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Electricity explained

Electricity generation, capacity, and sales in the United States

Three terms are important to understand when learning about electricity production and consumption:

- *Generation* is a measure of electricity produced over time. Most electric power plants use some of the electricity they produce to operate the power plant.
- *Capacity* is the maximum level of electric power (electricity) that a power plant can supply at a specific point in time under certain conditions.
- *Sales* are the amount of electricity sold to customers over a period of time, and they account for most of U.S. electricity consumption.

More electricity is generated than sold, because some energy is lost (as heat) in transmission and distribution of electricity. In addition, some electricity consumers generate electricity and use most or all of it, and the amount they use is called *direct use*. These consumers include industrial, manufacturing, commercial, and institutional facilities, as well as homeowners who have their own electricity generators. The United States also exports and imports some electricity to and from Canada and Mexico. Total U.S. electricity consumption by end-use consumers is equal to U.S. retail sales of electricity plus direct use of electricity.

The U.S. Energy Information Administration (EIA) publishes data on two general types of electricity generation and electricity generating capacity:

- *Utility scale* includes electricity generation and capacity of generating units (generators) located at power plants with at least one megawatt (MW) of total electricity generating capacity.
- *Small scale* includes generators with less than 1 MW of generating capacity that are usually at or near where the electricity is consumed. Most solar photovoltaic systems installed on building rooftops are small-scale systems.

did you know?

A standard unit for measuring electricity is the

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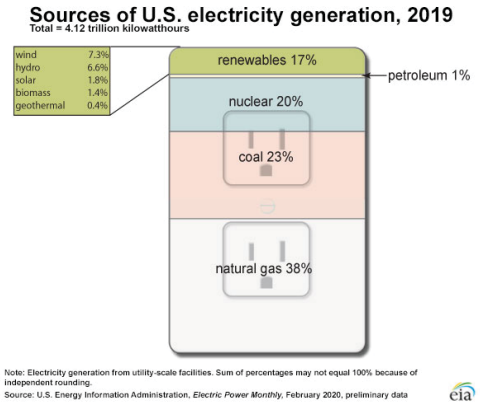
kilowatt (kW), which is equal to 1,000 Watts. A Watt is a measure of energy named after the Scottish engineer James Watt. One kW of electricity generated or used over the course of one hour is a kilowatthour (kWh). Other units for measuring electricity capacity and electricity generation and consumption are

- Megawatt (MW) = 1,000 kW; megawatthour (MWh) = 1,000 kWh
- Gigawatt (GW) = 1,000 MW; gigawatthour (GWH) = 1,000 MWh



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Electricity generation

In 2019, net generation of electricity from utility-scale generators in the United States was about 4.1 trillion kilowatthours (kWh). EIA estimates that an additional 35 billion kWh (or about 0.04 trillion kWh) were from small-scale solar photovoltaic (PV) systems, most of which was direct use.

In 2019, about 63% of U.S. utility-scale electricity generation was produced from fossil fuels (coal, natural gas, and petroleum), about 20% was from nuclear energy, and about 17% was from renewable energy sources.

The shares of utility-scale electricity generation by major energy sources in 2019 were

natural gas 38%

coal 23%

nuclear 20%

renewables (total) 17%

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U.S. energy facts

Use of energy

Renewable energy types and usages

Frequently asked questions

What is the difference between electricity generation capacity and electricity generation?

Does EIA have data on each power plant in the United States?

Does EIA publish the location of electric power plants and transmission lines?

How much electricity is lost in electricity transmission and distribution in the United States?

- nonhydroelectric renewables **10%**
- hydroelectric **7%**

petroleum and other 1%

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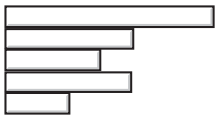

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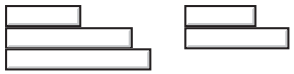

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Electricity generating capacity

To ensure a steady supply of electricity to consumers, operators of the electric power system, or *grid*, call on electric power plants to produce and place the right amount of electricity on the grid at every moment to instantaneously meet and balance electricity demand.

In general, power plants do not generate electricity at their full capacities at every hour of the day. Three major types of generating units vary by intended usage:

- *Base load generating units* normally supply all or part of the minimum, or base, demand (load) on the electric power grid. A base load generating unit runs continuously, producing electricity at a nearly constant rate throughout most of the day. Nuclear power plants generally operate as base load service, because of their low fuel costs and the technical limitations on load responsive operation. Geothermal and biomass units are also often operated in base load because of their low fuel costs. Many of the large hydro facilities, several coal plants, and an increasing number of natural gas-fired generators, particularly those in combined power applications, also supply base load power.
- *Peak load generating units* help to meet electricity demand when demand is at its highest, or peak, such as in late afternoon and as when electricity use for air conditioning and heating increases during hot weather and cold weather respectively. These so-called *peaking units* are generally natural gas or petroleum fueled generators. In general, these generators are relatively inefficient and are costly to operate, but provide high- value service during peak demand periods. In some cases, pumped storage hydropower and conventional hydropower units also support grid operations by providing power during periods of peak demand.
- *Intermediate load generating units* comprise the largest generating sector and provide load responsive operation between base load and peaking service. The demand profile varies over time and intermediate sources are in general technically and economically suited for following changes in load. Many energy sources and technologies are used in intermediate operation. Natural gas-fired combined cycle units, which currently provide more generation than any other technology, generally operate as intermediate sources.

Additional categories of electricity generators include

- *Intermittent renewable resource generators* powered by wind and solar energy that generate electricity only when these resources are available (i.e., when it's windy or sunny). When these generators are operating, they tend to reduce the amount of electricity required from other generators to supply the electric power grid.
- *Electricity storage systems/facilities*, including hydroelectric pumped storage, solar-thermal storage , batteries, flywheels, and compressed air systems . These systems typically use (or purchase) and store electricity that is generated during off-peak electricity demand periods (when electricity prices are relatively low), and they provide (or sell) the stored electricity during periods of high or peak electricity demand (when electricity prices are relatively high). Some facilities use electricity produced with intermittent renewable energy sources (wind and solar) when the renewable resource availability is high and provide the stored electricity when the renewable energy resource is low or unavailable. Nonhydro storage systems can also provide ancillary services to the electric power grid. Energy storage

applications inherently use more electricity than they provide. Pumped-storage hydro systems use more electricity to pump water to water storage reservoirs than they produce with the stored water, and nonhydro storage systems have energy conversion and storage losses. Therefore electricity storage facilities have net negative electricity generation balances. *Gross generation* provides a better indicator about the activity level of storage technologies and is provided in the data releases of the EIA-923 Power Plant Operations Report.

- *Distributed* generators are connected to the electricity grid, but they primarily supply some or all of the electricity demand of individual buildings or facilities. Sometimes, these systems may generate more electricity than the facility consumes, in which case the surplus electricity is sent to the grid. Most small-scale solar photovoltaic systems are distributed generators.

At the end of 2019, the United States had about 1,100,546 MW—or 1.1 billion kilowatts (kW)—of total utility-scale electricity generating capacity and about 23 million kW of small-scale solar photovoltaic electricity generating capacity.

Generating units fueled primarily with natural gas account for the largest share of utility-scale electricity generating capacity in the United States.

The shares of utility-scale electricity generating capacity by primary energy source in 2019 were

natural gas 43%

coal 21%

renewables (total) 24%

- nonhydroelectric **14%**
- hydroelectric **9%**

nuclear 9%

petroleum 3%

other sources 0.5%

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natural gas hydrocoal renewable hydroelectric petroleum nuclear and other

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did you know?

There are three categories of electricity generating capacity. *Nameplate capacity*, determined by the generator's manufacturer, is the generating unit's maximum output of electricity without exceeding specified thermal limits. *Net summer capacity* and *net winter capacity* are the maximum instantaneous electricity load a generator can support during the summer or winter, respectively. These values may differ because of seasonal variations in the temperature of generator cooling fluid (water or ambient air). EIA reports electric generation capacity as net summer capacity in most of its electricity data reports.

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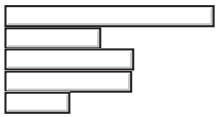

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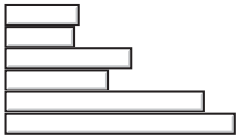

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Energy sources for U.S. electricity generation

The mix of energy sources for U.S. electricity generation in the United States has changed over time, especially in recent years. Natural gas and renewable energy sources account for an increasing share of U.S. electricity generation, while coal-fired electricity generation has declined. In 1990, coal-fired power plants accounted for about 42% of total U.S. utility-scale electricity generating capacity and about 52% of total electricity generation. By the end of 2019, coal's share of electricity generating capacity was at 21% and coal accounted for 23% of total utility-scale electricity generation. During the same period, the share of natural gas-fired electricity generating capacity increased from 17% in 1990 to 43% in 2019, and its share of electricity generation more than tripled from 12% in 1990 to 38% in 2019.

Most U.S. nuclear and hydropower plants were built before 1990. Nuclear energy's share of total U.S. electricity generation has held steady at about 20% since 1990. Electricity generation from hydropower, historically the largest source of total annual utility-scale renewable electricity generation (until 2019), fluctuates from year to year because of precipitation patterns.

Total U.S. electricity generation from nonhydro renewables is increasing

Renewable electricity generation from sources other than hydropower has steadily increased in recent years, mainly because of additions to wind and solar generating capacity. Since 2014, total annual electricity generation from utility-scale nonhydro renewable sources has been greater than hydropower generation.

Wind energy's share of total utility-scale electricity generating capacity in the United States grew from 0.2% in 1990 to about 9% in 2019, and its share of total annual utility-scale electricity generation grew from less than 1% in 1990 to about 7% in 2019.

Although relatively small in terms of its share of total U.S. electricity capacity and generation, solar electricity generating capacity and generation have grown significantly in recent years. Utility-scale solar electricity generating capacity rose from about 314 MW—or 314,000 kW—in 1990 to about 37,329 MW (or 37 million kW) at the end of 2019, of which about 95% was solar photovoltaic systems and 5% was solar thermal-electric systems. Solar energy's share of total U.S. utility-scale electricity generation in 2019 was about 1.8%, up from less than 0.1% in 1990. In addition, EIA estimates that at the end of 2019, there were 23,211 MW of small-scale solar photovoltaic generating capacity, and electricity generation from small-scale photovoltaic systems totaled was about 35 billion kWh.

did you know?

The number of small-scale distributed solar photovoltaic (PV) systems, such as those found on the roofs of buildings, has grown significantly in the United States during the past several years. Estimates of small-scale solar PV capacity and generation by state and sector are included in the *Electric Power Monthly*. As of the end of 2019, almost 40% of total U.S. small-scale solar PV electricity generating capacity was in California.

Various factors influence the mix of energy sources for electricity generation

The major factors that have contributed to changes in the U.S. electricity generation mix in recent years include

- A decline in natural gas prices
- State requirements to use more renewable energy sources
- Availability of government and other financial incentives for building new renewable capacity
- Federal air pollution emission regulations for power plants
- Slowing electricity demand

The declining price of natural gas has been a major factor in the rise in natural gas-fired electricity generation and the decline in coal-fired electricity generation since 2008. When natural gas prices are relatively low, high-efficiency, natural gas-fired combined-cycle generators can supply electricity at a lower cost than coal-fired generators. Coal-fired power plants then operate less often and earn less revenue, which decreases their profitability and reduces the incentive to invest in new coal-fired generating capacity. Sustained low natural gas prices encourage development of new natural-gas fired capacity. Unlike coal-fired generators, natural gas-fired generators

- Can be added in smaller increments to meet grid generating capacity requirements
- Can respond more quickly to changes in hourly electricity demand
- Generally have lower compliance costs with environmental regulations

Retail electricity sales

U.S. retail electricity sales to end-use customers totaled about 3,750 billion kWh—or 3.7 trillion kWh—in 2019, a decrease of about 111 billion kWh from 2018. Retail sales include net imports (imports minus exports) of electricity from Canada and Mexico.

The sales of electricity to major types of U.S. retail customers and shares of total sales in 2019 were

residential ***1,435 billion kWh*** 38%

commercial ***1,355 billion kWh*** 36%

industrial ***952 billion kWh*** 25%

transportation ***8 billion kWh*** 0.2%

Created with Highcharts 7.1.2billion kilowatthoursChart context menuU.S. retail sales of electricity to major end-use sectors, 2019residentialcommercialindustrial03006009001,2001,5001,800Note: Sales to transportation sector equal 7.7 billion kilowatthours.Source: U.S. Energy Information Administration, Electric Power Monthly, Table 5.1, February 2020, preliminary data

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Who sells electricity?

Four major types of electricity providers sell electricity to end-use consumers.

The shares of electricity sales by type of provider in 2018 were

- investor-owned utilities 57%
- power marketers 15%
- federal, state, and local utilities 16%
- electric cooperatives 12%

About 1% of electricity sales in 2018 were by other types of providers. In addition to sales to end-use customers, electricity is also often traded on wholesale markets or through bilateral contracts.

Last updated: March 19, 2020

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Washington, DC 20585