

SOLAR BOX COOKER

ASPI Technical Series

WHAT IS A SOLAR BOX COOKER?

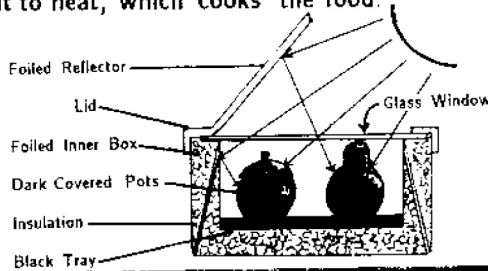
A solar box cooker or "solar oven" is an insulated box—within—a-box which utilizes solar energy for cooking food. A solar oven is approximately 1 m by 1.5 m (3 ft. by 4 ft.) and is large enough to capture 37.2 square centimeters (4 square feet) of sunshine. It usually weighs around 7 kilograms (16 pounds) and can be made from simple materials which are easily obtained in most areas.

HOW DOES A SOLAR BOX COOKER WORK?

A solar cooker works through three common physics concepts:

1. Dark objects absorb sunlight and convert the energy to heat.
2. Shiny surfaces reflect rather than absorb heat.
3. Light passes through transparent materials, while heat (to a large degree) does not.

The solar box is designed so that an adjustable reflector directs sunlight through a tight-fitting glass lid. The sunlight enters the insulated box and is reflected off the sides, which are lined with aluminum foil or other reflective material (Mylar for example). Inside the box, the cooking pots, which are dark colored (black works best) absorb the sun's energy and convert it to heat, which cooks the food.



ADVANTAGES OF THE SOLAR OVEN

1. Economic

Free fuel -- It uses no electricity and there is no need to buy other fuel.

Inexpensive to build -- The materials are relatively inexpensive and readily available in most areas.

Can be built by almost anyone -- The design is simple and requires no special expertise or tools.

2. Time

No collecting of firewood or dung is necessary.

No constant watching of the cooking food is required.

Several foods can be cooked at the same time.

3. Health

No smoke, so there is less chance of lung disease.

The cooker can be used to purify water, so there is less danger of intestinal disease from drinking unsafe water.

4. Environmental

Reduces:
 deforestation and desertification
 fossil fuel use.
 soil depletion.
 air pollution.

WHERE CAN THE SOLAR OVEN BE USED?

The solar oven needs to be placed in a spot that will be in sunlight for several hours.

In the sunny tropics it works year-round, and in temperate zones it can be used for 6-8 months of the year.



Mid-day and midsummer are the peak cooking times.

When the sun is at least 1/3 of the way from horizon to overhead (30 sun angle), easy-to-cook foods will cook. The closer the sun is to a 90 angle (directly overhead), the greater the cooking power. The most intense cooking takes place from 10:00 a.m.—2:00 p.m.

In the winter when the sun is farther away, it doesn't get as high in the sky; therefore cooking power is decreased.

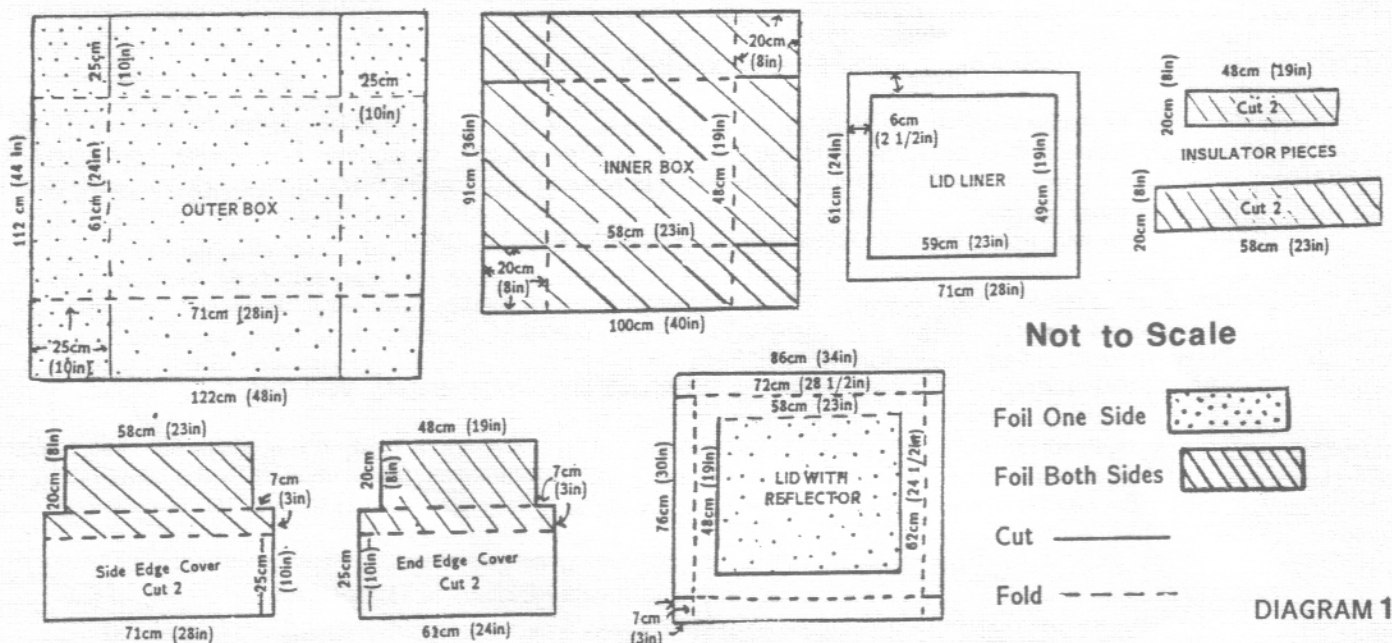
Wind, humidity and outdoor temperature affect the cooking very little. The oven also works well at high altitudes. Dust and smog will, however, slow down the cooking time.

NOTE: In some places the Solar Box Cooker will not completely replace current cooking methods, but it can offer convenient seasonal relief from the high cost of fuel.

A. MATERIALS

1. Corrugated Cardboard — Enough to make 2 large boxes plus 4 edge covers, lid, and 4 insulator pieces (optional). SEE DIAGRAM 1 for measurements. If you don't have enough large pieces of cardboard, smaller ones can be overlapped and glued or taped together.

SUBSTITUTES: Wood, baskets, a hole in the ground can be used for the outer box.



2. Glass — A single pane at least 51cm by 61cm (20in by 24in) and slightly larger than the inner box.

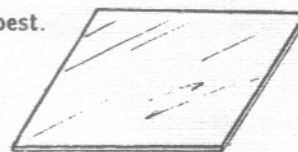
SUBSTITUTES: fiberglass, polyester, polycarbonate (must be heat resistant).

3. Aluminum Foil — about 22.86m long by 60.96 cm wide (75ft by 12in).

SUBSTITUTES: Any shiny thin metal, mirror, Mylar, shiny white materials are the next best.

4. Glue — 1 pint of water based white glue or carpenter's glue.

SUBSTITUTES: Tape, flour paste, papier mache' (shredded paper soaked in water and mixed with glue).



Glass Pane

5. TO SEAL GLASS IN THE LID — Silicone Caulk or papier mache'.

6. Crumpled Newspaper — For Insulation

SUBSTITUTES: Clean dry straw, rice hulls, sawdust, fiberglass, wool, extra layers of cardboard/foil. Insulation must withstand high temperatures. DO NOT USE STYROFOAM OR PLASTIC, — THEY WILL MELT!

7. Large Black Tray — Thin metal (or foil-covered piece of cardboard) for inside bottom. Paint top side with black tempera or high temperature black paint.

SUBSTITUTES: Black cloth, cooking oil/soot mixture instead of paint.

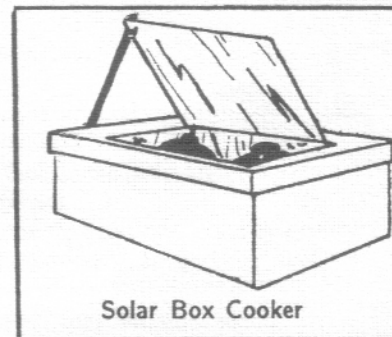
8. String or cord and a stick or wire — to prop reflector.

9. Dark Colored Cooking Pots with Dark Lids.

SUBSTITUTES: Blacken cookware with paint or soot/cooking oil mixture.

NOTE: Shiny pots cook less effectively.

10. Tools: Scissors or knife, bowl or flat pan (to mix glue), brush or roller (to spread glue), measuring stick.



Solar Box Cooker

NOTES ON SIZE: A solar box cooker needs a window about 25 square meters (400 sq in.) in size (about 50cm X 50cm or 20in X 20in) for dependable family cooking.

For the box itself, bigger is better for cooking power but is more cumbersome to move. Generally about 2 kilos (5 lbs) of food can be cooked for each 6.25 square meters (25cm X 25cm or 1 square ft). Start with a box that is 48cm X 58 cm X 20cm (19in X 23in X 8in) or proportionally bigger.

B. BUILDING THE SOLAR BOX

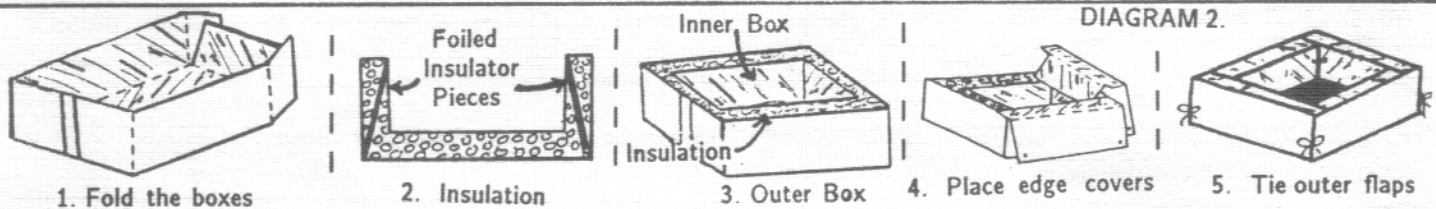
1. Glue foil (shiny side out) to cardboard pieces as indicated in Diagram 1. NOTE: Pieces for the inner box are foiled on both sides.
2. Make the boxes by folding up the sides (along the dotted lines) and gluing or taping in place.
3. Check the size of the boxes. There should be 6cm (2 1/2 in) of space between the four sides and at least 2.5cm (1 in) between the bottoms.

3. Insulating the Box: Fill the bottom of the outer box with insulating material to a depth of about 2.5cm (1 in) to support the inner box. Place the inner box inside the larger box so that 6cm (2 1/2 in) of space remains on the four sides.

Place the foiled insulator pieces into the box with the top lying against the inner box and the bottom against the outer box. Fill the remainder of the box with the insulating material. (See Diagram 2).

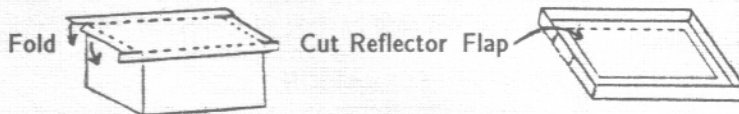
4. Sealing the space between the boxes: After filling the box with insulation fold the 4 edge covers to seal the top edges of both boxes. Note that these cardboard pieces are foiled on both sides but only to the fold line. (See diagram 2.) Tie or glue the outer flaps.

5. Place the black tray in the bottom of the inner box.



C. MAKING THE LID WITH REFLECTOR FLAP

1. Remember, the lid must fit snugly. Fold the lid piece over the box. Cut the corners, fold and glue them in place.
2. After the lid is made cut 3 sides of the reflector flap. (This opening will be a little smaller than the glass pane. As indicated in Diagram 1 foil the inside surface of the flap.



3. Put silicone caulk or papier mache' around the edge of the glass on one side. Press the glass firmly into the inside of the lid. Make sure there is a complete seal.
4. Put glue on the glass and on the cardboard lid liner. Press into place. (See Diagram 3).
5. Attach a stick or wire to hold up the reflector.

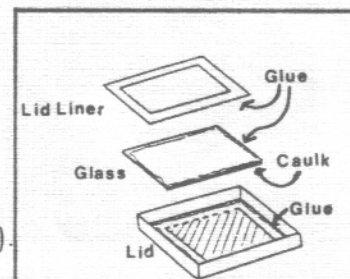
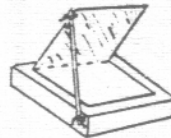


DIAGRAM 3.

IMPORTANT: Before cooking for the first time with your new solar box cooker, LET IT HEAT EMPTY FOR SEVERAL HOURS IN THE SUN. This will insure that all of the paint and glue is dry and will not give off harmful fumes.

D. MAINTENANCE OF THE SOLAR BOX COOKER.

The solar box cooker requires little to no maintenance and with reasonable care can provide convenient cooking at very low cost. If the box is to be used or moved frequently you may wish to build the outer box from a sturdier material, such as wood if it is available.

DO NOT leave the cooker out in the rain. Cover it with a water-proof cloth or move it inside. If the cooker does get wet inside or out, let it dry with the lid off.

After cooking, remember to wipe moisture off of the glass or leave the lid off so the inside of the box will dry out.

COOKING WITH THE SOLAR BOX COOKER —The amount of food the solar cooker will cook at one time depends upon the size of the box. The box described in this paper will cook 5–7 kilograms (10–15 pounds) of food per meal on a sunny day. Food will not spoil during slow cooking. The bacteria that cause food spoilage as well as disease-causing organisms (germs and parasites) stop growing at 49 C (120 F) and are killed at 65 C (150 F) well below the cooking temperature of the solar box cooker.

NOTES ON USING THE COOKER

1. Add no water when cooking meats, fresh fruits or vegetables.
2. No nutrients are lost during cooking.
3. When cooking dried beans and grains, add the usual amount of water.
4. The gentle cooking temperatures (95–135C/200–235 F) are ideal for cooking food without burning it.
5. Tough meats are tenderized naturally during cooking.
6. There is no need to stir the food, but it can be checked occasionally. However, if the lid is opened frequently, the heat-loss will significantly slow cooking time.
7. No special recipes are needed.

If possible the cooker should be moved to follow the sun, especially when:

- * the day is very cloudy (more than half)
- * the sun is at a lower angle (as in winter months or at a higher altitude)
- * a higher temperature is desired (as in baking)
- * a large quantity of food is being cooked.

To keep food hot after sunset, several bricks or heavy stones can be placed in the cooker when the food is put on to cook, and insulating materials such as blankets placed over the cooker.

TO COOK FOOD:

1. Put the food in dark pots with tight-fitting lids.
2. Place the pots in the cooker and put the top on the cooker.
3. Set the box in a sunny spot with the reflector facing the sun. Fasten the prop stick so extra light will shine on the pots.
4. Leave until mealtime.
5. Be careful when removing the pots, they will be very hot.

**TYPE OF FOOD/COOKING TIME ON A SUNNY DAY
for 4 kilos (10 lbs) of food**

EASY TO COOK 1–2 hours	MEDIUM 3–4 hours	HARD-TO-COOK 5–8 hours
eggs	potatoes	most dried beans
rice	pastry	large pieces of meat
fruit	vegetables (root)	
vegetables (above ground)	some beans	
fish	lentils	
chicken	bread	

OTHER USES

WATER PASTEURIZATION AND HEATING

To kill water-borne disease organisms, the water needs to be heated to a temperature of at least 65 C (150 F).

A 4 liter jar of water heated for 3 hours in a solar box on a sunny day will be free of biological contamination.

FOOD PRESERVATION

Acid foods (fruits and vegetables) can be preserved or "canned" for long term storage in heated sealed containers with a solar box. **DO NOT CAN MEATS** or non-acid vegetables unless pickled (with vinegar).

DISINFECTING MEDICAL EQUIPMENT, BANDAGES AND SEPTIC WASTES —when other methods are unavailable.

IN DISASTER RELIEF —when electricity, gas and safe water are disrupted.

AS A TRADITIONAL "WONDERBOX"

(Also called "hayboxes" or "hotboxes") Food is brought to boil over a fire, then the pot is wrapped in a blanket and placed in the insulated box to continue cooking by itself. This will also be of use on sunless days or at night.

REFERENCES — "Your Own Solar Box," Solar Box Cookers International, 1724 11th St. Sacramento, CA 95814 (916) 223–228

"How to Build and Use a Solar Box Cooker," Solar Box Cookers International

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