Energy Efficiency World
Teacher's Guide

INTRODUCTION
The *Energy Efficiency World* booklet teaches the basic principles of energy and how to use it efficiently. Topics include renewable and nonrenewable energy sources, energy transfer and transformation, electrical circuits, reducing greenhouse gases, and energy efficiency tips for home and school.

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

Page 2: Your Energetic World
<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. Matter is anything that takes up space or has a mass of any kind. Any change or movement of matter requires energy. 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 them 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 list two or three items that use each of the energy sources listed. Here are some examples:
- Electricity: *radio, TV, refrigerator, lights, computer, electric vehicle.*
- Natural Gas: *range, dryer, water heater, barbeque, fireplace.*
- Sunshine: *solar-powered calculator, solar-powered lights, plants.*
- Gasoline: *car, bus, truck.*

Page 3: Energy Has Many Forms
<u>Objective:</u> To familiarize students with the five forms of energy.

<u>Background/Discussion:</u> Explain the structure of the atom before working on this lesson. An atom is the smallest unit of matter. Everything in the world is made of different combinations of atoms. Every atom has a nucleus in the center. Tiny particles called electrons travel around the nucleus.

<u>Matching Activity:</u> This lesson explains five forms of energy. Students must match the pictures with their definitions. The campfire and the nuclear power plant each represent two forms of energy.

- The **campfire** represents radiant energy and chemical energy.
- The **jellybeans** represent chemical energy.
- The **lightning** represents electrical energy.
- The **kid kicking the ball** represents mechanical energy.

- The **nuclear power plant** represents nuclear energy. It also depicts electrical energy, as nuclear energy is used at this plant to generate electricity.

Page 4: Energy Moves
Objective: To explain how energy can be transferred and transformed.

Background/Discussion: Discuss some ways energy can move, or be transferred, from one object to another. Transfer of heat energy is an easy one to understand as there are so many examples of it in our daily life: heat moves from an oven burner to a teakettle, from the sun to us, from a blow dryer to our hair. Discuss some ways energy can change, or be transformed, from one form to another. Examples: When fuels are burned, their chemical energy is transformed into heat. When a car runs on gasoline, the engine converts the gas into the mechanical energy that makes the wheels go.

Page 5: Where Does Electricity Come From?
Objective: To explain how electricity gets from the power plant to buildings.

Background/Discussion: This illustration is a simplified diagram of the path electricity takes to get from the power plant to a building. The illustration does not include a depiction of underground power lines, so be sure to explain that in some neighborhoods power lines are not on poles but buried under the ground. Students may wonder how the generator actually creates electricity. Simply put, when a magnet spins near a copper wire, the electrons in that wire move from one atom to another. This movement of electrons results in a flow of electricity in the wire.

Activity Answers:

1. power plant (given)	3. electricity	5. substation	7. homes
2. generator	4. power lines	6. distribution lines	

Page 6: The Many Sources of Electricity
Objective: To explain the many sources of energy used to generate electricity, and to help students distinguish between renewable and nonrenewable energy.

Background/Discussion: Before teaching this lesson, discuss the meaning of the word *replenished*—to make full or complete again by supplying what has been used up. Explain to students that no matter what fuels produce the electricity they use, their lights shine, their radios play, and their computers run in the same way. Explain that the fuels used to generate most of the electricity used in this country include fossil fuels—coal, oil, and natural gas—followed by nuclear energy and hydropower. Here is some more background on various fuel sources and how they are used to produce electricity:

Fossil Fuels: Coal, oil, and natural gas are burned to heat water into steam, which is pressurized and used to turn a turbine. They are called fossil fuels because they 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: Nuclear power plants also create heat that is used to convert water into steam, which is used to turn a turbine. The uranium that runs nuclear power plants must be mined from the ground. Like fossil fuels, uranium supplies are finite and nonrenewable.

Hydropower: Hydropower plants rely on falling water to turn turbines. 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.

Solar Energy: Solar energy captures radiant energy from the sun and converts it into electricity. The sun's energy will never run out (at least not for several billion years), so solar energy is considered renewable.

Biomass: Like fossil fuels and nuclear energy, biomass is used to heat water into steam, which is pressurized and used to turn a turbine. Wood is the largest source of biomass energy, followed by corn, sugarcane wastes, straw, and other farming by-products. Although it is possible to use biomass faster than we produce it, more can be grown, so biomass is renewable.

Wind Power: Wind power relies on moving air to turn turbines, which are connected to windmills. The wind will be around as long as the earth is, so wind power is renewable.

Geothermal Energy: Steam or hot water from geothermal energy facilities can be used to turn turbines. This word 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.

Page 7: Go with the Flow
Objective: To teach the characteristics of an electrical circuit.

Background/Discussion: The light bulb, base, battery, and wire can be found at electronics retailers. 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 on wires that are a closed path with no breaks or obstacles. This is called a circuit. The electricity in your school or home flows in a circuit. It goes from the power outlet to the appliance along one wire inside the appliance cord and back from the appliance to the outlet on the other wire inside the cord. Electricity on power lines also flows in a circuit. Simply put, it flows out from the power plant or substation on one power line and back on another. Ask students to list the various things that electricity in circuits can do. *(Run motors, produce light, create sound, make heat, etc.)*
Experiment: In this activity, electric current flows from the positive side of the battery to the light bulb and back to the negative side of the battery. Students' predictions and observations for this experiment will vary. Answers to #4 should include the idea of adding more batteries to supply more electricity for additional light bulbs. Answers to #5 should include the idea that the switch opens and closes the circuit that brings electricity to the lamp. When you turn on a light, the circuit is closed, and when you turn it off, the circuit is open.

Page 8: What Is Energy Efficiency?
Objective: To explain what it means to use energy efficiently.

Background/Discussion: An analogy that may help students understand the efficient use of energy is comparing a motorcycle to a tall, wide monster truck with giant tires. The motorcycle is more aerodynamic, has skinnier tires, weighs less, and has a smaller engine that uses less energy to run. Which of these is more efficient for getting a person from point A to point B? *(The motorcycle* *does a better job of moving a person without wasting a lot of energy on things that aren't useful—carrying the extra weight of a large truck bed, providing high ground clearance to simply drive on pavement, etc.—so the motorcycle is more efficient at transporting one person.)* Which vehicle would be more efficient at transporting a huge pile of rocks? *(The truck, because it could move the rocks in one trip while the motorcycle would have to go back and forth.)*

Activity: Other examples of efficient people, animals, or machines might include various athletes, birds soaring, aerodynamically designed jets and racecars, etc.

Page 9: Why Save Energy?
Objective: To explain some environmental and financial reasons for saving energy.

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.

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

Y	S	L		C				
T	A	E	W		O			
I	G	U		O		A		
C	L	F			O		L	
I	A	L				D		P
R	R	E						R
T	U	S	R					O
C	T	E	A					P
E	A	I	L					A
L	N	D	O					N
E	G	A	S	O	L	I	N	E

Page 10: Energy Efficiency Helps the Environment
Objective: To explain how energy use affects the environment and how energy efficiency reduces these impacts.

Background/Discussion: All energy resources have an impact on the environment. Most of the energy we use comes from burning fossil fuels like coal, oil, and natural gas, which releases carbon dioxide and other greenhouse gases into the atmosphere. Many scientists feel this is a significant cause of climate change. Renewable energy sources also have an effect on the environment. For example, burning biomass also releases carbon dioxide (although less than fossil fuels). Manufacturing solar cells results in pollutants that must be specially disposed of. And the construction of dams for hydropower facilities changes the ecosystems of the rivers they are built on, affecting the animals and plants that live there. So no matter where our energy comes from, using it efficiently means we use less of it and reduce our impact on the environment.

Word Game Solution: Trees can help people save **energy**. In summer, tree shade can keep your home and car **cool** so you don't have to run your **air conditioner** as much. And in winter, trees can block cold **winds** so your **heater** doesn't have to work as hard.

Interesting Statistic: Over one year's time, one acre of mature trees removes the same amount of carbon dioxide from the air as is produced by driving a gasoline-powered car 26,000 miles.

Page 11: 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 *global warming* or *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 12 and 13: Save Energy at Home and at School
Objective: To offer students age-appropriate tips for reducing home and school energy use.

Background/Discussion: Explain that just as each slice of the pie is a portion of the whole, each type of home energy use shown in the pie chart on page 12 represents a percentage (or portion) of the total home energy use. Students may require help with labeling which energy uses go to which slices of the pie, as several percentages are similar. (Counterclockwise, starting with the pale grey slice at the top: Home Electronics 4%; Other Devices and Appliances 14%; Lighting 4%; Water Heating 15%; Large Appliances 10%; Heating and Cooling 53%.)

Students may need some help in understanding the link between hot water and energy. Explain that water heaters use electricity or natural gas to heat the water we use in our homes, so using less hot water saves energy.

Activities: Encourage students to commit to doing at least three of the actions on page 12 or 13, at home or at school. Assign buddies or small groups so students can describe to each other the actions they've taken. For the creativity activity, students could also do a charade-type game to act out examples of the energy-saving actions they've learned.

Page 14: Buy Energy-Efficient Products
Objective: To help students understand that ENERGY STAR® certified appliances are more efficient than others and can cost less to run, and that efficient appliances can save money overall even if they cost more to buy.

Background/Discussion: Before doing the activity, introduce students to the concept of lifetime cost calculations. Explain that the actual lifetime cost of an appliance must take into consideration not only the purchase price, but also the cost of energy needed to operate the appliance over its lifetime. Buying the lowest-cost appliance can end up being more expensive in the long run than paying for a more expensive model.

Activity Answers:
(Please note: This scenario is based on an imaginary appliance, not the TVs pictured on the top half of the page.)
1. How much more does Appliance A cost to buy than Appliance B? *($460 - $400 = $60)* How much less does Appliance A cost in energy per month? *($20 - $10 = $10)*
2. Appliance A can make up for its higher purchase price through dollars saved on energy bills. How many months will this take? *(If Appliance A saves $10 per month, it will take 6 months to equal $60.)*
3. Why is A the smarter choice in the long run? *(Answers will vary. Some students may recognize that at 6 months Appliance A has cost the same as B, and after that time Appliance A continues to save its owners $10 per month.)*

Follow-up: Invite students to use the Internet or visit a local appliance store to compare prices and energy use of ENERGY STAR certified appliances versus less efficient appliances.

Page 15: YOU Hold the Key to Energy Efficiency
Objective: To empower students to change their energy use behavior.

Background/Discussion: Emphasize that how people use their appliances plays a big role in how much energy they use. Explain to students that their families can buy the world's newest, most efficient refrigerator, but if they keep the door open all the time it will waste energy just like an old, inefficient model would. Similarly, an efficient air conditioner won't be able to run efficiently if doors and windows are left wide open when it is running.

Activity: Encourage students to record something new they have learned about using energy efficiently. This is a good time for students to review the book.

Back Cover: Home Energy Inspection
Objective: To encourage students to share important energy efficiency tips with their families.

Background/Discussion: Why should you carry out a home energy inspection? *(You might find something that wastes energy in your home that could be fixed.)* Ask students to take this inspection checklist home and to do the inspection with their families. Ask students to report what they found. How did their families respond to their efforts? More advanced students may enjoy trying to figure out why each of these tips saves energy.