INTERCONNECTION INNOVATION e-XCHANGE
U.S. DEPARTMENT OF ENERGY

Overview of the DOE Transmission Interconnection Roadmap

May 14, 2024

An initiative spearheaded by the Solar Energy Technologies Office and the Wind Energy Technologies Office

How familiar are you with i2X efforts?

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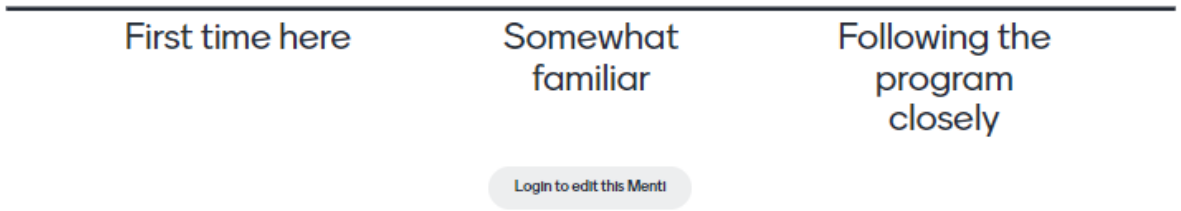

Meeting Recording Announcement

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Agenda

- DOE i2X Program Overview (10 min)
- Final Transmission Interconnection Roadmap (35 min)
  - Overall structure and format (5 min)
  - Success Targets for 2030 (5 min)
  - Overview of Solutions in each goal (25 min)
- Future i2x Efforts & Upcoming Events (5 min)
- Interactive group discussion (10 min)

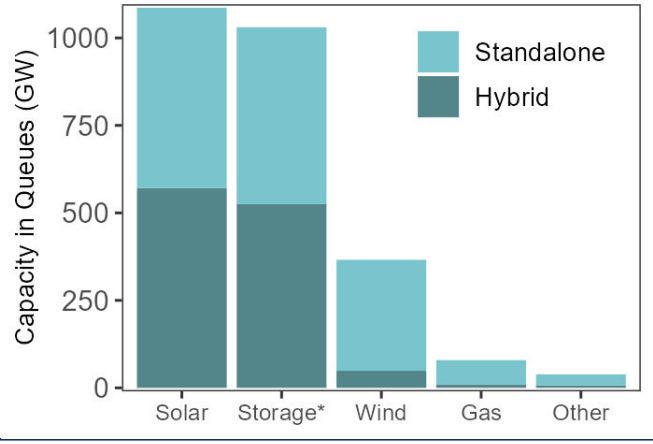
Cindy Bothwell
U.S. Department of Energy

Will Gorman
Lawerence Berkeley National Lab

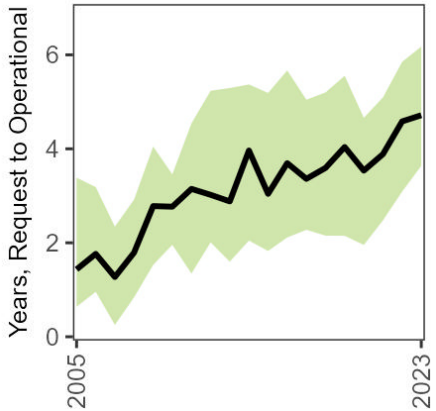
State of Transmission Interconnection

Developer interest in solar, storage, and wind is strong

- Nearly 11,600 projects with 2,600 GW actively seeking interconnection



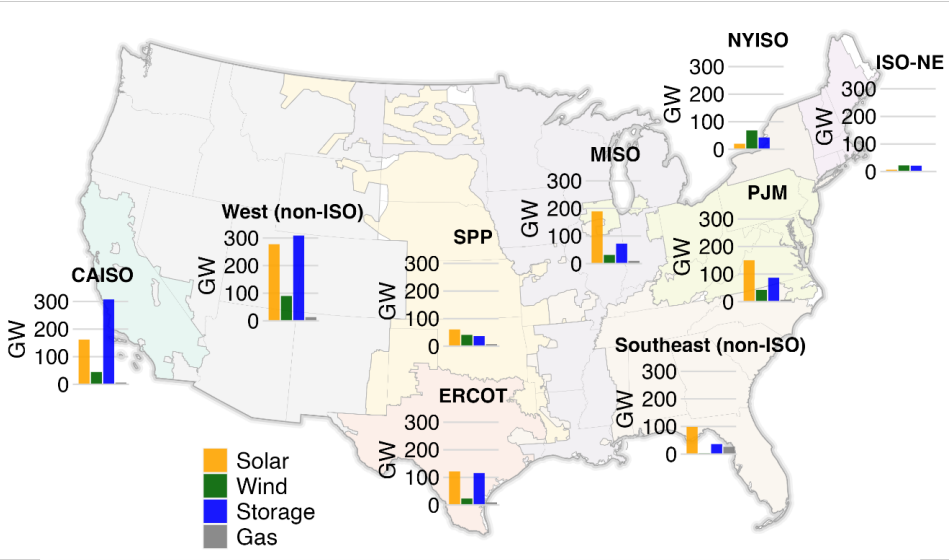
Completion rates are generally low; wait times are increasing



- For projects built in 2023, the average time from request to commercial operations is 5 years compared to 3 years in 2015 and <2 years in 2008

Proposed capacity is widely distributed across the U.S.

- Most regions are experiencing high demand for interconnection of solar and storage projects.
- Demand from wind projects is highest in the West, NYISO (off-shore), SPP, and PJM.



Source: LBNL's Queued Up Report 2024

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 working groups

Data & Analytics

Collect and analyze interconnection data to inform solutions development

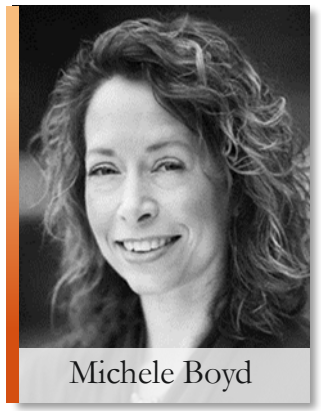
Strategic Roadmap

Create roadmap to inform interconnection process improvements

Technical Assistance

Leverage DOE laboratory expertise to support stakeholder roadmap implementation

i2X is a collaboration among DOE offices and labs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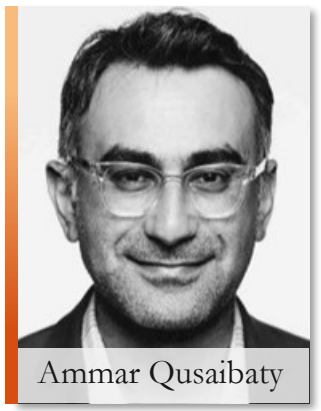
Michele Boyd


WETO
Jian Fu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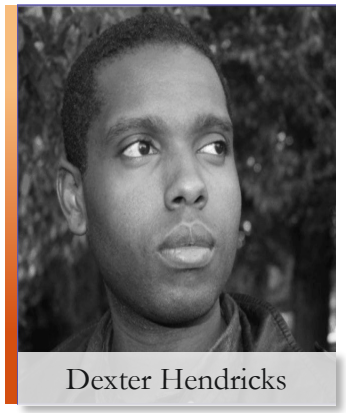
SETO
Dexter Hendricks


WETO
Bret Barker

BERKELEY LAB

Pacific Northwest NATIONAL LABORATORY

Joint Office of Energy and Transportation

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Office of Energy Justice and Equity

OTT Office of Technology Transitions

Sandia National Laboratories

NREL Transforming ENERGY

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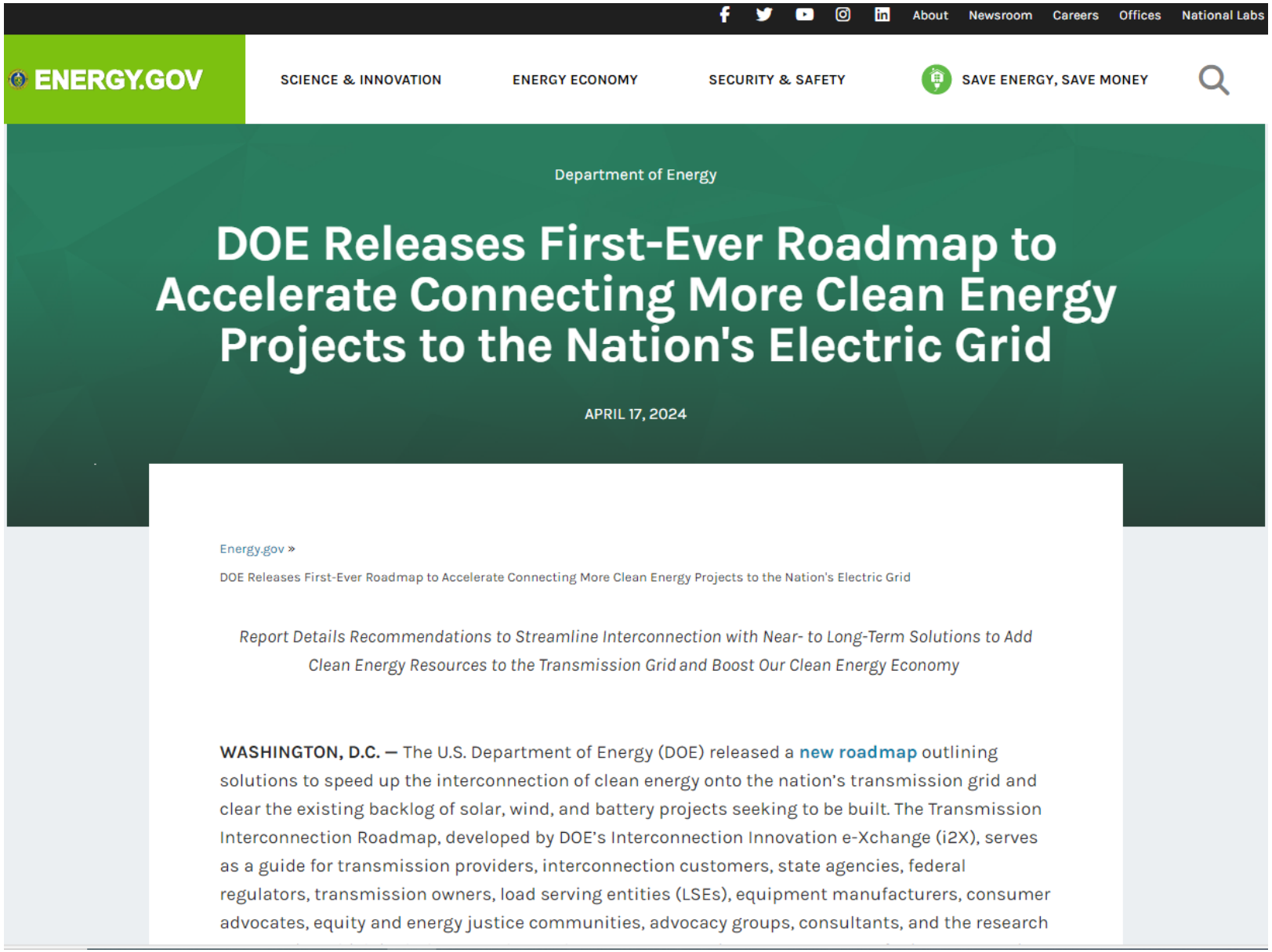
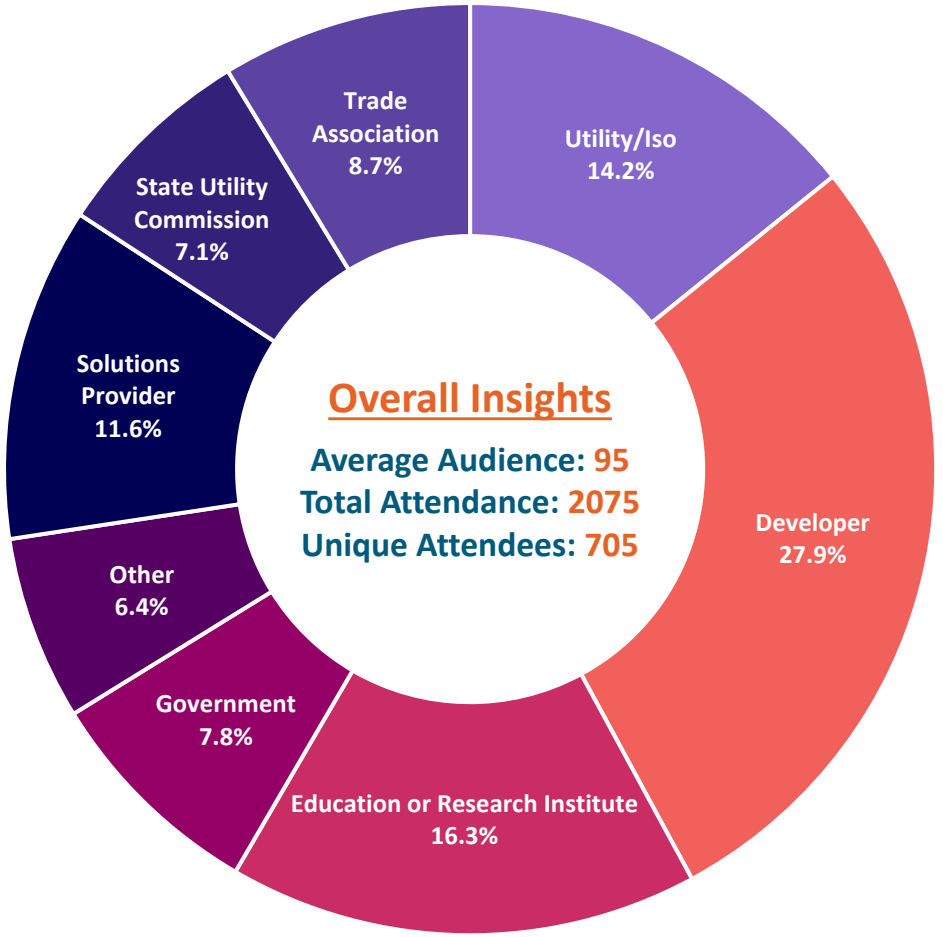


www.energy.gov/i2x

Transmission Roadmap Development

Roadmap informed by

- Solution e-Xchanges
  - 705 stakeholders from 350 organizations during 22 Solution e-Xchange meetings
  - 20+ public events
- Draft Roadmap
  - Comments from EERE Offices and other DOE offices
  - Request For Information (RFI) Responses on Draft
    - 40 organizations (ISOs/RTOs, utilities, clean energy industries, non-profit organizations)
    - Total of ~280 comments
  - Comments incorporated into the Final



Solution e-Xchange Participation by Stakeholder Group

Major Changes to Roadmap from Draft to Final

- Expanded description of the ***role for DOE*** (discussed earlier)
- Added context about ***FERC Order 2023*** and its relationship to key solutions
- Metrics reduced to three with more ***aspirational targets***.
- Expanded and better ***contextualized key actors*** and their roles
- Created separate section on ***fair and inclusive interconnection*** process
- Expanded connection to ***transmission planning***
- Added discussion of ***post-interconnection agreement issues***
- ***Increased specificity*** of several solutions, relying on initiatives provided by RFI comments
- Enhanced cross-referencing of which and how roadmap solutions relate to each other to note ***synergies and connectivity of the ideas***

Framing the Interconnection Roadmap

Context and Scope of Roadmap

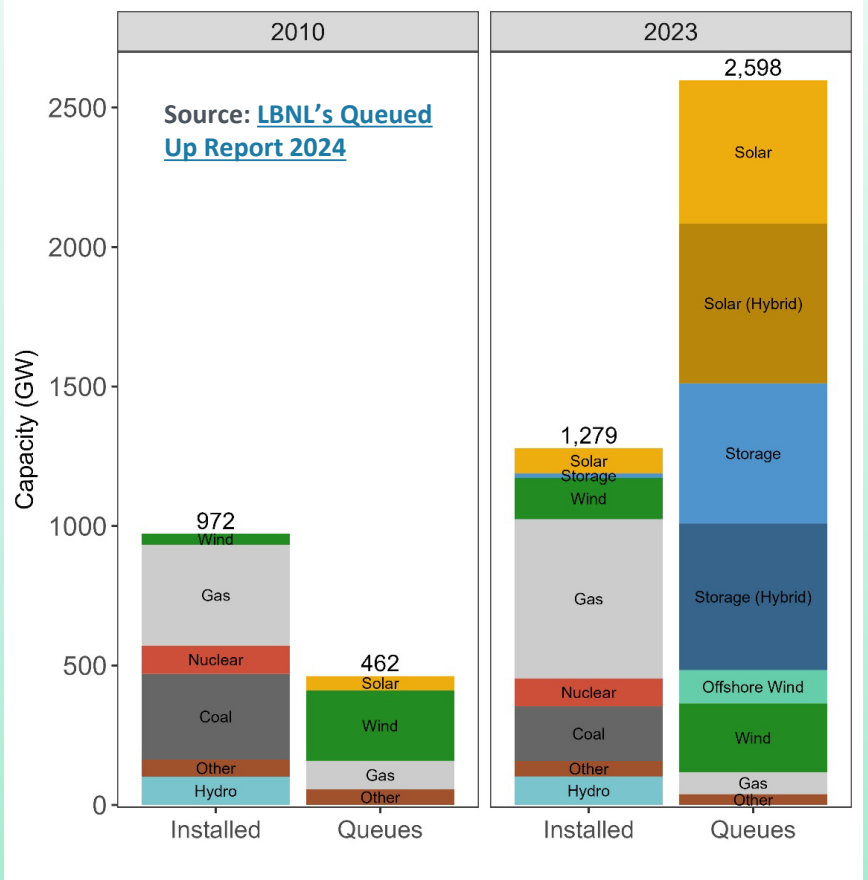
The Need for Reform

- Rapid rise of interconnection requests
- Expectation that these levels will remain in future due to load growth, plant retirements, and government policy.

Synergistic with Ongoing FERC Initiatives

- Solutions in the roadmap are intended to complement and support Order 2023.
- Include challenges and opportunities related to Order 2023 implementation
- But also incorporate ideas not raised in Order 2023 to provide comprehensive vision for longer-term process evolution.

Entire U.S. Installed Capacity vs. Active Queues



Source: LBNL's Queued Up Report 2024

Transmission Roadmap Key Components and Implementation Actors

35 solutions organized in four goals

Solutions with different implementation time frames

- *Short-term:* within 1-3 years (by 2027)
- *Medium-term:* 3-5 years (by 2029)
- *Long-term:* beyond 5 years (2030 and after)

Solutions describe collaborative actions among key actors

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

Measurable 2030 success targets

DOE has multiple potential roles in enabling Roadmap implementation

- Convene Stakeholders
- Provide Technical Support
- Fund Research and Innovation
- Evaluate Progress

Measurable Success Targets for 2030

Interconnection processes align well with Federal, state, and customer's decarbonization goals

	Target Value by 2030	Recent Value
 **Reduced interconnection process time** Average time from request to agreement	< 12 months	33 months (2022)
 **Lowered cost uncertainty** Standard deviation of interconnection costs	< $150/kW	$551/kW (2020-2021)
 **Increased Completion rates** Completion rate for projects that entered facility study phase	> 70%	45% (2016)
 **Maintained system reliability** Number of system disturbances due to modeling inaccuracy	Zero	4 (2022)

Four Interconnection Goals with 35 Solutions

Goal #1: Increase Data Access and Transparency

Goal #2: Improve Process and Timeline

Goal #3: Promote Economic Efficiency

Goal #4: Maintain a Reliable, Resilient, and Secure Grid

- Solutions are a collection of strategies rather than a rigid package of prescriptive fixes.
- Some solutions are complementary: to be effective, they would need to be implemented in tandem with others.
- Other solutions are exclusive: adopting one might obviate the need for another.
- Solutions may be topically specific (e.g., Cost Allocation)

Roadmap does not assess the costs of implementing the solutions.

Goal areas most critical to you and/or your organization?

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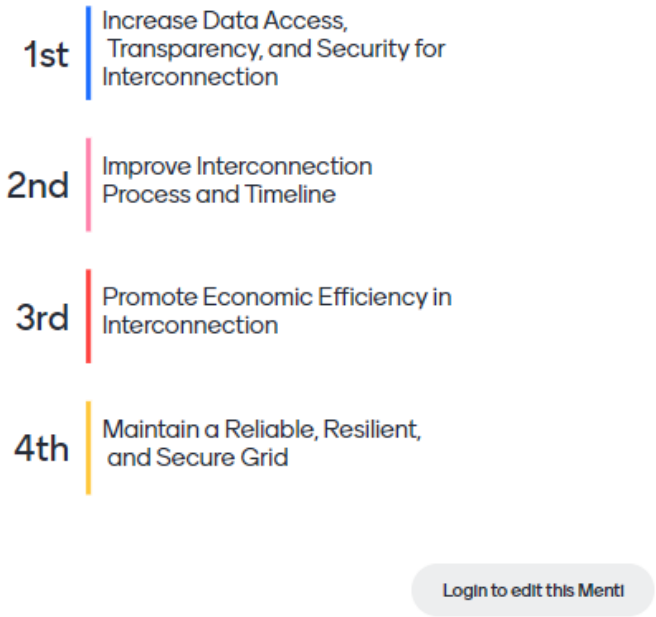

Goal 1: Data Access and Transparency

Challenge: Inadequate access to information is contributing to high volumes of interconnection requests, high withdrawal rates, and processing delays. How can improvements to data access and transparency support interconnection stakeholders?

Objectives

Key Tradeoff: Providing information to promote transparency, which take time and resources to implement, and which need to abide by security and confidentiality concerns

- Enable tracking and auditing of process performance
- Facilitate screening, optimal siting, and automation
- Improve the predictability of interconnection studies
- Reduce barriers to assess proposed projects

Example Solutions

- Improve the scope, accessibility, quality, and standardization of ***data on projects already in interconnection queues*** (short-term)
- Enhance the scope, timeliness, accuracy, and consistency of ***interconnection study models and modeling assumptions*** (medium-term)
- ***Develop tools*** to manage, analyze, and visualize transmission and interconnection data (medium-term)

Solutions under data transparency goal you are most excited to implement

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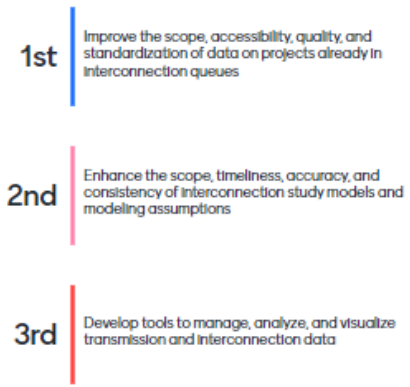

Goal 2: Improve Process and Timeline

Challenge: Backlogs and delays are the result of rapid growth in interconnection requests and inefficiencies in process. What changes can be made to handle larger quantities of requests while reducing study process timelines and maintaining access?

Topical Area	Example Solutions
Queue Management Key tradeoff: ***rationing quantity*** of proposed projects while ***maintaining competition*** and open access industry principles	• ***Automate*** data input, study validation, and customer communications (short-term) • Better utilize ***fast-track options*** for interconnection (medium-term) • Consider ***market-based approaches*** to rationing (long-term)
Affected System Studies Key tradeoff: creating more ***consistent and harmonized*** interregional processes while ***maintaining independence*** of individual balancing areas	• Increase ***collaboration and standardization*** on affected system studies (short-term) • Develop processes for ***joint transmission planning*** efforts on neighboring affected systems (medium-term)

Goal 2: Improve Process and Timeline

Challenge: Backlogs and delays are the result of rapid growth in interconnection requests and inefficiencies in process. What changes can be made to handle larger quantities of requests while reducing study process timelines and maintaining access?

Topical Area	Example Solutions
Inclusive and Fair Process Key tradeoff: Providing ***targeted support*** for stakeholders that do not start with the same tools and resources ***without ignoring open access*** principles	• Incorporate ***equity goals in transmission planning*** and valuation (short-term) • Provide ***independent engineering, admin, and legal services*** to support interconnection process navigation (medium-term)
Workforce Development Key tradeoff: Focus on ***growing and retaining workers*** while acknowledging challenge of ***competition for interconnection skills*** amongst interconnection-focused employers	• Assess ***scale of interconnection workforce*** growth requirements (short-term) • Upskill the ***existing workforce*** (short-term) • Grow workforce via ***outreach, career counseling, apprenticeships, and new curriculum*** (medium-term)

Solutions from process and timeline goal area you are most excited to implement

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Goal 3: Promote Economic Efficiency

Challenge: Interconnection and transmission planning are closely related, though often not closely coordinated. How can coordination be improved to keep costs low for consumers and more fairly allocate costs?

Topical Area	Example Solutions
Cost Allocation Key tradeoff: Balancing ***uncertain interconnection cost outcomes*** with the need to provide appropriate ***incentives for resource siting*** and efficient use of current transmission system	• Ensure generators have ***option to be re-dispatched*** rather than paying for network upgrades (medium-term) • ***Explore delinking*** interconnection processes from network upgrades (long-term)
Planning Coordination Key tradeoff: Transmission facilities not selected through ***long-term planning*** could be triggered by ***less efficient interconnection processes***	• Align ***data inputs, assumptions, and process timing*** between interconnection and transmission planning (medium-term)
Interconnection Studies Key tradeoff: Changing generation mix requires ***study method updates***, which take ***time and resources*** to implement	• Evaluate ***all effective mitigation options***, including alternative transmission technologies (short-term) • Consider allowing interconnection customers to ***provide own interconnection study*** (long-term)

Solutions from economic efficiency goal area you are most excited implement

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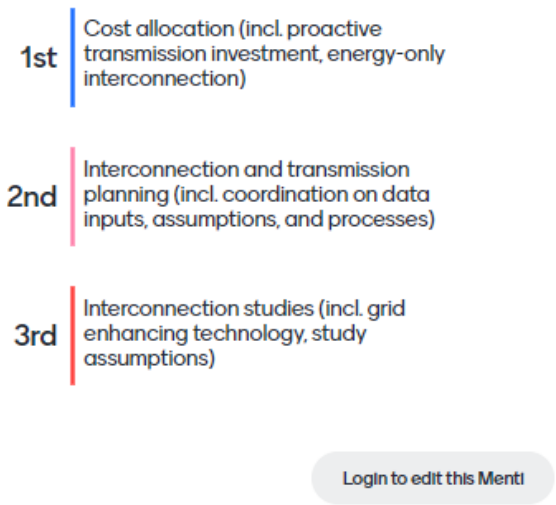

Goal 4: Maintain a Reliable, Resilient, and Secure Grid

Challenge: In recent years there has been a series of disturbance events leading to inverter-based resource (IBR) disconnection. How do we build the foundation to manage high penetration rates of IBRs & minimize disturbances?

Topical Area	Example Solutions
Interconnection Reliability Assessment Models and Tools Key tradeoff: Providing ***accurate and precise resource modeling*** without significantly ***slowing down the interconnection study*** process	• Require ***submission of EMT models*** and develop screens that determine when EMT studies are necessary (short-term) • Develop ***study process flow*** aligned with project development timelines (medium-term) • Advance ***computational speeds*** of studies (medium-term)
Interconnection Standards Key tradeoff: Providing ***clear upfront requirements*** that ensure reliability in real-time operations while allowing enough flexibility to ***leverage innovation and technology efficiencies***	• Adopt and implement ***IEEE 2800-2022*** (short-term) • Assess need for new standards to cover ***emerging technologies*** (medium-term) • Evaluate ***cyber and physical security*** concerns during interconnection (medium-term)

Solutions from reliability, resiliency, and security goal area you are most excied to implement

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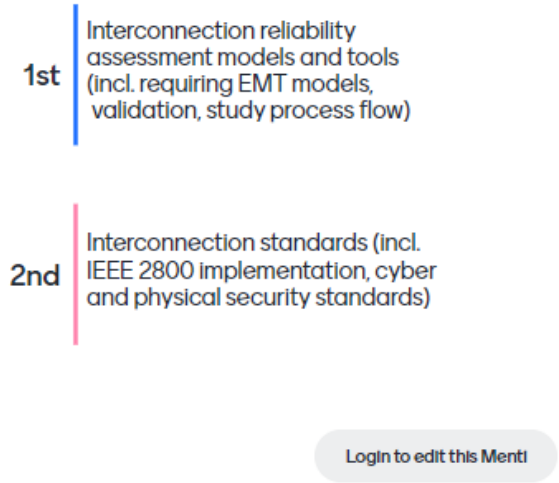

Current DOE Actions to Implement Roadmap Solutions

Solar and Wind Interconnection for Future Transmission (SWIFTR) Funding Opportunity - Released March 19

i2X Forum for Implementing Reliability Standards for Transmission (i2X FIRST) – Starts May 28

i2X Roadmap outreach and technical assistance

Collaboration among DOE Offices and other federal and state agencies

Explore solutions in depth together (subject to change)

July - Increase Data Access and Transparency

December - Maintain a Reliable, Resilient and Secure Grid

August - Improve Process and Timeline

October - Promote Economic Efficiency

Interactive Discussion and Q&A (10 min)

Website: energy.gov/i2X
Email: i2x@ee.doe.gov

i2X office hours

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