THE GRID

WHAT IS THE TRANSMISSION GRID AND HOW DOES IT SERVE YOUR COOPERATIVE?

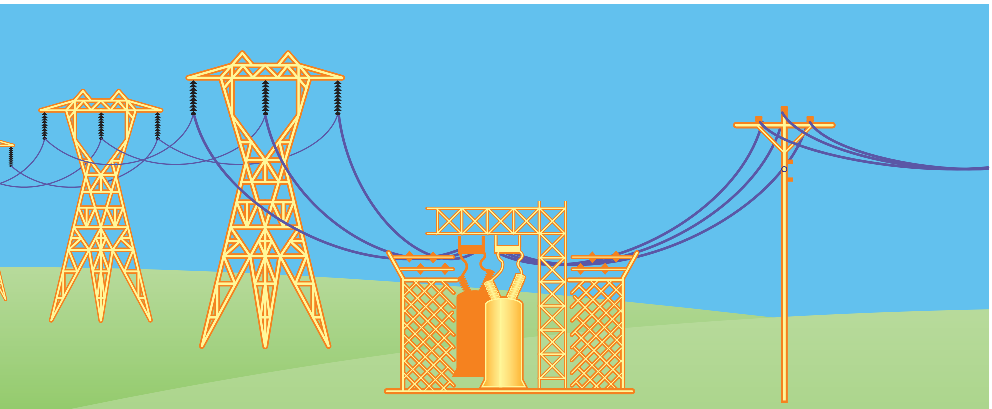
By Michael E.C. Gery

The electricity grid is the network of lines that carries electric power from its source—typically power plants—to where it's needed, such as your community and your home. To work effectively, electricity must at all times flow safely and reliably throughout the grid so the power is there when you flip on a switch.

When you cut that switch off, the electric power doesn't stop at your switch. Like water, it finds the path of least resistance and goes somewhere else through the grid to where it's needed.

Most people are familiar with the power lines and poles that run alongside roadways or the lines that run underground in a neighborhood. These lines distribute electricity to users and are called "distribution lines." Your electric cooperative is a "distribution utility," because it manages and maintains the system that supplies you with power.

The part of the grid that carries electric power from generating stations to distribution utilities is called the "transmission grid." To allow electricity to cover great distances efficiently, power from its source is transmitted at voltage much higher than what your household appliances need. (See illustration.)



The power in the high-voltage transmission lines you see crossing fields and ravines is transmitted at voltages as high as 500,000 volts (500kv). The fenced substations you see outside industrial plants or near population centers contain transformer equipment to "step-down" transmission line power to voltage that can run safely through distribution lines.

The grid's operational structure

As the need for electric power grew over the past 100 years, the industry had to expand the transmission grid and adjust how it would operate. For a time, utilities served local areas such as a city or a portion of a state. Today, many utilities have grown to serve service territories that may span several states.

Planning for growth in the transmission system has not been easy, because "you can't put a power plant on every corner, and you can't always predict where load will materialize in the future," says Bob Beadle, manager of transmission resources for North Carolina Electric Membership Corporation (NCEMC), the cooperative that supplies bulk power to most of the state's distribution co-ops. Power plants need to be near their fuel source and a source of water to operate at the lowest cost. Planners and engineers balance cost, reliability and geography when planning transmission expansion, Beadle says.

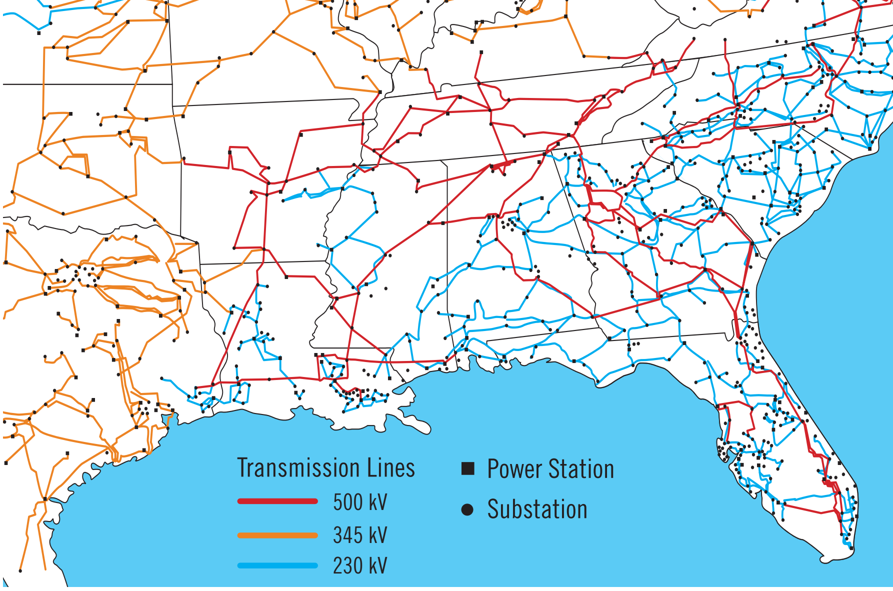
In the U.S. today, the electric grid is composed of about 186,500 miles of line, owned by some 500 companies. Rather than a single grid covering the entire nation, the system is served

1910 1920 1930 1940 19

Early 1900s. Private power companies (investor-owned) and the public power authorities (government-owned) acquire the right-of-way and build transmission poles and lines that move their power to distribution utilities.

Late 1920s. The federal government assumes jurisdiction over transmission because it had become an interstate commercial activity.

1935. Congress limits the geographic areas where utilities can operate and expands jurisdiction of the Federal Power Commission (today's Federal Energy Regulatory Commission or FERC) to regulate both the rates and transmission of electricity production across state lines.



Maps are for general information and not to scale.

Regional transmission grids and grid operators

through three regional grids, called "interconnections." A single grid serves eastern North America, for example. The Eastern Interconnection ties together utility transmission systems encompassing central Canada to the Atlantic coast to Florida to the eastern edge of the Rocky Mountains. The Western Interconnection likewise covers western Canadian provinces south through California and the Rocky Mountain region. A third grid serves systems in Texas.

Within the regional grids, about two-thirds of the transmission is controlled by seven independent authorities called Regional Transmission Organizations (RTO) or Independent System Operators (ISO). These entities are not structurally tied to the utilities, generators or other users of the transmission lines, but they work with the users of the system to manage load requirements, transmission access and pricing. They also operate a wholesale power market, which allows utilities and other merchant generators to buy and sell power on the open market. The remaining transmission is controlled primarily by transmission-owning utilities like Duke Energy and Progress Energy. These systems are interconnected with each other, allowing these utilities to buy and sell power to manage cost and reliability.

To safeguard the reliable planning and operation of the grid, the industry has established mandatory standards, which are applicable throughout North America. The North American Electric Reliability Corporation (NERC) establishes and enforces these reliability standards. The SERC Reliability Corporation monitors compliance with these standards for electricity service areas in the southeastern U.S., including North Carolina. Reliability standards became mandatory after the worst blackout in U.S. history in 2003. (See timeline.)

Ultimately, the federal government has jurisdiction over interstate transmission activity. Over the years, various acts of Congress and orders by the Federal Energy Regulatory Commission have controlled the development and operation of power transmission.

Your cooperative and the grid

Power for North Carolina's electric cooperatives comes from a variety of sources. Some co-ops negotiate contracts with power generators and wholesalers. Most band together to buy power from their statewide power supply cooperative NCEMC, based in Raleigh. NCEMC itself contracts with power generators, including Duke Energy, Progress Energy, Dominion Power, American Electric Power and others. NCEMC also will buy power on the open "spot" market when economical purchases are available. In addition, NCEMC is part owner of the Catawba Nuclear Station in South Carolina, which supplies nearly half the bulk power to NCEMC, and also owns four

50 | 1960 | 1970 | 1980 | 1990

1960s. Utility companies form regional interconnection systems to coordinate power transmission throughout large geographic areas. After a November 1965 blackout leaves some 30 million people in the Northeast in the dark, the industry forms nine regional "reliability" councils to conduct planning operations, leading to the formation in 1968 of the National Electric Reliability Council (NERC).

1977. A New York City blackout in July forces the industry to establish a series of reliability standards and procedures across the transmission grid.

1978. Congress recognizes the existence of non-utility power generators and requires utilities to give those generators access to their transmission systems.

1992. Congress deregulates the wholesale power generation system. This opens up competition among electricity producers and requires transmission owners to allow wholesale power generators access to their grid at fair and predictable prices.

smaller generating stations that supply power during peak demand and emergency periods. This multi-source system allows co-ops a degree of flexibility in determining where their power comes from.

North Carolina's electric cooperatives use the transmission systems of Duke Energy and Progress Energy, as well as the PJM Interconnection, an RTO serving an area from Indiana and Michigan to the mid-Atlantic. These transmission owners all operate control centers that are continuously engaged in monitoring supply, demand and reserves.

Because power plants sometimes take years to permit, design and construct, co-ops like NCEMC must plan well in advance for power supply and the required transmission, working with other utilities in the Southeast and the North Carolina Transmission Planning Collaborative, which produces an annual transmission plan to meet the transmission needs of the state.

The future of transmission

America's electric utility industry today universally agrees there's a need for new transmission infrastructure.

"For the last decade or so, new transmission construction has not kept pace with the development of new power supply," says Barry Lawson, manager of power delivery for the National Rural Electric Cooperative Association. "There hasn't been any significant, backbone transmission added to the grid in quite some time."

Planning and coordinating efficient bulk power transmission is one thing, building it is another. Government regulations affecting who owns and controls transmission can change. Environmental considerations about where to build transmission are always in the forefront. Acquiring the right-of-way and real estate to site transmission requires major effort. And in general people just don't want to see high-voltage transmission lines nearby.

"We've all heard of NIMBY, not in my back yard," says W. Terry Boston, CEO of the grid operator PJM Interconnection. "Now we're facing NOPE, not on planet earth."

In spite of these constraints, the electricity industry today is seeing stepped up activity toward improving the transmission grid and building new transmission infrastructure.

"The regulatory uncertainty in the middle 1990s brought on a decline big time," says Boston. "But now we have a new line across the Appalachians, another under construction, and another approved."

At the same time, federal officials are planning and implementing security systems intended to protect the grid against hackers and terrorist attacks via the Internet.

To help in future planning, transmission technology has improved. NCEMC's Bob Beadle points to several advances. New conductors used for transmission lines permit more power to move with less of the natural "loss" that occurs over long distance. The ability of new "smart grid" systems to manage distribution and usage lends to a more effective delivery. Advanced battery technology can increase how much power can be stored in reserve. "Distributed" power generation close to the point where it's used—such as fuel cells or solar electric systems on buildings, or individuals and businesses themselves producing power that can feed into the grid—is part of the coming mix of power supply. "All of this progress will help us to plan and manage transmission and distribution more efficiently," Beadle says.

Developing more renewable energy resources to generate electricity in the U.S. figures largely into the future of transmission. Wind resources, for example, are abundant in the Midwest, but the transmission grid does not yet extend to all those areas.

"If you like wind because of its low fuel cost," says PJM's Terry Boston. "If you like nuclear power because it can reliably serve your base load, if you like plug-in hybrid electric vehicles because they can get us off foreign oil, you have to love transmission. You have to build transmission."

Boston concludes, "There are consequences if we don't build. If you think the cost of electricity is high, you should see the cost of not having it." C

Sources: U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability, National Council on Electricity Policy, U.S. Federal Energy Regulatory Commission, National Rural Electric Cooperative Association.

2000 2010 2020 2030

Mid-1990s. FERC requires generators and transmission owners to communicate what power is available at any given time. FERC also urges formation of independent Regional Transmission Organizations (RTO) or Independent System Operators (ISO) to not only plan adjustments to the grid but also oversee grid operations. Continued stress and regional power failures bring calls for a new independent, self-regulating reliability authority to establish and enforce mandatory standards throughout North America.

2003. The worst blackout in U.S. history on Aug. 14 leaves some 55 million people in Ontario, Canada and eight states in the Northeast and Midwest in the dark for two days. The cause: too much power demand in a transmission system that couldn't handle it, so it shut down.

2005. Congress again steps in to create incentives for private investment in transmission improvements and authorizes a transmission coordinating entity whose standards would be mandatory and enforceable. By 2007, the NERC becomes the North American Electric Reliability Corporation (still known as NERC), and today its standards are mandatory and enforceable in the U.S.