

What's Cooking?

Student Objectives

The student:

- understands how the Sun's radiation, as heat, can be captured and used
- will name the parts of a solar oven and can explain their function.

Key Words:

glazing
insulation
solar collector
solar thermal

Materials:

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

Time:

15 minutes for discussion
Cooking & eating time will vary

Background Information

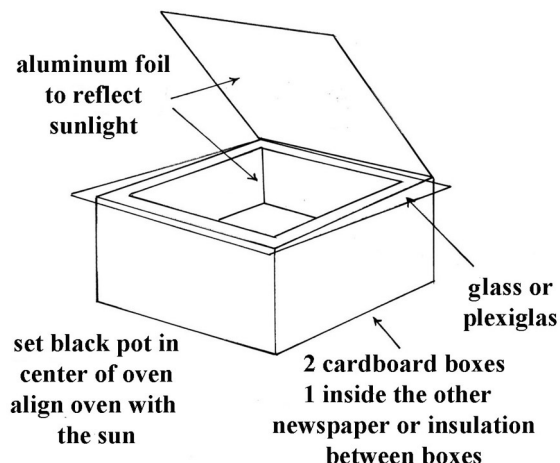
A solar cooker is a type of solar thermal collector. It gathers and traps the sun's thermal (heat) energy. Heat is produced when high frequency light (visible and ultraviolet) is converted into low frequency infrared radiation. Ultraviolet and visible light easily pass through glass, however when they strike a darkened surface they are converted into long wave infrared radiation (heat). The glass (called glazing on a solar collector) traps these long waves. For example, on a sunny day your car with the windows rolled up becomes a solar collector. The glass lets in the sun's energy, traps the thermal 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!

Solar cookers 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 cookers 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.

Besides cooking, solar ovens can be used to purify water. This is beneficial for areas where obtaining safe drinking water is a problem.

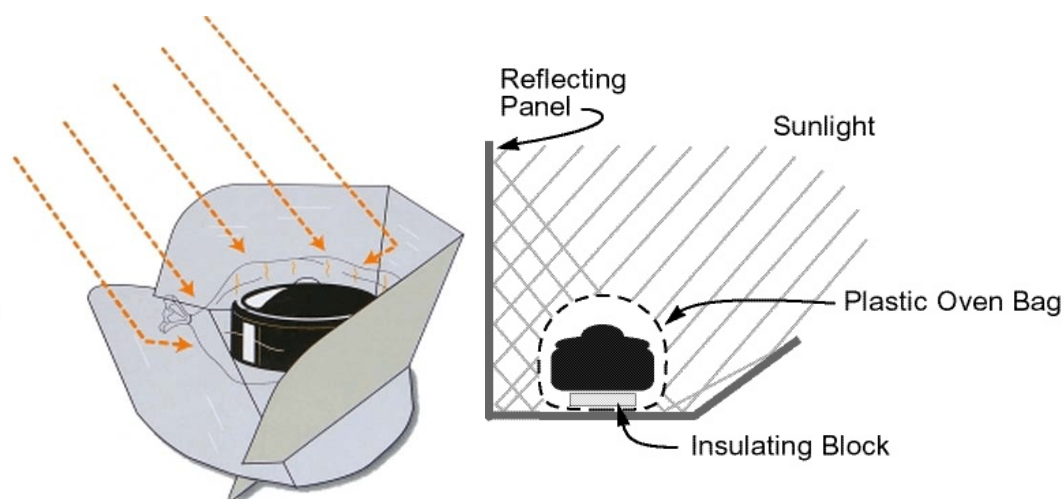
There are three basic types of solar cookers on the market today: box, parabolic reflector and panel cookers.

Box cookers



Box cookers (also known as box ovens) can cook the same foods you would cook in a standard oven or a slow cooker. As the name suggests, they have an interior chamber (“box”), although they do not have to be square shaped. They use reflectors to concentrate more sunlight into the box, glazing to allow sunlight into the box and then trap the heat, and insulation to retain as much heat as possible. Commercially made box ovens can reach 400° on a clear sunny day. Box ovens can be easily made from inexpensive or recycled materials, and are suitable for classroom construction and cooking.

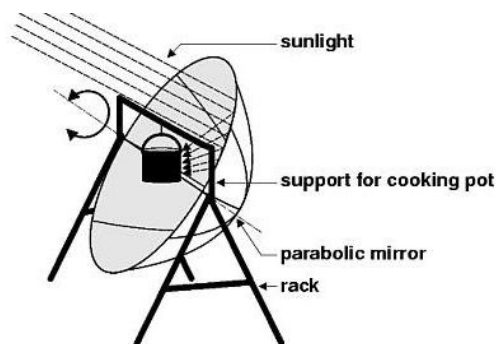
Panel cooker



Panel cookers can cook the same foods that you would cook in a covered pot on top of the stove. They use reflectors to “grab” a larger area of sunlight and direct it towards a black

cooking pot that is placed in a high temperature oven bag. The air inside the bag that surrounds the pot is the insulation that retains the heat. The temperature inside the pot of a panel cooker can reach and maintain boiling. Panel cookers can be easily made in the classroom from inexpensive materials, and are simple to use for cooking on clear sunny days.

Parabolic reflector



Parabolic cookers produce the highest temperatures, and can be used to fry or grill food--pot lids and cooking bags are not necessary. Parabolic cookers use reflectors to concentrate a large amount of sunlight into a single focal point, where the temperature can reach 500°. In the classroom, parabolic shaped cookers can be easily made from recycled satellite dishes or large umbrellas. However, the temperature can get very high at the focal point, so appropriate safety should be practiced while cooking.

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 an easily constructed box cooker and panel cooker are on the following pages.

Procedure (cooking day)

1. Mix or prepare the food to be put in the cooker according to the recipe.
2. Put the food in a covered dish, place in a baking bag, or cover tightly with plastic wrap.
3. Set the cooker facing the Sun.
4. Adjust the tilt of your cooker if necessary—for the file box cooker, objects can be placed under one edge. Tilt the reflectors (if necessary) so that the Sun's rays are directed into the body of the oven.
5. When food is done, be sure to use a pot holder to remove the food. **Solar Cookers can get extremely hot!**
6. Lead classroom discussion about how the heat from the Sun (solar thermal energy) was directed/trapped by the cooker (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 cooker? (*reflected /through the glazing*)

- What parts of the cooker help to hold the heat in? *(the insulation and the glazing for the box and panel cooker. Note that with the panel cooker the insulation is the air between the cooking bag and the pot)*
 - 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/cooking bag and the 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)*
7. 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.

Key Words and Definitions

- **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

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 Sunshine: The Complete Guide to Solar Cuisine with 150 Easy Sun-Cooked Recipes*** by Lorraine Anderson (Da Capo Press, 2006)
A classroom resource for those who want additional cooker designs and recipes
- ***Cooking With The Sun: How to Build and Use Solar Cookers*** by Beth Halacy and Don Halacy (Morning Sun Press, 1992)
A classroom resource for those who want additional cooker designs and recipes.

Internet Sites

<http://www.fsec.ucf.edu/go/energywhiz>

Florida Solar Energy Center's Solar Energy Cook-Off page includes links to student prepared recipes and photos of student built cookers.

<http://solarcooking.org/>

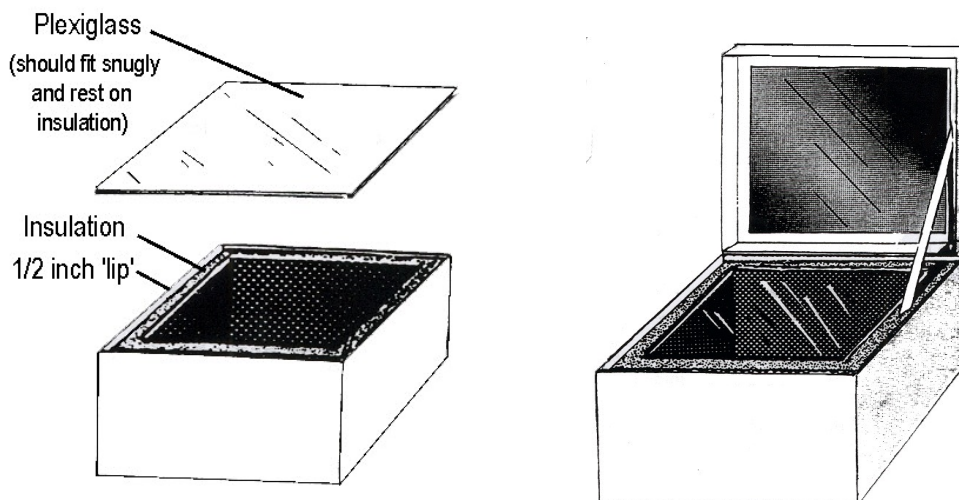
Solar Cooking International Network, solar cooking archive includes solar cooking plans, documents and a list of resources and manufacturers.

File Box Cooker

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. $\frac{1}{2}$ sheet per oven
- plexiglass, pre-cut to 12" x 15" (1 per oven)
- aluminum duct tape, 20 feet (per oven)
- black construction paper
- aluminum foil
- scissors
- wooden dowel, stick or pencil (1 per oven)



Procedure

1. Cut insulation material. Each oven requires:
 - (1) 12" x 15"
 - (2) 12" x 9 $\frac{1}{2}$ "
 - (2) 15" x 9 $\frac{1}{2}$ "
2. Put 12" x 15" piece of insulation inside the box on the bottom.
3. Fit the other pieces of insulation 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.

How to cook in your box cooker

1. Set the oven facing the sun.
2. Adjust the tilt of the oven (objects can be placed under one edge), and the tilt of the reflector (with a rod or stick) so that the Sun’s rays are directed into the body of the oven.
3. Mix or prepare the food to be put in the cooker according to the recipe.
4. Put the food in a covered dish, or cover tightly with plastic wrap. Do not cover your food with aluminum foil—it will reflect the sunlight away from your food! You can cook in any non-reflective pot, however thin black metal pots work best, and shallow ones work better than deeper ones.
5. Lift glazing, set the dish and an oven thermometer on the bottom of the oven, and replace the glazing (you may tape around the edges of the glazing if the box is not airtight).
6. Move the cooker periodically (every 20 minutes or so) to follow the sun as it moves across the sky.
7. 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!

Cook-it Style Panel Cooker

Materials

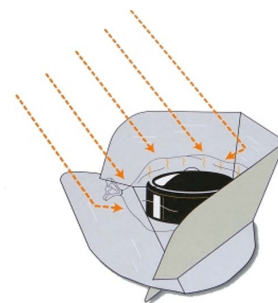
- Cook-it measurement sheet (next page)
- sheet of cardboard 48" x 36"
- mylar (from emergency "space" blanket)
- spray glue or white glue
- box cutter, scissors
- tape measure, ruler
- protractor

Procedure

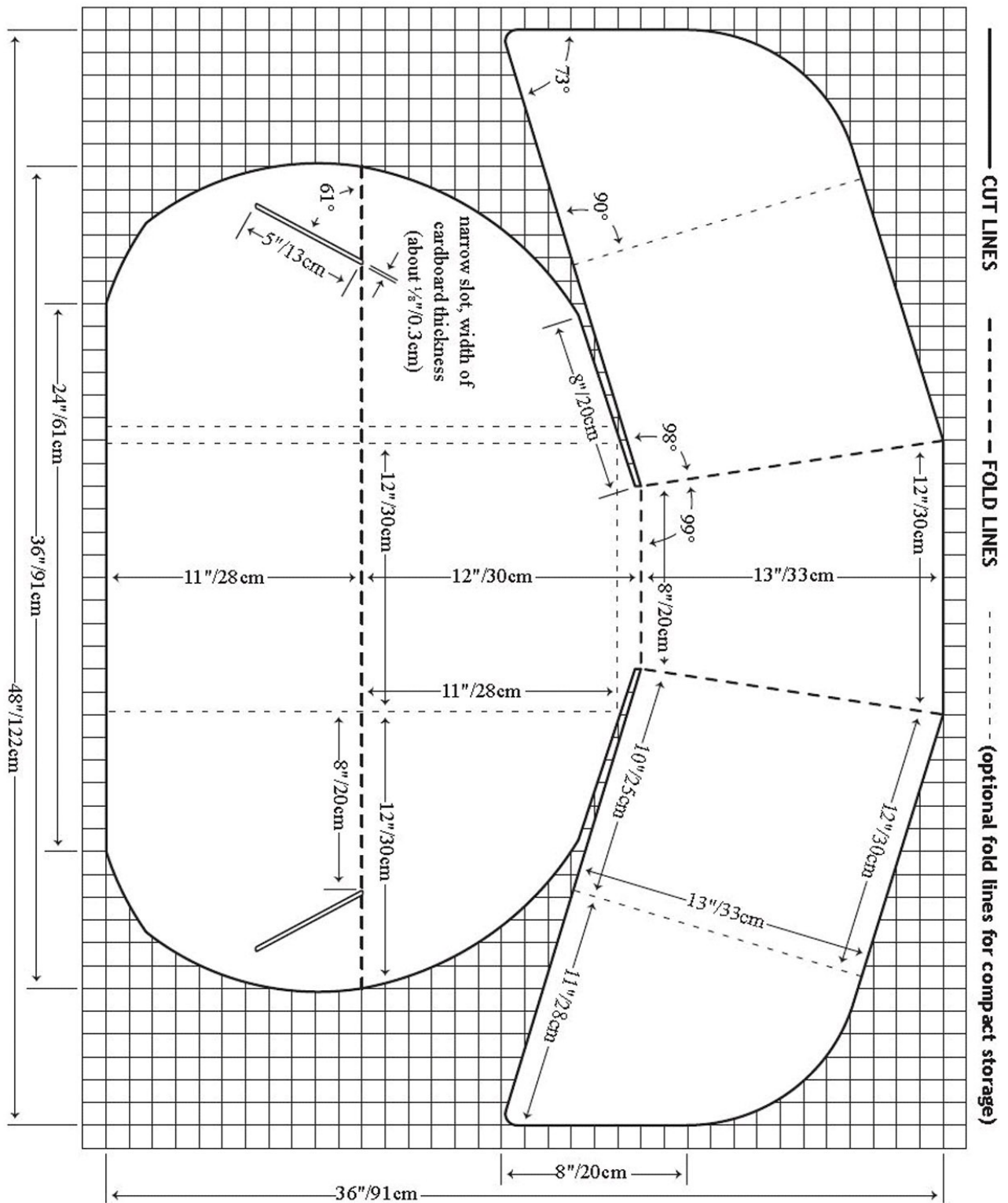
1. Using the measurement sheet, draw the cooker lines and fold lines onto the sheet of cardboard.
2. Cut out the cooker along the cutting lines. Fold the cardboard along the fold lines (Hint: It is easier to get a straight fold line if you firmly hold a yard stick or other straight edge along the fold line and then fold the other side up against the straight edge)
3. Affix the mylar to the side of the cooker that is on the inside of your folds. If using spray glue, spray the glue onto the cardboard and then place the mylar on top pressing out as many bubbles and creases as possible (a rubber roller or a plastic card—credit card, driver's license, etc—can be helpful). If you are using white glue, thin the glue until it spreads easily with a paint brush.
4. Trim the mylar around the edges of the cooker.
5. Cut the two slits.

How to cook using your panel cooker

1. Set up the cooker and place it facing the sun.
2. Mix or prepare the food to be put in the cooker according to the recipe.
3. Put the food in a covered black pot and put the whole dish in a high temperature baking bag. Seal tightly. Do not cover your food/pot with aluminum foil—it will reflect the sunlight away from your food.
4. If you do not have a black pot, you can paint the outside of a pot, or canning jar, black with paint designed for barbeque grills.
5. Place the pot in the center of the cooker. Move the cooker periodically (every 20 minutes or so) to follow the sun as it moves across the sky.
6. When food is done, be sure to use a pot holder to remove the pot. **Solar Cookers can get extremely hot!**



Cook-it Measurements



What's Cooking?

Cooking Tips - Box Ovens

1. Any conventional recipe that would be suitable for a conventional oven will work in a solar oven, also crock pot recipes are suitable for a solar oven.
2. Foods generally use less liquids or cook in their own juices. This produces better tasting and more nutritious food.
3. Foods never burn and rarely overcook in a solar oven.
4. When cooking foods containing liquids, 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.
5. Don't open your box cooker unless absolutely necessary! Every time you do, you let out the heat and slow down the cooking process.
6. Use a meat thermometer instead of a timer to determine if the food is done.
7. A Lazy Susan underneath your box oven can help you rotate it easily to follow the sun. Remember to adjust your box cooker every 20 minutes or so.
8. Foods particularly suited for the classroom include: hot dogs, slice and bake cookies, brownies, rice mixes, cocktail sausages in barbeque sauce, nachos, baked apples, kebobs.
9. Some specific food tips:
 - cook (steam) yellow and green vegetable in dark colored casseroles to prevent discoloration
 - vegetables and meats can be cooked with no water or added liquid
 - reduce liquids in cake recipes by one half
 - cook foods in their natural state (i.e. potatoes in skins and corn in husks)
 - sprinkle some cinnamon on the top of baked goods to darken the surface
 - doughs and batters containing eggs and milk will brown easier
 - chewy dessert recipes such as brownies come out better than crispy ones
 - meats cook better if cut into small pieces
 - if the recipe calls for the addition of oil, try adding it last, floating it on the top. This decreases the amount of evaporation (thereby decreasing the amount of heat loss). Stir in the oil at the end.
10. Temperature considerations:
 - On a clear and sunny day, a box oven will heat up to 250°F and above. On these days you can cook or bake anything.
 - On a partially cloudy day, the oven will heat to 200°F to 250°F. 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.

Cooking Tips - Panel Cookers

1. Always use lids on pans and place the whole pan in a tightly closed high temperature oven bag. Thin, shallow, aluminum or steel pans will heat faster.
2. Most recipes that can be cooked on top of the stove without frequent stirring will work with a panel cooker. Crock-pot recipes will also work well.
3. Foods generally use less liquids or cook in their own juices. This produces better tasting and more nutritious food.
4. Foods never burn and rarely overcook in a panel cooker.
5. Use a meat thermometer instead of a timer to determine if the food is done.
6. A Lazy Susan underneath your panel cooker can help you rotate it easily to follow the sun. Remember to adjust your panel cooker every 20 minutes or so.
7. Foods particularly suited for the classroom include: rice mixes, chili, chowder, stew, baked beans, couscous
8. Some specific food tips:
 - cook (steam) yellow and green vegetables in dark colored casseroles to prevent discoloration
 - vegetables and meats can be cooked with no water or added liquid
 - meats cook better if cut into small pieces
9. Temperature considerations:
 - On a clear and sunny day, a panel cooker will heat the contents to boiling for a sustained time. On these days you can cook anything.
 - On a partially cloudy day, the panel cooker will heat the contents above pasteurization temperature (149°), and probably to boiling. On these days you can easily cook most things, but extra care should be taken with meats (check the temperature).
 - Adjust your cooking time to account for the lower temperature. A rule of thumb is to figure twice the regular cooking time.

Cooking in the classroom

Some easy things to try with your solar cooker in the classroom are:

- packaged rice mixes that include the spices
- baked beans with pieces of hot dogs (or with small cocktail wieners)
- hot dogs in barbeque sauce
- heating up canned soups, stews, ravioli, etc.
- nacho cheese for chips

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
- ¾ 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?

Florida NGSS Standards & Related Subject Common Core

			.1	.2	.3	.4	.5	.6
Grade K								
The Practice of Science	Big Idea 1	SC.K.N.1				X		
Grade 1								
Earth in Space and Time	Big Idea 5	SC.1.E.5				X		
Grade 2								
Earth Systems and Patterns	Big Idea 7	SC.2.E.7		X				
Forms of Energy	Big Idea 10	SC.2.P.10	X					
Language Arts Standards	Kindergarten: LAFS.K.W.3.8, LAFS.K.SL.1.1, LAFS.K.SL.2.5 First Grade: LAFS.1.W.3.8, LAFS.1.SL.1.1, LAFS.1.SL.2.5 Second Grade: LAFS.2.W.3.8, LAFS.2.SL.1.1							

Kindergarten Benchmarks**Science--Big Idea 1: The Practice of Science**

- SC.K.N.1.4 - Observe and create a visual representation of an object which includes its major features.

Language Arts--Writing Standards

- LAFS.K.W.3.8 - With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.

Language Arts--Standards for Speaking and Listening

- LAFS.K.SL.1.1 - Participate in collaborative conversations with diverse partners about kindergarten topics and texts with peers and adults in small and larger groups.
- LAFS.K.SL.2.5 - Add drawings or other visual displays to descriptions as desired to provide additional detail.

First Grade Benchmarks**Science--Big Idea 5: Earth in Space and Time**

- SC.1.E.5.4 - Identify the beneficial and harmful properties of the Sun.

Language Arts--Writing Standards

- LAFS.1.W.3.8 - With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.

Language Arts--Standards for Speaking and Listening

- LAFS.1.SL.1.1 - Participate in collaborative conversations with diverse partners about

- grade 1 topics and texts with peers and adults in small and larger groups.
- LAFS.1.SL.2.5 - Add drawings or other visual displays to descriptions when appropriate to clarify ideas, thoughts, and feelings.

Second Grade Benchmarks

Science—Big Idea 7: Earth Systems and Patterns

- SC.2.E.7.2 - Investigate by observing and measuring, that the Sun's energy directly and indirectly warms the water, land, and air.

Science—Big Idea 10: Forms of Energy

- SC.2.P.10.1 - Discuss that people use electricity or other forms of energy to cook their food, cool or warm their homes, and power their cars.

Language Arts—Writing Standards

- LAFS.2.W.3.8 - Recall information from experiences or gather information from provided sources to answer a question.

Language Arts—Standards for Speaking and Listening

- LAFS.2.SL.1.1 - Participate in collaborative conversations with diverse partners about grade 2 topics and texts with peers and adults in small and larger groups.

National Next Generation Science Standards

Kindergarten Standards

Science—Energy

- K-PS3-1 - Make observations to determine the effect of sunlight on Earth's surface.

Engineering Design

- K-ETS1.1 - Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Note: Related Common Core Language Arts Standards are listed in the Florida section above.

First Grade Standards

Engineering Design

- 1-ETS1.1 - Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Note: Related Common Core Language Arts Standards are listed in the Florida section above.

Second Grade Standards

Engineering Design

- 2-ETS1.1 - Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Note: Related Common Core Language Arts Standards are listed in the Florida section above.

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

