

Interconnection Innovation eXchange: A Roadmap for Unlocking Queue Backlogs

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Outline

- Challenges within the Interconnection Process
- i2X Program Roadmap: Opportunities for Reforms and Solutions

Thanks to DOE, and especially the i2X program, for supporting this work

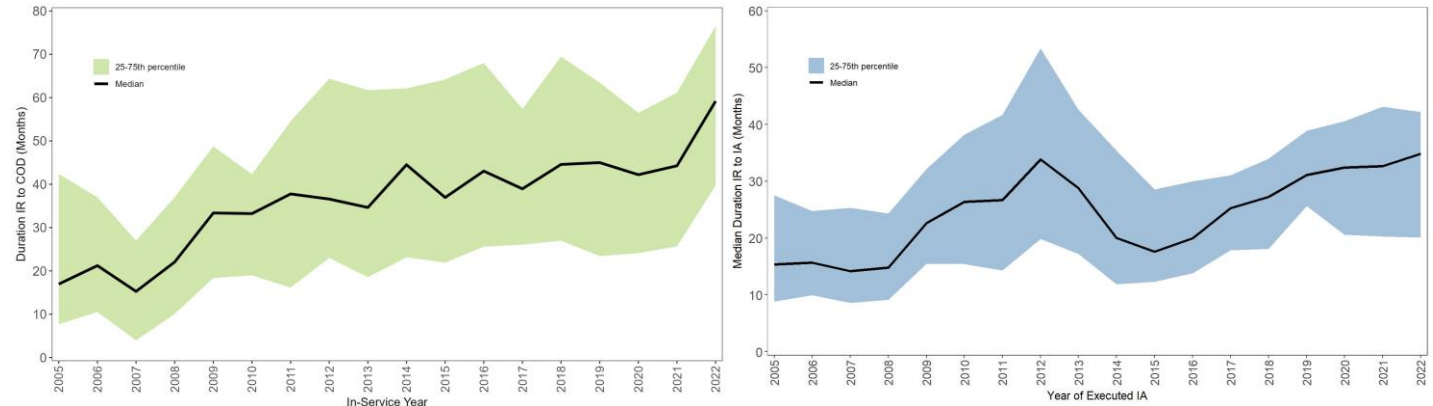
Recap evidence of a problem: Increasing timelines and increasing costs

The median duration from interconnection request (IR) to commercial operations date (COD) continues to rise, reaching ~5 years for projects completed in 2022

After falling from a 2012 peak, the typical duration from interconnection request (IR) to interconnection agreement (IA) increased sharply since 2015, reaching 35 months in 2022

Interconnection costs have grown over time in all studied regions

Increasing Interconnection Timelines



Increasing Interconnection Costs



A “wicked” problem: multifaceted drivers of interconnection backlogs

General sentiment: we are asking the queue process designed in 2003 to do too much. Reforms are needed, but also perhaps a fundamental re-thinking is required given clean energy transformation demanded.

Transmission expansion has been *limited over the last decade, focused primarily on local reliability upgrades*

Bulk grid not developing rapidly, leading to *inadequate transmission* and to high *network upgrade costs assigned* to generators in queue

Developers use queue requests for data collection given low information *transparency, low entry cost, high network upgrade costs*, and *uncertain costs* given serial nature and re-studies

Enormous *increase in number and capacity* of projects in queues, creating *workflow and workforce challenges* when relying on existing tools and administrative processes

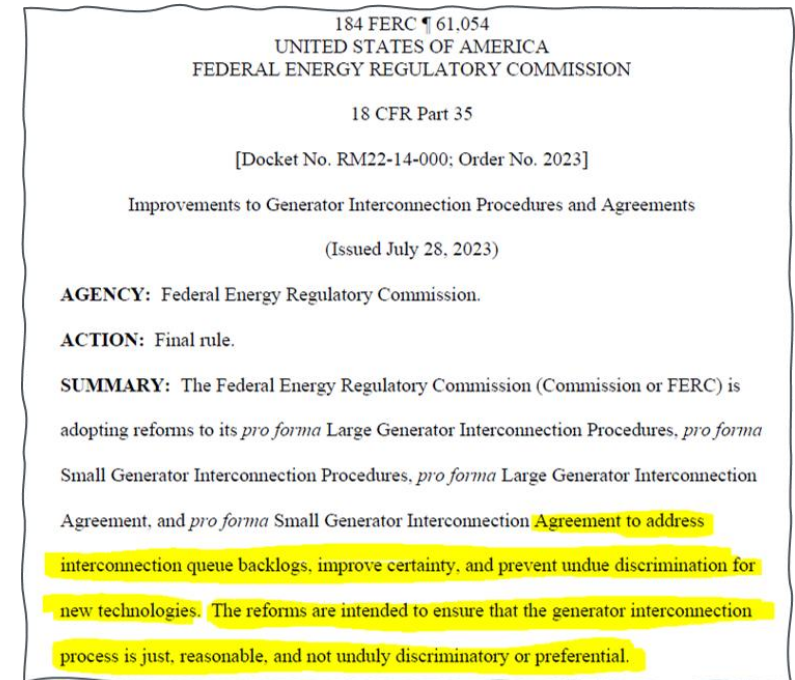
Lack of *standardization, inaccurate study data* & assumptions, low consideration of *grid-enhancing technologies*, generator technology changes, *network cost assignment*, and late *withdrawals*

Multi-year *queue delays* leading to re-studies, *reliability concerns, high generator-pays upgrade costs*, and frustrated stakeholders (developers and transmission operators alike)

A vicious cycle: the increasing number of requests increase delays and uncertainty, which further incentivizes developers to submit more requests

As we were developing the roadmap, FERC issued Order 2023

- Notable *all commissioners agreed* to support the order
- In the roadmap, we try to provide context that:
 - ▣ Interconnection reform has been happening for at least the *last 20 years* (Order 2003, 2006, ISO/RTO reforms in the late 2000s through today)
 - ▣ Items like cluster studies and some “first ready, first served” milestones *had already been implemented* by some large ISOs / BAs already.
- Still an important step towards industry-wide standardization
- Roadmap contains some solutions that *relate and align with this order*, but also introduces additional ideas to support longer-term interconnection process evolution



FERC Chair Willie Phillips at his press conference on July 27, 2023, after the commission *unanimously approved* Order 2023. 5

FERC Order 2023: A strong baseline, but not a ceiling for possible reforms

Included in FERC Order 2023

- *Cluster studies; first ready, first served*; higher *deposits & readiness* criteria for developers
- *Timeline, process, and reporting* requirements for transmission providers; *Financial penalties* for delays
- Visual representation (*heatmaps*) of available *transmission capacity*
- Improved and standardized process for *affected system studies*
- Framework for *shared network upgrade costs*
- Improved procedures and *flexibility for storage and hybrid resources*
- Consideration of *alternative transmission technologies (GETs)*

Possibilities Beyond FERC Order 2023

- Proactive *transmission planning* and *enhanced coordination* between transmission planning and interconnection.
- Facilitate generator *project prioritization/rationing* (e.g. via auctions)
- Enhance *data transparency* on transmission availability and possible interconnection costs to pre-screen interconnection requests
- Better harmonize interconnection study methods and requirements; goal to enhance *automation* of the interconnection study processes
- *More interconnection resources and staff* to speed the process
- Revisit *impact threshold criteria* and potentially update energy-only interconnection process
- *Revisions to interconnection cost allocation*: reform of participant funding for network upgrades
- Consider *surplus interconnection and generator replacement* business models

i2X Program Roadmap: Opportunities for Reforms and Solutions

DOE's Interconnection Innovation e-Xchange (i2X)

Mission: To enable a **simpler, faster, and fairer** interconnection of clean energy resources while enhancing the **reliability, resiliency, and security** of our **distribution and bulk-power electric grids**



Stakeholder Engagement

- Nation-wide engagement platform and collaborative exchanges
- Generate innovative solutions from discussion with utilities, grid operators, state/local governments, clean energy industry, non-profits



Data & Analytics

- Collect and analyze interconnection data to inform solutions development
- Increase transparency of interconnection process



Strategic Roadmap

- Create roadmap to inform interconnection process improvements
- Identify both near- and long-term opportunities and solutions



Technical Assistance

- Leverage DOE laboratory expertise to directly support stakeholders
- Focus on requests targeting key problems identified in roadmap



Focus today

Setting up the context and purpose of the roadmap

- We aimed to *harmonize and develop solutions* that could provide a more comprehensive, rather than piecemeal, set of reforms
- Solutions identified are a collection of *viable strategies*
→ NOT rigid package of prescriptive fixes
- Some *regions have adopted* a subset of these ideas already, and we try to highlight those efforts in the roadmap, where possible
- Some solutions *are complementary* to each other (i.e. needed to be implemented in tandem)
- Others *are exclusive* (i.e. adopting one might obviate the need of another)

Roadmap aims to be a starting point for discussions around pathways and solutions



Key Attributes Included within the Roadmap

The roadmap serves as guide to key actions that stakeholders could take, within the next five years and beyond, to implement solutions to bulk power system interconnection challenges.

The solutions are informed by:

- 2,075 stakeholders at 350 organizations:
 - 300 from utilities/transmission providers,
 - 550 interconnection customers, and
 - 140 at state, local, and tribal governments
- 22 Solution e-Xchange meetings covering six topics (e.g., equity, cost allocation)
- 18+ public events (e.g., RE+ 2022, 2023)

Solution implementation time frames:

- Short-term: within 1-2 years
- Medium-term: 2-5 years
- Long-term: beyond 5 years

Solution Actors:

- Transmission providers (Utilities, ISOs, BAs)
- Regulators (FERC/NERC, State PUCs)
- Interconnection customers
- Research community
- OEM and software vendors
- State, local, tribal governments
- Equity and public benefit organizations

DOE plays multiple roles: convening stakeholders, facilitating solution adoption, providing technical assistance, supporting the research community, and can also become a solution provider.

The roadmap is organized around four main interconnection goals

Goal #1: Increase Data Access and Transparency

- Highlight improvements that *go beyond* FERC Order 845 and 2023 to improve decision making
- Facilitate screening, optimal siting, and automation
- Enhance equitable outcomes by enabling *benchmarking, tracking and auditing* of processes and reform performance

Goal #2: Improve Process and Timing

- Backlogs and delays often result of *rapid growth in requests* and ineffective management
- Balance tradeoff between *rationing queue space and maintaining open access / competition*
- Key focus areas
 - Queue Management
 - Affected System Studies
 - Workforce Development

Goal #3: Promote Economic Efficiency

- Acknowledge that interconnection and transmission planning are closely related
- Focus on both *allocative efficiency* ('who pays') and *productive efficiency* ('minimizing costs')
- Key focus areas
 - Cost Allocation
 - Coordination btwn IX and TP
 - Interconnection Studies

Goal #4: Maintain a Reliable Grid

- In recent years there has been a *series of disturbance events* leading to IBR disconnection
- Foundation to manage *high penetration rates of IBRs* and minimize disturbances
- Key focus areas
 - Interconnection Models and Tools
 - Interconnection Standards

Goal #1: Increase Data Access and Transparency

Solutions

Activities

Improve the scope/quality of **data on projects already in interconnection queues**

Implementation timeframe: short-term

Enhance the accuracy/timeliness of **interconnection study models and modeling assumptions** that are made available

Implementation timeframe: medium-term

Develop tools to visualize transmission and interconnection data

Implementation timeframe: medium-term

Federal entities (e.g. FERC/EIA)	Transmission Providers (e.g. ISOs, BAs)	Interconnection Customers (e.g. Developers)	Research community (e.g. Academia, DOE)
<ul style="list-style-type: none">-Expand and improve data reporting requirements-Aggregate, organize, and publish interconnection data	<ul style="list-style-type: none">-Collect and organize data as needed-Automate data compilation and reporting-Identify IT infrastructure need	<ul style="list-style-type: none">-Develop tools to leverage data to improve pre-request screening	<ul style="list-style-type: none">-Increase scope, depth, and frequency of data analysis- Engage with FERC, developers, transmission providers to determine data needs
<ul style="list-style-type: none">-Expand and improve requirements for study data-Review and update guidelines for CEII data access	<ul style="list-style-type: none">-Explore opportunities for automating study data updates-Integrate data updates with queue cycles and transmission plan updates	<ul style="list-style-type: none">-Develop or support development of open-source study models-Engage with transmission providers to determine additional information needs	<ul style="list-style-type: none">- Develop or support the development of open-source models
	<ul style="list-style-type: none">- Develop and support development of visualization tools	<ul style="list-style-type: none">- Propose additional visualization tools and metrics	<ul style="list-style-type: none">- Propose additional visualization tools and metrics- Support software development

In total, there are more than 30 solutions identified in the roadmap

(Select) Solutions for Goal #2

Queue Management
2.5 Create new and expand fast-track options for interconnection (e.g. surplus, generator replacement, energy-only)
2.7 Consider market-based approaches to rationing interconnection access
Affected System Studies
2.8 Increase voluntary collaboration on affected system studies
Workforce Development
2.11 Assess scale of interconnection workforce growth requirements



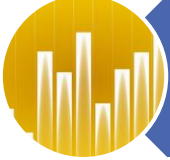


(Select) Solutions for Goal #3

Cost Allocation
3.2 Ensure that generators have option to connect without paying for congestion-related upgrades (energy-only)
Planning Coordination
3.5 More closely align interconnection and transmission planning processes
Interconnection Studies
3.6 Continue to develop new best practice study methods , and harmonize methods to adapt to a changing generation mix
3.8 Explore options for generator self-funding of their own interconnection studies

(Select) Solutions for Goal #4

Models and Tools
4.1 Require submission of verified EMT models for all IBRs, and develop screening criteria to determine when EMT studies are necessary within a region
4.3 Develop study process flow that is better aligned with generation project development timelines
Interconnection Standards
4.4 Adopt comprehensive set of generation interconnection requirements consistent with IEEE Standard 2800-2022
4.7 Evaluate cybersecurity concerns during the interconnection process

How could interconnection success be measured?



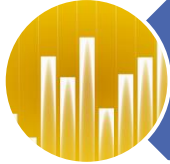


	Target Value*
 <div>Reduced Interconnection process time Average time from request to agreement</div>	??
 <div>Increased completion rate 3-year completion rate by capacity</div>	??
 <div>Lower interconnection costs Average interconnection costs</div>	??
 <div>Lowered cost uncertainty Standard deviation of interconnection costs</div>	??
 <div>Maintained system reliability Number of system disturbances due to modeling inaccuracy</div>	??

Some elements of interconnection success lend themselves to measurable targets

These targets not intended to be authoritative or exhaustive, but aim to provide a more tangible vision for success

* Target value year is 2030.

Current proposed target values within roadmap

		Target Value*	Recent Value	Hist. Best Value
	Reduced Interconnection process time Average time from request to agreement	< 18 months	33 months (2022)	18 months (2005-2008)
	Increased completion rate 3-year completion rate by capacity	> 30%	< 15% (2016)	29% (2013)
	Lower interconnection costs Average interconnection costs	Under Stakeholder Development	\$87/kW (2020- 2021)	\$43/kW (2014- 2015)
	Lowered cost uncertainty Standard deviation of interconnection costs	< \$150/kW	\$551/kW (2020-2021)	\$154/kW (2010-2011)
	Maintained system reliability Number of system disturbances due to modeling inaccuracy	Zero	4 (2022)	0 (2019)

* Target value year is 2030. Target values are close to historical best values achieved within the past 20 years.



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More Information:

- Visit <https://www.energy.gov/eere/i2x> to learn about and participate in the DOE's i2X program
- Visit <https://emp.lbl.gov/queues> interconnection queue analysis and data
- Visit https://emp.lbl.gov/interconnection_costs for research on generator interconnection costs

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