ELECTRICITY

The backbone of social advancement for the past 100+ years. How electricity is generated, transported, used, and stored has numerous economic and societal implications.


Photo Credit: Dennis Schroeder/NREL50700

OVERVIEW

Electricity is the flow of electrons in one direction (direct current) or two (alternating current). The flow starts by spinning a magnetized turbine, which requires an energy source, either directly applied (wind or water, for example) or combusted/reacted (coal, gas, nuclear) to create steam and to force it through the turbine. Solar uniquely uses light energy to start electrons moving.[1, 2]

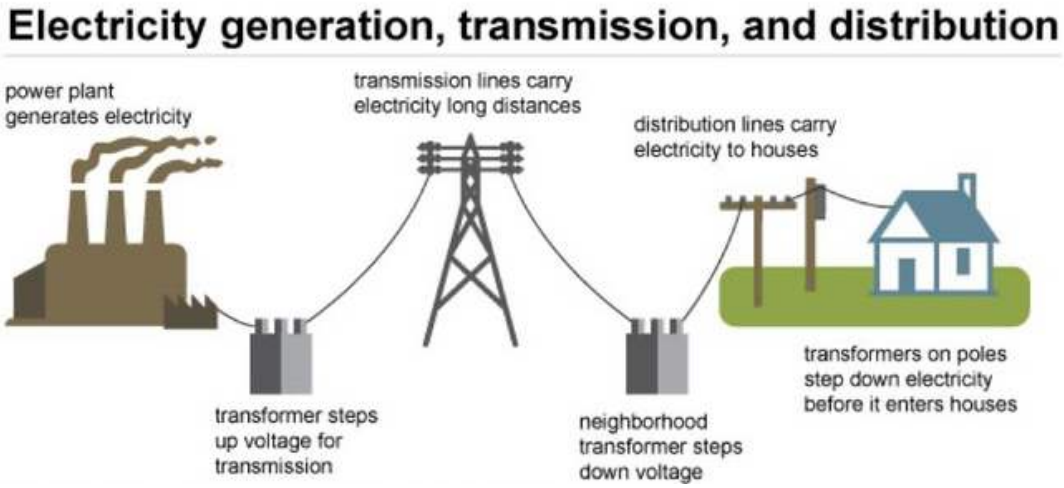


Figure 1. shows the electricity generation, transmission and distribution system. (Adapted from National Energy Education Development Project (public domain))

TRANSMISSION & DISTRIBUTION

Electricity is a product that needs to move constantly from source to use, to maintain system balance. From the source (generation) it moves at high voltages over long distances to get closer to consumers. Then its voltage is "stepped-down" (240v; 120v) for delivery to commercial and residential users.[3]

Electric System Challenges[4,5]

- Increasing demand and changing customer expectations unable are unable to be facilitated by the current aging system.
- Our aging system faces increasing risk related to severe weather and national security threats.
- New transmission encounters permitting and siting hurdles, and long wait times from regional operators to review/approve proposed projects.
- Distributed energy resources, including renewable generation, can be located closer to end users, which changes existing system dynamics.

AT A GLANCE

- **Clean/Renewable Energy** - Defined in state statute which differs between states.
- **Demand** - The level at which electricity is delivered to end users at a given point in time.
- **Peak Demand** - The highest period of demand within a particular time. Meeting peak demand is usually the most expensive.
- **Dynamic Rates** - Reflect real-time market conditions and can shift demand to lower cost periods.
- **Load Growth** - Increases in load (consumption). Often forecasted over time.

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REGULATING BODIES & RESPONSIBILITIES

- Utilities (locally), balancing authorities (sub-regionally), and RTO/ISOs (organized regions) plan for and match demand with supply within a small margin of error.
- In exchange for limited competition within utility service areas, the public utilities (or service) commissions (PUC, PSC) regulate generation, generating companies (like utilities), transmission, retail electricity rates, utility expenses, revenues (through rates) and earnings (through setting maximum allowable returns).[6]
- The Federal Energy Regulatory Commission (FERC) regulates wholesale electricity transactions and interstate transmission of electricity, gas, and oil. It also provides hydropower licensing.

HISTORY OF THE UTILITY

- Pearl St. Station in New York, Edison's first commercial power plant and distribution system. [7]
- Multiple utilities begin to create overlapping systems: too many wires; oversight needed.
- Creation of "monopoly" utility legal status in exchange for increased governmental regulation.
- Regulation: a "surrogate" for the market in setting rates and earnings; oversight service: safety, quality, reliability, and efficiency standards.
- Since the 1970s: steady rethinking of monopoly status; wholesale competition; retail choice; dividing up utilities into parts.
- Today utilities are facing new demands and opportunities: customers as generators, technological innovation, disruption of the status quo, and new policy pressures.

TYPES OF UTILITIES

1. Investor-Owned Utilities (IOUs)

- Large electric distributors owned by shareholders.
- Almost three-quarters of electric customers are served by IOUs. [8]

2. Cooperative Utilities (Co-ops)

- Built and owned by communities they serve.[9]
- Serve 42 million Americans and return over $1 billion in capital credits to members annually.

3. Municipal Utilities (Munis)

- Operated as a part of government or subdivision not for profit. [10]
- More than 2,000 in the U.S. [10]

3. The Utility of the Future?

- Greater focus on resilience, clean energy sources, and energy choice.

CONSIDERATIONS

1. Are current state regulatory practices yielding the best balance of lowest cost and highest service to end users and society?

2. Is the regional structure (RTO, ISO) decision-making process understandable and transparent and is authority appropriately allocated between all relevant parties?

3. Are there parts of the electric system in your state where the utility-customer relationship should be revised?

Resources

1. MIT. 2013. "What's the difference between AC and DC?" https://engineering.mit.edu/engage/ask-an-engineer/whats-the-difference-between- ac-and-dc/
2. EIA. 2023. "Electricity explained." https://www.eia.gov/energyexplained/electricity/how-electricity-is-generated.php
3. Edison International. 2014. "How is Power Stepped Down?" https://energized.edison.com/stories/how-is-power-stepped-down
4. G&W Electric. 2024. "Navigating the Future of Electric Power Transmission Systems: Challenges and Innovations." https://www.gwelectric.com/ blog/2024/01/31/navigating-the-future-of-electric-power-transmission-systems-challenges-and-innovations/
5. Utility Dive. 2023. "Meeting Electric Transmission Needs for the 21st Century Grid." https://www.utilitydive.com/spons/meeting-electric-transmission-needs-for-the-21st-century-grid/695269/
6. RAP. 2016. "Electricity Regulation in the US: A Guide." https://www.raponline.org/wp-content/uploads/2023/09/rap-lazar-electricity-regulation-US-june-2016.pdf
7. National Grid. 2022. "The History of Energy in the U.S." https://www.nationalgrid.com/stories/energy-explained/history-energy-united-states
8. EIA. 2019. "Investor-Owned Utilities Served 72% of U.S. Electricity Customers in 2017." https://www.eia.gov/todayinenergy/detail.php?id=40913
9. NRECA. 2024. "Electric Co-op Facts & Figures" https://www.electric.coop/electric-cooperative-fact-sheet
10. American Public Power Association. n.d. " Stats and Facts." https://www.publicpower.org/public-power/stats-and-facts