Energy Conversion

In this project, you will design, build, and refine a device that converts solar energy to thermal energy. This system is also known as a solar box cooker.

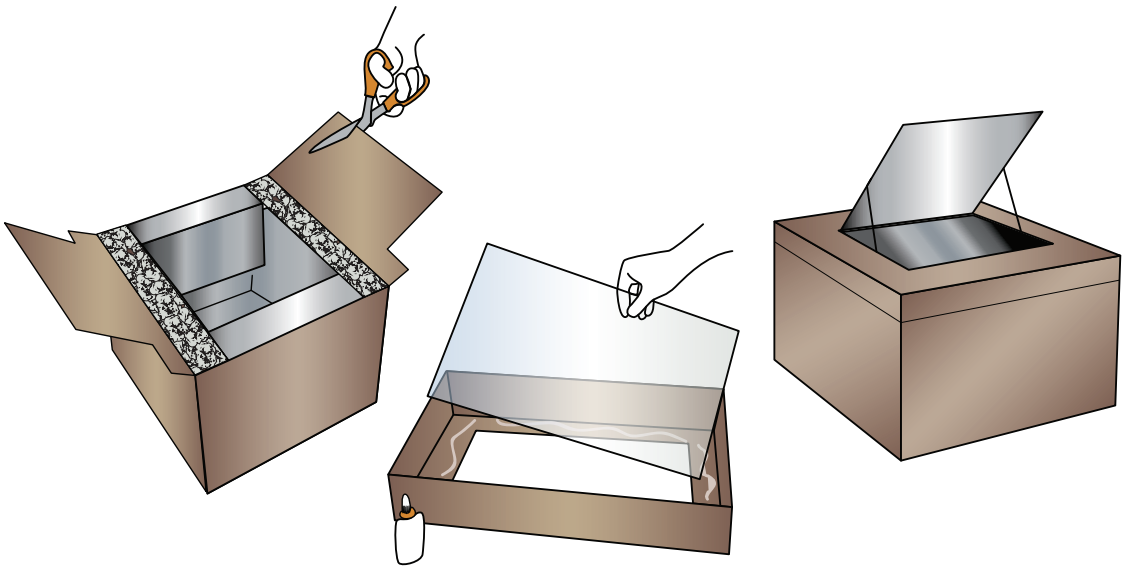
To do this, you will need

- Two cardboard boxes with flaps. The smaller box should have dimensions of at least 50 cm on each side. It will "nest" inside the other box, so the larger box should be about 5 cm larger along each dimension.
- A flat piece of cardboard about 20 cm longer and 20 cm wider than the top face of the larger box. This becomes the lid.
- A piece of (lightweight) glass or plexiglass about 50 cm by 60 cm, which approximately fits atop the larger box (see instructions below).
- Newspaper or other recycled paper.
- Thin metal tray about 40 cm by 50 cm, painted black.
- Cooking pots.
- Stick (about 1 ft long).
- Aluminum foil.
- Water-based glue.

Steps:

1. Remove (cut off) the flaps of the smaller box.
2. Glue foil on
    - The inside and outside of the smaller box.
    - The inside of the larger box (including flaps) and on the outside of its flaps as well.
    - One side of the (larger) flat piece of cardboard, which becomes the lid.
3. Cut out multiple 4-cm squares from the discarded flaps.
4. Glue these pieces together until you have four "stacks" of them, each 2 or 3 cm high.
5. Glue the four stacks to the inside bottom of the big box to support the smaller box.
6. Crumple up newspaper and line the bottom of the larger box with the newspaper for insulation.
7. Place the smaller box inside the larger box, and add more crumpled newspaper between the boxes as insulation.
8. Cut and fold the flaps of the outer box. You will fold them inward so they cover the gap between the boxes, then fold them down to lie along the sides of the small box. (See the first image in the illustration on the next page).

9. Take the thin metal tray and paint it black. Place it in the bottom of the small box.
10. Make a lid for the larger box. Take the flat cardboard piece with the foil facing down, center it on the top of the box, and make four cuts in the cardboard (two in from each opposite side) so you can fold down the flaps onto the sides of the large box. Once you fold the sides down, take the corners and wrap and glue them to secure the lid.
11. Cut a large flap in the lid (three sides of a rectangle), and cut sticks to the length needed to prop up the flap. Sunlight will be reflected off the shiny surface into the opening you just cut.
12. Glue the glass (plexiglass) inside the lid you just made. This retains heat inside the system (the greenhouse effect).



You will need to design a way to measure how well your system converts solar energy into thermal energy. Perhaps you could look up the solar constant to see how much solar power is delivered per square meter at your location, and measure the temperature rise of a known amount of water inside the system. We leave the rest to your creativity!

Questions:

1. How does the weather affect your cooker? For instance, a sunny versus a cloudy day? Humid versus dry days?
2. Explain the use of aluminum foil and why a surface is painted black.
3. If you have the opportunity to use the solar box cooker over a long period of time, does its effectiveness change between seasons, such as winter versus spring?
4. Vary the insulation. What is the most effective insulator you can find?
5. If there are different teams in the class, try some variations and see which is most effective.