

The Cost of Permitting Delays: Long-Term Impacts on Electricity Prices and System Reliability

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BOTTOM LINE UP FRONT: PERMITTING REFORM IS NOT ONLY A DEVELOPMENT ISSUE, BUT A CENTRAL DETERMINANT OF LONG-TERM ELECTRICITY AFFORDABILITY, RELIABILITY, EMISSIONS, AND REGIONAL ECONOMIC COMPETITIVENESS

Over the next two decades, permitting and interconnection delays will reshape wholesale electricity markets in PJM at a time when demand is accelerating due to artificial intelligence (AI), data centers, electrification, and the onshoring of manufacturing. When delivery timelines become the binding constraint, markets prioritize resources that can be deployed most quickly. This shifts investment away from firm capacity resources. The result is a system that requires more total installed capacity to meet demand, yet remains exposed during critical hours when reliability is most needed. These timing-driven distortions lead to higher wholesale electricity costs, increased reliance on higher-cost marginal generation, and elevated emissions during periods of peak system stress. In this context, permitting delays do not simply slow development; they alter investment pathways, resulting in a more expensive, less reliable, and less efficient power system over time.

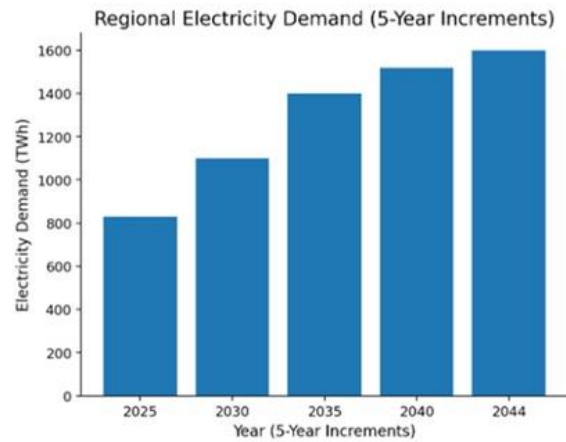
The United States Energy Association (USEA) and **Energy Exemplar** formed a partnership to analyze the PJM Interconnection, combining policy expertise with advanced power system modeling capabilities. USEA is a U.S.-based, nonpartisan organization that supports energy sector development and analysis domestically and globally. Energy Exemplar provides industry-leading simulation tools and datasets. The study leverages Energy Exemplar's **PLEXOS** platform, a widely used production cost and capacity expansion model that enables detailed representation of electricity markets, dispatch dynamics, and long-term investment decisions under varying system constraints. Together, this collaboration provides a rigorous, data-driven foundation for evaluating how permitting and interconnection delays affect cost, reliability, and system outcomes.

OVERVIEW

From 2000 to 2024, electricity demand growth in PJM increased by 0.64% annually. The growth was slow enough that delays in individual projects rarely posed a system-wide risk. That context has changed. In the PJM Interconnection, the largest U.S. wholesale electricity market and grid operator, responsible for coordinating generation, transmission, and market operations across 13 states and ensuring reliable system performance under evolving demand and infrastructure constraints, demand is now driven by data centers, artificial intelligence workloads, electrification, and broader economic growth. At the same time, significant portions of the existing generation fleet are retiring, and new resources face longer and more uncertain development timelines.

These trends have made **delivery timing** a central factor in whether the system can meet demand reliably and affordably. Interconnection backlogs and permitting delays are often discussed as administrative challenges, but in practice they shape system outcomes. When needed infrastructure arrives late, the system must adapt, sometimes in ways that are effective in the short term but costly over the long run.

Rather than asking whether permitting slows development (a widely accepted premise), this analysis evaluates how delivery constraints change investment timing, resource choices, and reliability outcomes in PJM under conditions of rising demand. The focus is not on any single technology, but on how the system responds when timing becomes the binding constraint. This paper examines the impact of permitting delays in PJM on capital investment in new generation, wholesale electricity prices, unserved energy, and broader regional economic outcomes. To isolate the effects of delivery timing, the analysis evaluates three scenarios that are identical in demand growth, technology costs, and system assumptions, but differ in how quickly new resources can be brought online.



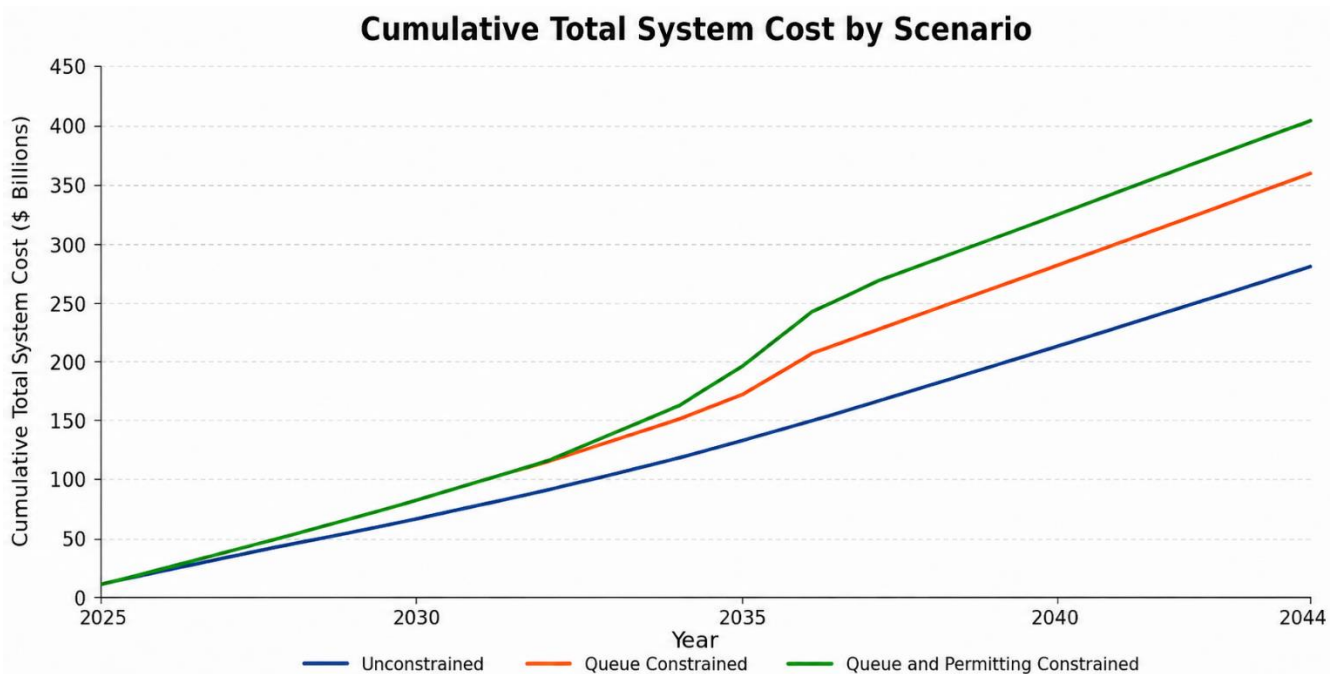
- **The Unconstrained Economic Baseline** represents a system in which generation and infrastructure can be developed and interconnected without delay, reflecting the least-cost resource mix under ideal conditions.
- **The Queue Constrained Scenario** incorporates limits in the interconnection process, where only a finite volume of projects can advance each year, delaying otherwise economic resources.
- **The Queue and Permitting Constrained Scenario** further reflects real-world development constraints by adding siting, environmental review, and local permitting delays that extend project timelines beyond interconnection bottlenecks.

By holding all other variables constant, this framework isolates the effect of delivery constraints on system outcomes, enabling a clear assessment of how timing, not technology or policy preference, reshapes investment decisions, cost trajectories, and reliability risk in PJM’s evolving power system. This analysis used PLEXOS, a widely respected modeling platform that supports power system optimization, simulation, and analytics. This specific study used PJM’s published demand forecast alongside Energy Exemplar’s PJM long-term dataset.

PERMITTING DELAYS DRIVE HIGHER COSTS AND INCREASED RELIABILITY RISK IN PJM

The figure below illustrates how permitting and interconnection constraints translate into materially higher electricity system costs over time in PJM. Under the **Unconstrained Economic Baseline**, total system costs remain comparatively low and increase gradually, reflecting an optimized buildout in which the most efficient mix of resources is delivered when needed. In contrast, the **Queue Constrained Scenario** shows a consistent upward shift in costs across the planning horizon, as delays in the

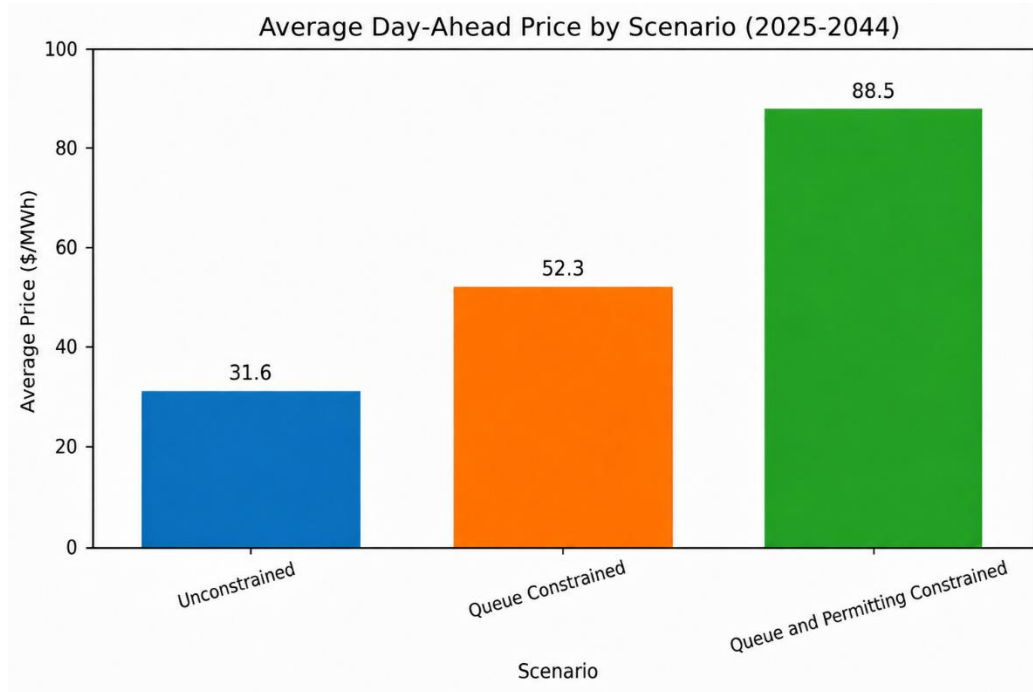
interconnection process prevent timely deployment of economically preferred resources, requiring additional capacity and higher-cost operational adjustments.



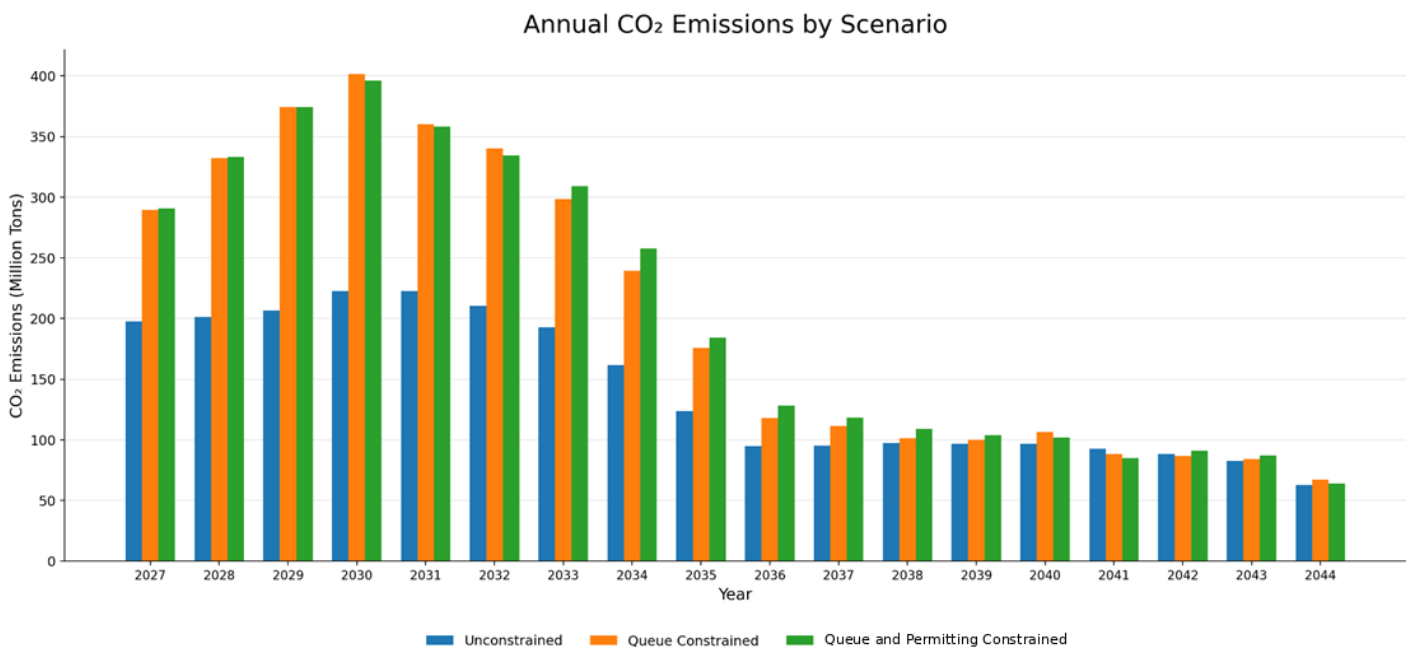
The divergence becomes most pronounced in the **Queue and Permitting Constrained Scenario**, where costs rise sharply beginning in the early 2030s and remain significantly elevated through 2045. This reflects the compounding effect of both interconnection bottlenecks and permitting delays, which push critical resources beyond key reliability windows. As a result, the system must rely more heavily on readily deployable but less efficient resources, while also building excess capacity to compensate for timing gaps. The outcome is a structurally higher-cost system that delivers less reliable performance during periods of peak demand.

Importantly, the widening gap between scenarios over time demonstrates that permitting delays do not create a one-time cost increase; they alter the long-term investment pathway. Early delays drive near-term cost escalation, but the resulting resource mix (selected based on deliverability rather than system value) continues to impose higher costs for decades. This dynamic underscores that **permitting reform is not only a development issue, but a central determinant of long-term electricity affordability, reliability, and regional economic competitiveness.**

PERMITTING DELAYS INCREASE COSTS AND RELIABILITY RISK



The substantially higher average prices observed in the Queue Constrained and Queue and Permitting Constrained scenarios reflect structural scarcity in available generation capacity. As system constraints delay the entry of new, lower-cost resources, the market increasingly relies on higher-cost marginal units to meet demand. This shifts dispatch toward the far right of the merit order curve, where less efficient and more expensive generators (such as oil-fired steam units or other peaking resources) set the clearing price.

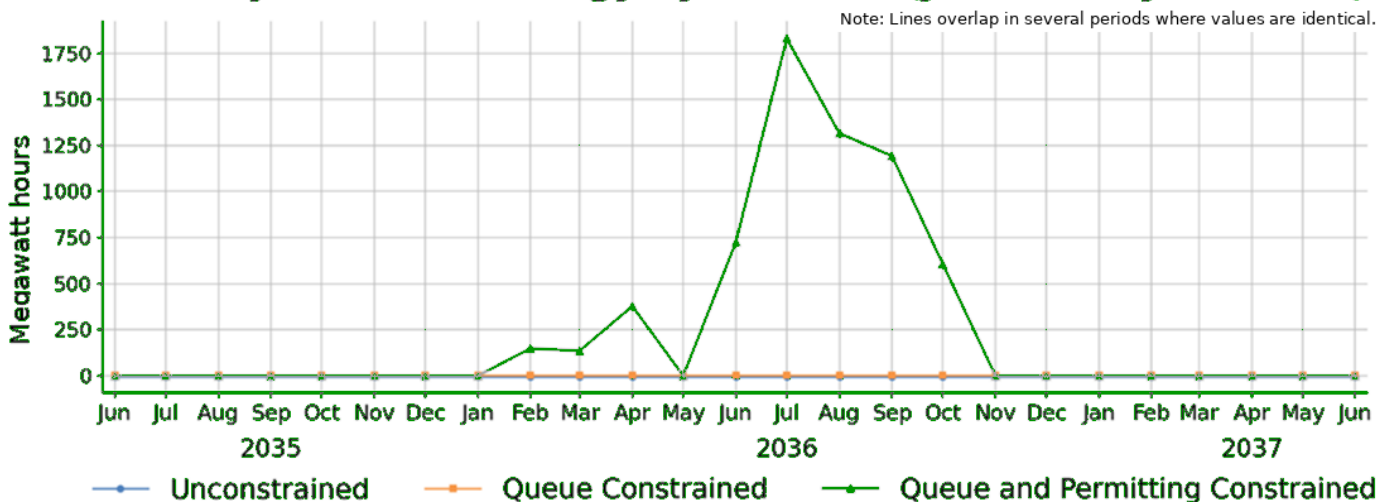


The figure above illustrates projected annual CO₂ emissions across three scenarios (Unconstrained, Queue Constrained, and Queue and Permitting Constrained), highlighting how delivery delays shape emissions trajectories over time. Emissions rise across all scenarios through approximately 2030, reflecting increasing electricity demand and the continued reliance on existing generation resources. However, the constrained scenarios consistently exhibit higher emissions than the unconstrained baseline during this period, indicating that delays in bringing new capacity online force greater utilization of existing, often more carbon-intensive generation. The divergence is most pronounced in the early-to-mid 2030s, where the Queue and Permitting Constrained case reaches the highest peak, underscoring how timing constraints can exacerbate near-term emissions outcomes even when long-term system composition remains similar.

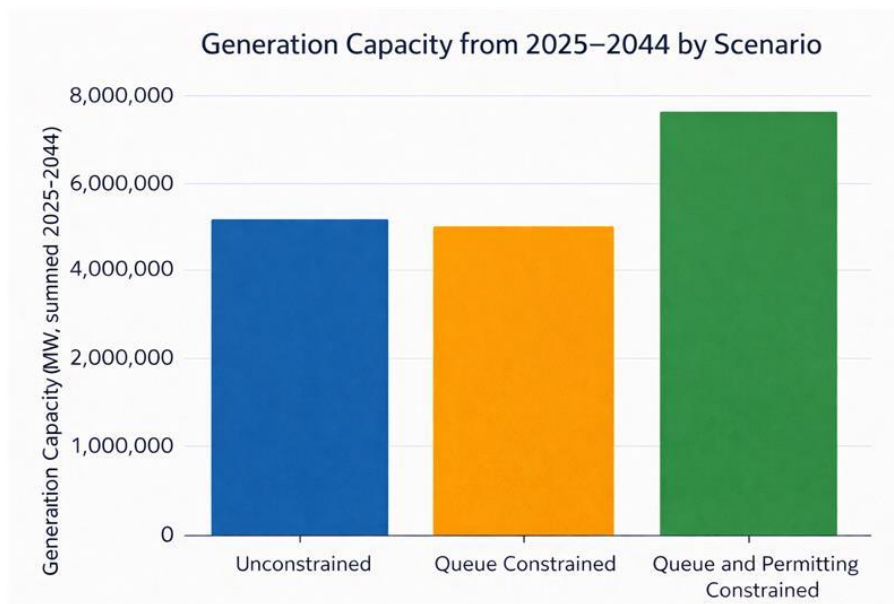
Beyond the peak period, emissions decline steadily across all scenarios as new capacity is eventually deployed and the system transitions toward a lower-emissions resource mix. By the early 2040s, the gap between scenarios narrows significantly, suggesting that the long-term emissions outcome converges once infrastructure is fully built. However, the figure makes clear that permitting and interconnection delays do not simply defer emissions reductions; they materially increase cumulative emissions over the transition period. This reinforces a key system-level insight: delays in delivery do not change the end-state trajectory, but they impose a higher-emissions pathway in the interim, with implications for both environmental outcomes and system efficiency.

In the most constrained case, this effect becomes pronounced: limited resource availability during periods of high demand forces the system to clear at significantly higher marginal costs, resulting in average prices that are roughly three times higher than in the Unconstrained scenario. Importantly, these elevated prices are not driven by fuel costs alone, but by the system’s inability to deliver sufficient capacity at the right time, highlighting the critical role of permitting and interconnection timelines in maintaining cost stability. These cost and reliability outcomes are not incidental; they arise from how the power system adapts when delivery timing becomes the binding constraint.

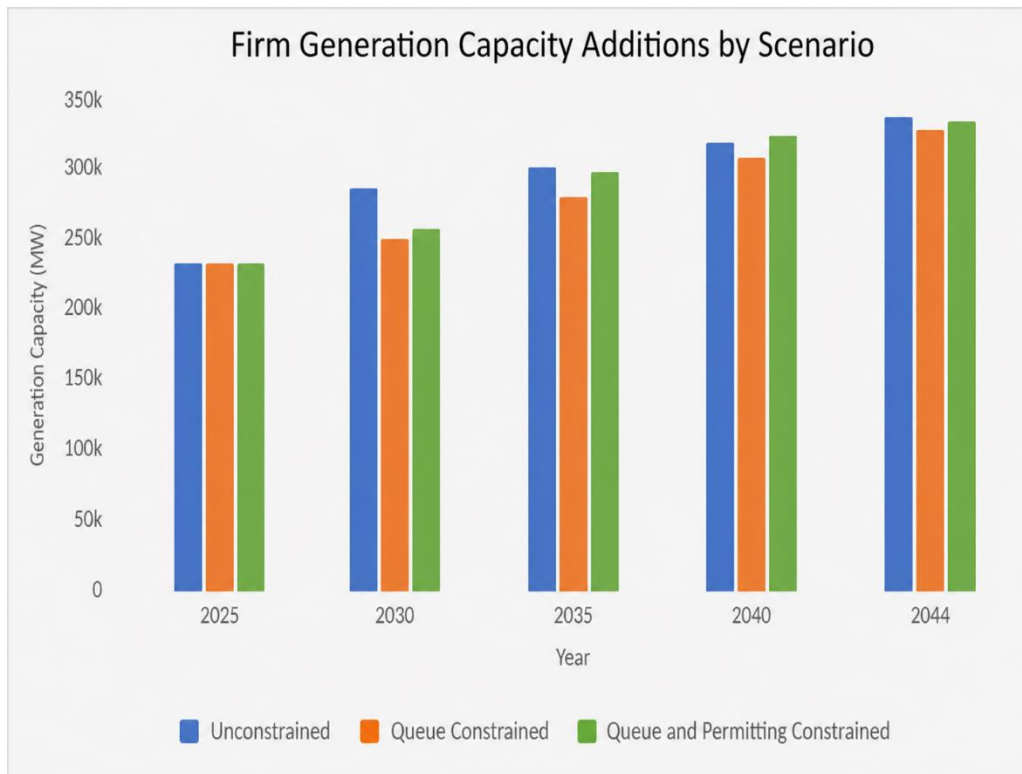
Monthly Unserved Energy by Scenario (June 2035-June 2037)



The figure above illustrates how delivery constraints translate into real reliability impacts in the form of unserved energy, which is the amount of electricity demand that cannot be met due to a shortage of generation or capacity in the power system (sometimes called “forced load shedding”). In the Unconstrained and Queue Constrained scenarios, unserved energy remains negligible, indicating that capacity is delivered in time to meet system needs. In contrast, under the Queue and Permitting Constrained scenario, there are periods of acute system stress, where demand cannot be fully met. These shortfalls are concentrated in the late 2020s and early 2030s, when rising demand coincides with delayed resource availability. While these events are temporary and decline as capacity is eventually built, they represent critical failures during the period when reliability is most needed. This pattern highlights that the primary consequence of permitting delays is not a permanent lack of capacity, but a timing mismatch that exposes the system to avoidable reliability risks and economic losses.



Under constrained delivery conditions, the system builds significantly more total capacity than in the unconstrained baseline, despite achieving inferior reliability outcomes during critical periods. This increase reflects the need to compensate for delayed firm resources with less firm capacity. As permitting and interconnection delays intensify, total installed capacity rises, demonstrating that the system becomes less efficient and more capital-intensive in physical terms.



At the same time, total expansion spending is lower in permitting-constrained scenarios. This does not reflect improved efficiency, but rather delayed and incomplete investment during critical periods. When needed resources cannot be delivered in the 2020–2030 timeframe, capital deployment is deferred, resulting in underinvestment during periods of peak system stress. The system subsequently compensates for this situation by building more total capacity later in time, typically composed of lower-cost, faster-to-deploy resources. As a result, higher physical capacity does not translate into a more efficient system. Instead, apparent savings in capital expenditures are offset by reliability impacts, including unserved energy and associated economic losses.

This figure shows how much firm capacity is built over time under three different scenarios in the PJM Interconnection, the regional transmission organization serving all or part of 13 states and 67 million people. This reflects real-world infrastructure layered with the options previously delineated: 1) Unconstrained/no delays; 2) Queue Constraints; 3) Queue and Permitting Constraints. In the scenario without delays, new power plants are built steadily and early, so the system stays ahead of growing demand. In the scenarios with interconnection and permitting delays, much less capacity is added in the early years, meaning the system falls behind when electricity needs are rising the fastest. In the early years, the system substitutes away from firm capacity because those resources cannot be delivered on time. Later on, these delayed scenarios try to catch up by building more capacity in a shorter period. By around 2040, all scenarios reach similar levels of total capacity, but the key difference is timing: delays push needed investments into the future. **In simple terms, the system eventually builds what it needs, but not when it needs it, creating a higher risk of shortages during the critical years in between.**

CONCLUSION

Permitting and interconnection delays are not simply administrative barriers, but system-level risks that directly shape cost, reliability, and long-term investment outcomes. As electricity demand accelerates, the ability to deliver infrastructure on time becomes as important as the resources themselves. Addressing these delays is therefore not about accelerating any single technology, but about ensuring that the system can build the right resources, in the right sequence, when they are needed. Without reforms that improve delivery timelines, PJM risks entering a cycle of higher costs, increased complexity, and recurring reliability stress. Conversely, improving permitting and interconnection processes offers a clear pathway to lower system costs, stronger reliability, and a more efficient long-term resource mix.

Delays shift, not reduce, investment needs. The system ultimately builds similar levels of capacity, but at the wrong time.

Early underinvestment creates real reliability risk. Capacity shortfalls emerge during critical years when demand is rising fastest and resources are delayed.

Substitution toward faster-to-deploy resources reduces system quality. When firm capacity cannot be built on time, the system relies more heavily on lower-capacity-value alternatives.

Higher total capacity does not mean a more efficient system. Additional buildout later in the timeline reflects compensation for earlier delays, not improved performance.

Delays reshape emissions pathways. Converging emissions outcomes mask the impact of delays, which increase emissions during periods of highest demand and system stress.

Apparent cost savings are misleading. Lower near-term capital spending is offset by higher long-term costs, including unserved energy and economic disruption.

Permitting delays reshape the system for decades. Investment decisions driven by timing constraints, not system value, lock in higher costs and reduced reliability over the long term.

This paper is intended to serve as a foundation for further discussion, not a final answer. It demonstrates how delivery constraints affect system outcomes under conditions PJM is already planning to serve. The United States Energy Association (USEA), working with Energy Exemplar, is expanding its analytical capabilities to help policymakers, regulators, and industry stakeholders better understand infrastructure timing risk, reliability exposure, and long-term investment consequences. Future work may extend this framework to explore alternative permitting pathways, infrastructure coordination strategies, and integrated electricity-fuel system interactions. By grounding these discussions in system-level analysis, USEA aims to support decisions that balance reliability, affordability, and long-term performance in an era of rapid change.