# The ultimate DIY solar water heater?

**Michael Gunter fancies himself as a bit of an innovator in the deregulated energy market, and gives us the lowdown on a solar hot water system that he claims can be installed by any 'talented amateur plumber'**

Now that energy utilities have launched into full retail contest ability there are new customer incentives to use more electricity, as they are offering financially attractive off-peak electricity tariffs, among other initiatives. I believe the new tariffs are a temptation to pollute, and to extend the financial viability of baseload coal-fired power stations. To fight back and help address the Australian greenhouse gas emissions problem, we need a cheap but effective energy market competitor that we alone control—a solar water heater. Better still, a 'do it yourself' solar water heater has the added advantage of saving money. I note that it is disappointing to see just how expensive some commercial solar hot water systems are becoming, as they get more and more high-tech. Their price also seems to have escalated since the introduction of government rebate schemes.

## Innovative concept

This solar water heater has one novel feature: the use of a very small photovoltaic panel to directly drive an efficient DC water pump, with the components carefully matched for power ratings to ensure the pump only moves water when there is sufficient solar radiation to provide some water heating.

A solar water heater collects radiant energy from that huge nuclear reactor in the sky (the Sun!) and traps it in a flat sheet of metal. Water tubes then transfer the heated water away for storage and later use.

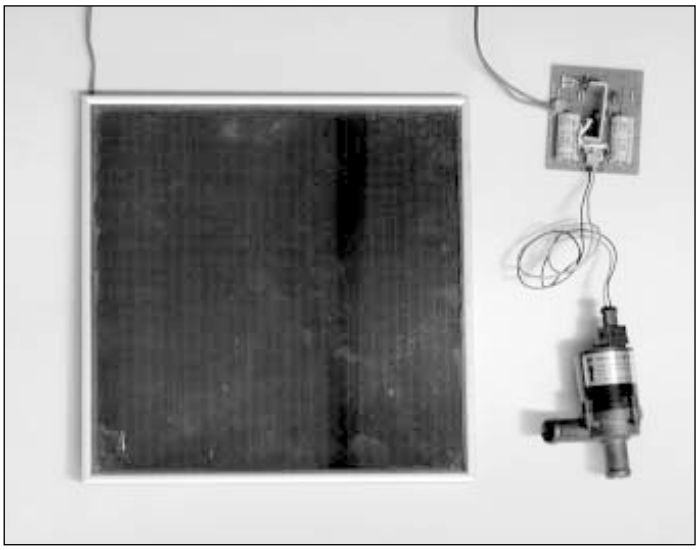
## Cheap and easy to install

Let's be honest—big tanks on roofs are often really ugly. The beauty of a 'split system' is not only improving the aesthetics of your house, but it is much easier and quicker not having to lug a 100kg water tank onto your roof, and not having to strengthen the roof trusses.

This design can be installed as a retrofit to an existing 300 to 400 litre ground-level mains pressure storage hot water tank for under $2000 with half a day's DIY labour, though a plumber should make the final connection. It should provide a tax-free 10 per cent return on that investment for around 20 years (maybe much more depending on the cost of gas and electricity in the future).

The schematic of the solar water heating system can be seen in Figure 1. The list of main components required to complete the conversion can be seen in Table 1.

Sundry items to complete your plumbing will include two 19mm hose barbs, two short lengths of 19mm radiator hose, four hose clips, various elbows, compression fittings, costing perhaps another $50. (The hose barbs, hose clips and radiator hose are necessary to adapt the EBP automotive pump to 13mm copper pipe water circulation system). To comply with plumbing regulations you should get the work performed, or at the very least checked, by a licenced plumber before connecting your system to the water mains. The EBP is rated to 135 degrees Celcius, but at this stage Davies Craig is unable to give a recommended operating pressure limit. The prototype installation has a 350kPa pressure reduction valve on the cold inlet, a 500kPa TPR valve at the top of the solar collector array (see Figure 1) and a 750kPa TPR valve at the top of the storage tank. In practice this means that in the hottest part of the afternoon,



**The solar panel, Davies Craig pump and maximiser**

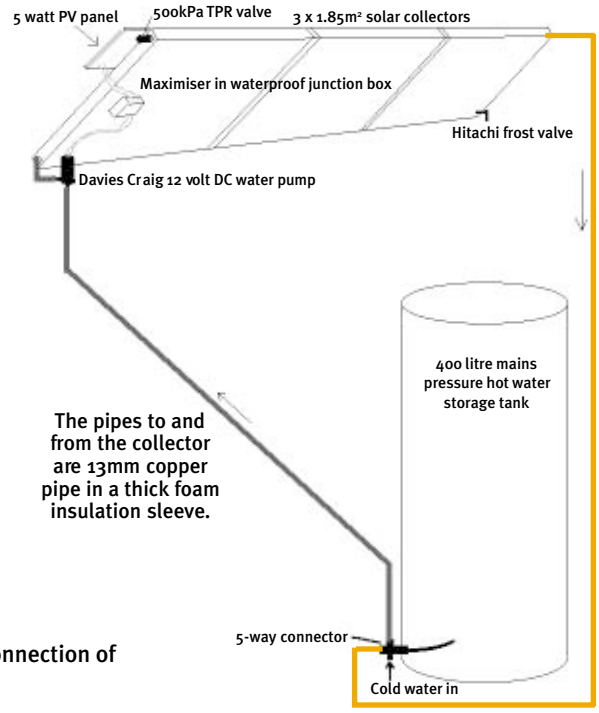



**Figure 1. The layout and connection of the major components.**

when the tank water is expanding because it is being heated, there will be a pressure of up to 500kPa in the circuit, at which point the TPR relief valve in the solar panel begins to open. So far the water pump has worked flawlessly at this pressure, at temperatures of up to 80 degrees Celsius.

## Test the pump first

It is a good idea to connect your mini-maximiser, solar photovoltaic panel and EBP, so that you can test the EBP in a bucket of water, remembering it is not a submersible pump! It should commence pumping when, under a bright cloudy sky, the PV panel is delivering about 80mA into a short-circuit (the shunt in your ammeter). This is the sort of radiant sky which will make a black car dashboard comfortably warm, and is therefore the same level of radiation at which your solar collectors will be able to start delivering usefully warm water into the hot water storage tank. To emphasise the amazing characteristics of the mini-maximiser, please note that with a conventional DC power source, the EBP pump will remain stalled until 1.5 amperes is flowing through it, but will start and run with only one-twentieth of that current from a 12 volt PV panel, if the mini-maximiser is present in the circuit.

Note well that the circulation pipes contain no non-return valve, and inevitably a small amount of warm water will flow back up into the solar panels each evening. This is minimised or eliminated by taking care to: 1. Keep the plastic tube on the five-way adaptor very short: protruding only 100 to 150mm inside the bottom of the storage tank. 2. Install a tank which has a booster element; and 3. Disconnect the main (bottom) electric heating element.

## Purging the air

When fully assembled and checked, your plumber must pressurise the tank and bleed all the air out of the highest points in both the storage tank and in the solar panels. No bleed valve is necessary, but at least one compression fitting must be accessible so that it can be loosened until air and water escape.

The 5-way adaptor is made from standard fittings and a piece of nylon beverage tube and is much cheaper than a commercial unit.

Warning: if it is a sunny day, escaping scalding water can burn your hands, so thick rubber gloves may be required. Failure to perform this operation will result in a non-functioning system, as the EBP will not provide a forceful enough flow to flush air down to the tank at ground level (not from a five watt PV panel, at any rate).

In sunny weather you will be able to tell that the system is working by feeling that the return pipe from the solar collector feels considerably hotter than the other pipe. The pump makes a faint whining noise because the maximiser feeds it with brief pulses of DC current, and this sound usually indicates that the pump is spinning, but not necessarily.

## Optimal performance

If you buy a new car, you don't normally drive around with the handbrake applied. If you have a bright lamp, you don't hide it under a bushell. Similarly, now that you have invested all that hard-earned money in your new hot water system, it is a good idea to consider the best way to optimise its performance, and return on capital investment.

After 20 years experience living with an electric-boosted solar hot water service, I suggest the following strategies.

Disconnect the heating element at the bottom of the tank, and use the booster element at the top alone. Check with your power company if you can still get cheap tariffs with this configuration (probably not).

Use the thermostat at the top of the tank to control the element at the top of the tank (they are usually wired that way, but check to be sure).

If you replace the upper boosting element with a 2.4kW element, it can be run from an ordinary 10 amp power point via a time switch. If you set the time switch to be off from 7am to 4pm each day, this can greatly reduce electricity requirements, though peak-rate electricity will cost a lot more, thus extending the payback time for your investment.

Set the booster element thermostat to the lowest possible temperature setting. If it is not adjustable, then get your electrician to install an adjustable one. Provided it is not against local regulations, I strongly recommend a setting of 40 to 45 degrees Celsius (on at 40, off at 45). This can save you very many dollars in a year, and adaptable individuals can cope well with showers, if not baths, at these temperatures. Despite the lack of evidence that luke-warm water from a solar hot water tank is harmful to health, solar heaters are being made less competitive because new regulations are requiring them to be operated at higher temperatures. If we have to bend a few rules to save the planet, it will be worth it in the long run.

| Quantity | Description | Indicative Price |
|---|---|---|
| 3 | 1.9m² solar collectors @ $450ea. (any Aussie-made brand will do. Mine were "Sunbather" from Albury Consolidated Industries, but see text for another suggested brand) | $1,350.00 |
| 10 metres | 13mm copper pipe | $75.00 |
| 5 | 2m lengths black foam thermal insulation ID 16mm | $50.00 |
| 1 | Davies,Craig EBP 12 volt water pump short version 9002 | $201.45 |
| 1 | 5-way adapter fitting | $50.00 |
| 1 | 5-watt photovoltaic panel | $135.00 |
| 1 | Mini-Maximiser | $33.00 |
| 1 | Hitachi frost protection valve | $100.00 |
| | **Total cost without tank** | **S 1,986.45** |
| If you need to buy a hot water tank, add this | | |
| 1 | 400 litre twin element tall cylindrical hot water storage tank (eg Rheem Optima) | $1,100 |

**Table 1: The components with indicative retail costs (October 2000)**

Turn off all electric supply to the heating elements, and 'see how you go' for the six months from spring equinox (21 September) to autumn equinox (21 March). You will fairly soon learn to judge which family member is wasting water in sunny weather, or how many days of normal usage and cloudy weather result in unacceptably low supply temperatures.

You may find that you can even leave the electric boosting off for several days at a time during sunny winter weather. Such a strategy will significantly shorten the period for a 'full return on investment'.

Without any electric heating element, this system makes a perfect pre-heater for an existing gas-fired storage water heater. Just cascade the hot outlet from this tank into the cold inlet of the gas hot water service. Again, it would be nice to be able to shut down and bypass the gas system for six months each year.

## The problem of frost

Since I published the plans of this design on my web site 15 months ago I am aware of at least two systems being installed in Tasmania. One has had problems with burst pipes in the solar panel, and water damage to the pump electronics. The sensible place for the pump is down off the roof sheltered from rain and from cold clear skies. In a really cold location it will also need to be lagged with insulation to prevent costly frost damage.

The solar panels are also at risk on cold clear nights, but I recently learned that Rheem has a new range of solar panels with tapered risers and insulated headers. I understand Rheem is confident enough of this clever design to warrant the panels against frost damage, but personally I would still use a frost valve as well just to be sure.

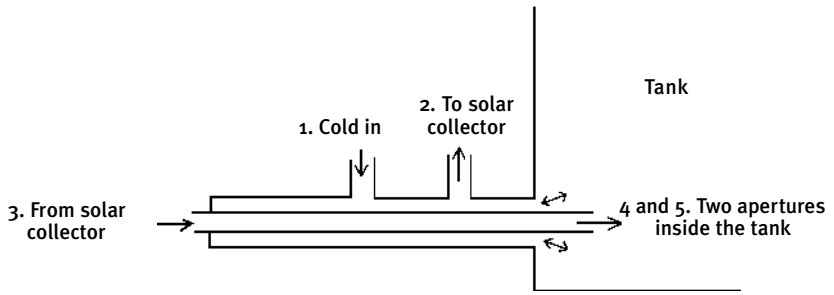



**Figure 2. The 5-way adaptor in cross section.**

Another possibility is to have a thermostat switch which connects the PV panel to a 6 to 9 volt, 200mA plugpack whenever the solar thermal panel goes below four degrees Celsius. This 'night sun' will run the pump just enough (via the mini-maximiser of course!) to prevent the panels from freezing.

## Rebates and Renewable Energy Certificates

If we retain more control over the energy we are using and where it is coming from, and thumb our noses at carbon trading and government hadouts, we not only assert our independence, but have the satisfaction of making it harder for polluters to buy RECs to meet their Mandatory Renewable Energy Targets. *(See Pears Report in this issue for another view on this, Ed).*

***ReNew* cautions all readers to comply with local plumbing and building codes by employing the services of a professional plumber when connecting it to the household pipes. Michael Gunter's overtly hostile attitude to the electricity industry is not necessarily the view of *ReNew* magazine or of the Alternative Technology Association.**

**The use and mention of commercial products is not an endorsement of any individual manufacturer or their product. If you can find equivalent products from other manufacturers, then please use them. The original version of this article is available as a free PDF document to download from my web site: show it to your plumber today!**

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