Small Solar Panel

by kinz1jg on November 22, 2006

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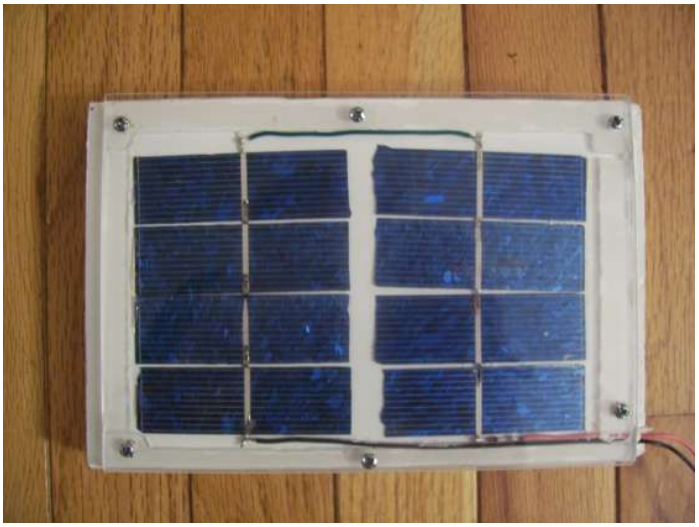
intro: Small Solar Panel

Construct a small, portable solar panel that will charge two AA rechargeable batteries in a day or two. Use the batteries to make any battery-powered device solar powered.

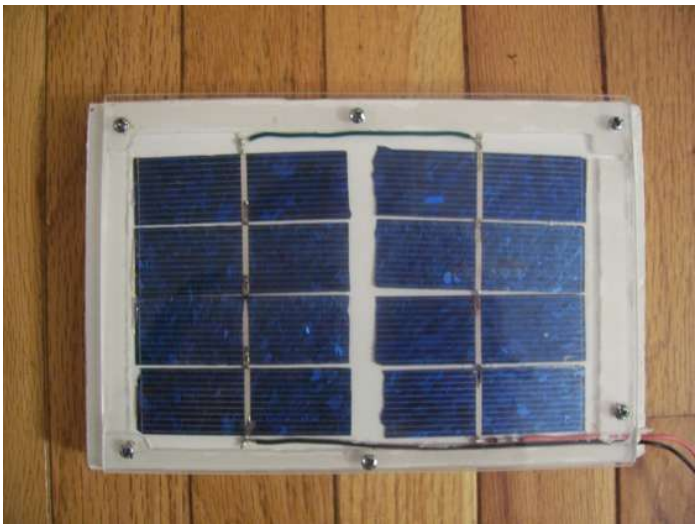


step 1: Introduction

Construct a small, portable solar panel that will charge two AA rechargeable batteries in a day or two. Use the batteries to make any battery-powered device solar powered. Or use the panel to directly power small DC electronics.

The panel consists of eight 1"x3" solar cells wired in series with a blocking diode mounted on a board and protected by clear plastic. In this configuration the panel provides about 250 milliamps at 4 volts, which will charge two batteries in a day or two, depending on the weather and the batteries' capacity. Other solar cell configurations are possible to provide more or less power to, for instance, directly charge a 3.6 volt cell phone battery, or to provide a faster charge to AA batteries.

There are a number of off-the shelf small solar panels available on the web, but building one yourself gives you the flexibility to configure it to provide exactly the voltage and amperage your project needs. And it could be cheaper.



step 2: Background

My original goal was to use several small 1"x3" solar cells I'd purchased a year ago to charge my cell phone. For my first panel I connected nine cells in series and very simply mounted them on a board with no cover. That generated enough electricity to directly charge my cell phone.

However, it had several shortcomings. First, I found that I needed to charge the phone when the sun wasn't shining. Second, when I wanted to receive calls the phone was often outside charging while I was inside. Third, the cells got dirty and one broke. Finally, because the circuit could run in either direction (no blocking diode), the cell phone battery would discharge to the panel when the was no light.

My solution to these problems was increase flexibility by charging two AA batteries instead of the cell phone and to put the charged batteries into the Minty Boost to charge the phone. To better protect the cells I glued them to the backing board and covered them with a clear plastic sheet. A blocking diode prevents battery discharge.

The inspiration for mounting the cells comes from otherpower.com
I couldn't find any other resources on the internet with details for creating your own solar panels, but there must be something out there.

step 3: Solar cell basics

It helps to understand some fundamentals about solar cells before designing a panel. All common solar cells, like the multicrystal cells used in this instructable, produce 0.5 volts or so. That is, the front and back have a 0.5 volt difference. The size of the cell determines the amperage. A full-sized cell (6"x6") could produce three amps, depending on its design, but smaller cells may produce only 250 milliamps or less.

To increase the voltage of a panel, wire the cells in series. To increase the amperage, wire the cells in parallel.

step 4: Materials

eight solar cells (I purchased multicrystal cells online. Try, for instance, Silicon Solar, Plastecs, eBay, or do a Google search.)

small gauge wire

ribbon wire (Flat wire commonly used to connect solar cells to one another. I purchased cells with the ribbon already attached to the front of each cell. You can connect with regular wire, but the flat ribbon is less likely to cause the cells to crack when mounted.)

clear plastic (I used plastic that was 0.1 inch thick)

four to six wood screws

battery holder for two AA batteries

wood, about 1/2 inch thick panel

paint

adhesive (I used an adhesive/sealant intended for bathrooms, but silicon should work fine)

solder

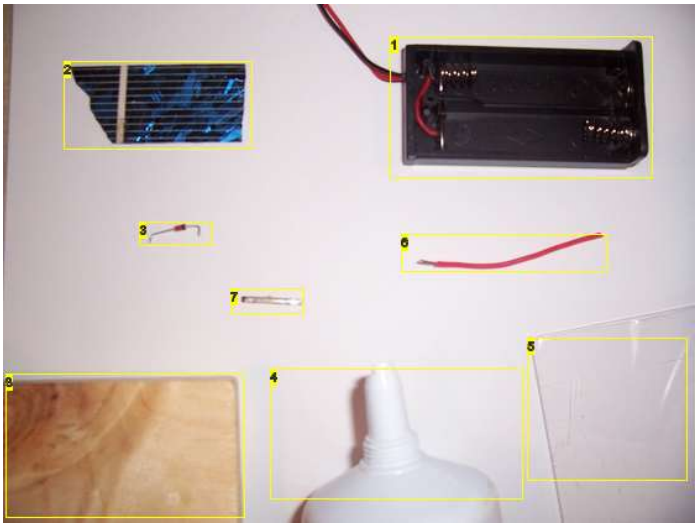


Image Notes
1. AA battery holder
2. Solar cell (this one is broken)
3. diode
4. adhesive
5. clear plastic sheet
6. connector wire
7. flat wire
8. wooden board for backing

step 5: Tools

soldering iron

wire cutter/stripper

drill

paint brush

saw

step 6: Building the backing

Cut a flat piece of wood the correct size to provide backing for the solar cells.

I arranged the solar cells in two columns of four cells (to make the panel more square than rectangular). That covered 6 1/2" x 4", plus I added additional space for wiring and to secure the cover to the backing, which came to a final dimension of 8" x 5 1/2" for the wood backing.

Sand and paint the wood. Set it aside to dry.

step 7: Begin wiring the cells together

All the cells will be wired in series, that is, the front of each cell will be connected to the back of the next cell in series.

Cut the ribbon into ten approximately 1 1/2" long pieces. Solder eight of them to the fronts of all eight cells, allowing about half of the piece to stick out beyond each cell. (The extra will be soldered to the back of the next cell in the series.) I found it easiest to apply solder to half of each ribbon first, allow them to cool, then put the soldered part of the ribbon onto the top of the cell, and solder it on without adding more solder.

step 8: Continue wiring the cells

Apply solder to the top of the portion of each ribbon that is sticking out beyond the cells. This solder will be used to connect to the back of the cells.

Carefully flip over the cells and arrange them in two columns of four cells. Position them so they are close to one another, but not touching (perhaps a quarter-inch apart--they will expand in the heat). Bend the ribbons so the soldered portions touch the backs of the cells. Solder the ribbons onto the backs.

Solder the two remaining ribbon pieces to the two unsoldered backs. Remember to apply solder to the ribbon first.

You should now have two sets of four cells with ribbons sticking out the front and back of each set.

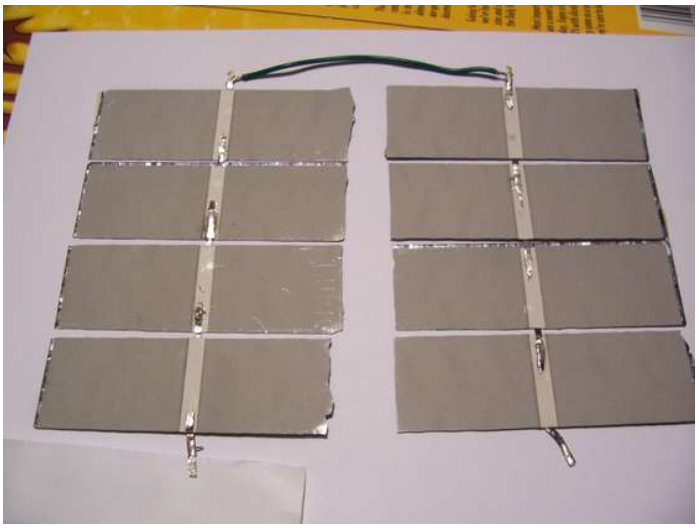
Image Notes
1. soldered connection

step 9: Continue wiring the cells

While the two sets of cells are upside down, place them next to each other as you want them positioned on the finished panel. Make sure that the ends of each set have ribbons connected to opposite side of cells. That is, the cell at the top of one column should have its top ribbon attached to the front while the top cell of the other column should have its top ribbon attached to the back.

Now that they are positioned, cut a piece wire the right length to connect the two top ribbons. Solder it to the ribbons.

You may want to carefully flip the cells over and do a continuity test. In full sunlight they should produce about 4 volts and 250 milliamps. The voltage and amperage will be less in indoor light. Make any fixes now and flip the cells upside down again.



step 10: Attach the cells to the backing

Using a blank piece of paper, create a template by tracing the outline of the backing constructed in step 6 onto the piece of paper. The outline will be used to position the cells onto the backing.

Carefully slide the template under the solar cells and position them within the outline as you want them mounted on the backing. Leave enough space on all sides to attach the clear plastic cover and for the two wires that will be soldered to the cells.

Apply a dab of adhesive about the size of a nickel to the back of each cell. You want enough to adhese the cells to the backing, but not enough to squirt out the sides, nor so much that the cells end up sitting up high off the backing--they need to be close against the backing to fit well under the plastic cover.

Hold the backing over the cells and, using the template outline as a guide, gently press the backing onto the cells. The cells are in danger of breaking in the step, so be gentle but firm. Pull up the backing, hopefully with the cells stuck on, and flip it over. You can do some repositioning and make certain that each cell is well pressed into the backing.

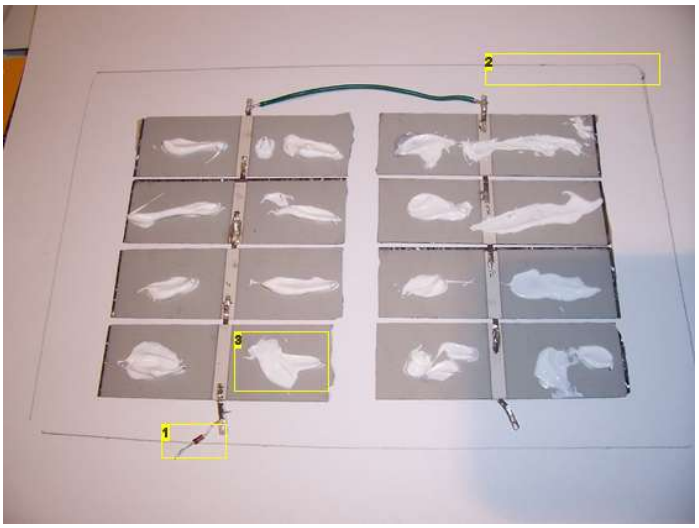


Image Notes
1. diode (attached in upcoming step)
2. template outline
3. dab of adhesive

step 11: Attach the connector wires

Cut two approximately six inch lengths of wire. Solder one to the ribbon attached to the back of the cell on the bottom so that the wire is pointed to the right, where it will exit the panel. This is the ground connection. To the remaining ribbon, solder the diode. The orientation of the diode is important--make sure it doesn't block the electrical flow. If it does, reverse it. Connect the second wire to the diode and have it go to the right as well.

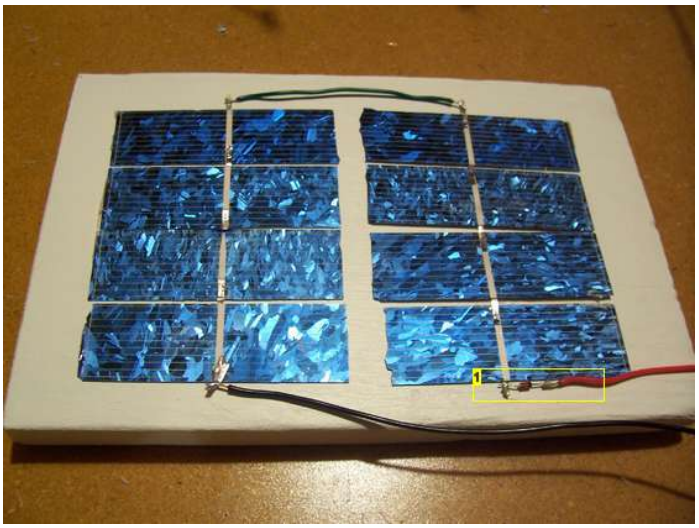


Image Notes
1. diode and connector wire

step 12: Create the cover

Cut a piece of clear plastic the size of the backing. Cut four pieces of plastic to create a frame around the cells. These pieces should be thick enough that when they are arranged around the cells that once the plastic cover is placed on top the cover doesn't touch any of the cells. Make sure that there is a small opening in the lower right side of the frame to allow space for the two connector wires to exit the panel.

Attach the frame pieces to the backing with a small amount of adhesive along the entire length of each piece. Position the connector wires to exit the frame. Once the four pieces and the wires are secure, place the plastic cover over the panel and drill holes for the wood screws. Make the holes in the plastic just a little bigger than the screws to keep the screws from stressing the plastic. Screw the panel in place and seal up any joints, especially where the connector wires stick out. Adhesive or silicon around the sides should keep water out fairly well.

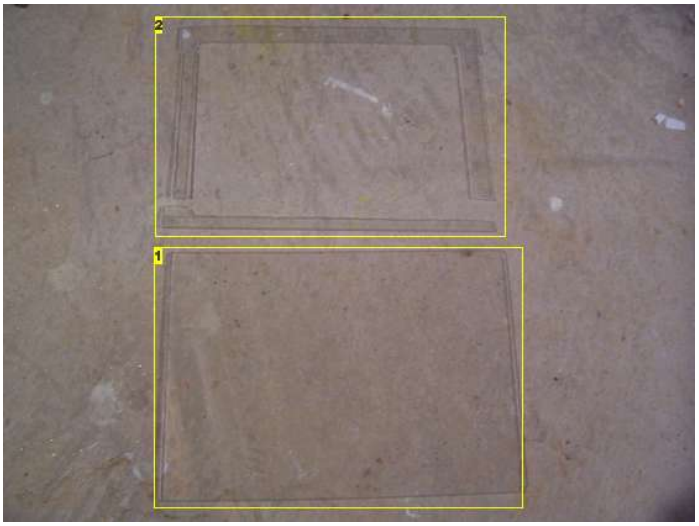


Image Notes
1. cover piece
2. frame pieces

step 13: Attach the battery holder

Solder the battery holder wires to the solar panel's connector wires, making sure that the positive and negative connections are correct.

To protect the battery holder from the rain, put it in a plastic container, like a cheap Tupperware container, with a hole punched through the side for the wires.

step 14: Put it in the sun

The solar panel is complete--place it in the sun and charge your batteries. I'm estimating that at 250 milliamps, the solar panel will take 10-12 hours to fully charge my 1800 milliamp/hour batteries.

Although the diode will prevent the batteries from discharging into the solar panel, there is no protection against over charging, so don't leave the batteries out too long. Also, the panel may not be able to take a drenching rain. Even though it is sealed up, I take mine inside if it looks like it is going to rain.

step 15: Possible modifications

The solar panel has worked great for me for the past month. AA batteries are charged in a day or two and the plastic cover has so far protected the cells. Minty Boost works to charge my phone with the AA batteries. (I had to splice together my cell phone connector to a USB connector.) By unscrewing the cover, I was even able to resolder the diode to the connector wire after it came free somehow. I also fashioned a jumper out of a paper clip to let me charge just one battery. (The jumper fits in the second battery's place in the battery holder.)

With some time, I'd like to improve the solar panel by adding a logic circuit to prevent overcharging my batteries. Also, I'd really like to leave the panel outside permanently and have the batteries inside, which would be convenient and would protect the batteries from temperature extremes. So far, I've been taking the panel and batteries outside when good weather is predicted and bringing them in during bad.

With a little work, this panel design should scale up to charge 12-volt batteries or perhaps an external laptop battery.

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hobbles says: May 13, 2009. 3:51 PM REPLY

Im gonna invest in getting better cells, you should make another panel and put it in series and it should cut the time in half. Im gonna try buying some from http://www.quadmodsusa.com/solarcells.html but i dont know how reliable they are.

hobbles says: May 13, 2009. 2:55 AM

(removed by author or community request)

ElectricMan1 says: Mar 28, 2009. 8:48 AM **REPLY**

Didn't your solar cells break over time because, like its already hard to solder them correctly, how do you put them in a plexiglass container without them breaking?

FaqMan says: Jan 7, 2009. 2:27 PM **REPLY**

This ible would help with our economy actually buying millions of none rechargeable batteries will pollute the Earth while rechargeable would not really. This can be the start of a cleaner earth.

Tobita says: Aug 16, 2008. 1:15 AM **REPLY**

hello, i am kinda of new to solid state electronics and learned most of what i know now from my grandpa, and i was wondering, if i had solar cells connected in series, and they charge a bank of capacitors (also in series) and i have a switch separating the wire that connects the +and- sides of the capacitors, and i have a transformer on there to regulate it, will i be able to sustain a charge long enough for say charging and operating a notebook?

---

kadris3 says: Sep 18, 2008. 3:59 PM **REPLY**

probably not. charge and use batteries. it's much simpler. a laptop requires about 18 or 19 volts. 12 for some systems, and 5 for the others. its a dual voltage menace. some use a single battery so make up one to parallel the internal system in your laptop. watch polarity to save your electronics. good luck.

Tobita says: Sep 18, 2008. 6:15 PM **REPLY**

oh my, dual voltage cells? well, if the problem would be shorting my battery or not having enough/too much voltage/amperage what if i simply connected the charging cable, if i stay in the operating amperage and voltage, i SHOULD be able to charge it, even for the smallest moment, right? if not, i could simply be the most hopeless person at this =P

---

kadris3 says: Sep 19, 2008. 8:19 AM **REPLY**

the internal battery cells usually aren't dual voltage. they are higher than the 12vdc systems available everywhere. the computer breaks the voltage down for the various systems it requires. if you are building a system for running the computer, you need two in series: a 12vdc jell cell and a 6vdc gel cell to give you the 18vdc that the computer uses. charge the battery array with about 20 vdc at low amperage. watch polarity carefully.

a starting point would be to measure the dc voltage on the output of the 117 vac charger that came with the computer. this will tell you the charging voltage. this is what you will need from the solar array. you can then design the solar array to charge the internal battery. you can then run it from the charged internal battery or the outboard 18 volt jell cells you made up. when charging it might be better to have the computer off to prevent an over voltage as the cells get near full charge.

the other alternative and much simplier is use an inverter on a 12 vdc system
to provide 117 vac to the charger which came with the computer.i have done this in the truck when i have been on the road and it worked well.
i used a 140 watt msw inverter from harbor freight $17.xx on sale. a 70 watt
unit as available from wally world for $14.xx and this also worked as well. i also did cell phones and electric razors in the manner. if you need more explanation please feel free to contact me directly to save bandwidth. go to unclecytheledguy.com and click on the contact uncle Cy. i will be happy to provide any electronic help i can at no cost to you. good luck

---

Tobita says: Sep 30, 2008. 3:34 PM **REPLY**

cool, but i am gonna keep most of my project for the winter months when it's too cold to go outside and have nothing else to do :D but hot damn, i can't wait !!!!

---

kadris3 says: Oct 1, 2008. 3:44 AM **REPLY**

good for you. many of us northerners do the same. i have several radios to build
and i pile them up until winter. lots of projects: electronic and otherwise.

i meant to mention earlier, a transformer is for alternating current, but a solar panel generates direct current. you might be successful at charging some capacitors but they would only provide tiny amounts of current. you need much more than that for the needs you described.

good luck with your project

Tobita says: Dec 11, 2008. 9:37 PM **REPLY**

it's winter now! and i put away most other things waiting for this one, first i need to reformulate the goal (charge things using the classic 2/3 prong North America plug) the power source (solar) and storage (pending, worst case is some capacitors in series with a high-end resistor at the end (i wouldn't do that)) so, if i get everything on paper/wetware/digital, i could start an instructable if i had someone capable of fixing the errors and putting things into effect (short on cash since a while, bought a tad too many gifts) then it doesn't seem too mind-meltingly massive.

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kadris3 says: Dec 12, 2008. 4:36 AM **REPLY**

with average intelligence, which you have already demonstrated, getting wired is no problem. as i have said before, forget capacitors. they will not work. get a couple of golf cart batteries at wally world. they are deep cycle 6vdc and more amperage than three trolling motor batteries. series up the two batteries for the 12vdc you need. keep everything on 12vdc and use an inverter to charge the computer. automotive lights(12v) work well and you don't need to convert anything. RV lights from an old RV, junk yard, RV store are easy to get, and work well. heed the cautions above and go for it. good luck.

Tobita says: Dec 12, 2008. 6:55 PM **REPLY**

i think now i would need to get the solar panels, but if we could use something that could diffuse the sunlight for more exposure and mount it on the panels it should chare faster, correct? and, when i visit saudi in march, should i dare attempt to bring it in the plane? xD (i wasn't serious, i would mail it instead)

kadris3 says: Dec 13, 2008. 8:30 AM **REPLY**

incorrect. diffusing sunlight cuts down on your output from the cells. this is especially true for crystalline, or polycrystalline. slightly less true for amorphous
silicone. there are some semi bullet proof(i.e. well built) panels out there but they are expensive. D.I.Y. is the only way to go if you are broke. if all you are doing id recharge a laptop, you may be able to go directly to an inverter and forget the battery bank. you need enough power to drive the inverter, so there is a downside to everything. have a safe trip.

Tobita says: Oct 2, 2008. 2:04 PM **REPLY**

cool, but either way, unless i move back to saudi arabia for good, i think this will stay as a novelty item xD

kadris3 says: Oct 3, 2008. 12:02 PM **REPLY**

that's o.k. too. even casual use may save a drop or two of foreign oil. as the whole nation does it, these little drops add up. besides being fun to play with, you have a back up system when the power fails. let the experiments begin.

Tobita says: Oct 4, 2008. 7:41 PM **REPLY**

yeap!

numenius says: Mar 7, 2008. 1:39 AM **REPLY**

This looks useful. I have a boat which has various battery needs so this would be a good soloution. Ready made panels seem overpriced here (UK) How much did this particular project cost?

liam01 says: Jun 7, 2008. 3:56 AM **REPLY**

yeah, solar panels are really expensive in the uk. Might try ebay.

stevezone says: Aug 8, 2008. 1:20 PM **REPLY**

seller fred480v on ebay sells the individual solar cells that you can inexpensively make your own solar panels with.

Ausi319 says: Oct 13, 2008. 9:36 AM **REPLY**

yea you can make your own.
i'm looking for a seller that will sell me some for a good price.
(and that i can just send the money in the mail or something.)

But how do you know how many milliamps you are getting?
i know the volts.
But how do you know how much your panel is putting into the battery(milliamps) at a time?

frontier says: Jul 16, 2008. 1:35 PM **REPLY**

http://www.allelectronics.com/index.php?page=search&search_query=solar&x=0&y=0
thats the cheapest place in the internet i've found for small solar panels anyway, i dont know about bigger ones :O

claire! says: Oct 8, 2008. 7:04 PM **REPLY**

this is great, but how big is each cell?

kadris3 says: Oct 1, 2008. 11:48 AM **REPLY**

here i am running my keyboard, and failing to complement the author.
i am sorry. this is exactly the thing which will free us from foreign oil. neither
right away nor overnight, but every time we succeed in less oil generated power being used we contribute to moving away from this house of cards.
we will win. it will be the students experimenting after school, the self directing mad scientist in his garage or basement, or the tinkerer in his shop that will eventually free us. keep up the good work. thank you.

eggplanthunter says: Sep 21, 2008. 3:13 PM **REPLY**

If I use 3v@200mA panel with a 1N5819 diode(drop=.34v@100mA), can I charge 2 AA NiMH(1.2v@2800-2900mA) batteries? Or will i need to go to a higher voltage, ie. 3.6v@200mA to charge the AAs.

kadris3 says: Oct 1, 2008. 4:09 AM **REPLY**

the 3.6 vdc would be better. you should be a volt or two over the voltage of the cells. at 2.4 vdc and a .34 vdc voltage drop across the diode you are about as low as you can go and still obtain a charge. even higher than 3.6 might be better as it will take longer to charge as the cells approach full charge. it will take 2 days of full sun to charge them up as winter usually has less sun than summer time.
good luck. be sure to tell everyone how it worked for you. we learn from the success of others. good luck

eggplanthunter says: Oct 1, 2008. 7:53 AM **REPLY**

Thanks, I decided to go with the 3.6s. Just one question. When you said a higher voltage would make it charge faster, I was under the impression the amperage affected charging speeds more than the voltage....

kadris3 says: Oct 1, 2008. 11:27 AM **REPLY**

both are related. if you are charging a 2.4vdc battery bank with 3 vdc array and have a diode in there, it may hardly ever get to full charge or take forever. you need a few volts over that which you are charging. 13.8 is used in car alternators to charge 12vdc batteries. 8vdc generators charge 6vdc batteries in older cars.
if 6.2 vdc were charging a 6vdc battery the time constant would be almost infinite.
once the proper voltage is established, get the amps you need by paralleling up more cells. you are correct in that amperage determines the length of charge, but this is only true once the proper voltage is established. you configuration will take about 2 days in bright sunlight. good luck with your array. please let us know how you do. thank you.

jackusage says: Sep 24, 2008. 12:47 PM **REPLY**

If you link the cheap solar light panels together in an array is there a limit to the amount of panels/voltage/amps that the array or each individual panel can take without getting damaged? If you could private message me the answer I would appreciate it.

iman says: Nov 29, 2006. 10:01 PM **REPLY**

this may sound extremely stupid, but what does a diode do ? :(

kinz1jg says: Nov 30, 2006. 11:26 AM **REPLY**

A diode allows electrical current to flow in only one direction. For this solar panel, the electricity should flow from the solar cells to the batteries or device, but not the other direction, thus the diode.

besilly says: Mar 9, 2007. 11:27 PM **REPLY**

Would you have any directions on how to connect such a diode? I am trying to hook-in some solar panels into my electric car batteries. I have bought some diodes. How would they be connected between the battery and the panel wires?

Ian01 says: Jul 28, 2007. 5:10 PM **REPLY**

kadris3's explanation confuses even me, and I'm very hard to confuse.

The diodes should have a line around one end. That end is the cathode. The other end is the anode. On a schematic, the cathode is the line at the tip of the triangle, and the triangle is the anode. Current can flow through the diode from the anode (positive end) to cathode (negative end) only. If you try to put a current through the other way, it will be blocked. There is a small reverse leakage current in all diodes. Diodes also have a forward voltage drop, meaning that the voltage at the cathode is always about 0.7 volts less (for a silicon diode) than the voltage at the anode. What this means for charging batteries is that if you use a 12 volt solar cell with a diode, the batteries will only get about 11.3 volts. 12 volt batteries need about 14 volts to charge, so you will need a ~15V solar panel. If you use a germanium or Schottky diode, you will have a forward voltage drop of 0.2 volts or 0.15 to 0.46 volts respectively. With these diodes, the batteries get more voltage, but there is more reverse leakage in the diode, but that's not very important, as there is not enough leakage to damage the solar cell. (Solar cells can be damaged by reverse current, because they are diodes, but they have a low breakdown voltage.)

kadris3 says: Sep 18, 2008. 3:50 PM **REPLY**

sorry, i didn't mean to confuse. by chasing electrons on paper it is easier to understand the direct short/infinate open of the diode.

kadris3 says: Jul 20, 2007. 8:16 PM **REPLY**

u should use a shottky diode as the forward voltage is about .2vdc. germanium is next w abt .4vdc. a silicon one has .7vdc. small voltage loss is better. the line is cathode and the arrow is anode. current flows against the arrow positive to negative. if u don't get this(many of my students don't), place the diode in one of the lines of the solar cell. take a reading w a volt meter. if u have voltage, it's in correct : solder it quick to insure it stays right. if u get nothing on the voltmeter, the doide is backwards. turn it around and check it again. if u get a reading solder it quick. if not ur diode is bad. get another diode and start again. when u get a volt reading, solder quick. if u don't have a voltmeter, use an led. solder a 680 ohm resistor in series. long lead is plus on the led. good luck. X

kadris3 says: Jul 21, 2007. 11:05 AM **REPLY**

major mistake:
current flows NEGATIVE to positive.
sorry

Ian01 says: Jul 28, 2007. 4:45 PM **REPLY**
Current flows from positive to negative, electrons flow from negative to positive.

iman says: Nov 30, 2006. 6:34 PM **REPLY**
Thanks :)

Matt

BruceMiller says: Mar 31, 2008. 1:39 PM **REPLY**
Good presentation, +1 points. Practical, easy to understand. The link to Plastecs is now 404, try cutting it down to http://www.plastecs.com/ and it should work.

projects2 says: Mar 31, 2008. 5:37 AM **REPLY**
I want to make food heater for one plate of food at a time. The food plate will be plced in a tightly sealed casing that is covered with aluminium foil in the inside. The project is for a school project.
I also intend using a heater fan of the following ratings
heater
115/230V
fan

24Va.c./d.c.

ajparag says: Mar 17, 2008. 9:22 PM **REPLY**
this is a nice instructable. thank you!

I suggest you update this instructable when u get more ideas.

static says: Mar 9, 2008. 8:06 PM **REPLY**
Some of the "solar yard lights" do have battery holders and charge a pair of AA nicads in a day. They have to be the most inexpensive solar battery charger I know of.

CommanderBob says: Jun 23, 2007. 12:12 AM **REPLY**
Nickle metal hydride batteries can take up to 1/10 of there mAh rating and safely dissipate this as heat. This is the minimum and I am sure that if your batteries were charged and you left it there for say an hour, nothing would happen. Now if your batteries are lithium than it is a different story.

r.abdou says: Jan 29, 2008. 3:56 AM **REPLY**
How Old are you?

denassdidu says: Dec 17, 2007. 7:59 PM **REPLY**
A poly backing work's great for placsing on top when you won't to flip them over!

denassdidu says: Dec 17, 2007. 7:48 PM **REPLY**
Great info. It work's best if you solder the tap's first' and then solder the tab's to the cell!!!1

denassdidu says: Dec 17, 2007. 7:44 PM **REPLY**
Good info!!! RECsilicon.com, realy has got my notice on quul's and supply.

denassdidu says: Dec 17, 2007. 7:40 PM **REPLY**
do not over heat the tab wire's, or they become frail.

diehlman says: Oct 29, 2007. 2:34 AM **REPLY**
During the day the process is
Sun > Solar Panel > Battery = charging
During the night the process reverses
Battery > Solar Panel = discharge
The panel will discharge a battery over night.
The diode is used to stop the discharge at night.

zener diodes regulate voltage and are rated in watts. a 1/2 watt circuit will burn out a 1/4 watt zener diode.
15 volt zener
25 volts in> 15 volt zener > 15 volts out

Regulators can be used to control voltage, and or current depends on the design. To figure watts multiply voltage times the amperage.
watts = Voltage X amperage.

A 64 watt solar panel say at 15 volts = 4.25 amps
a regulator would drop the voltage to 14volts and regulate the current to below 1 amp to safely charge a car battery. It should also include a blocking diode to prevent discharge.

denassdidu says:
Where to buy???

Dec 17, 2007. 7:29 PM **REPLY**

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