

## My DIY Solar Hot Water Heating System in Southeastern Pennsylvania

My name is Matt and I live just outside Philadelphia, Pa. After coming across BuildItSolar I decided I wanted to create a similar system. Below is a quick overview.

### Tank:



The tank is roughly 60Lx36Wx39H. I used 2 inch polyiso insulation on the inside walls and bottom plus another 2 inches of polyiso on the floor below the tank.

*Polyisocyanurate insulation should be used rather than polystyrene since polystyrene won't stand up well to temps over 130F*



Probably the biggest pain during the whole project was getting the liner in. It wasn't necessarily difficult, just time consuming and HOT.



Here I'm beginning to get the folds in the corners. Ok, maybe it was slightly difficult to get it "perfect"



Once I was finally happy with the folds, I put on the composite deck boards.



Deck boards installed and ready to insulate the outside.



I added additional R-13 insulation to the outside to get a higher R value and hopefully lessen standby loss.



I added some cheap wood panels to the outside for a more finished look. I may end up painting it or something but haven't decided yet.



Lid installed and controller/pump hooked up to Kill A Watt meter so I can see how much energy I'm using to run the system.

The lid is 2 inch polyiso insulation then  $\frac{3}{4}$  inch plywood wrapped in EPDM liner, another 2 inch polyiso insulation and  $\frac{1}{2}$  plywood on top all lagged down with multiple lag bolts.

*It's important to seal the tank tightly to prevent water vapor leaks.*

## Heat Exchanger and Plumbing:



I decided to go with copper since I had read in a few places online it was 4 to 5 times better at transferring heat than PEX. Whether that is accurate or not I don't know but I went with a total of 80 feet of ½ inch Type L soft copper. I went with a wider diameter figuring that the copper was spread through the tank more so on longer draws it would pull heat from a larger volume of water more evenly. Not sure if it matters but the heat exchanger is working very well regardless.

*Note that at a high flow rate (5 gpm), the pressure drop in the 80 ft of half inch copper is going to be about 10 psi. So, if don't have good water pressure, a larger diameter hx would be a better idea.*



I also added two temperature gauges (one just before the cold water enters the tank, the other right after it exits). These are ½ in Sharkbite Temperature gauges which cost about \$30 bucks each (PexUniverse and Home Depot carry them) but it makes it easy to see incoming and outgoing water temperature when running hot water. At this point I ran some tests and did not see any noticeable difference on water pressure when drawing hot water through this additional length of copper.



This is a picture of the U-Tube and return line finished and ready to fill the tank with water and close it up. Also a better picture of the temperature gauge on the incoming water line. I added an elbow at the end of the collector return line because I was concerned about both it possibly scratching at the EPDM on the lid as well as water shooting across the tank. This way it drops straight down with no sharp edges on the top. Also note that this line must end in the airspace above the water line or the collector won't drain.



3 ball valves which allow me to bypass the entire system by turning off the two horizontal ones and turning on the vertical one.

## Pump and controller:



\$100 Controller from Sun-Pump.com. It seems to be fairly warm to the touch just below the left-most buttons. Not sure if it should be that hot and it's only on the front. The back is slightly warm in the same area. In any case, it seems to work well.



Here is the U-Tube arrangement. The top yellow handle allows me to hook my hose up to the line to add water and prime the pump. Just to the left you can see the ball valve handle. This was a nice single piece that served both functions. I got it from PexUniverse.com for \$11.95. It's called *3/4" Sweat (CxC) Pro-Pal Ball Valve w/ Hose Drain*.

I also have a ball valve on the other side of the pump so I can remove it easily if necessary.

## Collectors:



Building the frame for the collector. It's made of 2x4s and  $\frac{3}{4}$  in plywood and painted with a few coats of exterior paint.

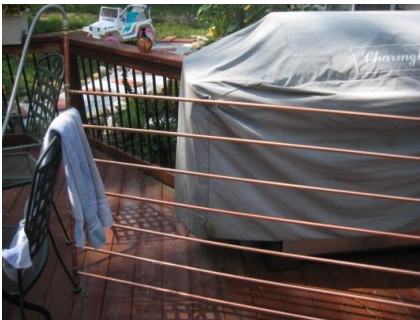


Dry fitting everything to make sure everything lines up where I want it.

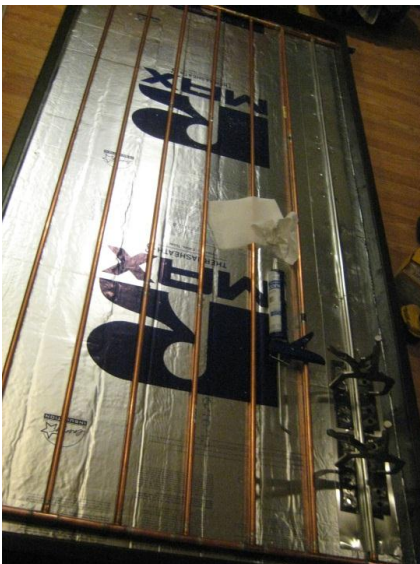
My collectors have  $\frac{3}{4}$  in manifolds and  $\frac{1}{2}$  in risers. PexUniverse.com had a 10 pack for \$12.10. I needed 3 packs.



It was a lot to solder but got it all done without any trouble.



Pressure tested both and no leaks!



I bought the absorbers and the clamps from U.P. Solar Solutions since I wanted a 90% wrap and for the price they charge, it isn't even worth doing it yourself in my opinion.

I also put the insulation inside the panel and the screws pass through the aluminum and insulation and securely screw into the  $\frac{3}{4}$  inch plywood.



First collector finished and pressure tested. No leaks...didn't think about the draining part in my living room. Oops!



Dry fitting to make sure everything will still line up when I attempt to connect the two collectors together on the roof. I connected the panels together with  $\frac{3}{4}$  in Sharkbite connections so I could easily take everything apart if necessary. All of the exterior plumbing is wrapped in that rubberized insulation they sell at Home Depot.



Collectors in rails on roof before connecting everything together and closing them up. They sit about 2-3 inches off the roof. Notice the return line inside the left collector. I figured it made more sense to keep the line inside the collectors to maybe get some additional heat. So it passes through the right collector as well before dropping inside the house and down to the tank.



Finally, everything is connected and sealed up on the roof. I'm very happy with the final look. After nearly two weeks running my Kill A Watt meter is saying it is costing \$1.92 a month to run everything. I'm not thrilled with that but unfortunately being about 18 feet from the pump to the top of the collector, I have to run the pump on the highest speed on startup. I'd like to figure out a way to use a second pump once the system starts and shut off the main one to cut down that monthly cost.

System just went live on 9/1/2012 and everything seems to be running well. A big thanks to Gary from Build It Solar and Tom from U.P. Solar Solutions for answering my questions along the way.

Any questions feel free to email me at [mmarnien AT verizion DOT net](mailto:mmarnien@verizon.net).

See below for a fairly complete cost breakdown. I know I missed a few items like the lag screws for the tank lid and whatnot. I may have spent an additional \$50 bucks on screws and the like. That would put the total system at around \$1800-\$1850. As many others have mentioned though, this really wasn't about cost as much as the enjoyment of doing it and seeing my electric bill go down. I certainly could have saved money by not buying the temperature gauges, using a Pex heat exchanger etc. but what is the fun in doing it exactly like someone else? Regardless, even with spending some extra money the system will still have a very good payback.

<b>Tank</b>		<b>Plumbing</b>	
3/4 Plywood (3)	\$ 76.41	Taco 00R 3-Speed Cast Iron Circulator Pump	\$ 82.00
2in screws (2 boxes)	\$ 18.74	Pump Flange (3/4in)	\$ 8.55
2 1/2in screws	\$ 9.37		
Gorilla Glue	\$ 6.47	1/2 in PEX (100 ft)	\$ 27.45
2x4 (17)	\$ 47.26	3/4 in PEX (100 ft)	\$ 40.95
Tie plates (4)	\$ 3.52	1/2 PEX Ball Valve (3)	\$ 8.85
Angle brackets(16)	\$ 9.28	1/2 PEX elbow (2)	\$ 1.34
2in Thermasheath (3)	\$ 89.04	1/2 PEX X 1/2 Copper Elbow (4)	\$ 6.36
Pond Liner (10x15)	\$ 85.00	1/2 Copper Coupling (4)	\$ 0.96
Pond Liner (5x10)	\$ 42.00	3/4 X3/4 PEX elbow(8)	\$ 7.12
Trex deck board 8ft(2)	\$ 44.94	3/4 PEX X 3/4 Copper(4)	\$ 3.36
Silicone(8)	\$ 19.88	1/2 PEX Tee (2)	\$ 4.10
R-13 insulation	\$ 9.72	1/2 PEX Clamps (100)	\$ 14.95
CPVC stand	\$ 15.32	3/4 PEX Clamps (50)	\$ 9.95
1/2 Plywood	\$ 20.23	1/2" x 1/2" SharkBite Coupling (2)	\$ 11.30
<b>Total:</b>	\$ 497.18	3/4" x 3/4" SharkBite Coupling (4)	\$ 27.96
		3/4" x 3/4" Pipe to Male Pipe Thread Connector (2)	\$ 9.16
		3/4" x 3/4" Elbow (2)	\$ 13.20
		1/2 in Copper Type L pipe 10 ft (1)	\$ 14.48
		1/2 in. x 20 ft. Soft Copper Type L Coil (4)	\$ 192.20
		1/2 in. Temperature Gauge (2)	\$ 56.12
		1/2 Pipe Insulation(3)	\$ 7.41
		3/4 Pipe Insulation(4)	\$ 12.50
		3/4" Sweat (CxC) Pro-Pal Ball Valve w/ Hose Drain	\$ 11.95
<b>Collectors</b>		Sun Pump Controller	\$ 100.00
1/2" Copper 10ft (11)	\$ 121.58	<b>Total:</b>	\$ 672.22
3/4" Copper 10ft (2)	\$ 35.85		
3/4 X 3/4 X1/2 Copper Tee (30)	\$ 36.30		
3/4 Copper Tee (4)	\$ 5.44		
3/4 Copper elbow (6)	\$ 4.02		
1" Thermasheath (2)	\$ 36.55		
3/4" Plywood (2)	\$ 48.04		
Glaze screws	\$ 4.21		
Suntuf foam	\$ 6.64		
Suntuf clear sheet(4)	\$ 79.99		
Lag screws (12)	\$ 4.56		
Corner braces (8)	\$ 16.62		
72" Steel angles (2)	\$ 32.96		
Aluminum Absorbers (102 ft)	\$ 77.00		
Deck screws (5lbs)	\$ 26.98		
2X4 (6)	\$ 12.50		
BBQ Paint (4)	\$ 25.14		
Aluminum Primer	\$ 8.53		
Exterior Paint (1 gallon)	\$ 35.09		
<b>Total:</b>	\$ 618.00	<b>Grand Total:</b>	\$ 1,787.40