

MARYLAND DATA CENTERS ANALYSIS GROUP

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THE BASICS OF ELECTRICITY & RATES

This news brief is the first of a two-part series looking at the fundamentals of electricity generation, transportation, and rate structure. This first brief presents the basics of generation and transportation. The second brief will explore what drives the expected increase in electricity rates in the State of Maryland.

Electricity Generation and the Grid

Electricity is generated from a variety of sources – fossil fuels, nuclear energy, and renewables (from geothermal to flowing water). Based on their characteristics, these sources are deployed to meet specific load requirements. Load is the demand placed on the system by various forms of end-use (from household appliances to industrial processing) and is categorized by three primary types:

- *Base load*, or constant, minimum demand, comes from sources such as nuclear power plants, large coal-fired power plants, hydroelectric dams and geothermal power plants. These plants run continuously and always provide the minimum amount of electricity necessary for grid operation.
- *Intermediate load*, or fluctuating demand, uses combined-cycle natural gas and some renewables such as hydroelectric power plants (curtailing output when demand is low). These plants can adjust their output to match the predictable fluctuation in demand between base load and peak load.
- *Peak load plants* start up quickly to meet the high demand during peak hours. They are designed for fast ramp-up and shut-down but are more expensive to operate. They use things like simple-cycle gas turbines, reciprocating internal combustion engines (often diesel) and pumped storage hydropower.

The grid must maintain a precise balance between generation and the entire demand of the system including transportation losses.

Fossil fuels were the primary energy source powering industrialization. Large-scale factories and longer distance travel became the key drivers to economic expansion. As a result, a significant portion of the world's electricity generation system today still relies on coal, oil, and natural gas for base and intermediate load requirements. With the ever-growing increase in demand for electricity, we face a conundrum. We know that fossil fuels pose a threat to health and the environment and they produce greenhouse gas emissions. Because of the environmental consequences of fossil fuels, industry and regulators are reevaluating energy sources and aim to shift

CONTACT

Elizabeth Bauer/
Faith H. Klareich
Editorial Board Members
mdanalysisgroup@gmail.com
(240)-558-8899

ABOUT DCAG-MD

Bringing verifiable information sources to counties around the state for community groups, local governments, and other interested parties.

SOURCES

United States Energy Information Administration

PJM – Capacity Market

FORBES MAGAZINE, Why Your Electricity Bill May Be Skyrocketing, August 17, 2025
By Robert Rapier

Library of Congress, Electricity-Overview and Issues for Congress

U.S. Department of Energy

dependence away from fossil fuels toward other sources to mitigate the impact (Federal energy policy is currently shifting to restore energy dominance and refocus on traditional energy resources).

The national power grid is a complex, interrelated system designed to deliver electricity from producers to consumers. This system consists of power plants, transmission lines, substations, and distribution lines which are owned and operated by investor-owned utilities, Federal government, publicly owned utilities, public power agencies, rural electric cooperatives, and municipalities. As a result, these entities find themselves operating under different regulatory regimes.

In the United States, there are seven Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs) that manage and oversee the electric grid for the country. Their role is to coordinate, control, and monitor the flow of electricity across wide geographic areas to ensure there is a reliable power supply. In Maryland, Pennsylvania-New Jersey-Maryland Interconnection (PJM) manages the mid-Atlantic region and parts of the Midwest.

Electric rates are sensitive to electricity-driven emerging technologies, resource price hikes, modernization of grid technology including resilience adoption, and generation transitions. Certain of these drivers are pushing demand to record levels. The unprecedented growth of data centers in the United States is creating challenges for the aging grid infrastructure. The impact of data centers is putting pressure on both the generation of electricity, but also the transmission and distribution. Construction of this infrastructure cannot happen fast enough in certain parts of the country.

How Does the Power Grid Work?

Power plants as described above generate electricity using a variety of energy sources such as fossil fuels, nuclear energy, and renewables like solar, wind and hydroelectric power.

Transmission lines connect to the power plant and carry electricity to sub-stations via high-voltage transmission lines. These lines are the backbone of the electric grid.

Distribution lines are the last step in the flow. When the high-voltage transmission lines reach the substation, the voltage is stepped down to a safer level through transformers. The distribution lines transmit electricity to the consumer.

How Is the grid regulated?

While state or local governments primarily regulate electricity, federal authorities also provide oversight. The following is an overview of how each level regulates the industry.

Federal Regulation

- The Federal Energy Regulatory Commission (FERC) regulates the interstate transmission of electricity, natural gas, oil, and the oversight of hydropower production. All these activities have implications for the ultimate price of

electricity. These regulatory activities have an impact on resale in interstate commerce, rates for transmission service across state lines and the reliability of many parts of the generation and transmission systems.

- North American Electric Reliability Corporation (NERC) ensures the reliability and security of the bulk power system and develops reliability standards.

State Regulation

- Public Utility Commissions (PUCs)/Public Service Commissions (PSCs) regulate electric utilities within a state; they set and approve rate categories and establish specific pricing structures. They also approve infrastructure projects.
- State Energy Offices and Environmental Agencies promote energy efficiency, renewable energy, and emission reductions. They develop state-specific energy policies.

Local Regulation

- Local municipalities and Cooperatives own and operate electric utilities, regulated by local governments which set rates and policies.

This multilayered regulatory system ensures the reliability, safety and accessibility of the grid and addresses environmental concerns.

What trends are impacting rates?

Hyperscale Data Centers

As the demand for Artificial Intelligence (AI) increases, so does the demand for more hyperscale data centers. “These facilities are energy-intensive, often consuming thirty (30) times more electricity than traditional data centers. A single AI center can draw as much power as 80,000 homes, and by 2030, data centers are projected to require 30 GW of new capacity—the equivalent of thirty (30) nuclear reactors” per Forbes Magazine,

Aging Infrastructure

The aging infrastructure is struggling to meet modern electricity demands and bring in new sources of generation such as renewable energy. More than 70% of the transmission lines in the U.S. are over 25 years old and are approaching the end of their typical lifecycle. The result could have major consequences such as power outages, susceptibility to cyber-attacks or community emergencies created by the faulty grid infrastructure. The grid languished for many years and the failure in forecasting future demands has left the country racing for a solution.

How are electric rates determined?

Electricity bills are comprised of generation (also called capacity), transmission, and regulatory costs (see discussion above). “The costs of the ‘energy’ and ‘capacity’ markets, plus transmission costs (discussed below), are the three principal components of wholesale electric costs borne by electric customers, with energy markets making up the largest portion of those costs.

Capacity

The 'capacity' market, called the Reliability Pricing Model, ensures long-term grid reliability. It does so by securing the appropriate amount of power supply resources needed to meet the predicted energy demand. Each year, PJM holds a forward-looking auction to purchase capacity from generators willing to guarantee availability three years in advance.

Each year, PJM conducts a capacity auction which is designed to secure the power supply resources needed to meet predicted energy demand for three years into the future. This is crucial for maintaining grid reliability and for ensuring there are enough resources to meet the future demand. Understanding the auction process is essential for large industrial and commercial consumers to manage their energy costs effectively and ensure reliability during peak demand periods. The auction sets pricing into the future.

Transmission

Transmission costs refer to the charges associated with the transmission of electricity. Most of these costs are borne by wholesale customers who purchase transmission services from PJM to move electricity over the transmission lines, after which the power is resold to consumers.

Summary

The growth in data centers is pushing the industry to make rapid investments in modernizing the entire system – from replacement of retiring baseload power plants to building more transmission lines and substations, these costs get passed along to ratepayers. The nation faces these challenges, but Maryland as an importer of electricity with a growing data center industry is under substantial pressure to solve for a reliable flow of electricity to meet all the needs of its citizenry.