Project "Build A Solar Panel"

Purpose

The purpose of this project is to demonstrate how to build a solar panel from individual components (not to mention that I was curious). With the correct components, the cost of constructing a solar panel with longevity against environmental degredation can cost up to 30% less than commercial solar panels of the same Watt rating (not to mention that what you create, based on your assessment of the environment a solar panel would be used in, could actually be more resiliant than a "cookie cutter" manufactured solar panel).

Introduction

A solar cell's purpose is to generate electricity through the release of electrons from a material that is bombarded by electromagnetic radiation or photons. Most crystalline solar cells are sensitive to visible radiation from 400 - 700 nanometers, which correspond to 3.1 - 1.8 electron volts, of the visible region as shown by ACEPT W3 Group (1999) and also into the near infrared spectrum. As the wavelength of the electromagnetic radiation increases, the amount of electron volts decreases. This means that infrared radiation has less electron volts than the visible spectrum of light (because it has a larger wavelength than visible light) and ultraviolet and gamma radiation has more electron volts than both the visible spectrum of light and infrared radiation (because they have a smaller wavelength than both infrared and visible light). Abramowitz, M., Davidson, M., Neaves, S. (2003) wrote that all forms of electromagnetic radiation originate from the atom which contain orbiting electrons around its nucleus. When those electrons absorb more external energy than they can contain in order to be stable, the extra energy is released in the form of an electromagnetic wave. That electromagnetic wave contains a magnetic field and an electric field, one offset by ninety degrees to the other along the propagation plane.

Noted by Seale, E. (2003) the first silicon solar cell was developed by Russel Ohl in 1941, was similar to a photodiode with a large light-sensitive area. Aldous, S. (2007) wrote that pure silicon, the main component of silicon solar cells, is a poor conductor of electricity in itself. In fact, the silicon atom is missing four electrons in its outer shell. A phosphorous atom, on the other hand, contains five electrons in its outer shell meaning that it can bond with silicon atoms and since it has an extra electron which can be displaced by electromagnetic radiation, energy is created in the process. However, capturing this energy is not possible without creating an electric field. This is done by introducing impurities in the silicon material. As previously mentioned, silicon mixed with phosphorous creates an N-Type semiconductor; N-Type or negative because the phosphorous contains free electrons. Silicon mixed with boron atoms (which contain only three electrons in its outer shell) represents an absence of electrons and becomes the P-Type semiconductor; P-Type or positive. At the plane of where the N-Type and P-Type are joined is where the electric field is generated and the solar cell reaches electrical neutrality. The introduction of photons (electromagnetic radiation) on the N-Type semiconductor (silicon and phosphorous) frees electrons that try to travel to the P-Type semiconductor (silicon and boron) where the photon would remove an electron. The presence of the magnetic field between the two layers prevents this travel from occurring to a degree directly from the N-Type semiconductor to the P-Type semiconductor. This means that when we connect a load to the P and N semiconductors, we observe current (from electron flow) and voltage (from the magnetic field) as the free electrons move from one semiconductor to the other through the load.

Significance of Solar Panels

A solar cell, in itself, is of little value in our energy consumptive world. Only when solar cells are joined together into arrays or panels do we commonly see their true benefit in delivering mass volumes of energy. Depending on what requires power determines the number of solar panels required. For instance, if you were interested in powering your entire house you would undoubtedly need a lot of solar panels; there is an online calculator that you can use to get an idea of how many solar panels and other components you may need, which you can find at the solar panel battery calculator page.

Now that we know how a solar cell is made, let's see how a solar panel is made since a panel is made from a collection of solar cells. In this example, the following items will be used:

Quantity	Item
1	48 x 48 x 1/8 inch Acrylite UV stabilized transparent sheet; this is used in place of the glass top sheet (http://www.usplastic.com/variant.asp?catalog_name=usplastic&category_name=21314&product_id=10477&variant_id=44308). Lexan could also be used.

1	48 x 48 x 3/16 inch ABS white sheet (http://www.interstateplastics.com/detail.aspx?ID=ABSsheetGP-SW1018)
4	72 x 1/4 x 1/4 inch clear extruded acrylic bar (http://www1.mscdirect.com/CGI/GSDRVSM?PACACHE=000000076797329)
1	Adhesive glue (http://www.vandykes.com/product/sb110008/gorilla-glue-4-ounce)
1	Silicone sealant/adhesive (http://www.liquidnails.com/products/product.jsp?productId=48)
2	Eight ounce Rosin core solder (http://www.radioshack.com/product/index.jsp?productId=2062713)
1	ERC81S-004 40V, 5A Schottky Barrier Diode (http://www.fujisemi.com/html/table/91500/91502.htm)
5	.060 x .002 inch by 25 feet solar cell PV tinned interconnection ribbon (http://windandsunpower.com/store/index.php?main_page=produ products_id=6)
36	Monocrystalline 6 inch (156mm) solar cell rated at .5VDC, 6 Amp Peak. You can get new 156mm solar cells in bulk from http://www.dms if you are interested in a set of 36 smaller solar cells, you can get a set from http://www.solarblvd.com/product_info.php?info=p13 Solar-Cells-36-Pieces-0-55-V--4-2A.html. You could also try to locate solar cells from a seller at http://www.ebay.com or http://ww
1	Four position dual row barrier strip (http://www.radioshack.com/product/index.jsp?productId=2103982)
1	Sixteen #8 insulated ring tongue terminals (http://www.radioshack.com/product/index.jsp?productId=2103306)
1	Twelve gauge hookup wire black insulator (http://www.radioshack.com/product/index.jsp?productId=2062647)
1	Twelve gauge hookup wire red insulator (http://www.radioshack.com/product/index.jsp?productId=2062646)
1	3 x 2 x 1 inch project enclosure box (http://www.radioshack.com/product/index.jsp?productId=2062279)
1	Crimping tool (http://www.radioshack.com/product/index.jsp?productId=2062789)
1	40 Watt soldering iron (http://www.radioshack.com/product/index.jsp?productId=2062738)
1	[OPTIONAL] Multimeter. About any DC voltage measuring capable multimeter will suffice. The DM9100 resembles what is actually used i (http://www.byramlabs.com/product_info.php/products_id/8184)
1	[OPTIONAL] Variable temperature heat gun (http://www.toolking.com/milwaukee_8975-6.aspx)
1	[OPTIONAL] 28 square feet of .018 inch thick Ethylene Vinyl Acetate (EVA) sheet -OR- UV resistant Surlyn sheet. This is difficult t quantities, but I have seen it available at http://www.ebay.com and http://www.ecrater.com. NOTE: EVA sheet shrinks as it is heated feet is recommended versus 20 square feet.

Other Resources

Before going further, let me take a moment to show you other resources that you may find to be valuable as it relates to solar cells and panels:

- **48" x 48" x 1/8" Polycarbonate Sheet**
- **48" x 48" x 1/8" Acrylic Sheet**
- **6' x 1/4" Square Acrylic Rod**
- **GC Waldom Electronic Grade Silicone Sealant/Adhesive**
- **Bulk Solar Cells on Computer Chips**
- **Bulk Polycrystalline Solar Cells**
- **Large Quantity Bulk Solar Cells**
- **Large Quantity Tinned Wire**

Broken Solar Cells

Personally I would not buy solar cell fragments or "grab bags" of broken solar cells as you could easily spend hundreds of hours piecing together enough fragments to come up with 100 Watts of power (not to mention that resistance increases with the more wire to solar cell connections you make; resistance restricts the flow of electricity and generates thermal energy or "heat"). If that's what you've got to work with, hey, that's okay.

Determine What Your Solar Panels Will Support

One of the big reasons more and more people are adopting solar power is to "go green" or reduce their carbon footprint since studies have been conducted revealing that buildings, houses (or residences) contribute something in the neighborhood of 20,000 pounds of carbon dioxide per year each (you may not have a carbon dioxide generator where you live, but if you consume electricity, natural gas, water, sewer service and so on then those "services" create carbon dioxide as a byproduct of what you are consuming). Others may be adopting solar power because they have no choice (maybe you live on an island, for instance, where there is no power).

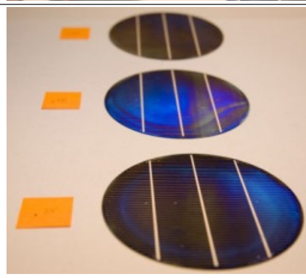
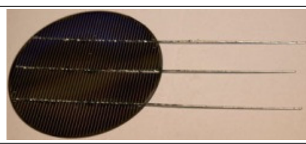
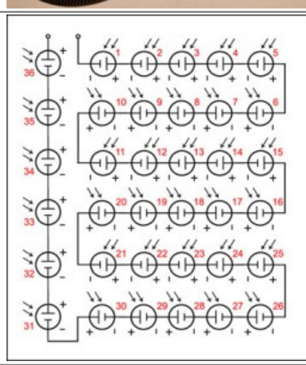
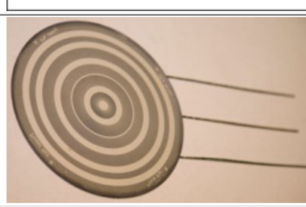
Regardless of the reason for getting or making your own solar panels, determine what they will be used for. If you want to provide power for an electric fence, you may only need one 100 Watt solar panel so your investment will be quite low. On the other hand, if you are trying to power your residence with solar panels, you will need more than 100 Watts. What I have found is that for a 1000 square foot residence, you would need roughly eight 100 Watt solar panels per person (this judgement is by no means scientific but a starting ballpark number to look into). To get a more precise reading on the amount of solar panels you would need, use this solar power calculator.
Here's a quick glimpse of what to expect, in terms of power needs, if you use 350kwh of power in a month...you'll need 2700 Watts of power (27 - 100 Watt solar panels) and roughly 16 - 12VDC, 100Ah deep cycle batteries (batteries incase you plan to use electricity when the sun is not shining).

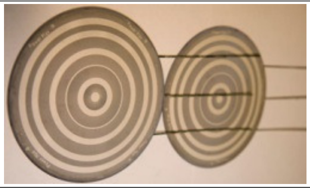
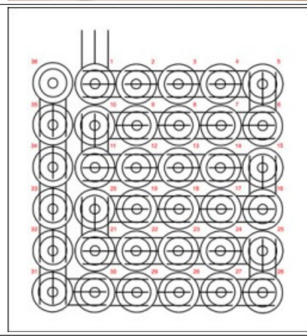
As you can see, defining the purpose of the solar panels and doing a little research may help a lot in getting an approximation of what it will cost. But, going back to the purpose of this project (to create a solar panel from component parts) can shave upwards of 30% of the cost of the solar panels. But, be ready to put in some work to create a

solar panel. It does take time (90% of that time spent soldering like there is no tomorrow). It took me about 12 hours to tin wire, solder that to the solar cells, and then solder the solar cells together...for a single 100 Watt solar panel.

Let's Make A Solar Panel

The type of solar cell that I will be using for this guide is the blemished (or class 'b') six inch diameter, Siemen's (now Shell) PowerMax monocrystalline solar cell...you can get class 'a' cells but they are more expensive. A perfect operating solar cell (class 'a') will normally generate a maximum of approximately .55 VDC, 5.6 Amps and 3 Watts of power (a watt is calculated by multiplying voltage and amperage together). Just as a side note, one horsepower is equal to just over 700 Watts.

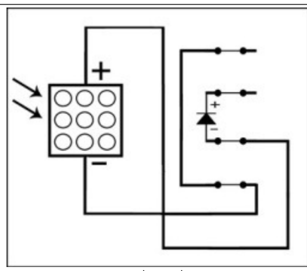
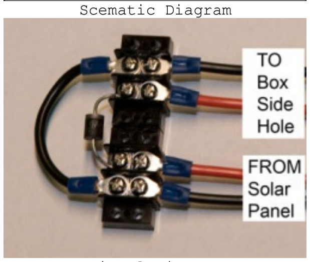
STEP 1		1. Grab a multimeter capable of measuring fractions of DC vol collection of solar cells. 2. Position a light source near your collection of solar cell to you get a consistent measurement of voltage output of e solar cells with a light source that has constant output a distance away.
STEP 2		1. Set the multimeter to measure DC voltage. 2. Place the negative test lead (usually black) on the side o which indicates negative voltage (usually the front). 3. Place the positive test lead (usually red) on the side of indicates positive voltage (usually the back). 4. Observe what the maximum voltage output is. Don't move the to try to get a higher reading since you will be grouping together according to how much voltage they generate at th your light source. 5. Separate your solar cells into groupings of .05 volt incre taking voltage measurements. 6. This will allow you to take maximum advantage of solar cel solar cells together (each group would be a solar panel). I had 35 solar cells which had an output of .45 volts and yo an output of .35 volts, the output of your solar panel wil
STEP 3		1. We need to connect our solar cells together with tinned in In order to do this, we'll need to take the spool of inter cut it into 10.5 inch lengths for the six inch solar cells
STEP 4		1. Each length of tinned interconnection wire must have solde is done by adding solder to 5.25 inches of the wire starti flip the wire length over and add solder to 5.25 inches of at the opposite end.
STEP 5		1. Solder a length of the interconnection wire to each connec on the front of each solar cell (in this case, three lengt interconnection wire are used per solar cell).
STEP 6		1. Connecting solar cells together in series using the Powerm cells in this example, uses a unique approach where all of soldered together in a zig-zag pattern to minimize the amo interconnection wire used.
STEP 7		1. In order to solder the solar cells together, one will be p

STEP 8		1. Take another solar cell, face down, and place the intercon of the previous solar cell (leave approximately 1/16 inch solar cells) and solder those interconnection wires to the cell.
STEP 9		1. Now that you've seen how to solder solar cells together, y the sequence of soldering the 36 solar cells together into (starting at #1 and ending at #36). See the graphical repr
STEP 10		1. After the 36 solar cells have been soldered together they is shown.
STEP 11		1. While it is not required, it is recommended that you sandw solar cells inside of a protective thermoplastic material vinyl acetate (EVA) sheet or UV resistant Surlyn sheet. Ov oxygen or other contaminants inside the solar panel, your degrade prematurely. If you have one of those types of she over the solar cells you've just soldered together and use sheet so that it adheres to the solar cells. 2. You will notice that I have placed the solar cells on top then soldered them together in advance of heating EVA shee reason for this is that the EVA sheet is a very adhesive m (it also becomes approximately 100% transparent after heat over the solar panel in a cardboard frame (so that the oth sheet applied to it), the paper can be easily removed; wit between the solar panel and the cardboard it would be nece inverted EVA sheet and solar panel from the rigid cardboar individual solar cells. 3. You will want to overcut the sheet since it will shrink as
STEP 12		1. Carefully turn the sheet of solar cells over, place the sh the solar cells and use the heat gun on the sheet so that solar cells and the sheet.
STEP 13		1. Take the 48 x 48 x 3/16 inch ABS white sheet and, using a down to a 38 5/16 x 38 5/16 x 3/16 inch sheet. Then drill through the sheet six inches from the right-top edge and o the right-top edge.
STEP 14		1. Place the 36 solar cells, which were soldered together, fa white sheet and center them on the sheet. Cut off excess E (if you applied it to the solar cells) so that it is appro less on each side than the size of the ABS white sheet.
STEP 15		1. Solder approximately 3 inches of the color-coded wire to t positive and negative interconnection wire on the #1 and # the other end of the wires through the 5/16 inch drilled h
STEP 16		1. Cut two 72 x 1/4 x 1/4 inch clear extruded acrylic bars to inch. Cut the remaining two 72 x 1/4 x 1/4 inch clear extr a length of 37.8125 inch.
STEP 17		1. Glue one 38.3125 inch clear extruded acrylic bar to the to sheet, lining the bar up with the edge of the ABS white sh to dry. Then take the second 38.3125 inch clear extruded a bottom of the ABS white sheet, lining the bar up with the white sheet. Allow the glue to dry.
STEP 18		1. Glue one 37.8125 inch clear extruded acrylic bar to the le sheet, lining the bar up with the edge of the ABS white sh to dry. Then take the second 37.8125 inch clear extruded a right of the ABS white sheet, lining the bar up with the e sheet. Allow the glue to dry.
STEP 19		1. Cut the remaining clear extruded acrylic bar into 1 x 1/4 Glue each block, centered, in between each solar cell in a pattern (this will provide strength to the solar panel).

STEP 20		1. Take the 48 x 48 x 1/8 inch Acrylite UV stabilized transpa using a cutting tool, cut it down to a 38 5/16 x 38 5/16 x Place glue along the top of the four acrylic bars which we white sheet. Place glue on top of each of the 1 x 1/4 x 1/ up the Acrylite sheet with the edges of the four acrylic b firmly on top. Allow the glue to dry.

What's Next

Congratulations, one solar panel has been created! The next section is here in the event that you want to protect your solar panel from reverse current. Current flowing into a solar panel will damage the solar cells and make them incapable of generating electricity (this typically can happen when you have the solar panel connected directly to a battery; if you have a charge controller, the controller will prevent this from happening). Assuming you don't have a charge controller, you'll need to add a rectifier diode to one of the wires coming out of your solar panel to block reverse current. This section will focus on adding the rectifier diode to the back of the solar panel.

STEP 1		1. Drill one 5/16 inch hole in the bottom of the 3 x 2 x 1 in box. Drill another 5/16 inch hole into the side of the box back of the box. Feed the wire, sticking out of the back o through the bottom hole of the box. Seat the box firmly on panel and allow to dry.
STEP 2	 Scematic Diagram  Visual Diagram	1. Assemble the junction block with wire and the diode as sho
STEP 3		1. Finally, apply enough of the Silicone sealant/adhesive to the bottom and side of the enclosure box. Allow the sealan

References

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