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DIY Solar Hot Air For Your Home

INTRODUCTION

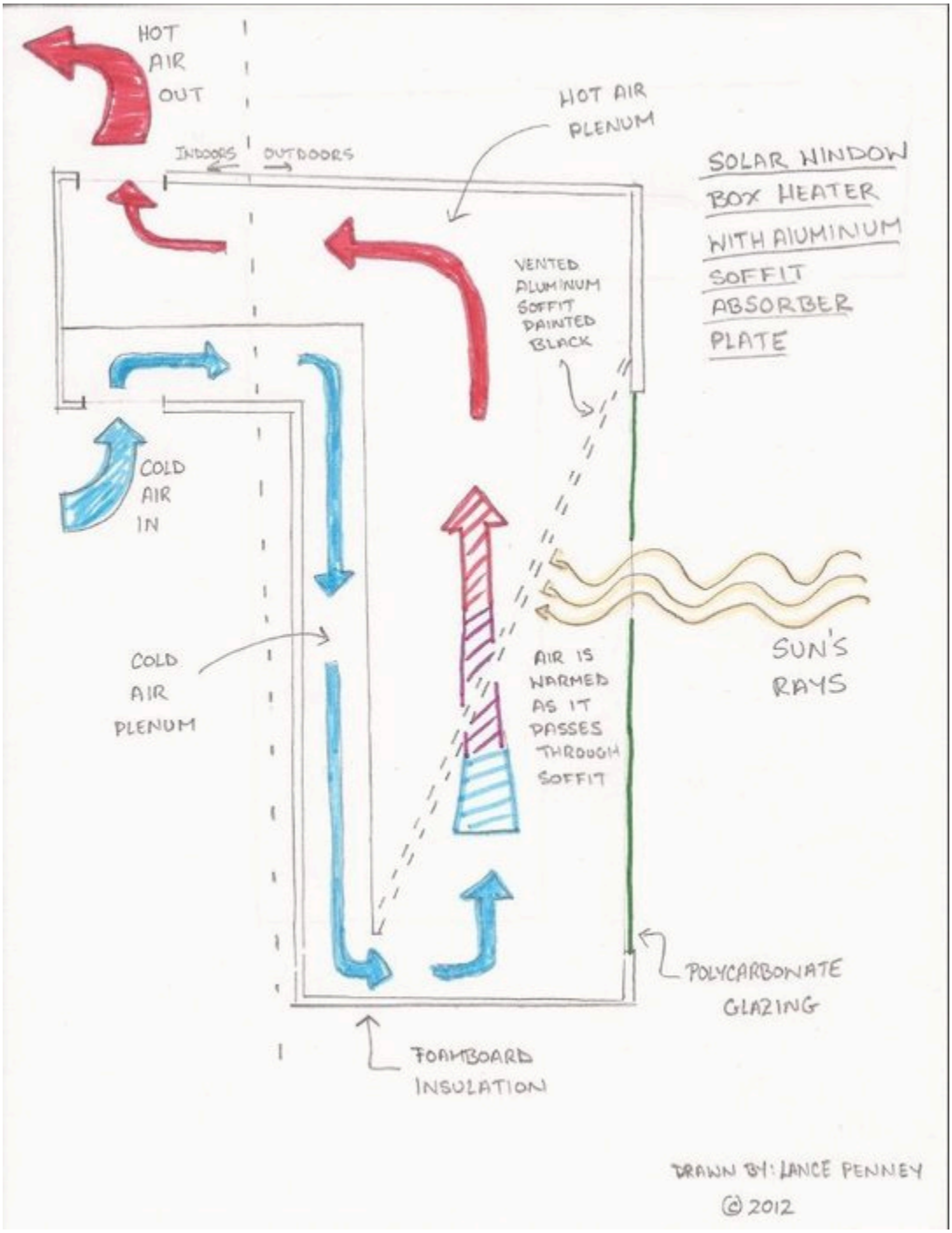
I present to you a product aimed at lowering your winter heating bill and carbon footprint by generating heat for free using the power of the sun!

Projects that involve warming air for space heating using the sun are plentiful. However, most of them involve permanently installed flat plate collectors made out of soda cans or aluminum downspout. Installing a permanently collector usually means drilling two large holes through the side of your house in order to route the ductwork.

My collector mounts just outside a window and can be taken down when the heating season is over. The most invasive part of the installation is the removal of the window's fly screen. Furthermore, the aluminum soffit based absorber plate is much more efficient than soda pop cans or aluminum downspout; you can harvest more heat for a given size of collector. The aluminum soffit based collector is more expensive than a soda can collector but less expensive than an aluminum downspout collector.

As an added bonus, this collector does not require electricity or fans or forced air of any kind. The current of air through the collector is driven solely by natural convection. As the sun heats the air in the collector, it rises and escapes through the output vent. As a consequence, cold air is drawn into the collector through the input vent to replace the warmed air. The whole loop continues without the need for fans.

Step 1: How The Vented Aluminum Soffit Collector Works



I've drawn a diagram for you that I hope is self explanatory but nevertheless I will go through it starting from the cold air intake.

1) Colder air from the room is drawn in from the intake vent at the bottom of the unit. From there it travels inside the cold air plenum until it reaches the chamber at the front of the unit that is exposed to the sun's rays.

2) Inside the chamber behind the polycarbonate glazing the sun's rays shine on the black aluminum soffit and heat it up. When the cool air encounters the soffit, it is warmed as it rises through the perforations. This rising air is continually replaced by cooler air being drawn into the cool air intake.
3) The warmed air travels through the hot air plenum until it is released out into the room through the hot air outlet.

The collector unit is meant to hang on a windowsill with the intake and exhaust vents inside the house with the rest of it on the outside of the house.

The window must be the single hung type; where the pane of glass slides vertically to open and close the window. The collector is built to be the same width as the window opening.

When the collector is hung on the windowsill, the window can be closed down onto the collector to sort of "clamp" it into place. After some weather-stripping is added to seal up the small gaps, installation is complete.

Step 2: The Outer Shell

The exact dimensions of this box are not important, as you will have to customize this design to fit your own window. If you are fortunate enough to be able to use a south facing window near the ground then all I can say is the bigger, the better. The reason for that is you can use the ground to support your collector and you don't have to worry about weight. You

should also use thicker materials, such as 1/2 inch sheeting instead of the 1/4 inch sheeting I used. But beware; collectors mounted close to the ground are at increased risk of shading.

My collector is hung from a second floor window. There is no support from below. Therefore I had to try to reduce its weight as much as I could. I opted for a shell of 1/4 inch OSB with very little supporting framing.

The only framing are small 3/4" by 3/4" strips of wood that were ripped down from 1" by 6" board. They are installed everywhere along the corners where two sheets of OSB meet.
The two "L" shaped sides of the collector are cut out of OSB in one piece. This is very important. If the sides of the collector were cut out of two pieces there would be nothing to keep it in shape and it would fold like a book as soon as you picked it up.
The whole thing was assembled using wood glue and 18 gauge 5/8" brad nails. When the foam board insulation was installed later in construction, I nailed everything over again with 1 1/2" crown staples.

Step 3: The Foam Board Insulation

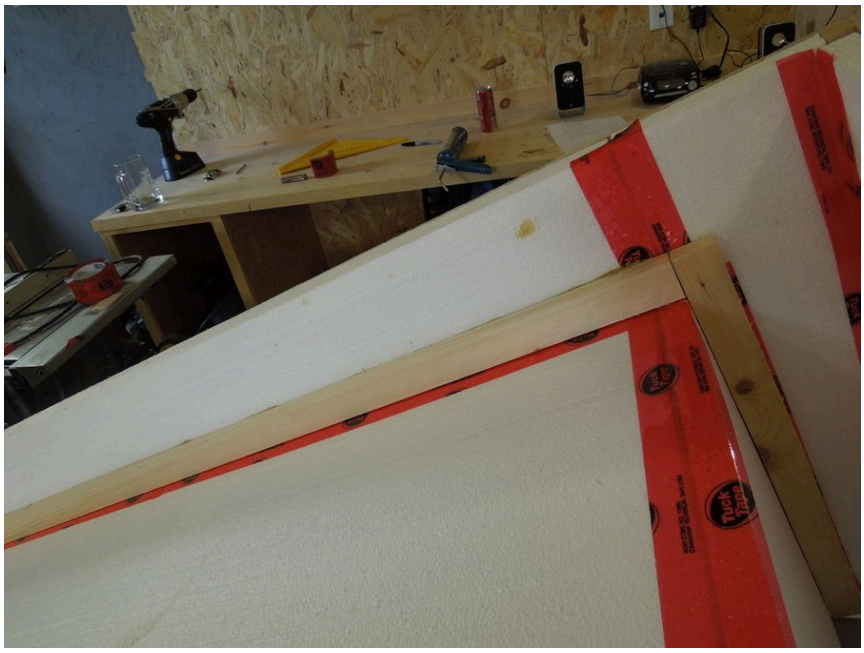
The insulation used was 1" polystyrene.

I am aware that I should have used polyiso insulation because the polystyrene has a tendency to melt at high temperatures.

However, I scoured the city for days in search of polyiso and couldn't find it. I had to settle for polystyrene and who knows, maybe it will work fine. The foam board was simple to install with little more than a knife and a tube of foam board adhesive.

I feel inclined to tell you that you're supposed to pull the board off of the wood after you first glue it and let it air out for five minutes before you stick it back on. However, when I insulated my basement with this stuff years back I purposely didn't air out a few panels after I glued them and they're stuck on just as good as the rest.
After insulating I sealed up all the joints with tuck tape in order to prevent drafts.

Step 4: The Divider Between The Hot And Cold Air Plenums

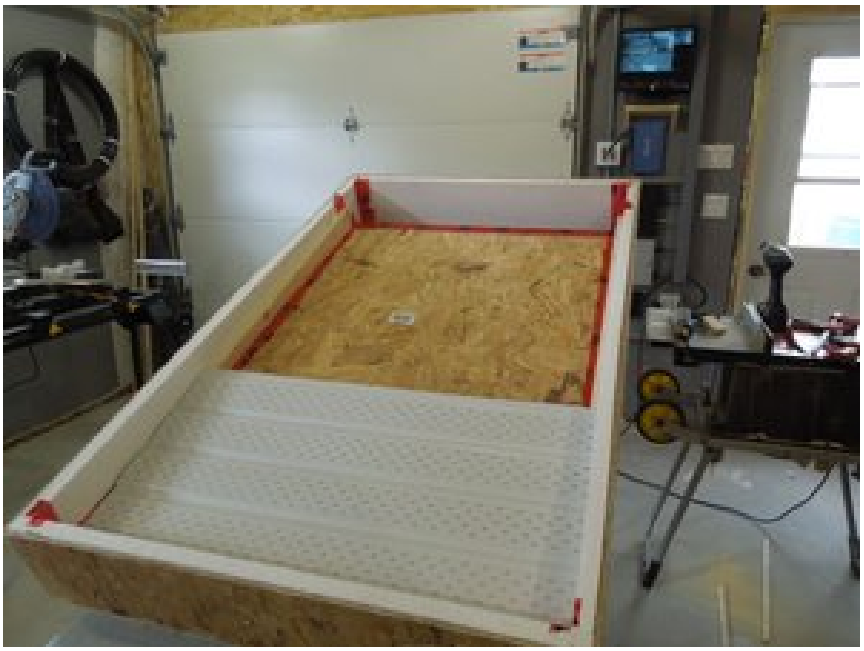


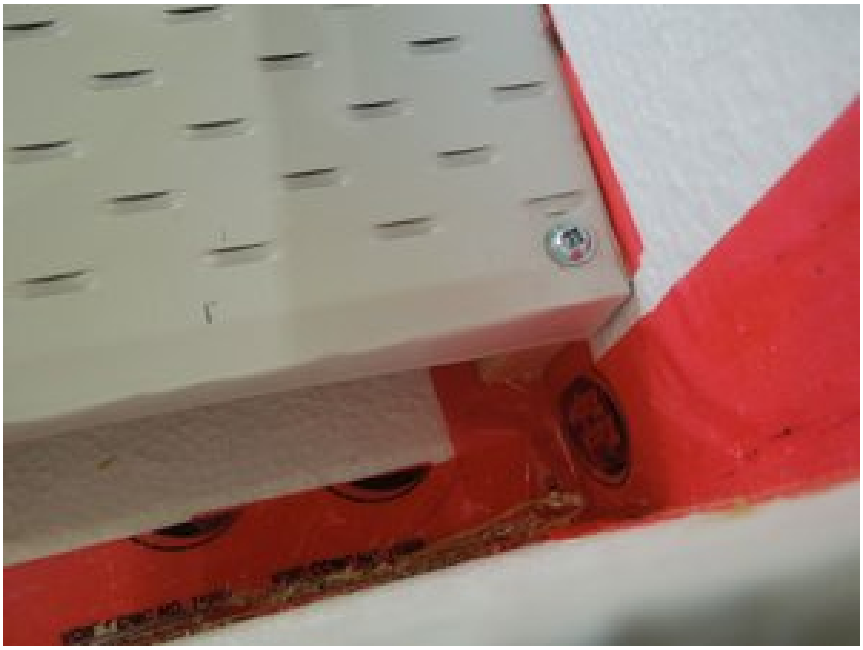
The divider splits up the space in the unit into two separate channels for airflow.

It allows cooler air from the intake to travel along the back of the unit and down into the chamber where it will be warmed.

It also allows warm air to travel up along the top of the unit and be exhausted into the room without mixing with cooler air.
The divider consists of 1/4" OSB with a spacer on each side. The spacer was made by ripping down 1 by 6 board into 1 1/2" by 3/4" strips. The strips were glued with foam board adhesive to the insulation and then secured with 2" 16 gauge brad nails shot in from the outside shell. They run along both sides of the collector and stop 1 1/2 inches from the bottom.
Next, two sheets of OSB were cut to fit across the spacers and then glued and nailed in place. At the bottom of the collector, a 1 1/2 space was left out to allow the cool air to enter the warming chamber.

Step 5: The Aluminum Soffit Absorber Plate





Now we get down to business. Now we get down to the real meat and potatoes of this whole thing. The absorber plate is a flat plate-like thing that absorbs the sun's rays, gets hot and passes the heat onto the working medium flowing through it. In our case the working medium is air but it can also be water. There are several types of absorbers that you can use including, solid soffit in a back pass collector, soda pop cans, aluminum downspout, vented soffit and aluminum window screen. I think that vented soffit is the best choice because it's one of the most efficient in terms of how much heat you get, it's easy to build and it's cheaper than window screen and downspout.

The vented aluminum soffit is pockmarked with hundreds of little holes called perforations. When the sun shines on the soffit it gets hot. Air is drawn through the perforations and is warmed up in the process. When you as an occupant of the home feels the free heat on your skin it warms you up and makes you happy in the process.

Anyways, the first step in installing the soffit is to make the spacers. They run the whole length of the OSB divider and are sloped from 1/2 inch at the bottom to 3 inches at the top. I just took some 1 by 6 board, cut it to length on the miter saw, ripped it down to 3 1/2 inches and then ripped that piece down on a diagonal. The two resulting pieces should be near identical with 1/2 inch thickness on one end and 3 inch thickness on the other. Next, they were glued in place with foam board adhesive and secured with 2 inch 16 gauge brad nails shot in from the outside sheeting.

The first piece of soffit was cut to length and then a 3/4" lip was bent into the tail at the bottom. The lip was made by clamping the soffit to my workbench and using the egde of the workbench as a guide as I went tapping along the piece with a hammer. When the first piece of soffit is installed, the lip covers up the air gap between the soffit and the plenum divider.

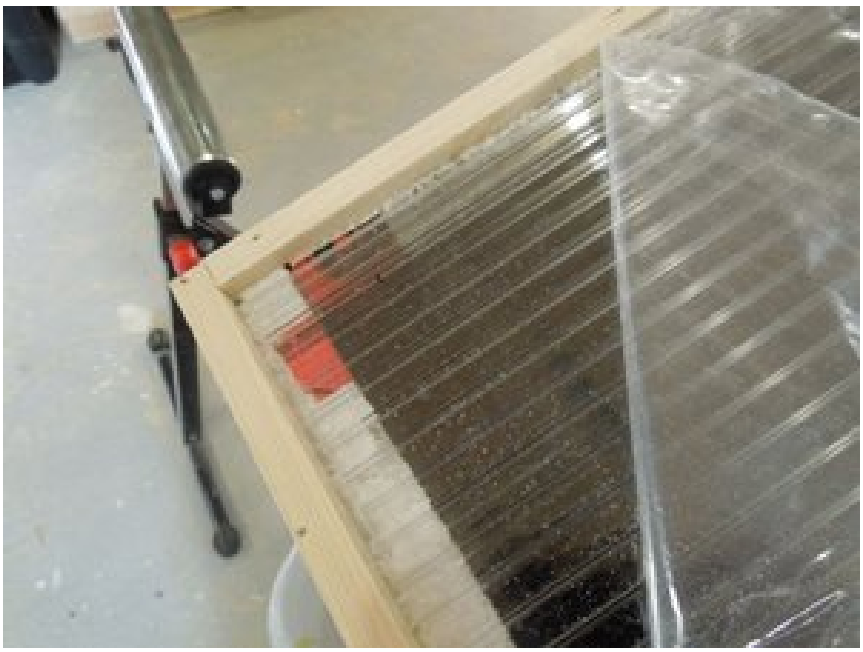
Two more pieces of soffit are cut and installed. They fit together they same way as you would if installing them on a house. Each piece has sort of a "tongue" one edge and "groove" on the other. The groove of the first piece accepts the tongue of the second.

Three pieces were used in all. A 10 foot piece from the hardware store was enough to do it all...About $17 worth.

After all of the soffit was in place, a foam board cap was made to fit inside the remaining space and glued in place with foam board adhesive. A piece of 1/4" OSB was cut to fit over the Styrofoam cap leaving a 1 1/4" of the bottom of the cap exposed. Now the absorber plate has a 1 1/4" border on all four sides. This is an important feature for the installation of the polycarbonate glazing and the batten trim.

Finally, the whole absorber plate was painted flat black with a couple cans of spray paint. I should have used the high heat barbecue paint but I couldn't find any.

Step 6: Installing the Polycarbonate Glazing



The first thing I did was make a frame on the face of the collector out of 3/8" by 1/2" strips. They are 3/8" thick to match the thickness of the twin wall polycarbonate glazing and they are 1/2" wide to cover up the OSB sides while leaving 3/4" of foam board exposed all the way around. The twin wall glazing is known to have good thermal insulation properties. The glazing

rests only on foam board all the way around in order to keep the presence of insulation seamless between the foam board and the glazing.

The glazing was cut with my circular saw with a special "plastic panel" cutting blade. It was cut 1/4" by 1/4" smaller than the opening of the frame to allow for thermal expansion. While cutting, it is a good idea to leave the plastic film on both sides on, in order to prevent burrs from forming. Make sure you cut so that the cells are oriented vertically. There is one side only that can be facing the sun's rays. It is usually marked by the plastic film that covers it. After cutting, peel away one corner of the film on the UV protected side, mark the panel with a piece of masking tape and peel off the rest of the film.

After cutting, take the blow gun from you air compressor and blow out all of the dust in each cell of the sheeting. Then seal the two ends with dust tape (also called vent tape or ventilated tape).

The polycarbonate glazing can then be laid inside the frame and then secured with the batten trim. The batten trim is 1 1/4" by 3/4" strips ripped down from 1 by 6 board. It is cut to fit around the polycarbonate glazing in a frame with mitered corners. The batten trim is secured down with wood glue and brad nails.

Finally, a bead of exterior caulking is run around the inside of the batten trim between the trim and the glazing.

Step 7: The Initial Test

When I got home from work late the next sunny evening I decided to prop the collector up in the sun and see how well it would do. I was very pleased with the initial results.

First of all, it was late in the evening so the sun was hanging low in the sky very far to the west. The collector received very little direct sunlight because of a lot of low lying clouds hanging around the sun. Most of the sunlight that reached the collector was partially filtered through the thin cloud cover. In addition, it was hard to avoid the shadows of my neighbor's shed as well as a nearby tree and telephone pole. Needless to say, conditions were less than ideal.

Nevertheless, the thing worked. Even without a fan there was a decent amount of warm air rising up out of the exhaust opening of the collector. However, I read that forced air dramatically increases the output of these collectors so with the rapidly setting sun, I scrambled to tear apart an old junk computer to get out the (very large) cooling fan. I quickly made up a

piece of OSB that was larger than the exhaust opening of the collector and drilled a hole in it the same size as the fan. With the sheet of OSB over the exhaust opening and the fan over that drawing air through the collector and out the top, I was amazed with the results.

For a short period of time thereafter, the collector was receiving full direct sunlight and I must say, the heat was bailing out of that thing. It felt like just as much output (in terms of both temperature and flow rate) as a 240 volt forced air electric heater such as the ones that are installed in my house for space heating. In other words, it felt like I had my hand in front of one of those heaters while it was running.

Before I could get my thermometers out it clouded over again. The output temperature dropped with a large margin. With the thermometers in place I measured a steady 12oC at the intake and 200C at the exhaust.

All with a good airflow; about the same as what comes out of a clothes dryer vent. Sorry, but I don't have any way of measuring and quantifying air flow yet. As a result, I also cannot calculate the power of the unit in terms of the rate that it is collecting heat energy from the sun.

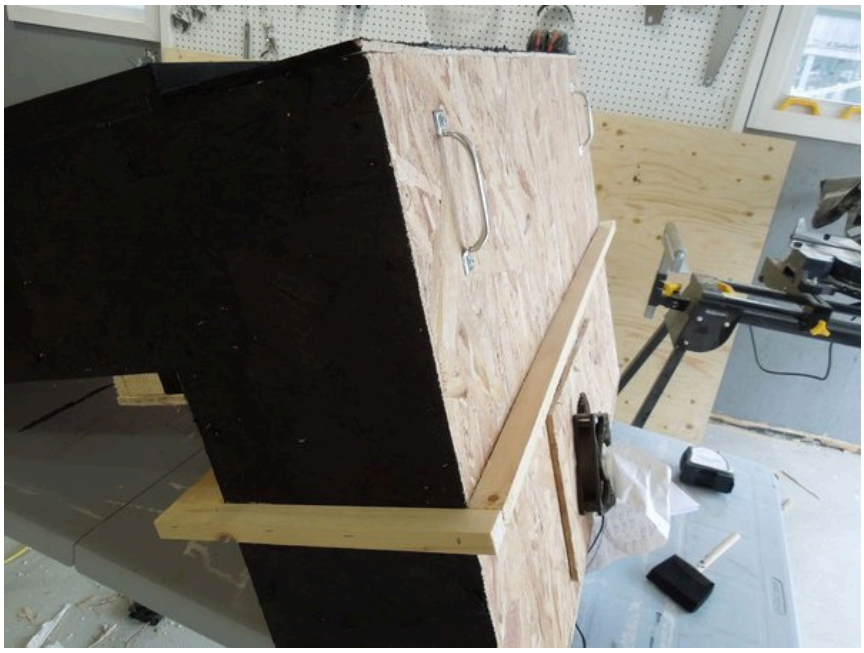
All that being said, I am confident that this collector will provide 100% of the heat required to keep a room warm during a sunny, clear winter day. Given that I cost approximately $60 in materials, it should pay for itself about three times each heating season depending on the weather.

Step 8: Painting

Before I had this thing hanging out my window for my entire neighborhood to see I wanted it to look a little more "finished" than an OSB box.

I used paint but the paint job is so horrible that you probably would think that I was two years old and that I did use a black marker.

Step 9: Profiling the Bottom to Match the Window and Installing the Sealing Flange



Profiling the bottom for my window was nothing more than adding a strip of wood of the appropriate size under the corner of the unit. The strip transfers the weight of the unit to the windowsill, rather than stressing the

vinyl trim around the sash of the window.

The sealing flange is the ring of wood that circles the unit in the second picture. A double ring of foam draft sealing tape will go around the outside face of the flange. This should create an airtight seal between the flange and the inside frame of the window.

Step 10: The Second Test

I'll be a little briefer about the results of the second test. I left the collector out with the fan running for about an hour and checked on it every five minutes or so.
This time it was much earlier in the afternoon than the previous test. The sun was higher in the sky and there were no shadows.

However the sun was just barely poking through the dense cloud cover for most of the test. The results were still good.

The heat output held steady at 29oC with a 17oC input and a pretty strong current of air. I made a makeshift streamer and taped it to the fan to try and give a visual of just how much air is coming out of this thing. It really is a lot for a fan that size.
I'm very happy with the results of this second test too. What it tells me is that I can still get plenty of useable heat even on a clear, cloudy day.

Step 11: Final Thoughts

This project was build mainly as a "Proof of Concept". I tried to save as much money and time as I could by buying cheap materials, using readily available materials that might not have been the best choice and taking little care in my workmanship. If this window box collector seems to be a worthwhile investment after a full heating season.

Upgrades in materials would include:

- Using sanded "good one side" plywood for the outer shell.
- Using glue and screws instead of glue and brad nails.
- Using polyisocyanurate insulation instead of polystyrene.
- Using foil tape instead of "DuckTape" for draft sealing.

Upgrades in quality of workmanship would include:

- Taking time with my cuts instead of sawing like a madman.
- Taking the time to clamp pieces together and waiting for the glue to dry between steps.
- Sanding and rounding the outside edges of the shell or maybe some decorative trim.
- A really nice paint job with a weatherproofing clear coat.