

Building a model solar water heater

Activity suitable from KS2 upwards

This method is designed to be simple to do with free or cheap materials.

Why solar water heating?

It is an important technology as it is the one type of renewable energy that it is worth any home owner thinking about installing. A professionally made system for an average house would cost at least £2000. It can be considerably more depending on the type and the practicalities of installation. It would be expected to produce at least 50% of the household's hot water needs (not space heating).

It is also valuable for pupils to learn the difference between solar water heating panels and solar cells that generate electricity, which cost a lot more for the energy they produce.

It is a great way for pupils to learn some basic scientific principles about insulation, the movement of the earth in relation to the sun and the movement and absorption of heat.

Basic principles of a solar water heater

It has to face more or less South and be set at an angle (20-50 degrees from the horizontal).

The pipes that hold the water will work best if they are black.

The collector will retain heat and therefore get hotter if it is insulated and there is some type of 'glazing' to act as a 'greenhouse effect' and prevent air movement from cooling the pipes.

Equipment

- Bicycle inner tubes. Bike shops that do repairs throw these away when they are punctured. You will need to cut out a piece of the length you need so just make sure you avoid the bit with the puncture.
- Something to 'plug' the ends of the piece of inner tube. A knot can be tied in one end but you need to be able to open the other end to test the temperature. The neck of a plastic bottle with its top works well. Cut the bottle neck a little way below the lid. The best ones are the ones that bulge out at the top of the neck and then in again.
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- Fairly shallow boxes. About the size of the lid of a box of A4 paper would be convenient. It needs to be deep enough for insulation material and the pipes. You may

find some handy expanded polystyrene boxes that can be box and insulation all in one. Broccoli comes in deep ones that could be cut down.

- Insulating material. Scrap expanded polystyrene from packaging is a very efficient insulator and also free and convenient but very messy to cut up.* Old fairly fluffy jumpers would work pretty well.
- A roll of clingfilm wide enough to stretch across the face and over the edge of the boxes you have collected
- Sellotape or masking tape to fix the clingfilm in place.
- Aluminium foil to reflect solar energy onto the tube (not essential).

Tools

Scissors

Pencils

Rulers

Breadknife

Hacksaws (also useful for cutting polystyrene but messy)

Heat sensor

Running the activity

- Prepare a piece of inner tube with one end tied, a bottle top in the other and filled with water.
- Show this to the class. Explain that you put cold water in it.
- Ask them what will happen if you put it in the sun. They may give various answers but they are sure to get round to saying the water will get hot.
- Ask them what they could do to make it work better (heat faster and/or get hotter)
- Make sure they all understand what insulation is and how it works. Insulation slows heating from getting through the substance. It has numerous small air bubbles inside it (so small you can't really see them in the expanded polystyrene). If possible show them various types of insulation, including sheeps wool. Ask them what they put on when they go outside in cold weather and talk about what works well. Also talk about duvets which are a clear example of a light fluffy material with lots of tiny air holes.
- Discuss what the clingfilm does.
- Explain that they need to design their box so that they can get at the bottle lid easily in order to check the temperature.

Key things they need to realise

The insulation needs to be behind the tube. If it slips between the sun and the tube it will stop the water from heating up (sometimes pupils wrap the tube up in the insulation)

If they use aluminium foil it can reflect the heat onto the tube but they need to think carefully about where it is placed and therefore what direction the heat will be reflected in. It needs to be used nice and smooth, not scrunched up. It could reflect heat back out of the box if badly placed.

The function of the clingfilm is to let solar energy in but do something to stop it all escaping again immediately (the greenhouse effect on a small scale). Outside it will also help to stop wind from cooling the pipe.

- Divide the class into small groups
- Give each group the equipment they need
- They make their solar water heaters
- Take them outside and discuss what the best place is to put them. Discuss what appears to us the movement of the Sun through the sky (seasonal and daily).
- Put them in the sun
- Discuss with the class how regularly you should all check them. How regularly depends on how sunny the day is.
- Check them – very carefully – the water can get extremely hot.
- Record the temperatures
- Discuss any differences in design and how that affected efficiency

* The neatest and easiest way to cut it is with nice sharp knives with thin long blades but as this is also just about the easiest way to lose a finger it should only be done by adults and nowhere near pupils. A bread knife will work but produces lots of messy little bits of polystyrene.

Further information –

On installing domestic systems –

http://www.cat.org.uk/information/info_content.tmpl?sku=info_faq&subdir=information

CAT Teachers' Guide to Renewable Energy Projects – Solar Heating -

www.cat.org.uk/edresources/