Lightning Rods

The Empire State Building is struck by lightning about 100 times every year. Millions of volts of electricity hit the skyscraper, but it doesn't suffer any damage. That's because its tall spire, covered in broadcast antennas, has a lightning rod at the very top of it.

Lightning can set fire to a building, electrocute the people inside, and fry the electrical and computer systems. But a lightning protection system, which consists of a metal lightning rod and some wires, keeps the building safe.

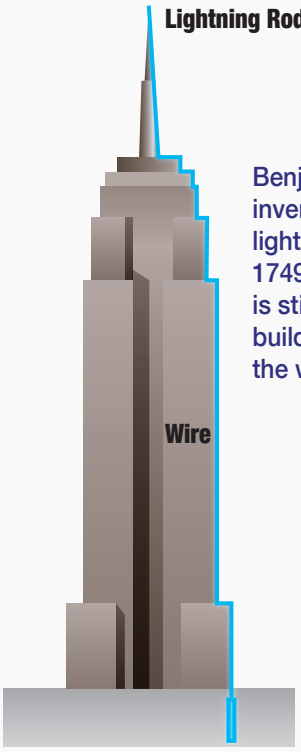
When Lightning Strikes

As a scientist, Benjamin Franklin was fascinated by lightning and electricity, and spent years studying them. As an inventor, he wanted to find ways to protect people and buildings from lightning. His solution was the lightning rod, a metal pole designed to save buildings from the "most sudden and terrible mischief" of a lightning strike.

A lightning rod is a pole attached to the roof of a building. It's made of metal—usually copper—because metal is a good conductor. That means electricity flows through it freely and easily, without meeting a lot of resistance.

The rod is attached to a copper cable that runs down the side of the building and into the ground. When lightning strikes the rod, the dangerous electrical charge is instantly conducted down the rod, through the wire, and into the ground.

Non-metals such as wood are not good conductors. Electricity does not flow through them freely. If lightning hits a barn with no lightning rod, the current will not travel through it easily. It will meet a lot of resistance as it travels through wood, and that can result in massive heat damage—in other words, fire.



Benjamin Franklin invented the lightning rod in 1749. His invention is still protecting buildings all over the world.

Photo: Dan Nguyen

Types of Batteries

The Energizer Bunny keeps going and going. But he never seems to wear out those spiffy flip-flops. Batteries wear out, though. They all run out of juice eventually, whether they're single-use batteries or rechargeable. Single-use batteries have one life cycle and must be replaced when drained. Rechargeable batteries can be recharged and used repeatedly. But in time, even they wear out.

Whether single-use or rechargeable, all batteries are storehouses of chemical energy. They are filled with chemical compounds, and those compounds store chemical energy. Reactions between the metals and the chemicals in a battery produce an electric current. That's how the battery turns chemical energy into electrical energy.

People use different types of batteries for different purposes. These are the most commonly used batteries in homes today.

Alkaline batteries

- Good for household electronics such as toys and flashlights
- Long shelf-life—up to 7 years

Lithium batteries

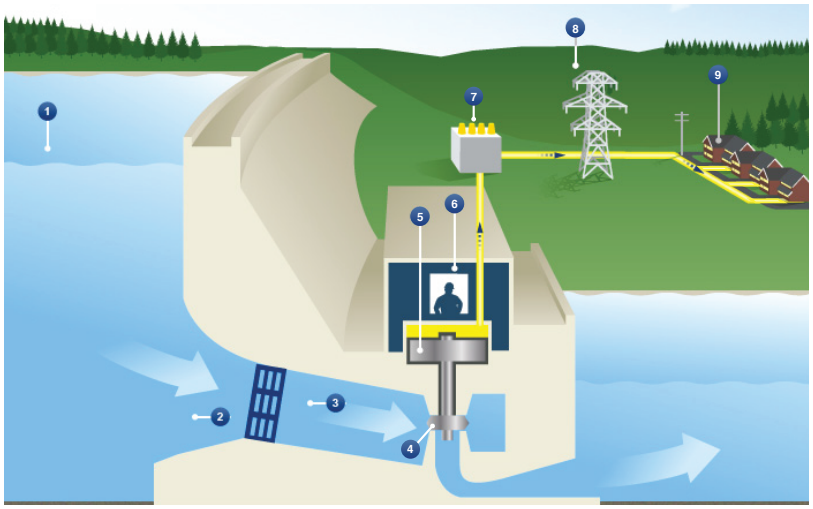
- Good for high-tech devices that drain power quickly, such as cameras and handheld games
- Weigh 33% less than alkaline batteries
- Long shelf-life—10 years when not in use

Rechargable batteries

- Good for high-use devices, such as audio players and remote controls
- Can be recharged hundreds of times
- Limited shelf-life. After a full charge, loses 1% of its energy per day

Hydropower

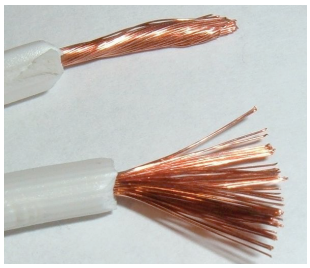
Hydropower: Using the energy of flowing water to generate electrical energy. Hydropower provides 20% of the world's electricity. At a hydroelectric plant, water released from behind a dam flows through a turbine, causing it to spin. The spinning turbine turns a generator, which produces electricity. The electricity flows from the plant to local substations through long-distance power lines.



Engineers use the word *flow* to describe the movement of both water and electricity. In fact, the flow of electricity is often compared to the flow of water. The comparison helps people visualize how electricity travels. But it can also give people the idea that electricity is a kind of fluid—and that's wrong. It's not a fluid, or any other type of matter. It's a type of energy. Here are two other big differences between water and electricity:

One leaks, the other doesn't. Electric current can only flow through an unbroken loop called a circuit. Water can flow through all kinds of channels, including a one-way path like a pipe. If the pipe bursts, water keeps spilling out from the break. But if a live wire is cut, the circuit is broken and the electric current stops flowing. No electricity leaks out onto your floor.*

A water pipe can be empty; an electrical wire can't. A copper wire is not an empty tube that gets filled with electricity. The charges that create electric current are already present within the atoms of the wire. When you attach a battery to the wire, that force gets those charges moving through the wire. That's what an electric current is—the flow of charges.



Water flows into a hydroelectric plant and electricity flows out. But even though both flow, water and electricity are very different. Hydroelectric plants don't turn one kind of fluid into another kind of fluid—they turn one type of the energy into another type. They transform the energy of moving water into electrical energy.

**That doesn't mean you can touch a broken wire. If you did, your body would complete the circuit. Electricity would flow again—right through you! And you'd get a nasty shock.*

Illustration: EDF Energy; Photos (top to bottom): EDF Energy; Scott Ehardt

Bears love honey—and that's a problem for beekeepers. Hungry bears destroy beehives to get at the honey. It takes a lot of time and dedication to raise bees, so beekeepers get very upset when they find that their hives have been pushed over and torn apart.

It would be nice if bears had good table manners and waited politely to be served their honey treats. But they're wild animals. Once they develop a taste for honey (and for baby bees, which they also find yummy), nothing will stop them from destroying any hives they find.

Well, *almost* nothing. There is one method that beekeepers have discovered. It's a simple but shocking solution: electric fences.

The hives (1) in this photo, home to thousands of honeybees, are well protected. The beekeeper has set up an electric fence around them. It will give any bear that touches it a good zap—not enough to harm the bear, but enough to make it back off. Electric fences are easy to install. The main parts are:

(2) **The energizer.** It sends pulses of electric current through the wires.

(3) **The wires.** These are uninsulated electrical wires—the "hot" part of the system. When a bear touches a wire, it gets a shock.

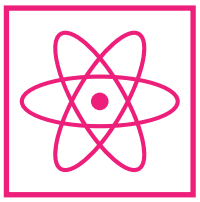
(4) **The insulators.** These are used to attach the wires to the posts. Their job is to keep the electrified wires from touching the posts. If wires touch the posts, energy is lost and the system could short out. Insulators are made of either plastic or porcelain, because those materials don't conduct electricity.

(5) **The handles.** These allow people to unhook the wires and get through the fence without getting a shock. They're made of rubber or plastic. Both materials are excellent insulators.

Photos: The University of Georgia College of Agricultural and Environmental Sciences

Types of Energy

Energy makes plants grow, lights our cities, powers our computers, cooks our food, plays our music. It's everywhere, and it takes many different forms.



Atomic Energy is produced when atoms are split. Nuclear power plants produce a tremendous amount of energy this way.

Chemical Energy is a form of potential energy that is stored in such things as food and gasoline.

Electrical Energy is produced by electrons moving through a substance. It lights our homes, runs motors, and makes our TVs, phones, and computers work.

Heat Energy is the movement of the atoms and molecules within substances. As the atoms and molecules move and collide faster, the substance heats up.

Light Energy is a form of radiation that travels as electromagnetic waves. These waves can carry energy through space and matter.

Mechanical Energy (kinetic energy) is moving energy. All moving objects produce mechanical energy.

Sound Energy is produced when an object vibrates. Sound waves travel out in all directions through a medium such as air, water, or wood.

Illustrations (top to bottom): The Noun Project; 3 Ryan Oksenhorn, from The Noun Project; 5 Boris Ruether, from The Noun Project
Photos (top to bottom): U.S. Nuclear Regulatory Commission; Pamela Graham; Dereks Key; Andreas; Alba Campus; Hindrik Sijens; Herbert Ponting