Introduction
The *Use Electricity Safely and Wisely Experiments* book uses experiments, nonfiction text, and activities to explain electricity-related science concepts and how to use electricity safely in daily life. The content addresses Common Core (informational text), science, and health education standards for grades 4-6.

This presentation guide provides the objective for each page, ideas for classroom discussion, activity and puzzle answers, and suggestions for experiment setup and completion.

Page 2: Introduction to Energy Use
Objective: To make students aware of how they use energy (*i.e.*, for light, heat, *etc.*) and the sources of energy they use.

Energy Use Chart: 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.*)

What Do You Think? 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.

Page 3: Why Save Energy?
Objective: To explain some environmental and financial reasons for saving energy, and to introduce energy-related vocabulary.

Background/Discussion: A lot of the energy we use at home, at school, and for transportation comes from fossil fuels that were created millions of years ago—even before the dinosaurs were here. There is only a limited amount of these fuels, and we are using them up very fast. Using energy more efficiently will allow our fossil fuel supplies to last longer. Using energy efficiently also helps the environment by reducing the amount of pollution that is related to energy use. And using energy efficiently saves you money. Your family pays for the energy you use, so using less means you have more money to spend on other things.
Page 4: Let It Shine
Objective: Demonstrate the transformation of electrical energy to heat (thermal) and light (electromagnetic) energy in a light bulb; compare the energy efficiency of incandescent and compact fluorescent light bulbs.

Discussion: Review with students the forms of energy: mechanical (energy of motion), thermal (heat), chemical (energy in chemical bonds that hold compounds together), electrical (electrical charges), electromagnetic (visible light, X-rays, and other wavelengths of the electromagnetic spectrum), and nuclear (energy that holds atomic nuclei together). Remind students that energy cannot be created or destroyed, but can change from one form to another. Ask: What form of energy operates a light bulb? (Electrical energy.) What forms of energy does a light bulb emit? (Light and heat.)

Heat…or Light
Safety Note: Caution students that a burning light bulb can burn skin or cloth. Have students use an oven mitt when holding the thermometer near either bulb.

#4. Ask students if they’ve heard the term lumens. Explain that lumens measure how much light a bulb provides, whereas watts tell us how much energy it uses.

Answer Key: #1 and #2: Actual temperatures will vary. #3: The incandescent bulb will produce significantly more heat than the CFL. #4: The 60-watt bulb produces about 13 lumens per watt; the 15-watt CFL produces about 53 lumens per watt. #5: The CFL is more energy efficient, because less of its energy goes toward making heat and more of its energy goes toward making light.

Page 5: You’re Getting Warmer…
Objective: To help students understand how the greenhouse effect works.

Background/Discussion: Greenhouse gases make life on Earth possible—without them, the planet would be much colder. The problem is that their concentrations have increased due to human activities. Natural sources of greenhouse gases, like volcanoes and animals, used to be in balance with natural absorbers of those gases—especially trees and oceans. But humans burn so much fossil fuel now that we release more carbon dioxide than natural absorbers can handle. Recent research shows that the concentration of carbon dioxide in our atmosphere is indeed increasing,
and as a result the Earth’s weather patterns, ocean levels, and habitats are changing. This phenomenon is known as **climate change**.

**Experiment:** Students’ predictions, observations, and conclusions will vary. Answers to #6 should include the observation that the ice in the covered jar melted faster because the plastic wrap kept the temperature in the jar warmer. Students should explain that the plastic wrap holds in heat just as the clear greenhouse gases trap the Earth’s heat. Ask students what kind of energy melted the ice cubes. **(Radiant energy.)**

**Pages 6 & 7: 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.

**Discussion:** No matter what fuels produce the electricity you use, do your lights shine, does your radio play, and does 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 United States? **(Fossil fuels including coal, oil, and natural gas; followed by nuclear energy and hydropower.)**

**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. The processes that formed them are no longer occurring, so fossil fuels are NONRENEWABLE.
- **Nuclear Power:** The uranium that runs nuclear power plants must be mined from the ground. Like fossil fuels, uranium supplies are finite and NONRENEWABLE.
- **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 will never run out, so solar energy is RENEWABLE. It’s true that sometimes the sun isn’t shining, so photovoltaic cells cannot always make electricity. However, some 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.
Page 8: Electricity Flows Easily Through Conductors…But Not Through Insulators
Objective: To explain how conductors and insulators facilitate and block the flow of energy through a circuit, and to show students first-hand how they work through testing a variety of materials.

Discussion: Point out to students that energy is transferred along the circuit’s path by electric current.

Make Your Own Circuit
1. The following materials are conductors: foil, paper clip, tin lid, penny. The following materials are insulators: toothpick, dry dirt, glass, leather, plastic lid, paper, eraser, and rubber band.
5. Answers will vary according to what items the students choose.

Going Further: Point out to students that water is also a good conductor, and that most insulators will not work if they are wet. Have students wet their best insulator from their experiment, observe what happens, and explain why it happened.

Page 9: Make a Simple Switch
Objective: To help students understand how an electric switch works.

Background/Discussion: Ask students what happens when they enter a room and turn on a light switch. (Explain that when a light switch is turned on, a circuit is completed, so that an electric current can flow to the light bulb.) Reiterate the safety tip, to never experiment with electricity from wall outlets.

Page 10: Make a Wet-Cell Battery
Objective: To show students that electricity can be created through a chemical reaction.

Background/Discussion: The battery you create changes chemical energy into electrical energy. There is a chemical reaction between the metals in the coins and the lemon juice. The acid in the lemon juice makes extra electrons collect on one coin. The electrons flow through the lemon when the multimeter completes the circuit. A single lemon usually produces only about 7/10ths of a volt of electricity—not even enough to run a digital watch!

Page 11: Build an Electromagnet
Objective: To teach students how an electromagnet works.

Background/Discussion: Have students test the power of the electromagnet depending on how many times the wire is wrapped around it. The students will determine that the more times the wire is wrapped around, the stronger the magnetic force. Explain that when the wires are attached to the battery posts the nail becomes magnetized. The students will see that by running electric current through a wire, they can create a magnetic field.

Page 12: If a Storm Threatens
Objective: To help students and their families learn how to be prepared for a storm.
Discussion: Ask students if they have ever experienced a serious storm that involved a long-term power outage or possibly even an evacuation, or if they know someone who has. Explain that being prepared ahead of time can make the stress of enduring such an event a lot easier and safer. Review outage procedures in class. Encourage students to share the lists on p. 12 with their families.

Page 13: Lightning Can Hurt or Kill You
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.

Discussion: 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. 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.

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

Page 14: Your Body Can Conduct Electricity
Objective: To help students understand more about the conductive nature of water and metal, and the dangers associated with electricity flowing through them.

Discussion: Explain to students that electricity is always looking for a path to the ground, and because water is a conductor of electricity, anything containing water can become electricity’s path. This includes the human body, which is 60-70% water.

Safety Note: Metal is a conductor of electricity, which is why it’s dangerous to allow metallic Mylar balloons outside where they could float up and get caught in power lines and equipment. If they get caught in a power line or substation, a fire, shock hazard, or power outage could result.

Predict and Explain: Students should understand that watering the grass while mowing with an electric lawnmower is not a safe combination. The wet conditions could create a shock hazard.

Page 15: Home Safety Family Inspection
Objective: To encourage students to share important hazard prevention tips with their families.

Discussion: Explain each of the hazards on 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. Heaters close to anything that can burn can cause a fire. 5. People who dig without calling the underground utility locator service could hit a buried gas or electric line and damage the line or be hurt. 6. Water conducts electricity, so appliances used near water can be a shock hazard.)
Homework: Ask students to take this inspection checklist home and to do the inspection with their families. Ask students to report what hazards, if any, they found in their homes and whether/how their family fixed the hazard.

Back Cover: Energy Education Resources
Going Further: Invite students to visit the links listed and choose an energy science or safety topic on which to conduct further research. Have them create an oral or written presentation to deliver to the class.