Thermoelectricity Generator

Blueprints and Construction Guide

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1. Introduction:

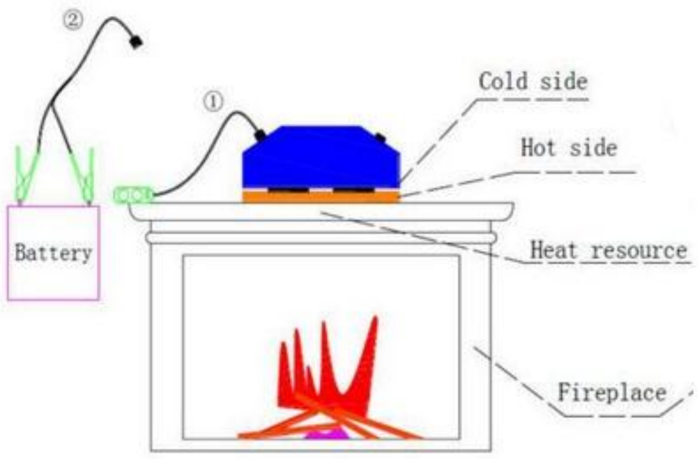
Harvesting energy from previously unemployed ambient sources can play an important role in saving energy and reducing the dependency to primary power sources.

In today's world, depleting reserves of conventional energy sources such as fossil fuels and petroleum has forced mankind to seek for alternative sources of energy. Renewable energy solutions such as solar energy, wind energy and hydropower etc., are being explored at a fast pace. However, an important alternative energy source that is often overlooked is thermal energy.

Anytime a work is done, a range of small to large amounts of thermal energy is dissipated into the air. If this thermal energy would be converted back into electricity it might well serve a useful purpose.

The thermoelectric energy is a fast-growing area of interest.

2. Working Principle:



The system is based on the phenomenon of thermoelectricity who was first observed in 1821 by the German physicist Thomas Johann .

The concept of thermoelectric energy is very broad, as long as the electricity generated by the temperature difference can be captured and stored.

In fact, the difference in temperature between the current standard generator is only generating the temperature difference between the two materials.

The system uses two different types of thermoelectric conversion materials with N and P, one placed on one end of the high temperature state, the other on the open end and given low temperature, due to the high temperature side effect of strong thermal excitation, hole and electron concentrations higher than the low end, in which the carrier concentration gradient, driven to the low end of hole and electron diffusion, resulting in the formation of low-temperature open-ended potential difference; if many of the P-type and N-type thermoelectric conversion material composed of connected module, you can get the voltage high enough to form a temperature difference generator.

Simply, that means there are 2 different materials (semiconductor or metal) connected, if the temperature is different betwen the sides of the conductor it produces electricity (there is no mechanical movement involved and it has nothing to do with the expansion or the contraction).

The Thermoelectric generator works using two different principal :

1. **Peltier Effect**: This effect sends power to the module with a resultant cooling effect of one of the sides and heating of the other.
   These type of modules are low amp, typically in the 6 amp range and are designed for low temperature exposure.
   Note: NO MORE THAN 100°C to 110°C. Higher temperature exposure will cause the module to either break apart or the soldered couples to melt from high heat making them poor choices for power generation!

2. **Seebeck Effect**: This effect is created by temperature differece across the module from heating one side and cooling the other side and

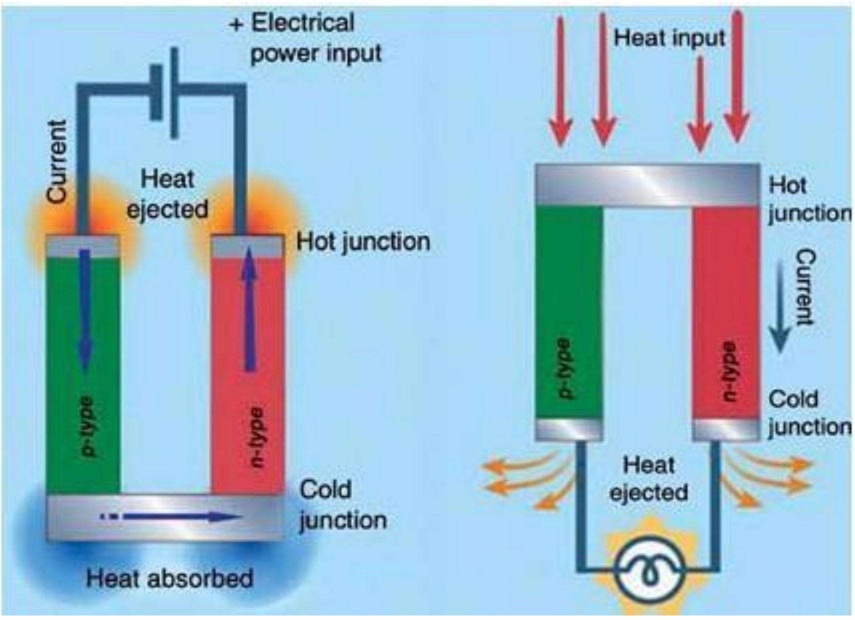
moving the heat flux away as fast as it moves through the module . You cannot describe a peltier module and say it produced power as many laymen do in the BLOGS.

Thermoelectric Generators using the Seebeck Effect work on a temperature differentials. The greater the differential (DT) of the hot side less the cold side, the greater the amount of power (Watts) will be produced. Two critical factors dictate power output :

-The amount of heat flux that can successfully move through the module.

-The temperature of the hot side must be considerably higher than the temperature of the cold side Delta Temperature (DT).

The Peltier and Seebek effects are illustrated in the picture below.

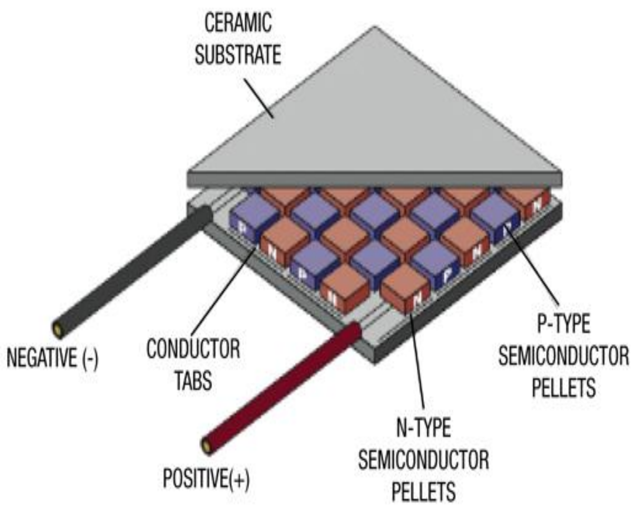


3. Part List:

1. **10 x Tec1 -12709 thermoelectric modules**

These amazing semiconductor coolers get ice cold in minutes or heat to boiling point by simply reversing the polarity. Incorporate both semiconductor technologies and electronic assembly techniques.

Couples:127
Umax(V):15.2V
Imax(A):9A
Tmax(degreeCelsius):67
Powercable:32cm
Max. power consumption: 136.8W
Dimensions: 40mm x 40mm x 3.5mm



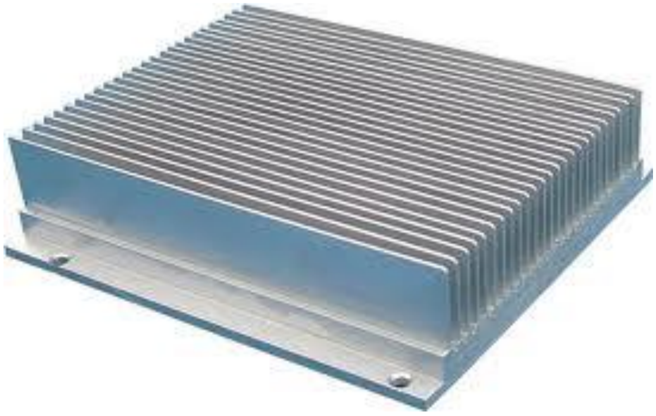
A sandwich implementing an array of n- and p-type semiconductor legs creates the typical TE module. The legs are pellets of either bismuth telluride or antimony telluride. The legs are strapped together to create a series electrical connection and a parallel thermal connection. The top and bottom of the module is most often aluminum oxide ceramic to provide electrical insulation and good thermal conductivity.

The coefficient of a complete module depends on other factors, but for the raw bismuth telluride material, it can be up to −287 μV/°C for certain compositions. For a complete module with modest dimensions of around an inch square (single-stage modules are between 2 and 5 mm thick).

2.1* Aluminum radiator big enough to cover thermoelectric modules

3. **Square Steel Tube or another aluminum radiator** big enough to cover thermoelectric modules

or



4. **Dimension Engineering Any Volt 3 DC switching regulator**

This is an adjustable step up / step down 3A switching regulator. The output is adjustable from 3 to 24V. The output voltage is set with a small screw potentiometer on the back of the AnyVolt 3. Once the output voltage is set, it does not matter whether input voltage is higher, lower, or the same as the desired output. The potential applications are endless and only limited by the unit's specifications and your collection of gadgets that require DC power at a different voltage than their supply.

Input power and output loads are connected with reusable screw terminals, so no soldering is necessary.

5. Red Hi-Temp Gasket Maker RTV

Is formulated for high temperature applications or heavy-duty use such as towing. It replaces almost any cut gasket by making reliable 'formed-in-place' gaskets that resist cracking, shrinking and migrating caused by thermal cycling. Coats pre-cut gaskets to increase reliability. Resists auto and shop fluids, with a temperature range of -65 degrees Fahrenheit to 650 degrees fahrenheit intermittent. Excellent torque retention and hi-temp, sensor-safe properties. Extended warranties, engine sensors and new component materials such as aluminum, bi-metal alloys and hightech plastics, have created the need for superior RTV silicone gasket makers in both OEM production and service applications. Permatex always has the right gasket maker for your application.

6. Ice Fusion thermal compound 200g

This is the best solution for thermal stability in high temperature. Has high thermal conductivity, low thermal resistance and it's non-corrosive. Excellent adhesion. Preserve in room temperature for longer lifespan. Ice Fusion provides excellent performance and stability.

7. 12V Car battery.

This is the battery you will use in your system once you build the full

scale generator. If you cannot afford a brand new battery, you can get one from an old cart or forklift.

8. 1* Inverter 12V to 220V-240V 1A 50/60Hz

The Inverter is used to transform the direct current or DC into alternating current or AC. This conversion is needed since most appliances around the house use AC.

4. Were to Get the Materials from:

Components:

Tec1 -12709 thermoelectric modules

http://www.alibaba.com/product-free/139939415/136_8W_12V_9A_TEC1_12709.html
http://www.auspiciousmall.com/index.php?main_page=product_info&products_id=263
http://www.amazon.com/TEC1-12709-Thermoelectric-Cooler-Peltier-100W/dp/B007TPCEKI

Aluminum radiator

http://www.alibaba.com/product-gs/1235438345/Cooling_Aluminum_Heat_Sink.html?s=p

Dimension Engineering AnyVolt 3 DC switching regulator

http://www.dimensionengineering.com/products/anyvolt3
http://www.amazon.com/AnyVolt-3-Universal-DC-DC-Converter/dp/B00B3YWW1W

Red Hi-Temp Gasket Maker RTV

http://www.amazon.com/Permatex-81160-High-Temp-Silicone-Gasket/dp/B0002UEN1A

Ice Fusion thermal compound 200g

http://www.amazon.com/Cooler-Master-IceFusion-Performance-RG-ICFN-200G-B1/dp/B003AVMRR0

5. Equipment

Multimeter:

A Digital multimeter is ok but we highly recommended to use an Analogue Amp Meter, which goes up to 1 amp or more. You will also need the meter to measure your thermoelectric modules as well as your battery voltages.

Soldering Iron:

The Soldering iron will be used to solder the wires. The wires will still operate if the connections aren't soldered, though once you are sure it is wired correctly, you should solder all the connections.

Sealant gun:

This will help you to stretch Red Hi-Temp Gasket Maker RTV exactly how you need

And of course:

Patent, screwdriver and knife

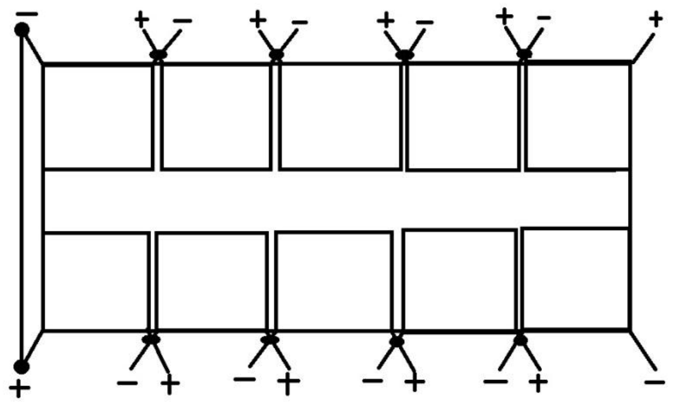
6. Construction:

Thermoelectric modules

Be gentle with the thermoelectric modules. Don't crush them, or pull or put stress on the wires. Take your time and think it through.

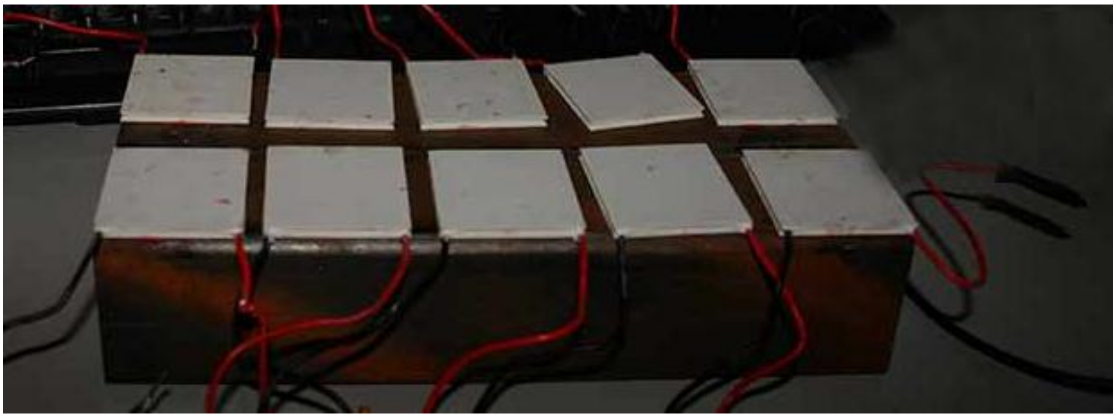
Determine the hot and cold sides of the thermoelectric modules using the multimeter , and label the modules.

Setup the thermoelectric modules in series like in the picture below and test again with the multimeter.



You can use the heat from your arm to send some voltage through in order to test the setup. Make sure each one is working and that there are no loose connections. Make sure they are all working in lower temperatures before proceeding.

Using higher quality and higher rated modules is recommended if your project budget allows!



The steel tube isn't an efficent way to transfer the heat to the modules, but for this design, we require a heat inefficently to accomidate for a lower temperature rating in the thermoelectric modules we are using.

It is posible to replace the steel tube with another aluminium radiator – would be more efficent.

Use the Red Hi-Temp Gasket Maker RTV as a glue, and attach the hot side of the modules to the steel tube, you won't need to use alot.

With a plan, and percision, strip and wrap the wires according to the series arrangement. I wrapped the wires with aluminum mig welding wires, and will solder these connetions later. Be careful with the wires to not touch the steel tube while heated!
With the modules attached flat to the steel tube, inspect the cold side to make sure it is very clean.

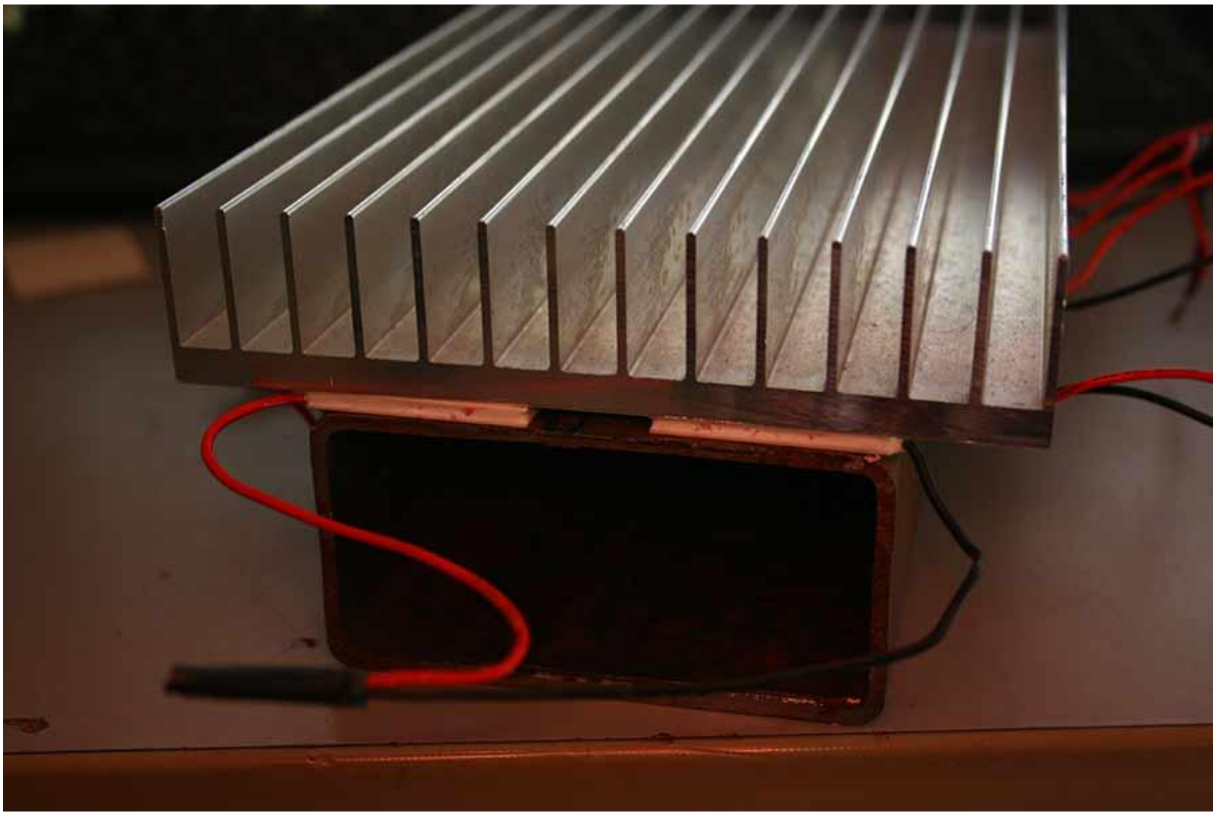
Be careful when applying the thermal grease.

Apply a thin layer of the thermal paste to the cold side of the thermoelectric modules. You do not want to apply a lot.

If there are gobs, there is too much. There should be just a thin, consistant layer.

I drilled 4 holes, about 1/8th inch, on each of the corners where the heatsink meets the modules.

Setting the modules onto the heat sink, I wraped the copper mig welding wire around one end of the heatsink, pulling the wire tight with some pliars, and again on the other side. Then wraped the holes again diagonally, on each side, making the wire really tight with the pliars.



You will connect the black and red wire to the switching regulator , red wire to the “+” and black wire to the” – “and from the regulator to the battery.

The DC output produced by the Thermoelectricity generator is then used to charge the driving battery, and the power level produced is substantially greater than the minor current drain from the battery. Consequently, it is a sensible precaution to pass this current to the battery via a circuit which prevents the battery voltage rising higher than it should. A simple voltage level sensor can be used to switch off the charging when the battery has reached its optimum level. Other batteries can also be charged if that is wanted.

From the battery by means of the inverter you will invert the direct current or DC into alternating current, 12 V to 220V.

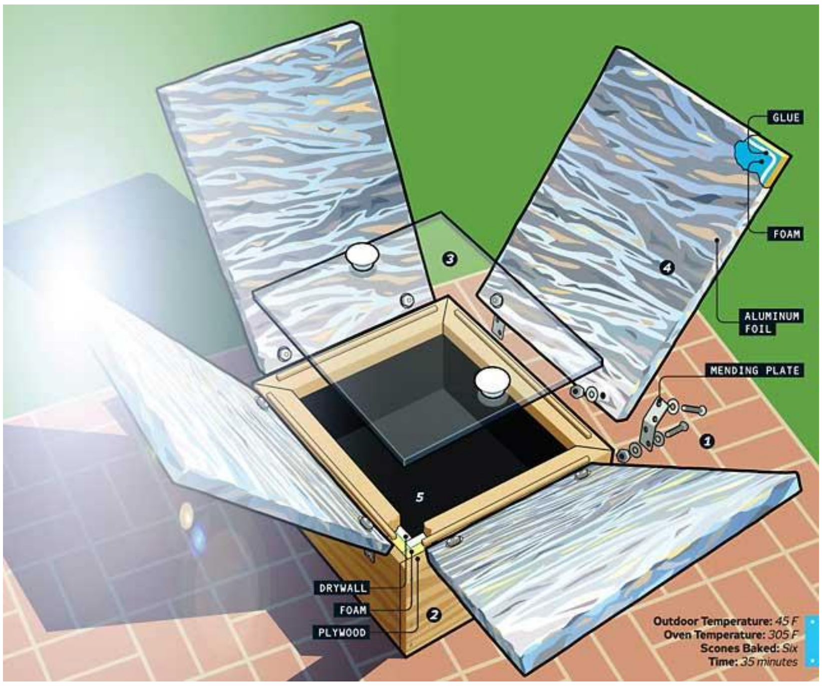
Notes

(1) The casing will become a bit hot after a while. Do not touch the generator casing.

(2) To the cold side you can to attach a computer fan for a better efficiency.

(3) The Generator can operate at temperatures up to 450 °C heat source surface.

The best method of heating for the generator is the solar power. For this you will need to build a solar box.

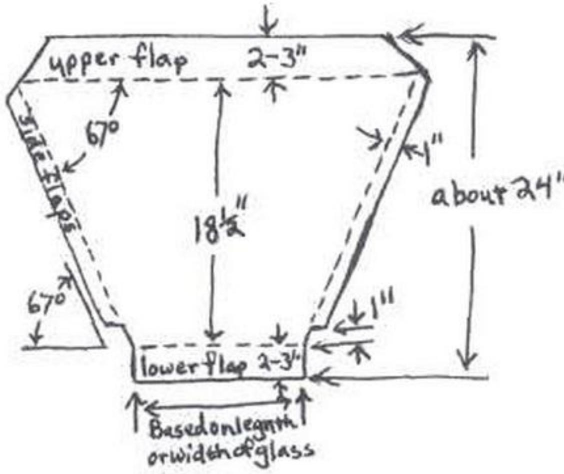


The solar box can be built in a few hours for very little money. The parts needed to build an inexpensive solar box are:

- Cardboard boxes
- One small roll of 18" wide heavy duty aluminum kitchen foil.
- A piece of double strength glass ½" larger than the length and width of the inner box
- Eight ounces of white paper glue
- A small amount of flat black paint.

Yet, because of the design, it is remarkably efficient and durable.

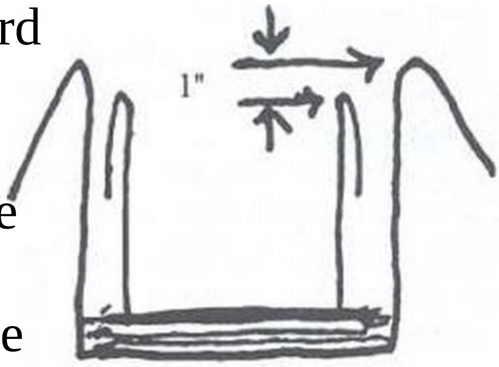
The first step involves searching for cardboard boxes. For the oven box, you are looking for two particular boxes. These can be rectangular or square (their collectors smaller of the two boxes becomes the defines the heating area and the power of the heating. For a medium size, the area of opening of the inner box (length times width) should equal 120 to 160 square inches, and it should be 9 to 12 inches deep. The larger box, the outer one, must be two to three inches larger in all directions.



Here's the pattern for the collectors. The dimensions will depend on the dimensions of your box.

For collectors, find four flat pieces of regular (not double strength) cardboard from appliance or bicycle stores. These should be about two feet by three feet. And gather five to seven more boxes which you will cut up for insulation.

Take the outer box and cut up cardboard pieces to fit in the bottom (cut the cardboard with a mat knife, being careful not to cut yourself). Make these layers thick enough so that, when the inner box is placed in the outer box, the top rim of the inner box is one inch lower than the top rim of the outer box.



The top of the inner box must rest one inch lower than the top rim of the outer box

The outer box must have two opposite flaps left sticking out. Tuck the other two between the inner and outer boxes. The inner box must have all of its top flaps bent out and all the way back so that they fit between the inner and outer boxes.

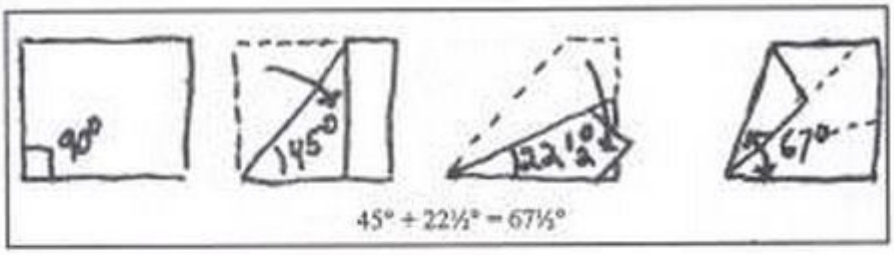
Now cut more pieces of cardboard to stuff between the inner and outer boxes until the inner box is wedged tightly. Doubled-over pieces look nicer.

The tops of these filler insulation pieces must be arranged so that, when the glass rests on the top rim of the inner box, it makes a good seal. (That is, you don't want big gaps where the heated air will escape.

In use, the solar box will be tilted toward the sun. Therefore, the sidewall, which will be lower when it's tilted, must be arranged so it will support the glass in position. Now paint the inside black.

Note for later: The box will smoke slightly during the first couple of times when heated up, but this is just a curing process. Also, cardboard shrinks slightly when heated, so you will have to repack later to keep the inner box tight.

Draw the collectors, as shown, on the four flat pieces of cardboard. A square solar box will have all four collectors the same size. The 67° angle can be found using a protractor, or by folding a piece of paper like an airplane.



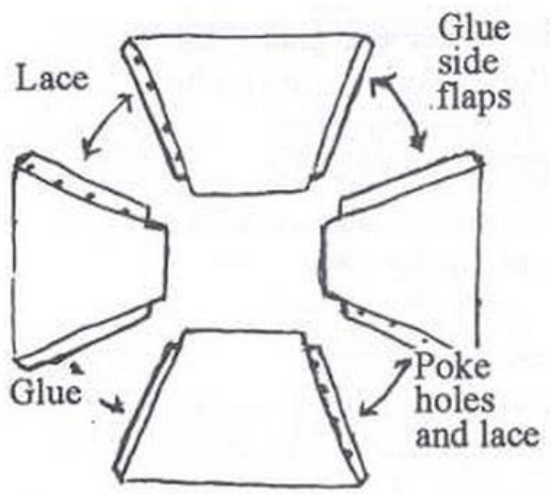
You can find the 67° angle by folding a piece of paper as shown here.

Cut out all four collectors. Then take a tool with a blunt point and crease a line along the dotted lines. Bend in on the crease lines. Next, bend the upper and lower flaps all the way over and glue them down.

Roll foil over the collectors, and rub your finger over the side flap bends to show where to cut. Cut the foil so that it does not quite reach these bends; it will be easier to center later. Do not cover the side flaps.

Smear a glue mixture (two parts water, one part white glue) over the dull side of the foil, using a piece of cloth and two to three tablespoons of glue mix. Line up the collector and lower it onto the foil, tap it lightly, and turn it over. Apply the foil to the side of the collector that is not glued to the bent-over upper and lower flaps.

Glue two opposite sets of side flaps together. Then lay them out as they will fit on the oven box. Cut off the side flaps from one of the unattached corners. Connect this corner by laying these two collectors next to each other, with the foil sides down. Now cut a cloth about 18" x 4" and glue it over this corner. When the glue is dry, fold inward on this cloth hinge and arrange the Collectors .

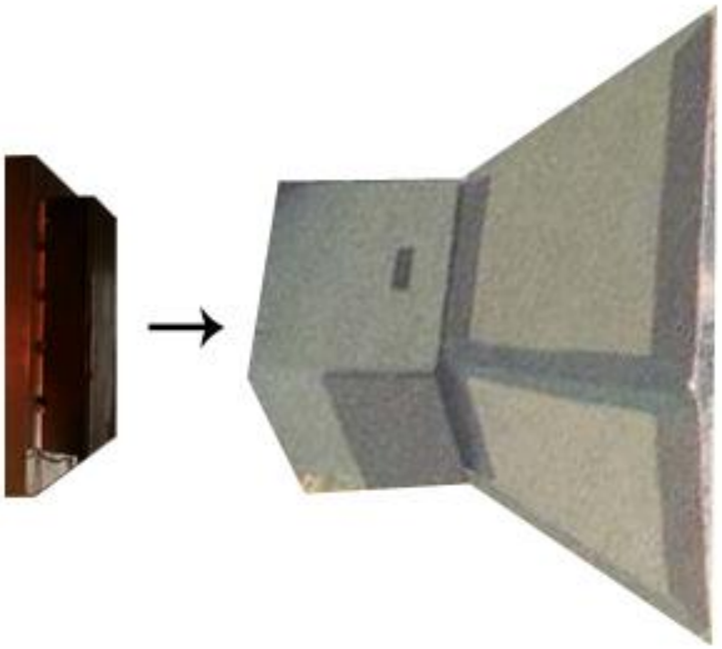


Connect the collector panels with glue and with laces.

A slip-in piece made from cardboard and cloth is attached to the upper collector. This slips between the cardboard filler pieces of the upper sidewall for quick attachment of the collectors to the oven box.

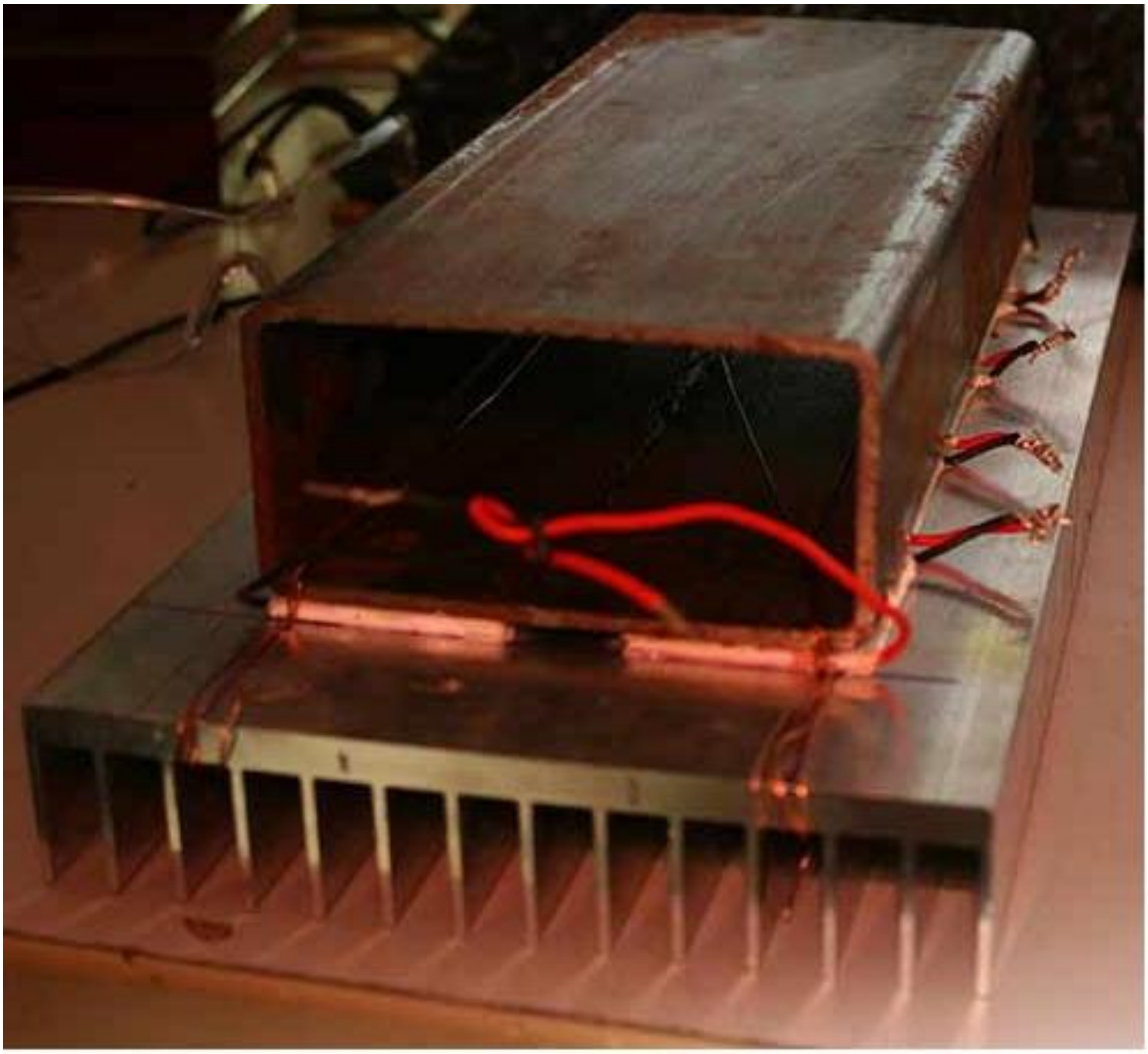
Now, the only thing that remaine to do is to cut the bottom of the boxes of collector to the exact dimensions like those of the heating part of Thermoelectricity generator and after introduce that inside.

Use the Red Hi-Temp Gasket Maker RTV as a glue and allso for insulate the connection.



The Thermoelectricity Generator can be placed on the surface of heat source also to oven, gas stove, wood stove or another source of warmth that you have.

7.Gallery



Thermoelectricity Generator attached to a wood stove