# Transmission Planning Fundamentals

Amy Rose, NREL

NASEO Transmission Planning for State Energy Offices

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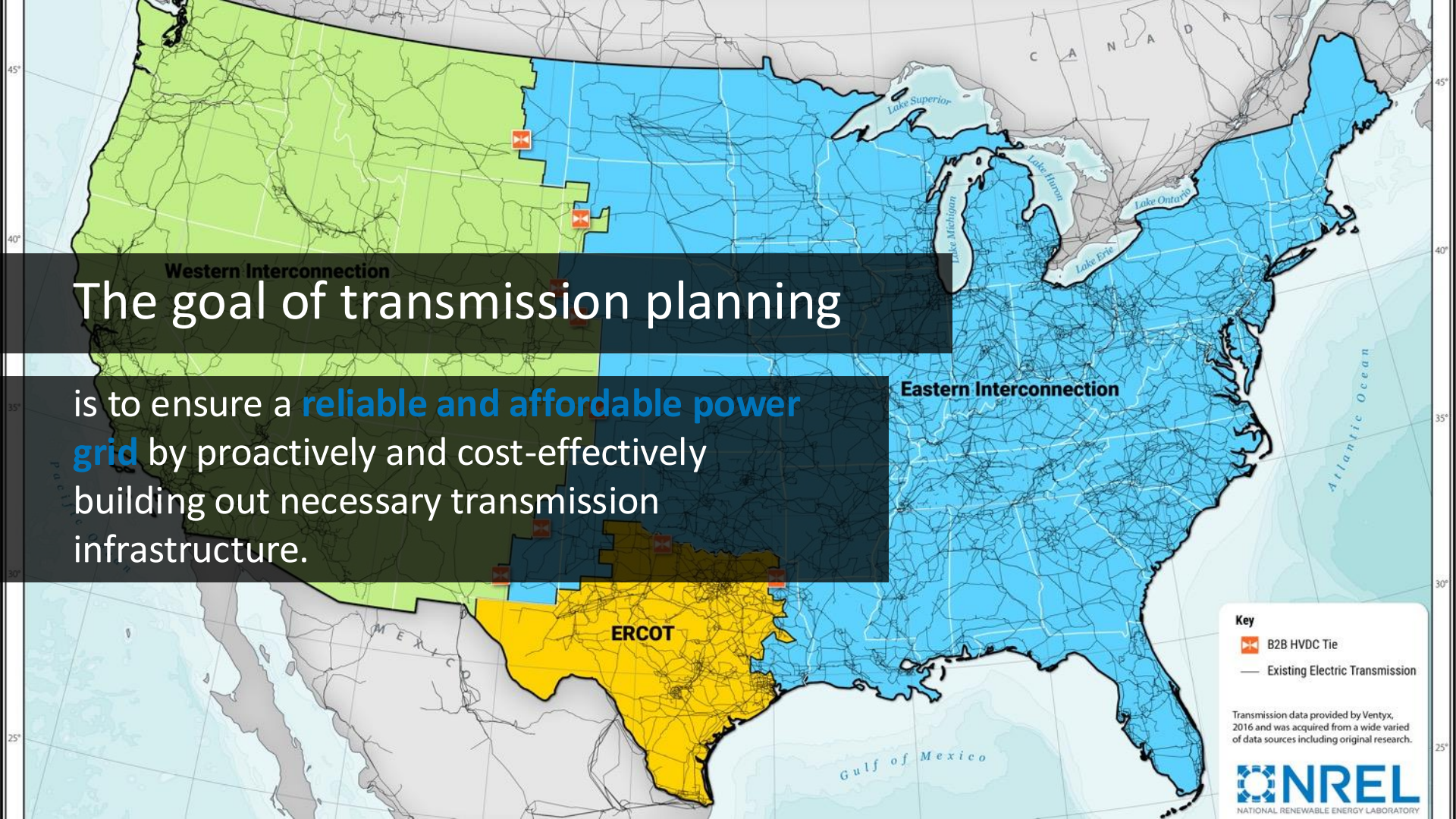
Photo by Josh Bauer, NREL 61725

1. Overview of transmission planning
2. How is transmission planned and built in the U.S.?
3. Transmission cost allocation
4. Order 1920 and its impacts on transmission planning


Group Poll

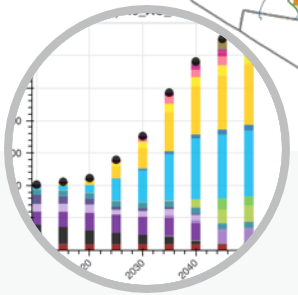
# Overview of transmission planning




# The goal of transmission planning

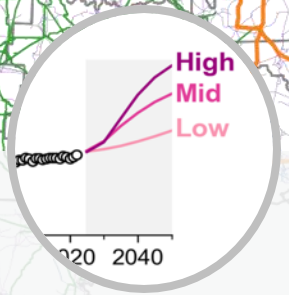
is to ensure a **reliable and affordable power grid** by proactively and cost-effectively building out necessary transmission infrastructure.

# Various factors drive the changing need for transmission

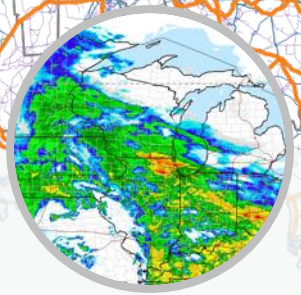


Resource mix

Aging infrastructure




Demand growth

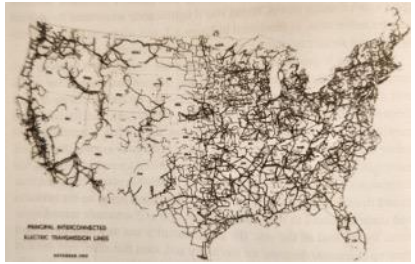


Extreme events

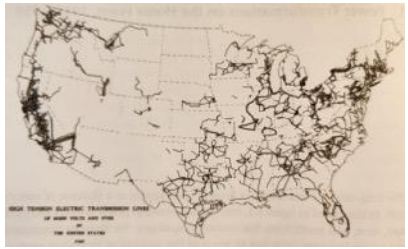
Distributed resources

*Images by NREL; Background based on Homeland Infrastructure Foundation-Level Data (HIFLD)*

1946

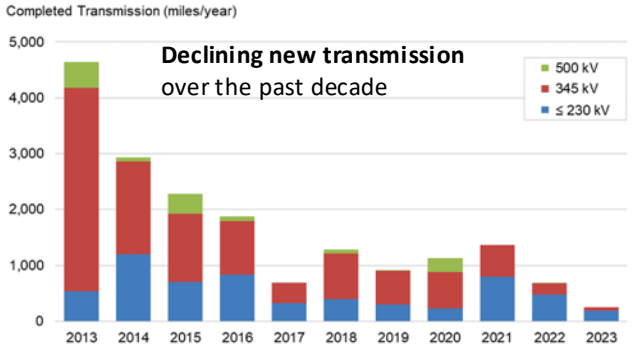


1949

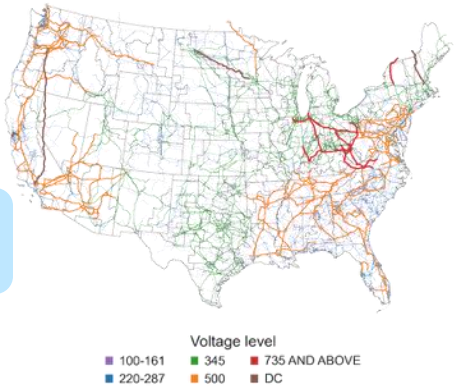


1960

2022



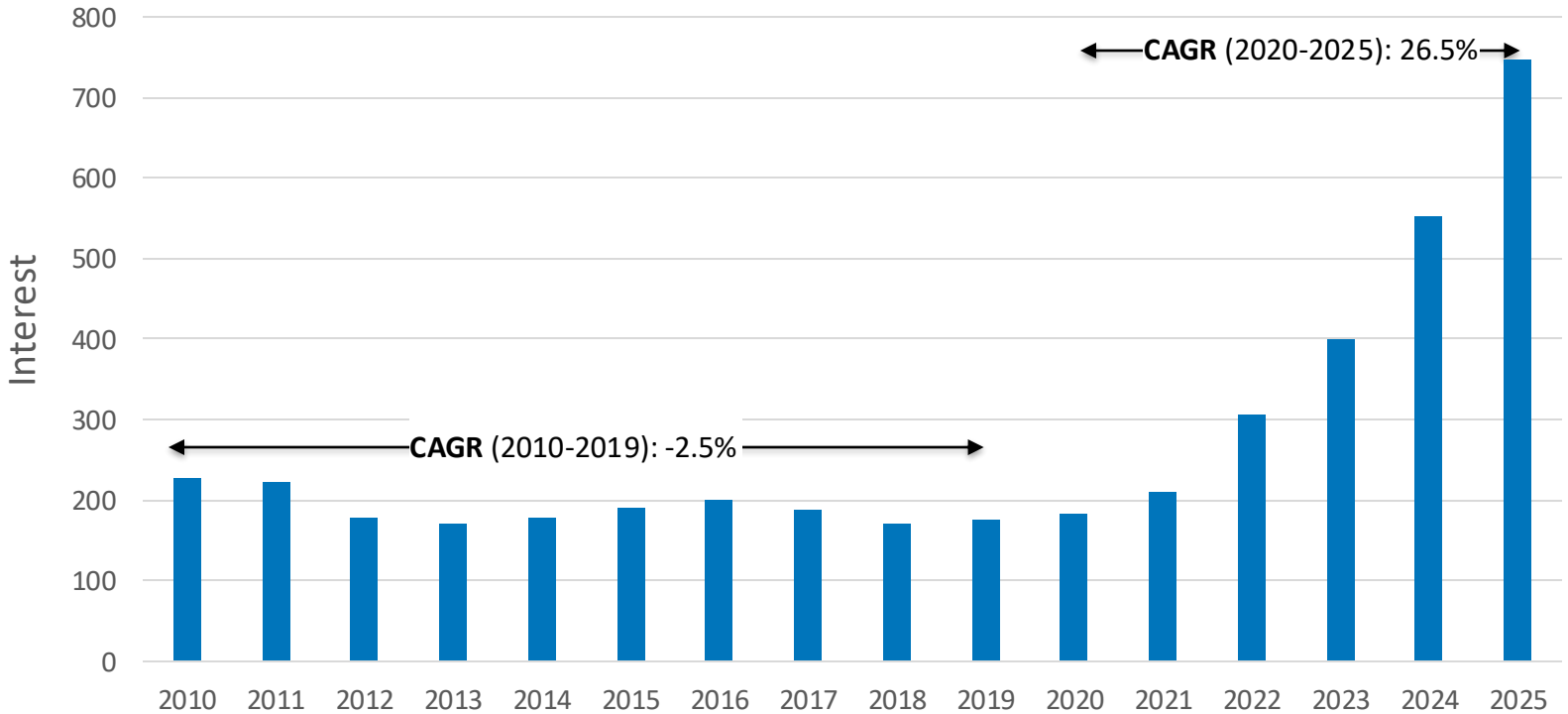

**Bulk transmission infrastructure is aging**




*Images (1946, 1949, 1960) from J. Cohn ("The Grid"); NREL (2022) (map based on Homeland Infrastructure Foundation-Level Data (HIFLD) data);*
Plot from Wiser et al. 2024. *Land-Based Wind Market Report: 2024 Edition*

# Large transmission expansion has occurred in stages … it's aging again.

# Interest in “transmission planning” is growing




Note: CAGR: Compound Annual Growth Rate; “Interest” is defined as search interest relative to the highest point for the given region and time. The graphic presented is aggregated annual relative interest, that is, peak monthly popularity = 100.

Source: Based on Google Trends data (https://trends.google.com, prompt: “transmission planning”, context: U.S. only)

# Transmission has unique properties that impact planning

## Discrete Investment Options

- Transmission facilities cannot be freely designed (i.e., cannot build half a line)
- Only a handful of standard voltage levels and configurations are technically feasible

## Economies of Scale

- It is more economic to add transfer capacity in large increments rather than continuously
- Transmission investments tend to be overbuilt for the existing system and new lines may not be fully utilized for many years

## Network Impacts of New Lines

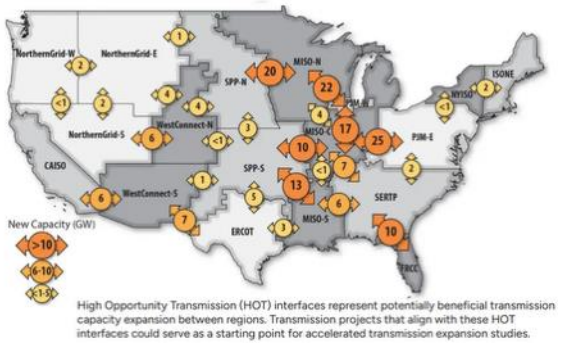
- Physical laws governing power flows mean there is no fixed definition of transfer capacity
- Any new line can impact the transfer capacities across the network, implying a need for coordination among network owners



Photo credit: Idaho National Laboratory, 2023. Advanced Conductor Scan Report

# How is transmission planned and built in the U.S.?

# Transmission Planning by Scale


## Local Transmission

Addresses needs within a single utility's service area such as reliability, asset management, and resilience

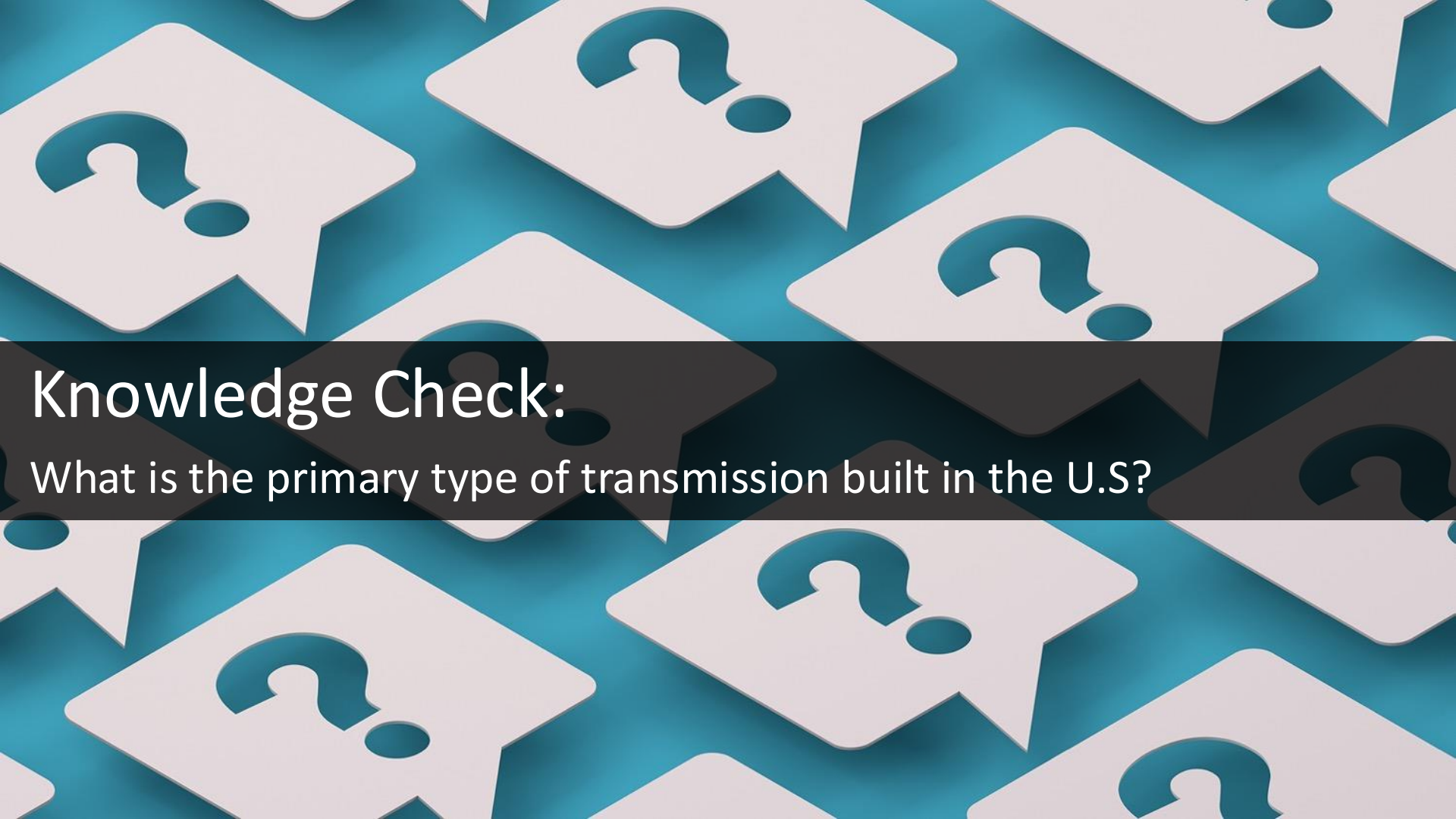
## Regional Transmission

Meets the needs of a multi-state or multi-utility region such as reliability standards, congestion management, or generation interconnection

## Interregional Transmission

Connects different regions to allow for resource sharing

Image Credit: Ameren service territory, https://www.ameren.com/about-ameren
PJM footprint, https://www.ferc.gov/electric-power-markets
Interregional High Opportunity Transmission: https://www.energy.gov/sites/default/files/2024-10/NationalTransmissionPlanningStudy-Chapter2.pdf



# Knowledge Check:

What is the primary type of transmission built in the U.S?

## Local Transmission

Addresses needs within a single utility's service area such as reliability, asset management, and resilience

| Region Type | Who Plans It? | Who Builds It? | Oversight |
|---|---|---|---|
| RTO/ISO Region | Transmission owners/utilities (submit plans to the RTO) | Individual utility companies | RTO/ISO + FERC |
| Non-RTO Region | Utilities | Individual utility companies | State PUCs + FERC (for interstate lines) |

*Example: A new line to serve a growing customer base in a city or to replace aging infrastructure in a specific neighborhood*

# Transmission Planning and Development


# Regional Transmission

Meets the needs of a multi-state or multi-utility region such as reliability standards, congestion management or generator interconnection

| Region Type | Who Plans It? | Who Builds It? | Oversight |
|---|---|---|---|
| RTO/ISO Region | RTOs and ISOs | RTO member utilities and independent transmission companies | FERC |
| Non-RTO Region | Voluntary coordination among utilities and planning groups (WestConnect, SERTP) | Utilities and independent developers | State PUCs + FERC (for interstate lines) |
| Texas (ERCOT) | ERCOT | Utilities and independent developers | PUC of Texas |

*Example: Building a new transmission corridor to connect a new generation facility in one state to load centers in multiple other states within the same region*


# Interregional Transmission

Connects different regions to allow for resource sharing

| Region Type | Who Plans It? | Who Builds It? | Oversight |
|---|---|---|---|
| All | Neighboring RTOs/utilities collaborate | Utilities and independent developers | FERC |

*Example: Coordinated effort between an RTO in the Midwest and an RTO in the Northeast to send power from the Midwest to the Northeast when the Northeast is experiencing high demand or a generation deficit.*

**Inform Transmission Needs**

State legislation that sets energy requirements can drive the need for transmission infrastructure

**Planning Processes and Guidelines**

State legislatures may enact laws with specific processes for transmission project review and approval from public utility commissions

**Project Siting and Land Use**

State and local governments can enact specific laws (i.e., land use and zoning ordinances) that transmission developers must comply with

**Transmission Authorities**

State agencies can be authorized to support project development through activities such as project finance, entering into lease arrangements, or owning and operating lines.

# Role of States in Transmission Planning

State policymakers establish policies and regulations that affect transmission development

# Example of State Action

Federal Right of First Refusal (ROFR)

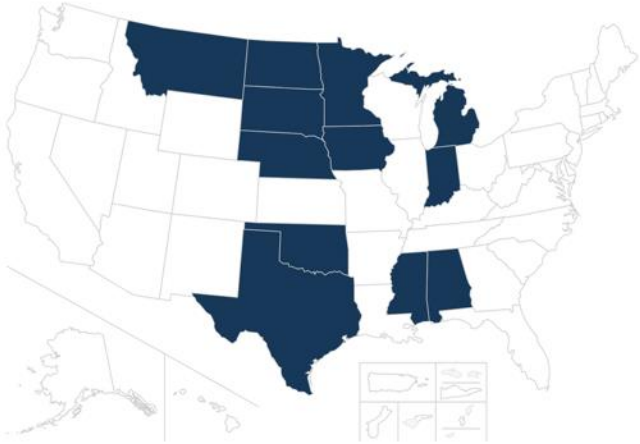
**Federal ROFR** gives incumbent utilities the option to have exclusive control over building, maintaining, and owning transmission lines in their service territory before a project is opened to competitive bidding.

- FERC Order 1000 **eliminated all federal ROFR** and opened transmission projects to nonincumbent owners and operators through competitive bidding. Order 1920 did not restore federal ROFR.

**States** are taking up ROFR laws as the need for transmission expansion grows

- 12 states have enacted ROFR laws for transmission development
- In 2023, seven states considered ROFR legislation
- In some cases (e.g., Indiana), these rights extend to interregional transmission

States with ROFR Laws



Source: https://www.ncsl.org/energy/right-of-first-refusal-for-electric-transmission

# Transmission Cost Allocation

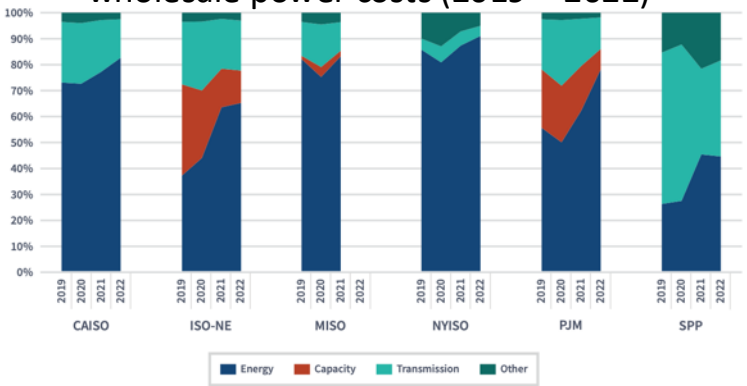
# The Importance and Challenge of Transmission Cost Allocation

Transmission cost allocation refers to **how the costs** of building new high-voltage electricity transmission lines **are divided among beneficiaries**

**Beneficiary Pays/Cost Causality**
- Best method conceptually
- No undisputed way to define and measure various transmission benefits
- Benefits and beneficiaries change over time

**Usage-Based Methods**
- Network usage serves as a proxy for benefits
- Not possible to directly measure how much network users use the network
- Network usage and users change over time

Transmission charges account for >20% wholesale power costs (2019 – 2022)



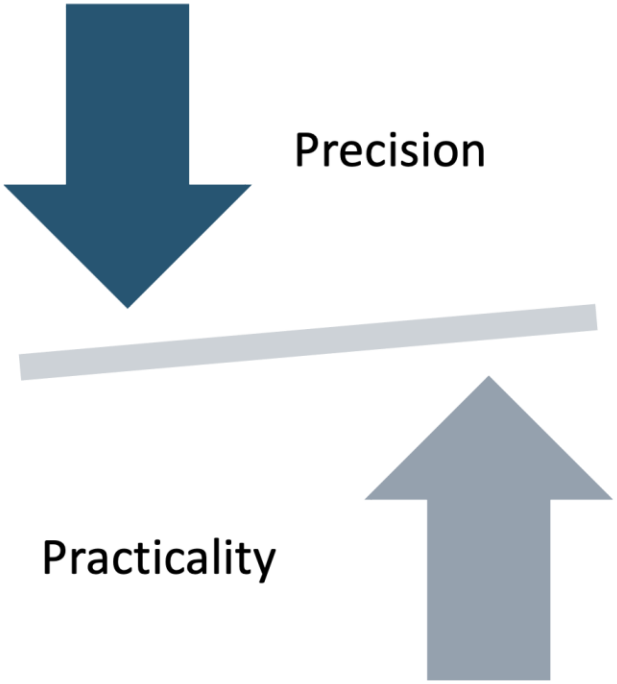

**NOTE:** The values for capacity in NYISO are not available as the NYISO does not record the capacity components of total wholesale power. MISO did not have data available for 2022 at the time data submissions were due.

Source: FERC-922 information collection.

**The Challenge:** There is no undisputed approach to assign project costs while transmission charges directly impact energy prices and ratepayer bills.

Sheets et. al. 2024. "2023 Common Metrics: Performance Metrics for ISOs, RTOs, and Regions Outside ISOs and RTOs for the Reporting Period 2019 to 2022." *Federal Energy Regulatory Commission*, January 31. https://www.ferc.gov/sites/default/files/2024-01/2023_Common_Metrics_Report.pdf.

# Cost Allocation in Practice: A Balancing Act




**Beneficiary identification**: The cost allocation method must accurately identify beneficiaries of the project.

**Evidence-based decision-making**: Cost allocation decisions need to be accompanied by adequate evidence and explanation.

**Free ridership**: Beneficiaries must pay, even when benefits are small. However, some external and unplanned free ridership may be permissible when balancing regulatory goals.

**Estimation of costs and benefits**: The benefit-cost calculation doesn't have to be exact.

**System-wide benefits**: Certain transmission investments benefit the entire network and therefore can be allocated to all system users.

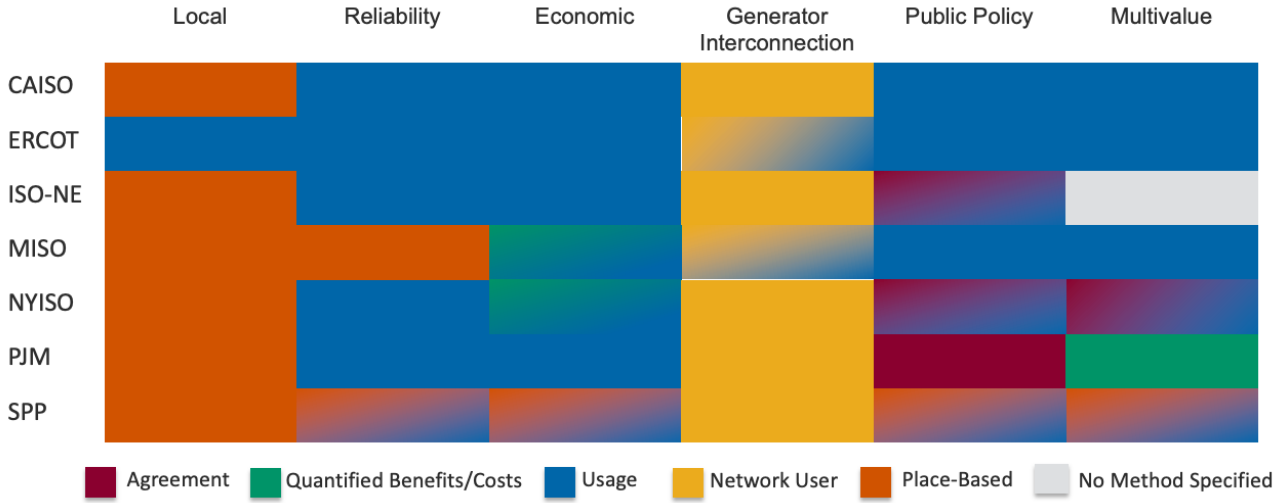
# Knowledge Check:

What is the most common approach to allocate costs for regional transmission in the U.S.?

# Transmission Cost Allocation Implementation in the U.S.

Summary of cost allocation methods used in each RTO/ISO for different project types.

Source: Tariff filings, written feedback from ISO-NE, CAISO, MISO, SPP, and informational interviews with ISO-NE and MISO




**Key Trends:**

1. Local projects are primarily cost allocated using place-based approaches.
2. Generator interconnection projects are almost exclusively paid for by specific network users.
3. Usage-based methods are the most common approach for regional cost allocation.
4. Direct cost allocation based on quantified benefits or costs is rarely used.
5. Even when regions use the same method, it is often implemented differently (e.g., load ratio share).

Interim results – do not cite or distribute

# Order 1920 and its impact on transmission planning

# Overall Need for Reform

**Building for the Future Through Electric Regional Transmission Planning and Cost Allocation**
issued May 13, 2024 and updated November 2024 (1920-A) and April 2025 (1920-B)

**Motivation:**
Current requirements fail to require transmission providers to:

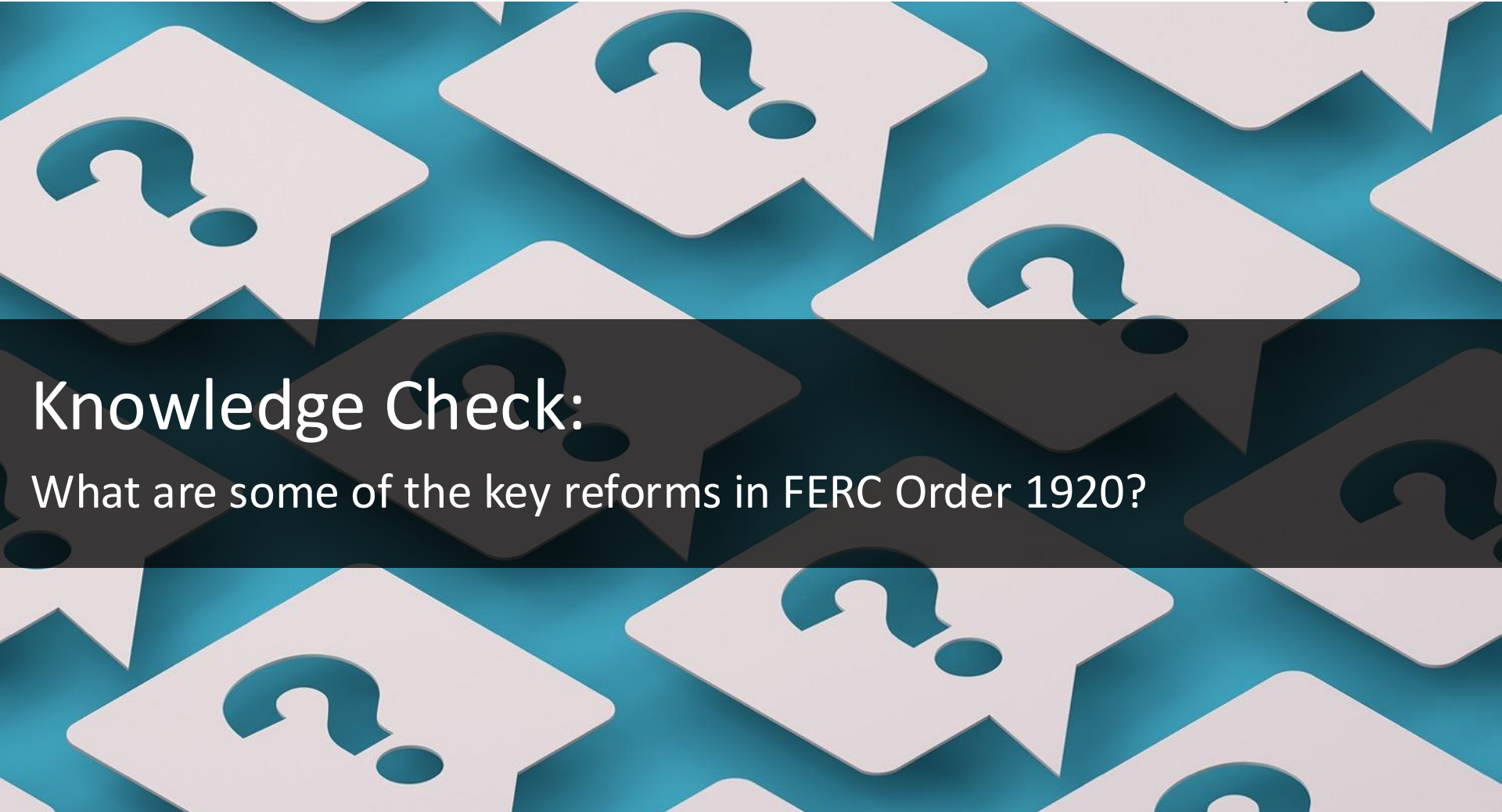
- Perform a sufficiently **long-term** assessment of transmission needs.
- Account adequately on a forward-looking basis for **known determinants** of long-term transmission needs.
- Consider a broader **range of transmission benefits.**

As a result:

- Current expansion is happening outside of the regional planning process through **local projects.**
- Non-Regional Transmission Organization (RTO) regions have **"black box"** planning.
- Some regions don't have a platform for **state participation**

"Sufficiently long-term, forward-looking, comprehensive regional transmission planning and cost allocation to meet long-term transmission needs is not occurring on a consistent and sufficient basis." (¶112)

https://www.ferc.gov/explainer-transmission-planning-and-cost-allocation-final-rule



# Knowledge Check:

What are some of the key reforms in FERC Order 1920?

Engage in **regional long-term transmission planning** to identify transmission needs

Develop **processes and criteria** for selecting transmission facilities **to resolve those needs**

**Engage with relevant state entities** on scenario design and input assumptions, selection criteria, and cost allocation methods

# Order 1920 Reforms

## How to Plan

Evaluate transmission facilities that will address **interconnection-related transmission needs**

Consider **transmission alternatives** including advanced conductors, power flow control devices, dynamic line ratings, and transmission switching for both new and existing facilities

Consider **local planning** and **"right sizing" replacement** transmission facilities

# Questions and Discussion

**www.nrel.gov**

*Photo from Getty-181828180*