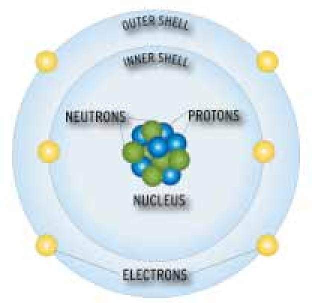
what is a watt?

The basics of electricity

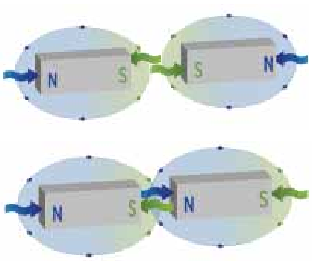
By Jeff Brooks

Most people understand that the power company keeps the lights turned on. But for many, the language of electrical energy and how it works is a bundled mass of formulas, acronyms and processes. Respecting the complexity of language is always a good thing, but being able to speak the language is even better.



The Atom

Negatively charged electrons (yellow) are attracted to the positively charged protons (blue). This attraction keeps the electrons attached to the atom. When atoms are near one another, electrons can pass from one atom to another seeking a positively charged counterpart. This transit of electrons is electricity.



The Magnets

Opposite poles of a magnet attract each other (north and south), while similar poles repel each other. The force of magnetism on electrons can be used to make electricity.

Illustrations on this page by Camden Watt

Electricity 101

As with learning any new language, it is important to start with the basics. Electricity is energy derived from the flow of electrons, which are negatively charged particles that orbit the nucleus of an atom. The world is filled with atoms. They are all around us and inside of us. Even our body is made up of atoms, which are so small that you could place millions of them on the head of a pin.

Atoms are composed of a nucleus which contains protons that carry a positive charge and neutrons which carry no charge. Orbiting around the nucleus, like little planets in a microscopic solar system, are the electrons.

Negatively charged electrons are attracted to the positively charged protons in the nucleus. This attraction keeps the electrons attached to the structure of the atom. Sometimes, however, atoms pass near one another and electrons can pass from one atom to another in their neverending search for a positively charged counterpart. This transit of electrons from one atom to another is electricity.

Electricity comes from many sources and can be found just about everywhere. Lightning is a form of electricity, with bolts caused by the passing of electrons from cloud to cloud or cloud to ground. Static electricity is another type caused by the exchange of electrons from one surface to another as a result of friction.

A magnetic personality

In their natural state, electrons orbit their atomic home in a kind of harmonious dance. Half of the electrons in the atom spin in one direction and the other half spin in the opposite direction. They are all evenly spaced and everything is in balance. But when the electrons are placed in the environment of a magnet, something very different happens. The evenly spaced, harmoniously spinning electrons skew themselves to one end of the magnet or the other, creating an imbalance in the forces found between each end. The resulting imbalance is called a magnetic field.

Most people are familiar with the behavioral tendencies of a magnet. Each end, or pole, of the magnet will either attract or repel another magnet that comes into contact with it. This bipolar behavior is caused by the magnetic field that pushes some electrons in one direction and the rest in another direction.

Since the magnetic force of a magnet flows from one pole of the magnet to the other pole, it will by its flow push away another magnet whose field runs opposite to the first. In other words, a north pole will repel a north pole, and a south pole will repel a south pole. But if the north pole of a magnet meets up with the south pole of another, there is an attraction that is, well, magnetic. Just as in the case of protons and electrons, when it comes to magnets, opposites attract.

This force of magnetism on electrons can be used to make electricity. By moving magnetic fields, electrons can be pushed or pulled to generate electricity. And by using magnetic fields on metals such as copper, whose electrons are arranged in a loosely assembled order, large amounts of electricity can be generated and moved along a path to be harnessed for work.

A powerful discovery

In the early 1800s, the scientist Michael Faraday discovered what is now known as electromagnetic induction. He found that if a magnet is rotated around a loop of wire, the wire becomes electrified from the movement of electrons in the metal.

Thomas Edison compounded that discovery and in 1882 opened the world's first electric power plant in New York City, employing the same model of a magnet rotating around a wire to generate electricity. His power plant burned coal to make steam for turning a mechanical dynamo containing magnets. Today, power plants use a larger but similar technique to provide for the electric needs of towns and cities around the globe.

Around the circuit

To express itself as energy, electricity "flows" in a current through a circuit (from the word "circle"). A device that is connected to the circuit, such as a light bulb, draws current, while the current continues running in its circuit. Think of linking negatively charged electrons to positively charged ones. The link completes the circuit. When the link is closed the circuit is complete and electric current can flow. Because of their atomic structure, certain materials (called conductors)—such as metal and water—allow a better flow of electrons than others. Glass and rubber are not good conductors—they resist current—and are instead referred to as insulators.

The charge of electricity through conductors, such as the common copper wire found in building circuits, varies according to several factors. A commonly used analogy is a water hose: the charge of the water running through a hose used to power, say, a lawn sprinkler, is affected by the pressure of water from the pump, as well as the size and physical condition of the hose. In this analogy, the water pressure is similar to the electric pressure or force available from a power source, known as "voltage" and measured in volts. The amount of current flowing through the conductor—similar to the amount of water flowing through a hose—is measured in "amperes." The power in an electric current that is available at the end—to run the sprinkler, in this example—is measured in "watts."

What's a watt and what it's not

The watt is named after James Watt (1736–1819), who made major contributions to the development of the steam engine. A watt is actually a very small amount of electricity. To put things in perspective, the average household light requires 60 watts of electricity to operate (energy-efficient compact fluorescent bulbs average only 18 watts). The average microwave oven uses 1,500 watts. An electric oven can require as much as 5,000 watts or more to operate.

Because most appliances require thousands of watts of electricity, the more commonly used unit is the kilowatt (kw). A kilowatt is equal to 1,000 watts. The watt and its variants are also used to measure the capacity, or generating potential, of devices that make electricity. For example, the average residential solar photovoltaic (PV) system contains a capacity of about 2 to 3 kw. The capacity of larger systems, such as coal and nuclear plants, is measured in megawatts (1 mw = 1,000,000 watts) and gigawatts (1 gw = 1,000,000,000 watts).

A common error among consumers is to mistake the kilowatt with its energy usage counterpart, the kilowatt-hour (kwh). A kilowatt-hour is a measurement of electricity generated or consumed over one hour. For example, a 60-watt light bulb will consume 60 watt-hours over the course of an hour. If the bulb is used 4 hours each day for 30 days, the resulting usage will be 60 watt-hours x 4 hours x 30 days, or 7.2 kwh (7,200 watt-hours).

It's easy to see kilowatt-hours in action. Simply take a look at your electric utility meter, typically located on the side of your home, to see a running tally of the kwh being used. The difference between the kwh recorded at beginning of the billing cycle to the end is the number that appears on your electric bill each month. That number will vary from month to month, based on the seasonal electrical demands of the dwelling. A 2,000-square-foot home typically uses around 1,000 kwh of electricity per month.

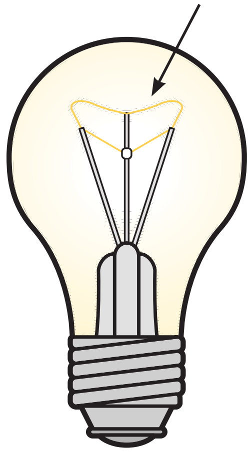
NC GreenPower's electrical connection

Understanding how energy is measured is important in helping you appreciate your participation in the NC GreenPower program. Every $4 that you contribute monthly toward renewable energy production adds 100 kwh, or about 1/10th of the average home's power consumption to the electric grid. Over the course of a year, that $4 contribution will add 1,200 kwh of cleaner electricity to the state's power supply. That means that more than one month each year of your electrical needs are being generated from renewable energy, and shared with citizens across the state.

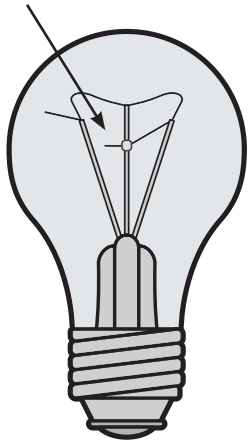
Today, most renewable energy generation capacity in the state is measured in kilowatts. It may not seem like much when compared to traditional sources. But if every citizen does a little bit, then one day soon renewable energy may comprise gigawatts of the state's energy supply and power your home with thousands of kilowatt-hours of reliable, environmentally-friendly electricity.

Jeff Brooks is marketing and communications coordinator for NC GreenPower, a statewide non-profit organization working to encourage the development of renewable energy resources across the state. For more information on the NC GreenPower program and what you can do to help, visit www.ncgreenpower.org or call (866) 533-NCGP.

The circuit is closed. Electrons flow through the wire and produce light.



The wire is broken. The circuit is open and no electrons can flow.



The Circuit
Electricity moves in a current through a continuous circuit (from the word "circle'). Connect a light bulb to the circuit, and you've got light. Burn a 60-watt light bulb for an hour, and you've used 60 watt-hours. Burn it 100 hours, and you've used 6,000 watt-hours or 6 kilowatt-hours.