

The Solar Water Heater

In our quest to reduce our energy consumption a little bit more, Karisha and I decided to install a solar hot water heating system. Although I had spent several months studying various solar hot water heating designs, I ultimately decided to buy a system that was professionally designed and manufactured. We chose to purchase a freeze-proof system from SolarRoofs.com. This system circulates propylene glycol (which doesn't freeze) through the solar collectors and down into a heat exchanger that heats the water in our existing electric hot water heater. The circulation pumps are powered by small Photovoltaic (PV) panels, so there is no electricity used. The great thing about this system is that it came with nearly everything I needed (except for the glycol and some extra copper tubing).

In eager anticipation, I studied the system manual while I waited for the products to arrive. When FedEx finally delivered the shipment I unpacked the equipment to make sure I understood all the pieces. Of course I didn't understand all the pieces, so I called SolarRoofs for help. They were extremely patient and handled my multiple phone calls with great professionalism. Finally, I understood all of the pieces and was ready to jump up on the roof and install this system!

I began by running the copper tubing from the basement all the way up to the attic. Luckily, the closets on the first floor and second floor were stacked one above the other, and they were situated almost directly above the mechanical room in the basement. There was a small spiral twist needed to get into our tiny attic, but the first piece of copper went in pretty well. To make the job as easy as possible, I cut away large sections of drywall from the interior of the closets and I fed the tubing from the second floor closet (in the middle of the run).



This first copper run took most of the 50 feet of soft copper tubing that was supplied with the system. A little while later I returned from the hardware store with another role of

copper in my hand and a wallet that was \$100 lighter than it had been when I left. I used the same approach to install the second run of tubing, feeding it down from the 2nd floor closet and then up into the attic. Unfortunately the spiral twist between the 2nd closet and the attic caused me problems this time and I ended up kinking the tubing. This meant I had to cut the line and solder in a coupling tube. In reality this is no big deal. Everything will still work just fine, but it's a little bit like ripping a brand new crisp \$100 bill in half and then taping it back together. It still functions the same way, but somehow, it's just not the same. Oh well, I got over it. Now that the copper tubing was in place I felt I was on role and I was eager for the next step.

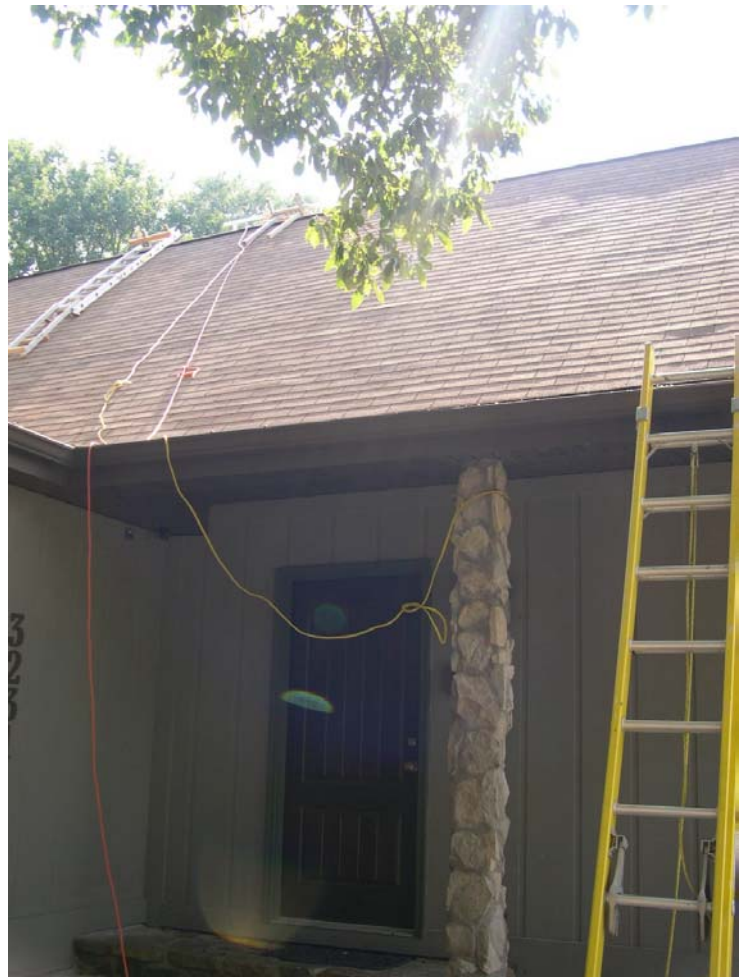
Oh, did I mention that our roof has a 12/12 pitch (which is a 45 degree angle)?

As it turns out you can't just walk up on to a 12/12 roof, unless you happen to be Spiderman. So now I had a whole new problem to solve: How can I get this system on the roof without killing myself? (Unlike Spiderman, real people tend to be killed or maimed when they fall off roofs.)



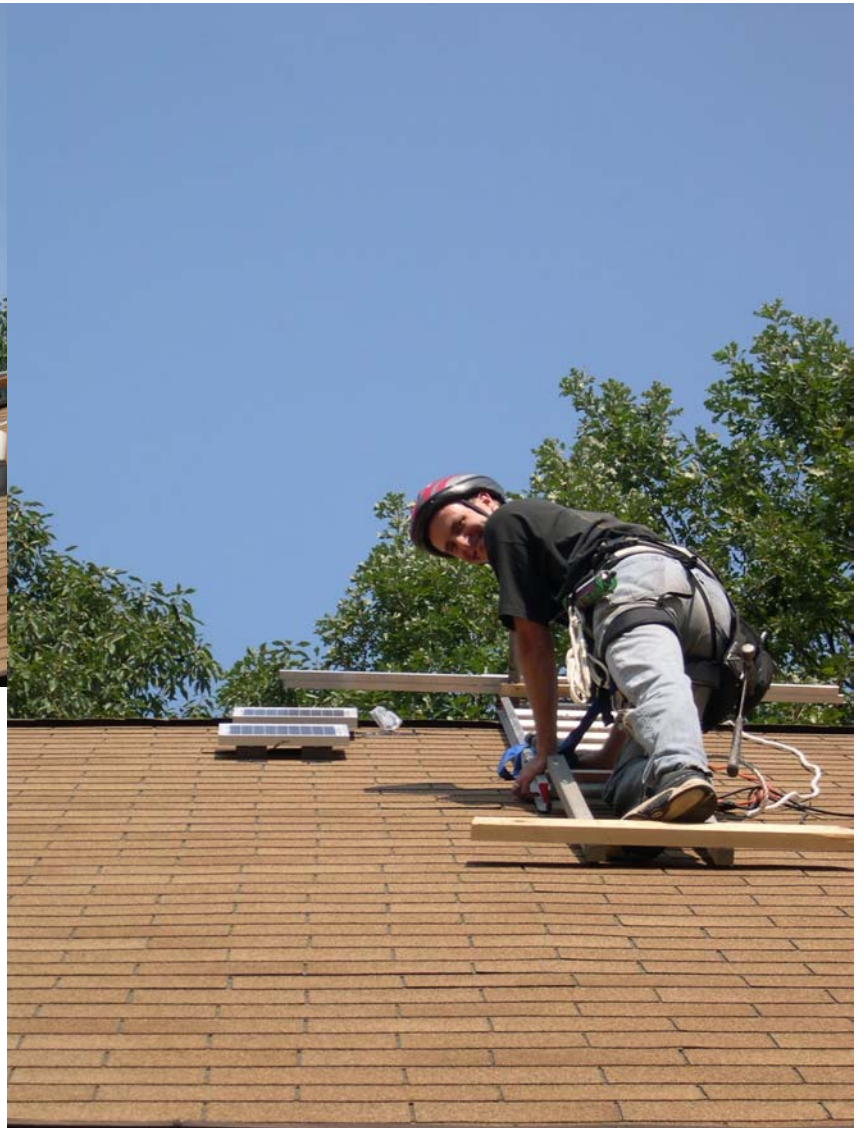
After consulting several people, I put a plan in place. I borrowed a rock climbing harness from a friend and a whole bunch of rope from a generous neighbor. I disassembled my extension ladder and screwed perpendicular supports to the top of each ladder section so I could hook them over the peak of the roof. I tied the long rope to one of the columns on my front porch and hooked the other end to the climbing harness. I strapped on my bicycle helmet and climbed up to the roof.

When I reached the roof, I measured and marked the placement of my roof penetrations. I drilled small pilot holes first and then went inside the attic to make sure my holes were in the right spot. Everything looked good, so I started by mounting the small PV panels. Since these were small and light, they were relatively easy to handle.





Next I mounted the square aluminum tubing that serves as the mounting rails for the solar collectors. The only tricky part about this was that I had to find the rafters so I could drive the lag screws into a good structural support. Luckily this was easy because I could see where the rafters were when I was in the attic.



Finally it was time to mount the actual collectors. The problem here was that I needed to attach the collectors, which are 6 feet long by 20 inches wide, while operating a drill and holding on to a ladder (it's important remember that I'm not Spiderman). So progress halted while I contemplated my next stunt. I ultimately decided to screw a 2x4 in to the roof so I could walk back and forth across the entire work area, and thanks to the climbing harness I was attached to two safety lines. I had a short line attached to the ladder and the long rope, which was attached to the porch column on the opposite side of the house. The 2x4 remained in place until I was

completely finished working on the roof, at which time I removed it and filled the screw holes with roofing tar. I was very happy I chose such lightweight collectors, which could easily be carried to the roof tucked under my arm.

Once everything was in place on the roof and tightened down, it was time to put the heat exchanger together. After shutting off power to the water heater, I cut out the rigid copper inlet and outlet lines, which I ultimately replaced with the flexible copper lines. Once the inlet and outlet lines were disconnected, I had to remove the threaded inlet and outlet stems that stick out of the water heater. I had some trouble with this



because these had been in place for several years, and I couldn't get them to budge even though I was using a huge pipe wrench. Eventually, I settled on a technique of tapping the end of the pipe wrench with a hammer. This worked wonderfully. It seemed to break things loose so I could unscrew the stems. Now I was able to screw in the special plumbing configurations that were provided with the kit. Although these pipes look confusing and complex, this was by far the easiest part of the installation.

Now there was only one step left, pressurizing the lines with glycol. I purchased a small drill pump to push the glycol into the solar loop. The installation directions were a bit unclear on this part, so I had to make a few more phone calls to SolarRoofs.com. Again, they were exceedingly patient. I encountered two significant problems. First, I attempted to use garden hoses to pump the glycol into the system. The instructions suggest that this might be OK. It does NOT work. The instructions also suggest using laundry hoses. This works much better! It is worth the time it takes to pull out your washing machine and borrow the hoses for a few minutes. Secondly, my drill did not provide sufficient RPMs to make the pump deliver enough pressure. I borrowed a high-speed drill from a friend, which worked wonderfully. Thirdly, it was difficult to keep the drill pump primed. To solve this problem, I attached the drill pump to the drill with a 12" extension and then simply submerged the pump in the bucket of glycol. This was the perfect setup. I was able to easily purge all of the air from the lines and pressurize the system to the recommended levels. Now, it was just a matter of flipping the switch to allow the PV panels to power the pumps and waiting for the sun to shine.

The following day at about 10 AM, I noticed a very quiet humming sound coming from the mechanical room. It was the sound of the solar powered pumps. I stood in front of the system nervously waiting for some kind of explosion or catastrophic failure. I continued to monitor the system closely for that first day and was relieved to find that the temperature of the fluid from the collector got up to 145 degrees F and the system pressure held steady at just over 50PSI. We had solar heated water at last! I continued to monitor the system over the next few days and on a sunny October day, the glycol from the collector reached temperatures above 160 degrees F. We are definitely making some hot water!

I am very happy with the simple elegance of the system. Given that the glycol pumps are powered by the PV panels, they only turn on when the sun is shining. In fact, on partly cloudy days, you can hear the pumps ramp up and ramp down as clouds move across the sun's path. Since the pumps only run when the sun shines, there's really no need for a complicated differential controller to tell the pumps when to turn on and off. In theory, if there's enough sun to turn on the pumps, there should also be enough sun to heat up the glycol. If we have days with no sun at all, then the electric water heater turns on whenever it needs to and we still have hot water. So far, things seem to be working very well. I estimate that we are now saving between 5-7kWh per day. Even greater savings may be achieved during the long, hot, sunny summer days, but we'll have to wait a few months before we can verify that.

At today's energy prices of 10 cents per kWh, the savings equate to \$15 - \$21 per month. Many experts estimate that today's energy rates are likely to double in the next 10 to 20 years. In addition to the financial benefits of this system, there are many more subtle benefits. For starters, we plan to eventually install Photovoltaic (PV) panels to generate electricity, but the cost of a system that could generate 5 -7kWh per day could easily cost more than \$10,000. So, by reducing our load, we are dramatically reducing the size and cost of PV system we will eventually need to buy. From a pollution standpoint, this system is a fantastic value. Thinking in terms of coal and CO₂, the savings are huge. Here in Indiana, 1kWh requires the burning of about 0.25lbs of coal, which results in roughly 1.5lbs of CO₂. So if we save 7kWh per day, that's a savings of 1.75lbs of coal and 10.5lbs of CO₂ every day. It's easy to see how these savings add up over a month or a year's time. This system is likely to be in service for 20 years or more. Over that time, it could equate to saving an entire Kentucky hillside from being dynamited and bulldozed for the sake of the coal that sits beneath it. Regardless of one's perspective, it's impossible not to conclude that solar hot water heating is a great value!