Up for a challenge?
Build-your-own solar HWS

After a slow and costly start, Martin Chape's DIY solar HWS is working so well that there's heat to spare. He describes the challenging build.

I RECENTLY managed to finally fulfil a promise made back in 2011 to build a new split-system vacuum-tube solar HWS that can be monitored via the internet.

At the time of making the promise I had already started collecting parts. I was lucky enough to find a used 300-litre Chromagen water tank for $100 that had already been used for solar and was still in good condition. Being solar meant that it already had the additional flow and return pipes required to go to the solar collector on my roof.

The reason for the new system was that my existing Edwards close-coupled solar HWS, while still working after 16 years, was looking a bit the worse for wear with signs of corrosion on the tank outer and some of the piping. In fact, when we came to remove it from the roof, we discovered that the screws holding the stainless straps had corroded right through. The only things stopping the tank from sliding down the 30 degree pitched roof were the screw heads holding the corrugated iron sheeting in place!

↑ The new evacuated tube panel sits neatly between the (many!) PV arrays.

Importing glass vacuum tubes: not for the faint-hearted

Importing the 30-vacuum-tube collector array direct from China proved interesting, to say the least! The tubes, manifold and frame cost only $335, but, when the boxes arrived at the Fremantle wharf, the shipping company contacted me to advise I needed to pay another $488 before I could collect the boxes.

Part of that charge, $150, was to make a declaration to Australian Customs that the items were under the $1000 threshold, and therefore avoid import taxes and GST. I declined to have the importer do that on my behalf but then discovered I was not allowed to lodge the form myself. Fortunately I found someone in Sydney who could lodge it for me for the bargain price of only $90.

I reluctantly paid the shipping company $338, which was the balance of the $488 port charges, and headed to the wharf with my Customs clearance sheet. On the wharf no one could find my crates and instead they offered me a cardboard box containing two bicycles! Finally, I was allowed to walk around until I found my crates.

When I returned home and unpacked the boxes, I found five of the 30 glass tubes were broken. I contacted the shipper and they refused to accept responsibility. I contacted the Chinese exporter who offered me 10 replacement glass tubes for only $25, but added it would cost more than $500 to have them shipped.

I eventually found a company in Australia that could supply five glass tubes for $125. There was an additional $25 for a crate and $75 to ship: a total of $225. I duly paid for these along with shipping costs. The courier arrived with a cardboard box rattling with broken glass, and I refused to take delivery. So the replacement tubes were returned to Melbourne, but thankfully these were replaced without further cost. Finally I had my five new tubes and was able to repair the broken collectors.

I haven't worked out the total cost of importing these tubes, but I estimate it must

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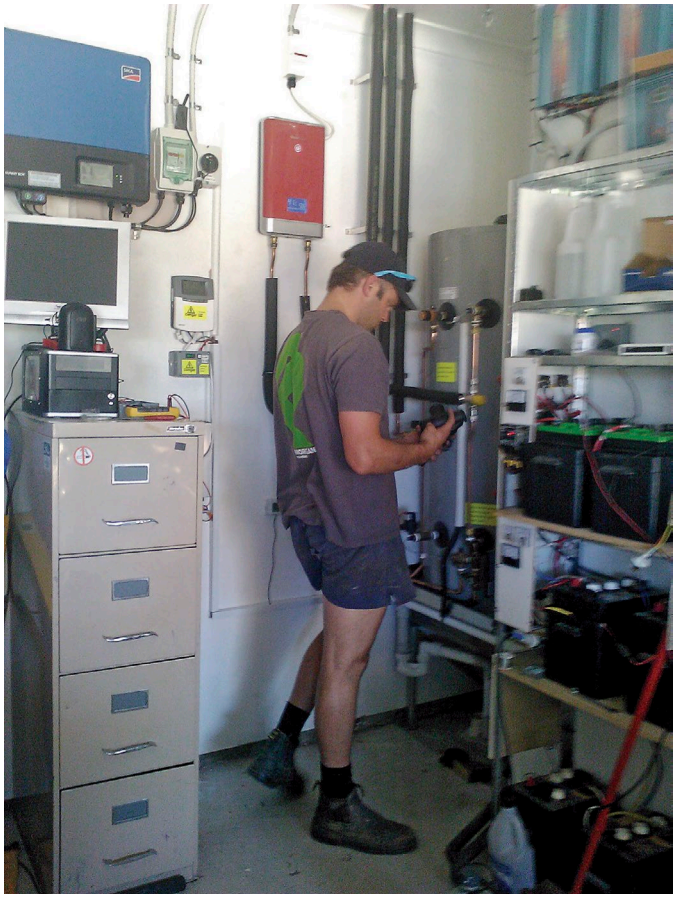


→ The 'found' Chromagen tank being plumbed. Note the Gleamous instantaneous hot water system on the wall (the red box).

be up around the $1k mark. My advice to folks buying vacuum tubes would now be: try and source locally, and pick them up yourself!

Controller confusion

Unfortunately importing the controller didn't go smoothly either. Having successfully brought items from China to Australia in the past I figured this was the best way to go. There's such an amazing amount of technology available at bargain prices from China. But communication can be a problem. When, as an engineer, you start asking about technical details, things can become confused.

After a bit of research I chose an SP26 intelligent solar HWS controller at a cost of US$90 that was advertised as having an RS485 port. However, despite several emails and reassurances from the seller, there were no ports on the controller I received. So we exchanged yet more emails which got me exactly nowhere.

Giving up on that supplier I found that a new SR1168 intelligent controller had become available from another store. This boasted not only an RS485 port but also a port to plug in an SD flash card, and even showed a diagram of it being connected into a network. I forked out another US$138 and it was on its way to Australia.

I was delighted to find when it arrived it was exactly what I had been aiming to purchase.

Gas or electric boost?

I chose an electric instant hot water unit for boosting temperature as I could cancel out the electric power drain by an extra PV panel on my grid-connected array. I avoided a gas booster as the capital cost of the appliance is around four times the electric one, and I also believe an electric heater has finer heat control than most of the gas appliances.

Additionally, it is my view that domestic gas prices will climb as it competes with the export markets to China, India and Japan. The WA government has managed to excise gas from the Gorgon project for domestic use, but at a higher price than is currently paid.

There are some amazing instant electric HWS on the market in Canada and the USA for around US$250, complete with remotes to set your temperature at the kitchen sink or in the bathroom. But importing these and having them approved here is a costly exercise. So I went for a Chinese unit, a Gleamous GL5 instant HWS with no remote, that has a local importer in Sydney, a two-year warranty and a quality control system in place.

They retail for just under $500, and the importer helped me out because he was interested in my project.

I estimate this system will use around 40% less energy compared to the immersion booster in my old solar HWS. I have installed Current Cost power monitoring on this new system and can view its energy use on my smartphone. The immersion booster in my old system was also monitored and I have a couple of seasons of data for it, so I will do a comparison to the new system after this coming winter to check my estimate.

Circulation pump

Most of the circulation pumps on commercial split-system solar HWS are 240 volt AC. But as I already have a 24 volt DC battery bank in my garage right next to where the water tank was going to be placed, I naturally chose a 15 watt 24 volt DC pump.

The pump I chose is Chinese but I sourced it locally for around $80. Unfortunately, neither I nor the plumber I hired read the pump instructions and it ended up fitted the wrong way up. Within three months it had failed and I had to purchase a replacement.

Putting it all together (finally!)

When I had all my bits and pieces ready I went out and found a licensed plumber. He agreed that I could set my hot water tank in place then he would do all the piping and connections.

To use a wash bay in the garage for the hot water tank I needed to build a small tank stand (so that we can still get access to plugs in the concrete floor needed for termite control). The stand was easy to build but I also wanted a drip tray to stand the hot water tank in. I went to my local plumbing supplier and they quoted me $348 plus GST and a three week wait for the tray. So I headed over to a local sheet metal worker and he quoted me $25 to fabricate the same thing. The sheet metal worker called me the following day and said I could come and pick it up. When I paid him the $25 he handed $5 back and said make it $20. I was over the moon.

So with the tank in place in its drip tray and the instant electric HWS mounted on the wall I had the plumbers over.

I provided them with all the valves and connections which I had sourced at good prices myself. I ensured they connected all copper pipes away from the wall so I could add insulation at a later date.

Now the inside part was ready for me to wire up. I included a digital flow meter in the pump circulation pipe so I could measure the water going through the collector on the roof . I also installed the thermocouples on the tank and the roof.

Then I found that I couldn't tap into the DC rail of the solar controller board and that it switched 240 volts AC to the relay contacts. I soon had a temporary fix by building a box with a 240 volt AC coil relay and using the relay contacts to switch the 24 volts DC to the circulation pump, then via a small sine wave inverter to provide 240 volts AC to the controller. I figure at a later time I will use hac into another controller board and remove the 240 volt AC stuff and so make it switch the DC pump directly.

On the roof

Moving outdoors, I repaired the damaged vacuum tubes with my replacement glass and assembled the frame to hold the manifold. With the help of my friend John, who had helped me pull down the old close-coupled solar heater, I lifted the frame and manifold onto the roof and fixed it in place. I cut two holes on the top of the corrugations to take the flow-and-return copper pipes and inserted rubber grommets to prevent dissimilar metals from touching.

Over the top of the grommeted holes I placed those little corrugated boots that plumbers use for vent pipes. Then I called the plumbers to install the flow-and-return pipes.

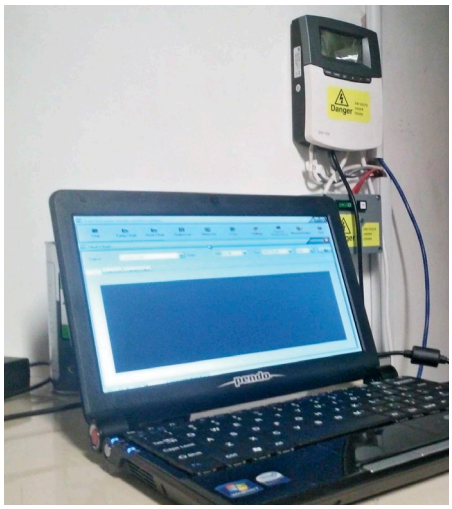
Then things got interesting again. I had previously called the plumbers' boss and he told me that his guys could solder the adapters for the copper pipes to the manifold while up on the roof—but when they arrived to do the job they said they couldn't do that. So I had to help them unfix the frame, lift it off the roof to be soldered and then put it back up. I also had to remove the corrugated boots which I had siliconed and screwed on so they could get the copper pipes through.

After the plumbers had finished I wrapped the exposed pipes from the manifold with insulation. To prevent ultraviolet from damaging the insulation I wrapped it with a foil tape designed to stand up to 150 °C.

Finally, John and I installed the vacuum tubes. The tubes have a copper section at the top that slips into a copper tube inside the manifold, and a rubber seal around the glass to keep external moisture out.

Any of the tubes can be removed from the manifold without turning off the water.

The tubes are slid into place through the ring on the lower end of the frame then a threaded piece locks the glass tube into the frame.



→ The controller talks to the computer and the data from the controller can be accessed over the internet.

Warning

Extreme care should always be taken when working on roofs and correct safety equipment, such as a harness, should be worn. All mains (240 volt) wiring must be done by a qualified electrician. The ATA encourages readers to always place safety first.

When all the tubes had been fitted we turned on the water and the solar controller. To our surprise, within three hours the 300 litre tank had reached 40 °C.

Next time...

If I were to do this project over again there are a few things I'd do differently. I'd carefully read the manuals and instruct my plumber better to avoid having to replace the circulation pump, and having to remove the frame from the roof and put it back up again.

I would also source my vacuum-tube array from within Australia: much better to let the importer bring in a container full of tubes and carry the risk of damage in transit, and the red tape of importing. Prices in Australia are comparable to what I ended up paying to import directly. My imported manifold also had odd copper pipe sizes which meant I had to fabricate special adapters. If you buy local you can go and have a look before you buy.

On the positive side, the vacuum tubes are so efficient that in the hot Perth climate they are generating too much heat! I am now looking at using a heat exchanger to draw heat off the tank and use it to create cooling for my home in my next project: a solar air conditioner. The hotter it gets, the more cool air I intend to produce. But that is a challenge for another day! ✱

Martin derives great pleasure from setting himself green challenges and solving the technical problems they produce. He uses his articles in this magazine to share his journey with others in the hope that they, their children, and grandchildren will all benefit. Find him at: www.sustainabilitysolutions.net.au.