THE SCIENCE & ENGINEERING BEHIND THE

Electric Grid

Contents

ELECTRICITY POWERS OUR LIVES.

We use electricity to light our homes, schools, and offices. It helps us store our food, heat and cool our buildings, charge our phones, and much more. Electricity makes our modern way of living possible. Even this book was printed on a machine powered by electricity!

WHAT IS THE GRID?

If you could shrink down small enough, you could zip through an unbroken series of wires that link the light in your bedroom to a streetlamp shining on the other end of town. Even more wires might connect them to lights in the next town over and then to a larger set of wires that connect them to power sources sometimes hundreds of miles away. This set of connected electric wires is known as the electric grid.

THINK ABOUT IT

Can you imagine what life would be like without electricity?

How would you do your homework at night? What would you do for entertainment?

THE GRID KEEPS US GOING

Electricity allows us to do many amazing things. But most of us don't usually stop to think about where that electricity comes from. The electric grid keeps energy flowing into the outlets we plug things into. The grid connects power plants to cities, towns, neighborhoods, buildings, and every electrical appliance inside your home.

The electric grid is an astounding achievement that countless scientists, engineers, electrical workers and public officials have worked together to build over the past century. We wrote this book to help you understand how it works—and the lengths electricity has to go through to make it to your home.

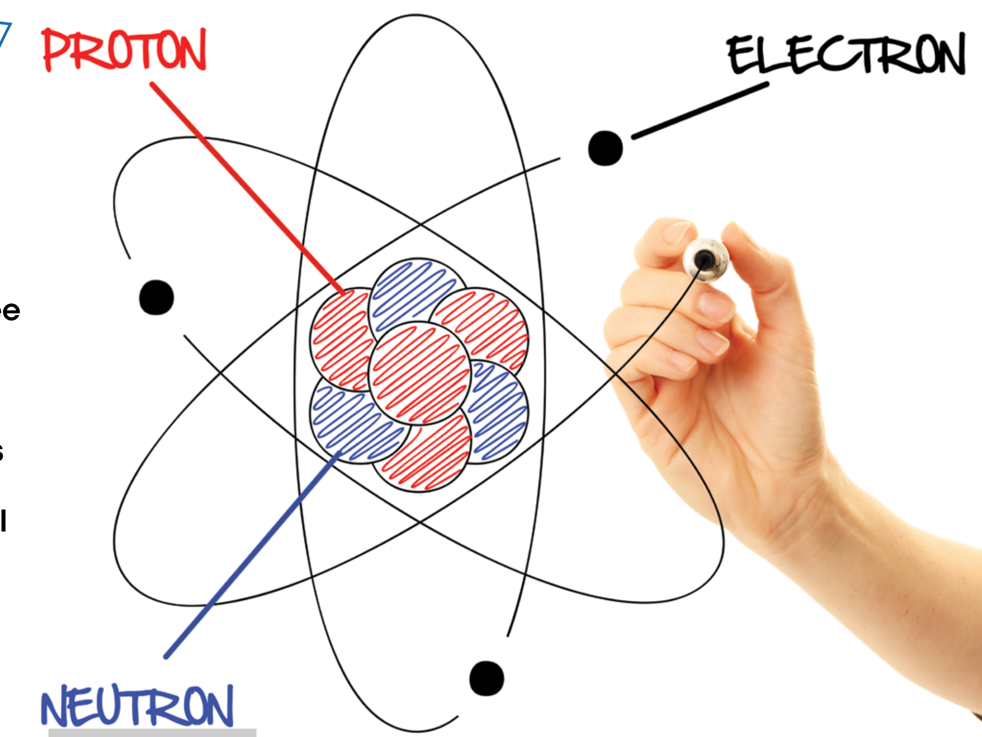
WHAT IS ELECTRICITY?

Electricity is a form of energy. Objects need energy in order to move or give off light, sound, or heat. Think of an object you use at home or in school every day. Can you switch it off and on? Does it have a plug or batteries? If so, that object uses electricity.

WHAT DO YOU THINK?

Which of the things below use electricity to operate? Circle them. Draw an X through the things that don't use electricity.

WHAT IS ELECTRICITY MADE OF?



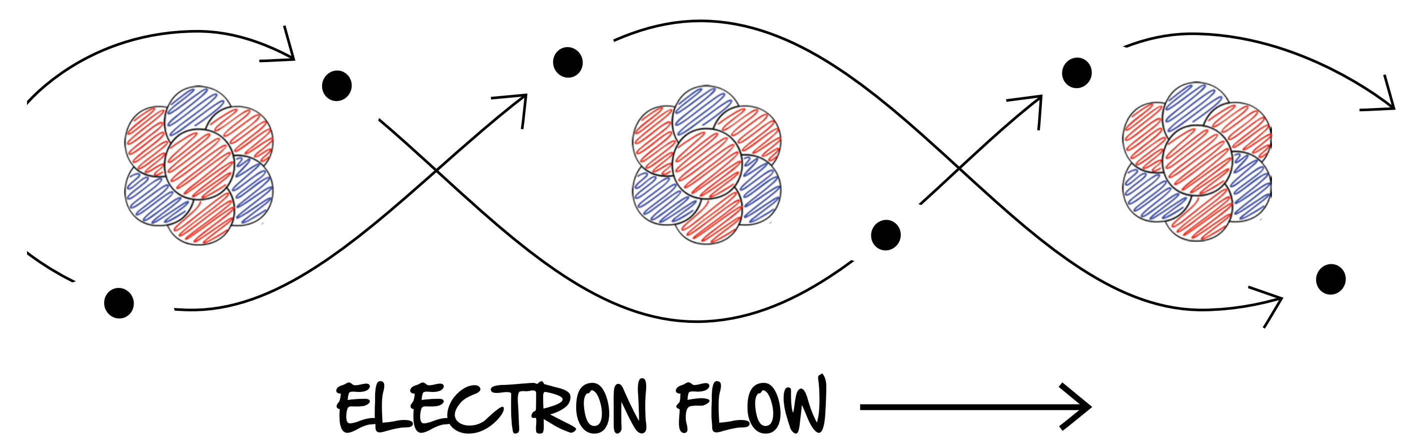
Electricity can power machines as big as buildings. But it exists because of particles far too small to see with the naked eye.

Everything in the universe is made up of tiny particles called atoms. These atoms are too small to see with all but the most powerful microscopes. Inside an atom are even tinier particles called protons, neutrons, and electrons.

ELECTRONS FLOW

Electrons are constantly moving around the atoms they belong to. Sometimes, electrons can escape from one atom and jump into the next. This movement of electrons between atoms is electricity. Each moving electron carries a tiny bit of electric charge.

As an electron escapes an atom, it leaves behind a spot for another electron to jump into. When many electrons jump from atom to atom in the same direction, they create a flow of energy called electric current.



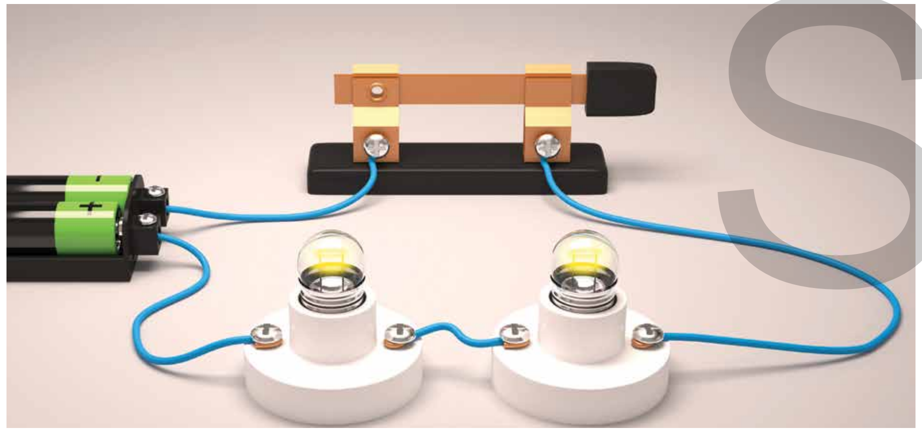
ELECTRICITY IS MOVING

Electric current moves in a closed circuit—an unbroken path that ends in the same place it began. If a circuit is open, the electricity cannot flow. Objects connected to the circuit receive energy from the electric current. That's how the electric grid powers everything from light bulbs to giant factories.

Electricity can be very dangerous if people, trees, cars, or other objects accidentally become part of electric circuits. Insulated wires allow us to harness electricity without touching the circuit—but we need to be extremely careful around them and other carriers of electricity.

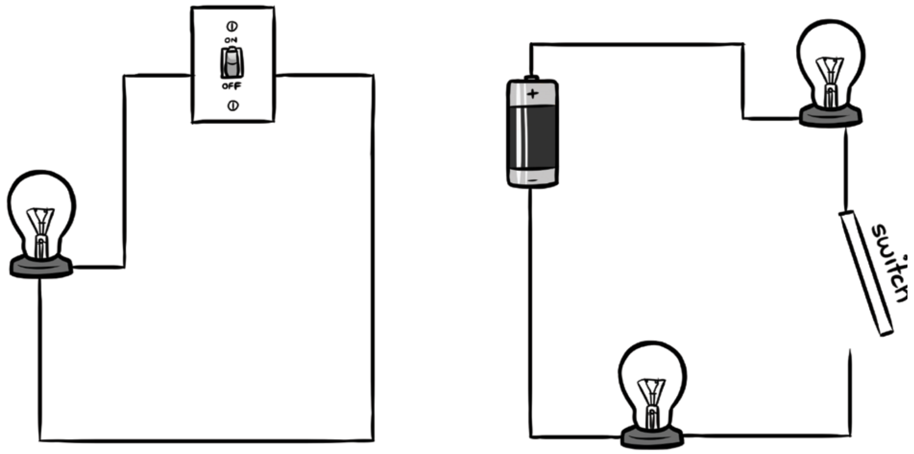
A SIMPLE CIRCUIT

When we flip on a light switch, we close a circuit. Electricity flows into a wire in the wall, through the light bulb, and back out another wire. When we flip the switch off, we open the circuit. Electricity stops flowing to the light.



WHICH BULBS WILL LIGHT UP?

Color the light bulbs yellow that will light up. Remember, in order for electricity to flow the circuit must be closed!



TERMS TO KNOW

Electricity isn't easy to understand. Sometimes an analogy, or comparison, can help. As you read the terms below, try thinking of electricity as water running through a pipe.

Electrons are tiny particles that carry an electric charge. You can think of them like individual droplets of water.

Electric current is a flow of many electrons. Think of it as the stream of water that comes out of a running faucet.

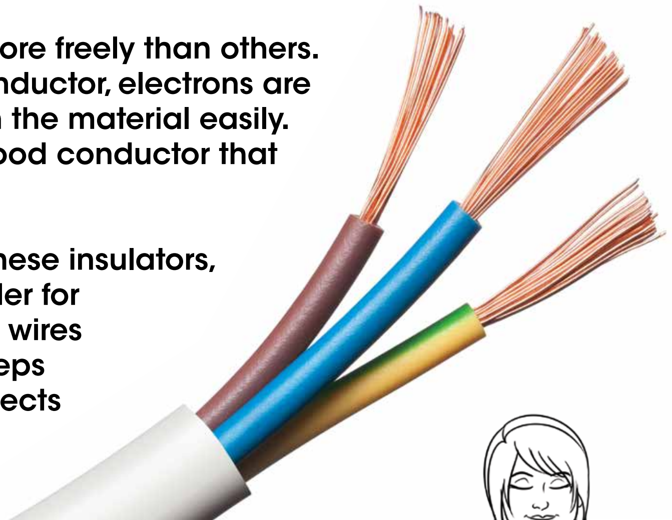
Voltage is a measure of how much current can potentially move through a wire. You can think of it like water pressure in a pipe before you turn the faucet on.

Resistance is a measure of how well electricity can move through a material. You can think of resistance as the size of the pipe the water is flowing through.

CONDUCTORS AND INSULATORS

Some materials allow electric current to flow more freely than others. These materials are called conductors. In a conductor, electrons are loosely bound to atoms and can move through the material easily. Many electrical wires are made of copper, a good conductor that allows electrons to flow.

Other materials resist the flow of electricity. In these insulators, atoms hold on tightly to their electrons. It's harder for electrons to jump from atom to atom. Electrical wires are often coated in plastic, an insulator. This keeps electricity from leaking out of the wire and protects people from electric shock. Can you think of some other conductors and insulators?

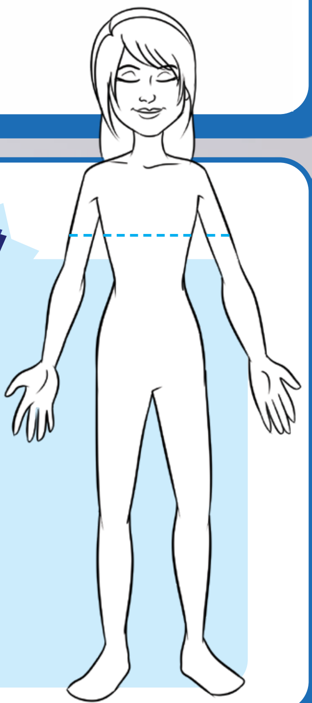


YOUR BODY IS A CONDUCTOR!

The human body can conduct electricity because **60-65** percent of our bodies are made of water and water is an excellent conductor. That means that electricity could easily flow through you. This is why you must be very careful around electricity!

TRY IT!

Color the body up to the 65% line—this represents the portion of your body that is made of water.



BE CAREFUL!

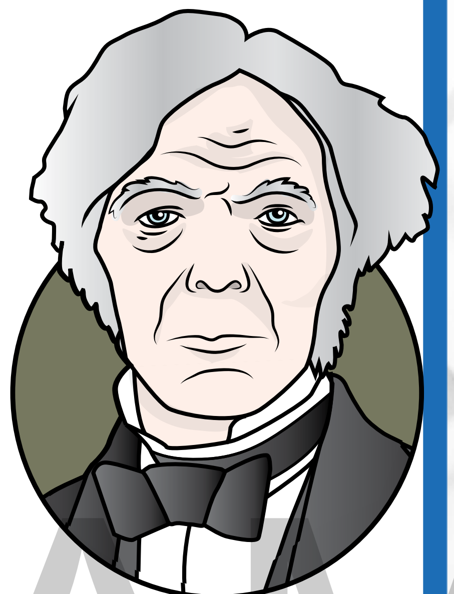
Line workers repair and maintain power lines and electrical equipment, so they need special safety gear and training to keep them safe. Here are some of the safety items and tools that that they use:

- Hard Hat
- Safety Glasses
- Hearing Protection
- Rubber Sleeves
- Gloves
- Safety Harness
- Fire Resistant Pants
- Work Boots
- Climbers and Gaffs
- Hot Stick (a long tool with a hook on the end)
- Handline (Rope)

Remember, never play near power lines or electrical equipment.

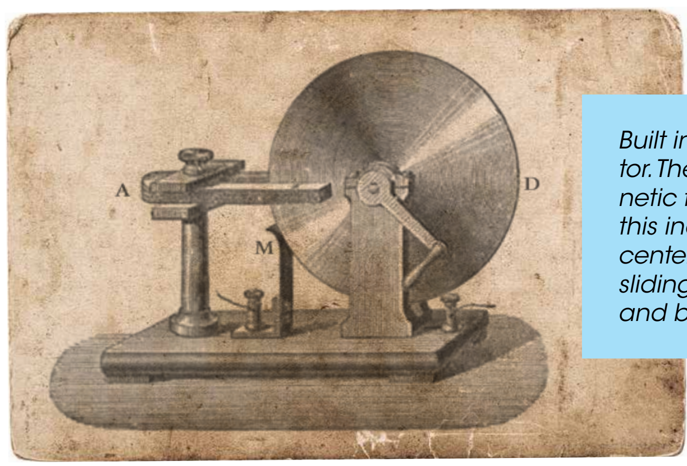
BEFORE THE GRID

Electricity wasn't always as widely available as it is today. Before people learned how to transmit electricity, they used candles and oil lamps to illuminate their homes at night. But these types of lights were expensive, produced lots of soot, and could start fires easily. Many scientists, engineers, and inventors helped develop the electric grid that safely powers our modern way of life.

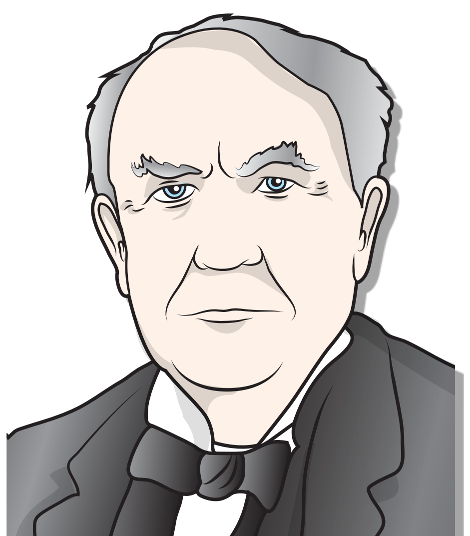


CREATING CURRENT

Michael Faraday, an English chemist and physicist, studied the relationship between electricity and magnetism. In 1831, he discovered that he could create an electric current by moving a copper coil around a magnet. The magnet pulled electrons out of the copper atoms to create a flow of electricity. Nearly two centuries later, most electricity is produced in basically the same way.



Built in 1831, the Faraday disk was the first electric generator. The horseshoe-shaped magnet (A) created a magnetic field through the disk (D). When the disk was turned, this induced an electric current radially outward from the center toward the rim. The current flowed out through the sliding spring contact (M), through the external circuit, and back into the center of the disk through the axle.

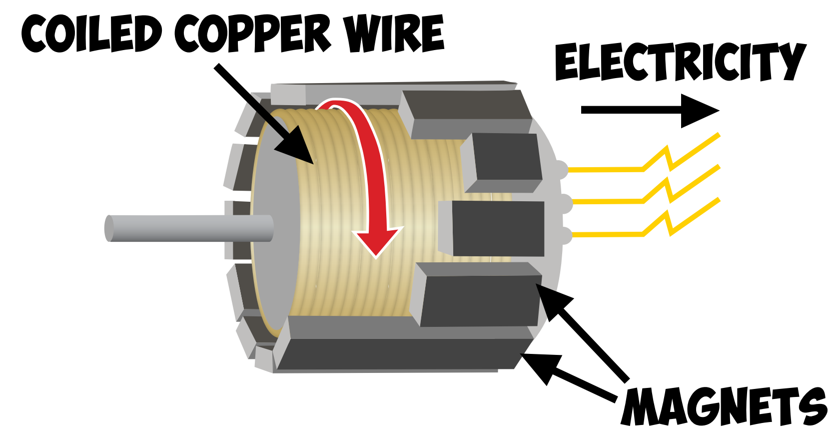


LET THERE BE LIGHT!

In 1880, Thomas Edison began making the first widely available electric light bulbs. He also founded one of the first electric power companies. Early power stations provided electricity for only a few stores and factories. But over the next several decades, the electric grid quickly grew.

An illustration from Edison's original light bulb patent

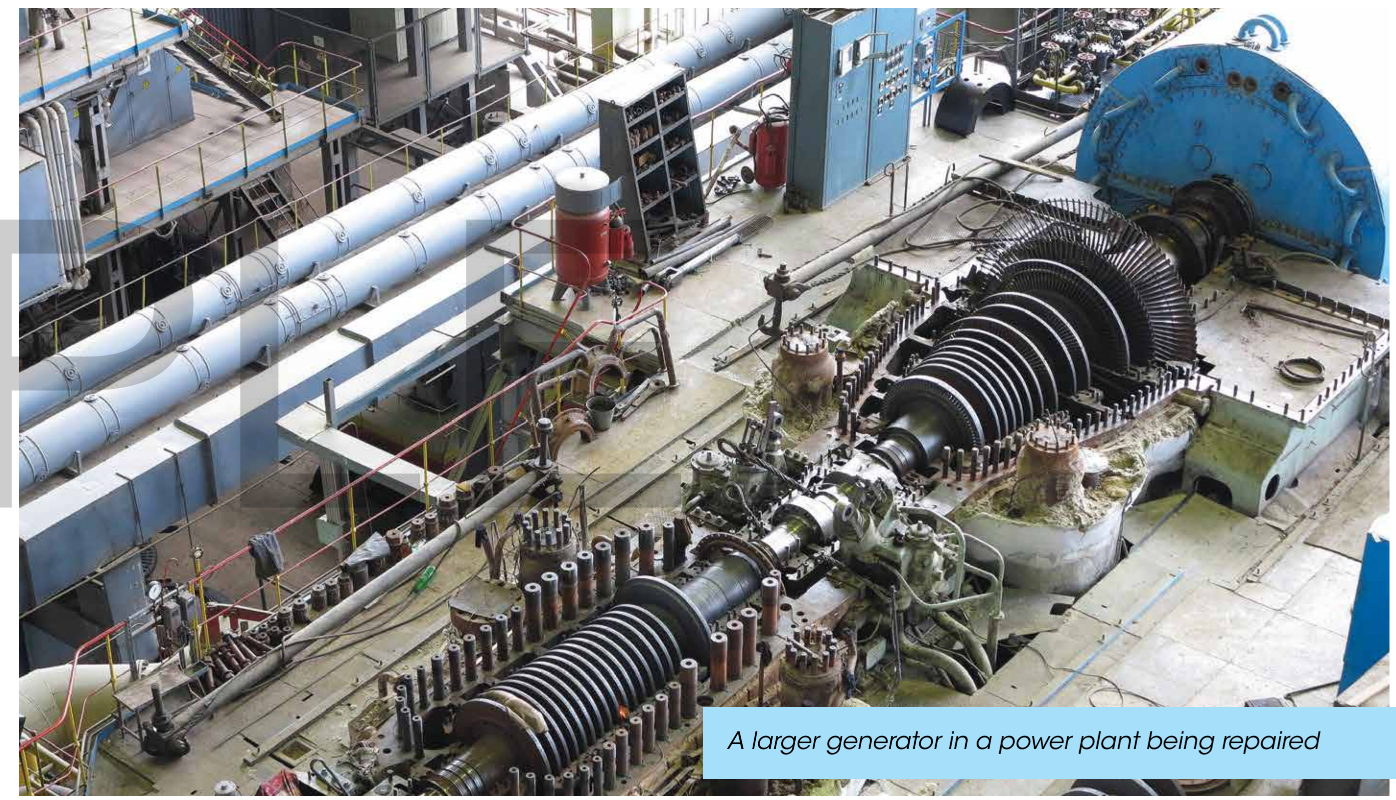
AN ELECTRIC GENERATOR



1) A turbine rapidly spins a coil made of copper.

2) Strong magnets around the coil pull on the copper's electrons.

3) This interaction creates an electric current that flows through a circuit.



A larger generator in a power plant being repaired

DID YOU KNOW?

In 1879, a company in San Francisco became the first in the U.S. to distribute electricity. It produced only enough power to light up 21 electric lamps.

ALL ABOUT ENERGY

The electric grid is a way of transmitting energy. Energy, or the power to do things, comes in many different forms. It can be changed from one form into another, but it can never be created or destroyed.

Below are the two basic types of energy.

POTENTIAL ENERGY

is stored energy that can be released if something changes.

A ball at the top of a hill has potential energy. If you start it in motion, it will roll down the hill.

A stretched rubber band has potential energy. It will change shape if you let it go.

Food has potential energy. It contains substances that your body can break apart to fuel your muscles.

KINETIC ENERGY

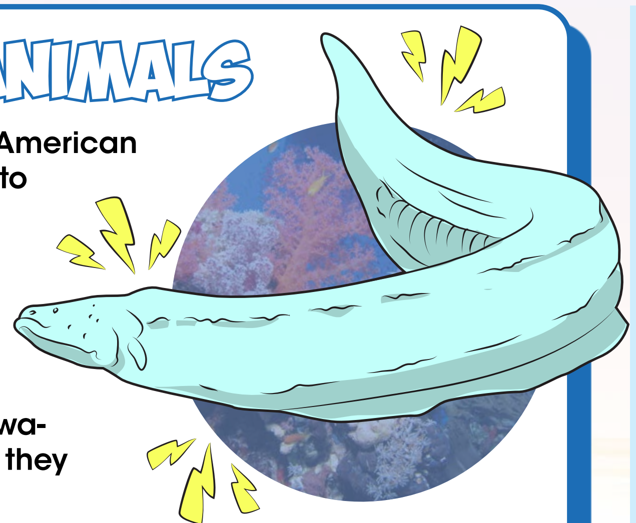
is energy that something has because it's moving.

A car driving down a street has kinetic energy.

So do light and heat, which move in waves we can't see with the naked eye.

Sound is also a form of kinetic energy. Sound is created when a vibrating object, like an instrument string, vibrates particles of air, which in turn vibrate your ear drum.

ELECTRIC ANIMALS



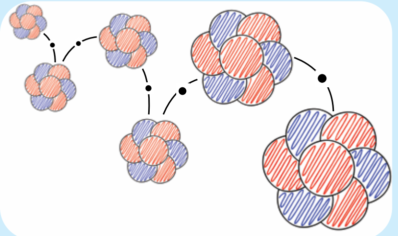
Electric eels are South American fish that use electricity to defend themselves and hunt food. They have thousands of cells in their tails that work like tiny batteries. They can send a jolt of electricity through the water to paralyze animals they prey on.

What Do You Think? Which do you think has a higher voltage: a typical home power outlet, or a shock from an electric eel?

A: An electric eel has higher voltage! Outlets supply 120 volts of electricity and electric eels can generate shocks of around 500 volts.

THINK ABOUT IT:

Electric current is created by electrons jumping from atom to atom. Does electric current have potential or kinetic energy?



Answer: The moving electrons are a form of kinetic energy.

INSIDE A POWER PLANT

Power plants are the driving force of the electric grid. To produce electricity, power plants take energy in other forms and use it to generate electric current. Remember the turbine generator Michael Faraday invented? (If not, turn back to page 8!) Most power plants use a more advanced version of the same device. Energy from the primary source is used to spin a turbine connected to a magnetic generator. This starts electrons moving, creating a flow of electricity.

ENERGY SOURCES

FOSSIL FUELS

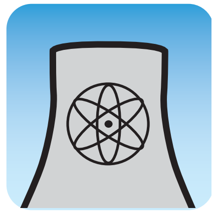
like natural gas, coal, and oil contain potential energy in the form of chemicals that burn easily. Power plants can burn these fuels to heat water, creating steam that turns a turbine.

MOVING WATER

has kinetic energy. Hydroelectric dams guide the flow from large rivers into a turbine. The force of the moving water makes the turbine spin.

WIND

has kinetic energy. Wind turbines capture this energy and convert it into electricity.



NUCLEAR POWER

uses the potential energy stored inside atoms. Smashing atoms into each other at high speeds breaks them apart, releasing heat that can power a steam turbine.

SUNSHINE

provides the light and heat that keep everything on Earth alive. Power plants can harness this energy to boil water to power a turbine, or solar cells can convert it directly into electric current.

EARTH'S HEAT

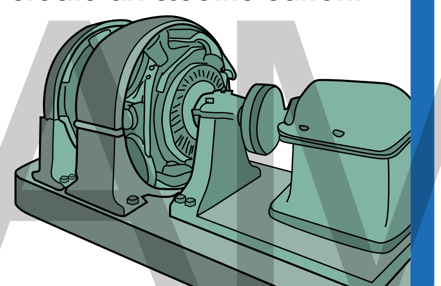
Energy generated from the heat of the Earth is called geothermal energy. The heat stored deep inside the Earth is used to generate steam in order to make electricity.

A JOURNEY THROUGH THE ELECTRIC GRID

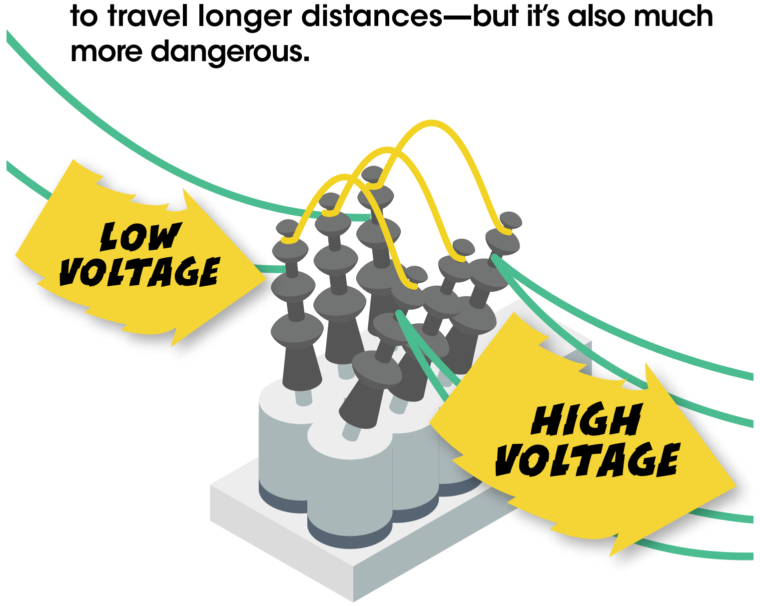
The construction of the electric grid is one of the greatest engineering achievements of the 20th century. In the early 1900s, there were more than 4,000 different utility companies. Each one served just a small area and relied only on its own power plants to provide electricity. Over the next few decades, these companies started to link their systems together so that they could share electricity and avoid power outages. Today's electric grid is widespread, interconnected, and works like one big machine to bring energy to our homes. Here's how it works:

1. More than 10,000 power plants across the country generate electricity. Different kinds of power plants use different primary energy sources, like fossil fuels, solar, wind, or hydropower.

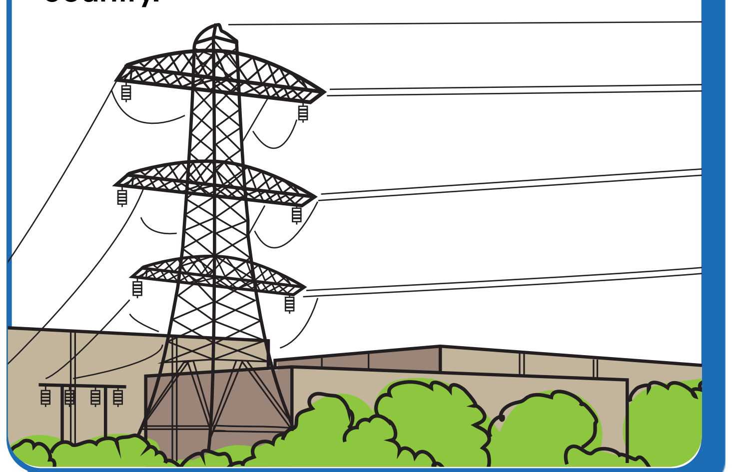
2. Inside most power plants, energy from the primary source spins a turbine that turns the shaft inside a generator. The shaft rotates magnets around a metal coil to create an electric current.



3. On its way out of each power plant, the electricity passes through a transformer. This device uses a set of coils around a magnetic ring to raise the voltage, or strength, of the electric current. High-voltage electricity is able to travel longer distances—but it's also much more dangerous.

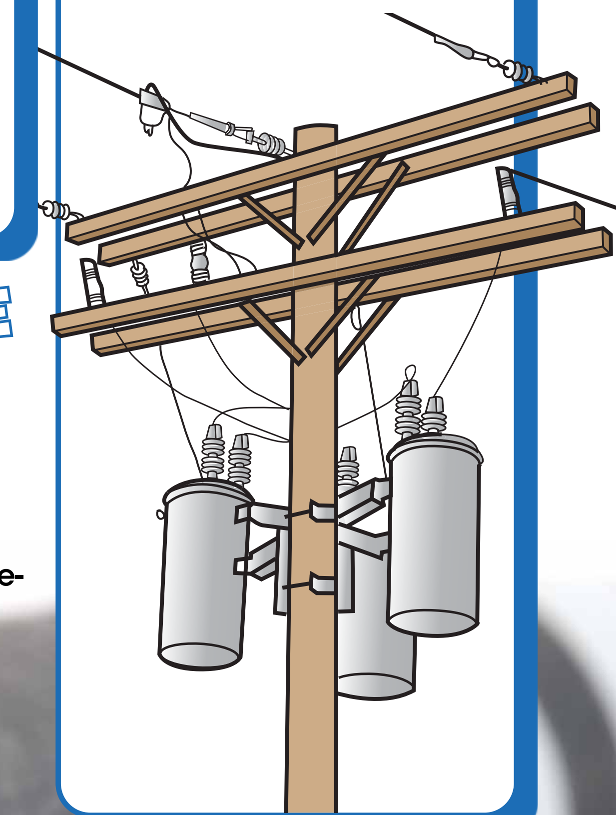


4. After the transformer increases the voltage, the electricity is ready to be distributed. It flows into high-voltage transmission lines that carry it out into the grid. The U.S. has hundreds of thousands of miles of these power lines that connect in a network stretching all around the country.



5. Once the electricity gets closer to its destination, transformers at a substation lower the voltage again. This lower-voltage electricity is safer to transmit through areas where people live. Electricity flows from the substation into distribution lines. You can spot these wires running along highways and sometimes on neighborhood streets. (In big cities, they're often underground.)

6. The voltage has to be lowered one more time before it's safe to enter your home. This happens at a pole-mount transformer, which is a smaller version of the ones used at the power plant and substations. Even though the voltage has been lowered, the electricity that comes out of your home outlets can still be very dangerous. An electric shock from wires in your home can cause injury or even death.



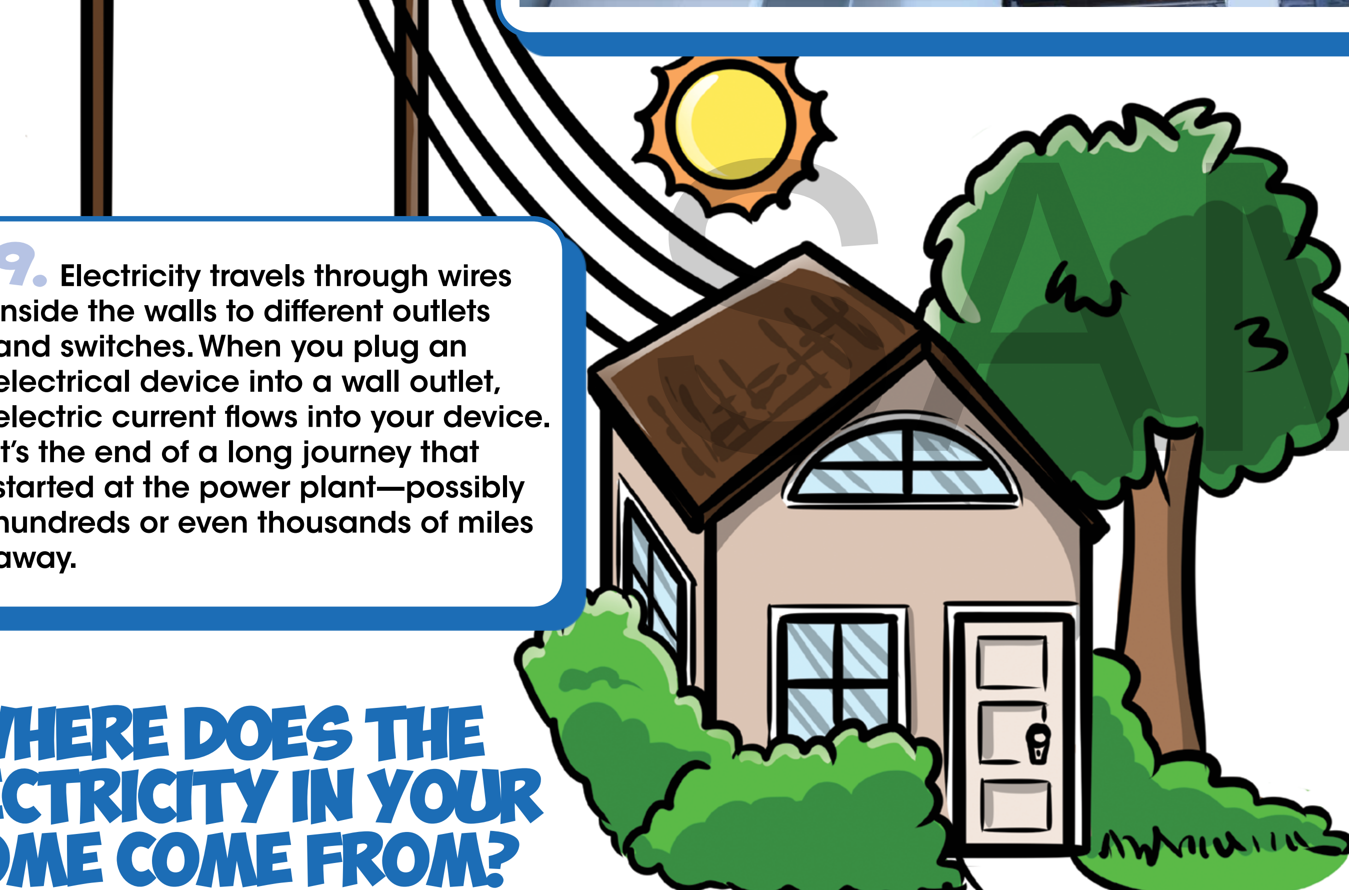
INSIDE A TRANSMISSION LINE

You might see transmission lines along major highways. They carry very high voltage electricity—up to 500 kilovolts (kV)! Transmission lines are commonly made of aluminum because it has low resistance and allows electrons to flow easily. This helps carry electricity over long distances. Transmission lines are extremely dangerous because unlike household wires, they are usually not insulated. Never go near or touch a transmission line or other power line.

CONTINUED ON PAGE 14!

7. Electricity enters your home through the service box. Here a meter keeps track of your home's electricity usage.

8. A service panel inside the building distributes electricity inside your home. It directs electricity to different switches, outlets, and appliances. Circuit breakers and fuses inside the service panel protect the wires inside your home from being overloaded. Only adults should ever open or touch the service panel.



9. Electricity travels through wires inside the walls to different outlets and switches. When you plug an electrical device into a wall outlet, electric current flows into your device. It's the end of a long journey that started at the power plant—possibly hundreds or even thousands of miles away.

WHERE DOES THE ELECTRICITY IN YOUR HOME COME FROM?

Do some research! (Note: Some of these things may be hard to figure out. If you need help, ask an adult.)

What is the name of your electric utility company? ______________________

Where is the nearest power plant? ______________________

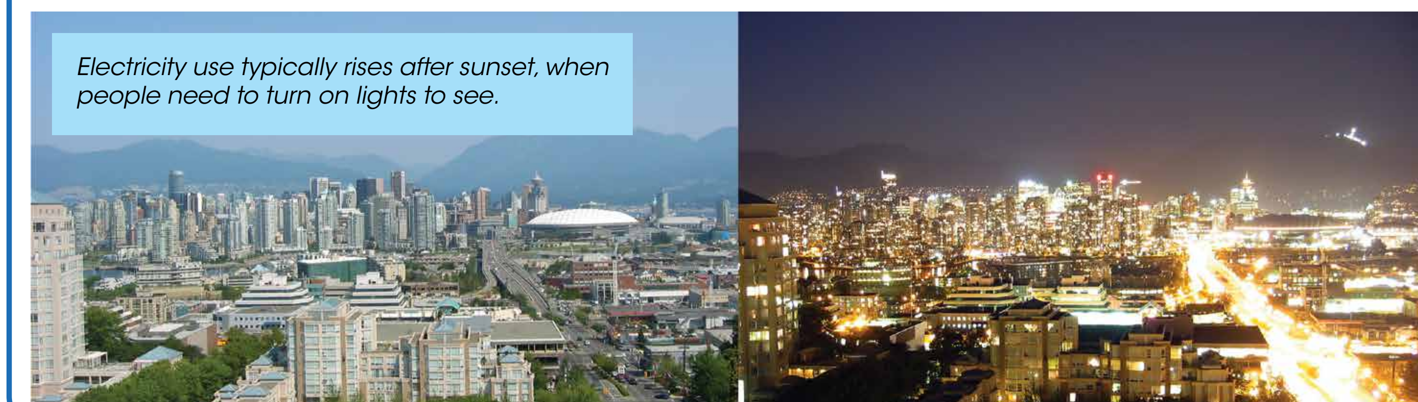
What primary energy source does it use? ______________________

How far does electricity travel from the power plant to you? ______________________

WHERE DOES IT ALL GO?

About two-fifths of the electricity used in the U.S. goes toward powering people's homes. Another two-fifths goes to schools, offices, stores, and other public places. Most of the rest is used in factories, on farms, or at construction sites. Altogether, the U.S. uses more than 3.8 trillion kilowatt hours (kWh) of electricity in a year. That's more than any other country except China.

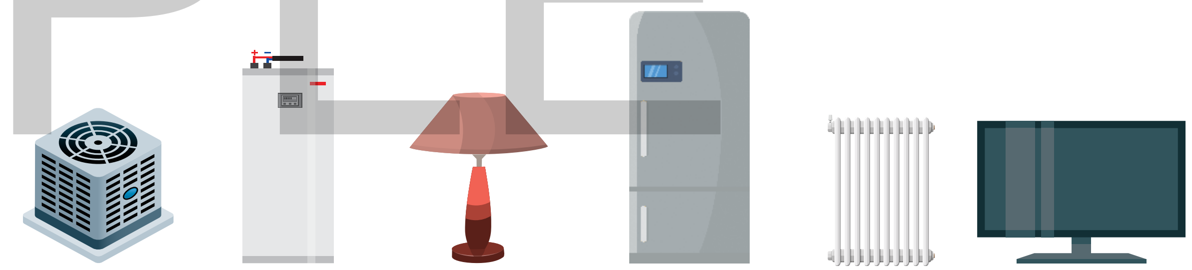
The amount of electricity we use changes depending on the day, the time, and even the weather.



Electricity use typically rises after sunset, when people need to turn on lights to see.

WHAT'S IT FOR?

How is electricity used in U.S. homes? Here are the top six uses, from most electricity consumed to least.



THINK ABOUT IT: Do you think this list is the same in every home? Why or why not?

WHAT IS A KILOWATT HOUR?

A kilowatt hour (kWh) is a unit used to measure electricity use over time. A mid-sized microwave running for 60 minutes would use about one kWh of electricity.

TRY IT: How many kilowatt hours (kWh) of electricity did your household use this month? ______________________

How much will this month's electric bill be If the utility company charges 11 cents per kilowatt hour? ______________________

DID YOU KNOW?

Today, there are three large, interconnected grid systems in the continental U.S. Within each one, electricity can flow in multiple directions depending on when and where it's needed most.

Source: US Energy Information Administration

ELECTRIC GRID WORD FIND

Can you find all the words you've learned in this book? Circle in green the words you know, and circle in red the ones you don't remember!

F	K	S	A	T	O	M	K	R	D	A	A	N	T	F	Y	I
D	F	Y	X	S	U	B	S	T	A	T	I	O	N	E	Q	E
A	Z	A	V	H	L	Y	G	H	J	K	F	O	O	N	O	F
W	E	L	C	O	N	D	U	C	T	O	R	Y	E	E	I	Z
T	L	L	Q	J	L	A	U	C	S	T	E	T	T	R	X	F
R	E	B	W	G	A	T	V	G	C	U	S	O	I	G	F	E
O	C	T	P	B	D	C	A	E	G	R	I	D	P	Y	K	T
S	T	G	V	R	B	A	L	G	T	R	F	T	Y	B	N	R
L	R	E	J	L	K	E	Z	J	E	A	C	X	T	F	L	S
W	I	N	D	T	T	R	A	N	S	M	I	S	S	I	O	N
D	C	E	N	U	O	O	C	B	Q	M	A	N	R	Z	C	R
S	I	R	H	R	B	G	S	I	T	K	S	S	E	S	A	R
F	T	A	Y	B	A	T	T	E	R	Y	J	A	F	L	H	J
N	Y	T	G	I	F	K	L	O	N	C	I	O	O	Y	N	R
A	W	O	K	N	J	A	F	H	L	L	U	S	P	O	H	E
C	U	R	R	E	N	T	Z	X	F	M	A	I	Y	K	K	N
J	K	S	L	S	D	S	T	A	T	I	C	S	T	E	B	B
N	M	N	U	C	L	E	A	R	C	Z	M	A	N	R	Q	R

Word List

- Atom
- Battery
- Circuit
- Conductor
- Current
- Electricity
- Electron
- Energy
- Generator
- Grid
- Nuclear
- Solar
- Static
- Substation
- Transmission
- Turbine
- Voltage
- Wind

TRY THIS SHOCKING EXPERIMENT!

HAVE YOU EVER touched a metal doorknob after shuffling across a shaggy carpet? If so, you may have felt a little zap of electricity. This is called static electricity. Don't worry, most household static electricity shocks are not dangerous—just startling.

WHAT IS STATIC ELECTRICITY?

Static electricity is a way electrons can move without flowing in a current. It happens when a buildup of electrons causes an imbalance in electric charge. Remember how electrons can move from one atom to another? When you walk across a carpet—especially if you're wearing socks—electrons from the floor rub off onto your feet. Each one carries a little bit of electric charge, which builds up on your body. The metal doorknob is a good conductor. When you touch it, the extra electrons discharge by jumping into the doorknob, and you feel a small shock. Dangerous electric shocks can work in a similar way, but on a much larger scale. Electrons move from an electrically charged object through your body to discharge.

TRY IT! MAKE YOUR OWN STATIC ELECTRICITY

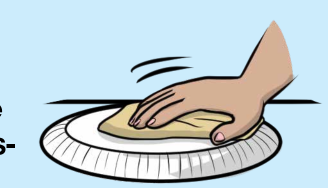
MATERIALS

- Styrofoam plate
- Thumbtack
- Aluminum pie tin
- Pencil with eraser
- Piece of wool fabric

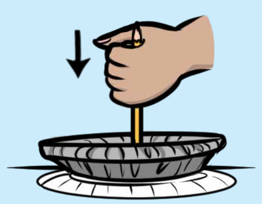
PROCEDURE

1. Gather your materials. Have an adult help you push the thumbtack through the center of the pie pan from the bottom up. Then carefully push the eraser end of the pencil into the tack.

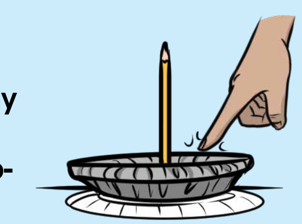
2. Place the Styrofoam plate upside-down on a table. Rub the bottom of the plate with the wool vigorously for at least 60 seconds.



3. Using the pencil as a handle, pick up the aluminum tin and place it on the Styrofoam plate.



4. Carefully touch the aluminum tin. You should feel a tiny shock! (If you don't feel anything, try rubbing the Styrofoam plate again.)



5. Now try it in the dark! Repeat steps 2-4 but turn off the lights before you touch the tin.

DID YOU KNOW?

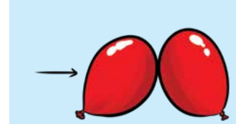
There is more static electricity during the colder seasons because the air is drier. During this time it's easier to build up electrons on the skin's surface. In warmer and wetter weather, the moisture in the air helps electrons dissipate slowly into the atmosphere.

IT'S AMAZING!

If two objects have the same charge they will repel each other. If two objects have different charges they will attract each other. An example of this is staticky hat hair! Your hairs all have the same charge and will push away from each other, causing your hairs to stand up and frizz out. Bummer!

TRY IT!

On the balloons below, label the charges based on their positions.



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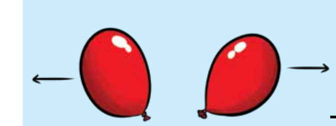

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ELECTRIC SAFETY

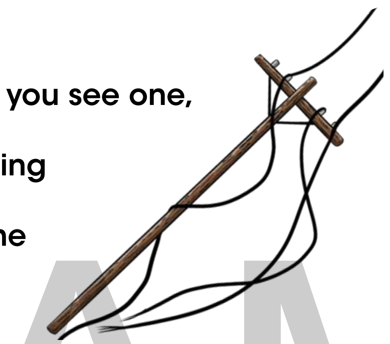
It's important to be safe around all parts of the electric grid. Electric shocks can seriously injure or kill people—but most shocks can be avoided if you know what not to do.

- **Stay away from areas marked with signs that say 'High Voltage' or 'Danger.'**
- **Stay away from and don't climb the fence around electrical substations.**
- **Stay inside during thunderstorms.**

POWER LINES

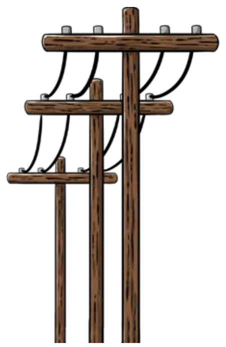
Power lines are one of the biggest electrical hazards outside. They carry high-voltage electricity that can be extremely dangerous. Be aware of your surroundings when you're outside. It's not uncommon for power lines to be damaged by wind or fallen trees after a storm.

DOWNED POWER LINES: BE AWARE!



- Stay far away from power lines that are dangling or on the ground. If you see one, ask an adult to call the power company right away.
- Never touch fallen electrical poles or transformers. These can fall during heavy storms or strong winds.
- If your car does come into contact with a downed wire, stay inside the car and do not exit. Call emergency services immediately for help.

INTACT POWER LINES: LOOK!



- Only fly kites in wide open areas away from power lines. If your kite touches an electrical wire, you are at risk of electrocution.
- Avoid climbing trees near electrical wires or power lines.
- Do not post posters or flyers on electric poles. Try posting in neighborhood shops instead.
- Do not plant trees that will grow tall near power lines. Make sure to plant them a safe distance away.

OUTLETS, SWITCHES, AND CORDS

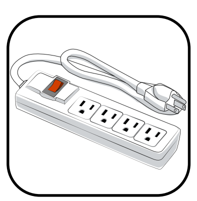
DON'T PLUG TOO MANY THINGS INTO ONE OUTLET. This is a common problem during the winter and holidays.

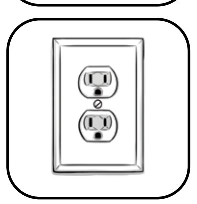
KEEP ALL ELECTRIC CORDS ORGANIZED.
Keeping cords neat means no one trips and falls.

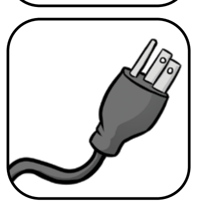
NEVER YANK ELECTRICAL CORDS.
Don't pull cords from outlets.

DON'T STICK ANYTHING INTO AN OUTLET.

CHECK CORDS FOR DAMAGE. Ask an adult to replace any frayed, loose, or cracked cords and plugs.







KEEP CORDS OUT OF THE WAY.
Do not run extension cords across doorways or under carpeting or furniture.

DON'T DAISY CHAIN.
Only plug extension cords and power strips into wall outlets. Do not plug them into other extension cords or power strips.

DO NOT STAPLE OR NAIL CORDS TO THE WALL OR FLOOR.
Use tape or twist ties instead. Damaging electric cords with staples or nails can create a fire hazard.

POWER'S OUT!

Utility companies do everything they can to avoid power outages, but blackouts do sometimes happen. Storms can damage electrical equipment, and high demand for electricity—like when everyone runs air conditioners during a heat wave—can overwhelm the electric grid.

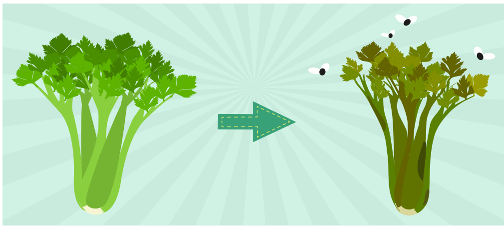
When an outage occurs, utility workers try to restore electricity as quickly and safely as possible. In the meantime, everyone needs to be careful. Here are some important tips for staying safe:

DURING AN OUTAGE:

- Keep the fridge and freezer closed to help them stay cold longer. Eat food from the pantry instead.
- Instead of using candles and risking a fire, use flashlights for light.
- Never use gas stoves, charcoal grills, or generators for heat indoors. The fumes are very dangerous. Stay warm with clothing and blankets.
- If it's hot out, stay cool by going to the lowest level of your home. Wear light clothing and drink lots of water.
- If it's extremely hot or cold, try to go somewhere that still has power to cool down or heat up.

AFTER AN OUTAGE:

- Throw out any food in the fridge that reaches 40 degrees Fahrenheit or higher for more than two hours—or anything that looks or smells funny. It could be spoiled and unsafe to eat.



BE PREPARED!

A few simple steps can help you and your family prepare for an unexpected power outage. Talk to an adult about assembling an emergency kit, stocking the pantry, knowing where flashlights and batteries are located, and making a family communication plan.

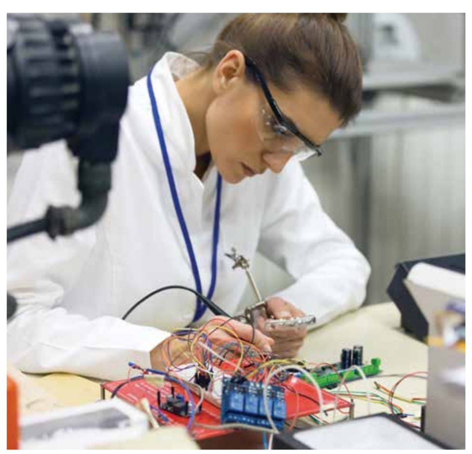
CAREERS IN ELECTRICITY

Interested in electricity and the grid? Here are some careers you might enjoy:

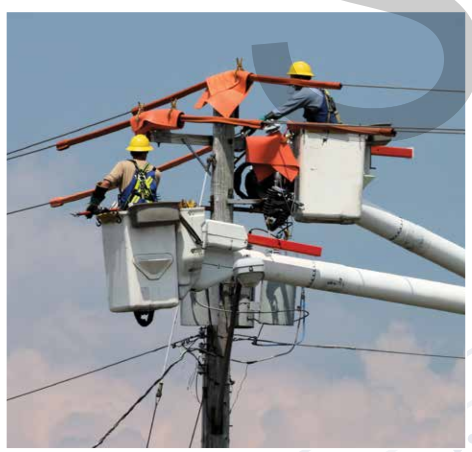
ELECTRICAL ENGINEERS
design, test, and install new forms of electrical equipment, such as machines in a factory.

ELECTRICIANS
visit homes and businesses to install and repair electrical wires, lighting, and other parts of the power system.

POWER PLANT OPERATORS
make sure power plants are running smoothly and adjust the flow of electricity to meet the community's needs.



ELECTRONICS TECHNICIANS
build circuits and other electrical components for computers, sound systems, phones, airplanes, and more.



LINE WORKERS
maintain and fix the electric lines that keep us all connected to the grid.

WIND AND SOLAR TECHNICIANS
inspect and repair solar panels or wind turbines to keep them producing electricity efficiently.

WHAT DO YOU THINK?

Think about everything you've learned in this book. How has the way we get electricity changed over time? How might it change in the future? What new ways might people find to harness and use electricity? Can you think of three jobs in electricity that might exist someday?

THE FUTURE OF THE GRID

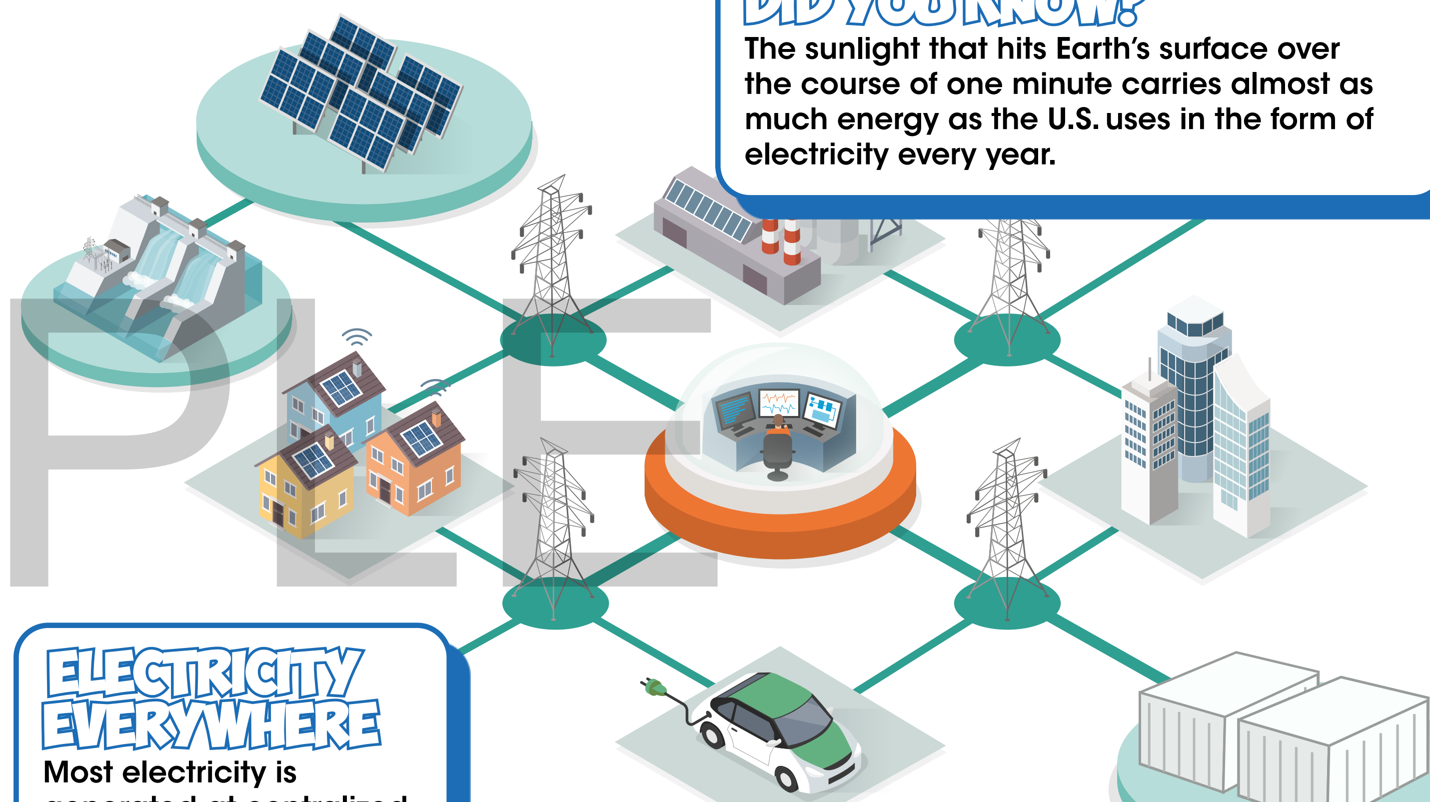
The way we get electricity has changed a great deal since the 1800s. To keep it efficient and reliable as technology improves, scientists and engineers are working to make some upgrades.

RENEWABLE ENERGY

Energy sources like fossil fuels and nuclear power are non-renewable resources. They rely on substances harvested from nature that will eventually run out. Sun, wind, and water are renewable resources. They cannot be used up. Today, most of the electricity generated in the U.S. comes from fossil fuels, but the amount of electricity from renewable sources has been steadily growing since the 1980s. Many people are working on improving renewable-energy technology so that this trend can continue.

DID YOU KNOW?

The sunlight that hits Earth's surface over the course of one minute carries almost as much energy as the U.S. uses in the form of electricity every year.



ELECTRICITY EVERYWHERE

Most electricity is generated at centralized power plants, then travels through the grid to reach its users. But electricity can increasingly be produced in the same place it will be used. Homes, factories, and farms can use solar panels or small wind turbines to generate their own electricity. As the technology becomes cheaper and more efficient, these ways of harnessing electricity are on the rise.

ENERGY STORAGE

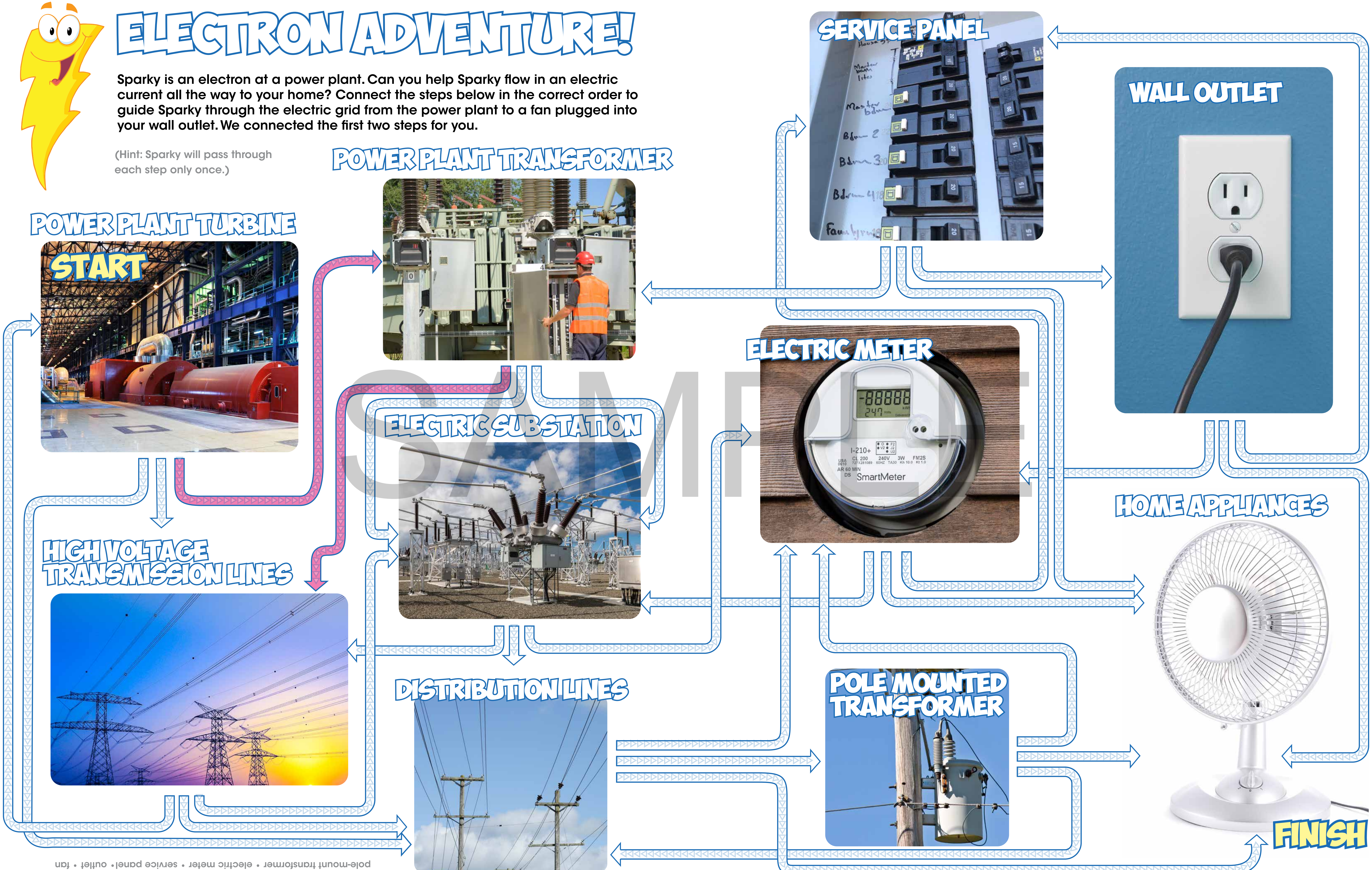
Because of the way it's generated, most electricity from power plants can't be stored for later. It must be used when it's produced. Utility companies try to generate the amount their customers will need, and because the grid is connected, they can also share and trade electricity with other areas. But getting this balance right is tricky, and some electricity—and the fuel used to generate it—still goes to waste.

Engineers are working on ways to store the energy harnessed at power plants. One way to do this is with giant rechargeable batteries, which can hold and then release electric charge. Extra electricity can also be used to pump water uphill or pressurize large air tanks. The water or air is released later to power turbines that generate electricity.

ELECTRON ADVENTURE!

Sparky is an electron at a power plant. Can you help Sparky flow in an electric current all the way to your home? Connect the steps below in the correct order to guide Sparky through the electric grid from the power plant to a fan plugged into your wall outlet. We connected the first two steps for you.

(Hint: Sparky will pass through each step only once.)



Answer: Turbine • transformer • transmission lines • substation • distribution lines • pole-mount transformer • electric meter • service panel• outlet • fan

Resources

ENERGY INFORMATION ADMINISTRATION
www.eia.gov/kids

WHAT IS THE SMART GRID? (DEPARTMENT OF ENERGY)
www.smartgrid.gov

ENERGY AND THE ENVIRONMENT (ENVIRONMENTAL PROTECTION AGENCY)
www.epa.gov/energy

ELECTRICAL SAFETY FOUNDATION INTERNATIONAL
www.esfi.org

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