Market Design Project Road Map

Market Design and Economics

July 3, 2024

For Public Use

Contents

Overview

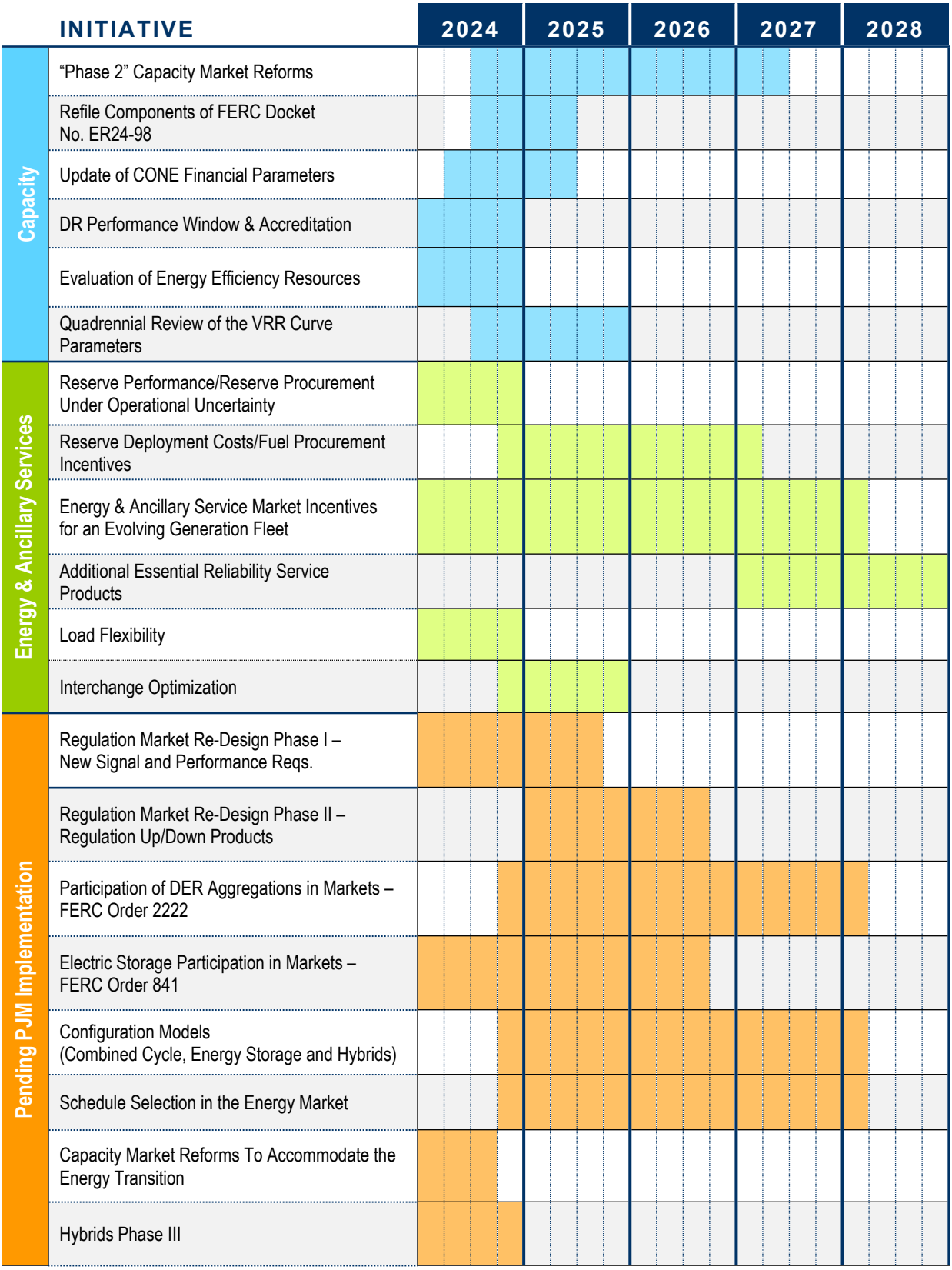
The purpose of this document is to provide transparency regarding the market design changes PJM feels are necessary and timing associated with them. This roadmap reflects PJM's thinking as of the date of publication of this document and is in no way intended to foreclose on other important, necessary, changes that may arise in the future. PJM fully expects that this will be a living document that will require periodic updates as issues are opened and closed and as timelines shift as PJM and the stakeholders prioritize their efforts.

As part of Ensuring a Reliable Energy Transition, PJM is taking steps to maintain reliability as we progress through the energy transition. PJM has identified three time frames for reliability concerns: immediate, near term and upcoming. The immediate concern supports the need for excellence in resource performance based on learnings from Winter Storm Elliott. The near-term concern seeks to ensure resource adequacy based on the recent Energy Transition in PJM: Resource Retirements, Replacements & Risks (PDF) report. The upcoming concern seeks to maintain and attract essential Reliability Services and the need for flexibility in generation as recommended in both the Energy Transition in PJM: Frameworks for Analysis (PDF) and Energy Transition in PJM: Flexibility for the Future (PDF) papers. PJM and stakeholders have worked on some of these concerns, but more action needs to be taken.

The Market Design Project Road Map outlines the key market initiatives and the expected timelines for the projects necessary to remain responsive to the energy transition. Projects in the Market Design Road Map include current and potential future stakeholder issues that impact market rule changes. For each initiative, the document briefly describes the issue to be solved, the anticipated project deliverables and the expected timeline for the effort. The timeline is broken out into phases, including internal PJM design, stakeholder process, software development, and implementation, to display the entire lifecycle of each initiative. The project descriptions, deliverables and corresponding timelines reflect information known at the time of this document. Projects are categorized as (1) Capacity, (2) Energy & Ancillary Services and (3) Pending PJM Implementation initiatives.

CATEGORY	Description
Capacity	Initiatives in the Capacity section represent future projects that address concerns raised in the near term and seek to ensure resource adequacy.
Energy & Ancillary Services	Initiatives in the Energy & Ancillary Services section represent future projects that address immediate and upcoming concerns about supporting resource performance and seeking to maintain and attract essential reliability services.
Pending PJM Implementation	Initiatives in the Pending PJM Implementation section represent projects that are in different phases of the implementation process where they could be concluding the stakeholder process, pending a FERC filing, anticipating FERC approval, or approved by FERC and in software development.

Market Design Project Road Map



Capacity Road Map Narratives

1. "Phase 2" Capacity Market Reforms

Problem Statement

The capacity market reforms accepted by FERC in ER24-99 represented a substantial step forward in improving the status quo. They will help PJM to maintain resource adequacy in the near and long term. However, there was limited time in the Critical Issue Fast Path (CIFP) stakeholder process to work with stakeholders on certain areas of the market design to meet the filing deadline that was required to have the changes effective for the 2025/2026 BRA, which led to certain items being removed or simplified in both PJM's and other stakeholders' proposals. In particular, in the October 2023 FERC filings, PJM committed to "continue assessing the design of the capacity construct with stakeholders, including whether and how a seasonal capacity construct could help support reliability and efficiency for the PJM Region." Considering further reforms to the capacity market would allow PJM and stakeholders to build upon the recently approved reliability enhancements to better position the capacity market for the evolving reliability challenges expected in the region.

Project Description

The primary focus areas include:

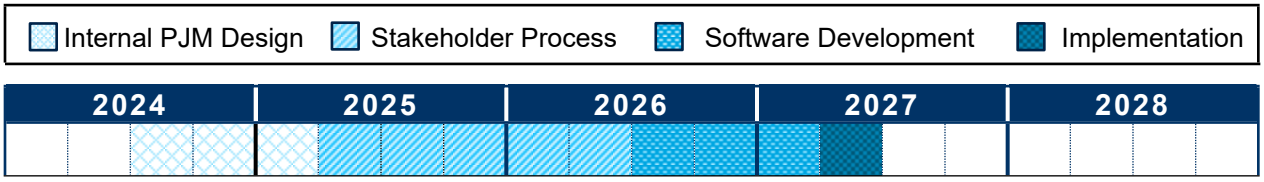
- Evaluating a seasonal or more granular capacity market design
- Improving the locational representation of supply and demand
- Assessing the forward period of the auction

Moving to a sub-annual procurement period aligns with the shifting patterns of reliability risk observed in PJM's new models, which show significantly more risk in the winter. This transition will impact various aspects of the market construct, requiring a comprehensive assessment of the tradeoffs between annual, seasonal and more granular designs. PJM will evaluate options for auction structure, demand curves, target reliability requirements and clearing mechanics under a sub-annual design, as well as the impact on cost allocation, market power mitigation rules and Capacity Interconnection Rights.

Improving the locational representation of supply and demand is crucial to ensure that accreditation and price signals reflect locational risks. This involves reviewing how supply resources and demand curves are represented in constrained regions of the RTO and evaluating conforming changes to a sub-annual market design and potential enhancements to the calculation of Capacity Emergency Transfer Limits.

Lastly, PJM will assess the benefits and tradeoffs of moving from a three-year forward Base Residual Auction to a prompt auction shortly before the delivery year starts. This change could improve reliability risk and accreditation modeling due to more accurate input data, but it may impact the timing of new entry or retirement decisions and the ability to evaluate future supply commitments against the need for transmission solutions. The role of incremental auctions will also be reviewed in light of the potential reduction of the forward period of the base residual auction.

Timeline: "Phase 2" Capacity Market Reforms



2. Refile Components of FERC Docket No. ER24-98

Problem Statement

On February 6, 2023, FERC rejected PJM's Filing ER24-98, which proposed Market Seller Offer Cap reforms, amendments to rules relating to non-performance during Performance Assessment Intervals, bonus eligibility and other topics. In the order, FERC agreed with PJM on several contested concepts and provided guidance for a potential future filing.

PJM had filed to allow resources to reflect incremental costs of taking on a capacity commitment without offsetting energy and ancillary service (EAS) revenues through a standalone Capacity Performance Quantifiable Risk (CPQR) adder. FERC agreed in principle but rejected the proposal due to a lack of specificity around the incremental costs.

Several other components of PJM's filing were not addressed in the order.

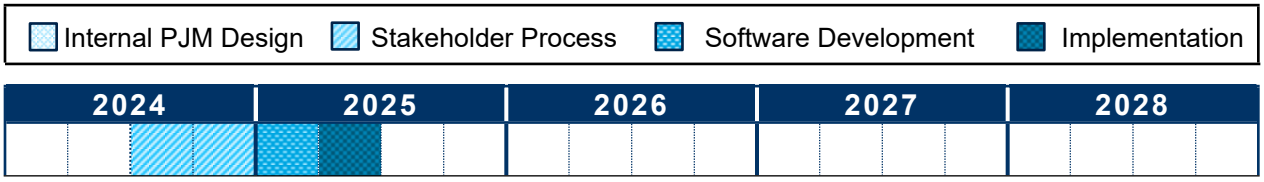
Project Description

In response to FERC's order, PJM proposes to re-file the following components:

1. Allow resources that do not plan to retire to include incremental going-forward costs of being committed as capacity, providing more specificity per FERC's guidance.
2. Additionally, PJM plans to re-file items not addressed in the order, including proposals on Forward EAS for MOPR/MSOC, offline resource excusal clarification and mitigation for planned generation.

The project will involve developing the revised filing components, engaging stakeholders for input, making any necessary adjustments based on feedback and, ultimately, re-filing the updated proposals with FERC.

Timeline: Refile Components of FERC Docket No. ER24-98



3. Update of CONE Financial Parameters

Problem Statement

The Cost of New Entry (CONE) is a critical component of PJM's capacity market, as it serves as a reference point for the price at which new resources are expected to enter the market. PJM conducts periodic reviews to ensure the

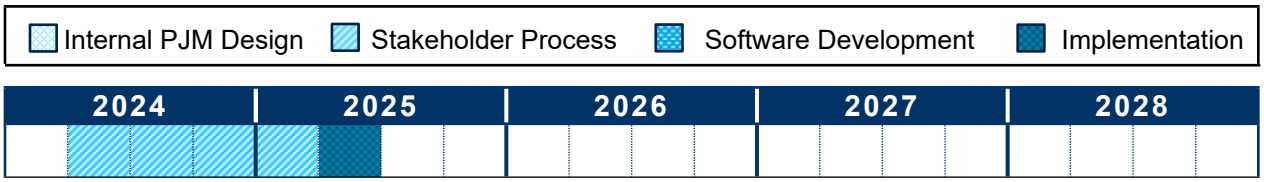
CONE accurately reflects the current costs and financial parameters associated with constructing and operating new capacity resources. The last Quadrennial Review, filed in 2022 and effective for the 2026/27 delivery year, saw a change in the reference technology from a combustion turbine to a combined cycle plant. The "gross cost of new entry" was based on construction cost estimates and financial parameters, such as cost inflation rates, cost of equity, and cost of debt, assessed at that time.

However, the extended lead time between the last Quadrennial Review and the applicable delivery year has allowed for significant changes in the financial landscape. PJM has reason to believe that the costs of debt and equity for constructing new combined cycle projects have increased substantially. These changes are expected to have a considerable impact on the gross CONE and, due to the calculation method that subtracts a substantial energy and ancillary service revenue offset, an even more pronounced effect on the "net" CONE. Failing to update the CONE to reflect the current understanding of financial costs could jeopardize the capacity market's ability to attract and retain sufficient resources to maintain reliability region-wide and in constrained locations. Specifically, the maximum price in the capacity market demand curve may be insufficient to incentivize resource attraction if it is at or below the reliability requirement.

Project Description

PJM plans to engage a consultant to re-evaluate the relevant financial parameters in a relatively short engagement to address this issue. The consultant will be tasked with reviewing the current costs of debt and equity for constructing new combined cycle projects and assessing their impact on the gross and net CONE values. The findings will be presented to stakeholders for feedback and discussion. Based on the consultant's recommendations and stakeholder input, PJM will file the necessary updates with the Federal Energy Regulatory Commission (FERC) to ensure that the CONE accurately reflects the current financial landscape and maintains the capacity market's ability to attract and retain sufficient resources for reliability.

Timeline: Update of CONE Financial Parameters



4. Demand Response (DR) Performance Window and Accreditation

Problem Statement

In the recent capacity market reforms accepted by FERC in ER24-99, PJM's enhanced risk modeling revealed that reliability risks shifted from summer to winter, where demand response (DR) is qualified to supply capacity but has a limited "performance window." Previously, most reliability risks occurred within the performance window, allowing DR to be accredited at 100%. However, with substantial risk outside the performance window, DR's reliability contribution was reduced without updating its expected performance time.

Furthermore, the current heuristic approach used to accredit DR – even within its performance window – somewhat simplifies the calculation of assessed available energy reduction potential across different hours of the year. While the error introduced by the heuristic is believed to be relatively small during the current performance window hours,

there is concern that it introduces larger errors during hours when DR loads are expected to be lower. Thus, extending the performance window without updating the assumptions used to assess the DR ELCC may overstate the reliability contribution of DR in those additional hours, thereby inappropriately and inefficiently displacing other resources, which could negatively impact reliability.

Enhancements to the modeling of DR in the capacity accreditation framework were not included as part of the packages voted on or ultimately filed pursuant to the CIFP.

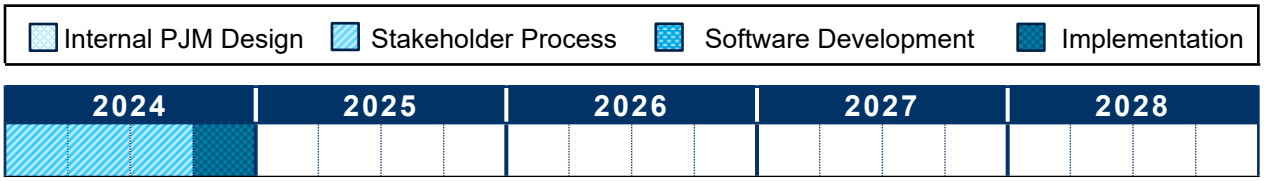
Project Description

PJM expects to evaluate the following with stakeholders:

- Develop a methodology that better assesses the actual reliability contribution of DR in all hours, including extended performance window hours, and that would provide confidence in extending the window.
- Explore the opportunity to introduce a 24-hour availability window DR product and gauge DR providers' interest in it.
- Determine whether to use a single DR product with a single performance window or multiple products with different defined performance windows to better fit diverse profiles across different loads and DR providers.

By addressing these issues, PJM aims to more accurately assess DR's reliability contribution, extend its performance window and offer products that better align with the diverse needs of loads and DR providers while ensuring overall system reliability.

Timeline: DR Performance Window and Accreditation



5. Evaluation of Energy Efficiency Resources

Problem Statement

Energy Efficiency (EE) Resources have participated in the PJM capacity market since the 2011/2012 Delivery Year. The original reason for these resources to participate in the capacity market was to reduce the load forecast and the amount of capacity procured to meet the reliability requirement. Since their introduction in the capacity market, many significant changes have occurred, and stakeholders have not had an opportunity to review the participation of the resources thoroughly. The key reasons for why it is now timely to revisit the rules governing the involvement of EE Resources include:

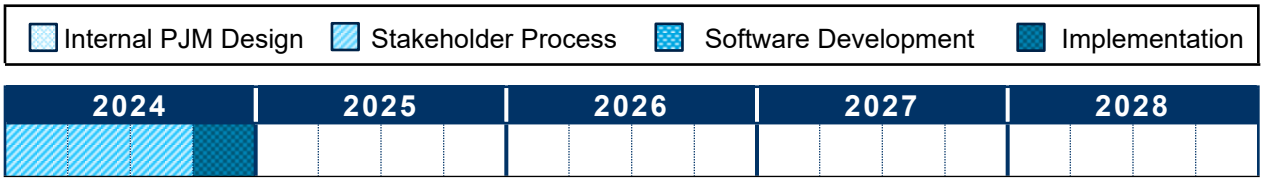
- EE Resources participating in the capacity market have dramatically grown from 78 MW in 2011/2012 to 7,669 MW for the 2024/2025 Delivery Year, representing about 5% of the total capacity procured.
- The IMM and PJM have recommended reviewing EE participation in the wholesale market in prior reports.

- Building standards, which are the benchmark for determining EE savings, continue to increase, thereby reducing the savings associated with additional EE measures.
- Existing measurement and verification rules have not been updated since the inception of EE Resource participation.

Project Description

PJM has been reviewing the EE participation rules with stakeholders at the MIC. The initial focus has been on measuring and verifying EE, and PJM has proposed various improvements in this area to better ensure that energy savings attributed to EE Resources are accurate and reasonably consistent across providers. PJM has also proposed reforms to the broader EE participation rules that include changes to the qualification requirements for EE to participate in the capacity market, as well as changes to the assessment of EE performance during Performance Assessment Intervals.

Timeline: Evaluation of Energy Efficiency Resources



6. Quadrennial Review of the VRR Curve Parameters

Problem Statement

The PJM Open Access Transmission Tariff (OATT) mandates a periodic assessment of key parameters of the Variable Resource Requirement (VRR) Curve, an administratively determined representation of demand used in the capacity market auction. The Quadrennial Review of VRR Curve parameters is crucial to ensure that the RPM continues to support reliability objectives cost-effectively.

In the last Quadrennial Review, PJM updated the reference technology for the CONE from a combustion turbine to a combined cycle. However, there is a growing need to evaluate other technologies, especially in areas of the PJM footprint where fossil fuel resources are either prohibited by law or de facto, based on permitting practices, or uneconomic due to policies encouraging clean energy resources and/or retiring fossil resources by a future date certain. This necessitates the evaluation of alternative new technologies, including batteries and renewable/battery hybrids, and assessing their costs.

Project Description

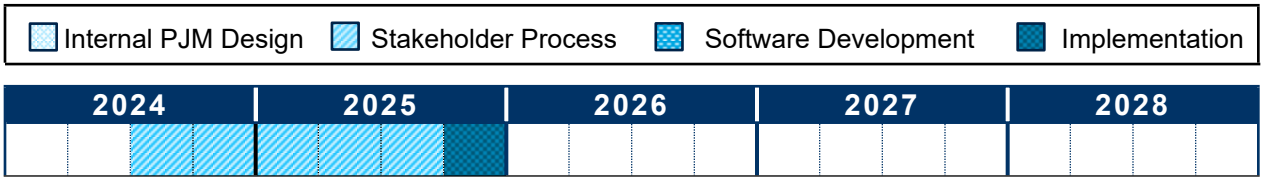
The Quadrennial Review project involves a comprehensive assessment of the CONE, the methodology used to determine Energy & Ancillary Service Revenues, and the shape of the VRR Curve. PJM typically engages a consultant to evaluate the performance of the VRR Curve, parameters, CONE and net CONE.

In addition to the standard review process, PJM will thoroughly analyze alternative technologies, focusing on batteries and renewable/battery hybrids. This analysis will include:

- Assessing the current and projected costs of these technologies
- Evaluating their potential to provide reliable capacity
- Examining the impact of state and federal policies on the economic viability of these technologies within the PJM footprint
- Developing recommendations for incorporating these technologies into the VRR Curve parameters, if appropriate

Furthermore, PJM will engage stakeholders throughout the review process to gather input and feedback on the proposed changes to the VRR Curve parameters. This engagement will ensure that market participants' final recommendations are well informed and broadly supported.

Timeline: Quadrennial Review of the VRR Curve



Energy & Ancillary Services Projects

1. Reserve Performance

Problem Statement

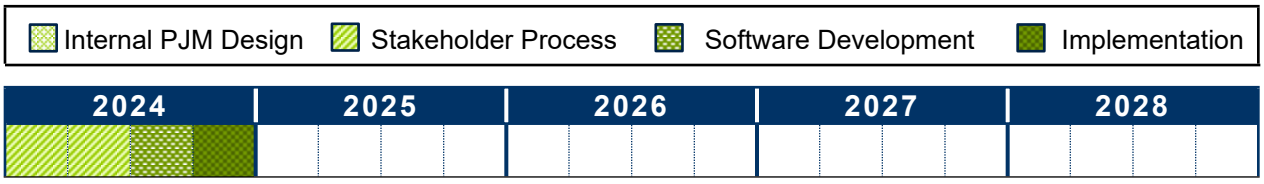
In the year following the implementation of Reserve Price Formation, the average response rate for Synchronized Reserve (SR) Resources during SR events was 43.7%. That poor performance has led to reliability concerns and a 30% increase in PJM's reliability requirement. Following outreach to market participants and a review of current practices and incentives, PJM has concluded that the lack of performance from SR Resources is driven by several factors, including confusion around the current reserve deployment mechanism, which relies on an All-Call message to all resource operators, communication delays that occur when the All-Call is relayed and, in some cases, a misalignment in financial incentives for resources to follow reserve deployment instructions.

In addition to concerns about SR performance, gaps in offline reserve resource performance evaluation and non-performance penalties have led PJM to identify areas for improvement. Non-Synchronized Reserve (NSR) Resources are only subject to a performance evaluation and non-performance penalties when deployed within an NSR event. However, PJM rarely, if ever, deploys NSR in a manner similar to a Synchronized Reserve Event. PJM dispatchers will instead call NSR Resources online to provide energy as needed. This presents an opportunity to update current performance evaluation and penalty business rules to better reflect how these resources are used to support system operation and reliability.

Project Description

Within the Reserve Certainty Senior Task Force (RCSTF), PJM is advancing immediate reforms to tackle acute issues contributing to reserve underperformance. PJM is proposing changes to how SR Resources are deployed during an SR event to eliminate communication delays introduced by the All-Call and to align SR deployment instructions with normal dispatch instructions. Additionally, PJM is proposing updates to the performance evaluation methodologies for both SR and NSR, as well as new penalty and make-whole payment rules to align financial incentives with PJM deployment instructions.

Timeline: Reserve Performance



2. Reserve Procurement Under Operational Uncertainty

Problem Statement

Different operating conditions inherently entail different levels of risk and uncertainty. As an example, currently, PJM's 30-Minute Reserve Reliability Requirement is set as the greater of: 3,000 MW, the Primary Reserve Reliability Requirement or the Largest Active Gas Contingency. The flat, 3,000 MW value in this calculation does not reflect how risk changes from day-to-day based on demand, nor does it account for the primary risk-drivers that PJM

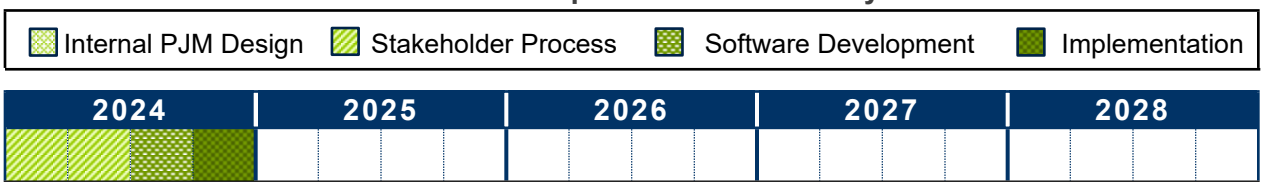
operators must consider to ensure reliability. Additionally and more broadly, PJM's manuals, Tariff and the Operating Agreement are currently written such that PJM is unable to reflect actions taken by system operators to maintain reliability and compliance with NERC Standards in the Reserve Market. This separation between the operating plan and actions taken by system operators and what the market is permitted to clear and price can lead to operators taking out-of-market actions for reliability reasons that are done manually and dampen market price signals. Aligning system operator needs with the reserve requirements in the market is a more optimal approach to taking out-of-market actions which will increase transparency and produce market results consistent with operational needs.

Project Description

Within the RCSTF, PJM is proposing a reform to allow all three reserve and extended reserve requirements (i.e., synchronized, primary and 30 minute) to be adjusted independently as needed to reflect operating risks and uncertainty. Additionally, PJM is proposing to update the 30-Minute Reserve Reliability Requirement to replace the static 3,000 MW value with a calculation that considers the forecasted peak demand for the operating day, the average forced generator forced outage rate, and the average under-forecasted load forecast error.

These changes address only a portion of what PJM views to be a more significant overall set of reforms to align actions taken by system operators and markets.

Timeline: Reserve Procurement Under Operational Uncertainty



3. Reserve Deployment Costs Within the Market

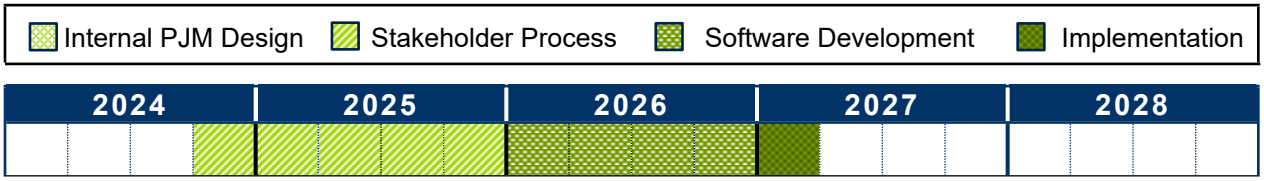
Problem Statement

Currently, the costs incurred from converting SR capability into energy when SR Resources are deployed are not directly accounted for in any of PJM's markets. Reserves are procured through a co-optimization with energy, and the SR market is cleared based on minimizing overall production costs. The cost of SR is driven by resource offers (up to the offer cap, which is calculated based on expected penalties) and lost opportunity cost. As a result, it is common that SR capability is cleared on resources with higher energy costs because those resources are not the most cost-effective to provide energy and less likely to incur lost opportunity costs. When SR Resources are deployed under the current reserve deployment paradigm, the cost of producing that energy may not be recoverable through the energy market in all cases.

Project Description

Ensuring that PJM markets appropriately capture the costs associated with utilizing system flexibility will be increasingly critical as the energy transition drives new levels of operational uncertainty. Drawing from an analysis of historical operations and practices at other ISOs and RTOs, PJM will explore different market designs that more directly address reserve deployment costs and bring forward a proposed set of solutions to stakeholders.

Timeline: Reserve Deployment Costs Within the Market



4. Fuel Procurement Incentives

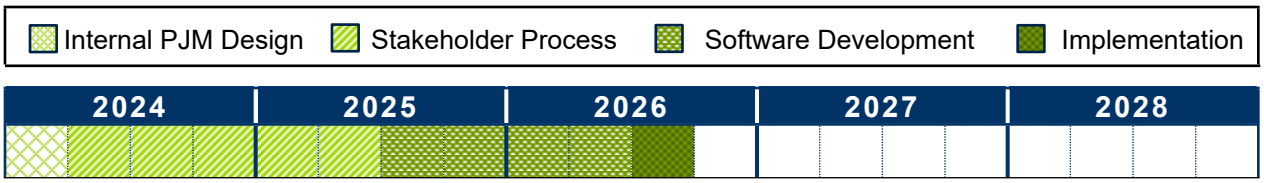
Problem Statement

PJM has observed instances where certain resources that could provide energy or reserves are unavailable due to fuel availability. Lack of timely fuel procurement when it may not be available on demand, specifically for gas-fired generators, can lead to inaccurate reserve calculations when resources are later called on to generate and cannot get fuel. The Electric Gas Coordination Senior Task Force has advanced reforms to align operators' reliability actions with the natural gas nomination cycles. There is an opportunity to build on this work to clarify fuel procurement expectations when natural gas may be unavailable on demand and to address how the costs associated with fuel arrangements could appropriately be reflected in PJM markets.

Project Description

PJM will explore reforms to ensure that procured offline reserves are available to provide energy when called upon. This project will build on some of the foundational work done to address reserve performance issues, including the proposed reforms to the performance evaluation and penalties for non-performance of offline reserves discussed previously. PJM will draw on lessons learned from recent winter storm events and do a landscape analysis of how other ISOs and RTOs address fuel assurance to inform a proposed set of new market rules to bring to stakeholders.

Timeline: Fuel Procurement Incentives



5. Energy & Ancillary Service Market Incentives for an Evolving Generation Fleet

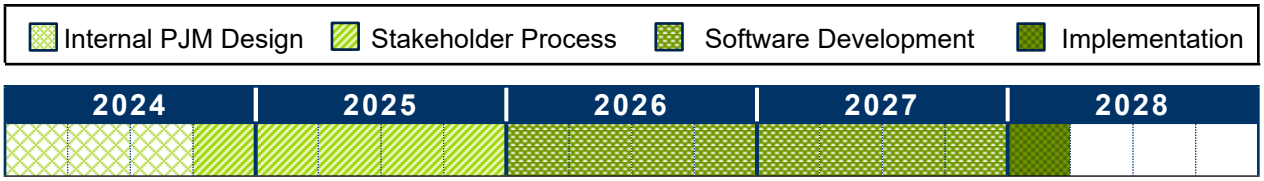
Problem Statement

In *Modernizing Wholesale Electricity Market Design, FERC Docket No. AD21-10*, PJM, other ISO/RTOs and various commenters detail how the shifting electricity system resource mix and the growing quantity of distributed energy resources are causing uncertainty and volatility in markets and operations. New products will be required to address forecast uncertainty and future ramping needs, and markets need to accurately reflect the value of flexible capacity in maintaining system reliability.

Project Description

PJM is analyzing system flexibility needs now and into the future. Building upon this analysis and best practices from other regions, PJM will begin discussions on energy and ancillary service market reforms to address these system needs with a focus on maintaining reliability in the face of the changing resource portfolio. As a part of this project, PJM will consider a broad range of reforms, including new market products, product participation requirements, advanced approaches to unit commitment and dispatch, and how costs should be allocated. As PJM considers new and existing products, locational aspects will be considered to ensure that services are procured and deployed in a way that ensures deliverability, appropriately manages constraints and maintains system reliability. PJM will then develop a proposed set of market reforms to be brought before stakeholders.

Timeline: Energy and Ancillary Service Market Incentives for an Evolving Generation Fleet



6. Additional Essential Reliability Services

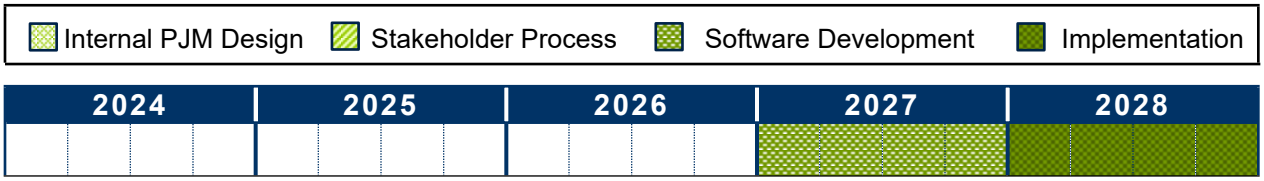
Problem Statement

Markets may be able to play a critical role in maintaining and attracting the Essential Reliability Services required for a stable and reliable electrical grid, including voltage control, frequency support and ramping capability. As the energy transition progresses, these services' requisite quality, quantity and nature will evolve. PJM must continuously monitor and forecast this evolution to ensure that its markets appropriately procure and incentivize these essential services.

Project Description

PJM continues to lay the groundwork for the energy transition by evaluating how the changing resource mix will drive the need for additional Essential Reliability Services in the future. In 2023, PJM collected data and conducted analyses to identify metrics that create more transparency around PJM's operational flexibility needs. In 2024, PJM is working with a consultant to co-design and complete a scenario-based study to prioritize key reliability risks associated with the grid of the future. These efforts provide a foundation for future analysis, including the metrics, tools and analytical approaches required to evaluate evolving system needs. This project represents a continuation of this work and will help prioritize ongoing market design initiatives.

Timeline: Additional Essential Reliability Services



7. Load Flexibility

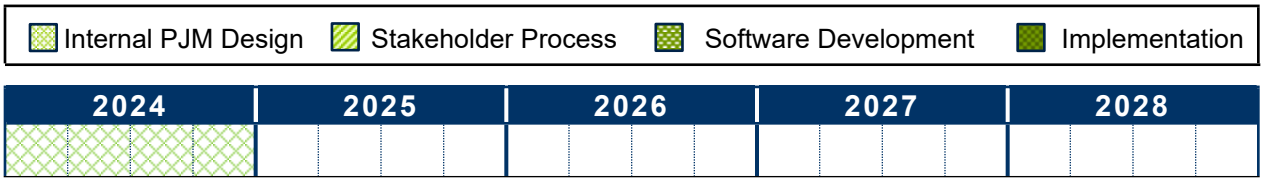
Problem Statement

PJM believes additional opportunities need to be explored with load flexibility in the electric grid. There is value not only in utilizing demand to help reduce grid stress in emergencies, as the existing demand response programs achieve, but also in looking at load to help balance intermittency, delay otherwise costly improvements for system reliability and establish robust markets with load participation. There is an opportunity to explore the current gaps in demand participation in PJM's markets today and identify opportunities for enhancements or reforms in the future.

Project Description

PJM's internal staff will undergo an initiative to complete research on load flexibility and the role, opportunities, and challenges for load flexibility in PJM's market. PJM will review the existing load flexibility and gaps in PJM's market. This review will encompass existing market pathways, demand response, price-responsive demand, distributed energy resources (DER), and behind-the-meter capabilities. Additionally, PJM will examine how to incorporate load flexibility into the demand curves. Further, the research will look at ways or opportunities to increase the load participation in PJM's market in the future. PJM will explore analysis and recommendations on furthering the ability to reflect the load's willingness to pay in the demand curves, potential new or refined pathways/products for load participation, and a specific look at large loads (data centers, bitcoin, etc.) and their ability to operate as flexible demand in the PJM footprint.

Timeline: Load Flexibility



8. Interchange Optimization

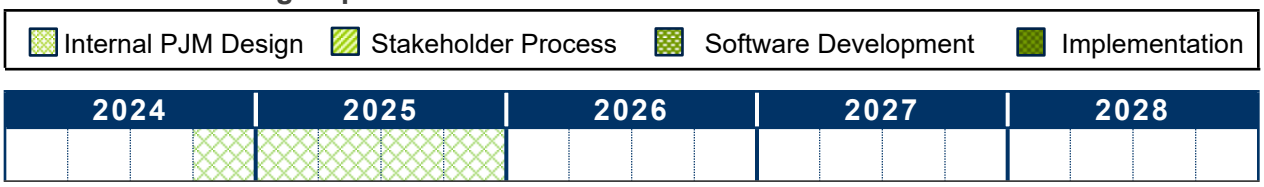
Problem Statement

The Energy Transition in PJM: Flexibility for the Future (PDF) paper highlights the need for increased coordination between interconnected systems. The fourth phase of PJM's ongoing initiative to assess the impacts of integrating increasing numbers of renewable resources explores the longer term-challenges that might arise if current state and federal energy policies are fully implemented or accelerated. The study addresses the complexity of the energy transition and the need for flexibility in generation resources and coordination of interregional interchange as increasing levels of intermittent resources create significant variability in generation output.

Project Description

PJM's internal staff, in coordination with our neighboring ISO/RTOs, will explore opportunities to enhance existing interchange optimization products, such as Coordinated Transaction Scheduling, and look to identify new opportunities to more fully manage and coordinate available transfer capability.

Timeline: Interchange Optimization



Pending PJM Implementation Projects

1. Regulation Market Design

Problem Statement

PJM's current Regulation Market utilizes two regulation signals (RegD and RegA) to dispatch of the regulation product. Using two signals but clearing them in a single market with a single requirement requires an accurate marginal rate of substitution, the benefits factor, to be utilized in the optimization. There are existing issues with how the benefits factor is currently applied in the optimization and how it is utilized in pricing and settlements. There is also the opportunity to reevaluate other operational and market components of the current Regulation Market design to ensure they align with the changing resource mix and operational needs.

Project Description

The Regulation Market Design Project will address Regulation Market design flaws and potential enhancements, including regulation signal design, regulation performance scoring, regulation requirement, Regulation Market clearing and Regulation Market settlement.

Stakeholder Materials

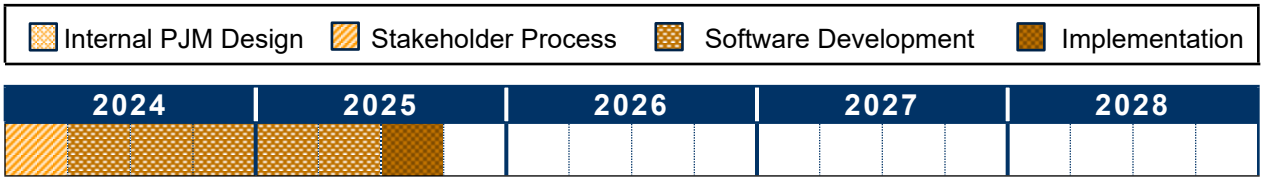
Regulation Market Design Senior Task Force

FERC Filing

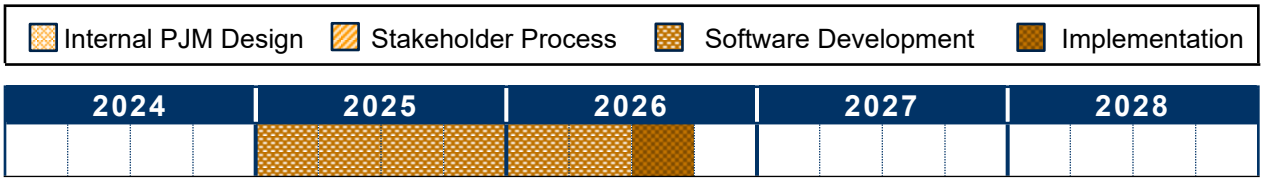
PJM Filing ER24-1772-000 (PDF)

FERC Order (PDF)

Timeline: Regulation Market Design (Phase 1)



Timeline: Regulation Market Design (Phase 2)



PJM filed Regulation Market reforms with FERC on April 16, 2024. PJM proposed a phased implementation approach to allow for more development and implementation time for both PJM and Members to move to the Up/Down Products. The Phase I implementation would occur in Q4 2025 and include the changes for the new signal and performance requirements. Phase II implementation would occur one year later in Q4 2026, when the splitting of the market clearing and operational signals would be included to effectuate the up/down products.

2. Participation of DER Aggregations in Markets – FERC Order 2222

Problem Statement

On Sept. 17, 2020, FERC issued Order 2222. The main goal of Order 2222 is to better enable distributed energy resources (DER) to participate in the wholesale electricity markets. The term "DER" covers a wide variety of resources, including electric battery storage systems, rooftop solar panels, products like smart thermostats that enable one to reduce power usage, energy efficiency measures, thermal energy storage systems such as ice storage, or electric vehicles and their charging equipment.

Since DER can be small compared to traditional resources like power plants and may be widely dispersed, the output of several or many DER would often need to be combined together so that there is a "bundle" of sufficient size for market participation. This bundle is called an *aggregation*, with the *aggregator* directly participating in the ISO/RTO. An aggregator, for example, may be able to bring together dozens of small DER and use their output to participate in the market, then share compensation back to the individual DER. This is easier to administer than having thousands of individual DER participating directly in the market.

In short, FERC's goal with Order 2222 is to remove barriers to DER aggregations' participation in the capacity, energy and ancillary services markets operated by RTOs/ISOs.

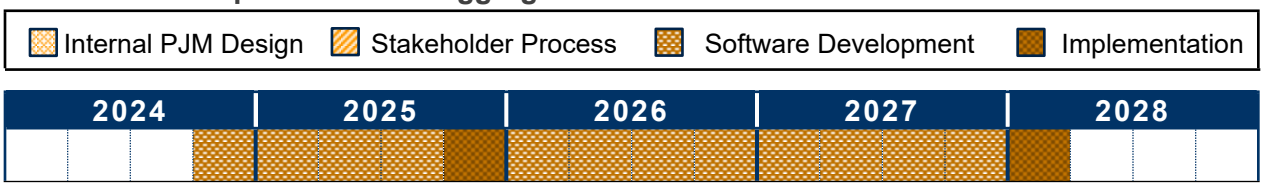
Project Description

PJM's Order 2222 filed proposal allows DER aggregation resources to be eligible to participate where they are technically and procedurally capable in all PJM's markets – this includes the Day-ahead Energy Market, Real-time Energy Market, ancillary services markets (Regulation and Reserves) and capacity market.

Stakeholder Materials
Order 2222 was discussed at a variety of meetings of the Distributed Resources Subcommittee.

FERC Filings
- PJM Compliance Filing ER22-962-000 (PDF)
- PJM Compliance Filing ER22-962-005 (PDF)
- Order on Capacity Market Participation Effective Date (PDF)

Timeline: Participation of DER Aggregations in Markets – FERC Order 2222



3. Electric Storage Participation in Markets – FERC Order 841

Problem Statement

FERC Order 841 addresses the participation of electric storage resources in the capacity, energy and ancillary services markets operated by ISO/RTOs. To remove barriers to their participation in wholesale markets, Order 841 requires each ISO/RTO to establish a participation model consisting of market rules that – recognizing the physical and operational characteristics of electric storage resources – facilitate their participation in the ISO/RTO markets.

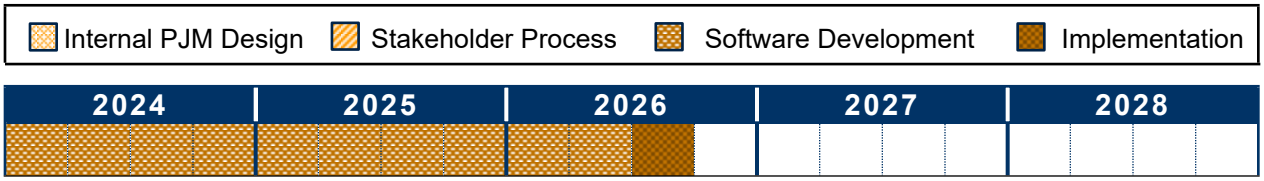
Project Description

While PJM's Electric Storage Resource (ESR) model went into production in 2019, the current model does not account for the state of charge in the dispatch. This requires market participants to manage their state of charge and can result in PJM providing an infeasible dispatch to the resource. PJM has a compliance requirement with FERC to update the model in 2026 to "account for state-of-charge." This enhancement will allow the engine to use the state of charge of the resource as a constraint to the dispatch and eliminate providing the ESR with an infeasible schedule due to available state-of-charge.

Stakeholder Materials
- PJM Issue Tracking: Electric Storage Participation – FERC Order 841

FERC Filings
- PJM Compliance Filing ER19-469-003 (PDF)
- PJM Compliance Filing ER19-469-005 (PDF)
- PJM Compliance Filing ER19-469-006 (PDF)

Timeline: Electric Storage Participation in Markets – FERC Order 841



4. Configuration Models

Problem Statement

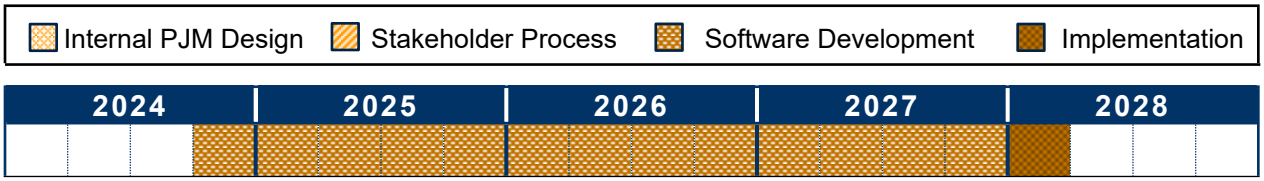
PJM's market software does not currently model various operating modes of configuration-based resources like combined cycles. While workarounds exist, parameters such as start-up cost, minimum run time, and minimum downtime of each combustion turbine and each steam turbine cannot be explicitly considered in the current model. The current model does not allow units to represent duct burners or other power augmentation methods.

Project Description

Multi-configuration models will be an important feature under the PJM Next Generation Market (nGEM) model. A multi-configuration model will be used for the Enhanced Combined Cycle, Energy Storage Resource and Hybrid Resource models. This modeling is needed in the market software to capture the resource parameters and operational characteristics best while allowing the PJM Market Clearing Engine (MCE) to commit and dispatch these resources best and maintain reliability reserve requirements.

Stakeholder Materials
Modeling Generation Senior Task Force

Timeline: Configuration Models



5. Schedule Selection in the Energy Market

Problem Statement

PJM markets currently allow generation resources to submit three types of schedules in the Day-ahead and Real-time energy markets: a market-based schedule (non-parameter limited) and two types of schedules used for mitigation: cost-based and market-based parameter-limited schedules. PJM's day-ahead commitment software is designed to commit resources based on the appropriate schedule offers, resulting in the lowest total system production cost. The MCE identifies the most cost-effective schedule by treating each schedule as a logical resource. This approach leads to a market resource represented by as many logical resources as eligible schedules. This method is known as the multi-schedule model in MCE optimization.

The multi-schedule model in MCE increases the optimization problem size and impacts the optimization solution time so that the commitment software requires more time to solve. The addition of enhanced combined cycle, energy storage resource, and hybrid models in PJM's Next Generation Markets (nGEM) clearing software will have a significant impact on performance that will jeopardize the clearing of the Day-ahead and Real-Time energy markets in the approved clearing time frame with sufficient accuracy.

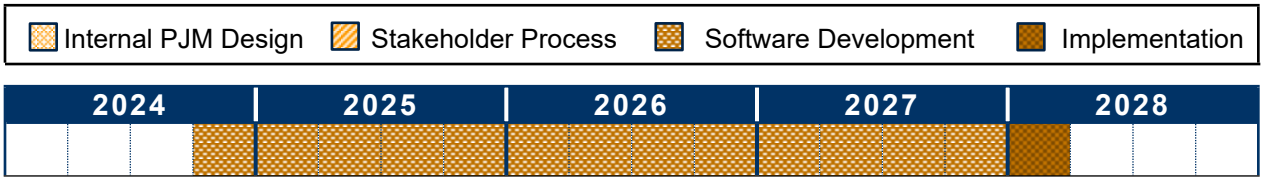
Project Description

Stakeholder Materials
PJM Issue Tracking: Performance Impact of multi-schedule model in MCE in nGEM ECC and ESR models

FERC Filing
FERC Docket No. ER24-1387-000 (PDF)

The offer schedule selection process for clearing the Day-ahead Energy Market needs to be reformed to address the performance impact of multi-schedule modeling on PJM's MCE resulting from the anticipated implementation of nGEM and the anticipated addition of configuration models in the nGEM clearing software. PJM has proposed to revise the approach for selecting the schedule on which resources may be committed in the Energy Market. Specifically, PJM proposes adopting the same schedule selection process currently used for clearing the Real-time Energy Market, such that the formula to determine the lowest dispatch cost among all eligible schedules will be extended to the Day-ahead Energy Market.

Timeline: Schedule Selection in the Energy Market



6. Capacity Market Reforms To Accommodate the Energy Transition

Problem Statement

The PJM Board of Managers initiated the CIFP stakeholder process in February 2023 to address resource adequacy challenges in the PJM capacity market. The PJM Board recognized the industrywide discussion regarding maintenance reliability during and through the energy transition. In response, the Board's primary focus in the CIFP was to resolve key issues that they believed would have a direct benefit to reliability and set the scope to include improvements in the following key capacity market areas: enhanced risk modeling, evaluation of potential

modifications to the Capacity Performance construct and alignment of permitted offers to the risk taken by suppliers, improved accreditation, and synchronization between the RPM and Fixed Resource Requirement (FRR) rules.

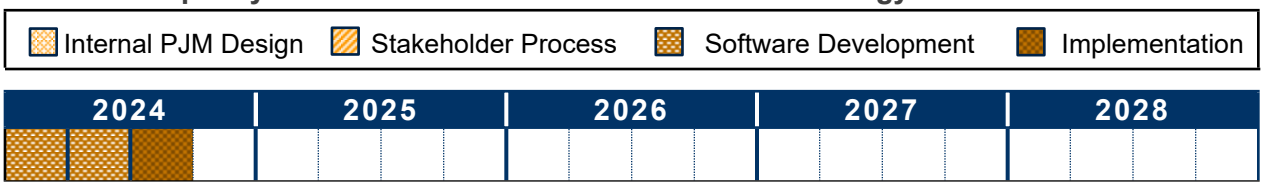
Project Description

PJM filed, and FERC accepted key reforms to the Reliability Pricing Model and related rules designed to enhance PJM's resource adequacy risk modeling and capacity accreditation processes and enhance testing requirements of Capacity Resources. These reforms will significantly improve the market signals conveyed by the capacity market by better aligning the market representation of capacity supply and demand with expected resource performance and system resource adequacy risks. These changes will also better balance demonstrated resource performance with financial incentives by increasing testing requirements and improve investability by removing extreme tail risk for Capacity Market Sellers via a reduction in the annual stop-loss limit. Finally, within these reforms are beneficial changes to the FRR alternative that allow time for transition to accommodate the modeling and accreditation changes but also align incentives for FRR entities to procure the required amount of capacity with the incentives to avoid a capacity shortfall in the rest of the PJM region.

Stakeholder Materials
- Critical Issue Fast Path – Resource Adequacy
- PJM Board letter regarding its decision within the Critical Issue Fast Path – Resource Adequacy process (PDF)

FERC Filing
FERC Docket No. ER24-99-000 (PDF)

Timeline: Capacity Market Reforms To Accommodate the Energy Transition



7. Hybrids Phase III

Problem Statement

Over the past three years, PJM and stakeholders have worked to define business rules for hybrid resources participating in PJM's markets. The first phase of this work focused on solar-storage hybrids. The second phase expanded the hybrid participation model to all types of inverter-based hybrid resources. The third phase of this work will focus on enhancements and/or clarifications to the existing market rules for these resources, as well as the definition of additional market rules for non-inverter-based hybrid configurations (e.g., gas plus storage).

Project Description

The scope of this work will focus primarily on enhancements and clarification to the existing business rules for inverter-based hybrid resources and energy storage resources, including enhancements to the existing rules and definitions for inverter-based open and closed-loop hybrid resources, hybrid resource LOC calculations and must--offer requirements. This effort will also consider what changes may be required to the hybrid market model to enable the participation of non-inverter-based hybrids such as gas plus storage.

Stakeholder Materials

PJM Issue Tracking – Hybrid Phase III Issue Details

Timeline: Hybrids Phase III