COSI ON WHEELS TEACHER PACK
INVESTIGATING ENERGY
PRE-VISIT CLASSROOM ACTIVITIES

Investigating Energy is designed to introduce students to the science of energy. The program consists of a 45 minute interactive assembly followed by exciting hands-on activities that engage the students and encourage the development of Science Process Skills.

During the assembly the following science concepts and more will be explored:

- Potential and Kinetic energy
- Energy transformation
- Renewable and Non-renewable resources
- Energy as heat, motion, and electricity
- Energy conservation ideas and practices

The hands-on activities are presented in several 30-45 minute sessions with each session accommodating 62 or fewer students. Hands-on activity session times are scheduled by the person at your school who coordinates the COSI on Wheels event. Students will have the opportunity to explore different renewable and non-renewable energy sources, test the power of wind, learn about energy conservation, as well as work to complete a circuit. In the hands-on sessions students informally interact with the activities, spending as little or as much time as they like at each station. While many students will try all of the activities, some may choose to have a more in-depth experience with only a few.

To prepare you and your students for **Investigating Energy**, we suggest familiarizing yourselves with the vocabulary list provided. We also encourage you to explore the activities detailed on the following pages.

NOTE: *Students should be reminded to never eat or drink any of their experiments, even when experimenting with food items.*

INVESTIGATING ENERGY
VOCABULARY

BIOMASS: Plant materials and animal waste used as a renewable source of fuel.

CIRCUIT: The complete path of an electric current, usually including the source of electric energy.

COAL: A non-renewable, solid fossil fuel formed from the remains of decayed plant material with heat and pressure millions of years ago.

CONDUCTOR: A material or object that permits an electric current to flow easily.

CONVERT: To change from one form of energy to another.

ELECTRICITY: Energy produced from the flow of a charge (electrons). It is a secondary source of energy converted from other energy sources such as coal, nuclear or wind.

ENERGY: The ability to produce change or to do work.

FOSSIL FUEL: Non-renewable fuels such as coal, natural gas and petroleum that are formed from decayed plants and animals (organic material) with heat and pressure millions of years ago.

GEOTHERMAL: Renewable energy that comes from the heat within the earth.

GENERATOR: A device that turns kinetic energy into electricity usually with a magnet spinning inside copper wires.

HYDROPOWER: Renewable energy that comes from the force of moving water.

KINETIC ENERGY: The energy possessed by a moving object. The faster an object moves, the more kinetic energy it has.

NATURAL GAS: A non-renewable gas fossil fuel formed from the remains of decayed plants and animals (organic material) with heat and pressure millions of years ago.

NUCLEAR ENERGY: The non-renewable energy obtained by the splitting of atoms (fission) in the element uranium. This controlled atomic chain reaction produces heat, which is used to make steam and run turbine generators.

NONRENEWABLE ENERGY SOURCES: Energy sources (e.g. coal, oil, natural gas, uranium and propane) that are either replenished very slowly or are not replenished at all by natural processes.

PETROLEUM (OIL): A non-renewable liquid fossil fuel formed from the remains of decayed plants and animals with heat and pressure millions of years ago.

POTENTIAL ENERGY: The energy stored in an object due to its position or the arrangement of its parts. Some forms of potential energy include chemical, gravitational and electric.

POWER: The rate at which work is done, expressed as the amount of work per unit time, and commonly measured in units such as watts and horsepower.

PROPANE: A non-renewable gas formed from petroleum and natural gas, and liquefied with high pressure and low temperatures. Propane is used in several ways such as to heat homes and operate farm equipment.

RENEWABLE ENERGY SOURCES: Energy sources (e.g. moving water, biomass, wind, solar and geothermal) that can be replenished in a short period of time.

SOLAR: Solar radiation that reaches the earth in the form of light and heat. This renewable energy can be directly or indirectly converted into other forms of energy such as heat and electricity.

TURBINE: A rotary engine moved by a current (water, steam or air) usually made with a series of curved vanes on a central rotating spindle. The spindle is connected to the generator.

WIND: The movement of air produced by the uneven heating of the earth's surface by the sun. Wind energy is renewable and can be converted into electrical energy.

HANGING NOTES

ACADEMIC STANDARDS: Physical Science 2.1, 2.2, 5.6, 5.7

OBJECTIVE: To explore and understand sound energy and how it moves.

MATERIALS: Wire hangers
Yarn
Scissors
Sturdy tabletop

PROCEDURE:

1. Cut two pieces of yarn between two and three feet long.
2. Tie the yarn to the corners of the wire hanger.
3. Wrap the other end of the yarn around your index fingers.
4. Tap the hanger on the table and observe the sound it makes.
5. Place your index fingers against your ears.
6. Bend over at the waist and tap the wire hanger on the table again. Listen to the sound.

WHAT HAPPENED: Does the noise sound the same with your fingers against your ears as it sounded the first time? In which case did the sound last longer? Would it make a difference if the strings were longer or shorter? What if you changed the object you hit the hanger against?

EXTENSIONS: Try different kinds of hangers or other objects, such as kitchen utensils.

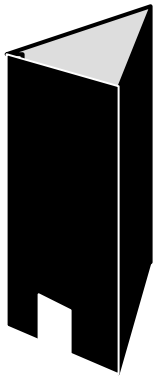
DID YOU KNOW? When the hanger is hit against the tabletop the kinetic energy of the hanger moving downward is changed into different types of energy. One of those is sound energy. The sound created travels through the air and the yarn in waves. The sound waves are transferred from the yarn to your fingers and then your ears, vibrating your eardrums. The smaller volume of the string relative to the volume of the air encompassed by the room allows less diffusion, which results in a louder sound traveling through the string. Also, sound travels faster through a solid than through a gas.

SNAKE

ACADEMIC STANDARDS: Physical Science; K-2 C, 3-5 D & 3-5F

OBJECTIVE: To understand the transfer of heat energy to motion.

MATERIALS:
Pencil & crayons or markers
Card stock
Scissors
Black poster board
Tape
Yarn or string
Hole-punch
Mug or pot of hot water



PROCEDURE:

1. Draw a snake on a piece of card stock large enough to fill the entire card stock.
2. Custom design and color your snake.
3. Cut out the snake and punch a hole in the center of its head.
4. Attach yarn or string through the hole and hang the snake in a place where wind won't make it move or spin.
5. Heat up a pot of water (not to boiling point).
6. Hold the hot water under the snake and observe what happens.
7. Make a solar tower with black poster board. Fold the poster board in thirds and tape it into a triangle with the black on the outside.
8. Cut a two-inch door in the bottom of one of the sides.
9. Place the triangle in the sun, hang the snake over it, and observe what happens.

WHAT HAPPENED: What made the snake spin? In what direction did it spin? What could you do to the snake to make it spin the other direction? What would happen if you positioned the snake farther away from the water or solar tower?

EXTRA INFORMATION: Because the gas molecules in hot air are moving more rapidly and are more spread out than the molecules in cold air, the hotter air is less dense and rises above the cooler air. As the hot air rises through the snake it presses on the bottom, causing the snake to turn. If the snake were flipped over it would twist in the other direction. A hole cut in the bottom of the solar tower provides airflow. If there were no hole in the bottom, cool air would be trying to go down into the tower at the same time the hot air was trying to get out. The black color of the tower allows it to absorb more of the heat energy from the sun.

SOLAR OVEN

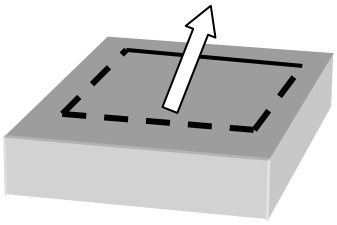
ACADEMIC STANDARDS: Physical Science 1.8, 1.9, 4.5, 5.1

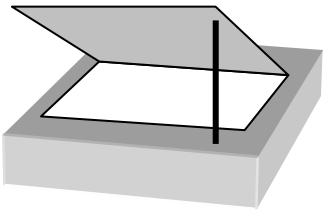
OBJECTIVE: To learn that the sun gives off heat energy and light energy that can be reflected and amplified under certain conditions.

MATERIALS:

Pizza Box	Tape	Ruler
Black Construction Paper	Scissors	Glue
Aluminum Foil	Clear Plastic	Thermometer
Stick/Dowel Rod	Magic Marker	

PROCEDURE:





1. With the pizza box closed, measure and draw a one-inch border around the top of the pizza box.
2. Cut along three of the borderlines and leave one side intact to form a flap.
3. Fold the flap back along the uncut borderline.
4. Open the box, and line the inside of the flap and the inside of the box with foil.
5. Glue clear plastic over the hole in the lid of the box where the flap is. Make sure that the flap hole is sealed.
6. Place a piece of black construction paper in the bottom of the box, on top of the foil.
7. Check the temperature inside of the box and then close the box, open the flap, and use a stick to hold the flap open.
8. Face the opening towards the sun for 30 min.
9. Carefully open the box and use the thermometer to check the temperature inside.
10. Compare this to your first reading.

WHAT HAPPENED: How hot did the sun make the box? Would the box get as hot on a cloudy day, or in the shade? What if the construction paper inside was white? Does the color of the outside of the box make a difference? Does the angle of the flap affect the inside temperature?

EXTRA INFORMATION: The foil on the inside of the flap helps to reflect sunlight into the box. The foil on the inside of the box helps to insulate it, as well as continually reflecting the light and heat that is already inside of the box. The clear plastic allows sunlight in and keeps heat from escaping. It is a good idea to try several boxes in different locations. After checking the temperature in each of the boxes, the students can decide what box they would rather use for cooking.

EXTENTION: Now that the experiment is over and you have a nice solar oven, you can try cooking s'mores or other treats in your oven. Treats that have toppings that you can see melt will allow you to know when your treats are warm enough.

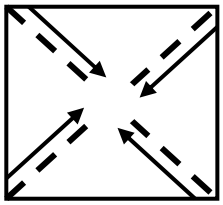
WINDMILLS

ACADEMIC STANDARDS: Physical Science K.5, 1.6, 1.7, 1.9, 3.1, 3.4

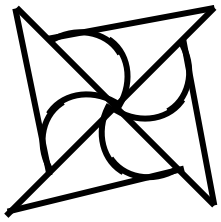
OBJECTIVE: To explore and understand how wind can be used as a source of energy.

MATERIALS:
- Construction paper
- Small shoebox
- 4 ft string
- Electric fan
- Tape
- Plastic straw (longer than width of the box)
- Paper clips

PROCEDURE:



1. Cut the construction paper into a large square.
2. Draw an X across the paper from corner to corner.
3. Cut along the lines from each corner, stopping 2" from the center of the paper.
4. Fold the right corner of each cut to the center of the pinwheel. Attach by punching the small end of a paperclip through the corners and center.
5. Punch a hole in each of the long sides of the box. Make sure the holes are directly across from each other.
6. Put the straw through the holes and make sure that it can spin freely. The straw should also stick out of each side of the box at least 1inch.



7. Attach the pinwheel by pushing the large end of the paper clip into one end of the straw.
8. Set an electric fan on a table or countertop and turn it on.
9. Place the pinwheel in front of the fan. Move it until you get an angle that spins the pinwheel the fastest. Remember that position, and turn off the fan.
10. Now attach the string to the free end of the straw with some tape.
11. Tie the other end of the string to a paper clip.
12. Connect five more paper clips to the first one.
13. Hold the pinwheel in front of the fan in the position that moved it the fastest.
14. Turn the fan on.

WHAT HAPPENED: What effect did the wind from the fan have on your windmill? What happened to the string and the paperclips? What do you think would happen if you added more paper clips? How many paper clips can your windmill lift? What if there wasn't enough wind or too much wind? What other problems might you face using windmills?

EXTRA INFORMATION: Windmills have been used for a long time to harness the energy of the wind. As the name suggests they have been used to mill many different things, from paper to grain. Many times kinetic energy is transferred from the blades on the windmill to a grindstone inside. The windmill you made uses the kinetic energy from the wind to lift weights. These weights, once lifted, have gravitational potential energy that can be used to perform other tasks.

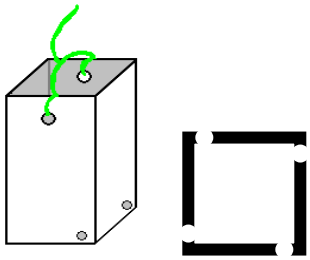
EXTENTION: Use the NREL website to download Wind Resource maps and find out if you have enough wind in your area to run energy converting wind turbines. Where are the best places for them and what are the pros and cons of installing wind turbines in those places?

WATER MOTOR

ACADEMIC STANDARDS: Physical Science K.5, 1.6, 1.9, 3.3, 3.4

OBJECTIVE: To explore and understand how water can be used to provide kinetic energy.

MATERIALS:
Paper milk or orange juice carton
Scissors
Yarn or string
Tape



PROCEDURE:

1. Cut the top off of the carton.
2. Cut two holes opposite each other at the top of the carton.
3. Tie yarn or string through the holes to form a handle.
4. Tie another string to the center of the handle. You will hold the motor up by this string while in operation.
5. Cut four more holes of the SAME size at the bottom left hand corners of each side.
6. Suspend the motor over a sink and fill it with water. Observe.
7. Dry the motor. Tape over the holes.
8. Try putting new holes in different places on the motor.
9. Suspend the motor over the sink and fill it with water again.

WHAT HAPPENED: What direction did the motor spin when the holes were in the left corners? How could you make the motor spin in the other direction? What happened when the holes were in other places? Does the size of the holes make a difference in how fast the motor spins? How does the amount of water in the motor affect how fast it spins?

EXTRA INFORMATION: The water flowing out of the holes exerts force on the carton. Isaac Newton's third law of motion states that for every action there is an equal and opposite reaction. The water coming out of the holes is the action, and the carton being moved is the reaction. Since all of the holes were in the same place on each side of the carton the force of the water coming out of the holes worked together to push the carton in the same direction. If the holes were in the center of the sides the forces would be working against each other and the carton would not spin.

INVESTIGATING ENERGY REFERENCE SHEET

Solar Oven: http://www.solarnow.org/pizzabx.htm

Windmill: Science Experiments for Young People, Thomas R. Rybolt & Robert C.Mebane

Sunny Snakes: Experimenting with Energy, Alan Ward

Other: Science Through Art: Energy, Andrew Charmen & Franklin Watts

Web Sites:

Department of Energy Kids Page – Focuses on renewable resources with links, games, and other resources.
http://www.eere.energy.gov/kids/

EIA Energy Kids Page – Facts and games related to energy.
http://www.eia.doe.gov/kids/index.html

Energy Quest - Games, science projects, stories, and more.
http://www.energyquest.ca.gov/index.html

National Renewable Energy Laboratory – Wind resource maps and other information about renewable energy.
http://www.nrel.gov/

Ohio Energy Project – Programs on energy and the kids teaching kids approach.
http://www.ohioenergy.org

Wisconsin Energy Education Program (KEEP) – Resources and other information to help you focus on energy.
http://www.uwsp.edu/cnr/wcee/keep

World Nuclear Association - Everything from uranium mining to nuclear waste.
http://www.world-nuclear.org/education/wast.htm

SCIENCE PROCESS SKILLS

On the day of the program students will have the opportunity to participate in a variety of hands-on activities. The activities are intended to create a fun and stimulating environment which encourages the development of Science Process Skills. The skills include:

OBSERVING: Using the senses and/or appropriate tools to gather information. Observing may also include the skills of: **Measuring, Comparing** and **Classifying.**

INFERRING: Making preliminary conclusions by assessing what is already known. Inferences are what you reason to be true, but have not observed or tested.

QUESTIONING: Raising questions about objects, events, or phenomena. This includes recognizing and asking *investigable* questions, often beginning with phrases like 'What causes,' 'How does' or 'What makes.'

HYPOTHESIZING: Offering a possible explanation or testable statement. A hypothesis can be a good reference point for further investigation.

PREDICTING: Using ideas or evidence to foretell the outcome of a specific future event. Often involves an action and a reaction or an if/then statement.

PLANNING: Designing one's own investigation using procedures to obtain reliable data. *Planning is <u>not</u> always formal.*

INVESTIGATING: Carrying out a planned experiment based on your hypothesis. Investigation uses many of the previously stated Process Skills.

INTERPRETING: Drawing conclusions by assessing the data. Finding patterns or other meaning in the data.

COMMUNICATING: Expressing observations, ideas, conclusions, or models by talking, writing, drawing, etc.

RELATING & APPLYING: Relating makes parallels to similar concepts, and applying uses the knowledge gained to help solve a challenge.

INVESTIGATING ENERGY HANDS-ON ACTIVITIES:

Pass the Juice: Students build circuits by attaching a variety of components to a power supply.

Rolling Along: Various potential energy sources are used to power small pinewood derby style car frames.

Paddle Power: Students design their own water turbines by choosing from a variety of blades. They test the power of blades to lift weight as the blades are placed in a circular stream.

Up in the Air: Students map routes along a map to determine the effects that fuel economy has on gasoline used and pollution created.

Bright Ideas: Students turn a hand-crank generator to light an incandescent or compact fluorescent light bulb.

Watts Up: Students use the "Watts Up" meter to determine the amount of energy used by various items that might be found in their bedrooms.

Good Vibrations: Students experiment with various items to determine the properties of sound and how sound is used to find crude oil.

Let It Flow: Students classify several solids and liquids as a good conductor of electrical current, a poor conductor, or not a conductor at all. Then the students will test each item to see if they predicted correctly.

Breaking Wind: Students use an anemometer to test wind speed and decide the best position to place a wind turbine.

Scrubber System: Students will act as smokestack scrubbers with the responsibility to clear out the pollution to conserve our environment.