# KS3 Lesson Plan

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| **Lesson 9** | Introduction to Solar Thermal Heating | | |
| **Level** | Key Stage 3 | **Time required** | 1 hour |

**National Curriculum Links**

Science, PSHE, Maths (view scheme of work for full details of links)

**Aims**

- The students will investigate how solar thermal panels use the sun's energy to heat water
- They will discuss the advantages and disadvantages of solar thermal panels energy to heat water
- They will experiment with the Solar Water Heater Kit to experience solar thermal energy

**Resources required**

Solar Water Heater Kit, timer, optional: lamp (with incandescent bulb)

**Web search keywords**

Solar thermal energy, solar water heater, solar heating, flat plate collector, evacuated tune

## Introduction

Lesson 7 and 8 involved discovering how the sun's power can be used to generate electricity. The infra-red energy from the sun can also be used to heat water for use in buildings.

During winter months when there is less sunlight a boiler or immersion heater will be needed to supplement the solar heating.

## How do solar water heating systems work?

A solar thermal system uses the sun's energy to heat water. There are three main types of systems:

- A flat plate collector system has a series of black metal plates with a metal tube running behind them circulating a fluid to a storage tank, usually within the building. The black collector fins absorb the sun's infra-red energy and transfer this as heat to the fluid within the tube. The fluid from the collector flows through a circuit that includes a coil in the hot water tank. The coil allows the heat from the fluid to be transferred to the water in the tank. The circulating fluid is kept separate from the hot water to allowing it to contain antifreeze, preventing the collector tubes freezing in winter.
- A similar system may be used in warmer climates where the fluid in the collector does not require antifreeze. The water heated by the collector can be stored in a tank connected directly to the hot water taps
- An evacuated tube system has an outer glass tube which is transparent to most of the radiation from the sun. Inside the tube is a much narrower metal tube usually coated to make it absorb more energy from the sun. The narrow tube contains a fluid which is boiled or evaporated by the heat from the sun. The hot gas rises to the top of the tube at a point where the tube is connected to the hot water supply. The hot gas condenses, transferring its heat to the water. The condensed fluid flows back down the inner tube. The inner tube gets hot and radiates energy which if allowed to escape would limit the maximum temperature achieved by the collector. To prevent this, the inside of the glass tube is coated with a material which is almost transparent to all

the radiation coming in from the sun, but reflects the energy trying to leave. This process is very similar to what we call the 'greenhouse effect'.

### Advantages of Solar Thermal Heating

- Can reduce dependence on traditional water heating that consumes oil, gas or electricity
- Particularly efficient in equatorial zones with large amounts of sunshine
- Government incentives are available to help cut initial costs
- Can reduce dependence on traditional water heating that consumes oil, gas or electricity
- Reduces energy bills – can typically provide 50% of a domestic hot water requirement per year in the UK

### Disadvantages of Solar Thermal Heating

- Evacuated panel systems are expensive due to complex manufacturing processes
- Efficiency – ideally in the Northern Hemisphere panel need to face south. If the panels face in another direction or are under shade, they will be less efficient
- Areas receiving lower amounts of sunlight due to their location, the season, will benefit less from solar thermal energy
- Although the solar thermal system will operate throughout the year, it will need to be supplemented by a boiler or immersion heater during the winter when daylight hours are shorter
- Overcast weather may reduce the heating capacity
- The amount of energy required to manufacture the solar thermal system needs to be considered. It is possible that more energy is used during the manufacture of a panel than the panel could produce in its life time

### Solar Water Heater Kit

Ensure the students are familiar with the Solar Water Heater Kit and how it works before starting the experiments.

Instructions are included with the Solar Water Heater Kit. These can be downloaded in PDF format: http://www.ecostyle.co.uk/products/solar_water_heater_kit/solar_water_heater_kit_activity_sheets_v2.15.pdf

The digital thermometer is originally designed to monitor refrigerator temperatures. The instruction booklet contains further details including setting a minimum/maximum temperature alarm.

### Risk assessment

The aluminium heating fin, copper heating tube and the water inside the tube may become very hot during use. Avoid leaving the kits in direct sunlight when not in use. Allow the kits to cool down before handling. Stop the experiment when the temperature exceeds 50°.

**Task**

Remove the black solar collector fin, copper tube and digital thermometer from the plastic case. Leave the white foam insulating block inside the case.

If not already installed, fit the battery into the digital thermometer.

Remove the solid orange bung and fill the copper heating tube with cold tap water. Replace the bung.

Place the panel on a windowsill or outside in the sun. Record the ambient temperature and the temperature inside the copper heating tube by toggling the 'Room-Fridge' button. When the display shows 'Room' this is the ambient temperature, and 'Fridge' is the temperature inside the heating tube.

After 5 minutes have elapsed on the timer, record both the ambient temperature and the temperature inside the copper heating tube by toggling the 'Room-Fridge' button.

Record the weather conditions, e.g. the sun was behind thin cloud etc.

What happens to the temperature?

Plot a graph showing the results.

Ask the students to consider why the temperature of the water in the heating tube has risen.