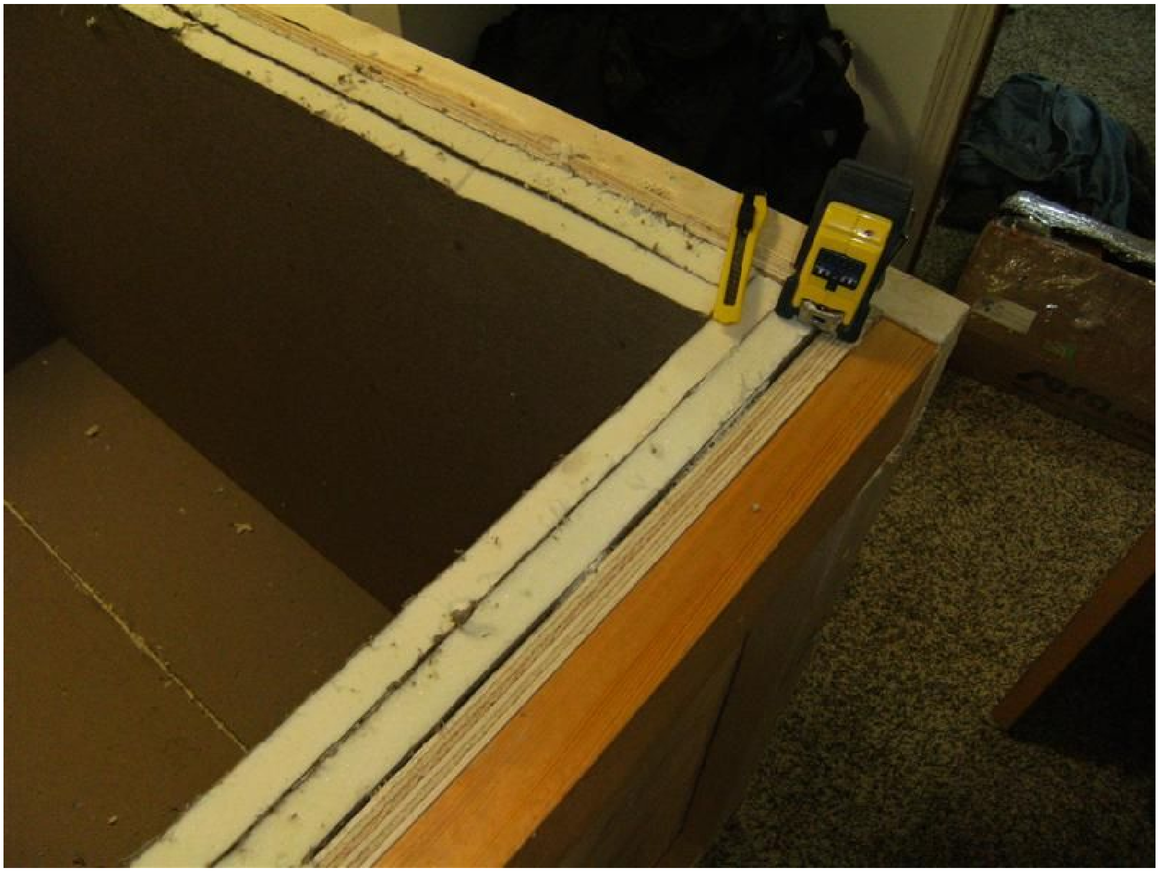
capacity compared to Gary's I might make up in heat exchange efficiency with the copper section. After the preheated water was gone, the copper would provide efficient on the fly heat exchange, I hoped.

The price of copper slowly came down from the stratosphere this winter, so I shopped around for four 12 foot lengths of ¾" type M copper pipe, and a whole lot of elbows. I cut the pipe into 20" lengths and learned how to solder copper pipe (brand new to me). I made a square spiral with ~30 elbows. I thought I had better pressure test my creation, so I soldered a garden hose thread on one end and capped the other. Miraculously, there were no leaks.

Copper part of heat exchanger

The tank was constructed similar to Gary's, using ¾" plywood and lots of bracing, 2" of polyiso foam, and an EPDM liner. I used 2 layers of 1" polyiso insulation. I figured that this would reduce the amount of scrap compared to buying 2" for the tank and 1" for the collector. I had some pieces of heavy 40 mil HDPE liner that I put in the tank bottom and sides so the heat exchanger wouldn't scrape the sides and cause a leak.

Tank construction. Note hole in drywall where tank will go through.


Tank detail showing 2 X 4 bracing and insulation


Partially connected PEX and copper combination heat exchanger

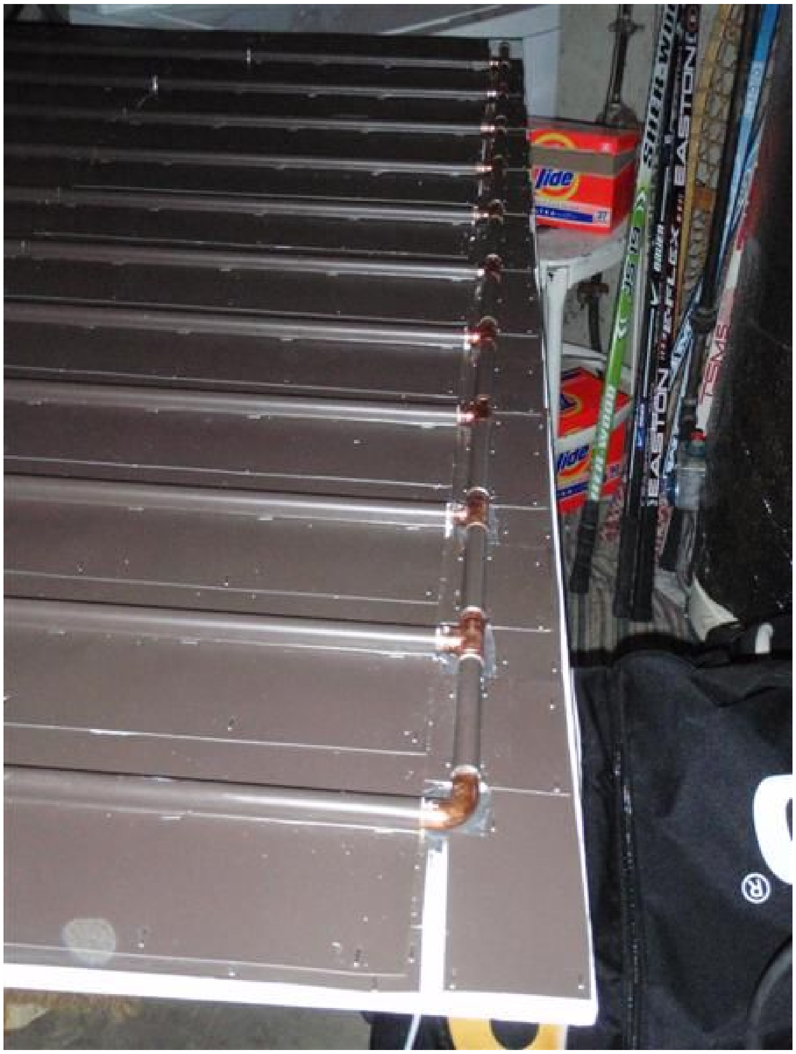
The major challenge was getting the tank into position. I was going to take out some of the studs to fit it in from the basement side, but I hadn't noticed that the main gas line and water line were also in the way. It looked like the only way in was through the wall of the bedroom, which took a bit of a family sales pitch. The family is quite supportive of the whole project, so they went along with the idea. My wife's comment was "just don't drywall it in, because you know you'll have to get in there again!" So I am putting a piece of plywood there for easy access.

<u>Collector</u>

I decided to go with a copper pipe collector instead of PEX, since being further north I thought I would need all the efficiency I could get. I wanted to make a 48 square foot one, but decided to split it up into two halves. This was both for drainback efficiency (a 12 foot long collector might not drain back quickly enough) and for weight, because unlike Gary I had to hang it on the wall of the house. I designed two panels with outside dimensions of 4' X 6' so that the Suntuf glazing would fit. I used ½" type M pipe and spaced the risers 6" apart. When mounting the pipe assemblies on the backing boards, I put them at a 3% slope for good drainback.

I debated with myself for a long while about what material to use for the aluminum absorbers, and of course consulted the guru Gary. I looked at soffit material, but didn't like the idea of having to pound out the pre-existing grooves. My final choice was two layers of flashing (0.010" thick and 9" wide, pre-painted). I covered the backing board with one layer and grooved the top layer with the 5/8” rod method, placing it as tightly as I could over the copper pipe. I decided not to trim the 9” wide flashing, so with a 6” riser spacing it overlapped by a few inches. Then it was a stapling and caulking frenzy – there are almost 2000 staples in my collectors! I covered the manifolds with aluminum as well as the risers, to give maximum absorber area.

Bottom layer of aluminum



Top layer, showing overlapping flashing and coverage out to edges

The rest of the collector construction was standard, with 1" polyiso foam insulation and Suntuf panels for glazing.

After putting the tank in through the hole in the bedroom wall, the next item was hanging the collectors. I don't know how it added up so fast, but the total weight of each 4' X 6' collector was 150 lb. The benefit of making slow progress on a project is that it gives you time to daydream about the best way to do the next step. I was getting worried about how I would get the collectors up on the side of the house and have them stay there. The original plan was to have the bottoms 7 feet off the ground to keep from hitting them while walking by, but I settled on 5 feet up (this will cost me another project, though – moving the gate away from the house to change the traffic pattern).

Collectors before glazing went on

Since two people could only lift these monstrosities with difficulty, and I wasn’t going to go whole hog with scaffolding, I decided to use a rope system as a safety measure when lifting. I installed screw eyes into the studs on the side of the house; one for the rope and two for hanging each collector from. I put eye bolts in the frame of each collector. While my capable assistants lifted the collector, and my daughters pulled the rope, I connected the collectors to the house using quick links. Quite a production! After the rope was taken off I put ¼” aircraft cable through the eyes for another attachment point.


Hangers use screw eyes and quick links

To get the angle and provide additional support, I put 2X4 frames with hinges on the backs of the collectors. Once the collectors were hanging, I attached the frames to the house studs with long lag screws. I decided to go with a 75 degree angle due to the northern latitude (55 degrees here). Changing this wouldn't be hard.

Side view showing the hinged 2 X 4 frame bolted to house

Next was plumbing the feed and drain lines. I went with ¾" PEX main lines, splitting into two ½" lines to and from the collectors. Thinking about efficient drainback, I used tees that had one ¾" side and two ½" ones at right angles to one another, and oriented them diagonally so that the ½" lines entered the tee at a steep angle.

¾” feed line splitting into two ½” lines, one for each collector half

Inside the house, the ¾” lines have a long (30 feet) run to the tank. I kept the slope at 3% as best I could. My hope is that everything outside will drain vigorously, and the lines inside the house may be more sluggish, but this won’t matter since they won’t freeze inside.


View of the completed collectors

One of the bureaucratic hurdles I had was a building permit. The town building inspector is reputed to be very strict. I didn't think I should even ask if I needed a permit, but I figured that hanging giant panels on the side of the house might be kind of obvious. So, I gritted my teeth and talked to him. He said that the collectors were no problem, but any plumbing modifications would need a $50 permit. Grumble, grumble…..The catch was that the plumbing needed to be done by a journeyman plumber certified in BC, and the further catch was that there aren't any of them in town. He finally relented and allowed a local guy who did most of the plumbing in town until this building inspector showed up (he's actually certified as a pipefitter, not a plumber) to do the work. We put the hot water line into my hot water tank at the bottom, where the drain valve is. The building inspector insisted on a double check valve on the main water line into the house, to prevent potentially contaminated tank water from messing up the town water supply if they lost pressure and my exchanger leaked and mixed tank water in.

He also recommended a check valve on the feed into the heat exchanger, to prevent potentially contaminated tank water from messing up our household water supply. We also added a check valve on the feed from the heat exchanger, to prevent hot water from the hot water tank from moving into the heat exchanger if the tank was cool – don't know if this is really necessary or if it will work as intended.

Setup with tank in background, controller, plumbing, and hot water tank

I made a U tube arrangement like Gary's for the pump. Because of the tight quarters I have my tank in, pretty much everything I worked on took way longer – kind of like working under the hood of an import car! Looking in the tank took this sideways head tilt move with a headlamp on, and if I really contorted myself I could also get one arm in…..

Tight squeeze…..

Pump (Swiftech MCP355) and 3/8" to ¾" piping arrangement

Once I filled the tank and primed the pump, it was ready for commissioning. Some sputtering and gurgling, then 50 seconds later, water back to the tank! I ended up with 9 feet of head because I didn't mount the collectors as high as I thought I would. The measured flow is 450 L/hour (2 GPM) so for my nominal 48 square foot collector area this is 0.04 GPM per square foot. The flow is bang on the pump curve for the MCP355 pump, accounting for friction losses.

Datalogging

I decided I wanted to get some data on the system's performance, so I got a datalogger. It's a PICAXE 18X 4 channel datalogger from the Canadian distributor of PICAXE, HVWtech.com, and the link to the datalogger is

http://www.hvwtech.com/products_view.asp?ProductID=849

I am definitely no electronics genius, but it's prebuilt and pretty easy to figure out. Data output is in a csv file, which you can pretty up in excel. I have made my own probes by taking a piece of steel antenna from the dump, wiring up a DS18B20 temperature sensor, and encasing the sensor in epoxy inside the piece of antenna. This setup is somewhere between a 'build it from scratch' system, which an electronics whiz could probably do easily, and a ready made one, and cost me ~$150 CAD. I am logging collector and tank temperatures, and am installing a sensor in the hot water output from the exchanger so I can run a test of the exchanger like Gary did.

Cost

As far as cost, I didn't make the $1000 target. Converting with an 80 cent Canadian dollar, mine cost about $1600 US ($2000 CAD). This is partly due to the more expensive heat exchanger I went with, and partly due to the generally higher cost of most things in Canada, even allowing for the exchange rate. My estimated natural gas consumption for hot water heating is $300 CAD a year, so I would be looking at a payback of 8 or 9 years at current gas prices if I get most of my hot water from solar.

That was only part of the point in building this system, though. Exciting as it is to get free heat from the sun, it's immensely more satisfying if you created the means to do this yourself. Who says hobbies have to have a payback?

Summary

I would rate this as a project that is within reach of most do it yourselfers with patience. It took me several months of picking away at it in the evenings, plus a few full days. Part of the fun was thinking about how I could adapt Gary's design to my own situation. There is plenty of room for departures from his prototype, and I think that's how these things improve with successive builds. His instructions are clear and understandable, and for him to go to the trouble of documenting his construction so well speaks volumes about his dedication to the science/hobby of home built solar. And he offers this for free, too!

I am happy to put up some performance data once I have gathered enough to say something meaningful, and answer a few questions. Be warned that response times may be long since I work a lot (gotta find a cure for that…)

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