

Solar Energy with Kids

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Back in 1970, thanks to the Whole Earth Catalog, I discovered Farrington Daniel's book *Direct Use Of the Sun's Energy* which was first published in 1964. It not only recounted solar energy history about turn of the century hot water heaters and distillation plants, but told how to make solar ovens, cookers and hot water heaters. I was worried about the greenhouse effect so it captured my imagination. I remember running down to the thrift store to buy an umbrella in July. I lined it with aluminum foil, chopped off the handle, made a stand for a cup and, viola! a cup of almost boiling water for tea. I made a fresnel lens focusing collector for heating water. It was great.

As time went on I built a beer can solar collector for my shop and made a solar water heater by painting an old hot water tank black. We bought a house with big south facing windows and probably get 20-25% of our heat from the sun by just opening the curtains. If only gas had gone to \$ 5.00 a gallon.

I stayed at least peripherally interested in solar energy but along about the middle 80's I noticed my friends' eyes beginning to glaze over any time the subject was brought up. I felt like the crazy uncle gone round the bend with impractical schemes.

A note of caution: The power of the sun can start fires. Collectors should be used only under the direct supervision of a knowledgeable adult. I once left my solar hot dog cooker unattended under shed roof, protected, I thought, from the rays of the sun. The sun dropped low in the sky and snuck in under the roof and over the end of the collector. The focal point became a beam of wood six feet above the collector. I did not think this was possible but, it was, and if someone had not been around to smell the smoke the building could have burned down.

Solar Energy with Kids

One morning I woke up and realized I'd been talking about solar energy for almost 15 years and hadn't really done much with it. I was working with kids doing science and carpentry and it occurred to me that they might be interested. At least I could make a demonstration project. So I built a solar hot dog cooker. Not exactly practical, but the kids loved it. I was amazed at their reaction: no glazed eyes, no chuckles about impracticality, just amazement and wonder, my feelings still. To make a long story short, the kids' reaction motivated me to make more equipment to demonstrate solar energy and what evolved was a 2 hour solar energy presentation for a classroom of kids. The following is a description of my gear in the order of presentation:

1. A sundial. Clamp it to the table so it won't move. Inside with the lights turned down, move a light past the sundial to illustrate how the shadow moves as the sun moves. Introduces the concept that the sun moves through the southern sky in winter.

To do: • Check the time when you start and kids will come back and check it again later.

- Copy the face of a sundial onto paper and the kids can make their own.

2. Black absorbs white reflects:

Materials: • Two pieces of copper, about six inches square, one painted black, the other white. If you have trouble finding copper or brass aluminum or steel will also get the point across.

- Digital thermometer is nice but not necessary

To do: • When you set these in the sun kids easily feel how much more heat black absorbs than white.

- Check the temperature difference with the thermometer.

3. Two, 2 pound coffee cans each filled with water, one painted black, the other white.

To do: • Same as #2 above

4. The hot water rises experiment: This experiment shows what happens inside the pipes of a solar water heater.

Materials:

- One clear plastic 1 gallon jar
- 4 oz artichoke hearts jar: drill two holes in the lid and glue in two pieces of drinking straws in the holes so they stick out 1/4" above the lid, like two small chimneys.
- food coloring

To do: Fill the big jar with cold water. Fill the small jar with hot water (solar heated of course), add food coloring to the hot water, put the lid on, and set the small jar inside the large jar. The colored water being hotter, takes up more space than the same number of cold water molecules, and rises up, through a straw, out of the little jar to the top of the cold water in the big jar. Like smoke coming out of a chimney.

5. Cardboard box heater.

Materials:

- shallow cardboard box with a lid, approximately 12" X 18"
- Flat black paint
- Piece of plastic sheeting or thin plexiglass, 10" X 16"
- Duct tape
- Digital thermometer

This is a basic box heater. Cut a hole in the lid almost to the edges. Use duct tape to fasten the plastic sheet over this hole. Paint the inside of the box black.

To do: • Stick the thermometer inside the box. How hot does it get? Mine approaches 200 degrees F.

- Cut a small hole in the end of the box and stick your fingers down inside. Feeling how hot it is makes more of an impression than looking at a thermometer.
- Would painting the outside of the box increase the temperature inside the box?
- How could you make it hotter inside the box?

6. A hot water heater: This is the combination of experiments 2, 4, and 5. See Direct Use of the Sun's Energy, chapter 6, for details of water heater construction.

Description: A 2' X 4' box framed with 1" x 4". The back is 1/4" plywood. The inside of the box is insulated with 1/2" foam board, painted black with high temperature flat black paint and contains a framework of copper tubing (see book again). The top of the box is covered with clear plastic. The top of the copper grid is connected to the top of a three gallon plastic paint pail. The bottom of the grid is connected to the bottom of the plastic paint bucket. The water flows through the copper pipe, rising, gaining heat, into the water tank. The cooler water settles to the bottom of the tank and then flows to the bottom of the collector.

To do: • Stick your hand in the water, carefully. It's hotter than you think.

- Look for the hot water where it comes out of the hose from the copper pipe. You will see it shimmer, like heat waves coming off hot pavement.
- With a piece of surgical tubing and large syringe inject some water with food coloring in it into the tank drain that feeds back to the bottom of the collector.
- Measure the temperature difference between the top and bottom of the tank.
- How could this water heater be made to work better?
- Comment on how inventions are often a combination two or three ideas known to most people but put together in a clever and simple way. In this case: Black absorbs heat, hot water rises and a box with a clear lid combine to become a hot water heater.

7. Solar heated kid warmer. I built this for those chilly days in the fall and spring. It really works and my preschool kids loved it. It is just like the small box heater only bigger.

Materials: • Large cardboard dryer box

- Duct tape
- Flat black paint
- 3" X 4" piece of visquine

Directions: Cut a large hole in the side of a dryer box. Cover this hole with plastic sheeting using duct tape around the edges. In the opposite side from the window cut a small door. Paint the box black and face towards the sun.

To do: • Kids can hide inside this cozy space to warm up on chilly days.

8. Make or buy a small solar oven. I got a small cardboard oven (the sun spot) for \$20. a while ago. There are good plans in the book Heaven's Flame by Joseph Radabaugh. You can buy more expensive ovens from Kansas Wind Power or Real Goods.

To do: • I always make cookies (even if they are small) and put them in the oven before we start.

- After the cookies are finished baking the kids can put their hands in the oven to feel the power of the sun. (Although I did this it was the 1990's and there may be some rules about food handling which I didn't observe).

9. Solar Hot Dog cooker This is a parabola shaped frame that holds a plastic mirror. The parabola focuses the sunlight on the hot dog and will burn it if the hot dog is not rotated. The plastic mirror (available at glass stores) works a lot better than aluminum foil and it is easier to clean. This rather silly device I've used in my summer class and it is definitely an attention getter. Check Farrington Daniel's book for how to draw a parabola if you don't know how. Then just make a wood frame to hold the parabola.

To do: • Have the kids two or three at a time put their hand at the focal point if they want to. It is hot.

- Cut the hot dogs in half and let the kids cook their own.

10. Umbrella lined with aluminum foil.

Materials: • old umbrella

- Aluminum foil
- metal cup painted black
- bailing wire, pliers

Cut off the handle at the focal point and make a wire stand to hold a black cup. Mine took about 15 minutes to heat a cup of water.

To do: • Put your hand quickly in and out of the focal point to feel the heat

- Heat water for tea or hot chocolate

11. Fresnel lens cooker.

Materials: • 1 X 6 Lumber

- Approximately 18 square feet of plastic mirror
- a stand to hold the cooking pot
- Pan painted black

I made this from VITA plans. I would probably be easier to just find an old satellite dish which would do the same thing, only better. Be careful of the focal point, it's HOT! Mine was about 4' in diameter and had four steps, each 6 1/2" wide, aimed at the focal point. It heats a quart of water to near boiling in 15-20 minutes.

To do: • Heat water for tea or hot chocolate

- cook soup or rice
- Keep the collector aimed at the sun so the focal point will remain on the item being cooked.

12. Solar cells. This is an old 30 watt ARCO panel connected through a volt and ammeter to a rubber bladed 2 speed fan.

To do: • This is a good demonstration to teach that blocking the sun blocks the energy. People often stand in front of the solar cells and ask why they don't work.

- Use the fan for air conditioning
- Hook up other electrical devices, a pump, motor or light

13. A race against solar cells. An old war surplus hand crank generator. This machine will put out about 50 watts, but it is hard to keep up for long.

To Do: • Kids crank to see how many watts they can produce and compare their output to the output of the solar cells. This will entail a short lesson about how to measure power. And you will need to mount volt and amp meters on the generator so the kids can figure out how many watts they are producing.

14. Books, magazines and plans: Direct use of the Sun's Energy, Heaven's Flame, The 12 Volt Bible for Boats, The latest Popular Science on solar cells and power plants, plans for a solar furnace made from beer cans and other miscellaneous stuff from my solar file.

Here is how I make my presentation:

Set all my equipment outside in the sun in the order they are to be presented. Put cookie dough in the solar oven. Go into the class room with the hot dog cooker, sundial and the two copper plates. I'll talk to them for about 5-10 minutes and try to cover the following points:

- Use of solar energy is not new
- Native American Pueblos
- Greeks, Archimedes setting ships on fire
- Water distillation in South America 1890's
- Cloths line or sun coming in a south facing window is solar energy
- There is a lot of power in the energy of the sun, 1000 watts/ square yard
- Kinds of energy, coal, gas, hydro, nuclear pollute, solar does not except in the manufacturing process
- Will be important in the future, during their lives because of greenhouse effect
- Many uses of solar energy are very simple
- Based on fact black absorbs heat and white reflects it
- Safety: • Be careful of the hot water, it is hot
 - The focal points are hot, test carefully

I demonstrate the use of a sundial by turning out the classroom lights and moving a light past the sundial. Kids can see the shadow move.

Outside I explain each demonstration in order asking for questions after each one. After we've worked through all the demonstrations they get 1/2 hour or so to check out things on their own. We take the cookies out of the oven and pass them around. Then we have our race between the solar cells and the hand crank generator. This involves a short explanation of volts X amps = watts. Then inside for questions and answers. This is the best part and the kids never cease to amaze me with their questions and avid interest.

I guarantee this demonstration will get kids excited about solar energy. There are several directions for follow-up activities: Explanation of heat energy vs electrical energy, writing about the history of solar energy, making their own solar oven or cooker, use of math to figure out how many solar cell you would need to supply their classroom lights, study and use of low voltage electricity, or making model solar powered boats or cars, to name a few.

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About the Author

Jack McKee has worked as a mechanic, remodeled houses, built small boats and designed equipment used by children's museums, schools and preschools. He has worked at a Montessori school teaching "shop" to 3-6 year olds and for the parks department teaching summer woodworking classes for kids. His articles have appeared in Home Education, Tech Directions, Early childhood Today and Wooden Boat. He has written two books, Woodshop for Kids and Builder Boards. You can see more of Jack's creations in the do-it-yourself section of his web page at: home.earthlink.net/~mckee

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