Home Made Solar Panel Installation For Under £900.

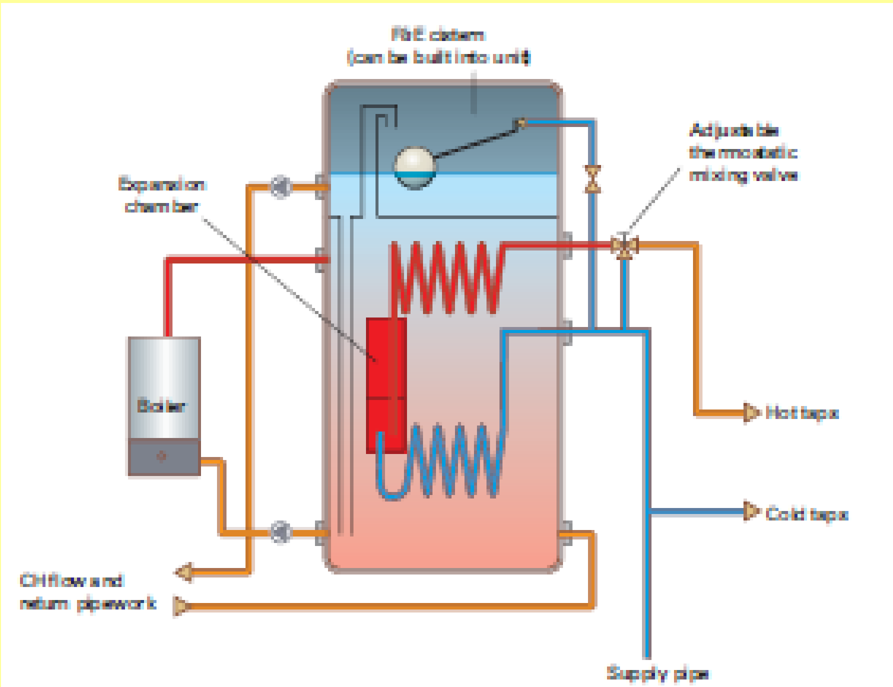
Before I go into detail on my homemade creation I would just like to thank the numerous amount of people that have inspired me to proceed with this project both on this website, well done Gary, and at my place of work.

I live in the UK, latitude 52° north, in the middle of the country, close to the city of Leicester. After toying for several years about installing solar and weighing up the cost of a full installation I decided to bite the bullet and make and install my solar panel from scratch.

I was a plumber by trade but now teach it at a college for Further Education close to my home, so have experience with plumbing design and installations.

Being tight fisted and already owning certain plumbing fittings and components required, I looked to adapt the installation I previously have. Dread the thought of buying a new cylinder at a cost of £800. It was quiet convenient that I have a “Thermal Store” cylinder.

This works in-reverse to a normal in-direct cylinder. It heats the water up instantaneously. The cylinder is full of primary water (120 litres) with a high heat recovery coil passing through it heating up the mains fed cold water to supply mains pressure hot water at the appliances.



This type of system is open vented, so open to atmosphere on the primary side. The hot water is un-vent but because there is no volume of stored hot water it only needs to small expansion vessel to stop it expanding back down the main. The primary water is stored at 75°C so a blending valve is needed to cool the hot water down before going to my hot water appliances.

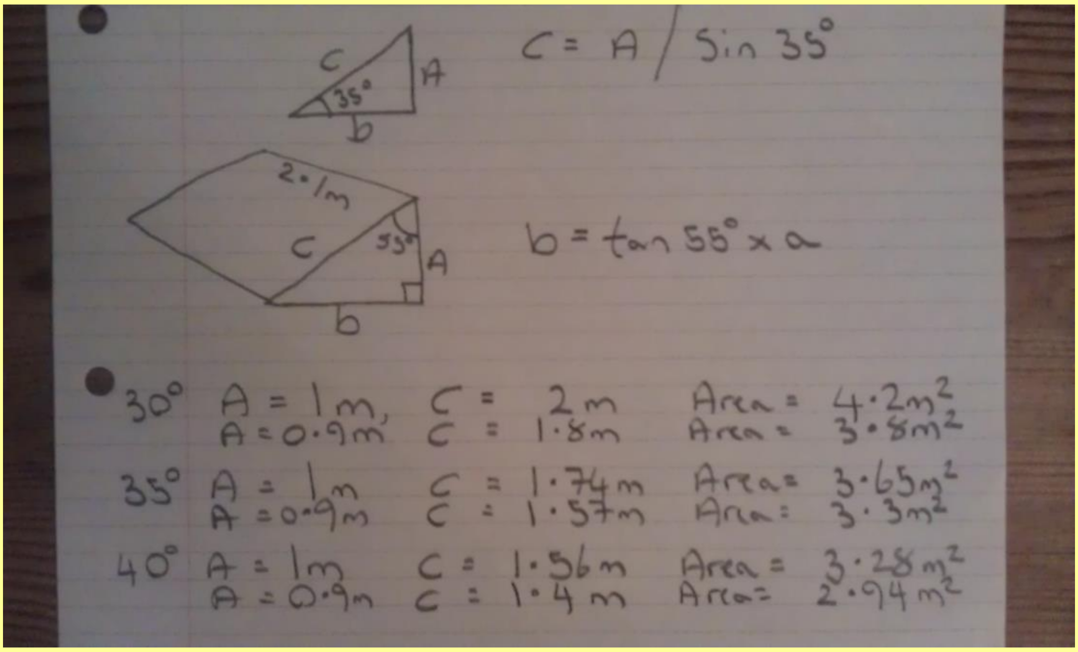
With this system type, all I have to do is put the solar panel lower than the cylinder and it can be open vented, then get a flow and return from the solar panel into the thermal store. Simply!

Now for the interesting bit, how I made my panel.

Panel Design

The solar panel was to be positioned on a flat roof, which is part of my small kitchen, facing 220° South West. Above the flat roof is my bathroom window, this only allowed me 1 metre in height for my solar panel.

Because of this restriction I had to use trigonometry to work out different angle to height scenarios. The maximum sun inclination is 60° at my latitude so ideally a 40° angle of installation for my panel would be ideal if this could be achieved for spring, summer and autumn use.



After pondering over the size and taking professional opinions into account, I decided to make my panel 2m x 1.7m giving 3.4m², fitted at a 30°.

This is over-sized for the amount of stored water (120 litres) but I would rather it be oversized than undersized. Standards suggest 25 litre of storage for 1m² of panel as a minimum but 50 litres per 1m² is the standard. The panel is accessible so I came up with a shading option for when irradiation is plentiful, along with a heat dump which I will explain later.

I started the panel by making my manifold out of 15 and 22mm copper pipe. I set the copper risers 135 mm apart. 15 of them. These connected to headers that were 22mm. I put a fall on the headers so it would drain down totally for the winter period.

Ideally I should have used 10mm columns (this seems to be industry standards on manufactured panels to keep the water content down) connecting on to 15mm headers but I didn’t have any 10mm so I used the materials I had to cut down on costs sacerifing an increase in water content.

The Bauhaus manufactured panels, at work, are 2.37m² and have a water content of 1.43 litres, making 0.6 l/p/ m².

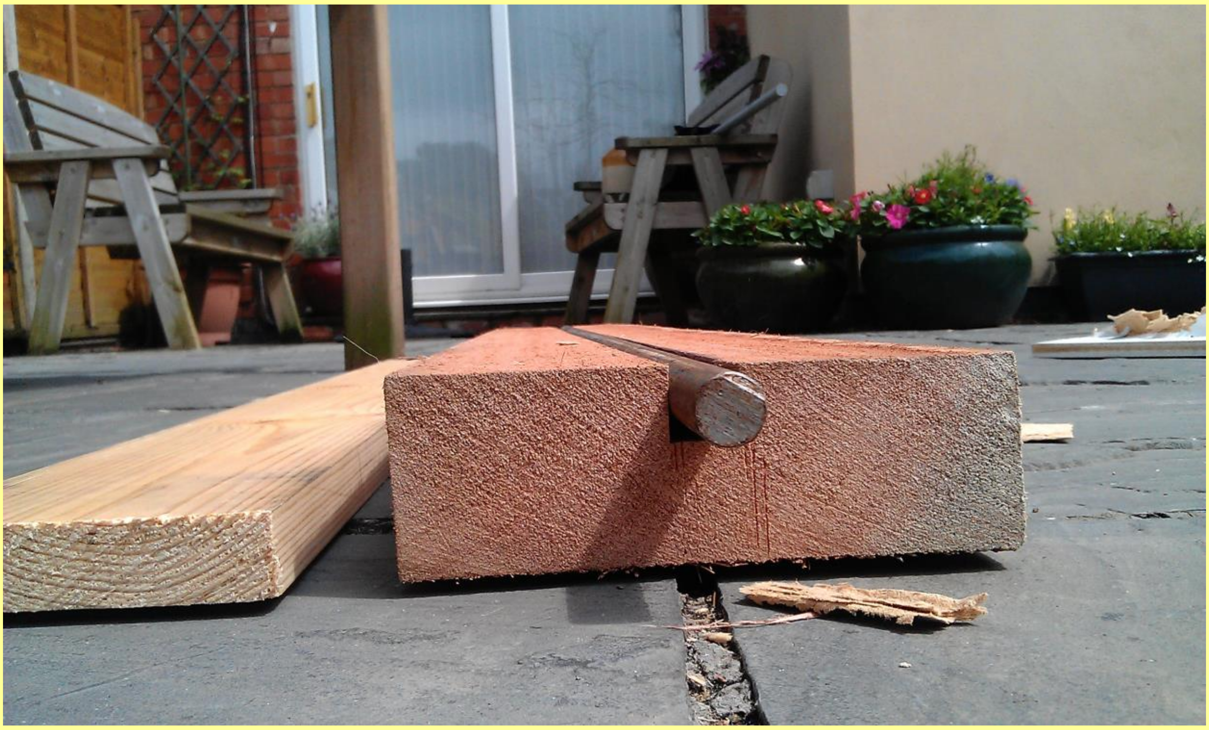
My panel being 3.4m² has a water content of 4.4 litres, making 1.29 l/p/m². That’s over double the water content.

The pipe clips are only there to aid make the manifold. Note the fall to the bottom of the panel.

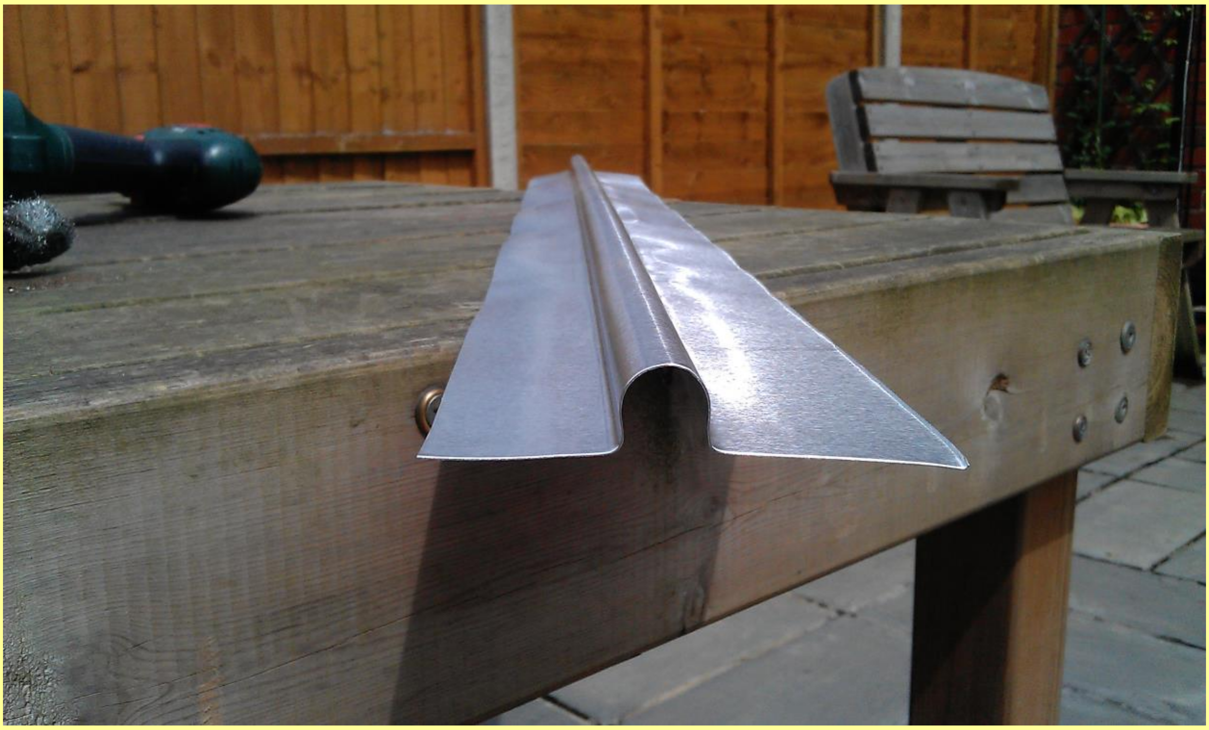
Industry standards, due to stagnation temperature possibly getting over 200°C, are that all joints should be brazed or compression. Normally panels are fitted on the house roof above the cylinder so heat gets trapped at the top of the panel and cannot escape. My panel is below the cylinder and I have designed the flow and return to raise all the way to the cylinder so when stagnation occurs, heat can convect and conduct to the highest point, my thermal store.

Due to my system being open vented it should not get above 100°C, so I used soft solder which melts at approximately 200°C.

Once I completed the manifold I started on the absorber plates. I used 0.5mm thick aluminium plate. Again taking examples from other on this website, I cut a channel into a piece of hard wood 17mm depth and 17mm wide then using brute force and ignorance beat a 16mm steel bar into the channel. I thought this was going to be harder than it was but this was the easy part. The hard bit was cutting all the bits of sheet with tin snips.



The absorber plate gives the panel more surface area to heat up, so heat conducts to the cooler water channels.



I covered a 6mm piece of shutter ply with aluminium sheet using staples. Put the manifold on top and fastened the absorber plates on with staples and screws. I used screws because at this stage it had to be lifted vertically into my shed and staples on their own would not hold.

I pressured tested the manifold at 5 Bar before covering with aluminium sheet.

Once fully covered I sprayed the manifold with black baroque paint and made the framework for the manifold to fit in with 96mm x 20mm soft wood. This was lined with 25mm polystyrene insulation board

The framework was designed to be self supporting. The framework was cut at the angle the panel was to be positioned at. I also waterproofed the framework before painting it with 3 coats of black exterior paint.

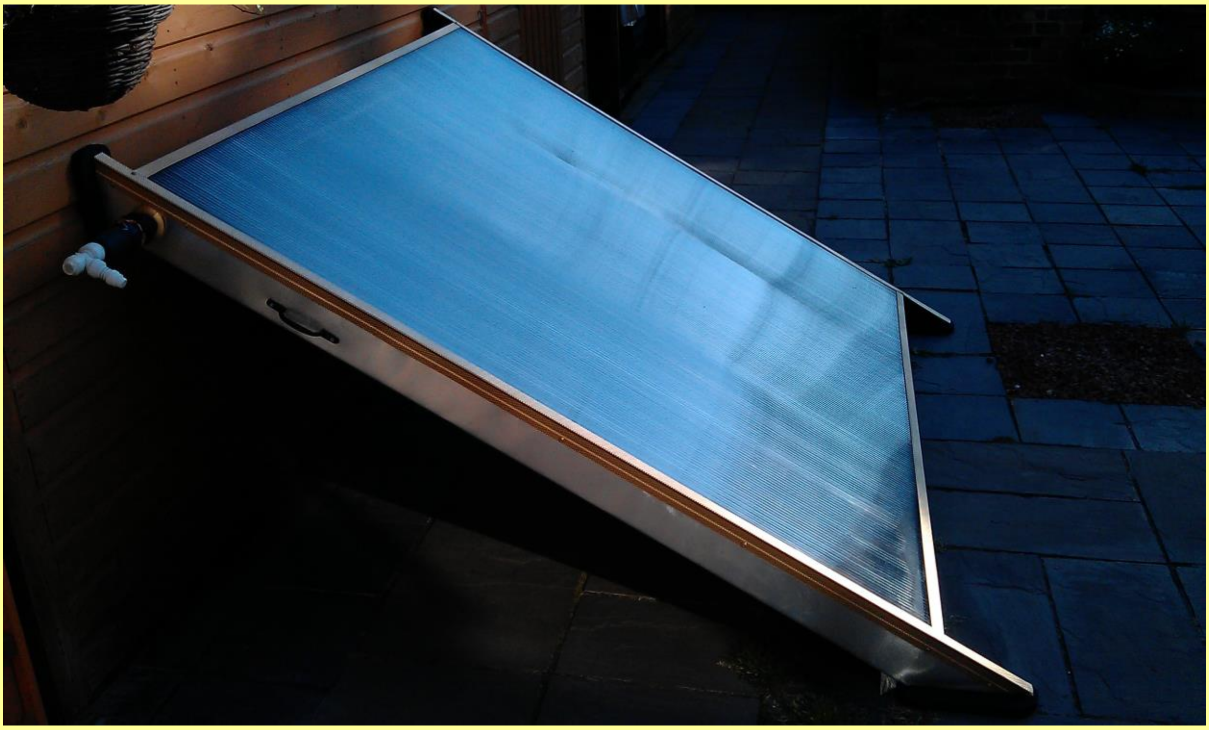
I made a pocket at the top of the panel for the temperature sensor.

The manifold was then sealed to the framework using outdoor sealant.

I had some aluminium left over so I covered the sided to make it look more professional. I placed some supports on the inside of the panel so it could be covered in one piece, without any fixing showing with 10mm twin-wall polycarbonate. It has a light transmission of 88% with a U value of 2.5w/M²/K. I researched float glass but this was going to cost £200 and would have to be in two pieces. The twin-wall cost £60 and guaranteed for 10 years. 5mm conservatory seal was used to seal the polycarbonate.

On the day of fitting the polycarbonate I took a temperature reading and could not believe what it was showing. 3 degrees from boiling and this is without the panel sealed lying at a flat angle. Amazing!

The polycarbonate was secured with 25mm aluminium angle iron sprayed gold to give it a bit of bling. Handles were attached to help move it around. It's a heavy beast. Feet were made to spread the weight.



I was very pleased with the finished product, better than I ever imagined before I set out to make one.

Time to think about my pump station now and getting a flow and return to my thermal store.

The Pump Station

My cylinder resides inside my airing cupboard with little or no room to accommodate a pump and some simple controls, so I came up with the idea of putting the pump station at the back of my panel. When I initially started to design the installation I was going to try and design it so it would work by gravity, without a pump. I only had a 300mm rise from the top of my panel to the flow entry point into my cylinder and I wasn’t convinced it would work efficiently so I decided to have it pumped using a temperature differential controller, TDC.

I brought a five pound lining box big enough to accommodate a pump, isolating valves, pressure relief valve and a flap valve.

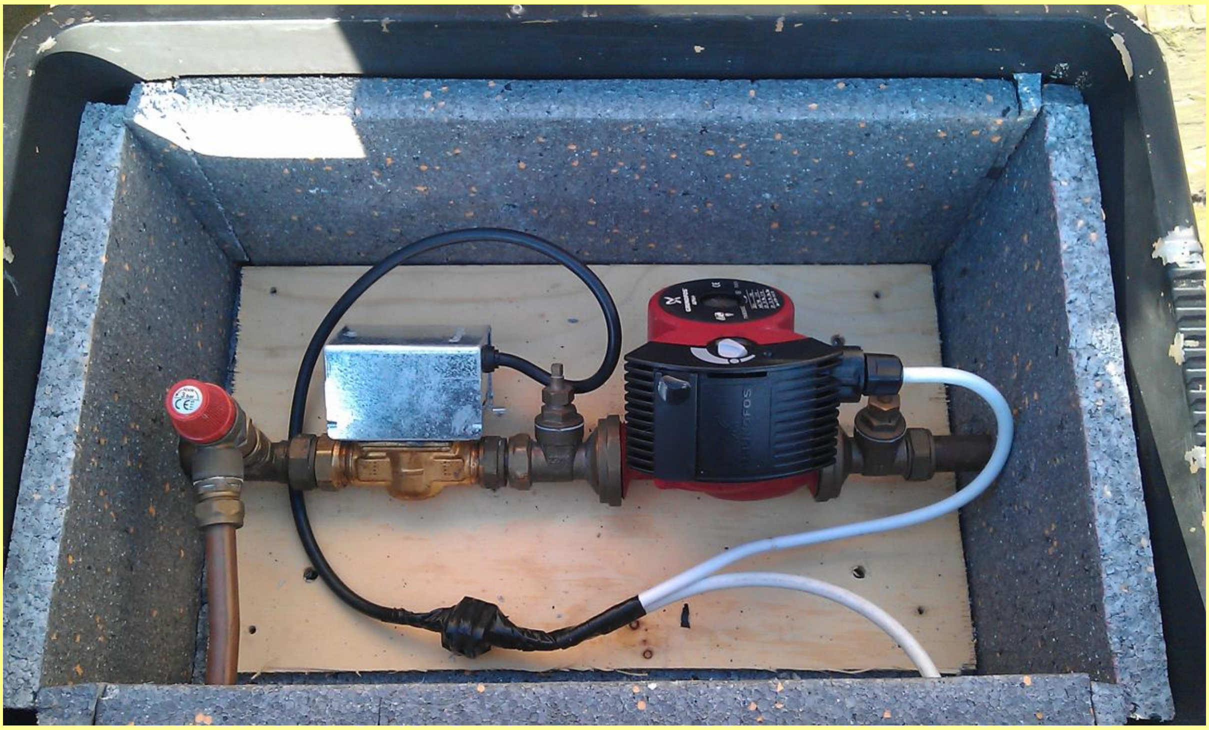
The pressure relief valve will open if the pressure gets above 3 Bar, this should not happen under no circumstance has the installation is opened vented but just in case the open vent or the cold feed got blocked this would release pressure. The boiling point of water increases when under pressure and this can be very dangerous. When water changes state it volume will increase when it converts to steam by 1600 times. This can create a rocket so be very careful. Watch Myth-busters on You Tube, Exploding cylinders.

The flap valve (non return valve) is there to stop reverse circulation. It’s a simple device that contains just a flap with no resistance.

This stops reverse circulation. If this wasn't installed the panel could take heat from the cylinder if the panel is cooler than the cylinder. This did happen because my flap valve stuck open and the panel temperature was showing higher than my cylinder on one occasion at night. This fault did confirm that the installation would work via gravity circulation.

The box was lined with insulation left over from the panel.

This was later altered and a motorised valve installed instead. Plan "B".



The pump is positioned on the return with the PRV after the motorised valve.

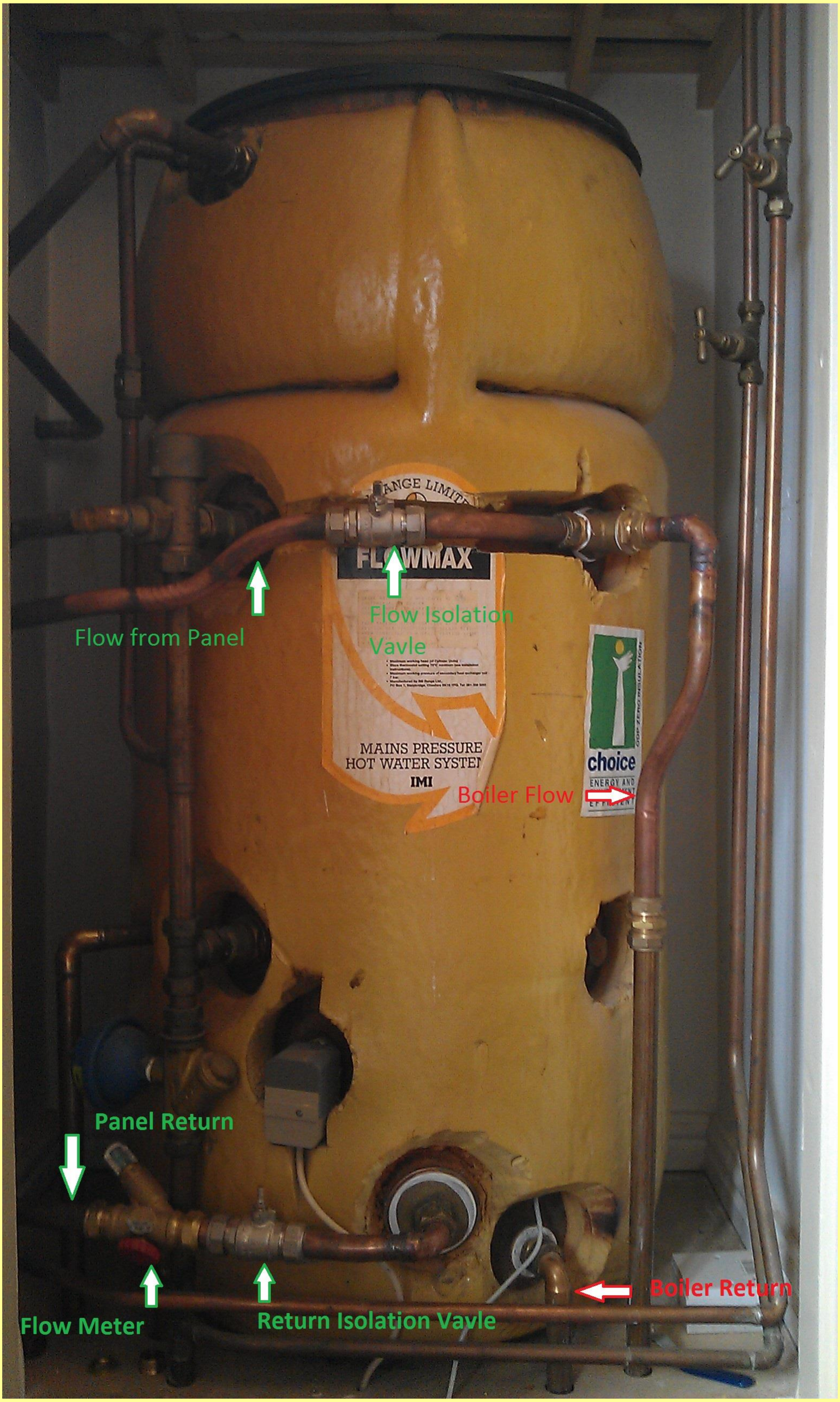
My initial design was floored because the flap valve should have been on the flow in a vertical position. I could not achieve this so I tried to put it on the return with a slight fall back to it to keep the valve shut when the pump wasn't on but it kept sticking open so plan "B" came into action.

Positioned centre of the panel to keep it shaded.

The panel was piped to the cylinder in 22mm copper using soft solder and compression fittings , externally, with brazed and compression internally.

The external pipe-work was insulated with 12mm thick armaflex to stop heat loss.

Piping up the Cylinder



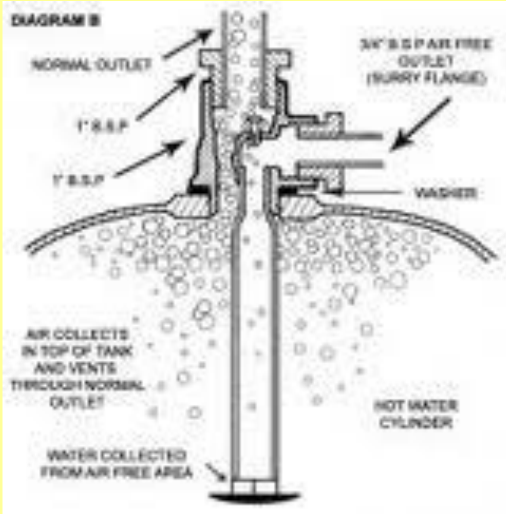
The space inside my airing cupboard is very limited and as you can see from the photo the isolation valves do not have any levers on them this is because the door will not shut if left on so they have been removed. It is also good because nobody can accidentally turn them off or temper with them, so a bonus in some ways.

Because my cylinder is a thermal store this acts has a neutral point. This means that you can have multiple pumps connected to the cylinder and it will not affect any other circuit connected to it**,** eg: if the panel pump comes on it will not pump heated water round my central heating system.

To connect into my cylinder I used a Surrey Flange for the flow and adapted an immersion heater blank for the return with a pipe going to the other side of the cylinder internally to aid solar circulation.

<u>Surrey Flange.</u>

This allows two entry points into one connection normally used on shower installations at the top of the cylinder.



<u>**Immersion Heater Blank Plug**</u>

I took out my immersion heater to incorporate a connection at the bottom of the cylinder. An immersion heater in a thermal store is used as a back- up heat source if the boiler breaks down. There about as good as a chocolate tea-pot on this cylinder.

I fitted isolation valves on the flow and return to the solar panel so it can easily be drained down in winter time along with a flow meter so I can set up the correct flow speed through the solar panel.

Flow meter (Litres Per Minute) with Isolation Valve

To stop the water in the thermal store from reaching boiling point I have wired up a overheat thermostat to my central heating pump. Obviously you don’t want your radiators coming on in summer time, so to over- come this you just turn all of your radiator valves off and I just leave the one on in the bathroom and one in a bedroom that is not used. Because our building regulations “Part L” insist we have thermostatic radiator valves on all radiators apart from the radiator where the room thermostat is fitted. To make sure that the radiator will circulate heat and not be turned off by the room temperature just undo the top of the thermostatic valve to ensure the radiator will circulate.

Heat Dump. Over heat Thermostat

This is positioned near to the top of the cylinder and set at 95°C.

Temperature Differential Controller. TDC

To control the solar pump that pumps heated water from the solar panel to the cylinder I used a TDC. This uses two temperature sensors to operate the pump, one in the panel and one on the cylinder.

When the sun comes out and starts to heat the water up in the panel, if the temperature of the panel gets 6°C higher than the cylinder temperature it will then turn on the pump and send the hotter water to the cylinder. When the difference is only 4°C it will turn the pump off. This can be added to by putting another sensor on the return. Because I have a flow meter fitted, the controller I have will work out how many KWH of energy the panel has produced so giving me an accurate measurement of how much energy the panel as saved me.

The controller as a multitude of different options on it, but one of the main ones for me was the frost protection. If the outside temperature gets to near freezing it will bring the pump on and send heated water from the cylinder to the panel to raise the temperature by a couple of degrees.

My panel installation is not for use over winter time. The temperature can drop below - 12°C and because this is a thermal store the overall capacity of the system is over 150 litres (that's including the water in my central heating system) which would require an antifreeze mix of 50/50 making it not cost effective. Gycol antifreeze is very expensive, £30 for 5 litres, a normal solar installation when connected to a twin coil indirect cylinder would not have a capacity over 20 litres.

I commissioned my panel late last summer (2012) and run it up till the end of October when the controller I had at the time did not have frost protection. I went out on a couple of occasion to see the panel covered in frost. Luckily the pipes did not freeze and split so it's nice to have that little bit of protection come the end and start of its use throughout the year.

We had a terrible late summer last year with constant rain and not a lot of sun so I don't know if I've cursed our weather system by building my panel.

As I write this (beginning April 2013) there's 300mm (12") of snow on the ground and minus temperature figures. It's the coldest Easter on record. That's no good we want warm weather with clear skies and the sun shining though.

<u>TDC</u>

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I turned the controller on in winter (the panel was decommissioned) when we had a sunny day to see the temperature in the panel at 100.8°C. The outside air temperature was 7°C.

Commissioning

When the day came to commission my installation I was full of anticipation. Nobody wants to spend all that time (roughly 60 man hours) and money on a dead donkey. This project was a labour of love and hopefully one that will in the long run pay for itself.

With all the electrics tested, pump running, overheat stat working I filled the system up. No leaks so now it's just a matter of waiting for the panel to heat up. The day was a mix of cloud and sun. Within an hour of filling up, the panel was producing energy. What a joy it is to see and to use hot water that has not been heated by fossil fuels.

For three days my boiler had been on standby not coming on at all. My panel had supplied me with enough energy to take the temperature of my thermal store up to 82°C. This was even when we were not baking in sunshine all-day.

When the suns out and it's not raining it will easily supply my partner and I with enough hot water and in spring and autumn contribute a little towards the space heating.

I'm in the process of commissioning my panel again, for the summer, and with my new controller registering the amount of energy that it produces I will keep track and up -date Gary at the end of the year with some energy figures.

I have also fitted a datalogger sensor in the panel to record the temperatures that the panel gets up to. This takes a reading every half hour.

I have thoroughly enjoyed every part of learning about and building my panel and would encourage anybody with the ability to build one but please be careful, it can be very dangerous if not designed and installed correctly. Just watch mythbusters.

With the cost of energy nowadays it's fantastic to tap into renewable solar energy and costing just over £900 I should hopefully see a return in about six years. I know that it's not as efficient as a manufactured panel and it will not produce over winter time but where I live we only get 7.5 hours of sunlight on the shortest day with the inclination of the sun being at 14°, so there's not a lot of prolonged energy to tap into.

I hope what I, along with others who have helped me especially my loving partner Justine, have built will inspire others. I have wrote this for an overview only and the information I have provided should not be taken as being in line with building regulations in the UK or any other country. This is for pleasurable reading only.

If anybody who reads this and is local to Leicester wanting access to irradiance data then please use the link below. If you go to history you can access charts and data from the past.

http://skylink-pro.com/schools/stephenson/energy.php?stationid=T053

Regards

David Bowler