

Manu Asthana
PJM President & CEO
STRENGTHENING ALLIANCES. BRIDGING DIFFERENCES. SERVING THE COMMON GOOD.

During a year of continuing transition for PJM, we reflected on our role to deepen our commitment to forging common ground. With members and stakeholders, we refocused on our defined roles and authorities, while working together on challenges and opportunities in PJM’s wholesale markets, innovation, planning and operations. From these efforts, we refined our priorities, and we are prepared for a renewed approach to collaboration going forward.
Listening

As an independent arbiter of information to aid policymakers in making informed decisions, PJM’s management and Board of Managers expanded efforts to facilitate transparent conversations. The Board of Managers launched a series of listening sessions to review the many complex and sometimes controversial issues facing PJM and its stakeholders. Broad, strategic and thoughtful conversations during these sector-specific meetings resulted in deep and continuing engagement with transmission owners, electric distributors, generation owners, consumer advocates, end-use customers and other suppliers.

Effective Tools & Streamlined Processes Enhance Collaboration

Effective governance and the collaborative stakeholder process help achieve PJM’s vision to be the electric industry leader in reliable operations, wholesale markets and infrastructure development. As the industry confronted significant change, PJM initiated a cross-divisional team to enhance the member experience and best serve our shared critical mission. During the fall, PJM capped a long-time effort to streamline key aspects of the stakeholder process. Members strongly supported enhancements, including shortened, prioritized meetings and the new “Critical Issue Fast Path” process for expedited consideration of major, urgent concerns. Embracing change to the stakeholder process includes ongoing efforts to simplify the user experience on pjm.com, facilitate effective stakeholder meetings, enhance the clarity of presentations, drive customer service, broaden transparency and improve PJM’s self-service communities. While PJM’s membership has grown to approximately 1,047 members, process improvements like these promote communication and timely issue resolution.

PJM Value Proposition

PJM produces value in a variety of ways – by reducing costs, facilitating information sharing and administering transparent markets that encourage innovation and investment in new resources. Across the six aspects of PJM value – reliability, savings, investment, innovation, environment and independence – we produce annual savings to consumers totaling $3.2 billion to $4 billion. Estimated economies range from annual cost reductions of up to $300 million in congestion relieved by regional planning efficiencies, and up to $1.8 billion in economies on generation investment derived from PJM’s geographically diverse and fuel-diverse resource fleet. Notable emissions reductions, estimated at more than 10 million fewer tons of carbon dioxide annually, accompany the robust competition from our wholesale markets. At the same time, PJM facilitates a productive marketplace for innovators to enhance the bulk power grid.
MANAGING RISK. ADAPTING WHOLESALE MARKETS.

Organized wholesale electricity markets were created to address increasing electricity rates and to encourage innovation through free-enterprise competition. PJM’s wholesale electricity markets have done just that. Competition has helped to create a less expensive, more reliable and cleaner bulk power grid that offers market-based solutions for public policy and industry. These trends continued in 2019 with robust reliability, record-low prices reflecting lower fuel costs and more efficient resources, and overall emissions rates that have dropped since 2005.

Comprehensive Risk Management Safeguards Markets and Market Participants

At mid-year, a new chief risk officer joined PJM and assumed leadership of the Financial Risk Mitigation Senior Task Force. The task force was created to consider what action should be taken to address the recommendations of the independent consultants hired by the PJM Board of Managers in the wake of the 2018 Financial Transmission Rights default by a PJM member. The chief risk officer also chairs PJM’s internal Enterprise Risk Management Committee to implement sound policies, procedures and practices for the enterprise-wide management of the company’s material risks.

Together, PJM and its stakeholders achieved critical milestones to safeguard market participants from risk while building consensus, strengthening our culture of holistic risk management and incorporating industry best practices. Action was initiated to:

- Enhance the credit risk policy
- Clarify PJM’s role in the market
- Incorporate “Know Your Customer” best practices
- Establish a robust risk management process
- Develop and expand professional staff
- Increase frequency of Financial Transmission Rights auctions

By year’s end, a clear majority of stakeholders signaled support on basic concepts and worked with PJM to finalize revisions to the PJM Tariff and Operating Agreement to confer authority and establish or improve guidelines required to update key risk policies and procedures to mirror the financial industry’s best practices. PJM will continue to assess market participant risk profiles and follow a one- to three-year road map for improvements as a direct result of its comprehensive risk management overhaul.
Improved Market Operations

Aiming for operational excellence and cost efficiency, PJM engaged in a comprehensive review of its market operations processes in 2019. Improvements underway increase the speed and consistency of market clearing processes and enhance opportunities for process simplification, automation and reduction in human errors.
Capacity Market Rules Revised

PJM’s capacity market, the Reliability Pricing Model, plays a central role to many diverse interests. Auctions provide certainty, representing reasonable expectations that commercial interests – of both the supply chain and consumers – have come to rely on. 2019 marked a year of continuing transition for the Reliability Pricing Model.

In December, the Federal Energy Regulatory Commission (FERC) ordered PJM to revise its capacity market rules to incorporate a minimum offer price rule (MOPR) to address the price-suppressing effects of state-subsidized capacity resources, with certain exemptions. This ruling followed the FERC-ordered delay of the 2019 base capacity market auction.

Asserting that such out-of-market state subsidy payments to generators threaten the competitiveness of PJM’s capacity market, FERC directed PJM to expand its MOPR to apply to any new or existing resource that receives a state subsidy, unless an exemption applies. Exempt resources include existing resources participating in state renewable portfolio programs and existing demand response, energy efficiency, storage and self-supply resources. Federal subsidies do not trigger application of the MOPR.

The FERC order did not include many of the exemptions proposed by PJM to accommodate state public policy initiatives. PJM filed its Request for Rehearing and/or Clarification on Jan. 21, 2020, and its compliance filing on March 18, 2020.

Reserve Price Formation

The Energy Price Formation Senior Task Force deliberated nearly a year without reaching consensus on a path forward to revise PJM’s energy reserve pricing rules. Therefore, in February 2019, the PJM Board of Managers asked PJM to file a proposal with FERC to address concerns with PJM’s energy reserve pricing rules, while reflecting certain changes influenced by stakeholder discussions and feedback.
In March, PJM filed its proposal under section 206 of the Federal Power Act, acknowledging the hard work of stakeholders in debating the difficult and complicated issues around reserve pricing. The proposal aimed to revamp its energy reserve pricing rules to fairly value resources that play a vital role in the reliability of the bulk power grid. These reserves help balance generation and demand during times of unexpected generation loss, increase in electricity use or variable output of generation resources like wind and solar. PJM’s current rules do not accurately value reserves for their reliability nor drive consistent response when the resources are called upon. PJM’s proposal represents a major step forward in the design of the market. These resources are not just critical to reliability today and in the future – they also will provide the backup flexibility needed, so that the bulk power grid is prepared for the continued integration of alternative sources of energy.

**Five-Minute Settlements**

Following a yearlong development and testing program with stakeholder input, PJM implemented a market settlements solution that better aligns market credits and charges with real-time dispatch intervals. This enhanced market settlement solution better aligns the dispatch and settlement intervals in the Real-Time Energy Market, removing the misalignment of 5-minute dispatch signals and hourly settlements, solidifying incentives for resources to follow PJM dispatch instructions.

**Gas-Electric Coordination**

In late 2019, FERC approved PJM’s revisions to extend the deadline for participants to submit bids and offers in the Day-Ahead Energy Market from 10:30 to 11 a.m. This extended time better aligns PJM’s market deadlines with those of natural gas pipelines. It provides generators additional time (natural gas generators in particular) to interact with natural gas markets and achieve increased fuel price certainty prior to submitting offers into the Day-Ahead Energy Market. PJM has also received stakeholder approval to incorporate gas contingencies into PJM reserve requirements and continues to enhance communications with natural gas pipeline operators.
INNOVATION

WORKING TO PERFECT THE FLOW OF ENERGY

As the operator of the bulk power grid in the PJM footprint, PJM is a convener, serving current and future needs of approximately 1,047 members and stakeholders and the 65 million people in the PJM region. We maintain operational reliability and preserve the value of markets that have defined PJM’s work to be a leader in the electricity industry. As a result, our staff and Board of Managers strive to listen, work collaboratively and deliver solutions aimed at the most reliable and efficient dispatch of power, market function and infrastructure planning while preparing for future needs in our ever-changing industry. We are proud to collaborate with members, stakeholders, governmental entities, researchers and industry partners to explore innovative solutions to the opportunities and challenges that lie ahead.
EVOLVING ENERGY MIX

Safe, reliable and affordable power is critical to our joint success and the health of our economy and our environment. For 65 million people, PJM is the steward of reliability and markets for our bulk power grid. Market forces and policy priorities continue, as ever, to shape the resource mix across 13 states and Washington, D.C.

Though ever-evolving, resources in the PJM footprint perform well and continue to be diverse, strong and reliable with excellent coordination by and with our members.

Smooth Summer

Over the course of the summer of 2019 during daily peak hours, natural gas made up 42 percent of the online fuel mix, followed by nuclear at 27 percent and coal at 24 percent. Renewables, including wind, solar, hydro and storage, made up 6 percent, with other fuel types comprising the remaining 1 percent.

During the summer of 2019, PJM recorded a peak load of 151,588 megawatts (MW) on Friday, July 19, one highlight of a relatively uneventful season. Handling of the peak load was eased by disciplined operations, upgrades to the bulk power grid through the Regional Transmission Expansion Plan (RTEP), capacity performance and the capacity market, which has worked to replace aging generators with more efficient new resources. As a result, PJM experienced significantly reduced forced outage rates, dropping from nearly 5 percent during the summer of 2018 to less than 3 percent during the same time period in 2019.

Improving Winter Grid Performance

The winter of 2018-2019 demonstrated that the bulk power grid in the PJM footprint is strong, diverse and reliable.

Overall, generator performance continued to improve, with forced outages during the winter peak from Jan. 28–31 occurring at a rate between 8.6 percent and 10.6 percent. That outage rate illustrated continuous improvement from the 12 percent outage rate experienced during the 2017-2018 winter peak. This trend line marks evolving performance from the 22 percent total forced outage rate during the January 2014 Polar Vortex.

During the winter of 2018-2019, electricity was supplied by a diverse set of resources, including natural gas, coal, nuclear and renewables. A major natural gas pipeline break occurred during winter peak operations but did not significantly impact generation. On Jan. 21, Texas Eastern quickly isolated a ruptured pipeline segment in Ohio, and gas flow to nearby PJM generation was not interrupted.

For all winter hours during the 2018-2019 season, nuclear power composed 35 percent of the online resource mix, followed by natural gas at 31 percent and coal at 27 percent. Renewables, including wind, solar, hydro and storage accounted for 6 percent.
Carbon Pricing Senior Task Force Studies Market Frameworks

PJM’s markets traditionally had focused solely on reliability at least cost. For the first time in 2019, PJM explored mechanisms to incorporate an externality – carbon pricing – into its market clearing engine.

PJM is not proposing a carbon policy or price. Rather, at the behest of members, PJM initiated the Carbon Pricing Task Force in 2019 to explore the potential effects that different carbon-pricing scenarios could have on the region we serve. Toward this end, the PJM Study of Carbon Pricing and Potential Leakage Mitigation Mechanisms was conducted to illustrate a framework that would enable states to incorporate potential carbon-pricing policies into PJM’s energy and ancillary services markets while mitigating the policies’ impact on surrounding areas not participating in such programs.

The study used current states (Delaware, Maryland and New Jersey) participating in the Regional Greenhouse Gas Initiative (RGGI). Pennsylvania and Virginia are also poised to join the RGGI program, a market-based effort currently underway by 10 states to cap and reduce carbon dioxide emissions. Modeled on the 2023 calendar year, PJM found that carbon-pricing initiatives established by individual jurisdictions could be accommodated by PJM’s competitive markets, with border adjustment constraints mitigating the resulting impacts on generation, emissions and price.

As individual jurisdictions within the PJM footprint continue to explore carbon policies, PJM will continue to listen and respond with information and insight to serve the interests of all members and stakeholders while preserving our mission to efficiently operate the bulk power grid.

Redesign: PJM.com & Inside Lines

Operating the largest grid and energy market in North America while planning and coordinating for the future power needs of 65 million people is a complex undertaking. Keeping up with PJM got easier in 2019 as we relaunched Inside Lines, our official news site, on the heels of a redesign of our home page, pjm.com.

With a refreshed, updated design and easy-to-navigate layout, both of these initiatives help drive our mission to accurately and transparently provide information about the latest PJM news, stakeholder initiatives and industry developments.

Line-Rating Technology

When planning, operations and cutting-edge technology align with federal regulatory policies, the grid functions at its best. Upon a FERC call for testimony on the opportunities and challenges that grid-enhancing technology innovations present to transmission developers and regulators, PJM shared its innovative perspective.
Dynamic line-rating technologies have the potential to increase efficiency and reliability in the electrical grid by allowing operators to better understand how the capacity of transmission lines increases or decreases with changing conditions. Line ratings that adjust a transmission line’s capacity based on ambient air temperature can be deployed today. Should FERC require the universal use of dynamic line ratings, PJM asserts regional transmission organizations should be allowed leeway to implement them in a way that accounts for regional differences and the challenges presented along seams where grids are linked.

For emerging technology, PJM serves as a testing ground for further development and use of ambient-temperature-adjusted facility ratings and dynamic line-rating technologies. PJM and American Electric Power have partnered to study the application of flexible line-rating technology to reduce congestion. In another study, PJM field-tested phasor measurement units in collaboration with the U.S. Department of Energy. While striving for best practices with our members and stakeholders, PJM looks forward to further direction from FERC as our industry addresses incentive-rate policy for building new transmission assets that include advanced technologies.

**Embracing Energy Storage**

PJM has long recognized the unique value of storage resources that bring important flexibility to the supply mix. As the amount of renewables on the bulk power grid continued to expand in 2019, PJM helped eliminate historic barriers to electric storage resources to electricity markets. Just one year prior, FERC issued its “landmark storage rulemaking,” also known as Order 841. That ruling ensured that energy storage resources could participate in capacity, energy and ancillary services markets in every independent system operator and regional transmission organization.

PJM’s proposal to make that happen within our footprint was accepted by FERC in October. As 2019 came to a close, PJM followed up with FERC, submitting additional proposed Tariff provisions as requested.

PJM counts more than 5,300 MW of energy storage resources on the system, excluding those participating in markets as demand response. Of this, 96 percent is from five pumped-storage hydroelectric plants. Batteries represent more than 80 percent of fast-responding frequency regulation resources.

**Flexible Resources Partnership**

As electric vehicles begin to deploy in Chicago, Philadelphia, Washington, D.C., and elsewhere around its footprint, PJM is well prepared to ensure their successful integration into the bulk power grid, including as resources that can provide reliability services to the grid.

In Virginia, Dominion Energy is rolling out an electric school bus fleet capable of storing up to 105 megawatt hours (MWh) of electricity. That’s enough electricity to power more than 10,000 homes. When not on the roads, the school buses will have the ability to plug-in and provide power back to the grid in an effort to ease high demand or fill in for intermittent wind or solar resources. In extreme circumstances, the buses may also serve as mobile power stations. The Dominion project creates an aggregate grid energy storage resource as the utility grows its mix of distributed resources (including solar and wind).
PJM’s transparent regional transmission planning process takes into consideration proposed changes to the bulk electric grid in its region in order to maintain the future reliability and most economic performance of the grid.

The RTEP process looks ahead 15 years to assess factors that may affect grid reliability. To this end, PJM studies scenarios and analyzes various grid conditions that could lead to reliability problems throughout the region. As PJM identifies issues, it works with stakeholders to determine the best solution. Where appropriate, PJM opens competitive windows as part of the competitive planning process. As a result, the RTEP identifies needs, and the enhancements required to meet those needs, in order to maintain reliability in compliance with North American Electric Reliability Corporation (NERC) and PJM planning criteria. PJM does not review or approve locations where transmission lines and facilities are ultimately built. That is the responsibility of individual states. All transmission improvements identified through this process are discussed publicly in stakeholder meetings and reviewed and approved by the PJM Board of Managers before inclusion in PJM’s RTEP.
In 2019, the PJM Board of Managers authorized 80 new baseline projects at a cost of $1.27 billion and 95 new network transmission projects at an estimated cost of over $100 million in upgrades and additions to the RTEP. In addition, nearly $3.4 billion in supplemental upgrades were identified by the transmission owners for aging infrastructure and local reliability needs. In all, this action was required to meet PJM’s criteria to reliably serve 65 million people in 13 states and Washington, D.C.

New Long-Term Load Forecast Evolves and Reflects Electric Vehicle Trend

Effective planning requires continuous refinement of the long-term load forecast model to identify potential reliability needs and to ensure the procurement of adequate reserves through PJM capacity market auctions. To improve overall accuracy, reflect current energy usage trends and account for the increasing adoption of electric vehicles, PJM introduced enhancements to its long-term load forecast model in the second half of 2019. Back-casting analysis was performed to demonstrate that these changes reduced forecast model error. The proposed changes were thoroughly vetted with and endorsed by stakeholders in late 2019.

At year-end, PJM released its annual long-term forecast report, which projected a modest 0.5 percent annualized growth rate in peak demand over the 15-year forecast horizon. Zonal annualized growth rates over the same period varied from -0.5 percent to 1.4 percent. Factors driving positive load growth include substantial data center construction, accelerated load associated with natural gas processing plants and the increasing adoption of plug-in electric vehicles. These factors were partially offset by the continued implementation of more energy-efficient processes and equipment and the installation of additional behind-the-meter solar generation.

Supplemental Transmission Projects

Supplemental projects are transmission owner enhancements to account for aging infrastructure, operational needs or new customer load connections. They are not required for compliance with NERC or PJM transmission planning criteria or state public policy projects according to the PJM Operating Agreement. Throughout 2019, PJM worked with stakeholders to address complex and controversial issues related to supplemental projects.

Eight months of deliberations between stakeholders and PJM regarding how to balance the treatment of supplemental transmission projects in the planning process yielded endorsement of new manual language that aims to integrate the transmission owners’ process with PJM’s RTEP process.

Members, stakeholders and PJM demonstrated how they work together, even when issues are complex and controversial, in addressing the incorporation of supplemental transmission projects into the RTEP.

PJM Transmission System: Economic Growth, Lowered Emissions, Flexibility

In 2019, PJM released a white paper entitled “Benefits of the PJM Transmission System,” which was a comprehensive look at the vast benefits enabled by the transmission grid. PJM’s detailed analysis quantified the value of transmission; quantified the cost of electricity flowing between PJM and adjoining transmission systems, efficiencies in system operations that reduce the need for controlling actions, savings in the capacity market resulting from increased generator diversity; reduced installed reserve margin and electricity transfers across PJM’s borders, and changes in transfer capability on reactive interfaces.

Interconnection Queue Improvements

Through organizational realignment, investment in report generation and automation tools, and closer coordination with transmission owners to improve on-time completion of studies, PJM reduced its interconnection queue-study backlog while managing the all-time highest annual number of incoming interconnection requests.
PJM operations preserved the reliability of the bulk power system, our primary responsibility, while facilitating performance of new resources in our changing generation mix.

**RELIABLY SERVED BY FLEXIBILITY: PJM OPERATIONS IN 2019**

While the summer as a whole featured relatively mild weather, it also included a record weekend demand of more than 150,000 MW in mid-July. Usage peaked at more than 151,000 MW on Friday, July 19. Still, the summer peak was not one for the record books. PJM’s all-time one-day highest power use was recorded in the summer of 2006 at 165,563 MW. As October 2019 began, a two-day heat wave sent temperatures into the 90s and resulted in an unusually high peak load of 125,500 MW – 5,500 MW higher than forecast. PJM members providing generation, transmission and load management cooperated to keep power flowing, despite the fact that some critical planned maintenance activities had temporarily trimmed generator capacity. It’s important to note that peak demand for that time of year is typically closer to 100,000 MW. As unusually hot weather continued on Oct. 2, PJM called for emergency procedures, including a Performance Assessment Interval and PJM’s first request for load curtailments from demand response resources in more than five years.

For winter 2018-2019, the grid continued to be diverse and reliable. Energy resources performed well during a short but intense cold spell from Jan. 28-31, with a mix of generators and resources similar to the 2018 cold snap. Lower prices for natural gas-fired generation drove an increase from such resources while growing coal-fired generation retirements. As PJM coordinated reliable power supply to the grid, gas-fired generators demonstrated remarkable improvement from the year prior. For example, during the peak demand of nearly 139,000 MW on Jan. 31, gas supply outages were 2,930 MW, compared to 5,913 MW during the 2018 cold snap. All fuel-supply-related outages also fell by more than 50 percent. This improvement was driven by generators “firming up” their gas supply contracts, pipeline expansions, better gas-electric coordination and the relatively short duration of the cold weather.

**Compliance Audits**

Security and compliance are paramount at PJM, where we remain vigilant and innovative in the face of ever-evolving threats. In 2019, ReliabilityFirst conducted audits of PJM’s compliance with the NERC Reliability Standards, including those related to Critical Infrastructure Protection (CIP), Operations and Planning. PJM successfully demonstrated a strong compliance program and that our security controls surpassed what was required by several of the NERC CIP requirements.
GridEx V

NERC’s fifth bi-annual Grid Security Exercise (known as GridEx V) took place in 2019 with PJM contributing to this critical two-day exercise platform with hundreds of partners in industry, government, law enforcement and other sectors. PJM’s Business Continuity Planning Team worked as a lead group on the national planning team for GridEx V, and as the lead planner for the PJM region and its members. Drills included a tabletop exercise attended by high-ranking government officials and industry executives.

Monitoring Fuel Security

On the heels of the groundbreaking, nationally recognized Fuel Security Study in 2018, PJM and its stakeholders ensured that the monitoring of fuel and resource security issues will be periodically reviewed via the PJM Operating Committee. In the 2018 study, and continued work in 2019 by the Fuel Security Task Force, the bulk power grid in the PJM footprint was found to withstand an extended period of stress while remaining reliable and fuel secure according to 4.7 million scenarios studied. While fuel security poses no immediate threat to the reliability of the system due to interdependencies of fuel delivery infrastructure, even in scenarios with the most conservative assumptions, regular review of this important issue will continue as a PJM operational strategy.

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<td>5.4</td>
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<tr>
<td>Winter Average</td>
<td>4.7</td>
<td>6.3</td>
<td>5.3</td>
<td>4.9</td>
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*Winter years include January and February of the following year.
Performance Assessment Interval

In early October, generators, transmission operators and curtailment service providers successfully worked with PJM operators to maintain reliability during a short, abnormal October heat wave that led to emergency procedures, a Performance Assessment Interval and the first call on demand response resources in more than five years.

On Oct. 1, hot weather across much of PJM’s footprint resulted in peak demand that exceeded the load forecast by about 5,500 MW, peaking at more than 125,500 MW. Peak demand at this time of year is typically closer to 100,000 MW. PJM will work with stakeholders to prioritize recommendations for further Performance Assessment Interval development. This includes tools to increase observation of distributed energy resources and load.

Human Performance Best Practices

In 2019, PJM continued forging a culture for excellence by expanding the industry-leading Human Performance & Operating Experience Program beyond grid operations to include departments at work on information technology, market services and more as part of PJM’s corporate goals. This initiative continues important work at PJM to prevent human errors from becoming significant, impactful negative events. Diligent use of these best practices produces positive results, focusing on core concepts of prevention, detection and correction. This includes recognizing a “good catch” when staff detects an issue and takes action before negative consequences emerge. PJM operators in its Control Center already receive periodic refresher training on human performance principles during scheduled training weeks. The tools and techniques of this program are so valuable that PJM is expanding this culture across the enterprise.
Transient Stability Assessment Tool Upgrade

The Transient Stability Assessment (TSA) tool was implemented in production in 2013 to ensure generator stability during real-time operations and was leading-edge industry technology at the time. In September 2019, a major enhancement to the application was released that included the ability for the tool to use the full nodal Energy Management System model in its analysis, as well as several other system improvements to ensure the speed of the solution was not reduced.

Load Forecast Applications Refresh

PJM completed a four-year project to upgrade the seven applications used for near-term and real-time load forecasting information used for both the operations and markets systems.
CULTURE OF CARING

The employees of PJM, responsible for keeping power flowing to more than 65 million people, underscored their commitment to the community and each other in 2019 with new and strengthened outreach.

DIVERSITY & INCLUSION AT PJM

Embedded in its Core Values, diversity and teamwork continue to be issues of importance within PJM. The Diversity and Inclusion Council recommends and participates in initiatives that address the workforce, the work environment and the external marketplace, including members, communities, regulators and key stakeholders.
Conference Rooms Renamed

In 2019, PJM renamed two conference rooms to symbolize inclusion and to recognize the diversity among energy industry pioneers. The names Edith Clarke and Lewis Latimer were chosen by PJM’s Diversity & Inclusion Council, because both contributed to the energy industry through groundbreaking innovation.

Employee Resource Groups

PJM hosts many employee resource groups to foster diversity and inclusion, including the African-American Networking Group, the Asian-American Employee Resource Group, the Innov8 STEAM Employee Resource Group, the PJM Professional Networking Group and the Women’s Empowerment Association. In 2019, Lambda, PJM’s LGBTQ+ employee resource group, was created to build a community that promises support, solidarity, acceptance and the bond of shared experience with LGBTQ+ people and their allies. In all, diversity and inclusion efforts at PJM enjoy sponsorship by the PJM Executive Team toward advancing progress on issues and challenges and the achievement of PJM objectives.

COMMUNITY

Dave Thomas Foundation for Adoption Award

PJM’s culture of caring includes a commitment to helping employees seeking to grow their families through adoption. For the 13th straight year, the Dave Thomas Foundation for Adoption named PJM one of the 100 Best Adoption-Friendly Workplaces in the nation, ranking it first among energy and utility companies. Companies are ranked based on their adoption benefits, such as financial reimbursements for the costs of adoption and paid adoption leave for employees.

GIVING: PJM Gives Back

More than 350 employees spent the day giving back in the communities where they live and work. More than 25 different events took place. Employee volunteer activities included: sewing pillowcases for children in hospitals, cleaning and organizing a local food pantry, distributing food from a food bank, grounds maintenance at a wildlife sanctuary, painting and building improvements at a local school, and landscaping at an animal rescue site.
STEAM Volunteerism

PJM staff worked with schools and students to promote our science, technology, engineering, arts and math (STEAM) initiative to empower the next generation of utility industry professionals. PJM hosted several visits by students on campus, exposing them to real-world experience. Staff also visited area schools and gave talks about the value of STEAM-related education, highlighting innovation taking place at PJM. PJM staff also participated in career fairs, robotics competitions, science fairs and other events where students worked hands-on with STEAM topics.
### PJM AT A GLANCE

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Membership</strong></td>
<td>1,047</td>
</tr>
<tr>
<td><strong>Generating Capacity</strong></td>
<td>186,788 MW</td>
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<tr>
<td><strong>Peak Demand</strong></td>
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<tr>
<td><strong>Transmission Lines (Miles)</strong></td>
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<tr>
<td><strong>Annual Energy</strong></td>
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<td><strong>Annual Billings</strong></td>
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<td><strong>States Served</strong></td>
<td>13 + D.C.</td>
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<tr>
<td><strong>Square Miles of Territory</strong></td>
<td>369,089</td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>65 Million</td>
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</tbody>
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