What's Cooking?

Student Objective
The student:
- will understand how the Sun's radiation, as heat, can be captured and used
- will be able to name the parts of a solar oven and can explain their function.

Key Words:
glazing
insulation
solar collector
solar thermal

Time:
15 minutes for discussion
Cooking & eating time will vary

Materials:
- solar oven (see note in procedure)
- oven thermometer, or thermometer that has a range to at least 300ºF
- pot holders
- disposable aluminum cooking pans ('brownie' size works well) with plastic wrap, clear glass covered casseroles, or oven roasting bag
- Science Discovery Sheet

Background Information
1. A solar cooker is a type of solar thermal collector. It 'collects' and traps the Sun's thermal (heat) energy. For example, on a sunny day your car with the windows rolled up becomes a collector. The glazing lets in the Sun's energy, traps the thermal (heat) energy, and the air inside your car becomes hot. As more light enters the car, the air gets even hotter, until we say that it feels like an oven inside!
2. Solar ovens are improving the quality of life for many people around the world. Solar ovens have been introduced in parts of South America, Africa and India. In these areas, it is typical for a woman to spend nearly half her workday looking for and collecting firewood. Also, respiratory problems in the children of these areas have been linked to fumes created by the burning of poor quality wood. The use of solar ovens helps to reduce the dependency on firewood. In addition, some women have turned their talents for building cookers into businesses--building and selling cookers for added income.
3. Besides cooking, solar ovens can be used to purify water. This is beneficial for areas where obtaining safe drinking water is a problem.
4. There are many types of cookers, and ways to build them. Each cooker must have 3 elements or components:

- Glazing that allows the radiant energy to enter (glass, clear plastic wrap, etc.)
- Insulation to retain heat and maintain temperature (styrofoam, cardboard, feathers, paper, etc.).
- Reflectors to concentrate more sunlight into the cooker (foil, mirrors, etc.).

5. There are three basic types of solar ovens on the market today – box, parabolic reflector and multi-reflector (truncated cone or pyramid). Box ovens produce lower temperatures, but are the least expensive and the most portable. Parabolic reflector ovens produce the highest temperatures but must be constantly adjusted to focus directly on the Sun. Multi-reflector ovens combine a good temperature range and can be designed to have a large cooking capacity.

Procedure (prior to class)

1. For this cooking demonstration, you will need either a commercially manufactured solar oven, or one that you construct yourself. Florida schools may borrow a solar oven from the Florida Solar Energy Center. Construction directions for a easily constructed box oven are on the following pages.

Procedure (cooking day)

1. Mix or prepare the food to be put in the oven according to the recipe.
2. Put the food in a covered dish, place in a baking bag, or cover tightly with plastic wrap.
3. Lift glazing, set the dish and an oven thermometer on the bottom of the oven, and replace the glazing.
4. Set the oven facing the Sun.
5. Adjust the tilt of the oven (objects can be placed under one edge), and the tilt of the reflector (if necessary) so that the Sun's rays are directed into the body of the oven.
6. When food is done, be sure to use a pot holder to remove the glazing and also the food. **Solar Cookers can get extremely hot!**
7. Lead classroom discussion about how the heat from the Sun (solar thermal energy) was trapped in the oven (solar collector) to cook the food. Have the students brainstorm other foods that could be cooked by the Sun. Questions that could be asked in classroom discussion are:
   - Where did the heat come from? *(the energy of the Sun)*
   - How did the Sun's energy get in the oven? *(through the glazing)*
   - What parts of the oven help to hold the heat in? *(the insulation and the glazing)*
   - When we open the lid to get the food out, what happens to the heat? *(it escapes)*
   - Did it get hotter inside the oven than it did outside the oven in the sunlight? *(yes)*
   - Why did it get hotter inside the oven? *(the glazing and insulation trapped the heat from the Sun's energy and held it inside. The Sun kept shining in with more energy which kept increasing the temperature)*
8. Have the students complete their Science Discovery Sheet. They should draw the food that they are cooking inside the solar cooker. Younger students can color the picture, older students should label the parts and be able to explain their function.

Further Activities

1. Study food preparation in other times and in other places. Was the Sun used in food preparation and food storage? How?
2. Discuss the benefits of solar ovens for people who live in areas that cook over wood fires. *(less pollution and pollution caused diseases, less time spent collecting firewood and tending a fire, less threat to forests)*
   Discuss how solar ovens might be used in our country. *(after a disaster like a hurricane, for recreational use–boating or camping)*
3. Invite another class to a solar tea party featuring solar tea and cookies baked in their solar oven.

Related Reading

- Cooking With The Sun: How to Build and Use Solar Cookers by Beth Halacy and Don Halacy
  A classroom resource for those who want additional cooker designs and recipes.

EnergyWhiz

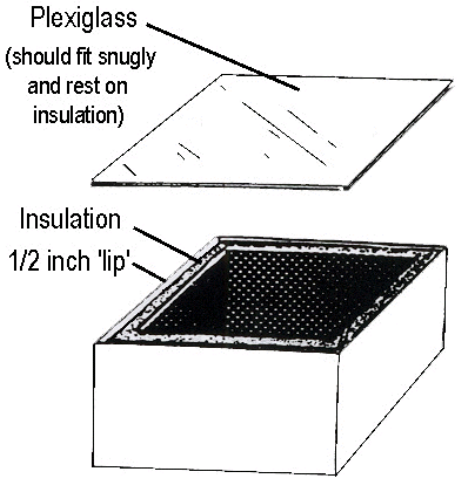
Submit your class' favorite recipe or a picture of them cooking to the EnergyWhiz website at **http://energywhiz.com/**. Get recognition for your class and school as solar chefs!

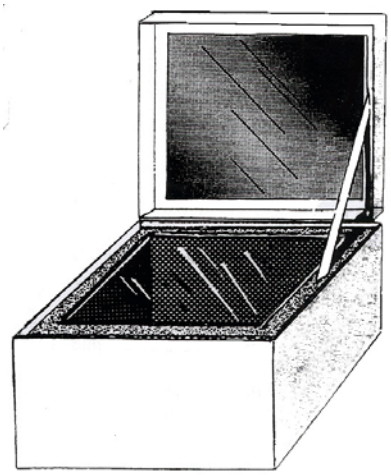
What's Cooking?

A simple box style oven can be constructed using a cardboard file storage box, some insulation and a piece of plexiglass (or glass).

Materials (construction):

- file storage box, or other box approx. 12" x 15" x 10" (1 per oven)
- foil backed foam insulation board, approx. ½ sheet per oven
- plexiglass, pre-cut to 12" x 15" (1 per oven)
- aluminum duct tape, 20 feet (per oven)
- black construction paper, 12" x 15" (1 per oven)
- aluminum foil, 18" x 21" (1 per group)
- scissors (1 per group)
- wooden dowel, stick or pencil (1 per oven)





Procedure

1. Cut insulation material. Each oven requires:
   - (1) 12" x 15"
   - (2) 12" x 9 ½ "
   - (2) 15" x 9 ½ "
2. Put 12" x 15" piece of insulation inside the box on the bottom.
3. Fit the other pieces of insulation fit around all the walls of the inside of the box.
4. Tape all seams: bottom, sides, and around the inside top of the box.
5. Cover the inside of the box lid with foil for a reflector.
6. Cover the inside bottom of the oven with black construction paper.

7. Place the glazing on the top of the oven.
8. Attach the box lid by one long edge to the oven with an aluminum tape 'hinge'. The rod or stick is used to adjust the tilt of this lid to capture more sunlight.

Common construction problems to avoid that can cause the ovens not to seal tightly and therefore not hold in heat:

- all seams are not sealed tightly with aluminum tape. Make sure that all the seams are covered, both inside and around the inside top opening of the of the oven. The box lid is used as a reflector, so the tape is not critical there.
- the plexiglass glazing does not sit tightly on the top of the oven. Make sure that the top edges of the insulation are level and flat. Low spots may be filled in with extra pieces of aluminum tape.
- sides of boxes are squeezed in while being taped, thereby making the top opening too small for the plexiglass to fit.

What's Cooking?

			.1	.2	.3	.4	.5
Energy	**Standard 1**	**SC.B.1.1-**	**X**	**X**	**X**	**X**	
	Standard 2	**SC.B.2.1-**	**X**				

Benchmark SC.B.1.1.1 - The student knows that the Sun supplies heat and light energy to Earth.
Grade Level Expectations
The student:
Kindergarten
- knows the effects of sun and shade on the same object

First
- knows that heat from the Sun has varying effects depending on the surface it strikes

Second
- knows that a thermometer measures the amount of heat absorbed by an object.

Benchmark SC.B.1.1.2 - The student knows that light can pass through some objects and not others..
Grade Level Expectations
The student:
Kindergarten
- knows that light can pass through some objeccts, but cannot pass through other objects

First
- predicts which materials will allow light to pass through and which ones will not.

Benchmark SC.B.1.1.3 - The student describes a model energy system.
Grade Level Expectations
The student:
Second
- understands that models can be used to illustrate how energy flows through a system.

Benchmark SC.B.1.1.4 - The student knows that heat can be produced in many ways.
Grade Level Expectations
The student:
Second
- knows different heat sources.

Benchmark SC.B.2.1.1 - The student recognizes systems of matter and energy.
Grade Level Expectations
The student:
Second
- understands ways energy and matter interact.

What's Cooking?

glazing - the clear material (for example glass or plastic wrap) that lets in light and traps heat

insulation - material used to reduce heat loss or gain

solar collector - a device that collects and traps solar energy

solar thermal - using the Sun's energy to heat something

What's Cooking?

Cooking Tips

- Always use lids on pans, cover tightly with plastic wrap, or use cooking bags to avoid condensation on the oven glass which blocks the solar radiation.
- Temperature:
  - On a clear and sunny day the oven will heat up to 250ºF or above. On these days you can cook or bake anything.
  - On a partially cloudy day the oven will heat to 200ºF to 250ºF. On these days you can easily cook meats, rice, baked potatoes, and frozen vegetables, but baking is not recommended.
- Adjust your cooking time to account for the lower temperature. A rule of thumb is to figure twice the regular cooking time.
- Use a meat thermometer instead of a timer to determine if the food is done.
- Any conventional recipe that would be suitable for your oven will work in a solar oven, also crock pot recipes are particularly suitable for a solar oven.
- Foods generally use less liquids or cook in their own juices. This produces better tasting and more nutritious food.
- Foods never burn and rarely overcook in a solar oven.
- Foods particularly suited for the classroom include: hot dogs, slice and bake cookies, brownies, rice mixes, cocktail sausages in barbeque sauce, nachos, s'mores,
- Some specific food tips:
  - cook (steam) yellow and green vegetable in dark colored casseroles to prevent discoloration
  - reduce liquids in cake recipes by one half
  - cook foods in their natural state (i.e. potatoes in skins and corn in husks)
  - chewy dessert recipes such as brownies come out better than crispy ones
  - meats cook better if cut into small pieces.

Recipes

Solar S'Mores 1

24 squares from chocolate bars
12 graham crackers, halved
6 large marshmallows

Place 4 squares of chocolate on each of 6 graham crackers, top with marshmallows. Cover with remaining graham cracker squares to form sandwiches. Press to seal. Wrap with foil. Place in oven. Bake until heated and chocolate begins to melt. Serve immediately. Makes six servings.

Solar S'Mores 2

½ cup crunchy peanut butter
12 graham crackers, halved
6 large marshmallows

Spread peanut butter on 6 graham crackers, top with marshmallows and place in oven. Cover with remaining graham cracker squares to form sandwiches. Press to seal. Bake until heated. Serve immediately. Makes six servings.

Banana Boats

6 bananas
chocolate bar squares, kisses, or chocolate chips
marshmallows, large or miniatures

Peel one strip of skin from banana. Remove small amount of banana or cut slit into banana. Place chocolate and marshmallows inside banana. Wrap in foil. Heat until chocolate begins to melt. Serve immediately. Makes six servings.

Backyard Baked Beans

2 slices bacon (optional)
16 oz. can (1¾ cups) baked beans
¼ cup firmly packed brown sugar
1 small onion, chopped
1 teaspoon prepared mustard
1/4 cup catsup
2 Tablespoons Worcestershire sauce

Cut bacon into small pieces. Combine chopped onion and bacon in container with lid. Cook covered until bacon is brown and onion is tender. Add remaining ingredients. Bake covered for one hour or until beans are thickened and heated through. Makes four servings.

Florida Solar Cookies

1 cup flour
½ cup blown sugar, packed
1 teaspoon baking powder
1 teaspoon baking soda
1/4 cup butter
3/4 cup granola
1 teaspoon vanilla

Mix butter, sugar and vanilla. Add dry ingredients and mix well. Drop spoonfuls of batter onto a disposable aluminum pan. Cover tightly with plastic wrap (tape on the bottom of pan if necessary). Bake until cookies puff up and appear brown. You can test doneness by inserting a toothpick into the center of a cookie. If it comes out clean, the cookie is done.

Newton's Apples

6 baking apples, cored
3 Tablespoons sugar
6 teaspoons butter
1/4 cup raisins
1/3 cup firmly packed brown sugar
1 Tablespoon flour
½ teaspoon cinnamon
1 Tablespoon water

Place apples in a 12 x 8 inch baking dish. Place ½ Tablespoon sugar and 1 teaspoon butter in cavity of each apple. Cover tightly with plastic wrap. Bake 1 hour in solar oven or until apples are tender. Combine brown sugar, flour, cinnamon, raisins and water. Spoon mixture in and over apples. Continue baking uncovered until sauce is thick.

What's Cooking?

Draw your food in the solar cooker.

Where does the heat come from to cook your food? Draw the source of heat (energy) that is used with your solar cooker

Where are these parts? Label them.

glass insulation reflective (shiny) surface