EXECUTIVE SUMMARY

UNLOCKING AMERICA'S ENERGY

How to Efficiently Connect New Generation to the Grid

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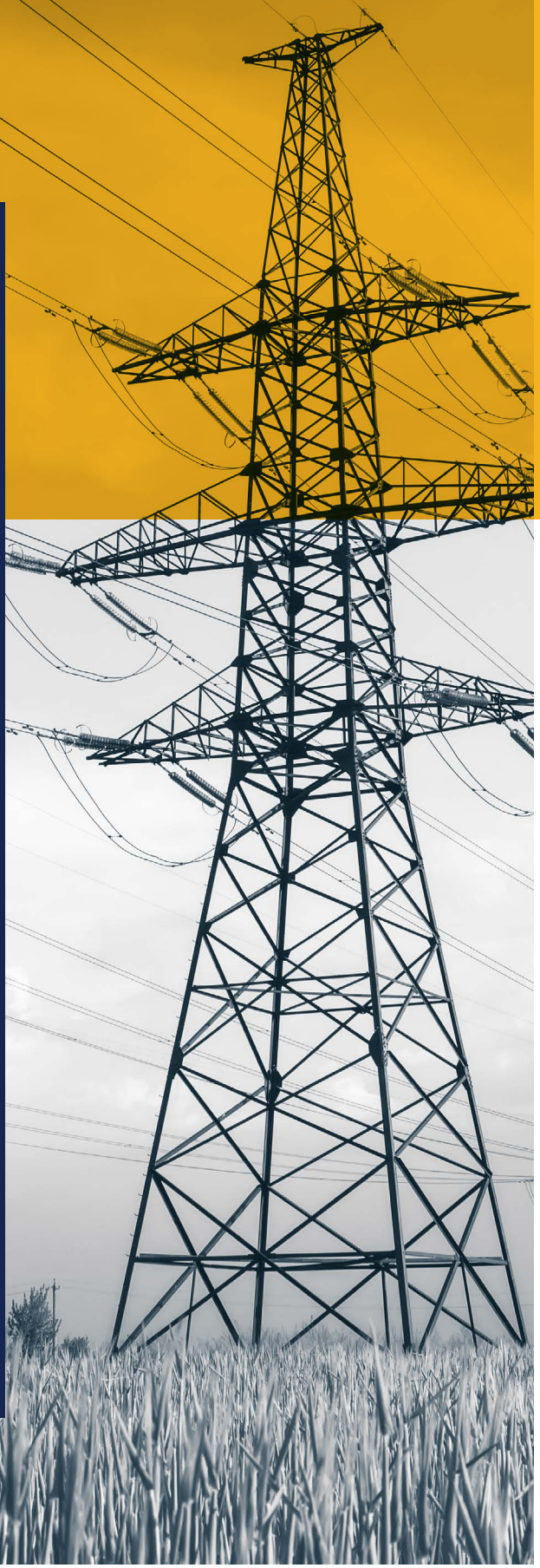

EXECUTIVE SUMMARY

Consumer demand for power is driving the need for a faster and more certain process for connecting new generation

With generator retirements outpacing the addition of new, cost-effective generation and storage resources and electricity demand soaring from new data centers and domestic manufacturing, keeping the electric power grid reliable and affordable has become a critical challenge for the nation. Meeting this challenge will require a timely and efficient approval process for connecting new electricity generators to the grid.

However, this approval process, known as "generator interconnection," has become a major barrier in recent years. The surge of generator interconnection requests has overwhelmed existing processes, causing major delays and producing an unprecedented backlog. In many cases, the total capacity of interconnection requests submitted in a single interconnection "queue" cycle exceeds the total regional peak load, resulting in impractical engineering studies with unrealistic results, delaying processes and creating cost and schedule uncertainty in the development of new generation resources.

Inefficient interconnection policy raises consumer costs, creates reliability risks

The inability to complete the interconnection study process and build necessary transmission facilities in a timely manner introduces challenges in new generation resource development and creates costs that are ultimately passed on to consumers. Developers currently face cost and schedule uncertainty due to the complexity and lack of transparency of existing processes and limited options for managing associated risks. Without opportunities to efficiently bring cost-effective new generation online, customers of all kinds — homes, businesses, new data centers,

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Reliability and affordability are twin objectives of regulatory policy, and both are at risk if new supply cannot meet rising demand. If new generation resources cannot connect quickly enough, the grid may risk having insufficient capacity to meet demand while maintaining required margins of backup generation. Already, some grid operators are turning to inefficient solutions to ensure adequate supplies of power, such as paying premiums to retiring generators to stay online or running emergency procurements. By reforming the interconnection process to bring new generators online more quickly and cost-effectively, consumers can be spared these kinds of expensive, ad hoc responses to reliability concerns.

Affordability in electricity markets also depends on robust competition amongst existing and new generators. Slow and unworkable interconnection processes reduce competition by creating unreasonably high barriers to entry for new generation resources, often requiring uneconomic, out-of-market actions to prevent retirements.

With the power sector facing significant load growth and the prospect for rapid development of new, cost-effective generation resources, now is the time to continue advancing generator interconnection process reforms to ensure streamlined and expedited additions of these resources.

FERC's Order No. 2023 is helpful, but additional reforms are urgently needed

Transmission providers—the entities responsible for administering the interconnection process—were initially slow to respond to the increased volume of new resources entering interconnection queues, resulting in significant interconnection backlogs. The *Generator Interconnection Scorecard* released in February 2024 assessed the current state of interconnection processes and gave five regional transmission operators low or nearly failing grades, highlighting the inefficiencies in their processes.[1]

TABLE 1 2024 Generator Interconnection Scorecard Grades[2]

	Overall Scorecard Grade
CAISO	B
ERCOT	B
ISO-NE	D+
MISO	C-
NYISO	C-
PJM	D-
SPP	C-

1 John D. Wilson, Richard Seide, Rob Gramlich and J. Michael Hagerty, *Generator Interconnection Scorecard: Ranking Interconnection Outcomes and Processes of the Seven U.S. Regional Transmission System Operators* (February 2024), Grid Strategies LLC and Brattle Group. Hereafter, "Interconnection Scorecard."

2 Interconnection Scorecard, p.5

In response to these challenges, the Federal Energy Regulatory Commission (FERC) and the transmission providers have recently been pursuing and implementing reforms to improve the generator interconnection process. In July 2023, FERC Order No. 2023 adopted reforms "raising the floor" for interconnection queue processes by moving all transmission providers to a cluster-based study process (i.e., studying all requests in a cycle together) and increasing readiness requirements through a first-ready, first-served approach to studying new generators (among other reforms). In May 2024, FERC Order No. 1920 adopted long-term transmission planning reforms that include a requirement to proactively consider future generation interconnection needs. FERC recognized in these orders that the problems with generator interconnection and related transmission planning practices over the past several years are structural, relying on outdated processes developed over 20 years ago for a very different set of needs.

FERC's orders occurred in the context of significant ongoing reform efforts by the six FERC-jurisdictional regional grid operators (collectively, the "Regions": CAISO, ISO-NE, MISO, NYISO, PJM, and SPP) and several other transmission providers (e.g., Duke Energy, Bonneville Power Authority, and Xcel Colorado).[3] Many transmission providers moved to a cluster study process in advance of Order No. 2023, and a few have developed proposals that go well beyond the requirements of Order No. 2023. Even ERCOT, which is not subject to FERC jurisdiction and received a passing grade in the Scorecard, is pursuing its own interconnection reform.

While FERC and transmission providers are making strides to improve the generator interconnection process, not all pressing issues have been addressed. For example, most transmission providers do not actively integrate interconnection studies with long-term, proactive transmission planning, instead relying on an inefficient, piecemeal approach to expanding the grid. Developers are still exposed to significant cost and schedule uncertainty at each stage of the interconnection study process, from queue entry through signing an interconnection agreement; this cost and schedule risk translates to higher power prices for consumers. Meanwhile, limited attention has been paid to addressing the significant delays occurring during the construction phase of grid upgrades (i.e., after an interconnection agreement is signed and upgrades are approved). Some of these added delays are driven by inefficient transmission owner practices for design and construction of interconnection facilities. All told, these challenges significantly raise consumer costs while delaying entry of new resources and put system reliability at risk.

A vision for an efficient interconnection process

Given these developments, we identify the urgent need for additional reform across many aspects of the generator interconnection process to ensure access to new, cost-effective generation and storage in a timely manner while maintaining grid reliability in the face of rapidly changing supply and demand fundamentals.[4] To this end, the additional generator

3 California Independent System Operator (CAISO), Independent System Operator of New England (ISO-NE), Midcontinent Independent System Operator (MISO), New York Independent System Operator (NYISO), PJM Regional Transmission Organization, and Southwest Power Pool Regional Transmission Organization (SPP). Henceforth, "Regions" refers to these six regional transmission organizations (RTOs) and independent system operators (ISOs) as well as, in context, the Electric Reliability Council of Texas (ERCOT). "Transmission owners" refers to any company or organization that owns and constructs transmission facilities. "Transmission providers" refers to the Regions and transmission owners collectively.

4 Note that throughout this report, generation is understood to encompass all technologies that deliver power to the grid, including storage technologies that also draw power from the grid.

interconnection reforms should advance three goals:

- **Cost Certainty and Transparency:** Generator interconnection costs, including the costs of needed transmission upgrades, should be certain enough to enable a manageable process for both transmission providers and generators seeking to interconnect (also known as interconnection customers). Improved cost certainty will help reduce the volume of queue submissions and withdrawals to more realistic levels, enhancing queue efficiency while reducing costs borne by consumers.
- **Speed and Schedule Certainty:** The generator interconnection process should move as quickly as feasible, considering state-of-the-art interconnection request processing (including automation), interconnection study methods, and construction management practices. Interconnection customers should have a high degree of confidence that transmission providers and owners will meet key milestones in all phases of the interconnection and upgrade construction process. Improving process timelines is essential for timely delivery of new generation resources to meet reliability needs and deliver cost-effective power to meet consumer demand.
- **Nondiscrimination:** No interconnection customer should face unreasonable barriers to competitive entry into electricity markets. The Federal Power Act (FPA) requires that the resulting rates, terms, and conditions of interconnection service must be just, reasonable, and not unduly discriminatory or preferential. A level playing field that provides similarly situated interconnection customers equal opportunities for adding new generation resources to the grid ultimately benefits consumers through increased competition and access to more cost-effective power.

THE STAGES OF INTERCONNECTION

CURRENT PROCESS (ORDER NO. 2023-COMPLIANT)

Level of risk for interconnection customers does not align with degree of cost and schedule certainty

Pre-Interconnection	Interconnection Application	Interconnection Studies & Interconnection Agreement	Network Upgrade Construction	Commercial Operation
Lack of actionable information about transmission system headroom due to uncertain costs, study delays, and construction backlog	Projects pay to enter queue but receive little cost or schedule certainty Limited information, not updated or reliable Managing entries with queue caps may not prioritize "most ready" projects	High queue volumes lead to ambiguous results that delay withdrawals Studies progress slowly, restudies common Studies identify deep network upgrades Costs and timelines uncertain	Cost increases and delays outside of developers' control with limited visibility Insufficient proactive solutions to supply chain bottlenecks	Consumer costs increased due to process uncertainty and delays Potential for reliability to be threatened due to lack of sufficient new resources

EFFICIENT INTERCONNECTION PROCESS

Level of risk for interconnection customers corresponds to degree of cost and schedule certainty

Pre-Interconnection	Interconnection Application	Interconnection Studies & Interconnection Agreement	Network Upgrade Construction	Commercial Operation
Proactive planning to ensure transmission grid can accommodate known amount of new generation at a known cost Existing and planned available headroom identified based on recent planning and interconnection studies	High fee to enter based on cost to increase planned interconnection capacity, in exchange for cost and schedule certainty Transparent, timely, and actionable upfront information guides applications	Most projects move through fast-track processes, do not encounter surprise costs or delays and fewer withdraw Competition for available headroom resolved through "most ready" scoring Study results are fast, predictable, and replicable due to limited scope (focused on necessary upgrades for level of service requested), expanded use of cost-effective non-wire solutions, and deployment of automation	Transmission providers meet construction deadlines and budgets Interconnection customers have visibility and recourse in the case of delays or cost increases outside their control	Generators efficiently come online as needed to deliver cost-effective, reliable power to consumers

To meet those goals, this report's recommendations are organized around four key themes for reforming the interconnection process, targeting different aspects of the interconnection process. Our recommendations should be considered and implemented together as a package to achieve the interconnection process goals.

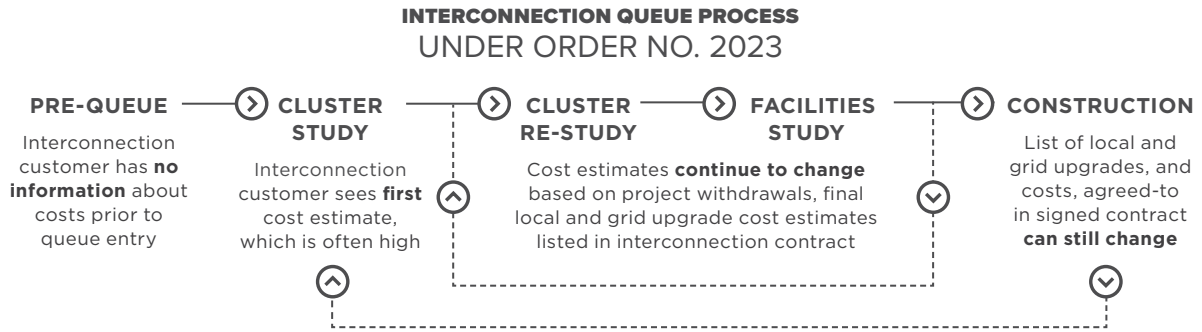
- **REFORM 1 |** ***Adopt an interconnection entry fee for proactively planned capacity***, provides interconnection customers significant interconnection cost certainty and addresses cost allocation of the upgrades identified through proactive planning processes. This reform allows projects to move forward with upfront certainty by specifying in advance the cost information in exchange for taking on some of the cost of planned transmission buildout.
- **REFORM 2 |** ***Implement a fast-track process to utilize existing and already-planned interconnection capacity***, implements an efficient process to quickly utilize existing and planned system capacity. In combination with Reform 1, these reforms create a fast-track process that opens up available transmission headroom for full utilization and prioritizes its use by "most ready" generator projects.
- **REFORM 3 |** ***Optimize the interconnection study process***, targets improvements to the interconnection study process to increase the system headroom considered to be "available" for interconnecting new resources through existing and new fast-track processes. It also identifies reforms necessary to make the study process more efficient. In combination with Reforms 1 and 2, interconnection requests should proceed through the study process more quickly.
- **REFORM 4 |** ***Speed up the transmission construction backlog***, addresses growing constraints to constructing network upgrades needed to bring new resources online after completing the interconnection study process.

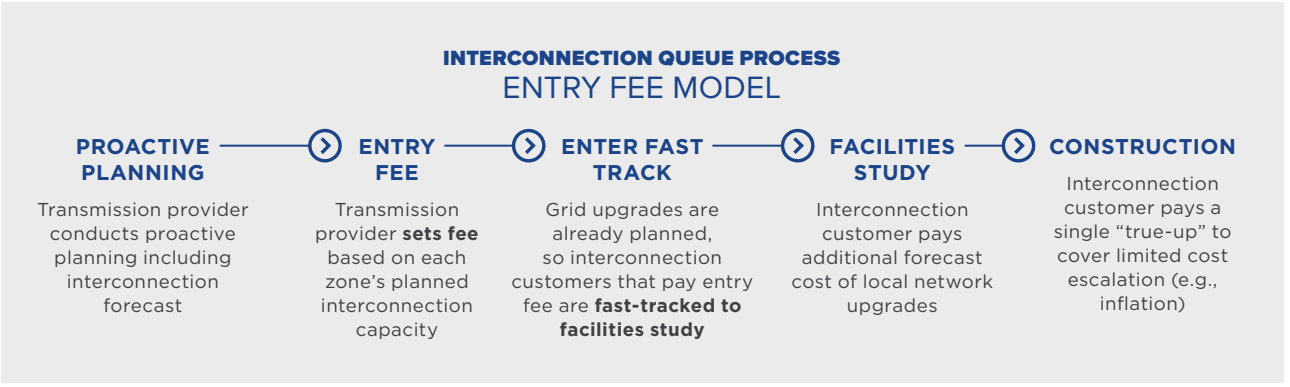
Although not the focus of this report, proactive transmission planning is an essential element to improving the interconnection process. As noted throughout the report, the recommended interconnection reforms will be greatly enhanced by (and rely on) transmission upgrades identified through long-term proactive, multi-value planning processes. Several transmission providers are already implementing proactive planning, while others are in the process of developing long-term planning processes to comply with FERC Order No. 1920.

REFORM 1

CERTAINTY | Adopt an interconnection entry fee for proactively planned capacity.

ENTRY FEE APPROACH





Through a well-designed "entry fee" approach, interconnection costs are set prior to the interconnection process for accessing system capability proactively developed through a long-term, multi-driver, and scenario-based planning process that accounts for projected new generator interconnection needs. Generators with ready-to-develop projects compete to gain access to the amount of proactively planned system capacity based on their willingness to pay the posted entry fee and reasonable exit penalties (as applicable). Transmission providers would subsequently confirm through a streamlined process, such as the "fast-track" process proposed in Reform 2, the reliability of specific interconnection requests and identify any local upgrades not addressed in the proactive planning process.

Increasing cost certainty through an entry fee approach for proactively planned interconnection capacity would remove the incentive to use the interconnection study process as a cost-discovery tool for specific locations and reduce the cost risks of the interconnection study process for interconnection customers. Generators would assume known financial and development risks that match the higher level of cost certainty provided by the proactively planned interconnection capability and streamlined interconnection process for accessing it. Such a process would naturally reduce interconnection queue volumes, unburdening queues from the structural problems plaguing them today.

REFORM 2

UTILIZATION | Implement a fast-track process to utilize existing and already-planned interconnection capacity.

There will be over 100 GW of aging existing generating resources projected to retire over the next decade as well as new capacity created for anticipated generator interconnection needs through proactive planning. Requiring resources that utilize available capacity to proceed through time-consuming cluster study processes designed to identify reliability needs and develop transmission solutions is unnecessary. Instead, transmission providers should significantly reduce interconnection timelines and provide greater schedule certainty by adopting interconnection processes that expedite interconnection requests that utilize existing and planned grid capacity ("headroom").

A fast-track process would allow transmission providers to quickly interconnect new resources at locations on the system with existing and planned headroom that do not require additional network upgrades. The sign of a well-functioning interconnection process would be one in which the majority of interconnection requests can move through a fast-track process, including the "entry fee" process for proactively planned grid capacity, and the cluster study process serves as a backstop for interconnection requests that exceed the currently available system capacity.

The "fast-track" process would screen whether interconnection requests result in no or only minimal adverse impacts on the system and allow those that pass the impact screen to advance on an expedited basis to the interconnection agreement phase of the process. Interconnection requests for which the screening analysis identified material adverse impacts would still need to go through the full interconnection study process to identify necessary upgrades.

To implement an effective fast-track interconnection process, we propose four specific reforms that are needed to efficiently utilize available or already-planned grid capacity:

Reform 2-A | Provide transparent, timely, and actionable information for interconnection customers to identify available or low-cost headroom. Prior to submitting interconnection requests, project developers currently have limited insight into points of interconnection with available capacity to support their projects. Actionable information about locations on the grid with existing or planned capacity, based on recent transmission planning and interconnection studies, should be available to interconnection customers and updated regularly so that interconnection customers can request access to the fast-track process.

The sign of a well-functioning interconnection process would be one in which the majority of interconnection requests can move through a fast-track process, including the "entry fee" process for proactively planned grid capacity, and the cluster study process serves as a backstop for interconnection requests that exceed the currently available system capacity.

Reform 2-B | Create a fast-track process for locations with clearly defined existing or planned available capacity. Once headroom is identified, interconnection customers with ready-to-develop projects should be able to request access to that capacity on an expedited basis. Transmission providers should offer a fast-track process that screens interconnection requests at locations with existing or planned capacity to verify that the new resource would result in no or only minimal adverse impacts on the system. If confirmed, the requests would advance to the interconnection agreement phase; if not, the requests would enter the standard interconnection queue.

Reform 2-C | Create or update fast-track processes for the efficient replacement of existing plants. Opening up opportunities for low-cost interconnection at the sites of retiring fossil-fired and nuclear resources through a fast-track process is also critical to utilizing available capacity. Many transmission providers already provide such an option, but not all, and existing processes are often needlessly inefficient. Existing resources with interconnection capability should be able to share or transfer headroom to new resources. Requests to utilize existing capabilities that do not exceed existing capability should be presumed to have no material adverse impact but be confirmed through a screening process.

Reform 2-D | Prioritize "most ready" interconnection requests for available headroom. The fast-track processes should be paired with an approach to prioritize access to limited existing or planned available capacity by identifying the "most ready" projects that are likely to be built expeditiously following the execution of an interconnection agreement. FERC should maintain the readiness requirements of Order No. 2023 to screen out the least-ready projects and, in addition, transmission providers should allow interconnection customers to compete for priority access to the available capacity, such as by implementing a "most-ready" scoring method.

REFORM 3

EFFICIENCY | Optimize the interconnection study process.

Order No. 2023 made significant progress towards reforming interconnection study processes, yet these processes remain unnecessarily complex, resource-intensive, and prone to delays. More fundamental reforms are needed to increase the amount of existing system capacity available for the fast-track process proposed in Reform 2 and to vastly increase the efficiency of interconnection study processes for resources that do not qualify for the fast-track process. These five recommended improvements should enable interconnection requests to proceed more efficiently through the interconnection study processes.

Reform 3-A | Identify only network upgrades that are consistent with the requested interconnection service level. Interconnection studies currently trigger network upgrades that are not required to maintain system reliability given how system operators manage the grid in real-time, such as through market-based generation redispatch. Adopting practices to better align required upgrades with requested service levels, including both ERIS and NRIS, and to provide interconnection customers an attractive (non-firm) energy-only option will relieve interconnection customers (and ultimately electricity customers) of unnecessary costs, and enable more efficient interconnection of new resources.

Reform 3-B | Identify the most cost-effective solutions for resolving reliability violations. Current practices that favor "traditional" solutions should be updated to allow for efficient solutions that enable increased utilization or low-cost expansion of the existing grid. Transmission providers should not just *consider* available traditional solutions, but also include well-tested and commercially available solutions that can rapidly expand available headroom on transmission systems. These options include use of simple remedial action schemes and grid-enhancing technologies.

Reform 3-C | More closely align data inputs, assumptions, and process timing between interconnection study processes of different local and regional scope. In Order No. 2023, FERC did not address study alignment issues that create significant challenges for completing interconnection studies. Alignment is needed in two directions, (1) local-to-regional and (2) host system to affected system, so interconnection requests can be studied more efficiently and with less uncertainty to developers.

Reform 3-D | Use automation to expedite interconnection studies. Transmission providers have recently demonstrated that automation can significantly expedite interconnection studies. To further increase process efficiency and reduce interconnection timelines, already-proven applications of interconnection study automation should be more broadly adopted and further applications of automation should be explored.

Reform 3-E | Establish independent interconnection study monitors. Many practices required or recommended by FERC (such as in

Order No. 2023 made significant progress towards reforming interconnection study processes, yet these processes remain unnecessarily complex, resource-intensive, and prone to delays.

Order No. 2023) leave substantial flexibility or discretion to transmission providers, which leads to different and often incompatible study criteria and approaches. Independent interconnection study monitors are needed to avoid inefficiencies and adverse impacts associated with the complex technical details of interconnection studies and the flexibility and discretion that transmission providers exercise. The transparency that independent monitors can provide would inform process improvements by the transmission providers or targeted areas for future regulatory action by FERC.

REFORM 4

CONSTRUCTION | Speed up the transmission construction backlog

Over the past few years, there have been increasing delays *after* the interconnection agreement has been signed. Much of the delay is beyond the developer's control. While network upgrade construction timelines are increasing across the industry, some transmission owners complete upgrade projects more quickly and with fewer delayed projects (or shorter delays) than other transmission owners, suggesting there is significant room for improvement. Looking across all transmission owners, the most convincing evidence for any confirmed cause of the transmission construction delays relates to supply chain constraints affecting key equipment for transmission upgrades.

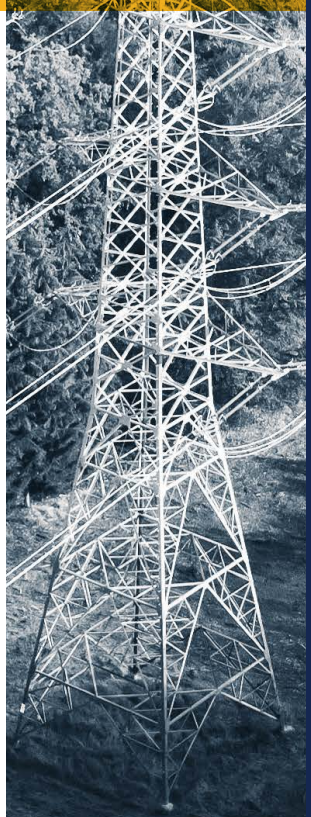
While network upgrade construction timelines are increasing across the industry, some transmission owners complete upgrade projects more quickly and with fewer delayed projects (or shorter delays) than other transmission owners, suggesting there is significant room for improvement.

Reform 4-A | Improve reporting on the transmission project construction phase. While supply chain constraints are a factor, the extent of their impact as well as other causes for the consistent increase in construction timelines are less well understood. To better understand the causes of the transmission construction backlog, FERC, the Regions, transmission owners, and state regulators should implement improved reporting on progress towards constructing new transmission facilities. These data will enable exploration of the portion of delays caused by various issues, including (1) project management prioritization by transmission owners, (2) other construction issues including supply-chain availability and limited outage windows, and (3) voluntary delays of in-service dates by interconnection customers.

Reform 4-B | Industry and government collaboration to reduce supply chain bottlenecks. To address supply chain constraints, we recommend a cooperative procurement program. Such a program could provide equipment manufacturers with the assurance needed to expand factories. This can best be accomplished through voluntary action by transmission owners, facilitated by federal assistance with financing.

Priority Reforms for an Efficient Interconnection Process

Process Phase	Reform Number	Reform Proposal	Contribution to an Efficient Interconnection Process
Proactive Interconnection Capacity Planning Phase	**REFORM 1** | Certainty: Adopt an interconnection entry fee for proactively planned capacity.		This reform introduces cost certainty and addresses cost allocation, allowing projects to move forward with upfront cost information in exchange for taking on some of the cost of planned transmission buildout.
Pre-Request and Interconnection Study Phases	**REFORM 2** | Utilization: Implement a fast-track process to utilize existing and already-planned interconnection capacity.		These reforms implement an efficient process to quickly utilize existing and planned system capacity. In combination with Reform 1, they create a fast-track process that opens up available transmission headroom for full utilization and prioritizes its use by "most ready" generator projects.
	2-A	Provide transparent, timely, and actionable information for interconnection customers to identify available or low-cost headroom.	
	2-B	Create a fast-track process for locations with clearly defined existing or planned available capacity.	
	2-C	Create or update fast-track processes for the efficient replacement of existing plants.	
	2-D	Prioritize "most ready" interconnection requests for available headroom.	
	REFORM 3 | Efficiency: Optimize the interconnection study process.		These reforms increase the system headroom that is considered "available" and make the study process more efficient. In combination with Reforms 1 and 2, these reforms should enable interconnection requests to proceed through the study phase more quickly.
	3-A	Identify only network upgrades that are consistent with the requested interconnection service level.	
	3-B	Identify the most cost-effective solutions for resolving reliability violations.	
	3-C	More closely align data inputs, assumptions, and process timing between interconnection study processes of different local and regional scope.	
	3-D	Use automation to expedite interconnection studies.	
	3-E	Establish independent interconnection study monitors.	
Construction Phase	**REFORM 4** | Construction: Speed up the transmission construction backlog.		These reforms address growing constraints to bringing new resources online after completing the study process. They deliver the benefits of Reforms 1-3 to consumers more quickly and cost-effectively.
	4-A	Improve reporting on the transmission project construction phase.	
	4-B	Industry and government collaboration to reduce supply chain bottlenecks.	



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Grid Strategies LLC is a power sector consulting firm helping clients understand the opportunities and barriers to integrating clean energy into the electric grid. Drawing on extensive experience in transmission and wholesale markets, Grid Strategies analyzes and helps advance grid integration solutions.

Based in the Washington DC area, the firm is actively engaged with the Federal Energy Regulatory Commission, Department of Energy, state Public Utility Commissions, Regional Transmission Organizations, the North American Electric Reliability Corporation, Congressional committees, the administration, and various stakeholders.

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