Designing a solar water heating system

FACTSHEET FOR PROJECT MANAGERS AND BUILDERS

Renovating or extending a house is a very good time to install a solar water heating system. It minimizes disruption and can cost less than a solar installation at other times. In particular, if the water cylinder is being replaced anyway, then the cost of the solar will be reduced substantially.

Soltrac is delighted to work with architects, project managers and builders, including self-builders, to find the best solar solutions. Our experience in the building trade means we are quick to understand plans and see how building work is to be progressed. Although we are always happy to have site meetings, this leaflet will give you the basic information on our solar thermal installations.

Is thermal solar a DIY job? Not in our view, due to the high temperatures reached in modern collectors (over 200°C at times) and the specialist solar skills required. Is it one for competent plumbers and roofers? Yes, provided they have the BPEC qualification in thermal solar.

Even better is to use a solar expert like Soltrac. Only a specialist can keep up with the rapid pace of change in solar technology and recommend the best system for each building. And only if you use an installer who has gone through the complex process of registration for the Microgeneration Certification Scheme, as Soltrac has done, will you be eligible for any government grant or subsidy that may be offered.

The solar panel

There are two options – flat plates and evacuated tubes – and we offer both. For domestic properties, we usually recommend flat plates as they look more attractive on the roof and are much more resilient, with a longer predicted life. Tubes will perform a little better on dull and cloudy days, especially in winter, but less well on sunny days.

If flat plates, we normally recommend two panels for most households. If tubes, we tend to suggest an 18-tube array for small households or two 12-tube arrays for larger households, such as a family of 4. These can be sized up if the situation is not ideal (eg some shading) or if water usage is high.

Whether tubes or flat plate, the solar panel is best placed on the roof:

- Find as unshaded a position for the panel as possible. Recall how low the sun can be on a winter's day and how easily the panel can be shaded, so ideally design for the panel to be as high as possible on the roof;
- South-facing is best, and between SW and SE is fine;
- The pitch of the roof is not normally an issue.

Most important, we want to minimize the distance between the panels and water storage device. Unlike heat from a boiler, the sun's energy comes in dribs and drabs over the course of the day, and so a long pipe run will reduce the energy transferred to the cylinder, especially for small systems.

On-roof or in-roof?

If you have chosen flat plate panels, there are two main ways of fixing them to the roof.

On-roof: The panels are fixed to aluminium rails mounted above the tiles. The rails are held in place by thick metal roof anchors, which slip under the tiles and are bolted to the rafters. Rain water runs under the panel over the tiles as usual.

This is the most common form of fixing in the solar industry. It is a bit less expensive than the in-roof option (right) and is best where space is tight.

Solar panels can also be mounted on flat roofs, where they are placed on frames so as to be at 45° to the roof. However, planning permission is usually needed and care has to be taken to ensure the wind cannot get behind the panels and dislodge them. It is important, also, not to break the seal on the flat roof itself. The best solution is to install anchors when the roof is being constructed.

In-roof: The tiles are removed and the panels fixed directly to the battens and through them to the rafters. A flashing kit is then installed round the panel, very similar to that of a Velux window, so no rainwater can get under the panel, and the tiles neatly placed around the array. This gives a much more flush and elegant finish to the job. Another advantage is that all pipework is under the flashing, so improving looks and reducing damage to the pipe insulation by birds.

Where the roof is visible and space permits, this is much our preferred approach. If the roof is new or being re-tiled anyway, it is much the best option - and of course saves on tiles. In this case the panels are fitted after felting and battening, but before tiling.

The flashing extends round the panel, although is hidden by the tiles over it. This means the panels cannot be placed very close to any edge of the roof.

In-roof systems work well with slates, but can only be done if the roof is being re-slated at the same time.

For close-up photos of in-roof systems, please see our website.

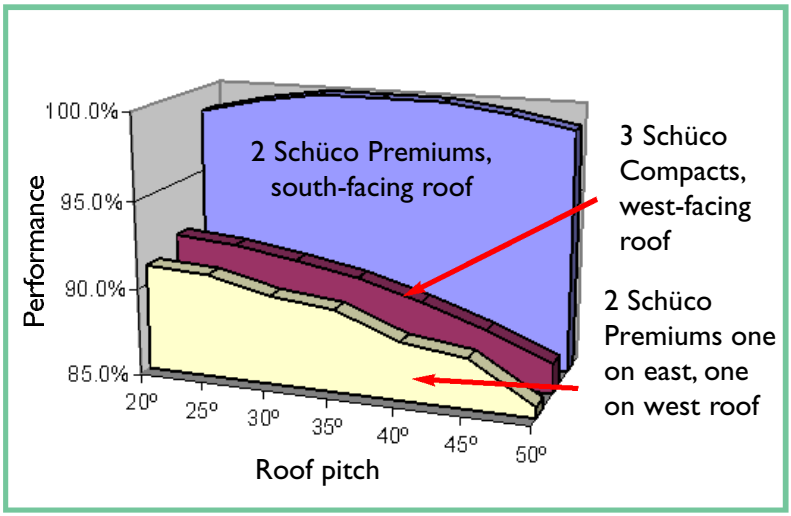
What if the roof faces east or west?

There are two options:

Either place a larger array on the east or the west roof. (This is usually our preferred option).

Or place one panel on the east roof and one on the west roof; this requires a double pump station and more complex controller as the two panels are run independently.

The graph (right) shows the difference in performance between the approaches. The performance is only a little bit lower than two panels on a south-facing roof. An east- or west-facing roof is not a barrier to effective solar water heating.



Size of components

Flat Plate Panels

Name	*Dimensions*	*Max output*
Schüco Premium panel (CTE 520)	2156 x 1256 x 93 mm	2.0 kW
Schüco Kompakt panel (CTE 319)	2101 x 1202 x 80 mm	1.7 kW

The Premium panel is available for use in landscape (see below) as well as in portrait formats. The other models are available only for use in portrait formats. Larger panels are available for industrial applications.

On-roof installations can be placed close to the ridge and edges of the roof. For in-roof applications, allow an additional 500 mm all round excluding the top two courses of tiles or slates under the ridge.

Evacuated Tube Panels

Ritter 12-tube panel with reflector	1290 x 1640 x 100 mm
Ritter 18-tube panel with reflector	2080 x 1640 x 100 mm

Tube panels are mounted over the roof surface and if need be can reach close to the roof edges. Simulations show that 2 x 12-tube Ritter panels produce slightly less than 2 Schuco Premium panels over an average year in typical domestic use but considerably more than 2 Schüco Kompakt panels. An advantage of the 18-tube array is that it can be used when one flat plate panel is too small and two panels are too big.

Some typical patterns for installation of Schüco Premium panels, more are possible:

Portrait formats (the norm)

Landscape formats (ideal for shallow roofs)

The water storage

Solar will only work with a water storage device, normally a water cylinder, since the energy has to be stored as it comes in.

Generally cylinders have to be larger than those normally used. Tall and thin is better than fat and thick, as it promotes the natural vertical separation of hot and cold water (stratification) – the solar always heats the water at the bottom and works best when working at lower temperatures.

The cylinder has to be sized to match the size of panels or number of tubes. Too large and the water will not be hot enough, too small and the water will get above permissible levels too often and heat will be wasted.

There are four options:

a) Vented solar cylinder. This is the most common approach, with the cylinder fed from a header tank in the loft. A typical cylinder for a house of four would be 1800 mm x 450 mm (286 litres). Cylinders come supplied with solar coil (specially finned), a primary coil for the boiler, and an immersion heater. We use Gledhill, who make such cylinders to measure, usually with an inside diameter of 450 mm (570 mm on the outside with the double insulation we prefer).

b) Unvented cylinder. Similar to a vented cylinder but for use with mains pressure systems. No header tank needed.

c) Thermal store. An alternative option for those who want mains pressure hot water systems. There are two advantages over unvented cylinders: first, since the mains pressure water is only in the upper coil, the legal requirements for unvented cylinders do not apply, including the rigorous 3 levels of safety systems and the requirement for annual maintenance and inspection. Second, the solar can take the water temperature in the store up to 75°C, since an in-built blending valve will ensure water reaching the taps will not exceed 60°C. However, solar performance in winter is lower than with a vented or unvented cylinder, since stratification is reduced.

d) Pre-heat cylinder. We would only use this with a combination boiler. In general 'combis' are not good with solar, and their big advantage – the absence of a cylinder – is lost. Such a combi must be 'solar-ready', meaning it can accept hot water at the inflow; few satisfy this criterion.

Note that if converting from a vented system to an unvented cylinder or thermal store, it is vital to ensure both the flow and pressure on the cold water main are adequate to sustain a pressurised system.

The cylinder is an integral part of the solar installation.

4 *A Gledhill Sunspeed vented solar cylinder.*

Four key points about thermal stores

a) A water softener should be installed in the main cold feed before the store to prevent scaling up inside the heat exchanger;

b) The cold water feed should be in 22 mm rather than the usual 15 mm pipe, right back the mains source, otherwise the flow may be too feeble if more than one tap is switched on at one time;

c) The thermal stores come with tappings that can be used to support underfloor heating;

d) A thermal store is a good option if you want to have solar, boiler and woodburner. The boiler connects to the primary coil while the woodburner back boiler connects by gravity feed to the shell of the thermal store.

Please see our separate handout on the Gledhill Torrent thermal store for more details.

The other heating source

Solar will rarely do much more than 70% of the hot water need over the year – a typical July day has almost ten times more solar energy than a typical December day – and so a second form of heating the water is needed. This is called the auxiliary heat source.

Normally this is a boiler, connected to the primary coil of the cylinder in the usual way. Our User Manual advises how to adjust the boiler controls so as to get the maximum benefit from the solar – mainly by not running the boiler in summer in the daytime!

Our cylinders also have an immersion heater fitted as standard, and this is often a good way of topping up the heat on dull days in summer, without having to start the boiler. A second immersion can be provided where this is the only auxiliary heating source, so as to benefit from night-time tariffs.

Solar is compatible with heating water in the back boiler of a woodburner. We specify a more angled primary coil in the cylinder, to promote convection, since such systems are normally not pumped. It is not permitted for a woodburner to heat an unvented cylinder, since it is an unregulated heat source. And remember that connecting woodburners to radiators can also be tricky. Such systems are normally run by convection, not pumped, so the thermal store must be above the woodburner, not alongside it.

Sadly solar and Agas do not make good partners. If the Aga is on all the time, then the water will be hot all the time too, so the solar cannot make its contribution. We recommend solar and Agas are only combined where the Aga is switched off in the summer. Alternatively, the back boiler of the Aga can be decommissioned (by an Aga engineer) – the Aga manual states this will result in substantial energy savings – and an alternative auxiliary heat source used.

Thermal solar works well with ground-source or air-source heat pumps. In this case we will work with the heat pump installer so as to determine a suitable water storage unit.

The pipe between panels and cylinder

The solar circuit is a closed pressurized system, with antifreeze. Liquid is pumped round the circuit when the temperature in the panel exceeds that at the bottom of the cylinder.

We construct the solar circuit from flexible stainless steel pipe (usually DN16 size), sometimes called Duo Solar. This comes as a pre-assembled pair of pipes held together by a single piece of Armaflex HT (high temperature) insulation. For large systems we use the bigger DN 20 size. We normally use a single run of DuoSolar, without joins.

The design needs to determine the shortest and neatest route for the pipe between panels and cylinder. If there is a loft, the pipe can be easily taken into the roof, across and down the loft into the airing cupboard to the cylinder.

If the roof space is used as a room, consideration has to be made as to where the pipe will run. It can run outside the house, but does not look very elegant and heat losses will be a little greater than if it was inside. Since there are no joins, it can go through closed spaces and ducting – provided of course it is put in before the ducting is closed off!

Flexible "Duo Solar" DN16 is approx. 90 mm by 45 mm in cross section.

Pipes can go underground if need be. We use concrete ducting, filled with insulation, into which the pipes sit. The difficulty is not that the pipe is underground, it is usually that the pipe run is then rather long.

Other components

The solar circuit also needs a pump station, expansion vessel and overflow system to prevent excessive presssure. These are best placed in the airing cupboard, but can go in the loft if space is tight.. The pump station, in an insulated box, contains pump, flowmeter, fill and flush system, air separator and pressure gauge.

An expansion vessel, usually of 18 litres, is connected to the pump station, at the end of the vertical uninsulated pipe. A 5-litre discharge vessel is also connected to the pump station.

Pump station, 310 x 440 mm

Electrical

The solar circuit needs a 3A fused switched spur, ideally placed close to the controller.

Our cylinders always come with immersion heaters, so an electrical supply for that is needed too.

The controller, technically a Temperature Differential Controller, measures temperatures from three sensors and based on these readings switches the pump on and off. One sensor is in the solar collector (using cable inside the twin bore solar pipework - see left), one at the bottom of the cylinder or thermal store (where the solar is heating) and one at the top (where water exits for the taps).

Controller, 110 x 160 mm

The installation process

If the only work being done is solar, then we would come and do the installation in one go, normally taking two days. Before that we would have done a site survey, to determine the positions and space requirements for the various components.

If existing work is being done, such as an extension or roof repair, we find the work is best done on 2 or more occasions, in the following sequence:

- First fix: If a roof is being replaced or built, we fit the solar panels to the roof once the roof has been felted and battened but before the tiles go on. We'll liaise with your roofers to make sure a good fit between tiles and panel. The DuoSolar pipe can also be put in place at this time;
- Second Fix: We then return towards the end of the building period and install the pump station and connect up the solar circuit. This can only be done when a) the cylinder or thermal store has been installed and is full of water, b) your electrician has installed the switched spur for the solar circuit and it is live.

Beforehand, if contracted to do so, we can supply the solar cylinder or thermal store for your plumber to install and connect up.

Soltrac Ltd
Unit 14, Ashfield Road Trading Estate, Sallisbury SP2 7HL
01722 415666; info@soltrac.co.uk; www.soltrac.co.uk

Version of 16 December 2011