



Centre for
Alternative
Technology

Tapping the SUN

an introduction to solar water heating

TAPPING THE SUN IS THE SECOND IN A SERIES OF FEATURES ON ALTERNATIVE TECHNOLOGY THEORY AND PRACTICE FROM THE CENTRE FOR ALTERNATIVE TECHNOLOGY (CAT).

Hot water from the sun

Heating water with the sun is one of the simplest means of using a renewable source of energy, and the most accessible for most householders. Over 44,000 solar water heating panels are fitted in the UK and hundreds of thousands worldwide. In this short feature we hope to answer the most common questions about integrating solar water heating panels into your domestic hot water system.

Can I do-it-myself?

Installing a solar water heating system is no more complicated than any other domestic central heating system, so if you feel confident about doing one, you ought to be able to do the other. Similarly, building simple solar panels is quite within the scope of the skilled DIYer.

A 'Solar Club' network is now operating

across England, Scotland and Wales, which allows members to join and get training and reduced material and equipment costs. The club aims therefore to reduce the installation costs of a solar system thus making it a better investment. See Fig. 1 for a list of regional club organisers.

What kind of panel should I use?

When choosing a solar water heating system, most people think they need to find the most efficient panel available. It is easy to get hung up on panel efficiency, and to forget the two factors which you really need to know – how much fuel your system will save you, and how

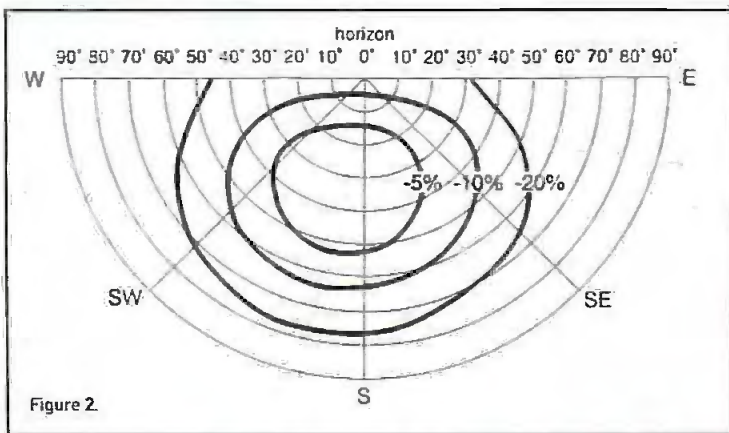
long it will take for those savings to recover the cost of the system.

If cost effectiveness is your main objective, then basic DIY panels or cheaper commercial flat plates are probably the best option. If you want to save the maximum amount of fuel, then high efficiency flat plates or evacuated tubes may be a better idea. Whether such an investment is worth it, in strict financial terms, depends on the factors outlined earlier. In particular, you need to consider how much you currently spend on heating water.

If you want to raise the temperature of a swimming pool a few degrees during the summer only, then simpler collectors will do.

Area	Organisation	Contact	Telephone
Ayr	South Ayrshire Energy Agency	Alan McGonigle	01292 280109
Bristol	Centre for Sustainable Energy	Mark Letcher	0117 929 9950
Dorset	Purbeck District Council	Tim Stokes	01929 556561
	Swanage Ahead	Jon Cull	01929 422893
Essex	Uttlesford District Council	John Farnell	01799 510538
Leicester	Environ	Huw Thomas	0116 222 0222
London	Southwark Energy Agency	Chris Dunham	020 7582 9191
Mendip	Mendip District Council	Kate Hall	01749 343399
North Cornwall	North Cornwall District Council	Paul Johnson	01208 893474
Shropshire	Marches Energy Agency	Andrea Hanne	01743 252571
South Cornwall	Community Energy Plus	Ian Smith	01326 316496
Stroud	Stroud Valleys Project	Karen Saunders	01453 753358
Surrey	Centre for Environmental Initiatives	Melanie Weatherall	020 8770 6611
Wales	Dyfi Solar Club	Andy Rowland	01654 705018
	Ymlaen Ceridigion	Helen Nelson	01545 572162

Figure 1.



Collectors made specially for swimming pool systems usually don't have glazing or insulation, but occupy a large area.

How many do I need?

Not surprisingly, the more hot water you use, the more panels it is worth installing, but the savings benefits become less dramatic with each successive panel. As a rough guide, for a typical four person household the cost effective surface area of panels is:

- 5m² of DIY panels;
- 4m² of typical commercial flat plates;
- 3m² of evacuated tubes.

Where should they go?

In the UK panels should be inclined at an angle to the horizontal or between 15° and 45°. The optimum

angle is approximately the same as most pitched roofs, another good reason for roof mounting. Solar water heating is as dependent on diffuse radiation as it is on direct sunlight and so solar panels do not need to be perfectly south facing, at the

optimum angle, to work just as effectively. In fact panels can face due west or east, and lose just 20% of their output. See Fig. 2.

How the water in your tank heats up

Once the water has been heated by the panel, that heat has to be taken into your plumbing system somehow. Simply running cold mains water into your panel and then directly to a hot water tap will not work reliably!

Fig. 3 shows one of the more common system layouts. Here, water is pumped through the panels to a coil in a hot water cylinder. Cold mains water first passes through the solar cylinder, in this case a pre-heat cylinder, where it is heated by the solar coil. As hot water is poured from the hot taps,

possible variations to this system, though, and the following sections run through some of the choices to be made.

Direct or indirect?

The system shown in Fig. 3 is an indirect system. The hot water in your tap is not heated directly by passing through a solar panel, but indirectly via a separate 'solar loop' and heat exchanger coil that help it absorb the heat brought to it from the panel. One advantage of this approach is that the water in the solar loop can be filled with anti-freeze and corrosion inhibitor. Special additives are produced specifically for solar water heating systems to carry out both of these functions. They are non-toxic, in case of leakage, and will not eat away at normal plumbing fittings and

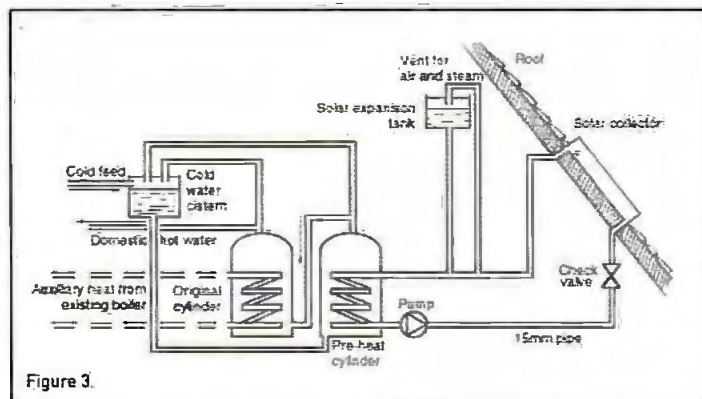


Figure 3.

panels – do not use car anti-freeze!

In a direct system, hot water comes out of the panel and flows directly into the top of the hot water tank. Cold water from the bottom of the tank returns to the panel to be heated. A direct system like this can be slightly more efficient than an indirect one, but clearly neither anti-freeze nor inhibitor can be used, and so some other means of frost protection must be included if there is any risk of freezing.

preheated water is drawn from the solar cylinder to the second cylinder, where it can be heated up to temperature with the conventional heating system if necessary.

There are a number of

It is possible to isolate and drain down the panels, and any other exposed pipework manually when there is a risk of frost. However, it is easier to opt for an automatic self draining system, as in Fig. 4. Here, the header tank is situated below the collector panel. The pump is thermostatically controlled (see 'Pump or Thermosiphon?') so when there is a danger of freezing, the pump should already be off. The water level in the whole system falls to the level of water in the header tank. The panels and all exposed pipework contain air only, so there is no risk of freezing.

This system requires an open vent as shown, but does not require an expansion tank, as the water to refill the panel comes directly from the cold supply. The pipes to the panels must be carefully arranged to drain easily without pools of water collecting in the bends, and to fill without air pockets forming. The cold water header tank must be large enough to contain the contents of the panels and drained pipes above the normal level.

Pump or thermosiphon?

Pump: In the system in Fig. 3 the water flowing through the solar panel is driven by a pump. This pump must be switched on when the panel can provide useful heat and switched off when it cannot.

If the pump was left on all the time, then your panel would be as likely to cool your water down as heat it up! Switching the pump on and off is done by a simple box of electronics known as a differential temperature controller or solar controller. The control box measures the temperature of the water in the solar panel and compares it with the temperature of the water in the bottom of the tank. If the water in the panel is significantly hotter than that in the tank, the pump switches on. When this temperature differential falls to a preset level, then the

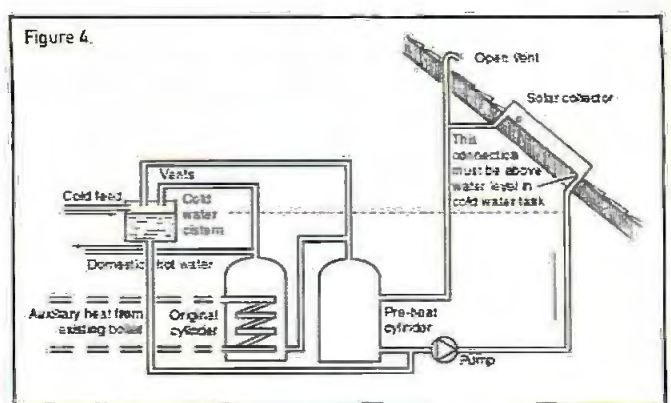


Figure 4.

pump switches off again.

Solar control units are commercially available from around £50 upwards, but it is also possible to build one yourself (see next

month's feature).

With a pumped system, you should include a check valve, as shown in Fig. 3. This is a one-way valve which prevents hot water from the coil flowing up into the panel when the pump is off, and radiating your solar heat out into the cold night air.

Thermosiphon:

There is an alternative approach to circulating the water which does away with the pump and the controller altogether. This is known as a thermosiphon or gravity system.

As shown in Fig. 5, the panel is sited below the hot water cylinder. When water in the panel is heated by the sun it becomes less dense than the water in the coil half of the circuit, and so it rises. As the water passes through the coil it gives up its heat and becomes heavier. As long as the water coming out of the top of the panel is hotter than the water coming out of the bottom of the coil, the water will continue to circulate, powered only by the heat of the sun and by gravity. This effect is called thermosiphoning.

On the face of it, this is an ideal system. There is no need to buy a pump, or the electricity to power one. Nor do you need to buy or build a controller – the system is entirely self-regulating. In fact, a thermosiphon solar water heating system contains no moving parts, unless you count the water. However, there are a number of restrictions:

- all the pipework in the solar circuit must be at least 22mm diameter and preferably 28mm
- the pipe from the top of the panel to the tank must run uphill all the way; the pipe running back must run downhill
- the tank should be at least a metre higher than the top of the panel, or more if the horizontal distance is more than a few metres
- pumped systems tend to be more efficient as they respond more rapidly in changing conditions
- some commercial flat plate collectors have a serpentine pipe layout, rather than a number of parallel risers, which is not suitable for thermosiphon systems (see Fig. 6)

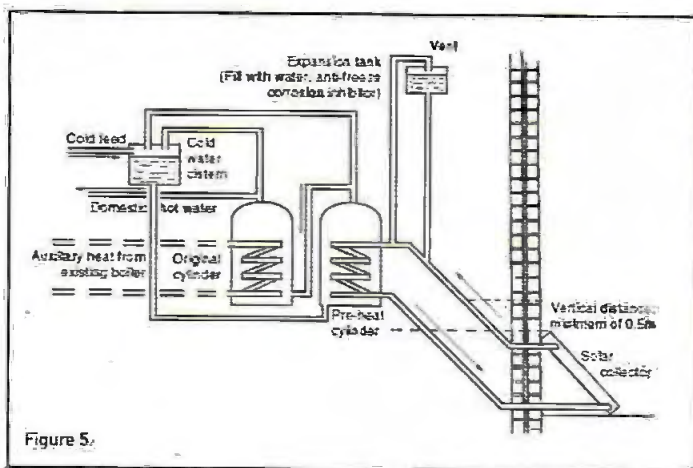


Figure 5.

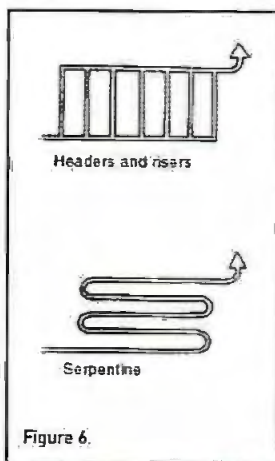


Figure 6.

- it is not possible to have a self-draining thermosiphon system.

Clearly, in many situations it will be difficult to fit the tank and pipework in suitable positions for thermosiphoning to work. It is usually impossible if the panels are to be sited on the roof. However, where a thermosiphon system can be made to work well, it can be cheaper to install and it will require less maintenance.

One cylinder or two?

The system in Fig. 3 includes two hot water cylinders. The original cylinder, supplied from the conventional heating source, has been left alone and an additional 'solar pre-heat' cylinder has been included on the supply side. Generally speaking, a single

cylinder system is more efficient (Fig. 7). The choice of system depends on what sort of existing plumbing and space constraints they are working with.

Another arrangement is to site the main cylinder above the pre-heat cylinder, and to connect the two via a thermosiphon loop, as in Fig. 8. This effectively acts like one big cylinder, but only costs the price of one small one.

Pressurised or unpressurised?

Generally pressurised systems are regarded as the best option as they have several advantages:

- unpressurised systems are always vented, and so are vulnerable to drawing air into the system
- pressurised systems have a higher boiling

point, reducing the possibility of boiling and therefore the risk of damage to the system

- pressurised systems do not require a separate header tank (feed and expansion tank) that has to go above the rest of the system, thus allowing the panels to be positioned at the top of the roof. The expansion vessel required for expansion of hot water can be placed almost anywhere in the solar loop, which makes installation easier and faster, plus it does not usually require a separate support platform to be built (see Fig. 9).

The rest of the plumbing

This should be made from conventional copper pipework and whichever jointing system you prefer.

A note about plastic semi-rigid plumbing pipes; these are not recommended for solar systems as the stagnation temperature close to the panel may exceed that recommended by the manufacturer. This is not a general complaint against these types of piping systems as they have proven their value under certain conditions, but we strongly recommend against them for solar systems. Jointing systems chosen should reflect the experience and level of skill of the installer. A professional plumber will probably prefer to use end feed soldered joints, whilst an inexperienced DIY installer may prefer something easier like push-fit joints, Yorkshire fittings with soldering tongs or even compression fittings.

Solar water heating and combination

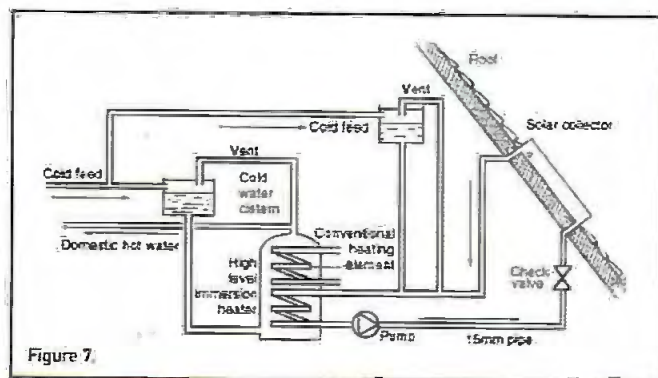


Figure 7.

boilers

We had hoped to provide some exciting new ideas on this area, but as yet we don't have the guarantees that we require when giving specific recommendations of this kind.

With the increased popularity in recent years of combination or 'combi' boilers, this has become a controversial issue in the solar trade. This is because most combination boilers are designed to take cold mains pressure water, and solar systems tend to supply hot or warm, low-pressure water. Some

makes of combi boiler are 'fully modulating', ie they check the temperature of water leaving the boiler, and adjust the flame accordingly to give out a sensible temperature. These modulating types are unfortunately rare in the UK at present. For new installers, it will soon be possible to buy a new combination boiler that is guaranteed to take hot water. This should work quite simply with a mains-pressure hot water cylinder preheated by an ordinary solar water heating system.

For 'retrofitters' (as opposed to new-build) with non-modulating combi boilers, things are more difficult.

There are several techniques for integrating a non-modulating combination boiler with a solar system. It would not be prudent for us to detail any of these at present for safety reasons, but please call CAT's information desk for more up to date information (tel. 01654 705989).

The legal position

(All the following applies to the UK only.)

The local planning authority should be approached to check whether planning permission is necessary. Unless the installation is on a listed building or in a conservation area, it is unlikely that planning permission will be necessary. If there are problems, you could try asking about panels at ground level, rather than on the roof. Building regulations are administered by the local council, and they should be contacted to check whether your plans need to be submitted for approval. Most solar installations do not involve structural changes, and do not usually require consent. The

local water company should be informed of any planned changes to domestic plumbing systems, including solar water heating installations.

For those looking for further information on this and related subjects, CAT is offering a number of books, products and courses to Electronics & Beyond readers. For further details and to order contact CAT Mail Order Department, CAT, Machynlleth, Powys, SY20 9AZ, Tel. 01654 705959 or visit the website at cat.org.uk and quote the reference E&B002.

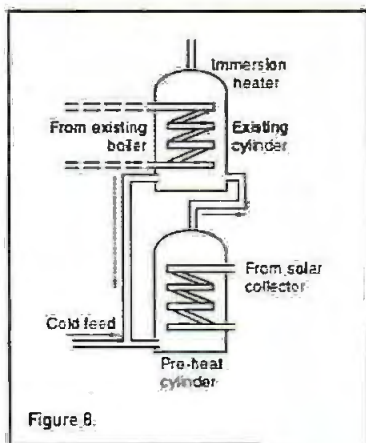


Figure 8.

be made by anyone with basic woodworking and plumbing skills and also make ideal practical projects for schools and science courses.

Solar Energy: a factsheet, CAT, 8pp, A4
Offer price £2.70 (£3.00 rrp)

An introduction to solar power: covering passive solar building design; the collection of solar heat for storage and use as a low temperature heat for water and space heating.

Hot Water from the Sun: How to construct your own solar panel, Jurgen Streib, 134pp
Offer price £13.50 (£15.00 rrp)

The central idea of this book is that solar panels ought to be constructed in the respective countries where they are being used. Covers everything from building panels to testing their efficiency.

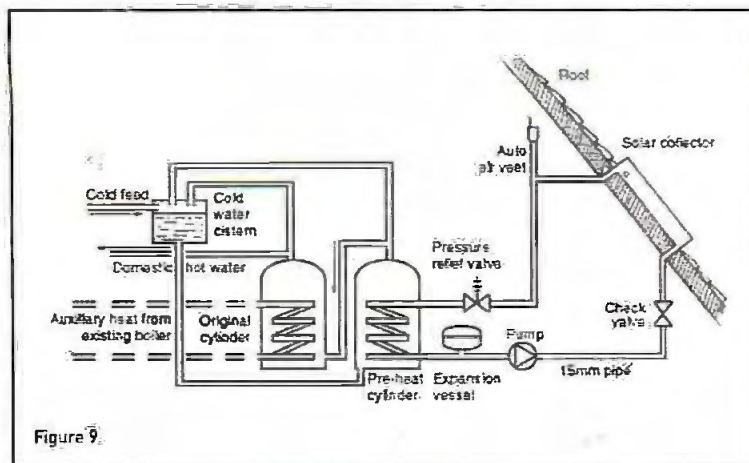


Figure 9.

Solar Water Heating Resource Guide, CAT, 14pp Offer price £1.80 (£2.00 rrp)

Complete listing of consultants, manufacturers and suppliers, sources of information, products and courses...names, addresses, telephone numbers and websites.

Products

Clip Fin Solar Collectors

Offer price £4.19 each or £45.00 for 12 (£4.65/£50.00 rrp)

High conductivity aluminium sheet, designed to clip on to standard 15mm copper

Publications

Solar Water Heating: A

DIY guide, Paul Trimby,

28pp

Offer price £5.40 (£5.99 rrp)

This practical DIY guide is packed with photographs and diagrams designed to help you through the process from design to construction and installation. The panels described in the book can

water pipe as part of a solar flat plate collector. This provides efficient transfer of heat to the water in the pipe, and makes DIY solar collectors easy to construct. Each fin measures 380 x 200mm.

Courses

The Solar House

July 13-15, 2001

Fees: High waged: £230; waged: £170; non-waged/student: £120

If you are interested in utilising the limitless free energy from the sun, then this course is for you. Taking examples from pioneering buildings in the UK, topics covered will include passive solar design, the use of solar water heating and integrated photovoltaic systems for electricity.

Solar Water Heating Systems

October 5-7 2001

Fees: High waged: £230; waged: £170; non-waged/student: £120

This course is ideal for those who want to design or install a solar water heating system. Sessions will cover types of collector, energy storage, plumbing and controls. There will be practical tuition on the construction of a collector and in-depth instruction on the design of solar heating systems.

For £16.00 per year you can join the Alternative Technology Association, CAT's

member organisation, which entitles you to quarterly copies of the journal, Clean Slate, a 10% discount on all CAT publications and other members' benefits. Contact ATA on 01654 705988, quoting the reference E&B002.

CAT is based in Machynlleth in mid-Wales and has been at the forefront of the alternative technology movement since its inception in 1975. The Centre is internationally renowned for its expertise in, and research into,

renewable energy systems, organic horticulture, alternative building methods and waste and water treatment systems. It offers consultancy in all its main areas of interest, runs a visitor's centre open to school and university groups and the general public, runs educational and leisure courses, has developed a travelling exhibition and collaborates with two universities on higher degrees. To get a full picture of the extent of CAT's activities check out their website www.cat.org.uk.