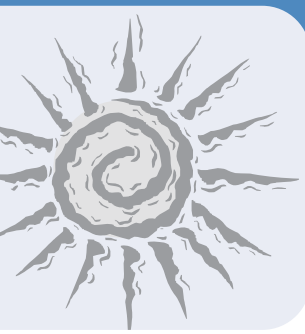


Shoebox Solar Cooker

Summary: Students build and use a simple solar cooker and experiment using the sun to heat food.

Objectives

Students will be able to

- construct an effective solar oven;
- explain how a solar oven works; and
- discuss the benefits and challenges of using a solar oven.

Rationale

Operating a solar oven helps students learn about solar energy and heat-related principles and appreciate the importance of energy-related technologies.

Materials

- Each group of students will need a copies from the *Student Book*:
  - ***Building a Shoebox Cooker****, page 125* and materials listed on this student page
  - ***Using a Shoebox Cooker,*** *page 130*
  - ***Solar Cooking Record***, page 131 (optional)
- Photographs of commercial solar ovens (optional)

Background

Did you ever hear the expression, "It's hot enough to fry an egg on the sidewalk?" Sidewalks don't really get quite hot enough to cook on, but you could build a solar box cooker, place it on a sidewalk, and allow it to collect the sun's heat energy and cook many different kinds of food. Commercial solar cookers are also available (see **Resources**). To work properly, a solar box cooker (also called a solar oven) must hold heat energy long enough for the food to absorb the heat and cook.

Making a solar oven can be both simple and difficult. Collecting energy from the sun is easy. When sunlight strikes a surface and is absorbed, it gets converted to heat energy (or infrared radiation). A glass or Plexiglas cover works like a greenhouse window to let sunlight in but not let the infrared radiation out. Solar cookers usually include some kind of reflector that increases the amount of energy the cooker receives by reflecting light inside the box onto the cooking container. Keeping the heat energy in the oven is more difficult. Solar box cookers must be carefully insulated and tightly sealed so the captured heat cannot escape.

The key to a successful solar oven is making sure it faces the sun. To keep the solar cooker hot all day, it must be continually turned to follow the path of the sun. For a gradual heating process, place food in an oven and direct it toward the sun's midday position. The food cooks slowly, reaching its peak heat by mid-afternoon. The food is ready to eat by early evening.

Solar box cookers reach between 140 degrees F (60 °C) and 266 degrees F (130 °C) depending on their construction and intensity of the sunlight. Clear, sunny days provide the best results. However, as long as the cooker faces the sun and is well-insulated, the temperature outside the cooker should have little effect on the cooking rate. So solar cookers can be used in December as well as in July.

The choice of ovenware can affect the cooking time in a solar cooker. Ovenware can be made from glass, ceramic, earthenware, or metal. Each material conducts and retains heat differently. Often dark-colored ovenware is best for solar cookers because it absorbs light energy better than light-colored materials.

What can be cooked in a solar oven depends on the quality of the cooker. Any conventional recipe suitable for a slow cooker works well, because the solar cooker will get hotter than a slow cooker. Baking should be done on clear, sunny days as it requires higher temperatures. Cutting the ingredients into small pieces will help the food cook faster. The foods, especially liquids and moist meals such as stews, need to be sealed in the solar box cooker so water does not condense on the glass cover.

Simple solar cookers, such as those made from a shoebox, should be able to do the following:

Grade level: 5-8 (K-4)

Subject Areas: Family Living and Consumer Education, Science, Social Studies, Technology Education

Setting: Outdoors on a sunny day and classroom

Time:
Preparation: one week
Activity: three 50-minute periods

Vocabulary: Greenhouse effect, Insulation, Solar cooker, Solar oven

Major Concept Areas:

- Natural laws that govern energy
- Development of energy resources
- Management of energy resource use

Getting Ready:

Use an unshaded outdoor setting where the solar ovens can remain undisturbed for at least an hour. You may want to provide students with the materials list the week before the activity is scheduled and have them bring the items from home. An alternative is to build one solar oven and have groups use a single oven to conduct experiments. If possible, invite aides or parents to help with the construction. Have students decide what food they'd like to cook and create a shopping list. You may request that students bring in these ingredients as well. See Steps 2 and 3 for variations for younger students.

Resources:

For Teachers

Burns Milwaukee, Inc.
4010 West Douglas Avenue
Milwaukee, WI 53209. Phone: (414) 438-1234. Vendor for solar ovens.

Solar Cookers International
1724 11th Street
Sacramento, CA 95814.

Sun Light Works
P.O. Box 3386
Sedona, AZ 86340.

Complementary Activities

Florida Middle School Energy Education Project. Energy Bridges to Science, Technology and Society. Tallahassee, Fla.: Florida Solar Energy Center for the State of Florida, 1991.

Hawaii Energy Extension SVC
Hawaii Business Cntr
99 Aupuni St., Rm 101B
Hilo, HI 96720
-or-
Hawaii State Dept. of Business, Economic Development & Tourism - Energy, Resources & Technology Div. PO Box 2359, Honolulu, HI 96804-2359

For Students

Arizona Energy Office. A Day in the Sun. Phoenix, Ariz.: Arizona Energy Office, 1991. Videocassette.

Gurley, Virginia Heather. Solar Cooking Naturally. Sedona, Ariz.: Sun Light Works, n.d.

Halacy, Beth, and Dan Halacy. Cooking with the Sun. Lafayette, Calif.: Morning Sun Press, 1992.

- Heat water for hot chocolate, tea, or instant soup
- Warm canned soups, vegetables, and stews
- Prepare hot dogs
- Melt cheese, chocolate, or marshmallows
- Make simple pizzas (cheese and tomato sauce sprinkled on prepared crust)
- Bake chocolate chip cookies

Better built solar cookers can cook regular meals. With a well-constructed or commercial oven you can prepare foods, such as vegetables and grains, that need to be cooked more thoroughly. For example, summer squash, fresh peas, green beans, spaghetti, noodles, instant potatoes and rice cook relatively quickly. White rice, rolled oats, pearl barley, and squash should cook in two hours. Lentils, black-eyed peas, black beans, and potatoes will need about three hours.

Frying eggs may not be the best use for a solar oven, but you can cook eggs in breads, casseroles, and cakes. Whether you decide to make a warm drink on a cold day in December or a complete meal, solar box cooking is fun and delicious.

Procedure

Orientation

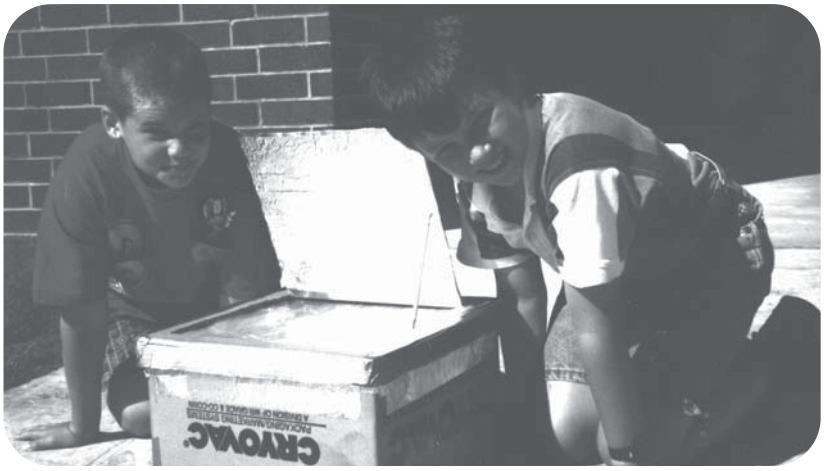
Ask if any students have ever been in a car that has been parked in the sun. Have a student describe what it feels like inside the car. Students may have also heard warnings about not leaving pets and children in parked cars because of the risk of heat exhaustion or stroke.

Discuss how sunlight passes through the glass windshield and windows in a car. When the light strikes the interior surfaces of the car, it is absorbed and converted to heat energy. The heat can not escape through the glass and causes the interior temperature of the car to increase.

Steps

1. Ask students if they think heat from the sun can be used to melt things such as chocolate or cheese. Tell students that by applying what they know about heat collecting in a parked car, they can design an oven that uses the sun's energy to cook food.

2. Divide the class into working groups. Hand out and discuss ***Building a Shoebox Cooker***, Materials and Procedure for Variation #1, #2, or #3. NOTE: Variation #2 involves cutting and placing foam trays in the box for insulation. Younger students may have a difficult time handling the pieces of foam and will get frustrated when they try to line the shifting trays with foil. Shifting can be minimized by cutting the trays to fit tightly against each other. Small hands may



find Variation #3, the two-shoebox method, easier. Variation #1 is the easiest but may not be as effective.

3. Provide students with copies of ***Using a Shoebox Cooker*** and have them prepare the food they want to cook. Have students test and use their cookers. The ***Solar Cooking Record*** can be used to document observations, and this data can also be used to make graphs. NOTE: For younger students, it may be enough to observe that the sun heats food and to note temperature changes.

Closure

Have students share the results of their cooking experiments. Do they think they would regularly use solar ovens? Remind students that the ovens they constructed are simple, and that there are more technical and efficient models available. Inform students that there are companies that sell commercial solar cookers that are very effective at heating food. If available, show pictures or overhead transparencies of some of these cookers. Students can compare qualities of these cookers to their own.

Discuss ways students can test or improve the cookers. Questions to explore include:

- How well does the cooker work on cloudy days?
- What effect does outside temperature have on the cooking rate?
- Is there any difference when the cooker is used in December than when it is used in June?
- Would a bigger box, more reflectors, or different types of insulation improve the effectiveness of the cooker?

Commercial Solar Ovens

Pease, Tom. "Getting Our Energy from the Sun" on *Daddy Starts to Dance*. Madison, Wisc.: Tomorrow River Music, 1996. Audiocassette.

Rickard, Graham. *Alternative Energy: Solar Energy*. Milwaukee, Wisc.: Gareth Stevens Children's Books, 1991.

Related KEEP Activities:

Use this activity as part of a unit on solar energy or heat. See K-5 Energy Sparks for Theme II: "Sunvestigations" or K-5 Energy Sparks for Theme I: "Exploring Heat." A solar cooker can also be used to enrich investigations in "Taking Temperatures." Older students can apply concepts from solar cooking to activities such as "So You Want to Heat Your Home?" Other uses of solar energy such as those found in "The Miracle of Solar Cells" could be done with younger students.

Credits:

Activity adapted from "Now You're Cooking—With the Sun" in *Florida Middle School Energy Education Project: Energy Bridges to Science, Technology and Society*. Tallahassee, Fla.: State of Florida for the Florida Energy Office, 1994. Used with permission. All rights reserved.

Activity adapted from Hawai'i Extension Service. *Making Shoe Box Cookers* Contact: Energy, Resources, and Technology Division. Department of Business, Economic Development, and Tourism, 99 Aupuni Street, #101B, Hilo, Hawai'i 96720.

Assessment

Formative

- How well did students construct the ovens?
- Can students explain how a solar oven works?
- How effectively do the solar ovens heat food?

Summative

- Have students plan a party for another class or their parents in which food is cooked in the solar ovens. The event can begin with students explaining how they made the solar ovens and how they work. During the presentation, students can discuss the potential and practicality of solar oven use in their own future.
- Students can research the many different designs for solar cookers and experiment with different properties and adaptations. For example, try placing a thicker piece of metal, such as a piece of a cookie sheet or baking pan, in the bottom of the solar oven to increase heat transfer and storage.

Extensions

Students may be interested in exploring how solar cookers are currently being used worldwide, especially in places where electricity is unavailable and traditional fuel sources, such as wood, are being depleted (see **Resources**).

Purchase a commercial solar oven or invite a guest speaker (such as a vendor) who regularly uses a solar oven to show and discuss more sophisticated models and methods of solar cooking (see **Resources**). Students can also see solar ovens in use at the Midwest Renewable Energy Fair (see Appendix).