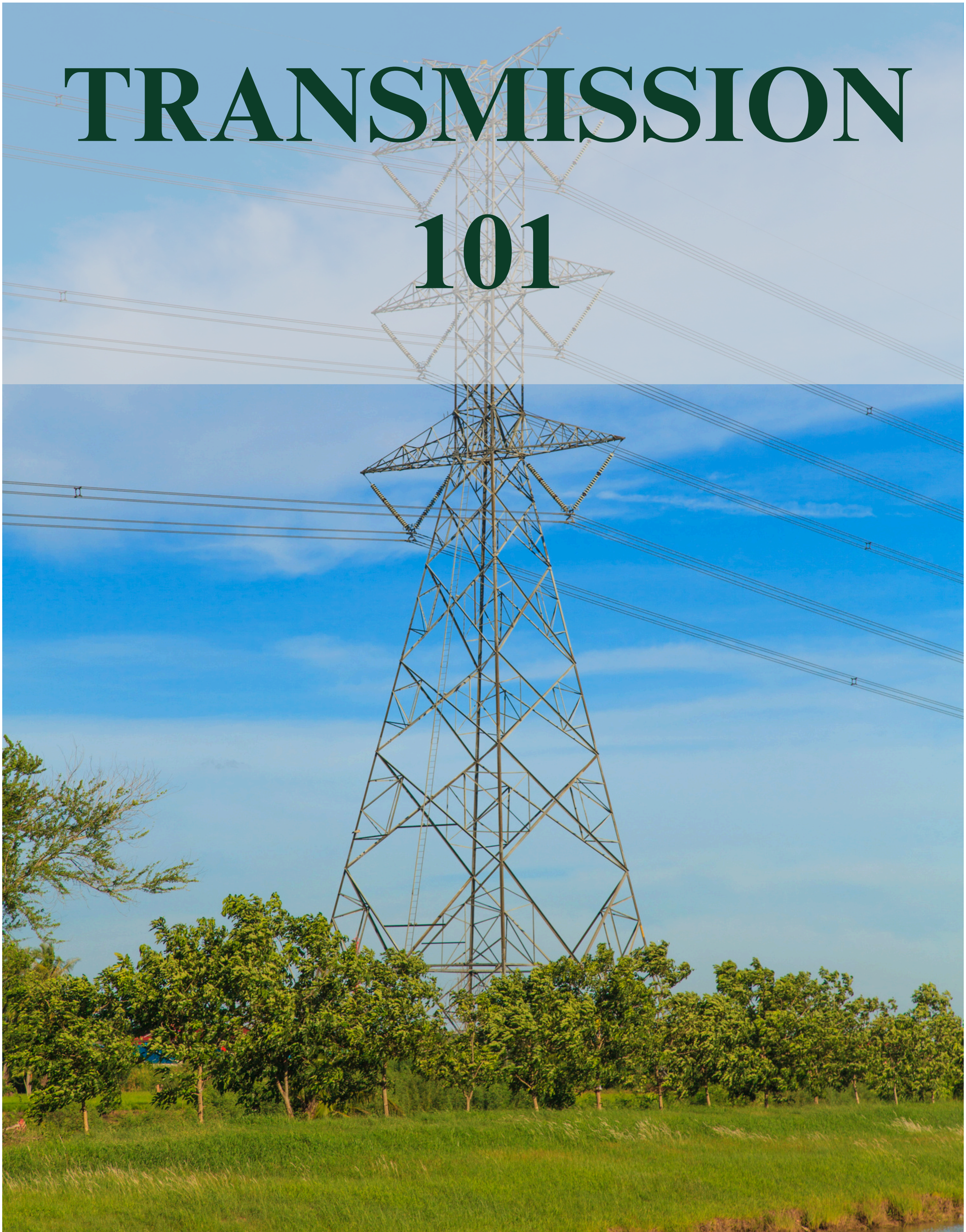
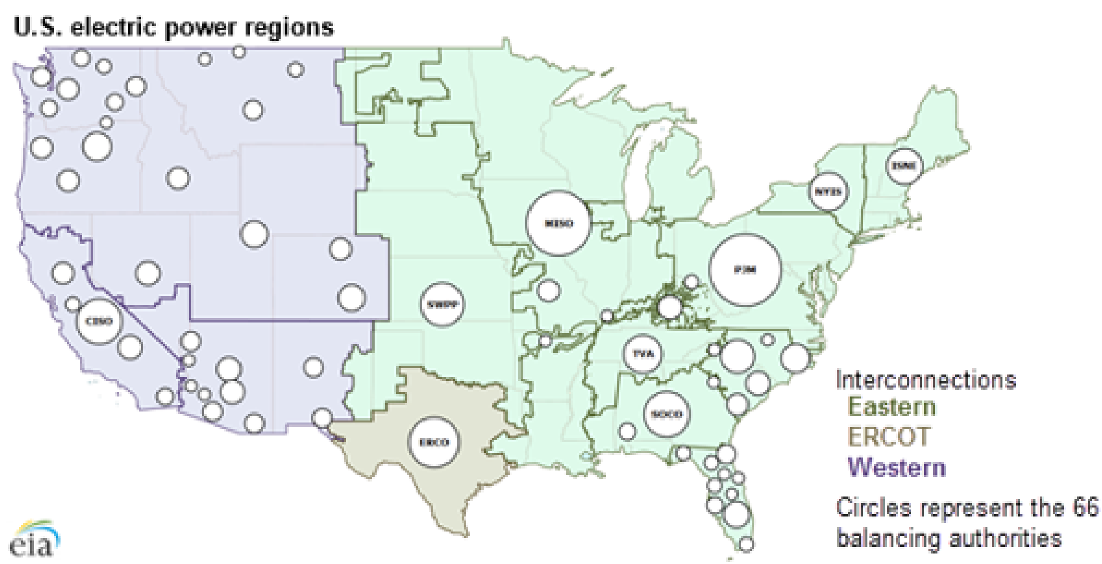
TRANSMISSION 101



WHAT IS "THE GRID"?

The United States uses a lot of power. Whenever you plug your phone into the wall or turn on your A/C unit or lights, you are drawing power from the country's vast network of power plants and power lines. Altogether, "the grid" comprises 7,300 power plants, 160,000 miles of high-voltage power lines, and 5.5 million miles of distribution lines that are all calibrated to work in tandem to keep America online.[1] Generation (e.g., power plants) produces the electricity that transmission and distribution then delivers to demand centers (e.g., homes and businesses) in real time, demanding constant balancing to regulate fluctuating supply and demand.

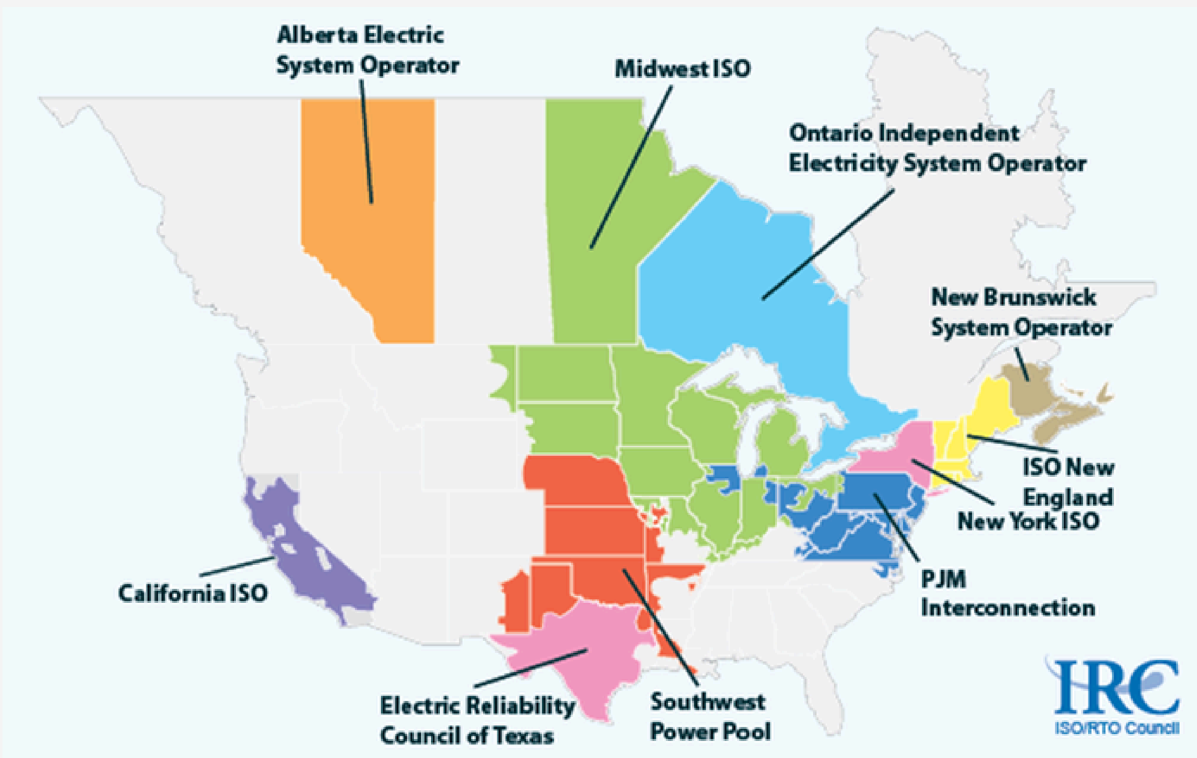
In practice, there are three separate U.S. grids, or self-contained "interconnections" of power production and transmission—the Eastern, Western, and Texas (referred to as ERCOT) Interconnections. These grids cover the contiguous United States and operate independently of one another. The Electric Reliability Council of Texas (ERCOT) covers most, but not all, of Texas and consists of a single balancing authority[2] in a single, competitive, state-wide wholesale market independent of federal regulation. Alaska and Hawaii, as well as each of the U.S. territories, also have their own grids that are not subject to federal regulation.[3]



Map of the 3 Interconnections

WHO ARE THE KEY ACTORS?

Within these three interconnections, there are seven Regional Transmission Organizations (RTOs), which are independent, non-profit organizations that oversee the grid operations in their defined regions. They perform several core functions, including balancing supply and demand, running competitive markets to adjudicate which plants get to provide power, and proactively planning regional grid upgrades to ensure the provision of reliable energy at the lowest cost. In total, the RTOs (sometimes called Independent System Operators (ISOs) for smaller regions) encompass 60% of the power supplied to U.S. consumers. Some of these RTOs have connection into Canada, enabling cross-border electricity market integration. However, the Canadian RTOs are not regulated by the U.S. government, and are only integrated commercially with the U.S. grid, similar to the cross-border pipeline network enabling oil and gas trade with Canada.[4]



The RTOs procure power by having auctions to see who can provide it at lowest cost. Different generators, each producing electricity from different sources and at different costs, sell their power at these auctions, where the RTO sets the clearing price of the market at the price of the most expensive generator that had to dispatch power onto the grid. While this sounds complex, it is essentially the same as other global commodity markets, such as the oil market. Some producers may produce a barrel of oil at a cost far below what the market is willing to pay, but the market (in this case, the RTO) dictates the final price at which the barrel is bought. In this way, the RTOs are set up to mimic the competitive forces of markets, with more structure than exists in a normal market to ensure that power is always delivered.

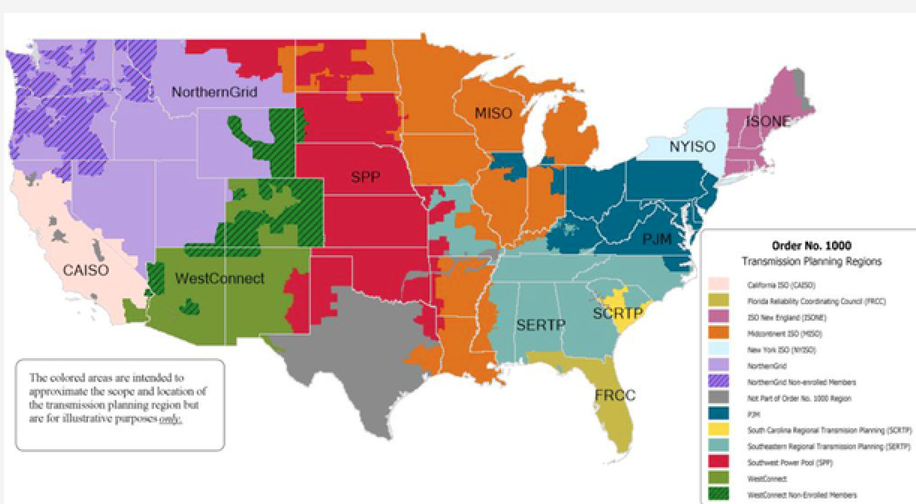
Outside of the seven U.S. RTOs, the Southeast and West (except California) operate under a more traditional, utility-driven model rather than a single centralized market. In these regions, rather than relying on power auctions among multiple independent actors, utilities build generation to supply their defined service territories. Because these utilities are essentially monopolies free of competition, central regulators known as utility commissions in these states determine how much money they are allowed to make.

Each of the RTO and non-RTO regions have many utilities within them. In total, there are about 3,000 electric utilities in the US. The vast majority of these utilities are small municipal utilities (about 2,000), which are owned by governments, or cooperative utilities (about 900), which are owned by their customers. Most municipals and co-ops are quite small—in some instances serving fewer than 100 people—and do not own either generation or transmission but rather take service from larger neighbors. [5]

Despite being larger in number and geography, municipals and co-ops serve far fewer customers than so-called investor-owned utilities (IOUs). There are just over 100 IOUs belonging to about 60 parent companies in the U.S. and providing power to over 70% of U.S. customers. [6] The IOUs are the primary subjects of federal and state regulation. As with the co-ops and municipals, they vary in structure (some own generation, transmission, and distribution, some own just one or two of the three categories) and size, though the smallest IOUs serve about 1,000 times more customers than the smallest nonprofit utilities.

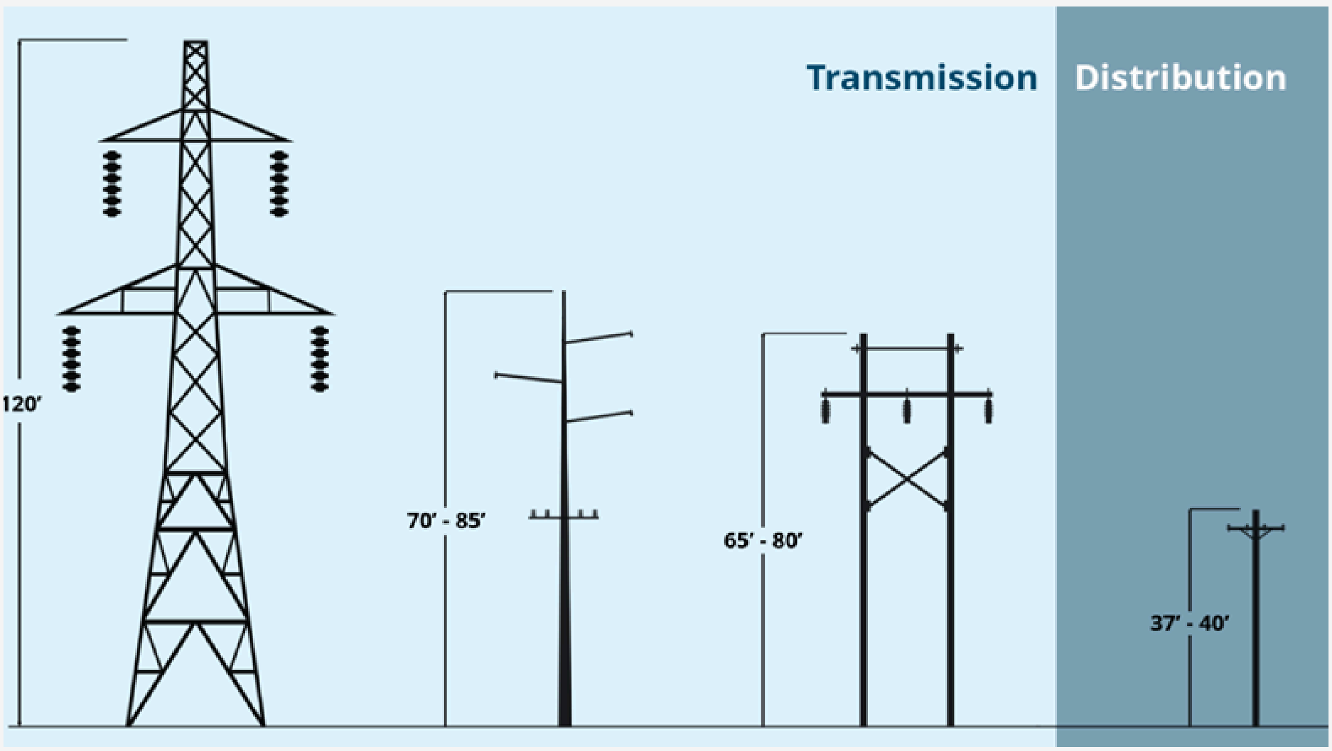
HOW DOES TRANSMISSION CONNECT THE UNITED STATES?

The transmission lines that connect the U.S. can be broken into three categories: local, regional, and interregional. Local lines move power within a single utility's footprint. Regional transmission is contained within a single RTO or non-RTO transmission planning region but goes between two or more utilities. Interregional lines move power between regions.



Local power lines tend to operate at the lowest voltage levels and carry the smallest amounts of power. After local lines carry the electricity to a distribution substation, distribution lines, like the ones you see in your neighborhood, carry the power to homes and businesses.[7] Regional and interregional projects, by contrast, tend to operate at higher voltages and carry more power over greater distances.

The vast majority (more than 90%) of U.S. transmission spending occurs either on local transmission or on targeted projects built on an emergency basis to address acute operational reliability needs. Spending on these two categories of transmission has gone up roughly tenfold in nominal value since the turn of the century.[8] Meanwhile, most regions do not plan regional transmission, and no significant interregional transmission has been successfully planned or built anywhere in the U.S. in over a decade.



This shortfall contributes to a widening gap between the U.S. and peer and rival nations' grids. For example, even as the U.S. has, in recent years, overtaken China in annual grid spending, China now consistently builds roughly 25 times as many gigawatt-miles of grid infrastructure as the U.S. each year.[9] This disparity is due to China's prioritization of constructing very high-voltage transmission to move power across the country, as opposed to the U.S. prioritizing on local projects. [10]

HOW IS THE GRID REGULATED AND MANAGED?

The flow of electricity through the grid is measured in megawatt-hours. A megawatt (MW) is a unit of power, where power is the rate at which energy is transferred. Think of energy as a liquid and power as how quickly it is flowing (e.g., how many gallons per second are moving). A megawatt-hour (MWh) is therefore the amount of energy you get if you produce 1 MW of power for 1 hour. For reference, a small town of several hundred to 1,000 people might average a power use of 1 MW.

The U.S. consumed a record 4.1 billion MWh of electricity in 2024, with 37.6% of that being residential use, 36.2% for commercial, and 26.2% for industrial.[11] All of this power needs to be regulated to ensure its safe and reliable transmission across regional, state, and local borders. Therefore, government agencies, balancing authorities, RTOs, and utilities all work in tandem to regulate and manage the grid.

Starting at the federal level, the Federal Energy Regulatory Commission (FERC) is the government authority on regulating the interstate transmission of electricity and the wholesale sale of electricity (i.e., the sale for subsequent resale), including the power markets, where electricity is bought and sold in bulk between generators (power plants) and retailers or large utility companies. FERC also oversees the RTOs' and utilities' other functions such as regional transmission planning, ensuring that electricity rates are fair and not discriminatory, and investigating and imposing penalties for market manipulation.[12] Outside of the electrical grid, FERC also has roles in regulating oil and gas pipelines and hydropower facilities.

FERC works in tandem with the North American Electric Reliability Corporation (NERC), which is a not-for-profit, non-governmental international regulatory authority whose main mission is to oversee and maintain grid reliability. Grid reliability breaks down into two distinct components: resource adequacy (making sure there is enough generation that can be transmitted to users 24/7) and operational reliability (making sure the system stays within its safe operating voltages, frequencies, etc.). NERC only oversees operational reliability, with the states being ultimately responsible for resource adequacy. NERC develops and enforces reliability standards for the North American power system that FERC approves. NERC oversees all of the U.S. and Canadian grids, plus a portion of northwestern Mexico, to ensure a consistent, stable supply of electricity throughout North America.[13]

FERC and NERC set the "rules of the road" for wholesale electricity markets and operational reliability across the country (and in NERC's case the continent). The RTOs and balancing authorities then follow those rules to maintain the day-to-day balance of supply and demand in their designated areas. Finally, each state has its own utility commission responsible for regulating distribution, retail sales of electricity, sometimes generation, and certain aspects of the transmission system.

CONSIDERATIONS FOR NEW TRANSMISSION LEGISLATION

There are four core issues that any piece of transmission legislation may try to address: planning, siting, permitting, and cost allocation. RTOs often take the lead on planning new transmission projects and determining where there is the greatest need. They consider reliability needs and the economic costs and benefits of the project. While planning takes place at the regional and local (i.e., utility service-territory) levels, siting (i.e., determining where the line physically goes) occurs via state governments. State officials oversee the siting of the line and can slow or even outright block transmission projects.

If regional and state officials agree on the necessity of the project and where it will run, permitting delays at the federal level can still delay projects, sometimes for decades, and make them unviable. Permitting reform legislation like the Standardizing Permitting and Expediting Economic Development (SPEED) Act seeks to reform the National Environmental Policy Act (NEPA) to shorten environmental review timelines and make planning large scale transmission projects more viable.[14] Other laws like the Clean Water Act and the National Historic Preservation Act have in recent years jeopardized significant transmission projects, and have also been the subject of congressional reform efforts.

Finally, the allocation of the cost of the new line is often the most contentious issue when building new transmission. The cost of building and maintaining the electrical grid is always ultimately paid by the end consumer, in the form of either a direct line item on the ratepayer bill or higher per-unit energy rates. Cost allocation is overseen at the federal level by FERC, who requires costs to be “roughly commensurate” with benefits. While this sounds simple, in practice there are vastly different methods of calculating who benefits from new transmission lines, especially when trying to weigh the varying economic, reliability, and political “benefits” of new transmission and power generation capacity.[15]

Today, *the Federal Power Act of 1920* (amended in 1935) remains as the primary federal statute governing the wholesale transmission and sale of electric power, as well as the regulation of hydroelectric power. The Federal Power Act established FERC as the sole authority over economically regulating interstate transmission. The Federal Power Act set the legal standard that electricity rates must be “just and reasonable” for ratepayers, which courts have interpreted to mean that the costs for new transmission should be allocated to those who cause a need for them, and must be allocated to consumers “roughly commensurate” with the benefits they receive.[16]

IMPORTANT NUMBERS

- The U.S. consumed a record 4.10 billion MWh in 2024, with 37.6% for residential use, 36.2% for commercial use, and 26% for industrial use.[17]

- About 60% of this electricity generation was from fossil fuels— mainly natural gas (43%) and coal (16%). Nuclear energy makes up 19% of the generation, followed by wind at 10%, hydropower at 6%, and solar at 4%.[18]

- The grid comprises 7,300 power plants, 160,000 miles of high-voltage power lines, and 5.5 million miles of distribution lines.[19]

- 53 and 888 miles of new high voltage transmission were constructed in 2023 and 2024, respectively, marking the first and third slowest years for such construction in the past 15 years. By comparison, nearly 4,000 miles were built in 2013 alone.[20]

- At the direction of Congress via the 2023 Fiscal Responsibility Act, NERC determined a need for 35 gigawatts of new interregional transfer capability in the U.S. to safeguard reliability between the regions.[21] A 2025 study by the Eastern Interconnection Planning Collaborative found that some regions have zero ability to move power between them at peak hours, posing a risk to reliability.[22]

SOURCES

[1]https://www.eia.gov/todayinenergy/detail.php?id=27152

[2] A balancing authority is a region over which grid operators ensure that supply is balanced with demand at every second of every day. If supply deviates by more than a tiny amount from demand, power can trip off, leading to blackouts, and equipment can be damaged.

[3] https://www.eia.gov/todayinenergy/detail.php?id=27152

[4] https://www.eia.gov/todayinenergy/detail.php?id=790

[5]https://www.mmua.org/municipal-utilities.

[6] https://www.eei.org/en/about-eei/us-investor-owned-electric-companies

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[9]https://x.com/NiyerEnergy/status/2032266545234149593?s=20

[10]https://nathandiyer.github.io/us-transmission-grid/analysis.html

[11] https://www.eia.gov/energyexplained/electricity/use-of-electricity.php

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[13] https://www.nerc.com/who-we-are/key-players/north-america

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[15]https://www.csis.org/analysis/assessing-electric-transmissions-cost-allocation-dilemma

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[18]https://www.eia.gov/tools/faqs/faq.php?id=427&t=3

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[21]https://www.nerc.com/initiatives/additional-initiatives/interregional-transfer-capability-study-itcs

[22]https://static1.squarespace.com/static/5b1032e545776e01e7058845/t/68c1a53c9efd472637969e1a/1757521212019/FINAL+Press+RElease+-+EIPC+ITC+Study+Report+-+9-10-25.pdf