Solar Thermal System Installation Instructions

Order of jobs

1. Install/replace hot water cylinder
2. Commission cylinder
3. Fix panel frame to roof and assemble collector panel (all except the glass tubes)
4. Drill holes in roof tiles for flow and return pipes, plus small hole for sensor cable
5. Install pumpstation
6. Add expansion vessel and pressure release overflow to tundish
7. Run pipework between panel-pumpstation-cylinder, including vent and drain points.
8. Install digital controller with temperature sensors
9. Fill system with water, flush through, test the pump, pressurize to 2 bar (note how much water it takes to fill the system)
10. Check pipework for integrity and fix if there are any leaks
11. Drain system and refill with solar fluid/water mix (40/60 mix ratio, pressurize to 1 bar)
12. Install vacuum tubes in panel
13. Insulate any remaining pipework

Stand back and admire your work! The system should work tirelessly for you providing free energy for many years to come.

Panel assembly and roof mounting

Fixings

The collector panel box contains the following fixings:

30 Tube panel

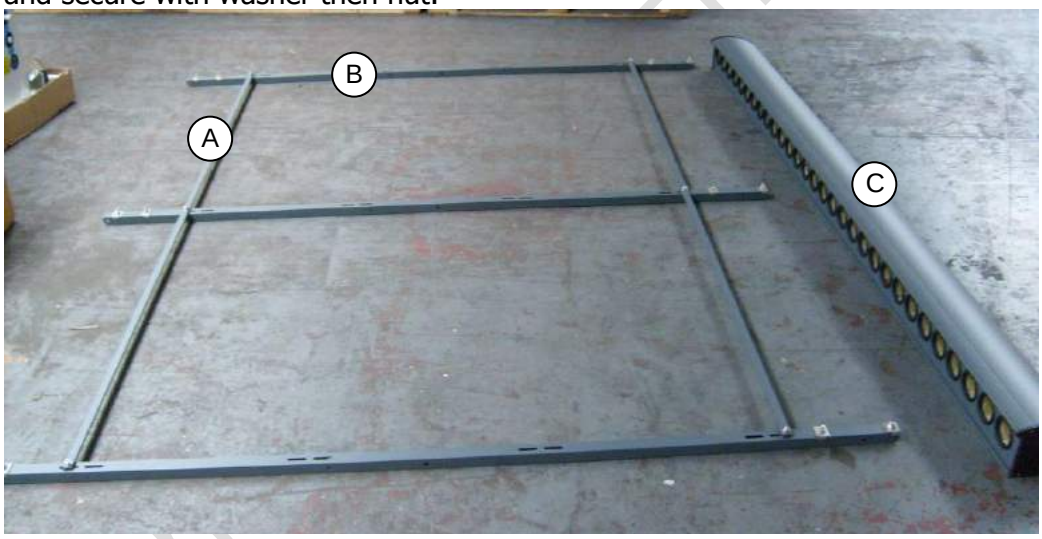
12 x clamp fixings
(nut, bolt, washer, clamp plate, U plate)
6 x frame fixings
(nut, bolt, washer, U plate).

18/24 Tube panel

8 x clamp fixings
(nut, bolt, washer, clamp plate, U plate)
4 x frame fixings
(nut, bolt, washer, U plate).

Frame

The frame which comprises:
2 thin spacer bars (A) – these will lie horizontally across the roofline when in place.
3 U-section bars (B) – these will lie vertically up/down the roofline when in place.
The frame members are bolted together using the 6 frame fixings. Place the U-plate on the bolt, and push up from the bottom of the U-section bar through the spacer bar and secure with washer then nut.



It is worth laying out the frame, the manifold (C) and tube bottom support (D) to understand how it is assembled before taking it up on the roof.

The manifold and tube bottom support, are each secured to the frame by 6 clamp fixings. By assembling the clamp fixing as shown the security of the fixing can be observed from ground level.
The stainless steel mounting straps are attached to the frame using the same fixings.
The manifold must always be at the top of the collector when in place.

Pictured above is the assembled frame. You will assemble it in-situ on the roof. It is best to put the down-slope clamp fixings in place before you take the manifold and bottom support up on the roof.

Roof mounting

First you need to erect a good platform to work from. A scaffold tower provides a quick and easy method.
Alternatively roofing ladders can be used.

The stainless steel mounting straps are used to hang the panel on the roof These are attached to the frame using the same bolts as the clamp fixings.

Use a thin spacer bar (A) as a gauge to help locate the best position for the panel fixings on the roof. The three holes in the spacer bar indicate the spacing between the U-section bars (B). Push up some tiles to locate the rafters (which you will be able to feel under the roofing felt). You are aiming to anchor each U-section bar (B) to a rafter. There is some leeway side-to-side with the mounting straps so they do not have to align exactly. It is best to secure the panel to rafters at 4 out of the six mounting points (the remaining 2 can be secured to battens). The straps are screwed directly into the rafters using coach bolts (e.g. M6x50mm) at the 6 chosen points. Drill 3mm pilot holes. Once screwed down the screw can be covered with silicone sealant to ensure a water tight seal. Using hex head coach bolts screwed straight down into the rafters is very strong and retains the membrane's integrity.

Once the mounting straps are in position you can fix the U-section bars to them. These are attached to the frame using the same bolts as the clamp fixings (see below).

The holes on the mounting frame are slotted to allow some adjustment when securing the frame to the straps.

With the frame secured in this manner in 6 places it provides a secure and strong mounting for the panel.

Alternative Mounting Method (e.g. for minimum disruption to slate roof etc)

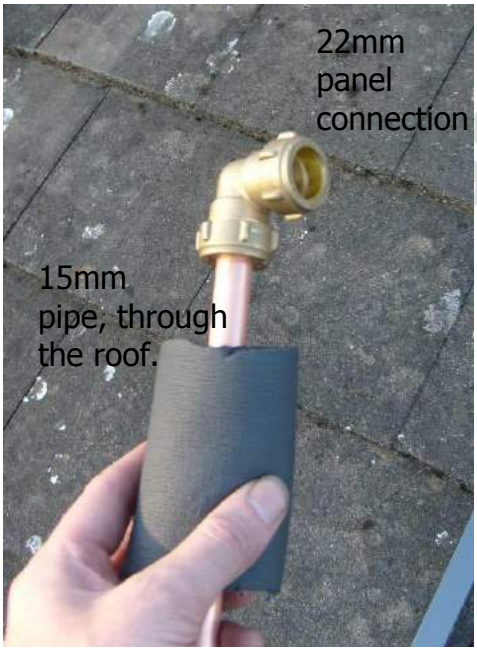
From the outside, slide the straps up underneath the slates/tiles. If necessary, use a screwdriver to lift the slates slightly to facilitate this. Slide the panel upwards, until the mounting straps hit the battens.

It is now necessary to go inside the loft space to locate the mounting strips. Once they have been located (a pipe/stud metal detector is useful for this), cut the felt to allow the straps to protrude. Once each strap is clear of the battens, get an assistant to slide the panel up until the strap is as far under the slate as it will go. (Sometimes it is possible to pull it up, using the straps, from inside.) Bend the strap over the nearest batten to produce a 'hook' to carry the weight, and fix securely to the batten with two screws.

If close to a joist, you can screw the metal mounting strap directly to the joist. With the frame secured in this manner in 6 places it provides a very secure and strong mounting for the panel.

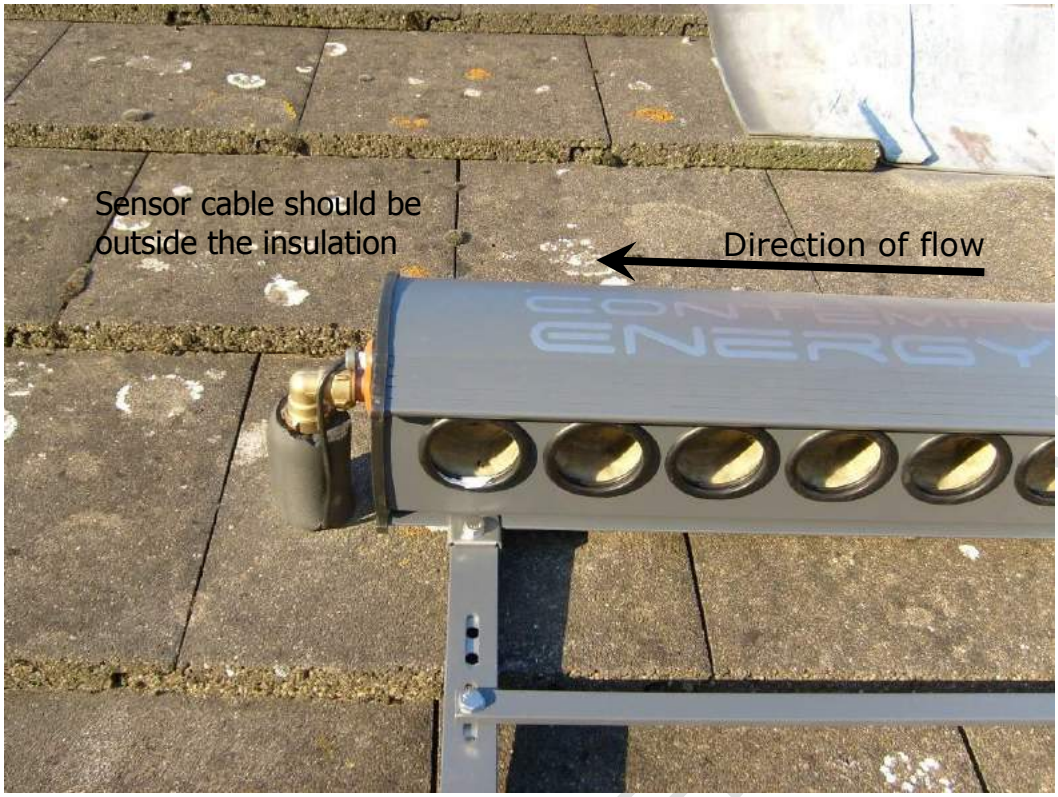
Now that the panel frame (U section members (B)) are attached to the roof at all six points, the manifold (C) and bottom tube support (D) pieces can be added, and clamped in place.

Once the panel is fixed, it is necessary to drill a 16mm hole through the tiles at both ends of the panel to accommodate the copper flow and return pipes. Note it is better to drill at least half way up the tile to avoid the batten. Check where the battens and joists are before drilling. It is also better to not drill at the joint between 2 adjacent tiles. The position of the frame/panel can be adjusted slightly side to side, and up and down so that the pipes do not come through where there is a joist or batten. Loosely assemble the elbow joint as shown below to enable accurate positioning of the hole. When drilling do not use the drill's hammer action, since this can result in tiles being cracked. It will take a while to drill through and you will usually have to drill through 2 overlapping tiles. Use some water splashed on the drill/in the hole to keep it cool. At this end of the manifold (the Left end) also drill a 5mm hole about 15mm up-slope of the larger hole for the panel temperature senor cable.



Using a 22mm elbow with a reducing olive (to 15mm), attach a copper pipe at 90° and feed through the hole into the loft-space. Route the thermal probe through the separate 5mm hole. Seal the holes with high temperature resistant silicone. Insulate the pipes, and insert the thermal probe using the thermal grease provided, to ensure a good thermal contact. Secure the insulation with ties to prevent the insulation from becoming detached. Secure the thermal probe cable using the same ties, routing the cable on the outside of the insulation.

Note a solar flashing unit can also be used.



Pipework, vents and drains etc.

You should install an air vent at the highest point in the system, and a drain point at the lowest point. In the most common configuration (non-thermosyphon) the collector panel is the high point of the system. Where this is the case an air vent should be installed, as can be seen on the right end of the panel in the photo below. The air vent pipe is bent though 90° as shown to keep it parallel to the roof-line. (No part of the panel should protrude more than 30cm from the roof line). If you are using a float-type automatic air vent this needs to be vertical.

The connection at the right end of the manifold is achieved using a 22mm compression Tee joint with reducing olives to 15mm for the 15mm pipe to the air vent, and 15mm pipe which penetrates the roof. Due to the high temperatures generated by these collector panels, stainless steel or copper pipe should always be used for the solar circuit, and compression joints should be used within 1m of the panel. (in stagnation conditions the panel can generate temperatures of 230°C which can cause soldered joints to melt).

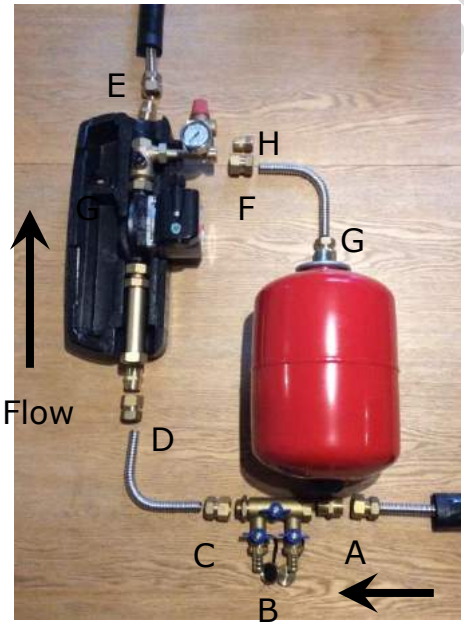
The panel manifold has 22mm pipes to give a sufficient flow/heat exchange in the manifold, but the rest of the circuit can use 15mm or

10mm pipe which will give sufficient flow for efficient heat transfer (and is flexible and comes in 20m reels so allows long runs with few joins). 15mm pipe is recommended if you have 2 or more panels in series. The direction of flow of the fluid through the panel should be from right to left, so that fluid flows through the panel and leaves at the end with the sensor (so that the heated water is flowing over the sensor).

Avoid horizontal lengths of pipe-work. It is best if there is a slight incline to all runs so that air bubbles will travel naturally to the vent at the high point of the system. If it is unavoidable to install lengths of pipe which go up-along-down, and hence result in a possible air-lock; an additional air vent can be installed at the high point of this section.

Pump-station connections

The pump-station should be installed on the return side of the circuit. i.e. the solar fluid leaves the heat-exchange coil in the cylinder (the fluid is hence cooler) then enters the pump-station and is pumped back to the panel.



Connections to the pump-station are as follows:

A. Flow (from cylinder) (¾ inch straight compression)
B. Fill/drain valve
C. ¾" to 15mm (¾ inch straight compression)
D. ¾ inch to 15mm compression + ¾ inch straight coupler (nipple)
E. Return (cold) to panel: ¾ inch to 10mm or 15mm compression depending on which used for pipe run + ¾ inch straight coupler (nipple)
F. ¾ inch to 15mm compression.
G. Expansion vessel connection, ¾ inch to 15mm compression
H. Over pressure release valve. (15mm – 15mm compression straight connector) This pipe should go to a container which will catch any fluid that is blown off. You can use the solar fluid container (5 litres).

The pumpstation should be mounted as shown in the picture. The flow goes upwards through the pump with the pressure gauge at the top. Mount the pumpstation as follows: The mounting allows the mounting plate to be screwed/bolted to the wall using the supplied bolts, the rear insulation piece is then put in place and then solar station can then

be pushed on to the dowel. If the dowel does not go in easily (and clip securely) you may need to slide the wire retaining clip back when putting the metal dowel in the hole. Then once the dowel is in, slide it on (it locates in the groove) to secure the mounting plate firmly. An alternative is to do this before attaching the plate to the wall, so that you can ensure it is solid, and then simply bolt or screw the whole unit in place. If necessary the wire retaining clip can be adjusted easily with pliers.

Once the dowel is located correctly with the retaining clip positioned such that it is keyed into the groove in the dowel, the whole mounting will be strong, secure and rigidly fixed to the wall.

From the pumpstation top connection, route the pipe to the right hand end of the panel (the cold inlet end).

From the left end of the panel (the hot end, where then sensor is located) route the pipe to the bottom heat exchange coil on the cylinder. This connection goes to the top connection for the bottom coil. If you are unsure blow in the bottom hole to feel which one it is connected to. The bottom connection from the lower coil is routed to the pumpstation, via the filling/drain valve. The valve can then be connected to the pumpstation bottom connection using 15mm pipe.

The over-pressure relief valve is the connection with the red knob on it. Pipe from this connection should be run to a suitable container (such as the 5 litre antifreeze container). If a stagnation leads to fluid being blown-off the fluid will be extremely hot, so you need to keep at least an inch of water in the bottom of the container to protect the container.

The pipe on the right side of the pumpstation (by the pressure gauge) is connected to the expansion vessel. The expansion vessel should also be supported/secured to the wall using steel strapping.

To fill the system use a garden herbicide spray type pump. Use water to flush the system through, note how much water was required to fill the system. Thus ascertaining the volume of liquid required to fill the system. Pressurize the system up to 2 bar and check all joints to verify there are no leaks. Drain the system. Since you now know the volume of the system, you can mix the correct amount of 40% antifreeze + 60% water mixture, and fill the system. Pressurize to 1 bar.

Then monitor the pressure over the next week. If there are any tiny leaks the pressure will drop gradually. If the pressure is maintained, the system integrity is good (note the pressure within the solar circuit will rise when the system is hot, so compare the pressures when the system is cold).

The antifreeze should be propylene glycol based, which is non-toxic (hence if there were any leakage into the water supply it would not be of danger). Solar Fluid is available from all plumber's merchants. Fernox S1 is a good brand. Do not use car anti-freeze!

Digital Controller

Install the controller in accordance with the instructions supplied. The single black cabled temperature sensor (PT1000) should be used for the panel since its cable is resistant to higher temperatures, the grey cabled sensors (NTC 10K) are for the cylinder. The sensor cables usually need to be extended. Alternatively bell wire can be used. Cable runs of 50m can be installed in this manner. Coat the temperature sensor probe with heat transfer grease (tube provided with the panel) before inserting into the sensor hole. In some cylinders the pocket for the sensors in the cylinder are larger diameter (e.g 20mm

diameter) if this is the case, pack the hole with suitable wadding whilst maintaining the metal-to-metal contact between the probe and the sensor hole. (Do not wrap the sensor in any way.) The three temperature sensors, controller, and pumpstation power cable are connected to the controller junction box as shown in the manual supplied. The recommended flow rate for a 30 tube panel is 3 litres/min; 24 tube – 2.4 litres/min; 18 tube - 1.8 litres/min. The flow rate achieved by the pumpstation will depend on the pipe used and the length of pipe. You can see the flow rate on the sight gauge (or electronic flow rate gauge), typically the slowest pump speed (1) will be sufficient for the 18 and 24 tube panels, the second setting (2) may be required for 30 tube panels. The pump can be tested using the controller's HND Manual mode. Press the Set button until HND1 is displayed. The pump power is turned on/off manually. When in normal mode the temperature display can be cycled between the three sensors by pressing the '+' button.

Once the plumbing has been connected and the system is full of fluid, you can install the vacuum tubes. For each tube, clip the plastic retaining cups onto the bottom rail, and unscrew the plastic cup from the retaining clip. Smear the silicon heat-transfer grease provided in the kit onto the tip of the copper heatpipe (use a scrap of card as a spreader). This ensures a good thermal contact between the heatpipe and the manifold. Insert the bottom of the tube through the retaining clip until it is just clear of the manifold, and then slide it up into the manifold. Once it is in, secure by screwing-in the retaining cup and tightening - but take care not to over-tighten.

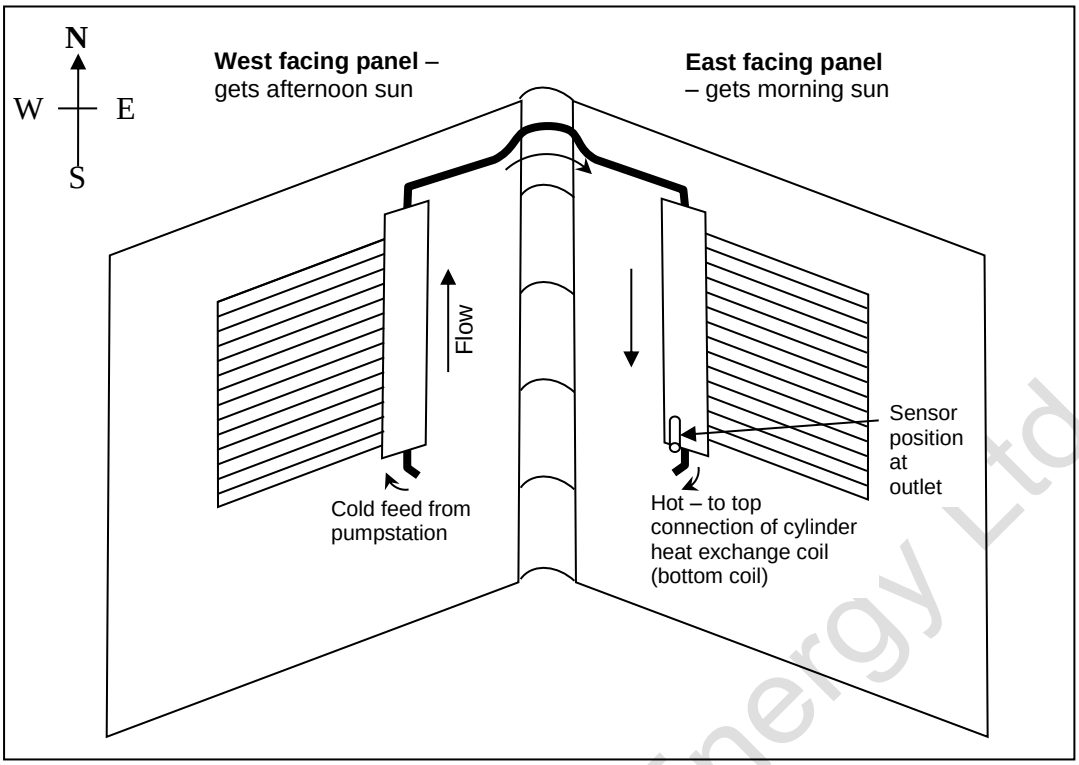
Note, if the tubes have a plastic end cap (silver or black, as can be seen in the right hand photo above) it is best to remove these to allow the bottom retaining cup to screw in fully. The plastic cap provides protection during transit, and is glued in place; it can be removed easily using a pen-knife/Stanley knife by cutting around the adhesive and prizing off gently.

Insulation

Adequate insulation is essential to the efficient operation of the whole system. Good insulation will ensure that the heat absorbed by the panel ends up in the hot water cylinder (and ultimately your bath/shower/washing machine etc) rather than escaping to the atmosphere. We recommend Armaflex HT insulation since it is capable of withstanding the high temperatures generated by the panel. Do not use standard central heating pipe insulation since this will melt! Secure the insulation where necessary with cable ties or tape. If you run the panel temperature sensor cable along the pipe, keep it outside the insulation. secure the pipe-work to the joists using large 28mm saddle clips outside the insulation.

Dual Aspect Configuration

If you do not have a suitable location for positioning a collector panel facing between south-west and south-east, the dual aspect kit can be used. Our dual aspect kit enables you to install a system which uses two panels mounted on opposite E/W facing roof slopes (if your roof ridge is oriented close to north-south). The east-facing panel works in the morning and the west-facing one in the afternoon/evening. This kit uses an innovative controller which negates the need for separate controllers pumps and pipework for each panel. Both panels are connected in-series in a single loop, thus saving cost and simplifying the system.
The panels should be oriented as follows:



For the controller connections fit one sensor only (black cabled PT1000 sensor) to the east facing panel (morning sun). The panels should be plumbed as shown above so that the fluid flows from right to left (as you look at the panel from the bottom). You then also need to set the pump interval and running time functions so that the pump does a 30 second test pump every 30 minutes, to probe the temperature every 30 minutes. (ref. page 30-31 of the controller manual, INTV, tRUN, tSTP functions)
INTV should be set to ON, Change the interval to be from 12:00 - 20:00, since you won't need to probe the temperature in the morning when the sun is on the east facing panel.
tRUN = 30 secs This will set the pump to run for 30 seconds to perform the temp probe.
tSTP = 30 mins (factory setting)
The flow through the east panel should go from right (inlet) to left (outlet) as you look at the panel (facing it from the bottom). That way the heated fluid is passing over the sensor as it is leaving the manifold. The panels should be configured as shown above.

Trouble shooting

Problem	Cause	Solution
Fluid does not circulate when pump is running.	Air lock.	Open filler and drain valve on the pumpstation. Use filler pump to pump fluid around the system to force the air lock out. Bleed air vent points to release any accumulated air. Pump fluid through and bleed air several times.
Pressure not maintained. (pressure falls slowly over time).	Small leak in the pipe-work.	Check all joints for tightness. Inspect when weather is dry to look for signs of moisture at joints. If a joint is leaking try to tighten, but do not over-tighten. If necessary take apart and remake the joint. Use LSX joint compound. You will need to pressurize and bleed the solar circuit once the joint is fixed.
Pressure in the system fluctuates daily.	Normal operation	No action necessary. The change in temperature of the working fluid from sub-zero to 95 degrees during normal operation results in expansion/contraction of the fluid, and changes in the pressure within the system. This is normal and no cause for concern. The expansion vessel should be able to absorb the change in fluid volume.
Controller gives “sensor error”, or unrealistic temp reading.	Sensor not connected correctly	There are 2 different types of sensor. The one with the black cable (PT1000) should be used to detect the panel temperature (it can withstand high temperatures and able to withstand outdoor environment) this black cabled sensor is attached to T1. The two sensors with grey cables are used to detect the bottom and top of tank temperatures T2 and T3. If one of the grey cabled sensors is mistakenly used for T1 you will get a sensor error, or the reading will be inaccurate (e.g. much too high). This is since the sensors have different resistances.
(!) Exclamation mark displayed on controller	Sensor not connected	Sensor connections have become disconnected/ open circuit. Check all connections.
Pump starts but does not run for long before cutting out.	Temperature sensors not connect to the correct ports on the controller.	The controller should be comparing the temperature of the panel with the temperature of the BOTTOM of the tank. If the bottom of the tank is at 10C the pump should start circulating once the panel temperature exceeds 18C. The controller expects the T2 port to be connected to the sensor at the bottom of the tank. If you connect them incorrectly the pump will not start circulating until the panel temperature exceeds the top of tank temp (typically ~50C). If the sensors are connected the wrong way round the system performance will be severely reduced.
The Solar system only heats half the cylinder	Solar circuit connected to the wrong coil on the twin coil tank.	The solar circuit should be connected to the bottom coil of your twin-coil cylinder. Thus it will heat the whole cylinder and will act as a pre-heat for the boiler (back-up) coil. The boiler is connected to the upper coil, and when required will be heating less water thus saving energy.

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Materials

From Contemporary Energy	qty
Solar Panel	1 (30 tubes)
Pump station	1
Controller	1
Cylinder	1
Solar roof flashing	2
Check Valve	1
Fill/drain valve	1

Ancillary Items required	qty
15mm copper pipe	~1.5m
10mm or 15mm pipe for main pipe run (use 15mm if 2+ panels)	~30m
Armaflex HT insulation, to match dia & length of pipe run.	~30m
Bell wire for sensor cable	~35m
expansion vessel (8 litre)	1
Fernox S1 solar fluid concentrated	5L
PTFE tape	1 reel
L-SX jointing compound	1
22mm T joint (cold end of manifold)	1
Auto bleed valve (e.g. Intasol high temp solar air vent)	1
large saddle clips	20
crimp connectors (for sensor cable)	6
Coach bolts	6
Wood screws (for saddle clips etc)	44
pressurizing pump (inc connections)	1

Tools

Apart from the usual DIY tools (screwdrivers spanners etc), you will require following tools.

Essential	**Probably**
16mm masonry drill	Roof ladder
5mm masonry drill	Scaffolding tower
Pipe cutter	
Crimping tool	
Bicycle pump	

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Institut für Solarenergieforschung GmbH
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Certificate of Collector Yield

Company:	**Wuxi Sunpeak New Energy Equipment Co. Ltd** Qunsheng Village, Luoshe Town, Wuxi Jiangsu Province CN-214189 China	Test report no.: Date of report:	64-09/KD 30.09.2009
Type:	**SCM30-58/1800**	Certificate no.: Date of certificate:	Z-W9609 02.10.2009

This certificate is based on the calculation of the yearly yield of the collector mentioned above when installed into a reference solar domestic hot water system. The reference system is defined in the „Empfehlung betreffend den Nachweis eines Kollektormindestertrags als Zuwendungsvoraussetzung zur Förderung von Maßnahmen zur Nutzung erneuerbarer Energien" (Recommendation concerning the proof of minimum collector yield, as a prerequisite for subsidies for measures for using renewable energies) of the German Federal Ministry of Economy.
The certificate of yield is based on an adopted aperture area, for which a **solar fraction of 40 %** will result for the location of Würzburg (meteorological data from the test reference year for Würzburg, total irradiation 1212 kWh/m²a onto collector plane).

Collector parameters (related to the aperture area)

Conversion factor
$\eta_0 = 0.624$

Effective heat transfer coefficient
$a_1 = 2.56$ W/m²K $\quad a_2 = 0.0034$ W/m²K²

Thermal capacity (calculated)
c = 10.0 kJ/m²K

Incident angle modifier
$K_{\theta b,trans}(50°) = 1.52 \quad K_{\theta b,long}(50°) = 0.94$

Result

The calculated yearly yield of the collector exceeds 525 kWh/m²a.

Remarks

The given yield applies only for this reference system and for the calculation procedure mentioned above. The actual yields of real systems can be markedly different from the result given here.

Emmerthal, 02.10.2009

Dipl.-Ing. C. Lampe, Head of the Test Centre EN

Note: Building Control sometimes ask for the panel coefficient of efficiency.
This is $\eta_0 = 0.624$
The area of the collector is 5.09m^2 and the annual output is 2963kWh (Results from testing at the Institute Für Solarenergieforschung GmbH in Germany, based on irradience of 1011 kWh/m^2)