



National Transmission Planning (NTP) Study : High Opportunity Transmission Analysis

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NOTICE

This presentation includes specific examples from preliminary modeling to facilitate discussion and feedback; final results will differ from any results shown here.



Where does the NTP Study fit into other national scope activities? (not a comprehensive list!)

- This is not the DOE National Transmission Needs Study

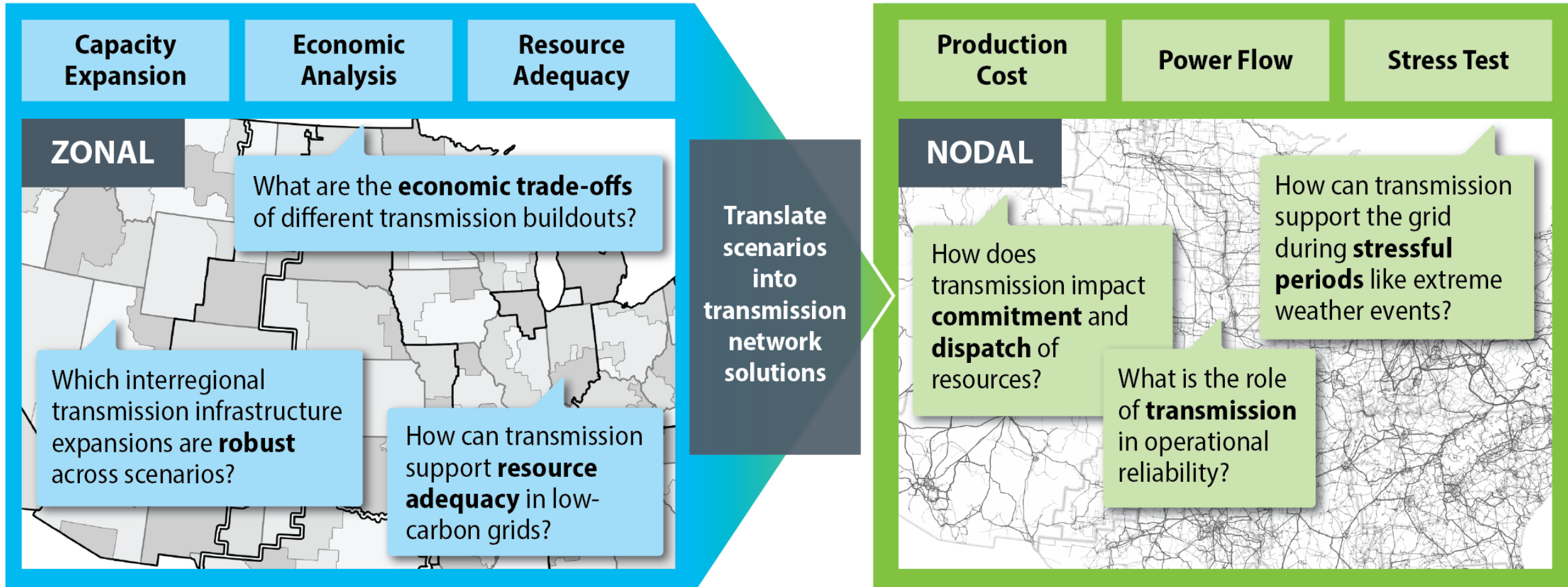
Related DOE/Lab Led studies:

- Atlantic Offshore Wind Transmission Study – recently published
 - Coordination in offshore assumptions
- Western Offshore Wind Transmission Study – Completion in 2025

Other relevant but separate activities:

- National Interest Electric Transmission Corridor (NIETC) Designation
- NERC Interregional Transfer Capability Study

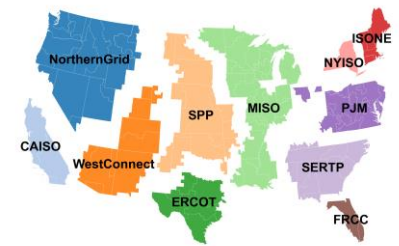
Multimodel framework for better understanding the role, value and opportunities for transmission in the U.S.



~100 scenarios out to 2050

3 scenarios for a single year (2035)

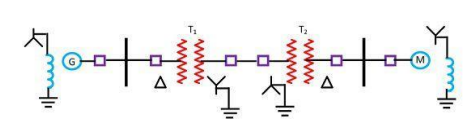
Today we will demonstrate that:



(presentation 1) There are many opportunities for interregional transmission,



(2) The benefits of transmission usually exceed the costs,



(3) There exist network solutions and the grid can balance in transformative futures,



(4) Reliability can be maintained in transformative systems.

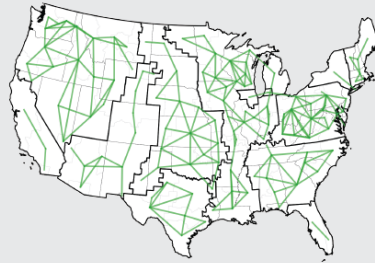
NTP Study Scenarios – Key Findings

Regional Energy Deployment System
(ReEDS)

Scenario Framework: Transmission Expansion Paradigms

Reference Transmission Framework

**Limited
(Lim)**



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

Scenario Framework: Transmission Expansion Paradigms

Reference Transmission Framework

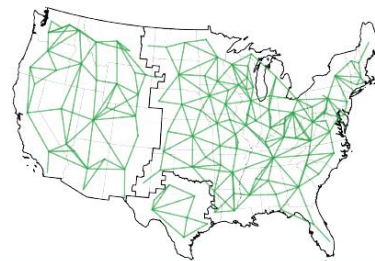
Limited (Lim)



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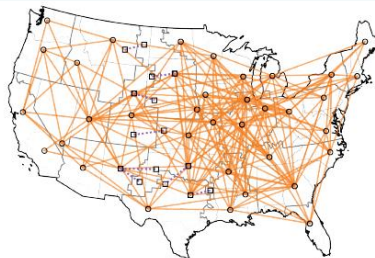
Accelerated Transmission Framework

Alternating Current (AC)



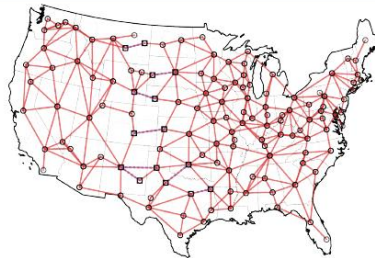
- Expansion allowed within interconnections
- No new DC connections

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

Scenario Framework:

Transmission

×

Demand

×

Emissions
Targets

36 core
scenarios

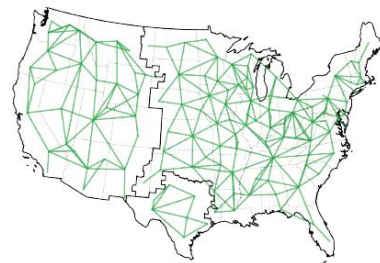
Reference Transmission Framework

Limited
(Lim)



Accelerated Transmission Framework

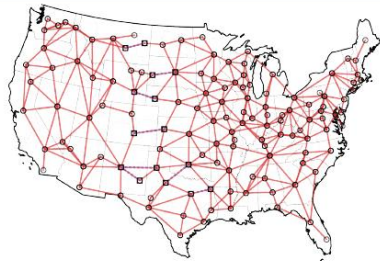
Alternating
Current (AC)



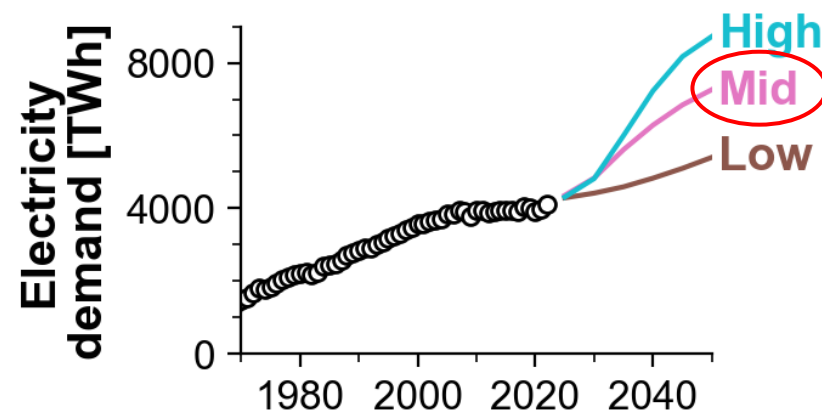
Point-to-
Point (P2P)



Multi-
Terminal
(MT)



× 3 Demand Growth



× 3 Emissions Targets

Current policies

90% CO₂ reduction by 2035

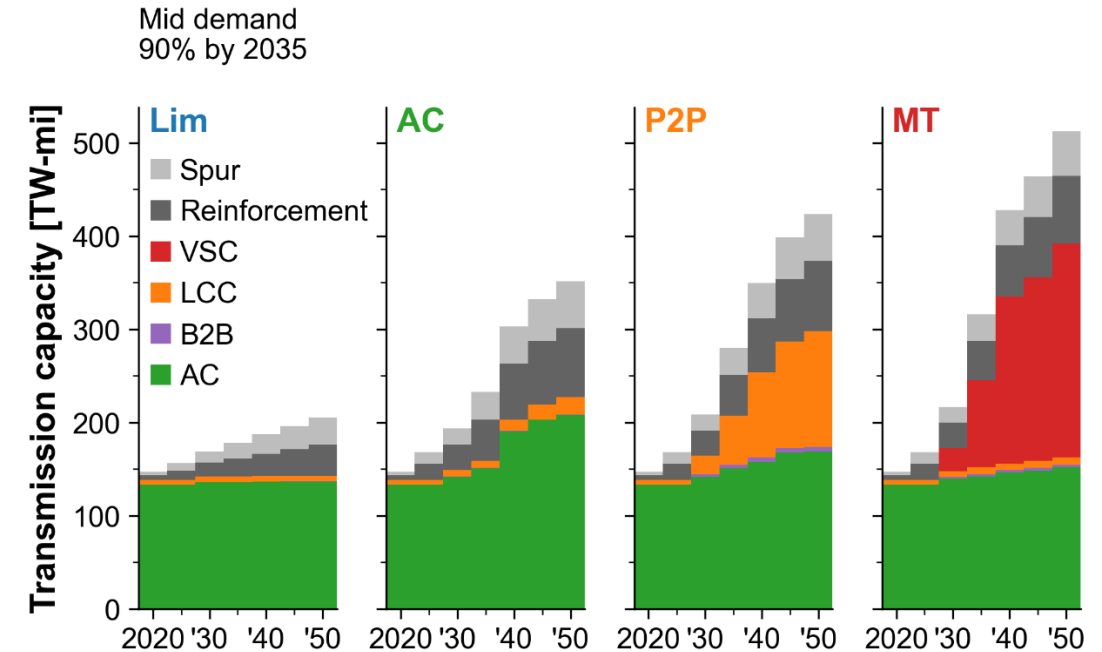
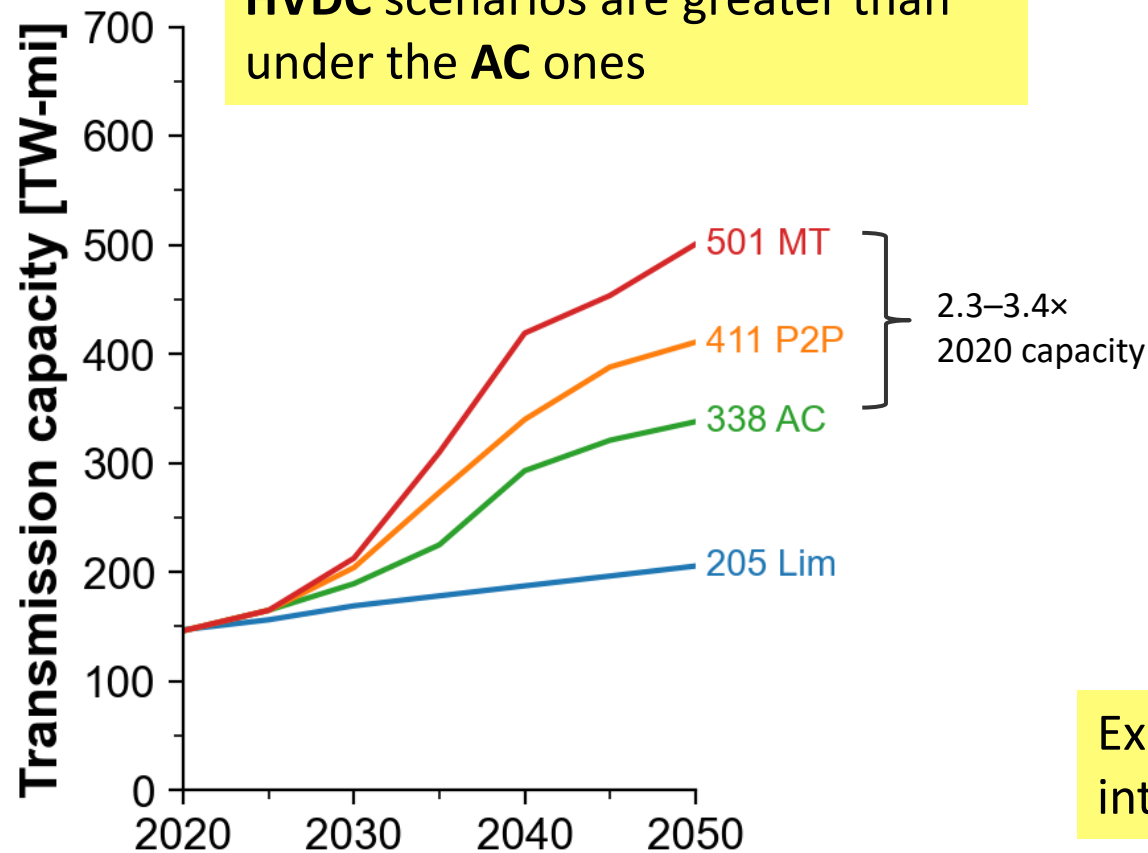
100% by 2035

Goal is to understand role of transmission across many possible futures

Rapid and significant growth in new transmission capacity occurs under the decarbonization scenarios

90% by 2035,
mid demand

Transmission additions under the **HVDC** scenarios are greater than under the **AC** ones

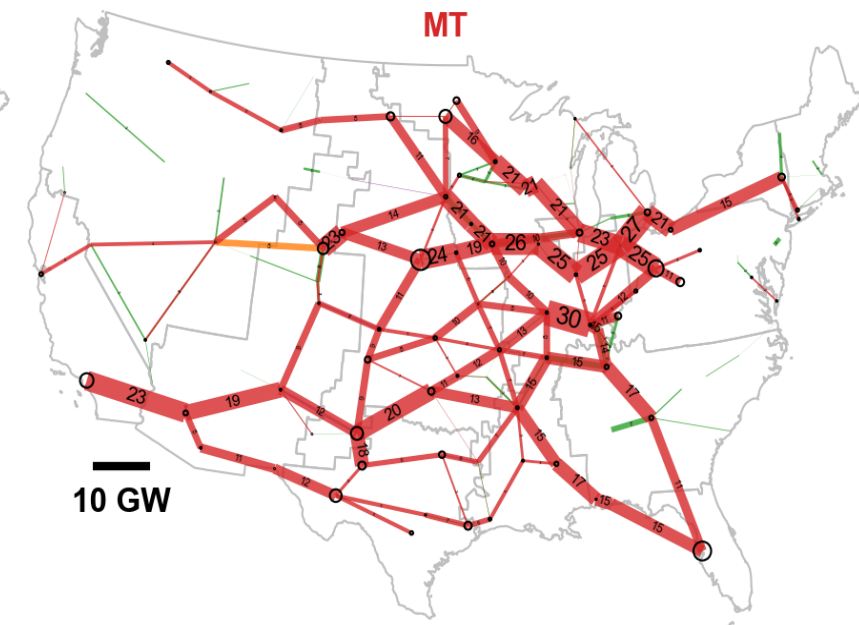
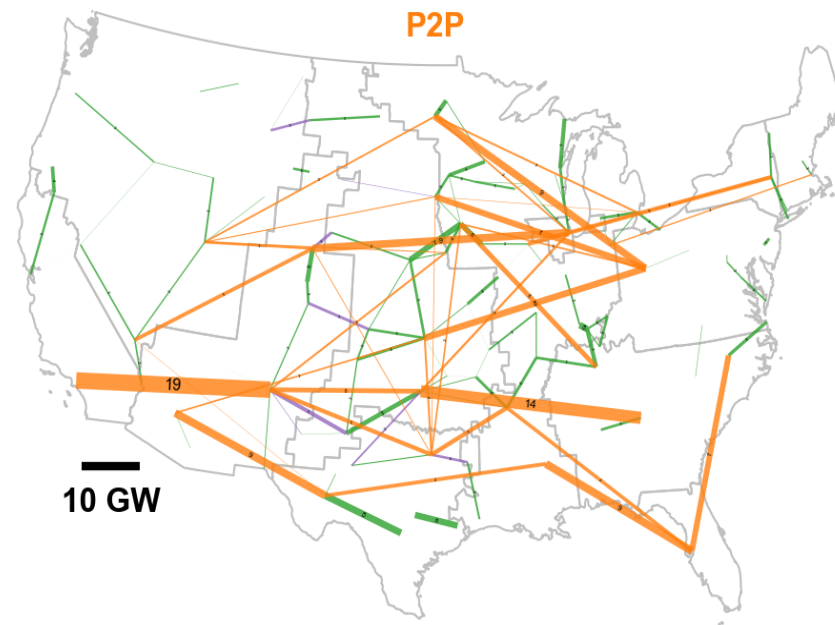
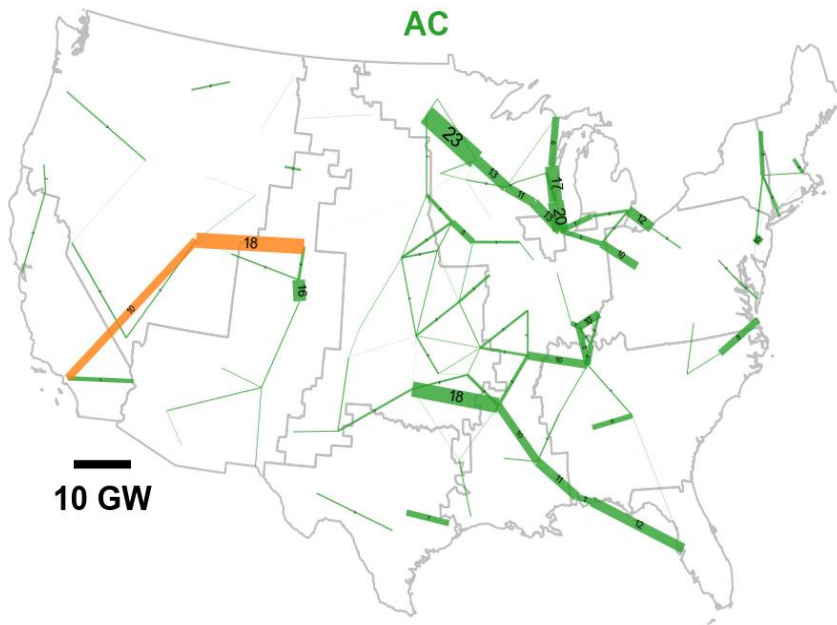


Expansion of **all types** of transmission—local, regional, and interregional—is observed under low-carbon futures

What have we learned from the capacity expansion modeling?

90% by 2035,
mid demand

Transmission is added in **all regions**, but expansion is particularly pronounced around the **central wind belt**



Including significant expansion across the interconnection seams (when allowed)

Scenario Framework: Transmission Expansion Paradigms

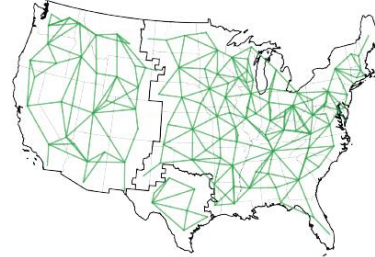
Reference Transmission Framework

Limited
(Lim)

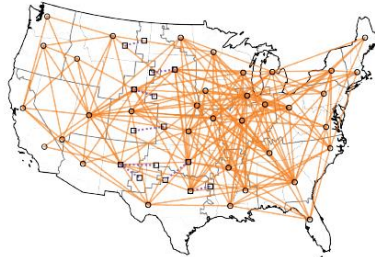


Accelerated Transmission Framework

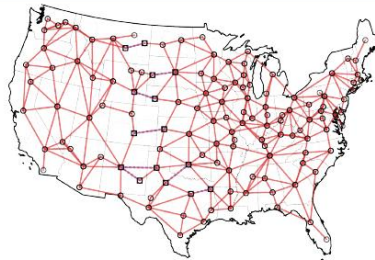
Alternating
Current (AC)



Point-to-
Point (P2P)



Multi-
Terminal
(MT)



× 3 Demand Growth

× 3 Emissions Targets

× 15 Sensitivities

Sensitivity

PV + battery low cost

Wind low cost

Electrolyzer low cost

+Nuclear SMR +DAC

No interface expansion limit

Transmission cost 2x

No RA sharing

Siting limited for PV and wind

CCS high cost

Many challenges

No H2

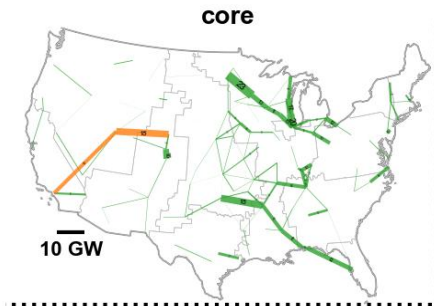
No CCS

No H2 or CCS

No H2 or new nuclear

Climate

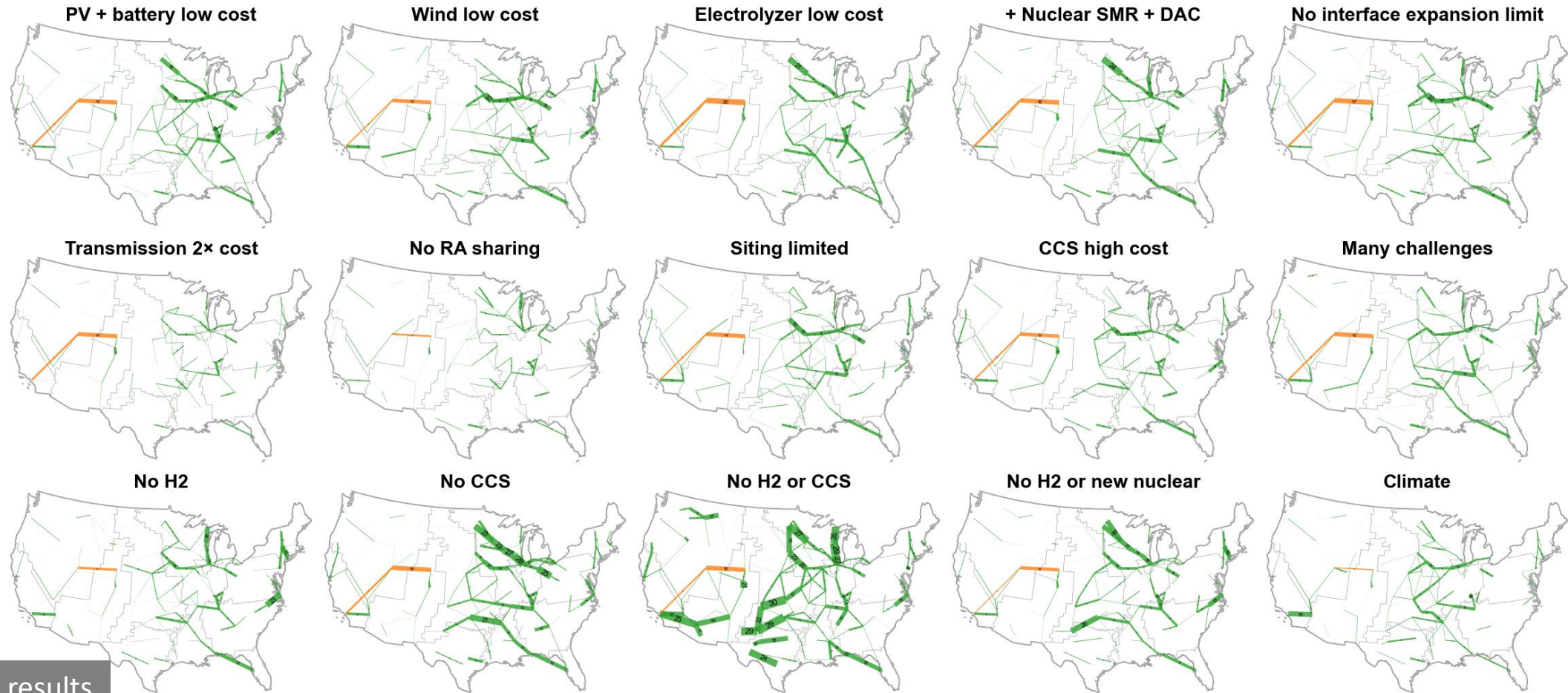
Spatial distribution of transmission expansion is robust across many possible futures



AC paradigm

90% by 2035 mid demand

But with variability in expansion magnitude—especially for individual regional interfaces



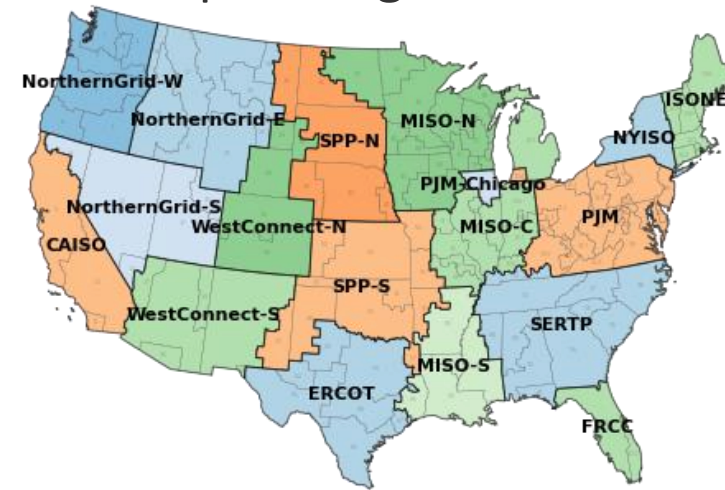
High Opportunity Transmission (HOT)

Scenario-based approach to identify robust
solutions from transmission expansion

****The results in this section are for 2035****

High Opportunity Transmission: Overview

- **Objective:** Use results across a large collection of scenarios to identify high opportunity transmission (HOT) expansion options to spur further assessment
- **Definition of HOT options**
 - Robust development across many scenarios → common and significant installations across majority of the sensitivities (next slide)
 - Applicable to ambitious, but not lowest, emission futures → 90% by 2035, Mid Demand
 - Timescales appropriate for early-stage transmission planning → focus on 2035
- **Geographic specificity**
 - Zonal interfaces across 18 sub-regions



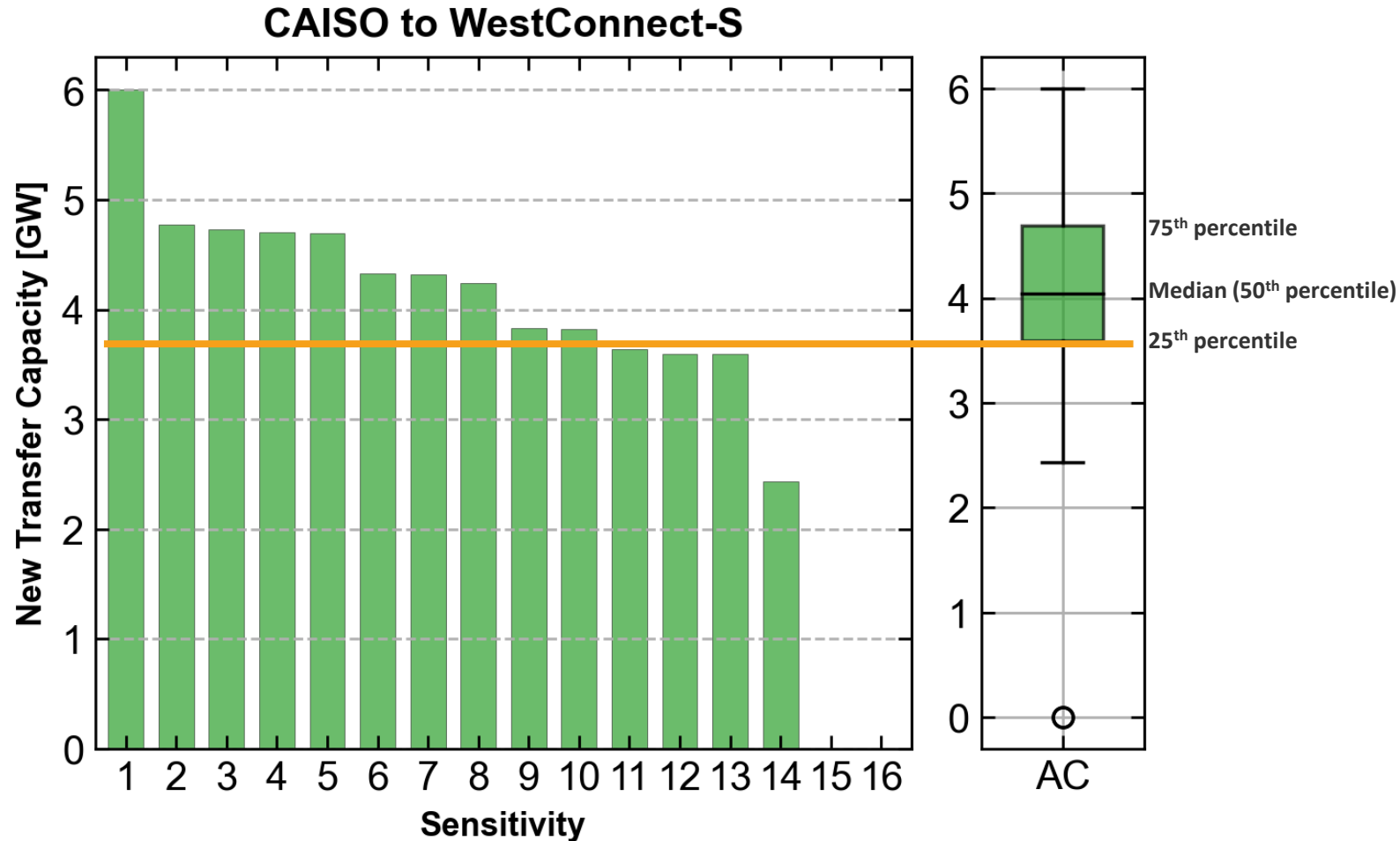
Diversity of transmission expansion across transmission paradigm, sensitivity, region

15



Distribution of new (2020-2035)
transmission under all 16 sensitivities

Range and quartiles



My slides focus on 25th percentile results to reflect robustness.

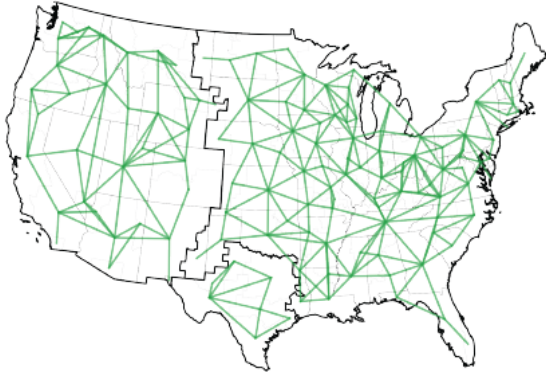
The 25th percentile $\approx 3/4$ of scenarios resulted in greater capacity expansion across the interface

Note: Limited sample size and nonrandom selection of sensitivities

Caveats and Notes

- **All results are directly from the capacity expansion scenarios.** ReEDS builds transmission because they are part of the least cost solution to meet policy, demand, and grid reliability needs.
 - Other NTP tasks are evaluating economics, operability, and reliability in greater detail
 - Options are examined zonally only; further investigation (e.g., siting feasibility) would be needed to evaluate specific transmission projects
- Analysis applied for **all three transmission paradigms** (AC, P2P, and MT)
 - Model implementation required distinction between AC and DC (and VSC vs. LCC), but ultimately increased interface capacity could be from either technology option
 - Increased transfer capacities could be achieved from a combination of new greenfield transmission, upgrades to existing transmission, or grid-enhancing technologies

Alternating Current (AC)

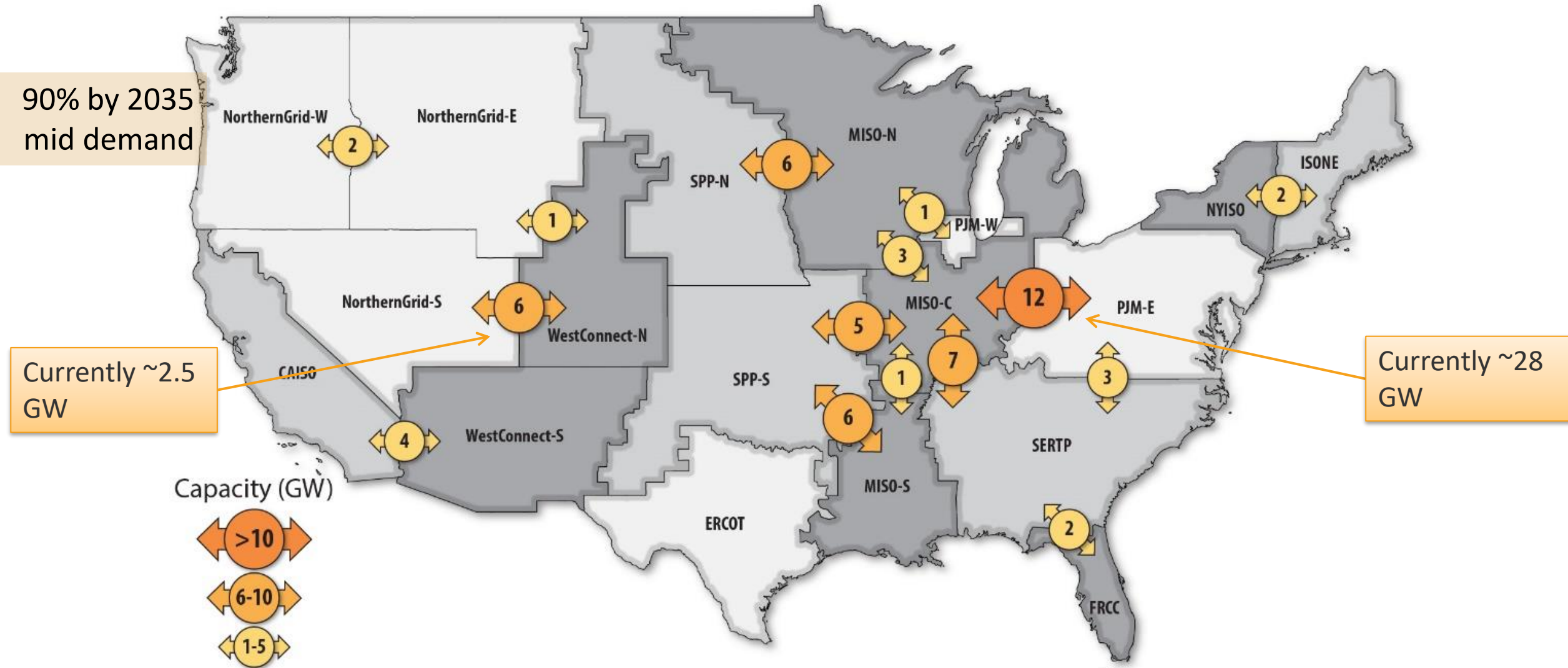


- Expansion allowed within interconnections
- No new DC connections

AC Transmission Paradigm

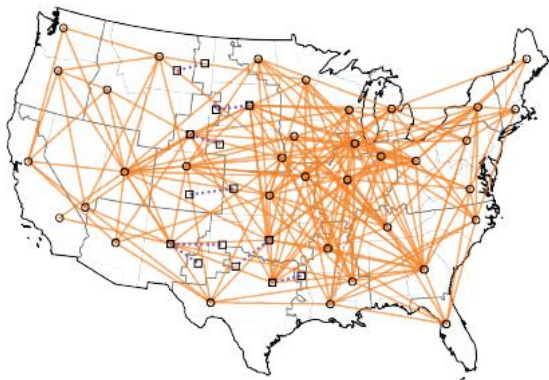
Ultimate selection of transmission technology (e.g., AC, DC-VSC, DC-LCC) requires further study and could differ from these assumptions. Upgrades, grid-enhancing technologies, and other non-greenfield expansion options could also be considered.

HOT: new interregional transfer capacity robustly developed by 2035 (AC paradigm)



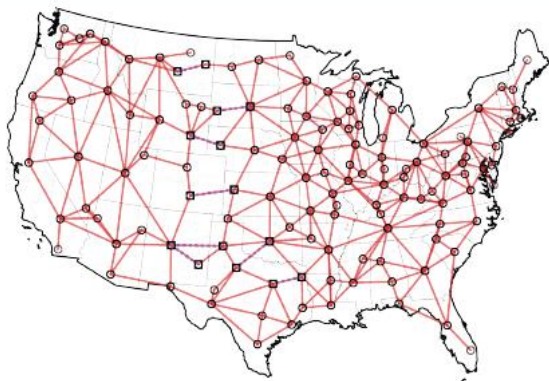
25th percentile capacity; > 1 GW expansions

Point-to-Point (P2P)



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

Multi-Terminal (MT)



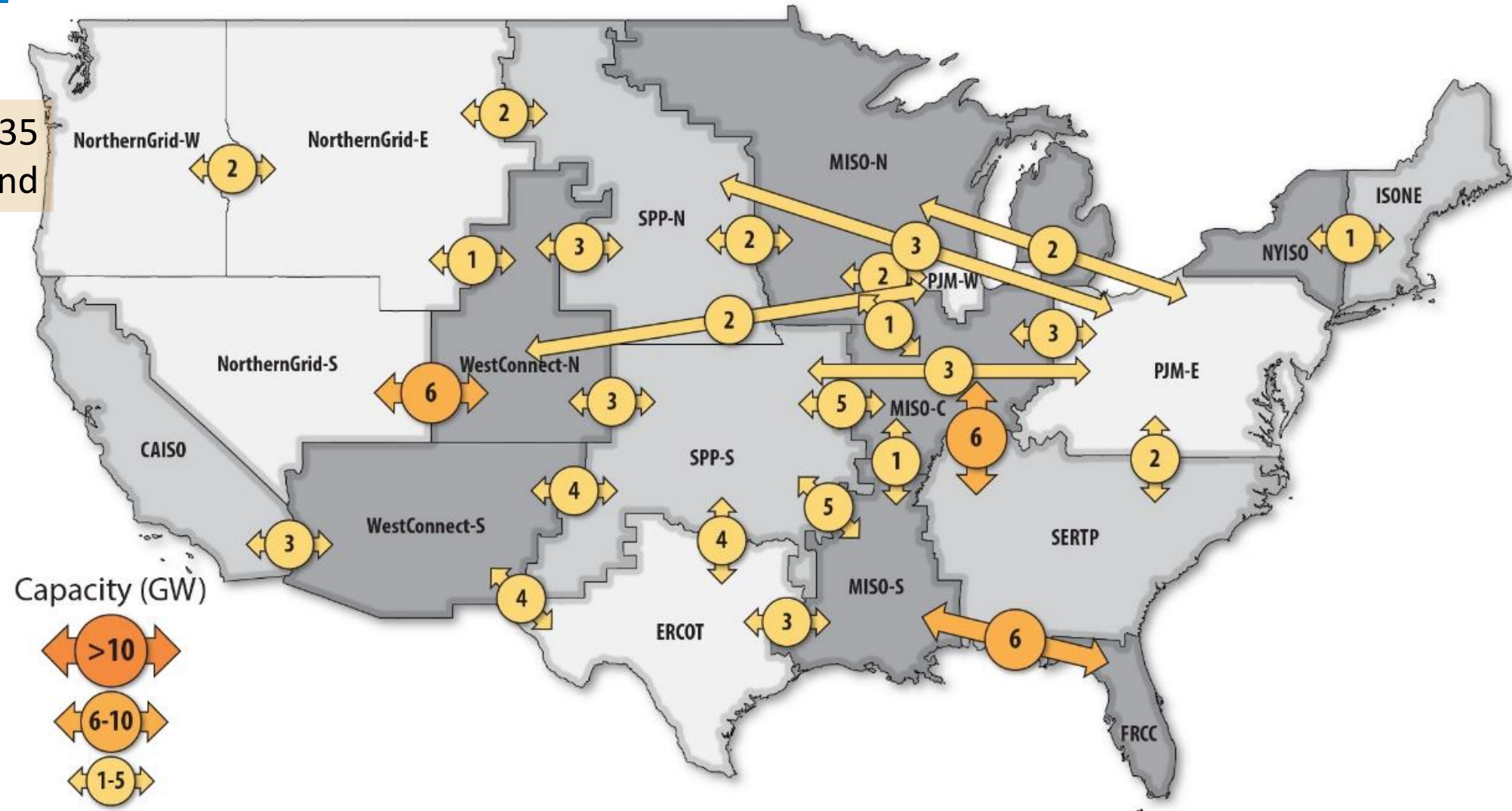
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HVDC Transmission Paradigm

Ultimate selection of transmission technology (e.g., AC, DC-VSC, DC-LCC) requires further study and could differ from these assumptions. Upgrades, grid-enhancing technologies, and other non-greenfield expansion options could also be considered.

HOT: new interregional transfer capacity robustly developed by 2035 (Point-to-Point HVDC paradigm)

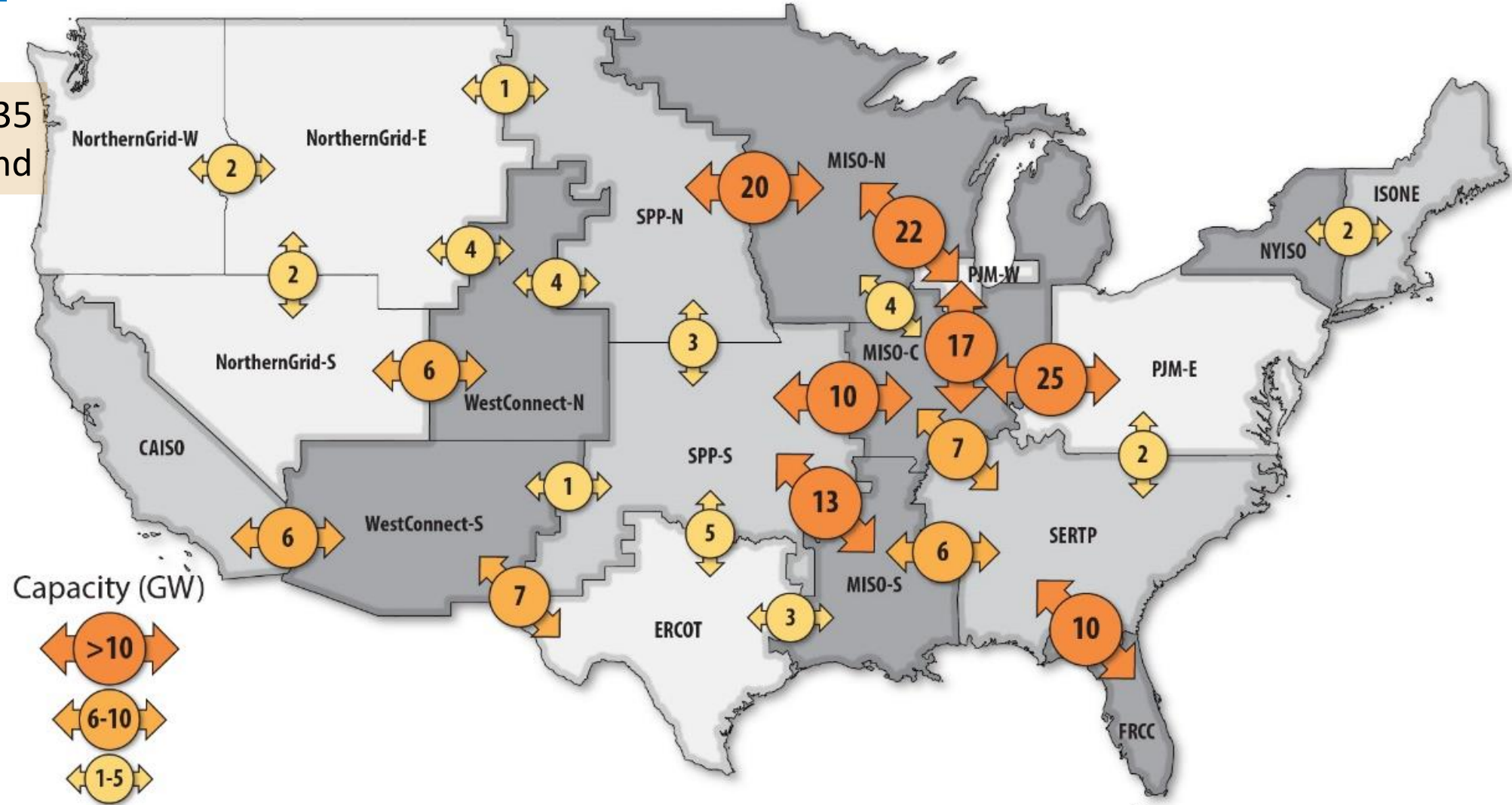
90% by 2035
mid demand



25th percentile capacity; > 1 GW expansions

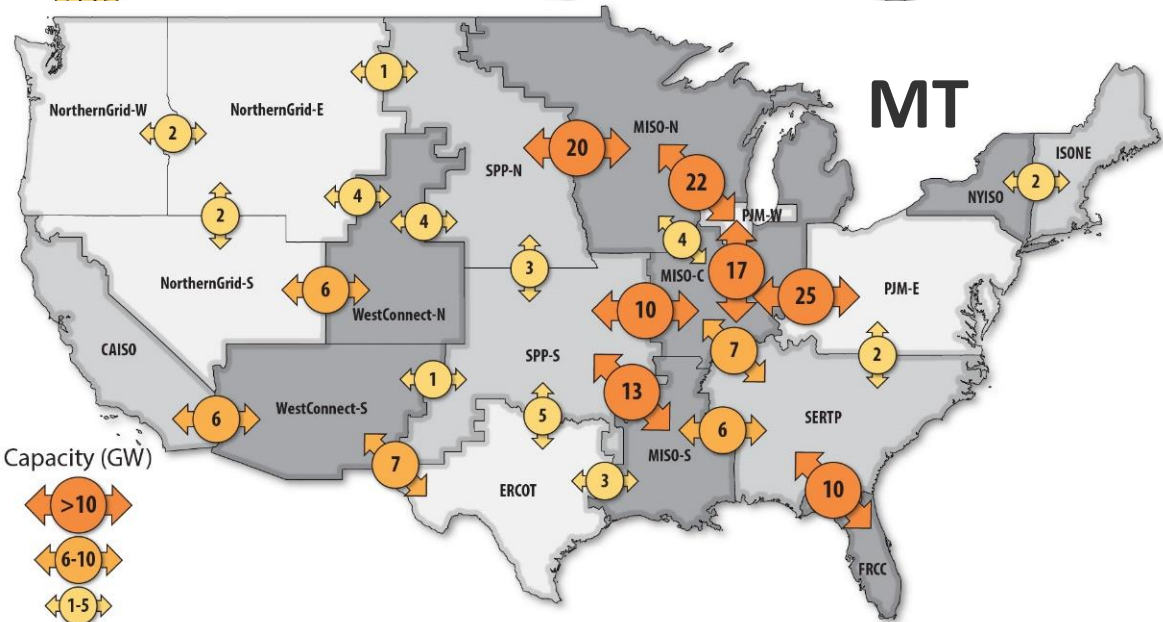
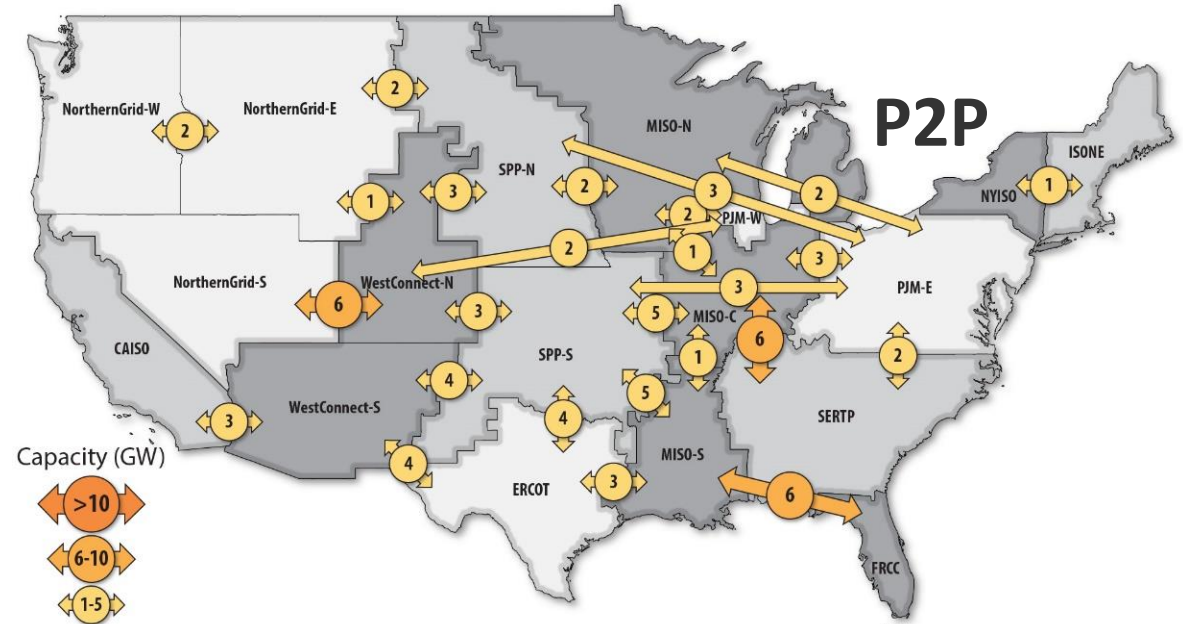
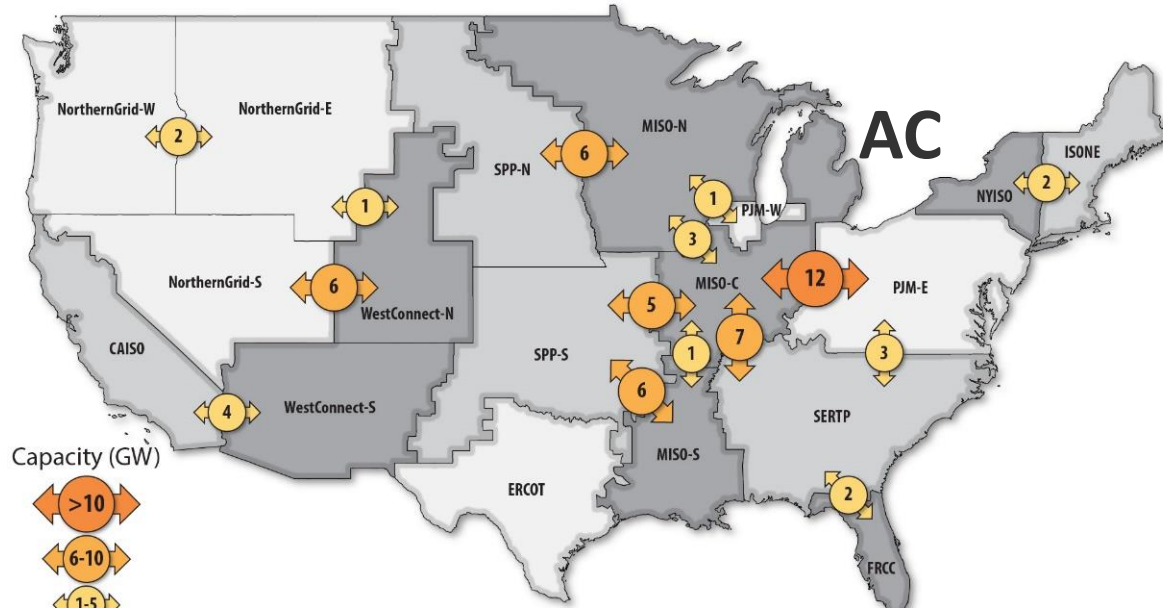
HOT: new interregional transfer capacity robustly developed by 2035 (Multi-Terminal HVDC paradigm)

90% by 2035
mid demand



25th percentile capacity; > 1 GW expansions

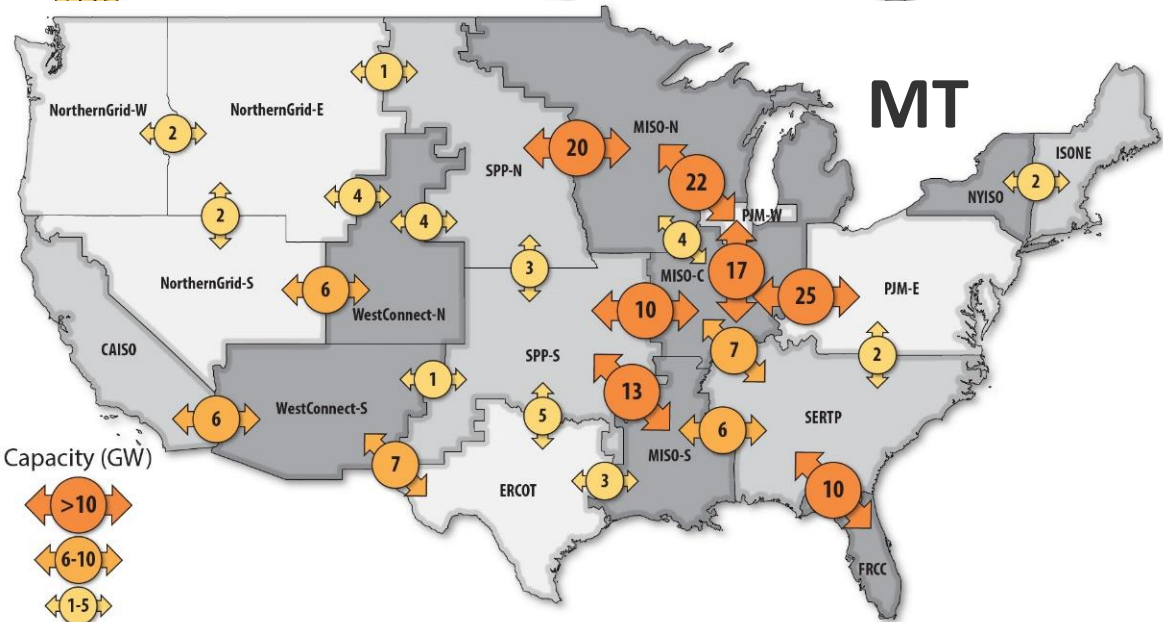
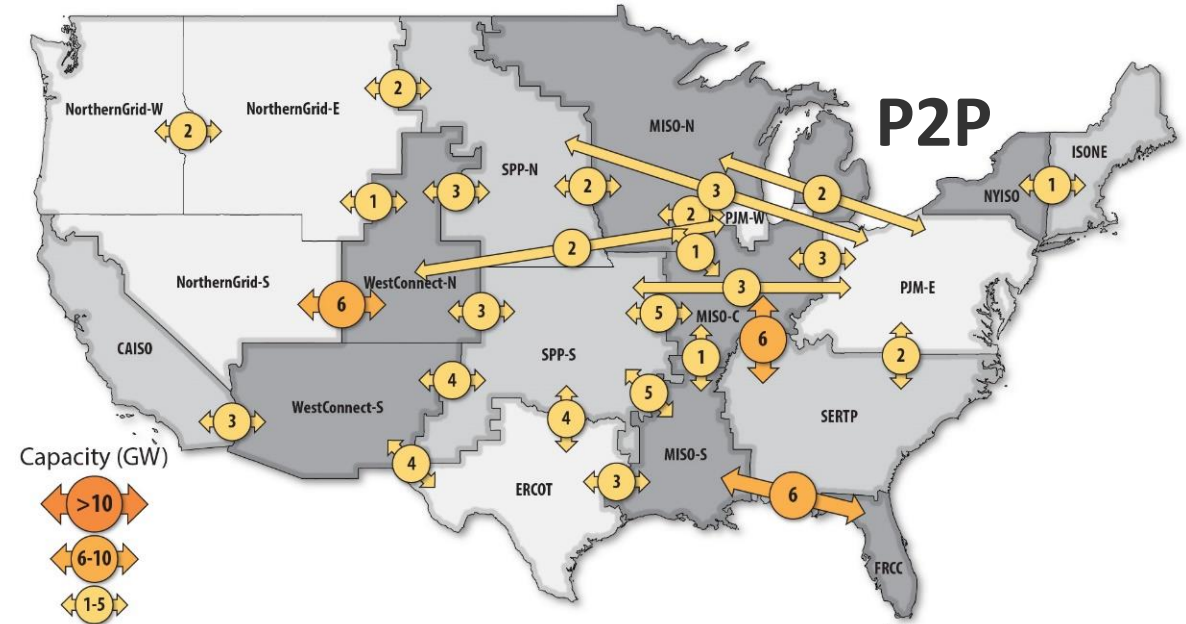
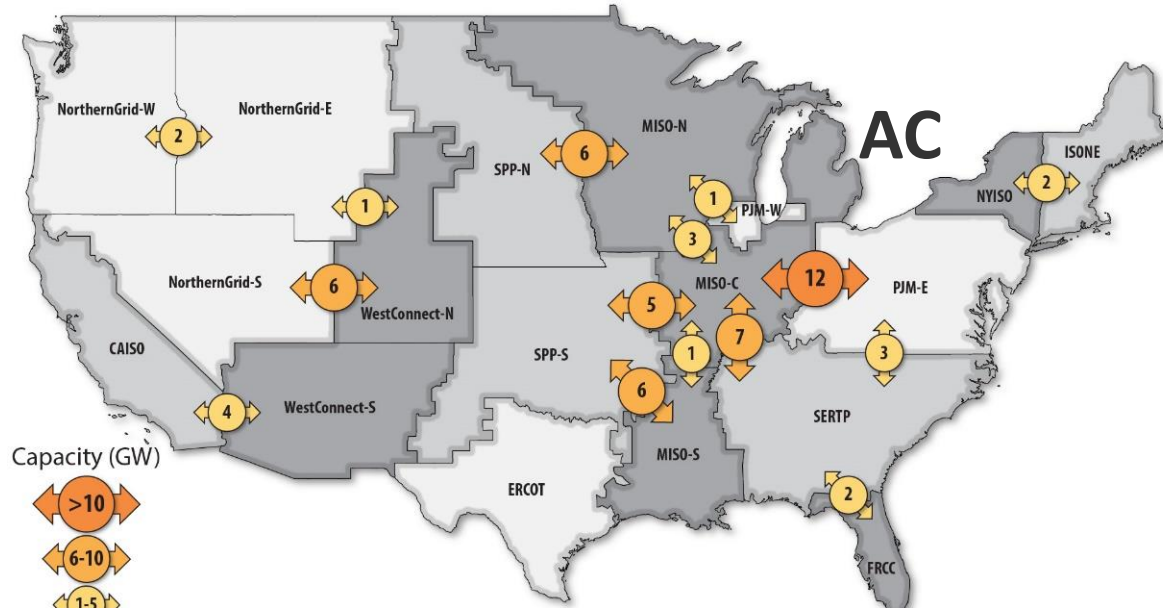
HOT options are starting points for further study



High Opportunity Transmission (HOT) options: interregional interfaces with robustly expanded capacity by 2035 across several decarbonization scenarios

- HOT options exist for all planning regions, but are concentrated in the central Midwest
- Expansion *beyond* these capacities are found in several sensitivities, and when looking at longer timescales or higher load growth

HOT options are starting points for further study



Thank you!

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