Electricity Generation

Overview of Electricity

Electricity—or electrical energy—is moving electrons. We depend on electricity for many tasks in today's world.

Electricity provides energy to lights so we can see at night.

Electricity runs our heating and cooling systems so we can be comfortable in our homes.

Electricity powers our electronics so we can work, communicate, and be entertained.

Electricity is a secondary energy source. We generate electricity by harnessing energy from other sources and converting it.

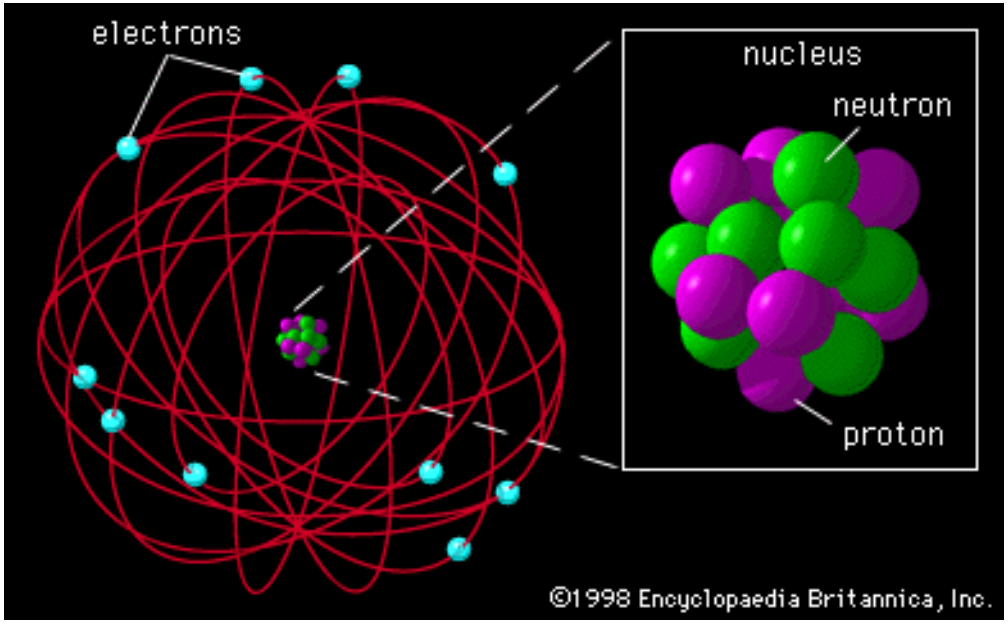
Coal power plants convert heat from burning coal into electricity.

Nuclear power plants convert heat from nuclear fission into electricity.

Photovoltaic cells and solar power plants convert sunlight into electricity.

The Basics of Electricity

All matter is made up of atoms. They are the building blocks that create everything in the universe. When electrons move between atoms – that's electricity.

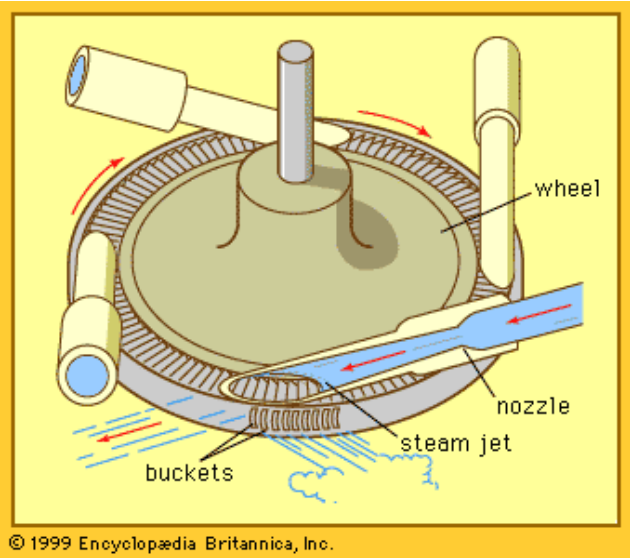


An atom is made up of even smaller particles. The atom's nucleus contains protons and neutrons. Protons have a positive charge and neutrons are neutral. Orbiting the nucleus are negatively charged electrons. Due to their opposite charges, protons and electrons attract each other, but a limited number of electrons can only fit into certain **orbits**, or **energy levels**. So, the electrons cannot just fall into the protons and make neutrons but must remain in a shell around the nucleus. In conductive materials such as metals, the electrons in the outer shell are weakly bound and can easily move between atoms. When an electric field is applied, the electrons move. The moving electrons are electricity that can be channelled in a wire to drive motors, light bulbs, etc.

Generating Electricity: Turbine and Generator

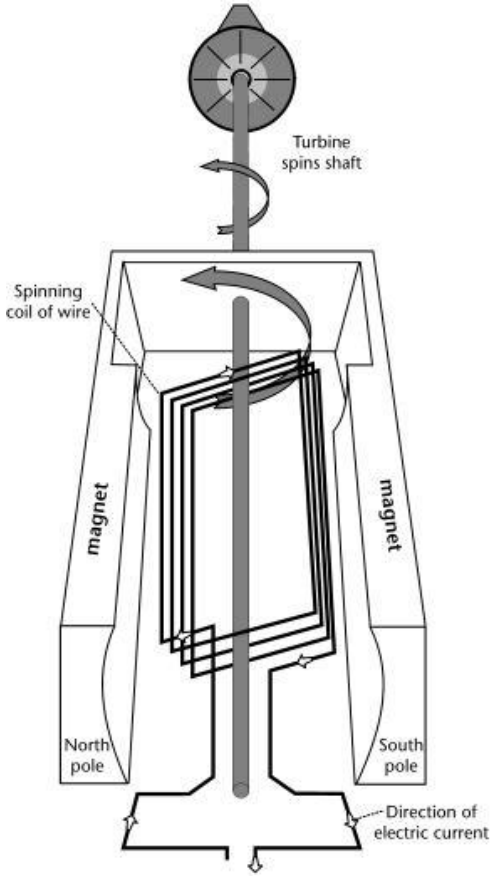
In order to get the electrons to move between atoms and generate electricity, some type of energy needs to be harnessed and applied to the electrons. A turbine harnesses the kinetic energy; a generator applies it to electrons.

Turbine



Power plants generate electricity by harnessing energy with turbines. Fluid or air flow can be used to turn a turbine. In the case of a hydroelectric facility, water flow turns the turbine. At a wind farm, wind turns turbines. But at most power plants, the energy source—like coal or nuclear fission—provides heat which is converted into steam to turn the turbine.

Generator



As the turbine rotates, that energy is used by the generator to spin the shaft. The shaft is attached to a series of wire coils. As the coils move past the magnet, the magnetic force moves the electrons and creates an electric current, or electricity. The current in the wire can then be transmitted to people who need to use the electricity.

Generating Electricity: Power Plants

Not all power plants are created equal. Different types of power plants harness different types of energy. The type of energy harnessed determines how much electricity a generator can output. A megawatt (MW) is equal to one million watts.

Type of Energy	NUCLEAR	COAL	HYDROELECTRIC (Pumped Storage)	NATURAL GAS	WIND	HYDROELECTRIC (Conventional)	WOOD	GEOTHERMAL	SOLAR
Average Electricity Output per Generator	977 MW	217 MW	144 MW	75 MW	49 MW	19 MW	19 MW	9.5 MW	5.5 MW

Power plants may have one generator or multiple generators.
The type of energy used plus the number of generators determines how much electricity a power plant can output.

According to the chart above, a nuclear power generator produces the most electricity by a sizable margin. A small nuclear plant with one generator may produce only 476 MW however a large plant with multiple generators might output 3,825 MW. This is because the nuclear, or “strong” force, is the most powerful kind of energy.

One of the most promising types of sustainable energy resources is wind. Extremely large wind farms can produce over 700 MW however the majority of sizable farms only produce 100-200 MW.

Measuring Electricity: What's a Watt?

The watt is a unit of power, but what can one watt do?

Watt

Regular incandescent light bulbs require about 25 to 100 watts. More energy-efficient light bulbs require fewer watts to provide similar light. A compact fluorescent bulb needs just a few watts to light up.

Kilowatt

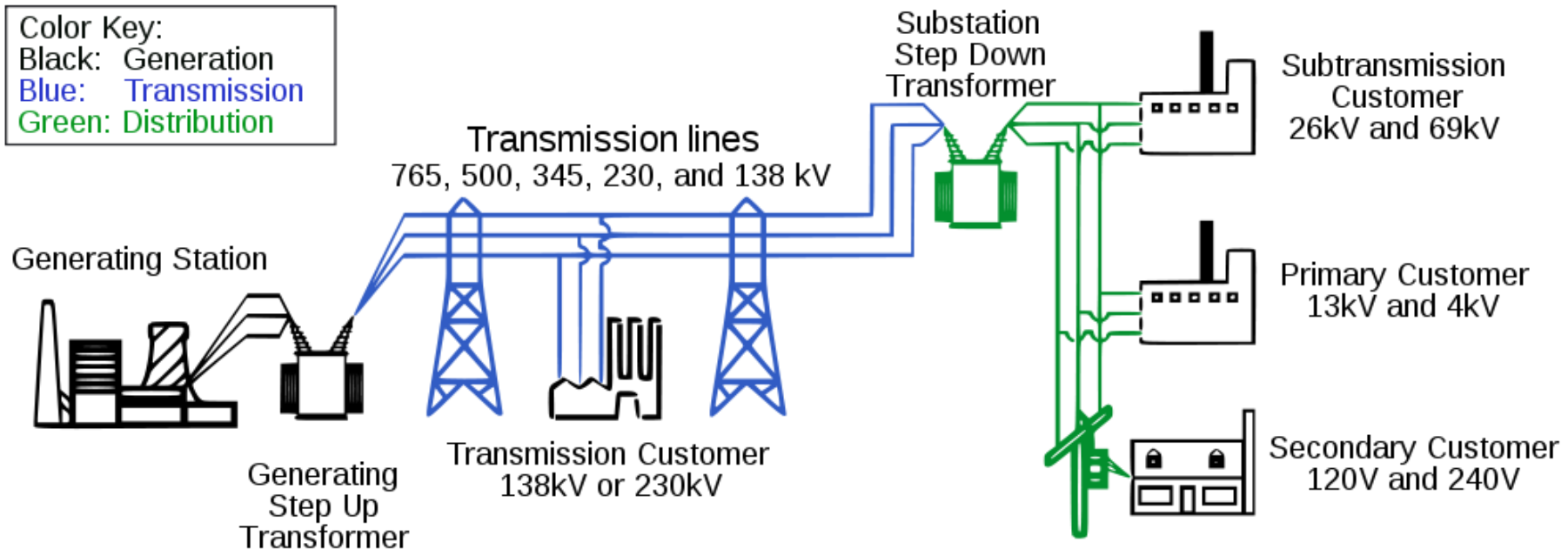
A kilowatt (kW) is equal to 1,000 watts. A kilowatt of power is about equal to the average annual electrical consumption of a single household in the United States for an entire year.

Megawatt

A megawatt (MW) is equal to 1,000,000 watts. Electrical generators at utility companies output so much power that it's measured in megawatts. The hydroelectric generators at Hoover Dam produce over 2000 MW collectively.

Transporting Electricity: From Power Plant to Homes

Power plants generate the electricity. Then there is a network of transformers and transmission lines that brings it to people's homes. This network is often called the *power grid*, or more simply—*the grid*.



GENERATION: After the power plant generates the electricity, it is sent through a transformer. Transformers are critical to electrical transmission because they can change the voltage of the electrical current, making it more efficient, economical and practical to transmit. Prior to transmission through power lines, the transformer "steps up" the voltage, which means the generated voltage is changed to a higher voltage. This way, lower currents can transmit the same energy, thus reducing resistive loss.

TRANSMISSION: The transmission system consists of large, high-voltage power lines. The lines are ever-present around the country, often near roadways. Sometimes, they travel underground or under the sea. This system can carry electricity over long distances, sometimes greater than 400 miles. In North America, there are three major transmission systems: The Western Interconnect, The Eastern Interconnect and the Electric Reliability Council of Texas.

DISTRIBUTION: The local distribution system consists of substations and smaller, lower-voltage distribution lines. The transformer at the substation "steps down" the voltage to a lower voltage. Then, the system distributes the electricity from substations and transformers to households. One final transformer steps down the voltage to 120V which is what people use in their homes.

Measuring Electricity: The Formula

Electrical power is defined as the amount of electric current flowing due to an applied voltage.

Here's the formula:

Voltage	x	Current	=	Power
V	x	I	=	P

Voltage (V) is a measure of the pressure applied to electrons to make them move.

Current is the number of electrons flowing past a fixed point. It is measured in **amperes (I)**.

Power is a measure of the rate of doing work. Electrical power is measured in **watts (P)**.