U.S. Department of ENERGY | Grid Deployment Office

National Transmission Planning Study

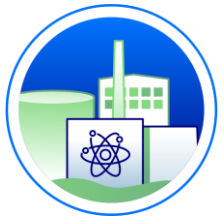
ESIG Webinar / November 14, 2024

Dr. Yamit Lavi, Technical Advisor

AGENDA

1. Study Background – What is the National Transmission Planning Study?
2. Principle Findings
3. Utility of Study (how will GDO use this study?)
4. Relation to Other Interregional Planning Efforts
5. Questions

GDO MISSION AND GOALS



Ensure **resource adequacy** by supporting **critical generation sources** and expanding and enhancing **electricity markets**.

Catalyze the development of new and upgraded **high-capacity electric transmission lines** and an improved **distribution system** nationwide.

Prevent **outages** and enhance the **resilience** of the electric grid.

STUDY BACKGROUND

THE NTP STUDY WAS PUBLISHED ON OCTOBER 3, 2024

You can find the National Transmission Planning Study on DOE's website:

https://www.energy.gov/gdo/national-transmission-planning-study

The public webinar was on October 16th and the recording is also available on the DOE website:

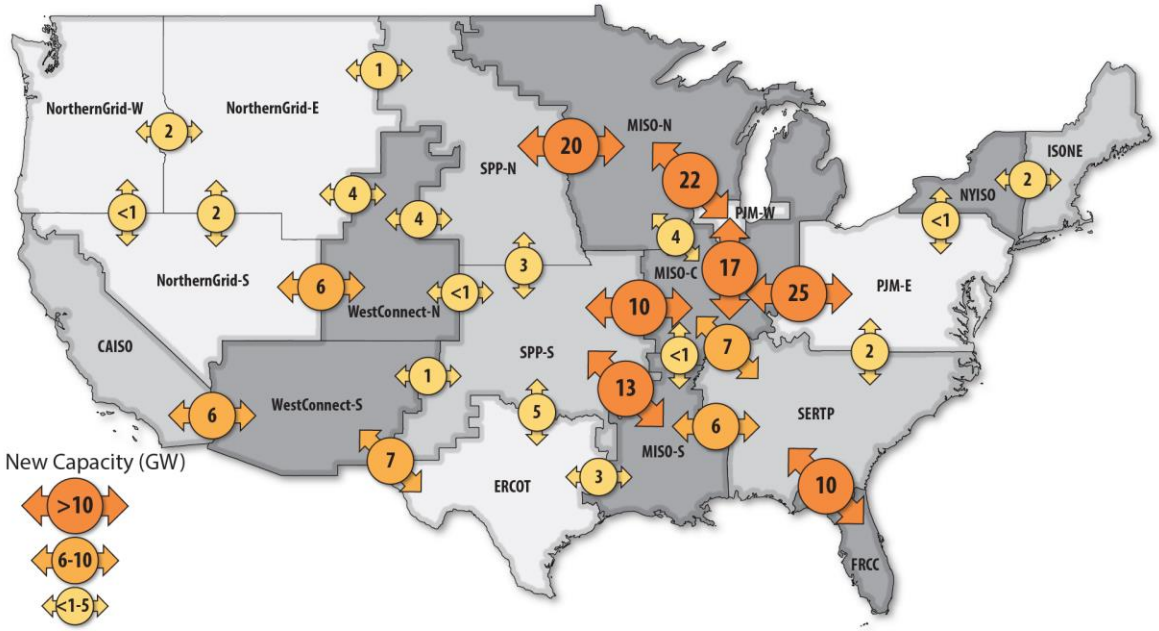
https://www.energy.gov/gdo/events/october-16-national-transmission-planning-study-informational-webinar

NTP STUDY FINDINGS SUMMARY

GRID RELIABILITY: Improving interregional transmission can enhance grid reliability, particularly in response to extreme weather events, as it allows more resources to be shared across regions and energy to be moved from where it is available to where it is needed.

CONSUMER SAVINGS: A substantial expansion of the transmission system throughout the entire contiguous United States delivers the largest benefits to consumers and would save the U.S. **$270-$490 billion** through 2050, with approximately **$1.60 to $1.80** in system cost savings for every dollar spent on transmission.

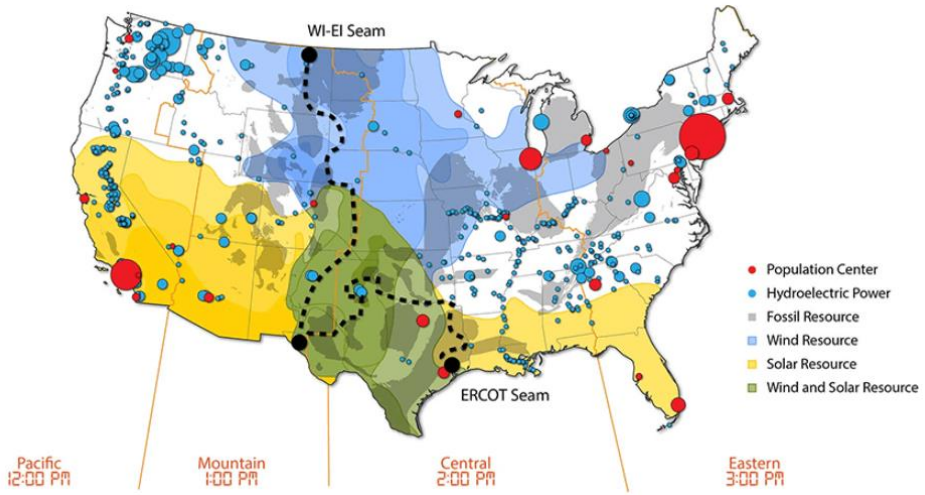
INTEGRATING NEW GENERATION ONTO THE GRID: Expanded transmission enables the grid connection of new generation projects, balancing the variability of wind and solar resources and accommodating growing energy demands while maintaining system reliability and energy affordability.



High Opportunity Transmission (HOT) interfaces represent potentially beneficial transmission capacity expansion between regions found across many future power system scenarios. Transmission projects that align with these HOT interfaces could be strong candidates for further study and serve as a starting point for accelerated transmission expansion.

PROJECT TEAM

- The NTP Study was led by the U.S. Department of Energy's Grid Deployment Office, in partnership with the National Renewable Energy Laboratory and Pacific Northwest National Laboratory.
- This study builds on past projects and expertise at NREL and PNNL with the support and direction of DOE's Office of Electricity and Grid Deployment Office.



U.S. DEPARTMENT OF ENERGY

Office of Electricity

North American Energy Resilience Model

BROAD STAKEHOLDER ENGAGEMENT

- Public Input
- Existing Convenor Groups
- Technical Review Committee
- Tribal Outreach

TECHNICAL REVIEW COMMITTEE

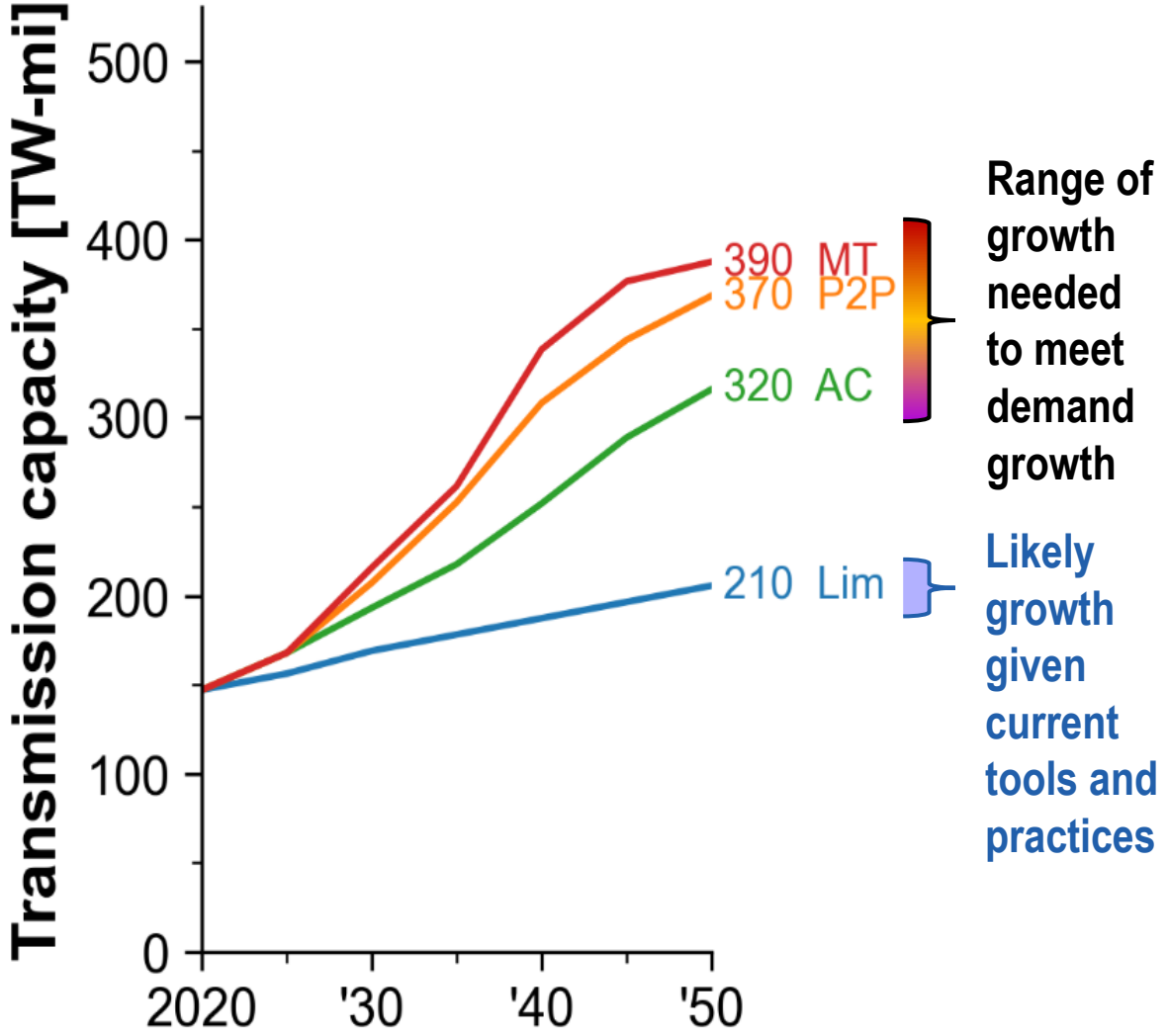
- Four public meetings (including the final public webinar)
- Three plenary TRC meetings
- Six Modeling Subcommittee meetings
- Four Government Subcommittee meetings
- Two Land Use and Environmental Exclusions Subcommittee meetings
- Four rounds of regional meetings
- Two sets of office hours

THE PROBLEM

The Nation needs **significant investments in new interregional transmission capacity** to meet growing demand, reduce costs, access energy supplies, and bolster resilience to extreme weather.

However, **existing grid planning efforts are fragmented** and focused on identifying local and regional solutions, rarely considering interregional solutions.

Moreover, **existing planning analysis tools** may not capture the reliability and consumer value of larger grid-scale interregional connections or answer questions about the operational reliability of larger systems.



NTP STUDY GOALS

The National Transmission Planning Study combines innovative methods with state-of-the-art industry practices to analyze the role and value of transmission in future power systems.

Specifically, the study sought to:

- Develop new national grid-scale planning tools and methods that can be used by industry, especially when planning for interregional transmission capacity needs;
- Identify potential transmission solutions that will provide broad-scale benefits to electric customers under a wide range of potential futures;
- Inform planning processes for regional and interregional transmission; and
- Identify interregional and national strategies to maintain grid reliability as the grid transitions, including to a reliance on variable energy resources.

WHAT THE STUDY DOES AND DOES NOT DO

WHAT THE STUDY DOES DO

- Link several long-term and short-term power system models to test multiple transmission buildout scenarios.
- Provide information that can be used in existing planning processes.
- Test transmission options that lie outside current planning processes.
- Assess a range of economic, reliability, and resilience indicators for each transmission scenario considered.
- Provide companion reports describing opportunities and challenges to realizing potential transmission benefits identified by the study.

WHAT THE STUDY DOES NOT DO

- Replace existing regional and utility planning processes.
- Site specific locations or provide approvals for individual transmission lines.
- Address the detailed environmental impacts or other land use issues of potential future transmission lines.
- Develop detailed plans of service or provide results that are as granular as planning done by utilities.
- Provide a roadmap for developing specific projects.

STUDY SCENARIOS AND METHODS

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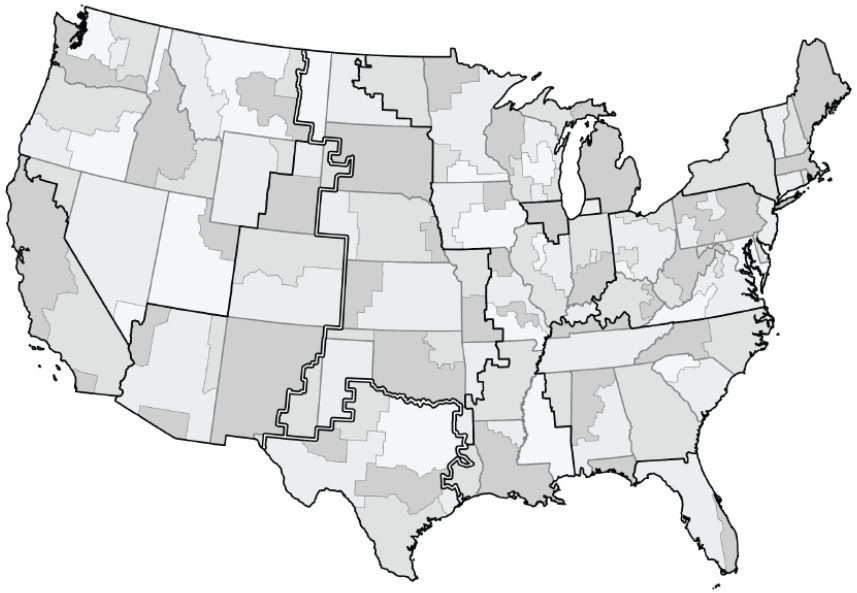
Multimodel analysis for a low-cost, reliable transmission system of the future



Zonal Resolution
Long-Term Scenarios through 2050

- Capacity Expansion
- Economic Analysis
- Resource Adequacy

Nodal Resolution
2035 Transmission Portfolios

- Production Cost
- Power Flow
- Stress Analysis

SCENARIOS: TRANSMISSION FRAMEWORKS

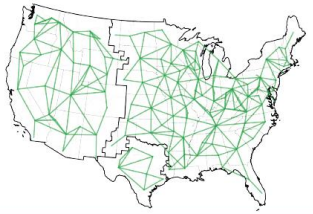
Reference Transmission Framework

Limited (Lim)

- No new interregional transmission
- Total annual transmission expansion limited to recent observed maximum

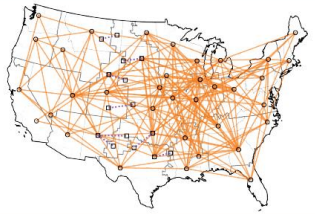
Accelerated Transmission Framework

Alternating Current (AC)



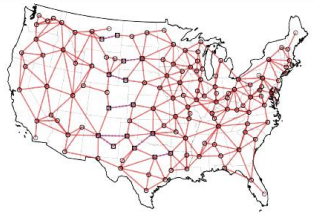
- Expansion allowed within interconnections
- No new DC connections

Point-to-Point (P2P)



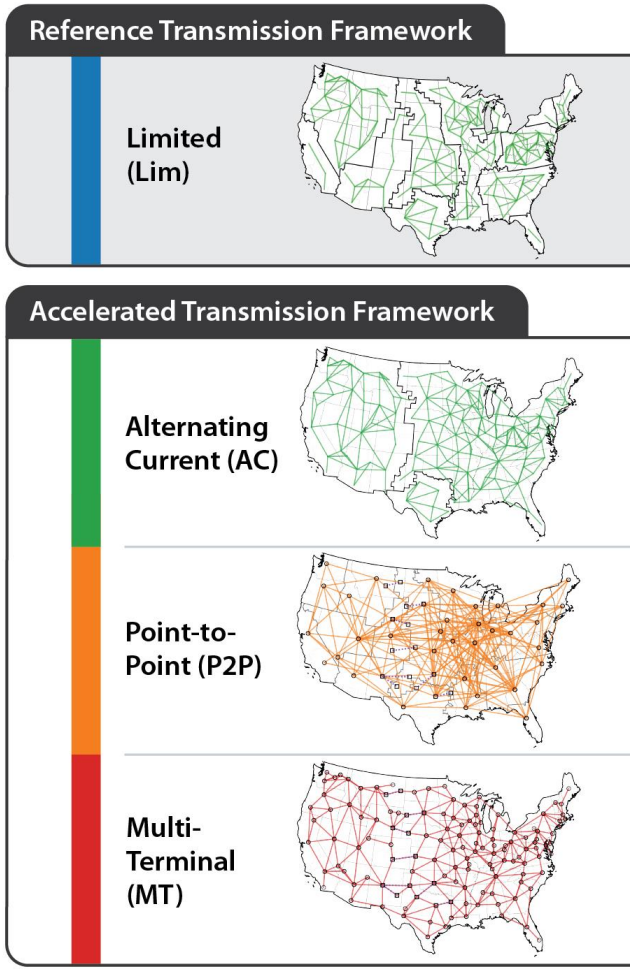
- Expansion allowed across the country
- Includes long-distance point-to-point HVDC options

Multi-Terminal (MT)

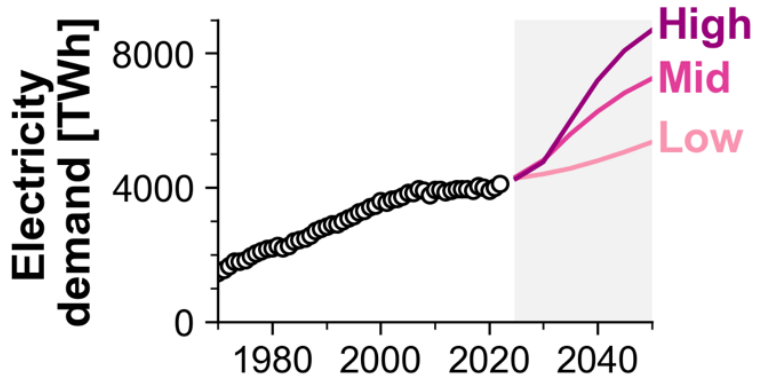


- Expansion allowed across the country
- Includes multi-terminal HVDC options between neighboring zones

SCENARIOS: TRANSMISSION X DEMAND X EMISSIONS TARGETS = 36 CORE SCENARIOS



× 3 Demand Growth



× 3 Emissions Targets

No national constraints
90% CO_2 reduction by 2035
100% by 2035

Goal is to understand role of transmission across many possible futures.

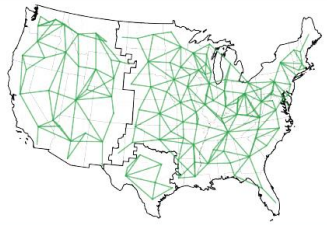
SCENARIOS: SENSITIVITIES

Reference Transmission Framework

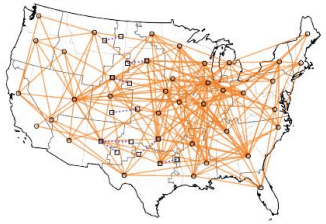
Limited (Lim)

Accelerated Transmission Framework

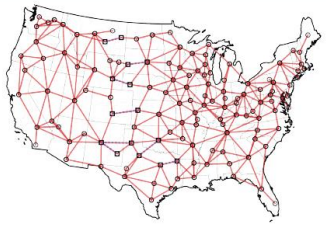
Alternating Current (AC)



Point-to-Point (P2P)



Multi-Terminal (MT)



× 15 Sensitivities*

Sensitivity
PV + battery low cost
Wind low cost
Electrolyzer low cost
+Nuclear SMR +DAC
No interface expansion limit
Transmission cost 2x
No resource adequacy sharing
Siting limited for PV and wind
CCS high cost
Many challenges
No H2
No CCS
No H2 or CCS
No H2 or new nuclear
Climate

**Full set of sensitivities modeled for the central (90% by 2035, Mid-Demand) case only*

PRINCIPLE FINDINGS

To help readers digest the technical report, the Executive Summary identifies

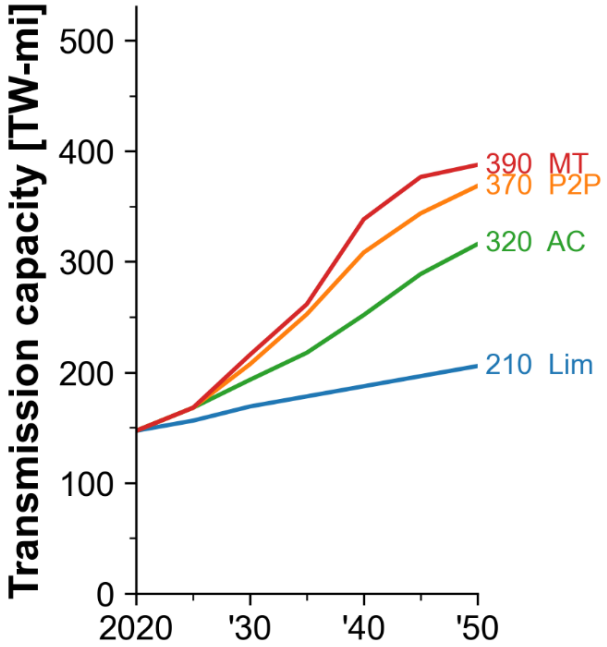
6 principal findings

1. Transmission expansion under current policies
2. Benefits of transmission
3. Substantial transmission expansion
4. Grid reliability
5. Promising interregional transmission
6. Advancements in planning approaches

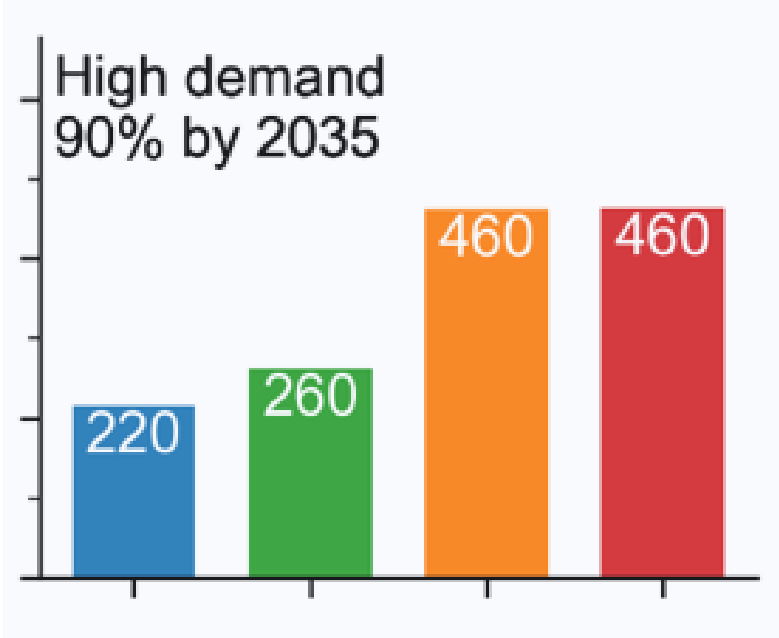
90% emissions reductions by 2035

I THE LOWEST-COST U.S. ELECTRICITY SYSTEM PORTFOLIOS THAT MEET FUTURE DEMAND GROWTH AND RELIABILITY REQUIREMENTS INCLUDE SUBSTANTIAL EXPANSION IN TRANSMISSION.

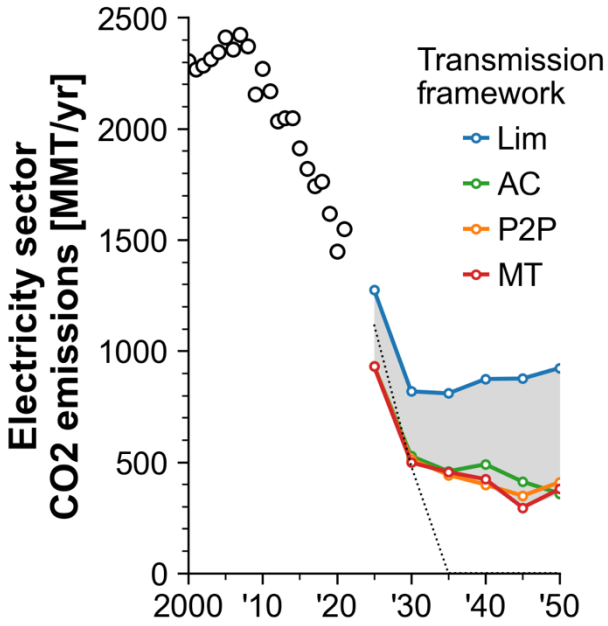
Double Current Transmission = Greatest System Cost Savings & Greatest Decarbonization



Total transmission expansion through 2050 given current policies and mid-demand assumptions.

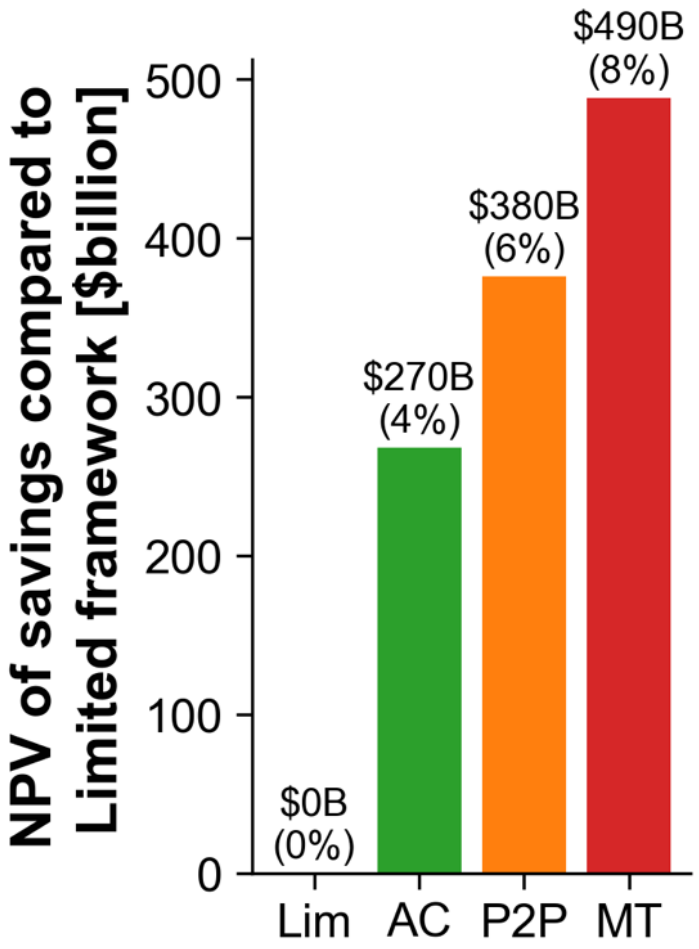


System cost savings achieved through 2050 from resource adequacy (RA) sharing, compared against a sensitivity where RA sharing between planning regions is not allowed. [NPV $billion]



Comparison of annual electricity sector emissions given current policies and mid-demand scenarios.

THE STUDY FINDS HUNDREDS OF BILLIONS OF DOLLARS OF NET BENEFITS FROM LARGE-SCALE TRANSMISSION EXPANSION COMPARED TO HISTORIC RATES OF TRANSMISSION DEPLOYMENT.



Benefits = Total System Cost Savings

Accelerated transmission expansion leads to national electric system cost savings of **$270 to $490 billion** through 2050.

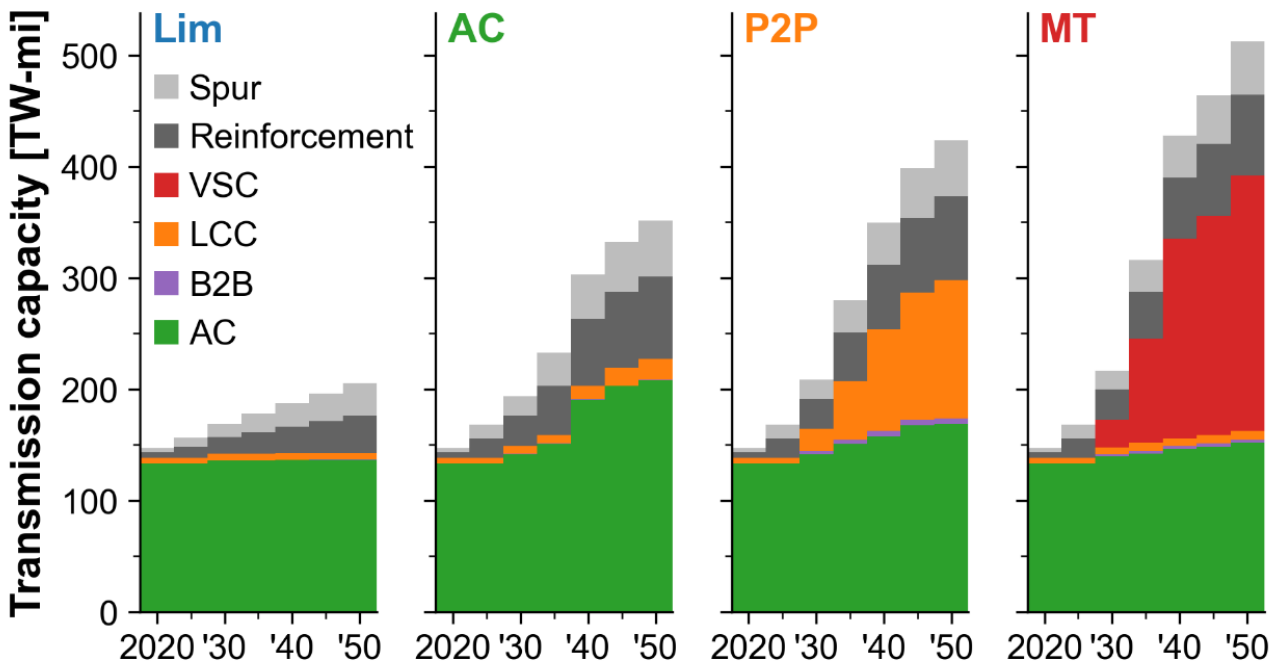
Incremental investments in transmission are more than compensated by reduced electric system costs for fuel, generation and storage capacity, and other costs.

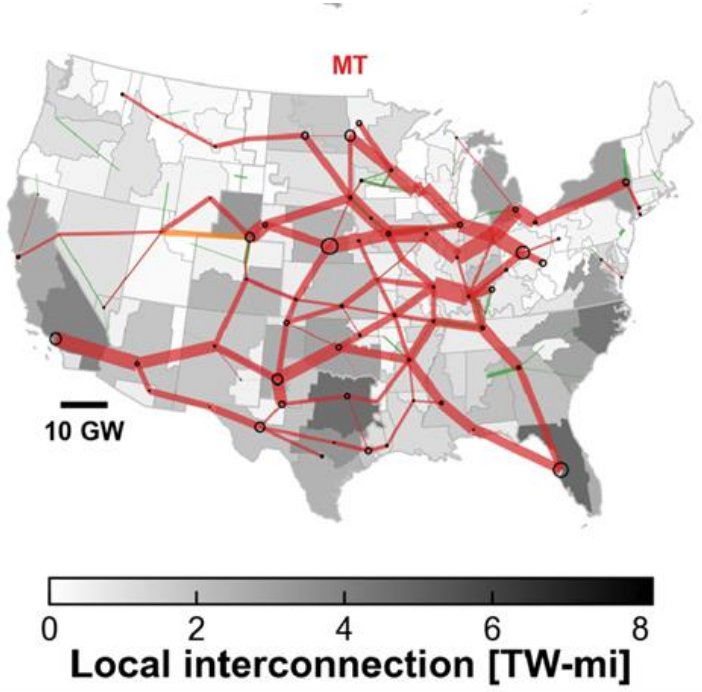
Approximately **$1.60 to $1.80 is saved for every dollar spent** on transmission.

A SUBSTANTIAL EXPANSION OF THE TRANSMISSION SYSTEM THROUGHOUT THE ENTIRE CONTIGUOUS UNITED STATES DELIVERS THE LARGEST BENEFITS ACROSS A WIDE VARIETY OF SCENARIOS.

Expansion in Transmission =

- Amount (2.4 to 3.5 times today's level),
- Type (HVDC, vs. just AC), and
- Topology (Interregional vs. just Local or Intra-regional)



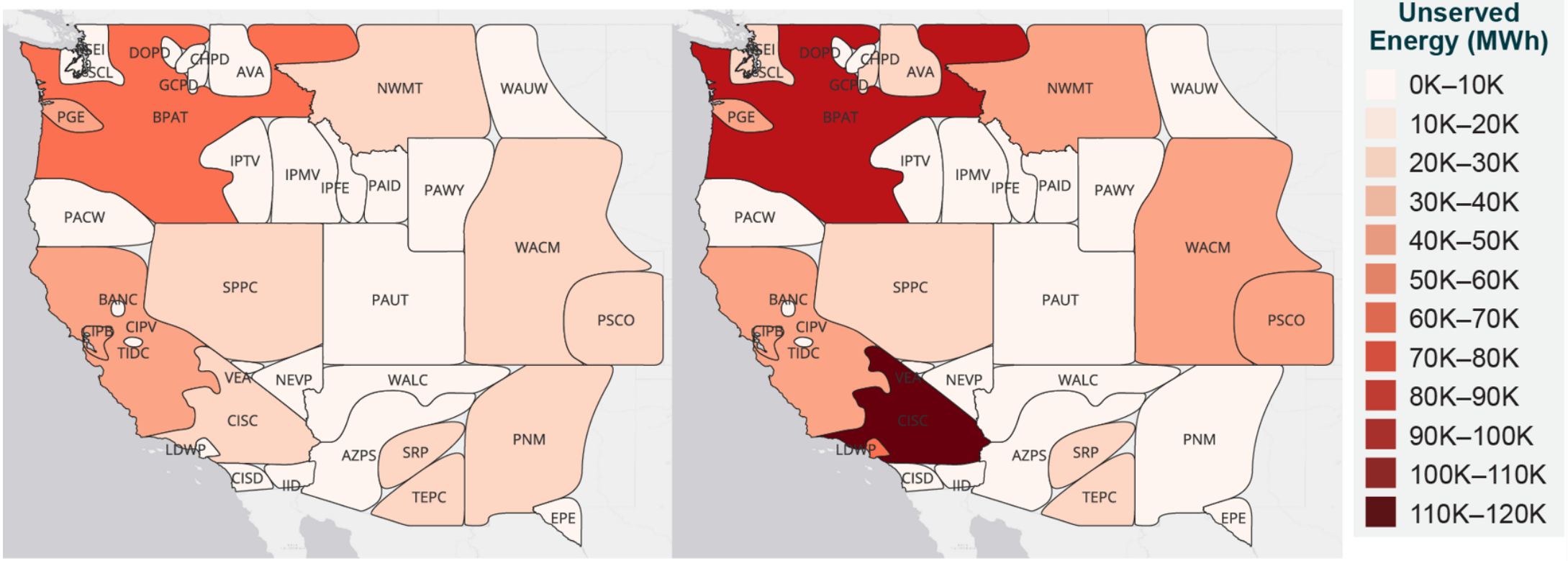


IV GRID RELIABILITY CAN BE MAINTAINED IN FUTURE LOW-CARBON GRID SCENARIOS WITH THE LOWEST-COST SOLUTIONS RELYING ON COORDINATED TRANSMISSION UTILIZATION BETWEEN REGIONS DURING PERIODS OF GREATEST STRESS.

Reliability = Resource Adequacy, Transmission System Integrity, and Extreme Weather Resilience

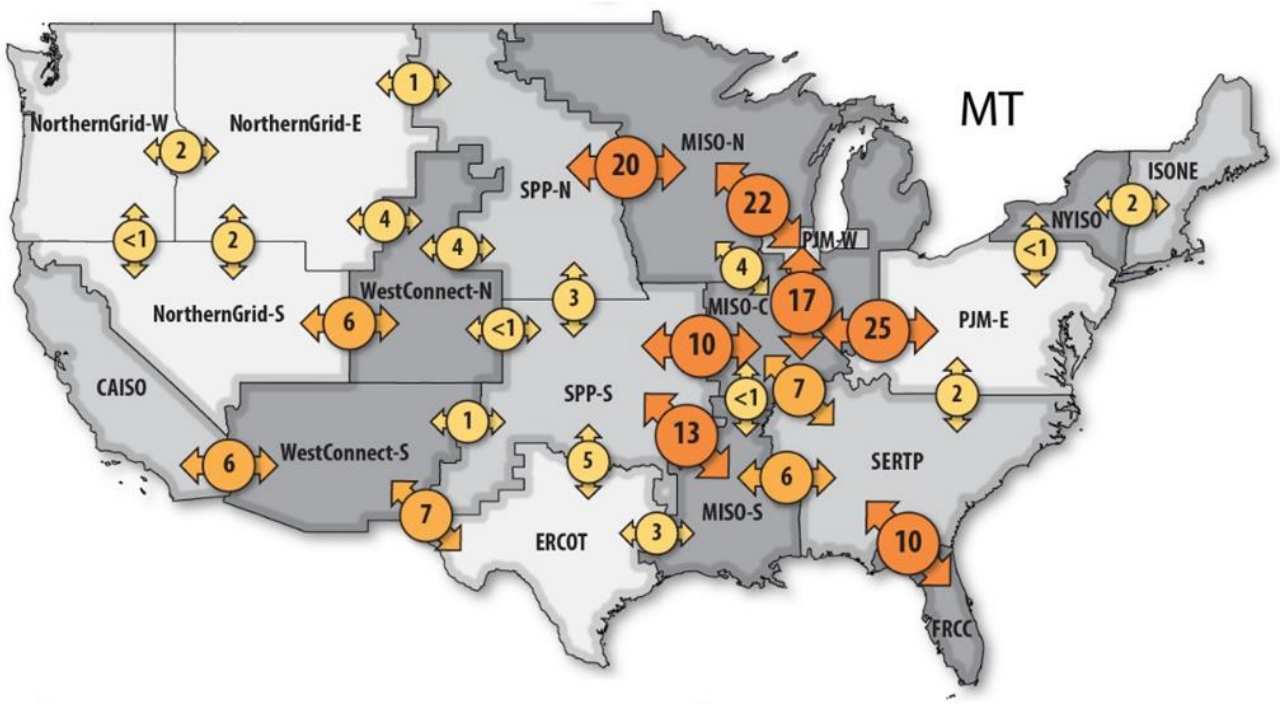
Unserved Energy of Interregional AC Scenario (Combined CA heatwave and PNW drought)

Unserved Energy of Limited AC Scenario (Combined CA heatwave and PNW drought)



V THE NTP STUDY IDENTIFIES SEVERAL EXAMPLES OF TRANSMISSION INVESTMENT THAT COULD BE PROMISING CANDIDATES FOR MORE IN-DEPTH CONSIDERATION BY PLANNERS AND DEVELOPERS.

High Opportunity Transmission Interfaces

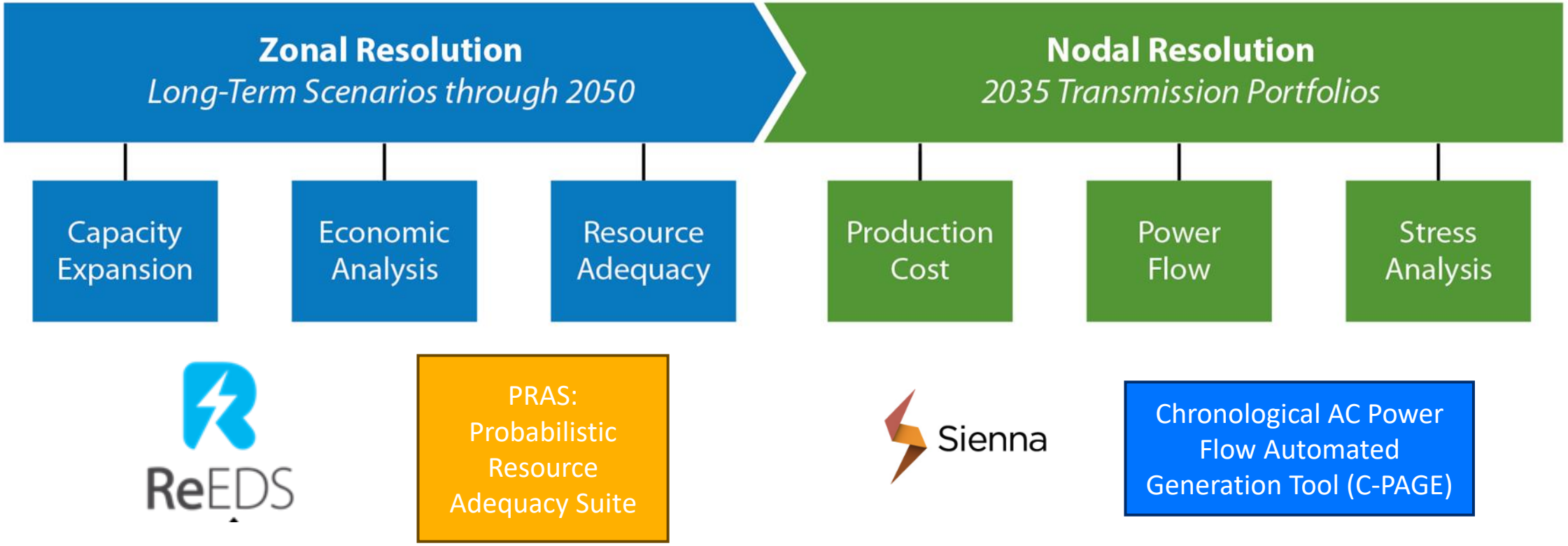


Transmission Portfolio Providing Broadscale Benefits

(<u>One</u> possible implementation of HOT interface result shown; not a recommendation or optimal design)

Note both results for mid-demand, 90% decarbonization by 2035 scenarios within a MT-HVDC transmission framework.
Different interfaces and portfolios would emerge for different scenarios and transmission frameworks.
Only transmission expansions from 2020 to 2035 are shown; existing capacity is not included.

VI GRID PLANNING AT THE NATIONAL OR MULTI-REGIONAL SCALE REQUIRES ENHANCED INSTITUTIONAL COORDINATION, ACCESSIBLE DATA, AND NEW GRID MODELING APPROACHES, WHICH HAVE ADVANCED UNDER THE NTP STUDY IN PARTNERSHIP WITH TECHNICAL AND PLANNING EXPERTS.



The 6 principal findings are supported by technical detail, further summarized in

22 key takeaways

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UTILITY OF STUDY

NEXT STEPS – TURNING THE FINDINGS INTO ACTION

Share the findings and analytical tools developed by the labs with transmission planning entities, RTOs/ISOs, utilities, and states to help **advance planning of interregional transmission**

Encourage examination by planners of **high opportunity transmission options** identified in the NTP Study

Inform DOE's use of financing and permitting tools:

- E.g., Transmission Facilitation Program, NIETC Designation, 2026 Needs Study, etc.
- NTP study results may help GDO shape programs and applicant submissions, but results do not affect selections processes.

NTP STUDY TOOL & METHODS DEVELOPMENT

Nationwide capacity expansion modeling

Zonal to nodal model disaggregation

- Detailed system modeling to analyze system costs and operations

Chronological AC Power Flow Automated Generation (C-PAGE) tool

- Samples many timeframes to analyze sequential snapshots of the most stressed hours of a year

Extreme event and climate change on load

ARE THERE OPPORTUNITIES TO EXPAND ON THESE TOOLS, DATA, AND RESULTS TO ASSIST STATES AND PLANNERS?

Additional capacity expansion modeling (scenario development) that could inform resource assumptions in existing planning process from a multi-regional basis

Interregional model development

- Multi-regional extreme weather events

Development or verification of "best available data," especially in longer-term horizons

- Wind and solar outputs
- Load with climate impacts, electrification, data center projections, etc.

Providing example benefits calculations

- E.g. assessing seven categories of benefits in Order No. 1920

HOW THE NTP STUDY RELATES TO OTHER INTERREGIONAL PLANNING EFFORTS

NEEDS STUDY VS NTP STUDY

NEEDS STUDY

- Published every 3 years
- Assessment of near-term transmission needs (through 2040)
- Uses existing power sector data and reports
- Does not identify specific solutions for assessed needs

Where is the lack of transmission harming consumers?

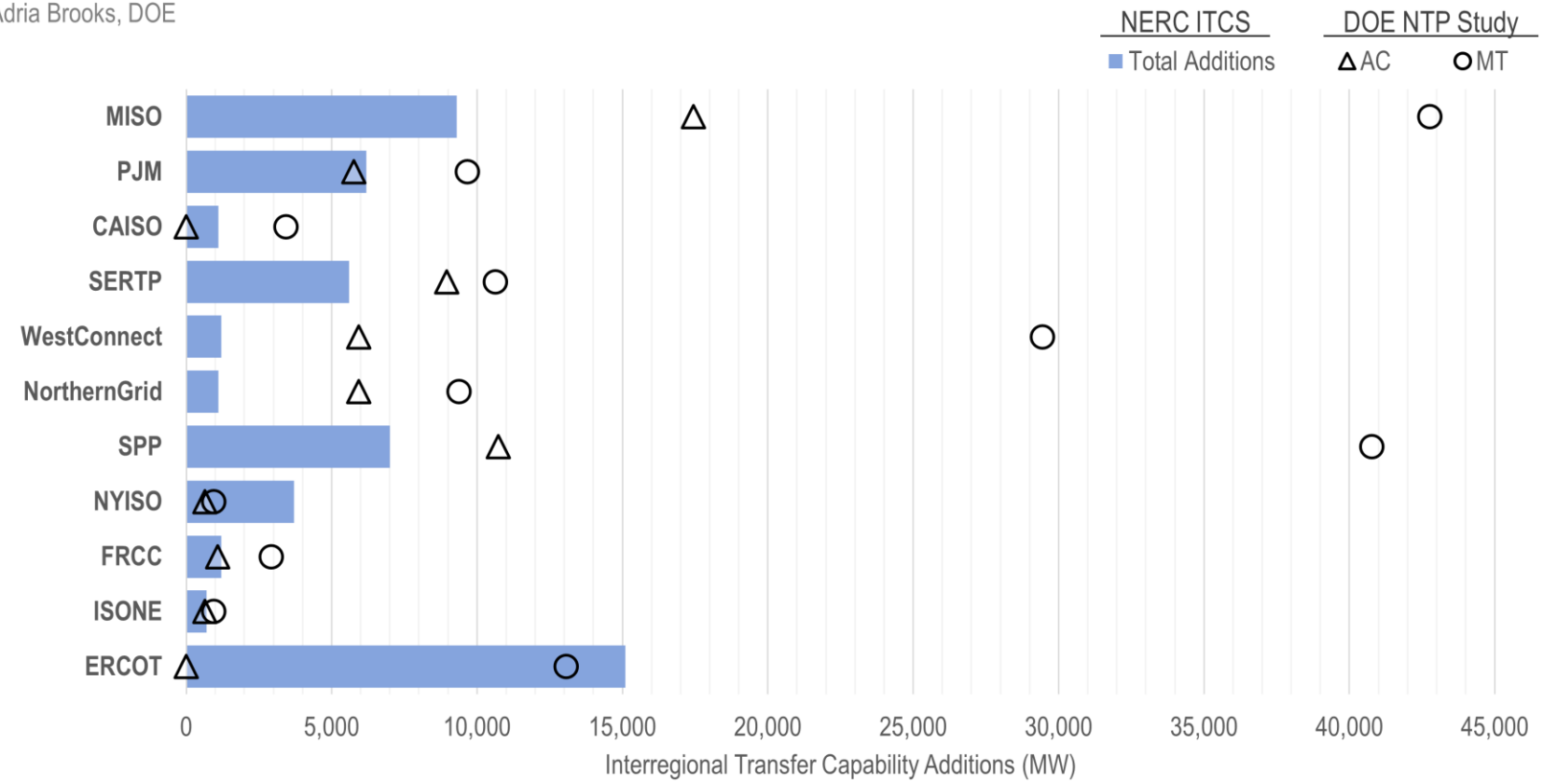
NTP STUDY

- No statutory cycle or timeframe
- Assessment of both near- and long-term transmission needs (through 2050)
- Uses new modeling and analysis
- Provides examples of potential transmission solutions.

What long-term national transmission investment strategies provide the most benefits to consumers?

NERC INTERREGIONAL TRANSFER CAPABILITY STUDY

Comparison of prudent interregional transfer capability additions across two studies.
ITCS results needed by 2033. NTP Study median results by 2030.
Data: NERC ITCS (2024), DOE NTPS (2024)
Adria Brooks, DOE



THANK YOU

Yamit Lavi

yamit.lavi@hq.doe.gov

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