



Bipartisan Policy Center

Electricity 101

Session 1: The Physical Grid & Who Does What

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Speakers:

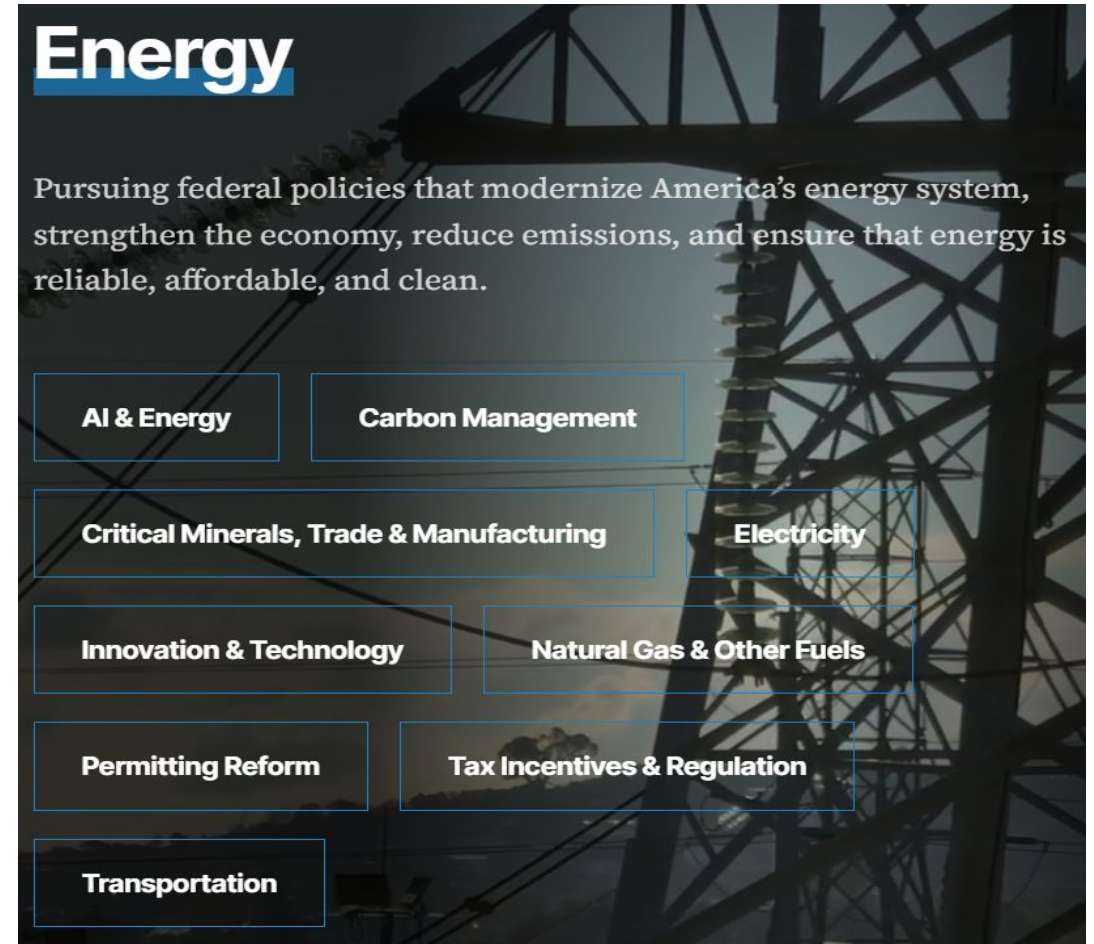
Kathryn Kline Tyndall: Associate Director, Energy, BPC

Devin Hartman: President, Lighthouse Energy Institute

Dr. Liza Reed: Director for Climate and Energy Policy, Niskanen Center

About the Bipartisan Policy Center

- The Bipartisan Policy Center was founded in 2007 by four former Senate majority leaders—Howard Baker, Tom Daschle, Bob Dole, and George Mitchell.
- They believed that cooperation across party lines was essential to solving the nation's toughest challenges.
- Their vision was clear: bring the best ideas from both sides of the aisle to create effective, durable policy solutions.
- Advancing pragmatic solutions, improving lives, and building a stronger America.



Course Overview

01

Session 1

The Physical Grid & Who Does What

How electricity flows from generation to consumer, and who regulates each piece.

02

Session 2

Markets, Reliability & Resource Adequacy

How wholesale markets work, how RTOs operate, and how the grid stays reliable.

To be announced this Fall!

03

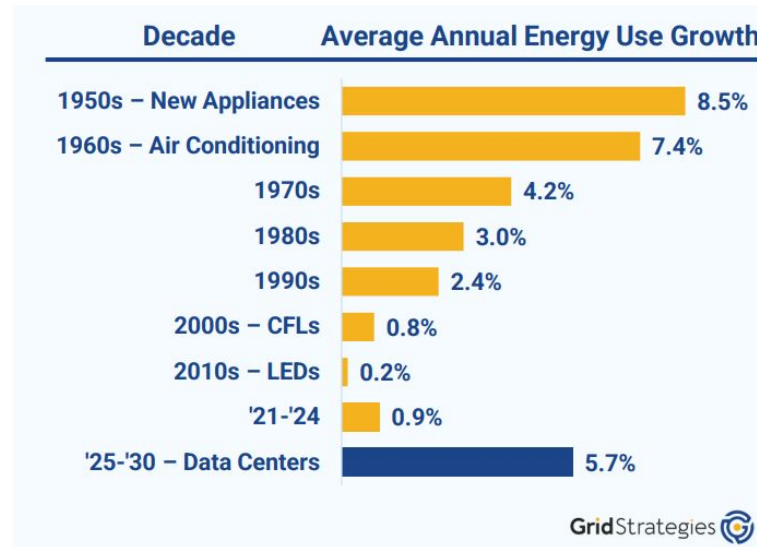
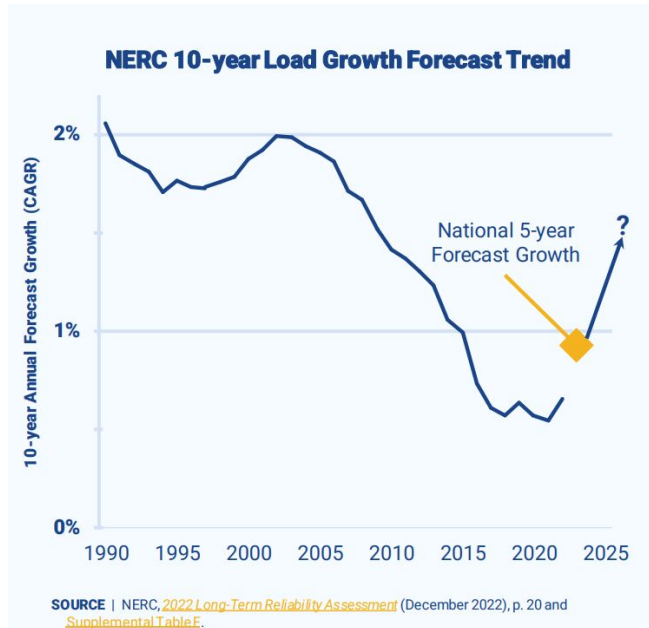
Session 3

The Path Forward

New demand, new technologies, challenges, and how Congress can shape the next era of electricity.

The Moment We're In: New Demand Growth

After ~20 years of flat electric power consumption, U.S. electricity consumption projections for the next decade are increasing significantly.



Key Drivers

Data centers

Economically-imperative development seeking speedy interconnection

Manufacturing and industrial uses

Reshoring and new industrial facilities increase industrial load.

Electrification

Transportation and building electrification shift fuel demand to the grid.

Unprecedented Investment

Utilities plan to spend \$1.1 trillion from 2025 to 2029

Hyperscalers' capex exceeds \$700B in 2026 alone

PART 1

The Physical Grid

Dr. Liza Reed, Niskanen Center

The Physics of the Grid

Electricity behaves differently than other commodities

The physics are key

Electricity flows according to physical laws, not contracts

- Electrons follow the path of least resistance, which means power generated in one system can flow into another interconnected system.
- Operators can guide flows with controls and pricing but cannot force a specific route.
- Congestion or reliability challenges in one area can impact prices and reliability across a wide region.

Supply Must Meet Demand

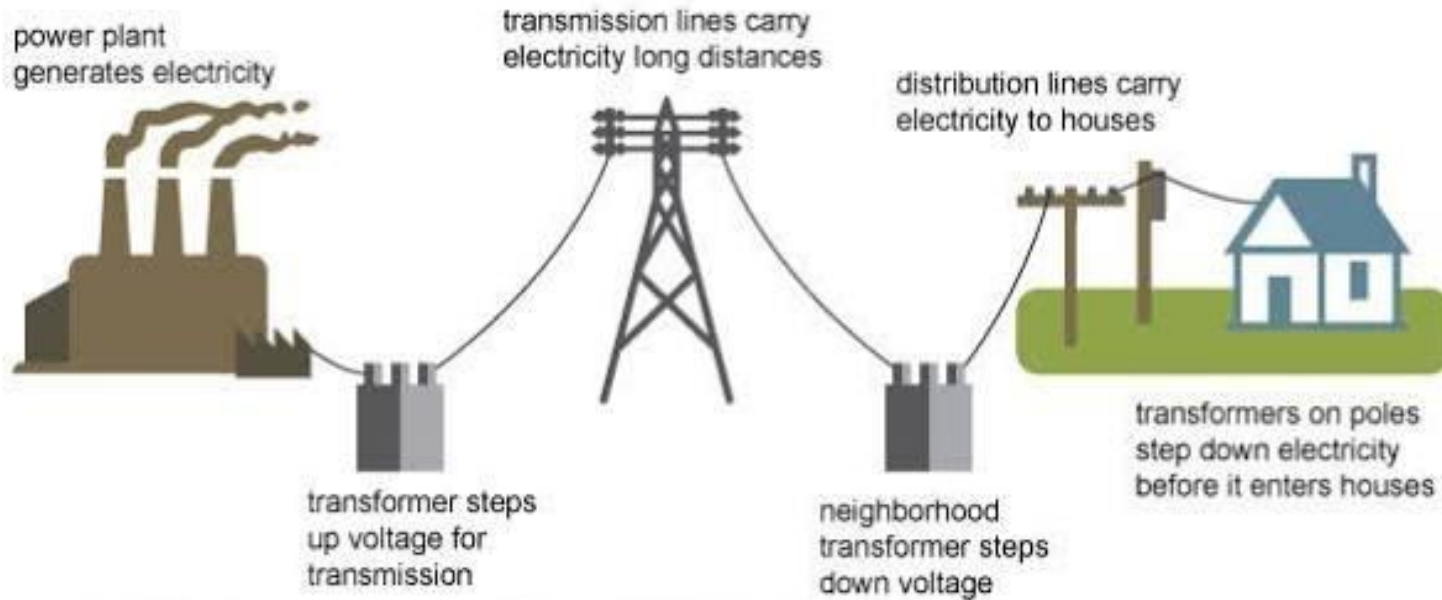
Mismatches create frequency and voltage problems

- The grid is balanced every second, 24/7/365.
- Frequency in North America is held at 60 Hz across each interconnection.
- Imbalances can reduce power quality, damage equipment, and trigger cascading outages.

Generation, Transmission, and Distribution

These three services move electricity to consumers and comprise the three primary cost components of the electricity service.

Electricity generation, transmission, and distribution



Source: Adapted from National Energy Education Development Project (public domain)

Types of Generation & Basic Profiles

Resources differ in how often they run, how fast they can respond, and whether they are dispatchable or weather-dependent.

Baseload

Runs continuously

Large plants designed to run many hours each year

- Nuclear
- Geothermal
- Hydroelectric
- Some natural gas combined cycle
- Coal

Intermediate

Ramps up and down daily

Considered *load following* with flexible operations:

- Natural gas combined cycle
- Battery energy storage

Peaking

Quick-start for highest demand

~999 peaker plants in the U.S. (2021), run less than 15% of hours

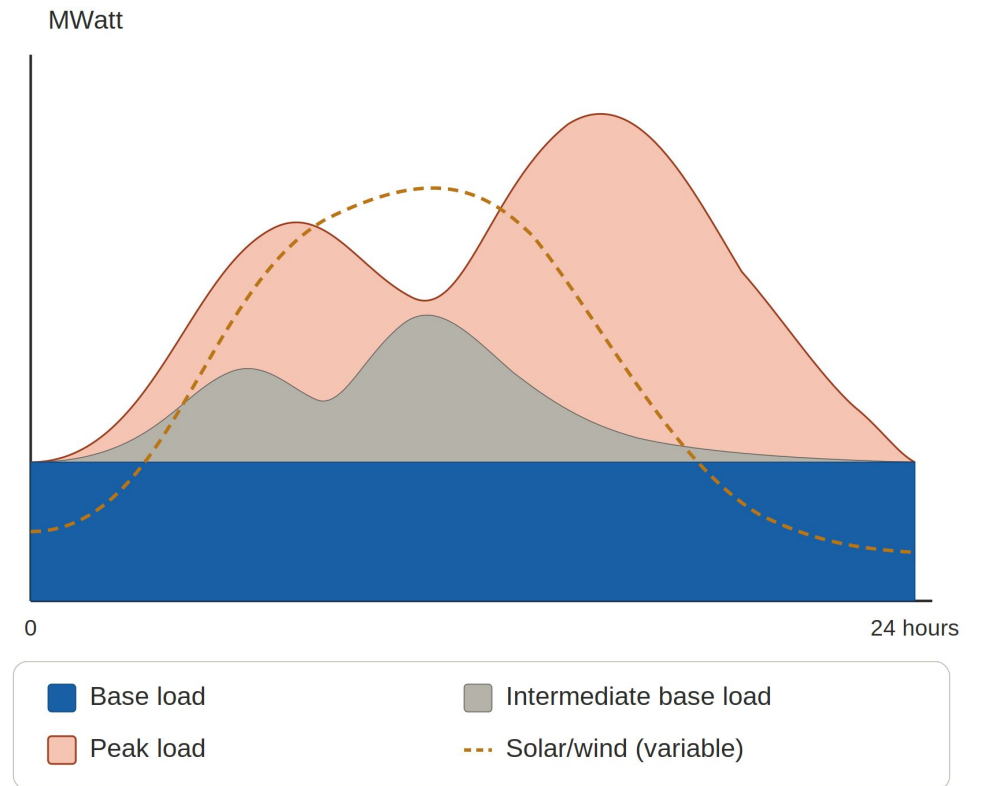
- Natural gas combustion turbines
- Oil and dual-fuel combustion plants
- Battery energy storage

Variable

Output depends on weather

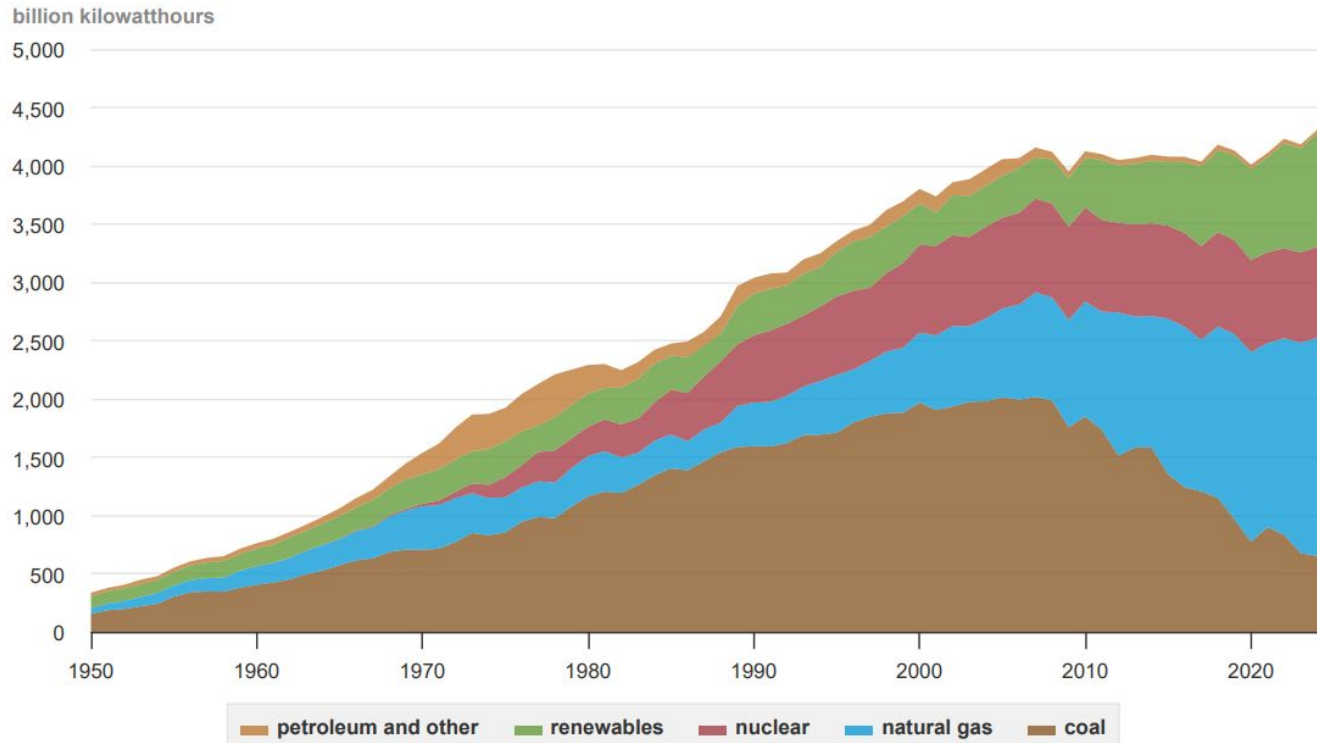
Intermittent resources with zero marginal cost. Can be paired with battery storage

- Onshore and offshore wind
- Solar



A Diverse Portfolio Powering the Nation

U.S. electricity generation by major energy source, 1950-2025



eia Data source: U.S. Energy Information Administration, *Monthly Energy Review*, March 2026, and *Electric Power Monthly*, January 2026, preliminary data for 2025
Note: Includes generation from power plants with at least 1 megawatt electric generation capacity.

Why Diversity Matters

Location, location, location

Different resources are better suited for different locations based on pipeline supply, wind and solar resource, and more.

Diversity manages risks

No single resource is immune to weather, fuel-supply, or market shocks.

Complementary attributes

Some energy resources are dispatchable, some are weather-dependent, and some are low-cost. Mixing attributes improves overall system reliability.

Resilience

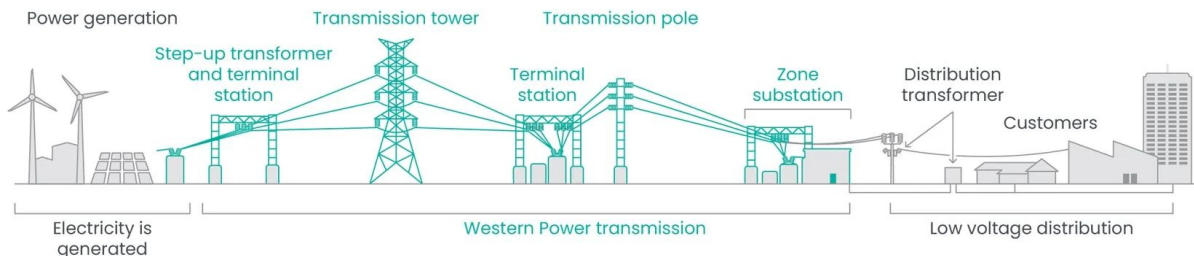
Diverse portfolios hedge against supply disruptions and price spikes.

Transmission: The Highway for Electrons

Transmission moves bulk power long distances at high voltage — minimizing losses and connecting generation to load

The categories of transmission lines:

1. **Local** transmission lines tend to be intrastate but high voltage (100+kV).
2. **Regional** lines connect generators to nearby load centers within a single planning region.
3. **Interregional** lines cross operator boundaries, enabling power to flow between regions during extreme weather events, supply shortfalls, or when one region has inexpensive surplus power that another region could use.



Scale of the System

- 600,000 circuit miles of transmission lines in the U.S., of which 240,000 miles are high-voltage.
- 70,000 substations move power between voltage levels.

What Is Congestion?

- When more power wants to flow on a line than capacity allows, operators must use more expensive generation.
- Congestion costs exceeded \$12B in 2024.

Why High Voltage?

- Higher voltage (500 kV+) dramatically reduces energy lost as heat.
- Voltage is stepped up at generators and stepped down at substations before reaching customers.

Distribution: The Last Mile

The low-voltage network that delivers power from local substations to homes, businesses, and industrial customers

What It Is

Voltage range:

4 kV to 35 kV, stepped down from transmission at local substations.

Hardware:

Poles, wires, transformers, switchgear, and increasingly smart meters.

Footprint:

Millions of miles of lines nationwide, mostly at street level.

Why It Matters

Where most outages happen

The vast majority of outages are due to distribution-system events.

Aging infrastructure

Much was built decades ago; utilities spend ~\$51B/year on distribution upgrades.

Evolving role

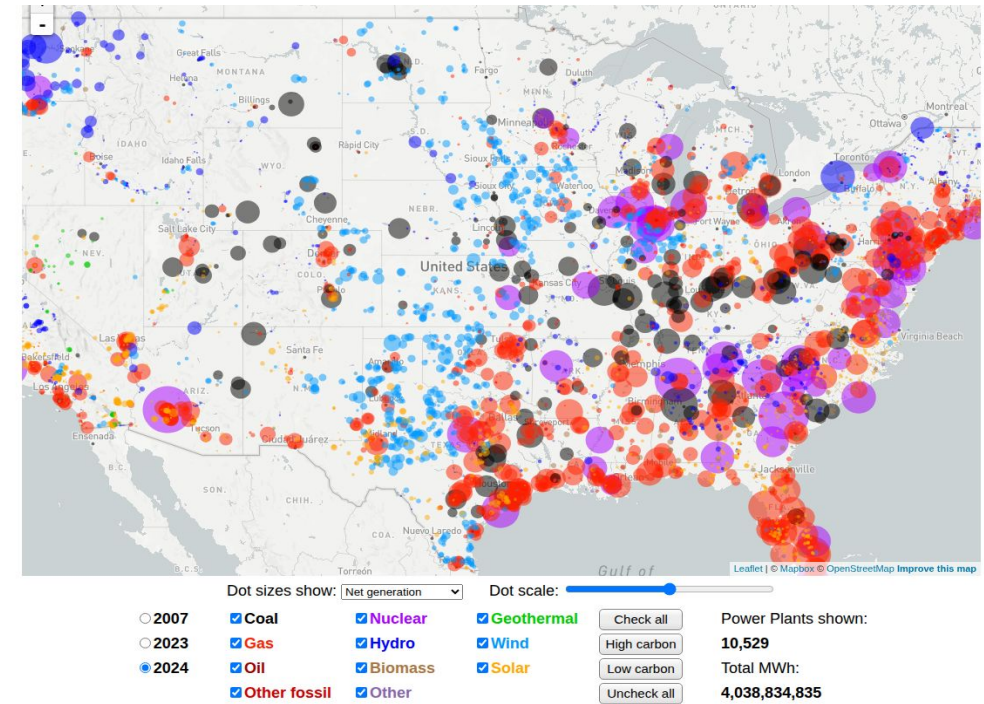
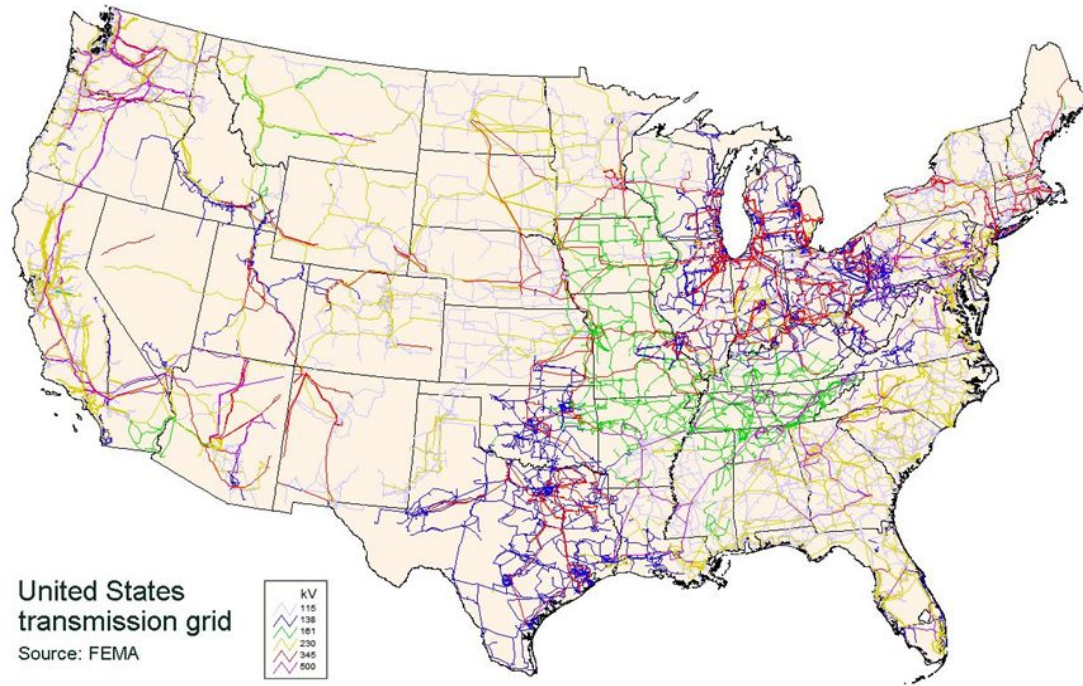
Rooftop solar, home-batteries, smart meters, and other distributed energy resources are changing the role distribution plays.



Source:
<https://texashistory.unt.edu/ark:/67531/metapth769678/>

Grid Regionalization Brings Benefits

The U.S. grid is tied together, but not efficiently. These maps illustrate that reality: transmission lines crisscross the country (Map 1), and generation resources of every type are distributed unevenly across regions (Map 2)



Why Regionalization Matters:

Generation Diversity: A larger and more diverse pool of resources for operators to call upon increases reliability and access to lower-cost resources

Load diversity: Peak demand occurs at different times across regions. A connected grid can serve all peaks using less total generation capacity than isolated systems require.

Weather diversity: Weather systems can vary within a region. A larger footprint creates an opportunity to potentially moderate generator or load stress from local weather

Source: EIA Electricity Maps (eia.gov/maps/); [Open Infrastructure Map](#)

Grid Infrastructure: Built for Peak Demand

The grid is sized for the worst hours of the year, which has big implications for utilization and costs

Sized for the Peak

The grid is designed to serve the peak demand, which occurs a handful of hours each year. The rest of the year, built infrastructure sits idle.

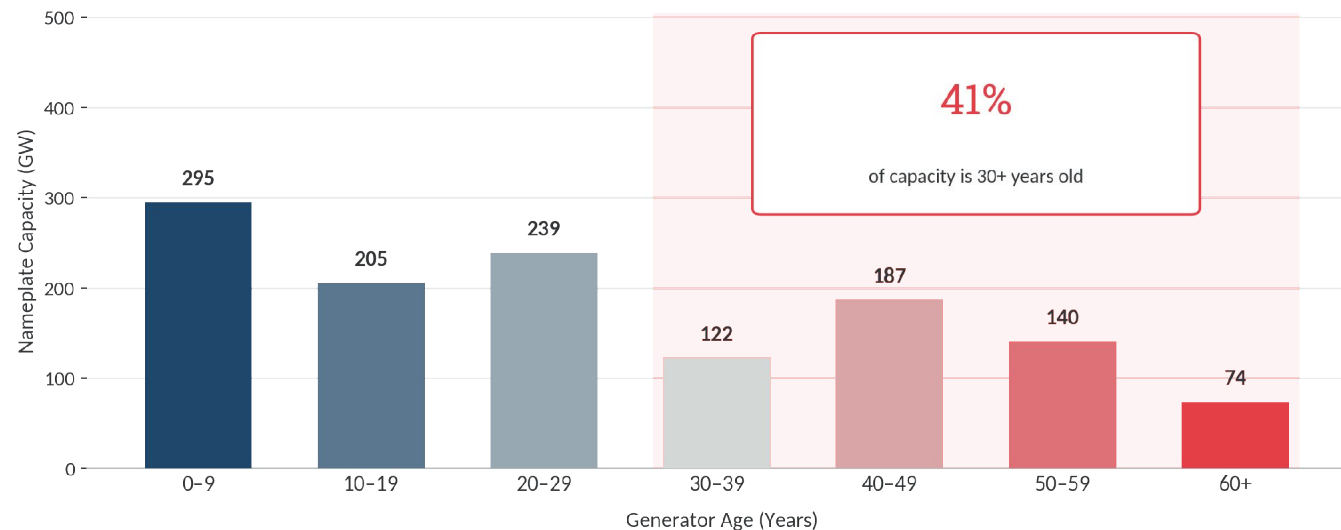
53%

Average generation capacity utilization rate,
2016-2024

\$11-17 billion/year

In customer savings with greater infrastructure utilization

An Aging Generator Fleet



From Physical Grid to Consumer Costs

Three categories of costs flow to electricity customers — and rate design and costs for each category vary significantly by region



GENERATION

This covers the cost of producing the electricity you use from traditional power plants and renewable sources. District residents can choose a licensed competitive electricity supplier, or they can receive default Standard Offer Service. **The DCPSC does not regulate these rates;** they are driven by regional wholesale market prices and the costs of meeting the city's Renewable Portfolio Standard (RPS) goals.

Source: District of Columbia Public Service Commission

TRANSMISSION

This covers the cost of moving high-voltage electricity from power generation plants across long distances to the local distribution system. Because this involves moving power across state lines, these transmission rates are regulated by the Federal Energy Regulatory Commission, rather than the DCPSC.

DISTRIBUTION*

This covers the cost of physically delivering electricity to your home, including local poles, wires, transformers, grid maintenance, and low-income customer assistance. **The DCPSC strictly regulates these charges.** Your utility cannot increase delivery rates without a rigorous technical and legal review process, known as a "rate case," approved by the DCPSC.

*includes certain surcharges

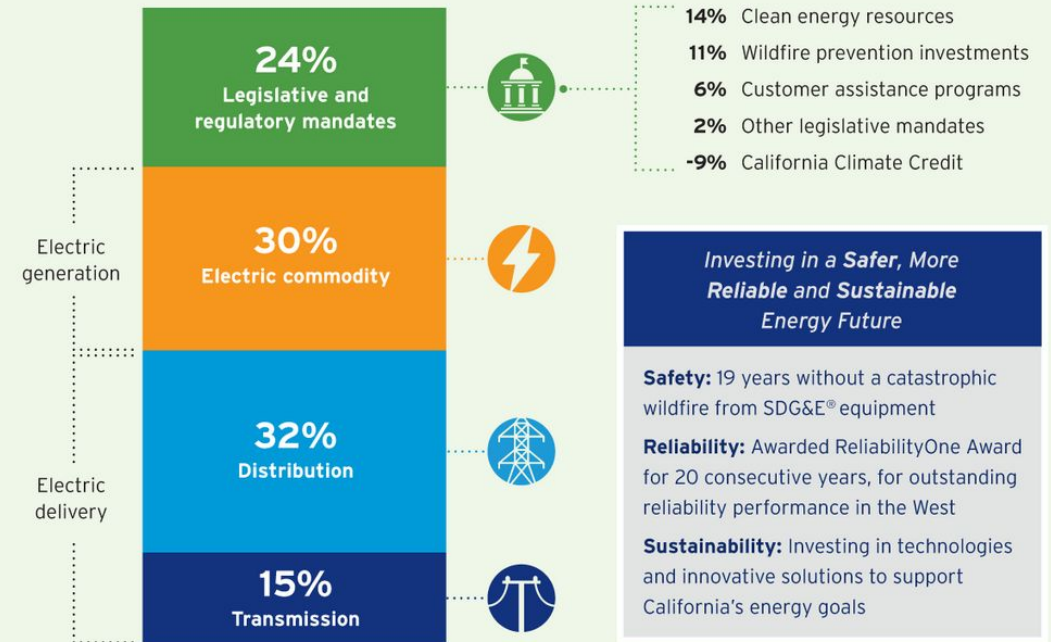
SURCHARGES & TAXES

These line items fund important initiatives, including energy efficiency programs, renewable energy sponsored programs, and critical underground infrastructure projects. They are mandated by a mix of different authorities, including the DC Council and the federal government.



Average residential bill breakdown⁵

More than half of SDG&E's residential bill for customers, where SDG&E provides both the electricity and the delivery, is driven by legislative mandates, regulatory requirements and commodity costs, which are passed through to customers with no markup.



⁵The average residential bill breakdown based on February 2025 bills.

Source: SDG&E

Key Design Choices

Fixed costs dominate

Most T&D costs are recovered even when customers use less.

Underutilization

Sizing for peaks spreads costs across fewer kWh.

Regional variation

States choose how to allocate costs across customer classes.

Q & A

The Physical Grid

PART 2

Who is in Charge of What?

*Devin Hartman: President,
Lighthouse Energy Institute*

State and Federal powers: the division of authority

The Federal Power Act (FPA), enacted in 1935, remains the primary statute governing the electric system establishes a clear division of power for regulating the energy system between state and federal regulators

Federal Energy Regulatory Commission

Wholesale sales and interstate transmission

The Federal Energy Regulatory Commission regulates the transmission of electricity in interstate commerce and its sale at wholesale (for resale). Those rates must be just, reasonable, and not unduly discriminatory.

State

Retail sales, generation investment, and local distribution

States regulate retail sales to end-use customers, local distribution systems, and the siting of generation and transmission facilities.

The public power carve-out

From rate authority, not reliability regulation

Public federal, state, and municipal utilities and rural electric cooperatives are largely exempt from FERC regulation under the FPA.

What “public utility” means

A defined legal term

Under the FPA, “public utility” is a defined term covering privately owned utilities that make interstate wholesale sales or transmit power; publicly owned utilities and cooperatives generally fall outside it.

Divided Jurisdiction

	Generation	Transmission	Distribution
States	• Site and permit power plants • Take more active roles in planning, determine which plants utilities build and recover their costs through retail rates	• Site and permit lines and grant eminent domain • Pass FERC-approved transmission costs through to retail bills	• Set retail rates, regulate costs and investments of the local poles-and-wires utility • Oversee local reliability and service
Federal	• Regulates wholesale power sales and the markets generators bid into • Oversees reliability standards for large plants	• Sets interstate transmission rates and requires open access • Sets transmission expansion planning requirements • Narrow siting authority • Oversees bulk-system reliability standards	• No authority

A Recent History of Key Decisions Shaping Federal Electric Rate Regulation

Pre-1978

State or municipal regulated monopolies

Utilities are recognized as natural monopolies. Regulators grant exclusive service territories under **cost-of-service regulation**.

1978

Public Utilities Regulatory Policies Act

After cost and overbuild challenges, PURPA requires utilities to buy from independent power producers, introducing competition in generation.

1992

Energy Policy Act

Congress affirms support for competition. FERC gains authority to order transmission "wheeling" at just and reasonable rates.

1996 + 1999

FERC Orders 888 and 2000

To combat rising costs, FERC requires utilities to separate generation and transmission functions, granting open-access to transmission and defining regional wholesale power markets

2005

Energy Policy Act of 2005

Authorized mandatory reliability standards and also put in place the authority for backstop siting of transmission

Cost of Service Regulation

A utility's local regulators determine what revenue it needs to recover its costs and make a fair return to attract investment, balancing the commercial needs of the utility with the public interest. Electric rates are determined using this regulatory process.

In return, utilities have a duty to serve new customers in their territory in accordance with the regulator's oversight.

Investor-Owned Utilities (IOUs)

What are they?

- Private, share-holder owned utilities providing electric service to a majority of the nation
- Public utility regulation balances their profit motive with public interest

Earning returns

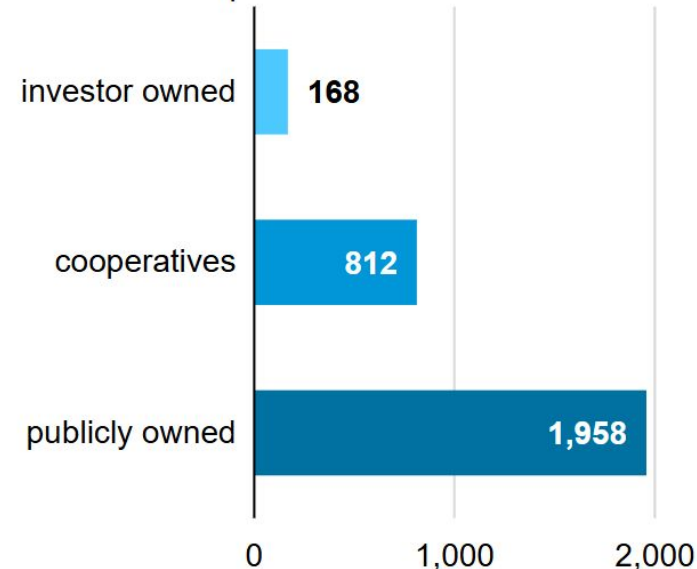
- Under cost of service regulation, IOUs earn a regulated rate of return on their investments and have a duty to serve new customers in their territory.
- In exchange, they are the sole provider in that territory.

Operating across jurisdictions

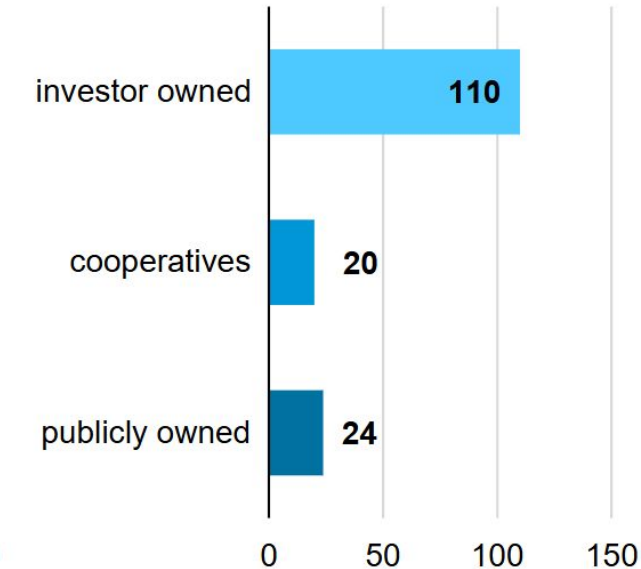
- IOUs are regulated by states on retail rates and distribution; generation depending on the state's approach
- Those same IOUs may own transmission, whose rates and regulation is overseen by FERC.

U.S. electric utilities by ownership type (2017)

number of companies



million customers



Source: U.S. Energy Information Administration, [Annual Electric Power Industry Report](#)

Public Power

While investor-owned utilities serve a majority of customers, public-power entities serve large portions of rural America and many large cities

Counties served by U.S. utilities, by type of ownership (2017)



Municipal Utilities

~2,000 in the U.S.

Owned and operated by cities or towns. Serve communities of all sizes — from Los Angeles to small townships. Governed by local officials and citizens.

Federal Power Marketers

Four federal agencies

BPA, WAPA, SWPA, SEPA. Market electricity from federal hydroelectric projects, primarily to public-power and cooperative customers.

Electric Cooperatives

~900 in the U.S.

Member-owned, nonprofit utilities. Concentrated in rural areas. Together they serve 42 million people across 88% of U.S. counties.

State Actors

States hold primary authority over retail rates, distribution, and most siting and permitting decisions in

Public Utility Commissions (PUCs)

PUCs set retail electricity rates for utilities in their jurisdiction. They may require an **integrated resource planning** process and approve grid expansion plans.

PUCs balance the commercial needs of the publicly regulated utility with the public interest.

State Legislatures

State legislatures have significant leeway to implement carbon and clean energy goals, often in the form of Renewable Portfolio Standards, or establish a number of other grid-related policies.

State Energy Offices

Shape energy policy by translating legislative directives and governors' goals into actionable programs

Consumer Advocates

Independent state offices that represent ratepayers in PUC proceedings, often advocating for affordable rates and adequate service.

Governors

Governors play a role in establishing state priorities and establishing the tone for the year's legislative sessions. Additionally, many state governors appoint Commissioners to the PUCs.

Environmental Agencies

Environmental agencies share responsibilities with PUCs for siting and permitting new grid infrastructure, including interstate transmission.

Federal Actors

Federal agencies and grid operators set wholesale market rules, reliability standards, and environmental requirements for the bulk power system

FERC

FERC regulates wholesale electricity markets and interstate transmission rates, and oversees reliability frameworks

FERC also oversees the RTOs/ISOs and approves their tariffs and market rules.

RTOs / ISOs

Regional Transmission Organizations and **Independent System Operators** operate the transmission grid and run competitive wholesale energy and capacity markets across most of the country.

They dispatch generation in real time, manage interconnection queues, and plan regional transmission expansion.

NERC

The **North American Electric Reliability Corporation** develops and enforces mandatory reliability standards for the entire bulk power system across the U.S., Canada, and part of Mexico.

NERC operates under FERC oversight and applies to any system user.

Federal Agencies: DOE & EPA

EPA sets air, water, and waste standards for power plants under the Clean Air Act and related statutes.

DOE funds grid R&D, administers loan and grant programs, and can order emergency actions to preserve reliability under FPA Section 202(c).

The Role of Congress

Congress shapes the rules of the road — and the federal-state balance — through statute, oversight, and the power of the purse

Statute

Establishes legal frameworks: Federal Power Act, PURPA, Energy Policy Act, IJJA.

Appropriations

Funds DOE programs, ARPA-E, national labs, and grid demonstration projects.

Oversight

Holds hearings on FERC, NERC, DOE, and grid reliability.

Tax Policy

Authorizes production and investment tax credits that shape generation choices.

Federalism

Decides where federal authority ends and state authority begins — especially on siting and permitting.

Trade & Supply Chains

Sets tariffs and trade policy affecting transformers, components, and critical minerals.

Q & A

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Join us next time

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