



Operations Road Map

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Overview

The purpose of this document is to provide additional insight into the key initiatives on the Operations Roadmap over the next five years. These initiatives are based on the PJM Strategy, with a focus on maintaining Reliable Operations, enhancing our current tools, continuing our work on gas-electric coordination, and preparing for a transitioned grid. This Roadmap is meant to be a living document and will be adjusted as needed.

Operations Road Map

An overview and timeline of activities for the Operations Roadmap is shown below, with additional detail following in the subsequent sections of the document.

INITIATIVE		2024	2025	2026	2027	2028
Technology	Forecasting Enhancements (Load, Solar, Wind)					
	Control Room 2030					
	Energy Management (EMS) Upgrade Roadmap					
Operational Processes	Transitioning to Risk-Based Operations					
	Gas-Electric Coordination					
	Operations Analysis for Renewables					
	Reserve Certainty					

Technology Narratives

1. Forecasting Enhancements (Load, Solar, Wind)

Problem Statement

In response to Winter Storm Elliott, PJM conducted an independent review of PJM’s short-term forecast and renewables processes, tools and organization to pre-position our practices and people to account for changing load behavior, increased penetration of renewables and behind-the-meter resources. While current load forecast performance is very good, there is an acknowledgement that there are forecasting challenges resulting from the energy transition in addition to changing load characteristics. As a result, PJM is looking to enhance existing tools and processes in order to maintain forecast performance moving forward.

Project Description

This project will evaluate short term forecasting tools and methodologies including probabilistic forecasting methods that increase model transparency and increase the in-house modeling ability in order to adapt our practices and maintain forecast performance moving forward.

2. Control Room 2030

Problem Statement

PJM is experiencing a rapid transition from traditional fuel secure fossil generation to intermittent resources over the next several years as well as changes in load characteristics. A resource mix consisting of intermittent resources coupled with hybrid and storage resources will require a unique strategy to ensure that the reliability of the system is maintained. Operators currently dispatch the system that consists of fewer large thermal ramping units. When evaluating future generation within the PJM Interconnection Queue, PJM operators will be dispatching the system with thousands of smaller, intermittent units and DER resources that are spread across the PJM RTO system. Having the appropriate level of situational awareness of these units and an understanding of the impact of weather on resource performance will be critical. Control room tools and processes must include risk identification and mitigation in order to manage the uncertainty associated with intermittent resources. The roles and responsibilities of operators will have to be evaluated to ensure that we are staffed appropriately to operate the PJM System during the anticipated changes.

Project Description

PJM will need to evaluate processes and tools to ensure operators have the appropriate level of situational awareness to address operational risks associated with projected resource mix with sufficient lead time. It will be crucial to ensure the day-ahead processes have an understanding of a resource mix in advance of the operating day so that risk can be appropriately measured and quantified so that decisions that require advanced notification and coordination with PJM members and stakeholders can be communicated. The process will need to quantify renewable resources and load forecast accuracy including confidence levels. Demand will continue to grow driven by data centers and some supply may be restricted due to co-located loads. This will require operators to have increased visibility. Tools that operators use to visualize and proactively monitor resource status and performance will need to change. Operator tools and visualization will need to be modified to present operators with advance insight of potential issues before they become problems so that advance decisions can be made ensure adequate levels of replacement energy is on-line to serve load and maintain adequate reserves. Human performance training and awareness and operational excellence will be very important as we navigate through this change and apply lessons learned.

3. Energy Management System (EMS) Upgrade

Problem Statement

The PJM EMS System – SCADA, AGC, Network Applications, Training, Modeling Management, and related subsystems – must be planned and developed to meet all reliability, security and operational needs now and through the energy transition. The operational needs, especially of control room users, continues to change along with the energy mix, weather and capacity in the system – and therefore what dispatchers need from their primary tool. Also, the EMS vendor landscape continues to evolve, as each North American ISO/RTOs strike a balance between custom solutions versus maximizing base product vendor solutions.

Starting from the original 2011 go-live of the AC² Advanced Control Center, which pioneered several EMS architectural features and technologies in the industry, PJM became the first RTO to leverage the rapidly emerging Monarch product for SCADA AGC in the spring of 2023, porting over some of the most prominent features such as dual-primary and advanced emergency environments. Now, long-term EMS planning must evolve to more steady

and regular upgrades and enhancements as compared to the legacy “big bang” approach to keep up with the changing industry. As PJM transitions to a more proactive and holistic approach to EMS design, next up are the Network Application, Training System, and Model Management systems.

Project Description

PJM has become a multi-vendor architecture. Currently, the Network Applications and Model Management runs on Siemens platforms, the SCADA/AGC on AspenTech Monarch, and real-time markets on GE. While the mixed vendors between major systems creates integration and complexity factors to consider, each vendor is also being leveraged for their current relative strengths, and also has important strategic flexibility and opportunities in the long run. The PJM middleware between these systems will provide commonality and scoping control between upgrade phases, while itself being upgraded to industry best practices.

The Monarch SCADA/AGC system, now in its second year of production use, is being leveraged for one of its core strengths; a more flexible and featured user interface that can be enhanced in shorter and safer development loops. A steady rhythm of display enhancements per end-user-feedback is established and will continue to optimize the look, feel and function for end users. As Monarch usage matures in 2024 and 2025 PJM will strike the first balance of a major “evergreen” system, portioning project cost and risk into smaller and more manageable updates, yielding functional benefits and sustainable support. Also, in 2024 through 2025, PJM is partnering with AspenTech for a vendor supported and PJM-approved & design FERC Order 882, Ambient Adjusted Ratings, and a sequence of regulation control and spinning reserves enhancements slated for the next few years.

PJM’s Network Application Upgrade is – exceptional for any EMS project – on-time and budget, as it nears stage environment buildouts this year and testing phases next year of the Siemens ISO TNA product. PJM utilized a robust and detailed functional specification, early planning, tight project execution with an emphasis on vendor-customer cooperation, to harness the best features of the existing network applications while enhancing architecture and integration, and laying the ground to future-proof PJM’s real-time observability and analysis for widespread nonconforming loads and tight system conditions. PJM is positioning itself for knowledge, technology and investment sharing with other RTO/ISOs in the execution of this project. The related training systems, including the unique simulation engine PJM and PJM members have been accustomed to, is likewise being upgraded to support proficiency in control room human performance.

PJM’s model management paradigm is rapidly evolving, with ongoing product installs and workshops exploring concepts and technologies such as model-as-you draw, cloud-hosted cooperative modeling strategies, and significant efficiency gains through CIM (Common Information Model). These initial proof-of-concepts in 2024 will material into a model management buildout that will add value for PJM and PJM members through more efficient and accurate modeling, and model sharing. These changes also afford opportunities to align PJM’s operations and planning models for internal efficiencies, as well as prepare for higher-volume generation interconnections, such as renewables and distributed energy resources newly entering the wholesale market.

Operational Process Narratives

1. Transitioning to Risk-Based Operations

Problem Statement

PJM is experiencing a rapid transition from traditional fuel secure fossil generation to intermittent resources over the next several years. PJM conducted ISO/RTO peer site visits to learn about their challenges with energy transition and the methods they have implemented to account for the inherent risks with intermittent resources. During the visits, the ISO/RTOs shared best practices in managing the transition to renewable energy from a Control Room Management and Operations Support perspective.

One observation is that all the ISO/RTOs are facing slightly nuanced challenges as some are experiencing rapid growth in battery-storage and others face issues of fuel security combined with an increase in renewable resources. Not one ISO/RTO is exactly like the other. The take-away; however, is that we have learned techniques on incorporating intermittent resources into Operations that can be leveraged as we undergo this imminent transition. As we look to make changes in our control room to increase Operator situational awareness, we are exploring alternative ways to reliably incorporate the significant increase in grid-connected solar and wind in addition to behind-the-meter solar generation. Another observation is that our peers have or are in the process of implementing risk mitigation processes, to include organizational changes, to focus on managing the uncertainty with intermittent resources.

Project Description

PJM intends to develop a streamlined and repeatable framework that evaluates current risk factors within Operations such as forecast and weather error performance; generator outage performance; time of year considerations; and other relevant factors determine a risk profile for the operating period. The output of the risk evaluation will determine what action should take place such as the procurement of additional reserves, increased regulation, etc. in order to manage risk. This process to develop a framework will be iterative as PJM evolves over time and potentially newer risk factors emerge such as increased electrification; however, the framework itself will be scalable and adaptable to handle such changes.

2. Gas-Electric Coordination

Overview – Gas-Electric coordination remains a key focus area for PJM and will remain one for the foreseeable future. Natural gas generation has seen significant expansion in the past decade, making up the largest portion of the generation mix at PJM. While gas-electric issues have been around for quite some time, Winter Storm Elliott highlighted the need for progress and shed light on additional challenges. As the energy transition to renewables ramps up, so does the reliance on natural gas resources to provide essential reliability services.

The gas-electric issues are often complex and require a tactical approach to not only get the desired outcome but one that has longevity. PJM has embarked on various gas-electric coordination initiatives spanning four main categories:

PJM Internal

PJM and Stakeholders

PJM and Industry

Federal and State Policy

The four categories encapsulate the general space in which the initiative is being worked in different venues.

Purpose – PJM is working on improving internal tools and process to provide better situational awareness to operators. Looking to better operationalize the information available for gas-fired generators such as gas nominations, pipeline alerts, and commodity availability. Using that information along with parameter exceptions and limitations reported by the units to understand the impact at the resource level. Unit commitment practices/tools are being enhanced to look better align with the cycles of the gas day and look beyond the next operating day.

The Electric Gas Coordination Senior Task Force (EGCSTF) has been a space where PJM has collaborated with stakeholders from various sectors to develop and advance many solution options. While not all the options were in scope/made it out of the EGCSTF, it did set up discussions at other stakeholder bodies like the Reserve Certainty Senior Task Force (RCSTF) to discuss the reserve considerations. The EGCSTF advanced the Real-Time Values filling that will streamline the process of getting generator parameter updates in real-time. The corresponding Markets Gateway changes are still in progress and are on track to complete prior to Winter of 2024. As part of the recent Capacity Market reforms, PJM established a new class to reflect dual-fuel gas capabilities and create the appropriate incentives. Additional work is planned to recognize firm transport arrangements.

PJM will continue to look for opportunities to work with industry to further the conversation on gas-electric coordination and find common ground to produce tangible results. PJM is building upon the numerous reports on gas-electric issues published by entities like the North American Energy Standards Board (NAESB), ISO/RTO Council (IRC), and FERC/NERC. PJM is working with different gas sectors to increase transparency and communication, explore new gas products more suitable for generators, understand dependencies on electric grid, and opportunities for infrastructure expansion. An emphasis is being put on gas operations during extreme cold weather and Black Start scenarios.

In addition to the categories where PJM has more direct involvement, PJM is keeping a finger on the pulse of evolving federal and state policies related to gas-electric. Not just to ensure compliance but also providing strategic input to ensure grid reliability.

3. Operations Analysis for Renewables

Problem Statement

The Operations Planning outage analysis process involves evaluating the impact of ongoing and future generation and transmission outages against forecasted demand levels. Evaluation begins 6 months prior to start of a transmission outage with the study frequency and quality of data improving as we get closer to the scheduled start. Traditionally, PJM's outage analysis processes mainly focused on evaluating the peak hour of the day, which has been considered as the most conservative. The analysis assumed a predictable generation dispatch following a

conforming load profile. With the introduction of intermittent generation that's located in front and behind the meter, the impact of varying generation and load profiles at different time frames needs to be taken into consideration.

Project Description

PJM performed a holistic review of the outage analysis process, including internal discussions and meetings with neighboring ISOs/RTOs, to consider improvements which would allow engineers to more accurately forecast conditions for a system with a high penetration of renewable generation. The effort identified a number of changes that PJM will be considering to implement in the future:

- Perform sensitivity studies during the mid-term study timeframe to identify areas sensitive to intermittent generation and coordinate transmission outages to avoid conflicts caused by the sensitivity.
- Provide the ability to retrieve solar and wind forecasts, by hour, into the EMS study package. This ensures that all the intermittent generation is at an appropriate level for the study period.
- Enhance automation and associated tools to create a summary report that identifies and helps visualize areas of concern for non-peak time periods within the day based on forecasted system conditions. The summary report would be used in conjunction with current manual study processes for the near-term period to help identify high risk timeframes of a future operating day.

4. Reserve Certainty

Refer to the Markets Roadmap for the details of this effort. PJM Operations and Markets will remain closely coordinated to ensure that the reliability needs of the system are supported by the PJM markets.

<https://www.pjm.com/-/media/committees-groups/committees/mic/2024/20240710/20240710-item-06-1----market-design-project-road-map.ashx>

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