

# Solar Thermal Water Heater For Less Than Five Dollars

by [TheNaib](#) on August 9, 2007

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## intro: Solar Thermal Water Heater For Less Than Five Dollars

This project will create a DIY solar hot water heater for less than five dollars (if you have access to a garbage dump). It will allow you to see the principles of solar water heating in action, and is highly customizable.

It's a great way to learn about using the renewable energy of the sun to produce useful effects, in this case hot water. You can use these instructions to build a device that will actually heat enough water to use in the home, but it would require modifications.

This device is more useful for camping or as a science experiment and teaching tool. A word of caution it is possible to create very hot water with this technique and you should be careful not to burn yourself. You can find this and more great DIY projects relating to renewable energy, solar cooking, and sustainable design at [The Sietch](#)

By using the sun instead of fossil fuels to heat your water you will be preventing dangerous greenhouse gasses from being released into the atmosphere, helping to prevent global warming.



## step 1: Materials

Materials needed:

- Water
- 2 buckets
- Drill (with both drill bits and screw bits)
- Some scissors
- A saw (a simple hand saw will do)
- Some wood
- A pane of glass.
- The back of a small refrigerator.
- 12 feet of air pump hose used in fish tanks
- Backing material (we used an old door mat)
- A box of wood screws
- Aluminum Foil
- Role of duct tape
- Angle Cutter (or hack saw)

Time:

This project took about 3 hours of construction time. It took a couple weeks to find all the parts.

## step 2: Collection Of Materials

After our first attempt at a home built proof of concept solar thermal panel, we were a bit disappointed with the results. It took about 4 hours before the thing started work, and was a bit costly (at over 50 dollars) to make.

I knew it could be done better and cheaper. My first mistake with the first one was purchasing everything new. With ample reusable resources at the local town dump I knew it could be done on the cheap.

Another flaw from the first panel was using pond liner as our collection medium. Pond liner is plastic, does not absorb heat as well as other materials (like metal) and is harder to work with as you have to use glue or tape to create an air pocket to hold the water. It leaked the first couple of times we used it and took extensive repairs to make it work.

We solved this problem by using a ready made collector. Something that was already designed to distribute heat, and made of metal.

The last major flaw in our first panel was using plexiglas for the cover. It's hard to work with as it will crack, and using two pieces left a hard to close crack in the middle.

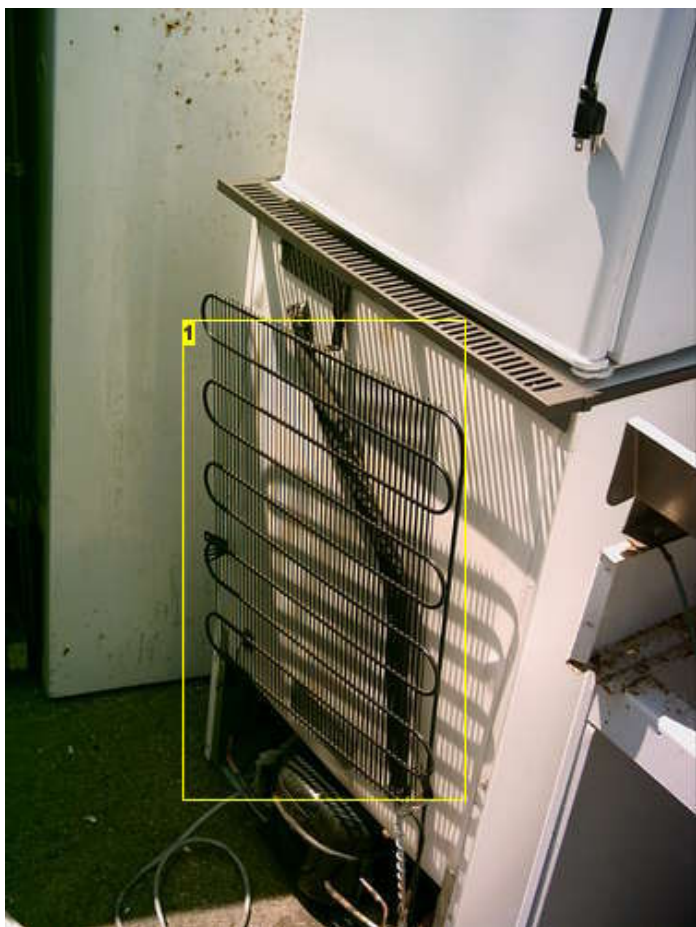
We solved this problem by using good old fashion window glass.

Now onto the project. The first thing we did was collect all of the parts.

Our local dump has a coolant removal program that has refrigerators and dehumidifiers that they remove old freon from. With this in mind I found the perfect heat collector. The back of a fridge is basically a heat dispersal system, with a slight modification it can be used to collect large amounts of heat.

<http://www.instructables.com/id/Solar-Thermal-Water-Heater-For-Less-Than-Five-Doll/>

Make sure that the freon, or other coolant has been removed, and cut the grill off at the base, near the large coolant holder.



**Image Notes**

1. This is what you want

**step 3: Collector Prepared**

This is what it looks like after you have it off the fridge. Note the two tubes, make sure you leave ample leads on the end for attaching the water hoses to later.



**Image Notes**

1. Leave enough pipe here for later

**step 4: The Rest Of The Parts**

There was an old couch that had been run over by one of the large dump plows, the inside wood was the perfect size for the frame. I found a pane of glass and an old rubber door mat that made the perfect backing and front. The glass was a real find, and may be the only part of the panel that may need to be purchased. Make sure your glass is big enough to fit over your collector and have enough room to attach it to the frame.





**Image Notes**

1. Be sure to clean the glass before you use it, dirt blocks the light.

**step 5: Preparing The Back**

The door mat was HUGE, so I had to cut it in half. Funny thing seems there was a lot of nasty black goo, and a metal sheet in the middle. Who knew. Remove the metal plate (or cut it in half as well) and leave the goo.





### step 6: Making The Frame

Once The backing was cut to size, it was time to start building the frame. As you can see I sort of built the frame around the collector, leaving enough backing to hold it all together.

The frame is held on by building a similar frame on the back and driving large wood screws through the front frame, the backing and into the back frame.

I added some foil to the backing. The reason for this is that counter to what you would think, you do not want the backing to warm up. You only want the collector to absorb heat (it was so nice of the fridge company to paint it black for us). The foil will take any sun that was not absorbed by the collector on the first pass and bounce it back over the collector for another try at absorption. The glass cover will help keep the heat inside the panel for further absorption.

Light can pass through glass, but heat has a hard time getting through glass, think greenhouse. If you were going to make your backing out of metal instead of rubber, you would skip the foil and instead attach the collector directly to the metal backing. The reason for this is that the metal back (painted black) would absorb heat and transfer it to the collector, the rubber mat however is not a very good heat transfer agent. If you use a metal backing consider using insulation on the back of the panel to try and keep as much heat in your collector box as possible.

Notice how duct tape was used on the inside to seal all cracks, you could use caulk but I didn't have any so I used the cheapest option. It worked well, and held the foil in place.



**Image Notes**

1. All projects should be done barefoot :)

### step 7: Attaching Collector To Frame

Next we cut some notches for the entry and return ports to the collector. Note again the use of duct tape to seal cracks.



#### Image Notes

1. You could close this hole up with putty for a more efficient panel.



### step 8: Finshing Touches

I got some air pump hose from the local fish store and attached them to the end of the entry and return ports.

The duct tape was applied to make sure it was a tight fit, it was later removed as it was not needed.

Next we attached the collector to the backing, using the mounting brackets that came on the fridge and some duct tape. If you wanted you could use some screws and wood, but I found the tape and the natural tension of the construction to be enough to hold it in place.

Lastly we attach the glass to the top. This serves to trap all the infrared radiation from the sun inside our panel where our collector will absorb it. Again light can pass through glass, but heat can not easily escape

As you can see simple duct tape is enough to hold it on. I would recommend using some sort of mounting bracket however as after a couple days in the sun the tape started to droop allowing the glass to slide off. A few screws would solve this, but I am cheap so I just put new tape on.

Set your panel up at an angle so that it catches the most sun.





### step 9: Wrapup

Here is the gross part, put one end of the hose into your bucket of cold water, and make sure it is at the bottom of the bucket, next grab the return hose and start sucking. That's right, unfortunately you have to prime the panel by getting some water into it. This can be done without getting water in your mouth, but inevitably I sucked just a little too hard and ended up with a mouth full of nasty water. I would recommend having a friend do this part. :)

Set your cold water bucket (source) up higher than your warm water bucket (return) and the whole thing will gravity siphon.

A word of warning, this panel works VERY WELL. We tested it on a very sunny day and within seconds the water coming out of the panel was hot enough TO SCALD. I burned my fingers. This very hot water is only formed when the water inside the panel is allowed to sit for about a minute without moving. If the water is moving (do to the gravity siphon) the water exiting the return pipe is about 110 degrees, and while hot, will not burn you.

The water does not flow through the panel very fast (as the pipes are very small) but that is sort of a good thing as it allows the water to heat up a lot on its journey through the collector. It does take a while to heat up a 5 gallon bucket of water, I ended up building an insulated return bucket that was all black and sealed on the top except for the port where the water tube enters. This kept the returned hot water hot long enough to be of use. Simply pour the heated water back into the "cold" bucket and send it through the collector a second time for even hotter water.

I let this guy run for a couple of hours one hot sunny day and heated up a five gallon bucket of cold water (measured at 70 degrees F) to over 110 degrees F. The temp that day was about 76 degrees F. If the water is allowed to sit in the panel for several minutes and then forced out (by blowing in one of the hoses) the water was measure at 170 degrees F. All in all we are much happier with the performance (and cost) of this panel. It performs much better than the previous one.

Our next modifications to this design will be to alter the return port so that it will thermo siphon, in this way the return hose can be fed into the source bucket and the water will continually circulate in the panel getting hotter and hotter. We have also talked about adding mirrors to the panel to concentrate more heat. Our goal is to boil water. This entire project cost less than five dollars, as I already had the screws, and the duct tape. The only thing I purchased was the air hose, which cost \$3.76.

Enjoy the hot water.



## Related Instructables



**Solar Heater** by  
robtoberfest



**How green is my green electronics ? Now with improved threshold detection !** by  
5Volt



**Homemade Solar Thermal Collector** by  
Tech for the Real World



**Going Green! A couple things you can do to help the environment.** by  
g0pher



**Space heater controlled by digital thermostat** by  
p914



**Estimating thermal performance of a solar-thermal system** by  
jarney1



**Turn excess attic heat into hotwater** by  
Senseless




**Build your own flat panel solar thermal collector** by  
iwilltry





# Comments


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 **-Aj-** says: Jan 18, 2009. 12:22 AM [REPLY](#)  
small black water water pipe is also good for collecting heat, just make a big flat coil out of it, much larger heat absorption capacity and perhaps easier to use as you can use standard stuff from a hardware / garden store. several meters of it only costs a few dollars.  
quite possibly easier to find and cheaper, also bending and joining is not a problem.  
hope this is helpful

 **prcsolar** says: Jan 16, 2009. 10:09 PM [REPLY](#)  
the idea the same as mine ,but i think that Heat loss is a two-way.Tank temperature down very easily, the best point of difference circulating pump.  
<http://www.cnsolarwaterheater.com>  
<http://www.prcsolar.com>  
[sales@prcsolar.com](mailto:sales@prcsolar.com)


 **drewbe94** says: Aug 23, 2007. 3:20 PM [REPLY](#)  
ummm sorry to say why do we need so many tool materials????? you should make a design that doesn't use so many drill-beds and saws


 **simharry** says: Jan 10, 2009. 8:58 AM [REPLY](#)  
I agree with coyotehope,  
i don't see YOU making one of these without tools. If you are going to criticize something why don't you make your own instructable, and then say "your design is cool, but i just made one modification to your instructable" and then put the link to it in your comment. Or at the very least please don't insult the other persons hard work, make a constructive response like, "this is an awesome instructable but, i think it could be better if it used less tools." see how that seems less offending than, "ummm sorry to say why do we need so many tool materials????? you should make a design that doesn't use so many drill-beds and saws" all i'm trying to say is be nice and have fun on instructables.  
  
-simharry


 **junits15** says: Jan 9, 2009. 1:20 PM [REPLY](#)  
that is cool dude! if i had the need I would so do this!


 **bdpf** says: Aug 16, 2007. 9:02 AM [REPLY](#)  
Our local dump has a coolant removal program that has refrigerators and dehumidifiers that they remove old freon from. With this in mind I found the perfect heat collector. The back of a fridge is basically a heat dispersal system, with a slight modification is can be used to collect large amounts of heat.  
  
Your warning could be stronger on the freon removal. This requires a connection to the system and a vacuum pump and receiver for the used freon gas.  
  
A better heat collector is soft copper on a metal back plate, painted flat black.

 **raiderX305** says: Aug 26, 2007. 2:57 PM [REPLY](#)  
Where could I buy a pump and receiver for the freon?

 **raiderX305** says: Aug 26, 2007. 6:35 PM [REPLY](#)  
sry i ment receiver

 **liquidsands** says: Dec 28, 2008. 2:55 PM [REPLY](#)  
These are sold by refrigeration repair suppliers but it requires a universal refrigerant license to buy. The reason is that if done wrong, incompletely or not stored properly the same kind of damage we have been doing with CFC's(chloroflourocarbons) to the ozone layer for 40+ years would continue.  
One bright spot though. To dispose of a fridge @ a legal dump facility usually the dumper is required to pay a fee that covers the freon evacuation cost before the unit can be placed in the general salvage area.

 **coyotehope** says: Dec 26, 2008. 10:21 PM [REPLY](#)  
get a life Drewbe94  
  
they come up with a great inexpensive way to heat water, which i for one badly needed, and your such a green dork you criticize the tools? wow.

 **Oldefarmer** says: Jun 12, 2008. 8:58 AM [REPLY](#)  
When i was a boy our water was heated by the wood cook stove in the kitchen. A water jacket in the firebox was plumbed to a 40 gal steel tank made especially for this "side arm" heater. The greatest advantage of this type of heater is that the thermal siphon will heat the water in the tank from the top down and hot water is available even when 80% of the water is cold. Replacing the water jacket with a solar collector will give the same results. A very simple collector made from a coil of inexpensive black plastic water line(50') will heat 40 gal of water to 120 deg F on a sunny summer day. I can draw up the design if anyone is interested.



**AGM58** says:

I am interested in your design. Please tell me how to order.

Dec 6, 2008. 8:55 AM [REPLY](#)



**revumup** says:

Sounds very simple and interesting please send me your design and i will make one up. thankyou

Dec 2, 2008. 4:04 PM [REPLY](#)



**pappyjag** says:

Yes Sir Can you please send it to me Thank you for your time in this matter

Aug 15, 2008. 10:06 AM [REPLY](#)



**Amy Cui** says:

we are the manufacturer for solar water heater from China. And our solar water heater can work well and offer plenty of hot water at winter. Meanwhile, we can offer the Heat pipe and U pipe solar collector. If have any demand, you can contact me.

Oct 7, 2008. 8:11 PM [REPLY](#)



**Amy Cui** says:

i have a skype ID: amycui06

Oct 7, 2008. 8:12 PM [REPLY](#)



**Oldefarmer** says:

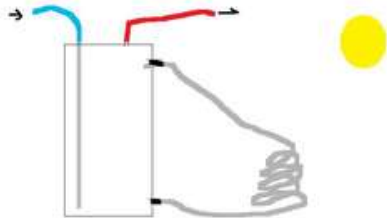
This is the basic configuration of my heater. Also of the way water was heated when I was a kid.....the grey coil was replaced by a water jacket in the cook stove (wood-fired).

Aug 17, 2008. 12:31 PM [REPLY](#)

There is no secret here ...as water heats in the side-arm it rises to the top of the tank pulling cold water from the bottom and will heat the whole tank from the top down.

The most important thing is the dip tube on the cold supply so that when you draw water the replacing cold water goes to it;s proper place.....the bottom of the tank ...where it won't mix with the hot water.

Make a small tee pee of scrap wood (or whatever) wind 1/2 inch black plastic pipe slowly from the bottom always going up. If you should have to go down from the tank to the bottom of the coil wrap that part in foil so it doesn't heat.



**kchapmans** says:

I'm in the Low Desert, in a town with spotty electrical and water services. I've already built several water holding tanks, now I need a way to heat up what my family uses for those times when this town once again loses power. Email me a copy of your instructions when you have the time, pretty please! :) Thanks kchapmans@valornet.com

Aug 8, 2008. 10:56 AM [REPLY](#)



**skye maher** says:

I'm interested in " A very simple collector made from a coil of inexpensive black plastic water line". Can you forward instructions? I have a house with no running water so I need something that does not require a constant supply of water or a large storage tank.

Aug 5, 2008. 3:00 PM [REPLY](#)



**atp** says:

Pls send design. I'm looking at using inch and a half diameter polypipe on a north facing tin roof.

Jul 20, 2008. 11:31 PM [REPLY](#)



**Adrian monk** says:

Please do post an instructable.

Jul 11, 2008. 8:46 PM [REPLY](#)



**dwarner** says:

send me your design to see if I can incorporate it into my remodeling project

Jul 10, 2008. 6:33 AM [REPLY](#)



**spdligh7** says:  
yes please, would you send me a diagram? I am interested, thanks a lot!  
my email address: spdligh7@hotmail.com

Jul 1, 2008. 6:47 PM [REPLY](#)



**Spartan 117** says:  
I reckon if you replaced the foil with black bin liner it would work better. The foil just reflects the the heat rather than containing it. but a great idea none the less

Nov 13, 2008. 8:12 PM [REPLY](#)

Aaron



**teiddy** says:  
get a tank from an electric water heater and put it in a defunct refrigerator. Lay the fridge on its back on the south side of your house and hook up the pipes. Open the door in the morning and close it in the evening. Oh, and paint the tank timer softwareblack!

Nov 11, 2008. 2:27 AM [REPLY](#)



**prcsolar** says:  
<http://www.prcsolar.com>

Nov 2, 2008. 10:13 PM [REPLY](#)



**patdoherty** says:  
wouldnt that radiator usually have freon in it?

Nov 1, 2008. 4:43 PM [REPLY](#)



**javipz** says:  
I think that aluminium paper reflects the solar energy outside faster than a simple inside painted in black.

Oct 23, 2008. 1:58 PM [REPLY](#)



**aniytchak** says:  
Yeah, if you paint the back black instead, that thing will get extremely hot (I live in Israel, and most of the houses use solar water heat, they are all built with black backings)

Oct 29, 2008. 8:58 AM [REPLY](#)



**killamilla** says:  
Flat white paint reflects much better than tin foil, and isn't very expensive or labor intensive. 170F is quite impressive, thanks for the info.

Oct 21, 2008. 7:35 PM [REPLY](#)



**mr. clean** says:  
I decided it was a great idea to duplicate. You can use it when you go camping instead of burning propane. mine works great it will heat the water in access of 120 degrees F. Great idea to use the condenser from a fridge. (unfortunately I ended up buying a glass pane for 15 dollars.

Oct 16, 2008. 3:30 PM [REPLY](#)



**dogfriend** says:  
How is it that the freon is removed without releasing it into the atmosphere?

Jul 31, 2008. 12:41 PM [REPLY](#)



**Derinsleep** says:  
piercing the pipe and making an instant airtight seal, then drawing the freon out with a pump probably

Sep 18, 2008. 10:30 AM [REPLY](#)



**jonw** says:  
oops.. forgot to post link on my previous post.. jonw in Veracruz  
solar water heater

Aug 18, 2008. 10:53 AM [REPLY](#)



**A good name** says:  
Kiteman has taught you well,

Aug 29, 2008. 4:08 PM [REPLY](#)



**jonw** says:  
I recently completed a solar water heater project.. check it out on mywebb site..

Aug 18, 2008. 10:52 AM [REPLY](#)



**jlmjrene** says:  
åŽ%â@!haha..... my coming physic text, text about how to make a Solar Water Heater oh~.....ths!!

Aug 4, 2008. 5:49 AM [REPLY](#)



**nilehorse** says:

Jul 27, 2008. 4:11 PM [REPLY](#)

The same thing can be done with garden hose. Its thicker and therefore holds more water.



**allanon** says:

Feb 7, 2008. 7:18 AM [REPLY](#)

Hello, great idea and on a small scale appears to work well. I have an idea to add that might assist in trying to bring water to a boil. I read somewhere the French way back in the 1800's made a thing called a solar furnace. A large cone device with mirrors and concentrated the sun's rays and used the heat generated to make a furnace. I remember...the motto is "Cheap". Well consider the hundreds of satellite dishes that are 10 and 12 foot in diameter just sitting around. I get them free all the time. Look around for one sitting in someones yard and I bet it is no longer hooked up and they will give it to you just for taking it away. Just glue 12in by 12 inch mirrors all over the surface and direct them to the center and create a furnace effect...use a little but larger copper tubing with a black chrome(can be painted black chrome from alsacorp) backing and direct the furnace or concentrator at the gizmo and I sincerely believe you could boil water like it was no ones business.

To the guy that wants to heat his hot tub....make an array of satellite dishes/furnaces and point at a larger set up and cook yourself in the hot tub.

Allanon



**recneps** says:

Jul 12, 2008. 1:05 PM [REPLY](#)

You mean like this?

[http://blog.makezine.com/archive/2007/08/the\\_light\\_sharpener\\_12\\_fo\\_1.html](http://blog.makezine.com/archive/2007/08/the_light_sharpener_12_fo_1.html)

That would be quite efficient in heating if you ran a water hose up the centre (from below) to the focal point (with a black metal object to transfer heat to the water) and back down. Hose coming up from below avoids crossing over the panels and reducing the reflected sunlight  
Instant hot water.



**picbuck** says:

May 22, 2008. 2:15 PM [REPLY](#)

Migosh! Furnace is right. Sounds like the Deathstar.



**qtm** says:

Apr 1, 2008. 12:59 PM [REPLY](#)

The problem with parabolic antennas is that they only focus properly when aimed at the source. Moving the antenna or the source a few degrees and you lose the focus.

If your antenna can track the sun it would work, but otherwise you'd probably get 15 minutes of heat a day.



**wizardx** says:

May 26, 2008. 1:07 PM [REPLY](#)

If you use parabolic reflector troughs with a vertical axis they can track the sun all day without having to be aligned, simply run the tube up the focal point vertically. It's less efficient than a dish and doesn't make a furnace but works well for hot water collectors. I am surprised that vacuum tube collectors do not have small parabolic reflectors behind them.



**rtorcasio** says:

Jul 8, 2008. 8:06 PM [REPLY](#)

In keeping with the existing coil/tubing idea, would a car radiator work?



**nitalynn** says:

Jun 27, 2008. 11:07 AM [REPLY](#)

I don't think I'd like to drink water out of this and even bathing in the water coming out of it would be questionable. I like the idea though. We are planning a new home and I am looking at ideas for water heating and came across this.



**Derinsleep** says:

Jun 28, 2008. 10:20 AM [REPLY](#)

it can be used for water heating and then storage inside a vacuumed tank  
vacuum is not conductive to heat



**hickarus** says:

Jun 12, 2008. 5:09 AM [REPLY](#)

Sorry if this has already been mentioned, but in the spirit of recovering free materials (I know copper is almost impossible to get for free anymore, but..) discarded baseboard heater pipe (i.e. slant-fin, etc) might be just right for avoiding the deadly toxins present in the plastics, absorb heat better and *if* you can recover the material from, let's say your neighbor's dumpster (like I did) when he remodels his house, you're all set.  
If I get around to this project (fingers crossed) I'll take some photos and show y'all what happens.



**wizardx** says:

May 26, 2008. 1:01 PM [REPLY](#)

Does anyone know what kind of temperature is the maximum for a DIY closed system. I am about to sink 3 x 600 gallon tanks in our yard and highly insulate them to a thickness of 2ft all round. They will be our thermal store for heating our small house. This will be linked to some panels similar to the one in this post, down slope 50ft with highly insulated line running up to the tanks, and with parabolic reflectors aimed at the collectors with the aim of it working in the winter (if it fails to collect enough energy I'll go and buy some factory made vacuum tube panels).

The question is - what kind of temperature can such a system take if it is closed? Would my steel tanks rupture at 2bar?



**Full Frontal Graphic** says:

Jun 5, 2008. 7:07 PM [REPLY](#)

Wizardx: Sorry but that question is like asking "Will my rope break if I hang a weight from it"?

You should check with the manufacturer of the tanks to see what pressure they will take. At a minimum, ask your question from someone who has some idea of what kind of tanks you are asking about.

Water can get very hot without increasing the pressure (all else being equal), but if you actually boil it you are producing steam, and steam production in a closed tank can be very risky.

An overpressure relief valve should be built into a system which might produce steam, unless you are using it to power something maybe.

Nice design on the solar panel, good use of existing discards!



**krispulo** says:

May 28, 2008. 3:31 PM [REPLY](#)

Hello, great idea and on a small scale appears too work well. I`m visiting your page from Venezuela

[view all 156 comments](#)