Grid Strategies

Transmission Opportunities and Needs in the Midwest: Insights from the National Transmission Planning Study

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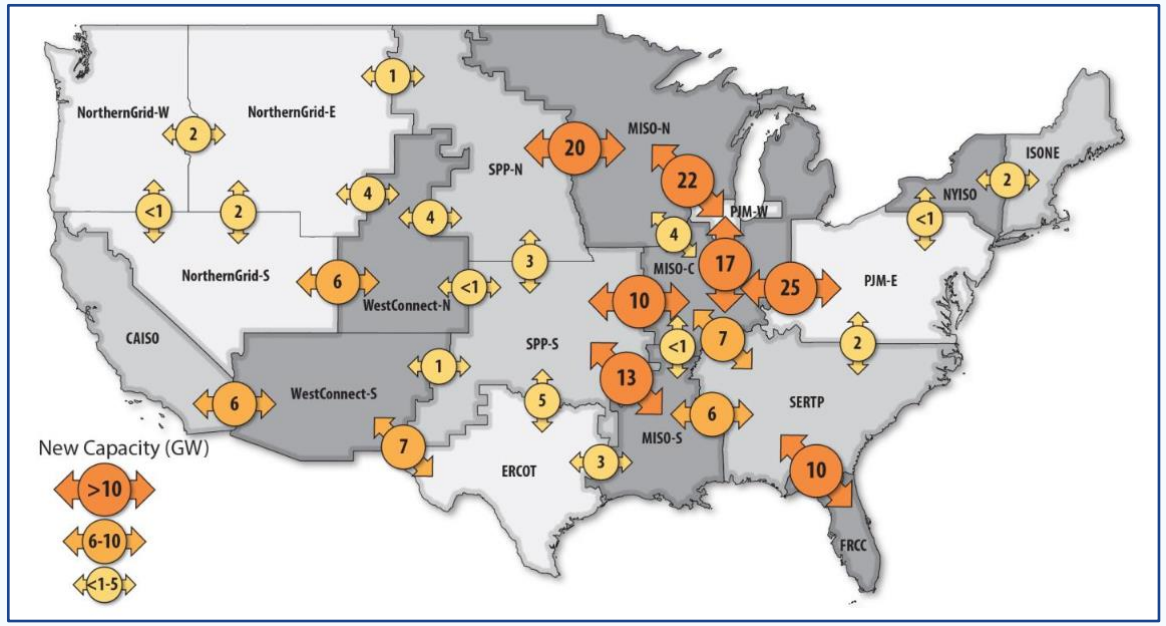
National Transmission Planning Study (NTPS) findings

Grid Reliability: Interregional transmission improves reliability particularly in response to extreme weather.

Consumer Savings: Would save the U.S. $270-$490 billion through 2050, approximately $1.60 to $1.80 in system cost savings for each $ spent.

Integrating new, cleaner generation onto the grid: Enables the grid connection of new generation projects, balancing the variability of wind and solar.



High Opportunity Transmission (HOT) interfaces: potentially beneficial transmission capacity expansion between regions found across many future power system scenarios.

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Source: DOE GDO, National Transmission Planning Study webinar

NTPS Scenarios: Transmission Frameworks

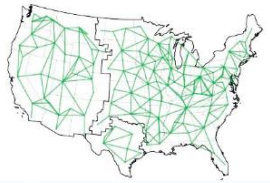
Reference Transmission Framework

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)

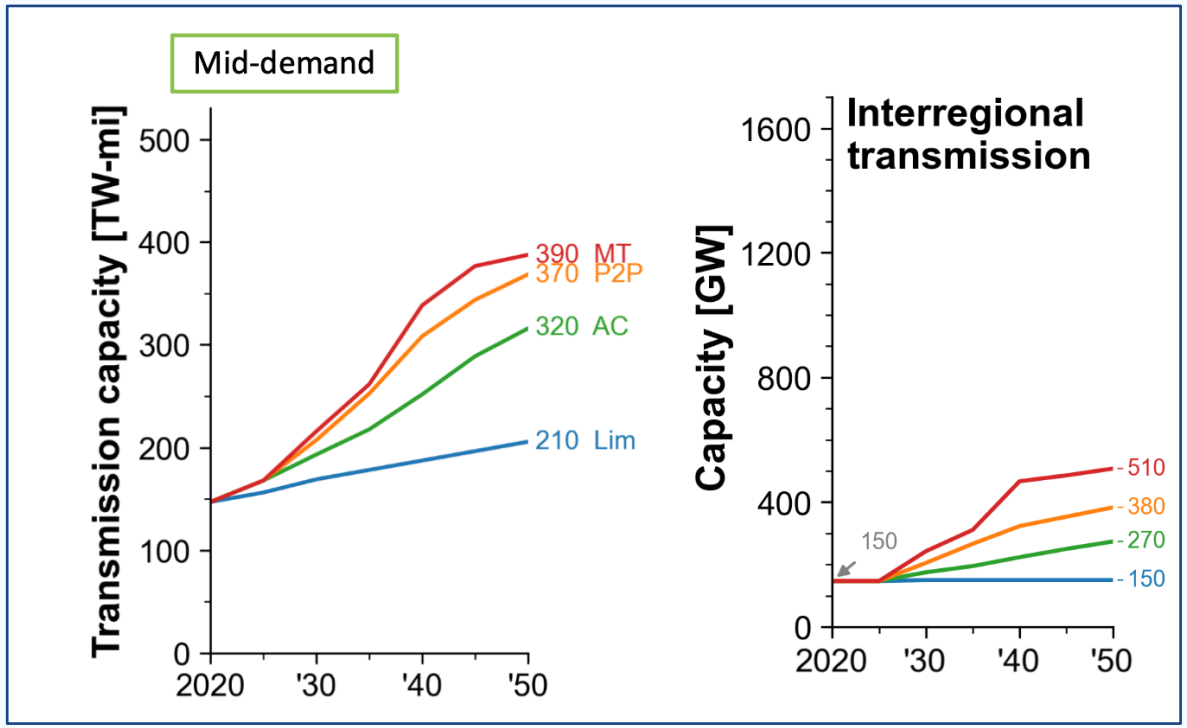
- Expansion allowed across the country
- Includes multi-terminal HVDC options between neighboring zones

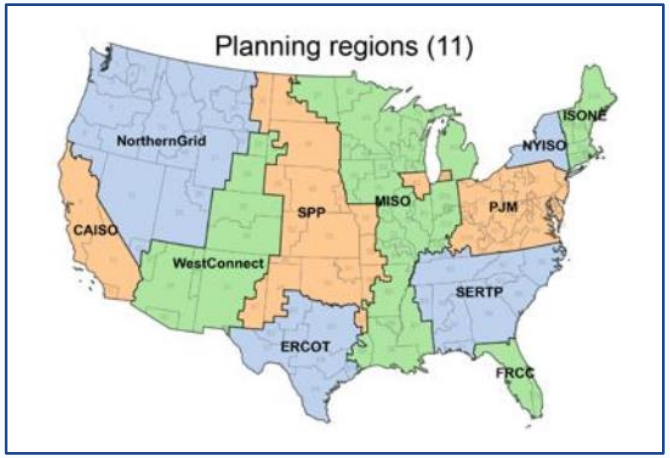
Source: DOE GDO, National Transmission Planning Study webinar

Key NTPS Takeaway: Large aggregate capacity expansion

The total transmission system of the contiguous United States expands 2.1 to 2.6 times the size of the 2020 system by 2050 and interregional transmission grows 1.9 to 3.5 times.

*Total transmission includes local (VRE interconnection), regional, and interregional transmission

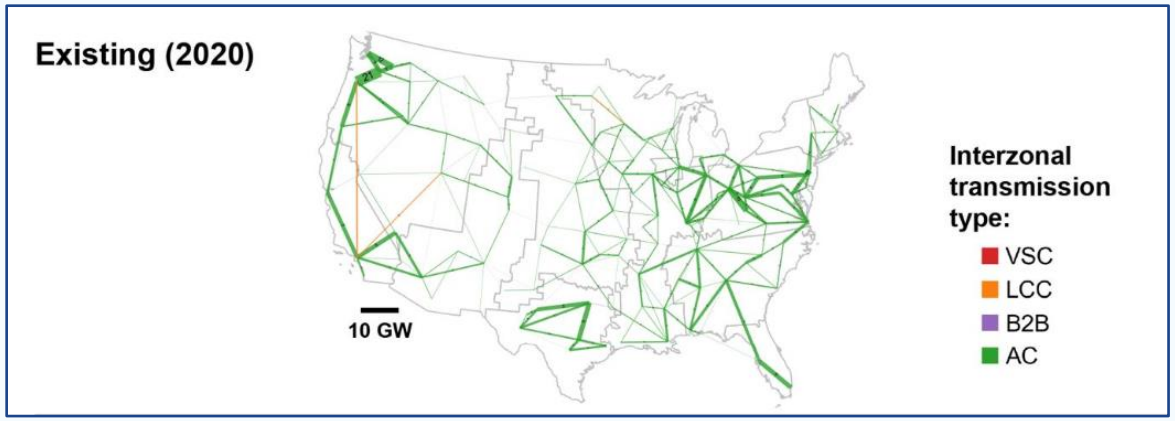


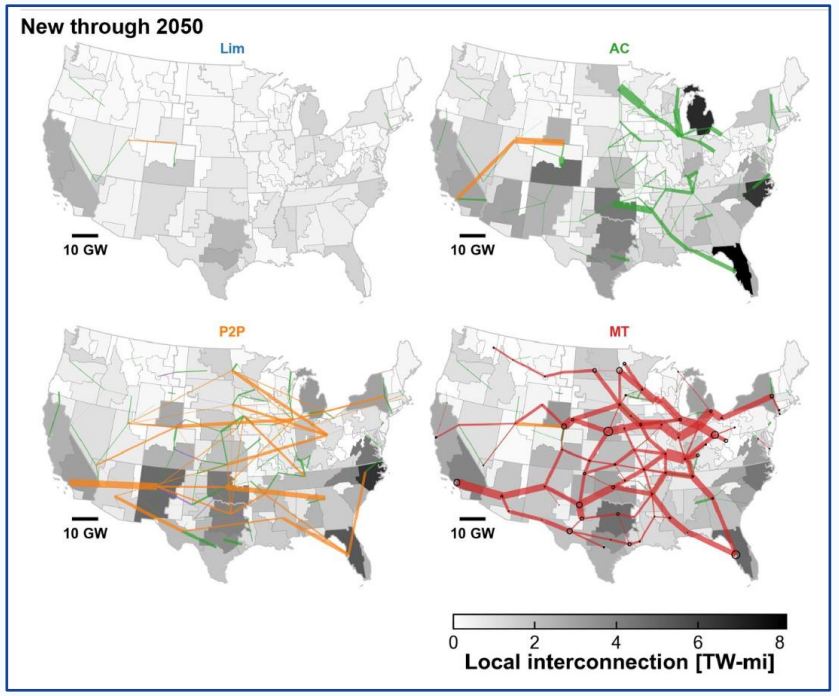


Source: DOE GDO, National Transmission Planning Study webinar

Key NTPS Takeaway: Low and High Voltage Expansion Needed

Transmission expansion occurs at all scales—including local, regional, and interregional—and for all regions of the country. Expansion of new long-distance transmission is concentrated in the central part of the country.

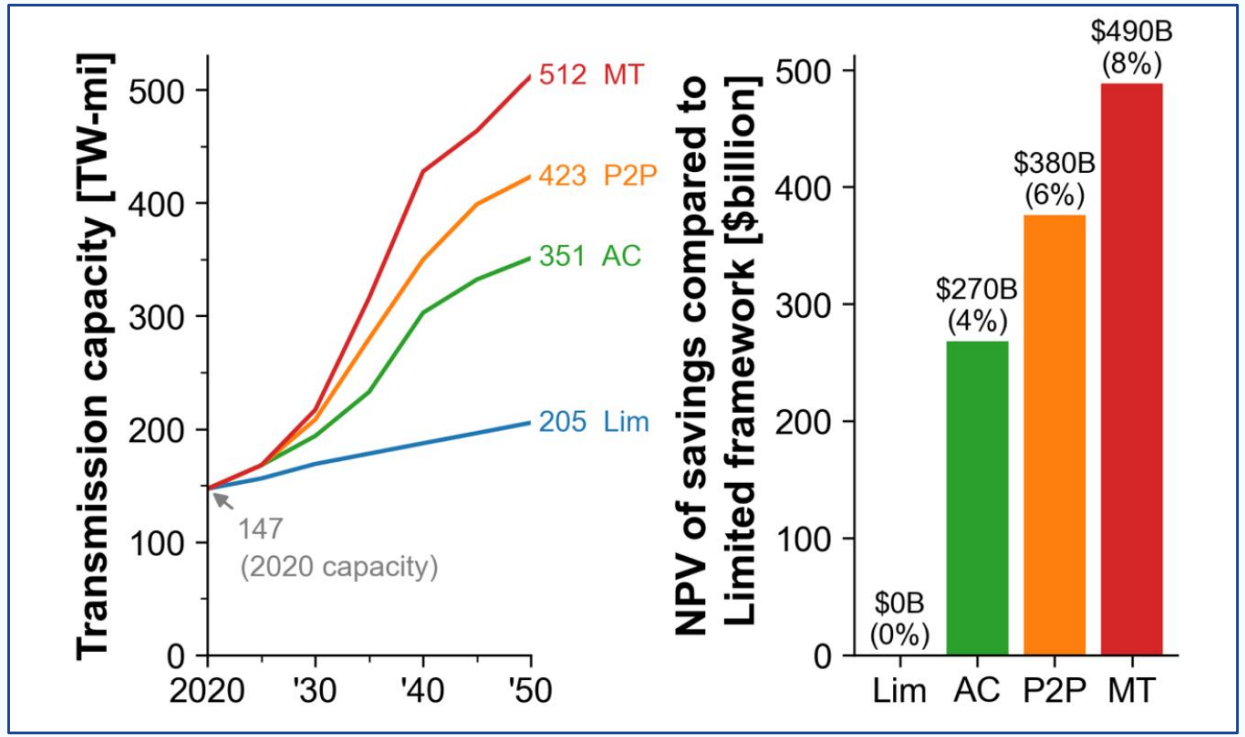




Source: DOE GDO, National Transmission Planning Study webinar

Key NTPS Takeaway: MT HVDC scenario provides greatest benefits

The use of high-voltage direct current (HVDC) transmission technologies, including advanced Multi-Terminal (MT) converters, results in the greatest benefits to consumers across the transmission options studied



Source: DOE GDO, National Transmission Planning Study webinar

Operational Benefits of HVDC

Most are not, or only partially, captured in economic comparison of grid expansion

- Sharing of energy, capacity, and services over the entire United States, thereby taking advantage of time zone diversity
- Sharing of contingency and other reserves, thereby reducing the total amount of reserves carried across the U.S. bulk system
- Supplying voltage and frequency support
- Providing dynamic voltage support to the AC system, thereby increasing its transfer capability
- Improving transient stability and reactive performance
- Providing AC system damping
- Serving as a “firewall” to limit the spread of system disturbances
- Decoupling the interconnected system so that faults and frequency variations between “variable” resources and the AC network, or between different parts of the AC network, do not affect each other
- Providing black-start capability to re-energize a 100% blacked-out portion of the network
- Mitigating weak grid issues that limit levels of inverter-based resources with grid-forming control of macrogrid nodes

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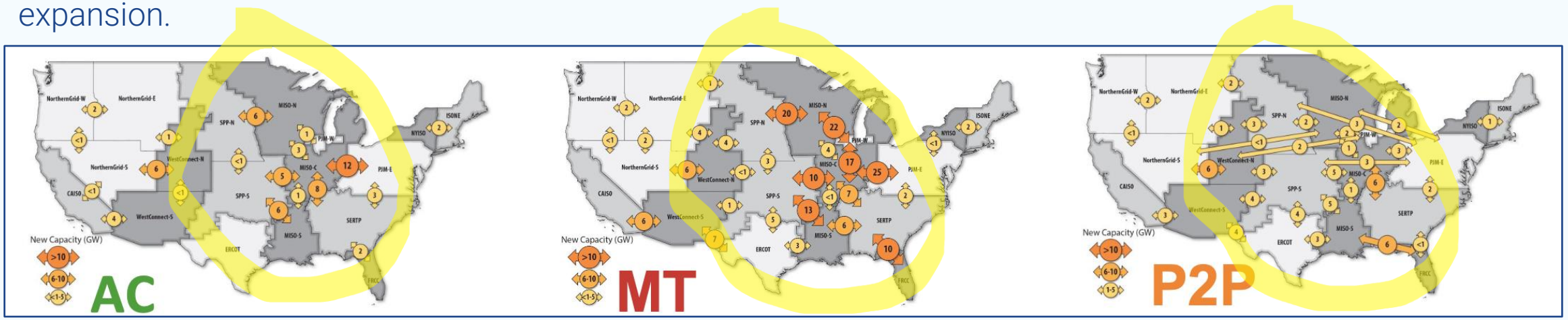
Source: ESIG Design Study Requirements for a U.S. Macrogrid, 2022, pp 41-42, posted at https://www.esig.energy/design-study-requirements-for-a-u-s-macrogrid/

Key NTPS Takeaway: Midwest has greatest need and opportunity

High Opportunity Transmission (HOT) interfaces represent transmission capacity expansion [2020-2035] results between regions across many 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.

What new transmission capacity is present in at least 75% of the 15 (+1) sensitivities?



AC = Alternating Current scenario

MT = Multi-Terminal HVDC scenario

P2P = Point to point HVDC scenario

Source: DOE GDO, National Transmission Planning Study webinar

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, refinement and prioritization by planners, stakeholders and regulators of **high opportunity transmission options** identified in the NTPS

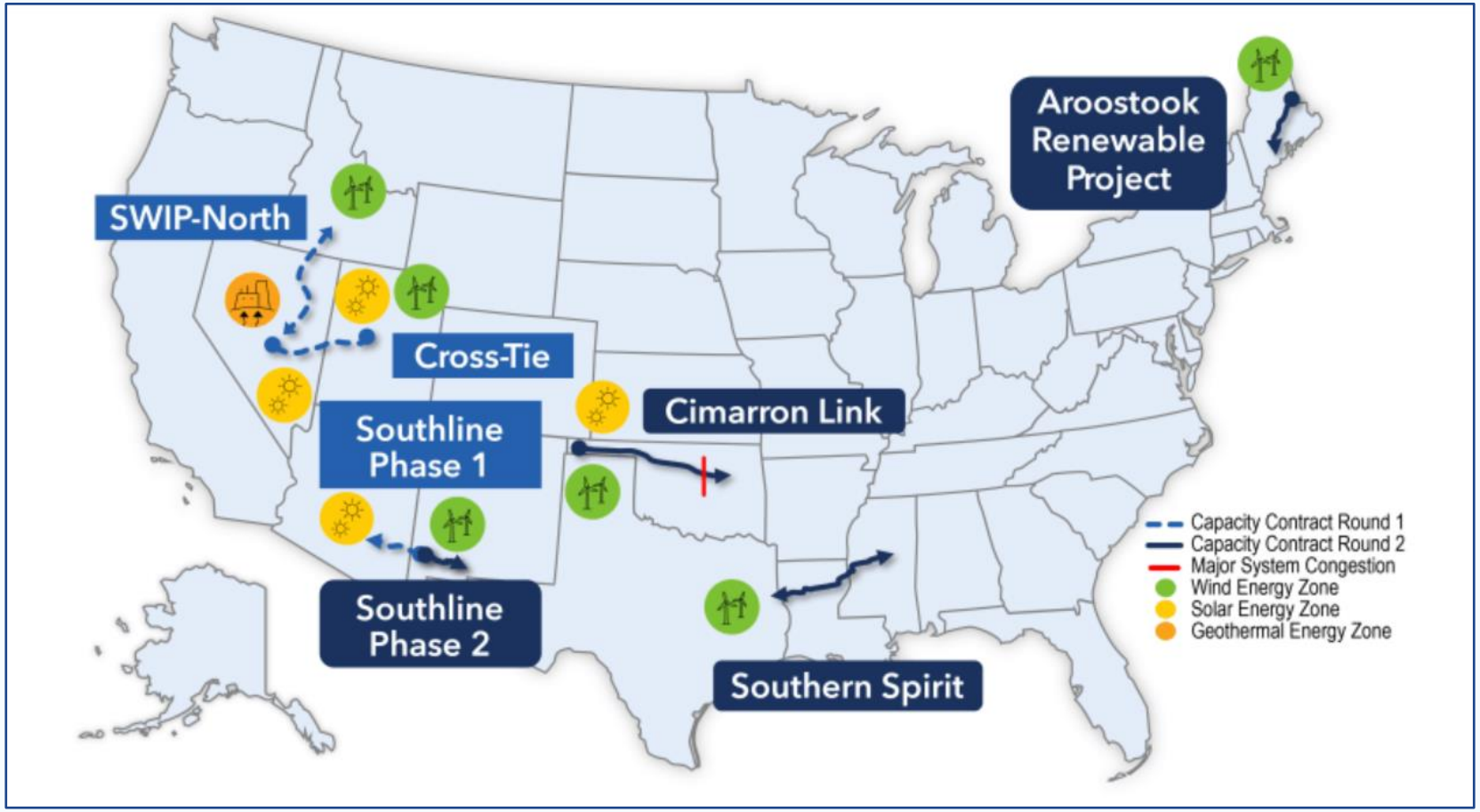
Ensure that interregional and long-term transmission planning allows **all technologies** (including HVDC and advanced transmission technology) to be selected as part of the solution

Inform DOE's use of financing and permitting tools:

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

Source: DOE GDO, National Transmission Planning Study webinar

Grid Deployment Office
Transmission Facilitation Program Awards



HVDC benefits

- Narrower rights of way and designs with fewer/smaller structures
- Lower delivered cost for long-distance delivery (over <300 miles)
- Efficient: ½ the power losses over long distances.
- Amount and direction of flow fully controllable by system operators
- Can connect asynchronous systems (WECC, EI, ERCOT)
- Voltage Source Converters (VSC) provide reactive power, fault recovery, black start, sub-second dispatch and control.

Source: DOE, Connecting the Grid with HVDC, Minnesota Power VSC HVDC Technology Attributes for the Future Power System

HVDC barriers and solutions

- Interconnection—treat like transmission rather than generation
- Create and adopt standards to support common study criteria to enable interoperability and transition from customized project-specific designs to an effective and efficient program for the majority of an HVDC network facilities
- Develop an operational guidebook with SPP, MISO, other operators to define how the line will be controlled
- Intertie optimization to take advantage of HVDC capabilities
- Adapt grid planning tools
- Cost allocation sharing approaches
  - UK floor/cap approach, with some costs recovered in tariffs, some in voluntary subscriptions

See Brattle Group, Benefits of HVDC

NERC's Interregional Transfer Capability Study (ITCS)

Key Takeaways:

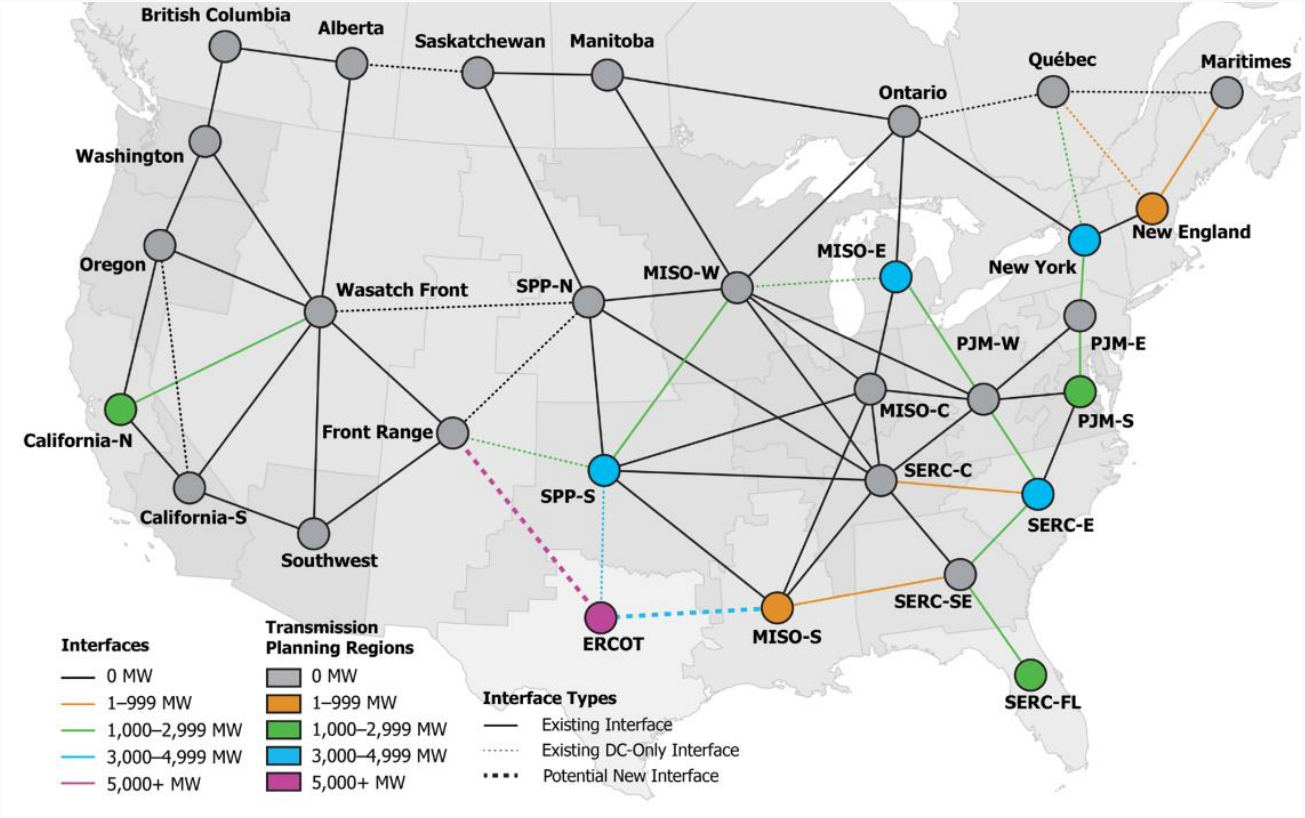
- Recommends an additional 35 GW of transfer capability across the US
- In the absence of additional transfer capability, 11 regions face resources deficiencies during extreme weather

Key limitations:

- Does not consider economic benefits of transmission build-out
- Does not reflect recent load forecast increases

Prudent Additions to Transfer Capability

Based on 2033 Resource Mix



Source: NERC, Interregional Transfer Capability Study (ITCS), Nov 2024.