Electrical & Natural Gas Safety World (Spanish)
Teacher's Guide

Introduction
Electrical & Natural Gas Safety World uses articles, experiments, and activities to explain electric and natural gas science concepts, and how to use these fuels safely in daily life. The content addresses many state and national science and health education standards for grades 4-6.

This presentation guide provides the objective for each page spread, background and ideas for classroom discussion, activity and puzzle answers, suggestions for experiment setup and completion, and follow-up activities.

Activities can be done with materials listed in the booklet; electrical components are available from electronics retailers.

Page 2: Introduction to Energy Use
<u>Objective:</u> To make students aware of how they use energy (e.g., for light, heat, etc.) and the sources of energy they use (e.g., electricity, natural gas, etc.).

<u>Background/Discussion:</u> Energy is the ability to change or move matter. Without energy there would be no motion, no light, and no heat, and life would not exist. Ask students where they get their energy. *(Food.)* Ask where the appliances in their homes get energy. *(Sources like electricity or natural gas.)*

<u>Energy Use Chart:</u> Help students complete the energy use chart. Ask them to consider whether they did any of the following things today: took a bath or shower, cooked food, watched a TV show or video, listened to music, were driven to school, enjoyed a warm (or cool) home, or played a computer game. Ask students what appliance or equipment they used to do each thing. Have them record their answers in the first and second columns. If students are not aware of the energy sources that run the appliances and equipment they used, ask them to check with their families and fill out the third column at home. *(Tips for recognizing energy sources: Electrical appliances plug into a wall outlet and portable electric devices run on batteries. Appliances and equipment that use natural gas or other fuels have a flame inside when they are on.)*

<u>What Do You Think?</u> Students' answers will vary. Depending on your climate and season, keeping warm or cool without using energy may require a lot of ingenuity. Students may find it interesting to speculate about—or do some research on—how people native to your area kept warm or cool before the invention of modern heating and air conditioning systems.

<u>Follow-up:</u> Have students complete a day's energy diary showing all the sources of energy they use from the time they get up until they go to sleep.

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Page 3: Energy Vocabulary
Objective: To familiarize students with some new concepts and vocabulary.

Background/Discussion: Review the vocabulary words in the word search. Preview the book by asking students to find the first time each of these words is used. *[Aislante (Insulator) —p. 8; Átomos (Atoms)—p. 4; Circuito (Circuit)—p. 6; Conductor (Conductor)—p. 8; Corriente (Current)—p. 6; Electricidad (Electricity)—p. 2; Electrón (Electron)—p. 4; Energía (Energy)—p. 2; Gas natural (Natural Gas)—p. 2; Mercaptano (Mercaptan)—p. 14; Voltios (Volts)—p. 9; Vatios (Watts)—p. 2.]*

Have students write a paragraph using some of these words.

Word Search Key: The first letter of each word is underlined and italicized.

A	I	S	L	A	N	T	E			*E*	
	T	N	E	I	R	R	O	*C*		L	
L	A	R	U	T	A	N	S	A	*G*	E	S
							A			C	O
I	*C*	O	N	D	U	C	T	O	R	T	I
G		I					O			R	T
R			R				M			O	L
E				C			O			N	O
N					U		S				*V*
E	L	E	C	T	R	I	C	I	D	A	D
					V	A	T	I	O	S	
								O			
O	N	A	T	P	A	C	R	E	*M*		

Pages 4 & 5: How Electricity Happens
Objective: To explain how electricity is generated and to distinguish which generation methods are based on renewable energy and which on nonrenewable energy.

Background/Discussion: How is electricity produced? *(It is generated at power plants using various fuels.)* No matter what fuels produce the electricity you use, do your lights shine, and does your radio play and your computer run in the same way? *(Yes.)* Which fuels on these two pages are used to generate most of the electricity used in the U.S? *(Fossil fuels including coal, oil, and natural gas; followed by nuclear energy and hydropower.)*

What does the drawing on page 4 represent? *(An atom.)* What is the name for the center of an atom? *(Nucleus.)* Have students draw pictures of atoms. Teach them that the atom has two main parts: a tiny nucleus and the electrons that surround it. The electrons actually fill the whole space around a nucleus. Electrons move in random orbits.

Which Are Renewable?
Before doing this activity, discuss the meaning of the word "replenished." *(To make full or complete again by supplying what has been used up.)*

Fossil Fuels: Coal, oil, and natural gas were formed millions of years ago, when plants and tiny sea creatures were buried by sand and rock. Their bodies decomposed and as a result of the earth's heat and pressure, they turned into fossil fuels. These fuels are considered NONRENEWABLE because they will some day be used up.
Nuclear Power: The uranium that runs nuclear power plants must be mined from the ground. Like fossil fuels, uranium supplies are finite and NONRENEWABLE.

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Hydropower: The most common form of hydropower uses dams on rivers to create large reservoirs. Water in rivers is continually replenished, so hydropower is RENEWABLE. In fact, hydropower is currently one of the largest sources of renewable power.
Biomass: Wood is the largest source of biomass energy, followed by corn, sugarcane wastes, straw, and other farming by-products. Because plants and trees need sunlight to grow, biomass is a form of stored solar energy. Although it is possible to use biomass faster than we produce it, more can be grown, so biomass is RENEWABLE.
Geothermal Energy: Comes from "geo" for earth, and "thermal" for heat. The hot molten rock inside the earth isn't going away anytime soon, making geothermal energy RENEWABLE. Although it is renewable, geothermal energy has some limitations: people must be careful not to draw steam or hot water out of the earth faster than it can be replenished.
Solar Energy: The sun's energy is captured in special panels of photovoltaic cells. The sun's energy will never run out (at least not for several billion years), so solar energy is considered RENEWABLE. It's true that sometimes the sun isn't shining, so photovoltaic cells cannot always make electricity. However, solar power systems can store electricity in batteries for non-sunny days.
Wind Power: The wind will be around as long as the earth is, so wind power is RENEWABLE.
Fuel Cells: Fuel cells run on hydrogen. If the hydrogen comes from a renewable resource like landfill gas, fuel cells are RENEWABLE. However, if it comes from a nonrenewable resource like fossil fuels, fuel cells are considered NONRENEWABLE.

<u>Follow-up:</u> After students complete this activity, make a list on the chalkboard of renewable and nonrenewable fuels.

Page 6: Go with the Flow
<u>Objective:</u> To explain how electricity flows in a home electrical system.

<u>Background/Discussion:</u> This illustration does not show electricity's complete circuit. Explain to students that electricity is generated in a power plant and sent out over transmission lines to a substation where the voltage, or pressure, is reduced. Then electricity flows through the overhead and underground distribution lines shown in the illustration, to homes and buildings. After it is used it flows back out into the power grid.

Find out how much your students know about electrical safety. Ask students to select three of the numbered locations on the drawing. Have them describe behavior that could put someone in contact with electricity at each location, and a safety tip or safe practice to prevent this. For example, for #10, the electrical outlet, a dangerous behavior would be to poke a sharp object into the outlet. A safety tip to prevent this would be "Put only plugs into outlets."

Page 7: Which Bulbs Will Light?
<u>Objective:</u> To teach the characteristics of an electrical circuit.

<u>Background/Discussion:</u> Before doing the activity, introduce the concept of a closed path. Explain that a closed path is like a continuous loop, with no breaks or obstacles in it. Ask students to name some shapes that are closed paths, and some that are open. Some examples of closed paths are a circle, square, rectangle, and triangle. Examples of open paths are a spiral, a line, and a U-shape. For electricity to flow, it needs to travel in wires that are a closed path with no breaks or obstacles.

In this activity, the path goes between the negative side and the positive side of the battery. Electric current flows from the positive side of the battery to the light bulb and back to the negative side of the battery.

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<u>Answer Key:</u>
Top Left: OPEN. The bottom wire touches the base of the light bulb but the top wire does not. The top wire touches the top of the light bulb, and because the glass of the light bulb does not conduct electricity, it is an obstacle that prevents electricity from flowing along the wires.
Top Right: CLOSED. Bending the wire does not affect whether the circuit is open or closed.
Middle Left: OPEN. Electricity cannot flow because the wire only goes from the battery to the bulb (or vice versa). There is no return path.
Middle Right: BOTH ANSWERS CAN BE CORRECT. This picture can be read in two ways. If students think it is showing the metal base of the bulb directly touching the bump on the battery, then the circuit is CLOSED. If they think the metal base of the bulb is not directly touching the bump on the battery, then the circuit is OPEN.
Bottom Right: CLOSED. There are actually two closed loops in this example.

<u>Did You Guess Right?</u> Setup: If you are doing this in class with batteries and bulbs, strip the wires ahead of time and make sure the batteries are fresh. Although the illustrations do not show it, it's helpful to twist the wire around the base of the bulb and to tape the wires to the battery.

<u>Follow-up:</u> When there is a break in a circuit, electricity cannot flow. In that case, we say the circuit is open. When you turn on a light, is that a closed or open circuit? *(Closed.)* When you turn a light off, is that a closed or open circuit? *(Open.)*

Page 8: Conductors & Insulators
<u>Objective:</u> To teach students to recognize materials that conduct electricity. To explain that water, metal, and the human body can conduct electricity, making people vulnerable to electrical shock.

<u>Discussion:</u> Why is it important to know the difference between conductors and insulators? *(If you know about some common objects that are conductors, you might be more likely to keep these objects out of electricity's path; i.e., you would know not to stick a metal fork into an outlet or toaster or touch a power line with a metal ladder.)* Do you ever use ladders or long tools when working outside around your home? What precautions should you take to stay safe? *(Answers may include use nonconductive fiberglass ladders and tools; keep all tools and equipment at least 10 feet away from any power line.)* What precautions do you think utility line workers take to avoid electrical shock? *(They use specially tested insulating gloves, tools, and equipment, and are specially trained.)* Stress to students that only trained people should climb power poles and work on power lines.

<u>Activity:</u> People who work around power lines would be more likely to use the fiberglass ladder, the work gloves, and the safety goggles. Here's why:
- The metal ladder is a conductor, while fiberglass is an insulator.
- The work gloves are specially tested rubber, while the kitchen gloves are very thin rubber and not designed to insulate from electricity.
- The goggles do not have any metal on them while the glasses do, and metal conducts electricity.

Safety Note: If insulators are wet, damaged, or dirty, or if the voltage is high enough, materials that are insulators can conduct electricity. Teach students never to assume that an insulator will block electricity.

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What Do You Think? *The characteristic properties of a substance are independent of the amount of the substance. So metal scissors will conduct electricity just as easily as a metal ladder.*

Follow-up: Draw a utility worker wearing safety equipment.

Experiment
If you have a battery/wire/bulb circuit setup, use it to test a variety of materials to see how these allow or block the flow of electricity (e.g. conductors: penny, metal paper clip, metal barrette; insulators: eraser, rubber band, glass button). Have students predict which objects will conduct and which will insulate against electricity. Attach one of the wires from the battery to one end of the material being tested, and one of the wires from the light bulb to the other end of the material being tested. Have students observe whether or not the bulb lights up, and see if their predictions were correct.

Page 9: Lightning
Objective: For students to understand that high-voltage shock can come from lightning as well as wires, and to learn how to avoid a lightning strike.

Background/Discussion: What is lightning? Electrical charges develop inside a storm cloud. Positively charged atoms go to the top of the cloud. Negatively charged atoms go to the middle or bottom. If the negatively charged atoms become too crowded, they jump to another part of the cloud, to a different cloud, or to the ground. This jump causes a huge spark of static electricity known as lightning.

In the U.S. each year, about 100 people are killed by lightning strikes and more than 1,000 are injured. Carissa was quite lucky. Most people who survive lightning strikes have much worse and longer-lasting injuries than Carissa's. Ask students: Have you ever been on a golf course, sports field, or near water when a storm was approaching? What did you do? If you stayed outdoors, did you realize that you risked being struck by lightning?

Emphasize to students that if a storm is approaching or under way, they must immediately follow these precautions: Get indoors. Stay away from windows. Lightning can travel through plumbing pipes and electrical and telephone wiring, so stay away from tubs, sinks, anything electrical, and corded phones.

What Do You Think? *The electricity from one lightning bolt could light up 250,000 homes. (30,000,000 volts/120 volts = 250,000)*

Follow-up: Have students make a list of safe and unsafe places to be during an electrical storm.
- Safe places: inside a large, permanent building; inside a hardtop vehicle.
- Unsafe places: near metal or water, under trees, on hills, near electrical equipment including computers, corded phones, and TVs.

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Page 10: Shocking Scene
Objective: To counteract a misleading movie scene, and to teach students to never contact or throw anything at power lines.

Background/Discussion: Electricity always takes the easiest path to the ground. It will stay in a circuit unless it can find a path to the ground. If you touch a circuit and the ground at the same time, you can become electricity's easiest path to the ground. Electricity can flow through water, and because your body is 70% water, electricity can flow through you!

Emphasize to students that if they touch a power line while standing on a ladder or a roof, electricity would travel through them. And if their kite or balloon got tangled in a power line and they touched the string, electricity could travel down the string and into them on its way to the ground. Both situations would mean a serious (and possibly fatal) electric shock!

Now that students know a little about electrical safety, they can notice electrical safety errors in movies, books, TV shows, etc. Ask students if they have seen examples of people doing unsafe things around electricity in movies or TV programs. Did the person get an electric shock? Encourage students to write up their examples and/or do an oral presentation.

What Do You Think? *Electricity doesn't travel down metal utility poles because specially designed insulators hold the electrical wires away from the poles. That's why it's so important to never shoot at or throw things at insulators. If they break, electric wires can touch the utility pole and travel down it to the ground.*

Page 11: Outdoor Safety Tips
Objective: To teach students how to be safe around overhead lines and underground utilities.

Background/Discussion: Why is it so dangerous to fly kites near power lines? *(Kites in power lines can cause outages or fires. If you touch the string of a kite that's caught in a power line, you could be shocked.)* Why is it so dangerous to use electricity near water*? (Because water conducts electricity.)* What is the safest way to use electricity in areas near water? *(Use battery-powered appliances. If you must use corded appliances, make sure they are plugged into a ground fault circuit interrupter, also called a GFCI. These devices monitor the flow of electricity in a circuit and if any is escaping the circuit, they quickly shut off power to prevent serious shock.)*

What can happen if someone uses digging equipment without knowing the location of underground utilities? *(They could damage underground gas pipelines and cause a fire or explosion, or they could contact underground electric power lines and get a serious shock. Even if the person digging does not get hurt, the damage to the utilities could interrupt electric or gas service to lots of people.)* What should people do before digging? *(Call the underground utility locator service—now accessible by dialing 811—several days before digging to have the location of buried utilities marked for safety.)*

Why are fallen power lines so dangerous? *(They could be carrying electricity and if you contact them or something they are touching, you could be shocked.)*

Get Creative: Make sure students' creations include both a safety tip about electricity or natural gas, and what could happen if people don't follow it.

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Follow-up: Have students practice how they would get out of a car with a power line on it. Emphasize that they must shuffle away from the car, keeping their feet close together and on the ground. If they take big steps, their feet could make a circuit for electricity to travel. Ask them what would be the hardest part of doing this in a real accident situation, and have them practice it so it becomes second nature.

Page 12: Indoor Electrical Safety
Objective: To help students apply what they have learned about conductors and insulators to some indoor electrical safety situations.

Background/Discussion: Why should you unplug a toaster before trying to get something out of it? *(A plugged-in toaster could conduct electricity to you, especially if you use a metal fork, which is very conductive.)*

Answer Key: 1. Unplug the toaster first. Don't use a frayed cord. Use a battery-powered radio near water.
2. Left picture: conductors are the girl, the metal fork, and the metal parts of the toaster. Middle picture: conductors are the copper wire inside the cord. Right picture: conductors are the water, the metal faucet, the metal sink, the metal parts of the radio, and the boy. 3. Here is why each situation is dangerous: GIRL: The girl could contact a live electrical part of the toaster. Electricity would travel through the fork into her and she would be shocked. CORD: The frayed cord is dangerous. Anyone who touches the exposed wires will be shocked. BOY: If the boy gets the radio wet or it falls into the sink, water could conduct electricity to him and he would be shocked. The same thing could happen if the insulation on the radio cord is worn or damaged.

Safety Tips: Students' answers will vary. Some possibilities include: "Don't put power cords under rugs or furniture legs. The cords could get damaged without anyone knowing." "Keep electrical heaters away from anything that can burn. Heaters get hot and can set flammable objects on fire." "Don't stick anything in an outlet but a plug, or you could get shocked." "Don't touch anything electrical with wet hands or when standing in water. Water conducts electricity and you could be shocked."

Page 13: The Three States of Matter
Objective: To help students understand the characteristics of solids, liquids, and gases.

Background/Discussion: What is matter? *(Anything that takes up space or has a mass of any kind. Everything you can touch is made of matter. If it is made of anything, it is matter.)* There are actually four states of matter. The fourth state, not discussed on this page, is plasma—a gas made up of free-floating ions.

Answer Key: Left box: Gas. Middle box: Liquid. Right box: Solid.

What Do You Think? *Oil is a liquid. Natural gas is a gas. Coal is a solid.*

Follow-up: You can show how three states of matter exist at once in a burning candle. (This experiment should only be done under a teacher or other adult's supervision.)

1. Ask an adult to light a candle. Let the candle burn for a minute.
2. Which part of the candle is solid? Which part is liquid? (The wax is solid. The melted wax is liquid.)

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3. Is any part of the candle a gas? To find out, have an adult light a match, then blow out the candle and quickly move the lit match to about ½″ above the wick. The match should light the candle without touching the wick. If it does not, repeat steps 1 and 2.
4. What happened? (The first flame heated the candle wax, turning it to a liquid. As the candle burned, the liquid wax heated up even more and turned into a gas. The gas rose up the wick and into the air. The second flame from the match ignited the gas.)

Page 14: All Those Pipes!
Objective: To familiarize students with the natural gas distribution system so they understand how gas gets from the well to their homes.

Background/Discussion: Natural gas is pumped from wells drilled deep into the earth to processing plants, where impurities are removed. Natural gas is then pressurized so it will flow through many miles of pipes, where it can either be stored in storage tanks or delivered directly to homes and businesses by the local natural gas utility. The gas travels through larger pipes, called distribution mains, to smaller service lines that lead to individual homes. The service lines pass through a gas meter that measures the amount of gas being used. Then the pipes deliver the gas to appliances inside the home.

Because natural gas travels to homes and businesses in underground pipes, natural gas service can't be interrupted by storms. But people need to take care not to damage underground gas pipes with digging equipment, or the natural gas can leak out, causing a fire hazard. Remind students that if their family is planning a digging project, they must call the utility locator service at 811 several days before digging so underground utilities can be marked for safety.

Follow-up: What does the word "processing" mean? *(Treatment.)* What does the term "compress" mean? *(To make smaller, compact.)*

Page 15: Natural Gas Safety Tips
Objective: To teach students important gas safety practices, and what to do if they smell gas.

Background/Discussion: Why is it so dangerous to store flammable objects near gas appliances? *(Gas appliances use a flame and some, like an oven or heater, can get hot enough to set fire to something flammable that is close by. Also, the fumes of flammable liquids could be ignited by the flame or pilot light inside a gas appliance.)* If you smell gas when no one is home, what should you do? *(Leave and take everyone with you. Don't use a light switch, candle, TV, radio, garage door opener, or even a phone. Any electrical appliance can emit a spark that could ignite the gas. Go to a safe location to report the leak to 911 and your local natural gas utility.)* What does it mean if your gas range has a large, yellow, or flickering flame? *(It is not working properly and you should call a repairperson.)* Why shouldn't you let small children play with gas appliances? *(They could turn them on by mistake or damage the pipes and cause a gas leak.)* What are some signs of a gas pipeline leak and what should you do about them? *(A smell of sulfur or rotten eggs, a hissing or roaring sound, dirt spraying or blowing into the air, continual bubbling in water, grass or plants that seem to be dead or dying for no reason.)* What should you do if you suspect a gas pipeline leak? *(Do not use electricity or fire as a spark could ignite the gas. Go far away from the area immediately, and do not go back until safety officials say it's safe. Ask a trusted adult to call 911 and the local natural gas utility.)*

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Back Cover
<u>Objective:</u> To encourage students to share important hazard prevention tips with their families.

<u>Background/Discussion:</u> Why should you carry out a home safety inspection? *(You might find something hazardous in your home that could be fixed.)*

Explain each of the hazards in this list. Ask students if they can explain why it is a hazard. *(1. Overloaded outlets can overheat and cause a fire. 2. Worn or frayed cords mean insulation can't do its job, so anyone who touches the cord could be shocked. 3. Cords under rugs or furniture can become worn or frayed without anyone's knowledge, and can overheat or become a shock hazard. 4. Kids who play near gas appliances or pipes can cause gas pipe connections to loosen, which could result in a natural gas leak. 5. Heaters close to anything that can burn can cause a fire. 6. Digging without first calling 811 to have underground utilities marked can result in someone accidentally hitting and damaging underground power lines or gas pipelines. This could create a shock hazard or a fire hazard. 7. Water conducts electricity, so appliances used near water can be a shock hazard.)*

<u>Homework:</u> Ask students to take this inspection checklist home and to do the inspection with their families. Ask students to report back what hazards, if any, they found in their homes and whether/how their family fixed the hazard.

<u>Follow-up:</u> Can you think of any other items you could add to this safety inspection checklist?

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