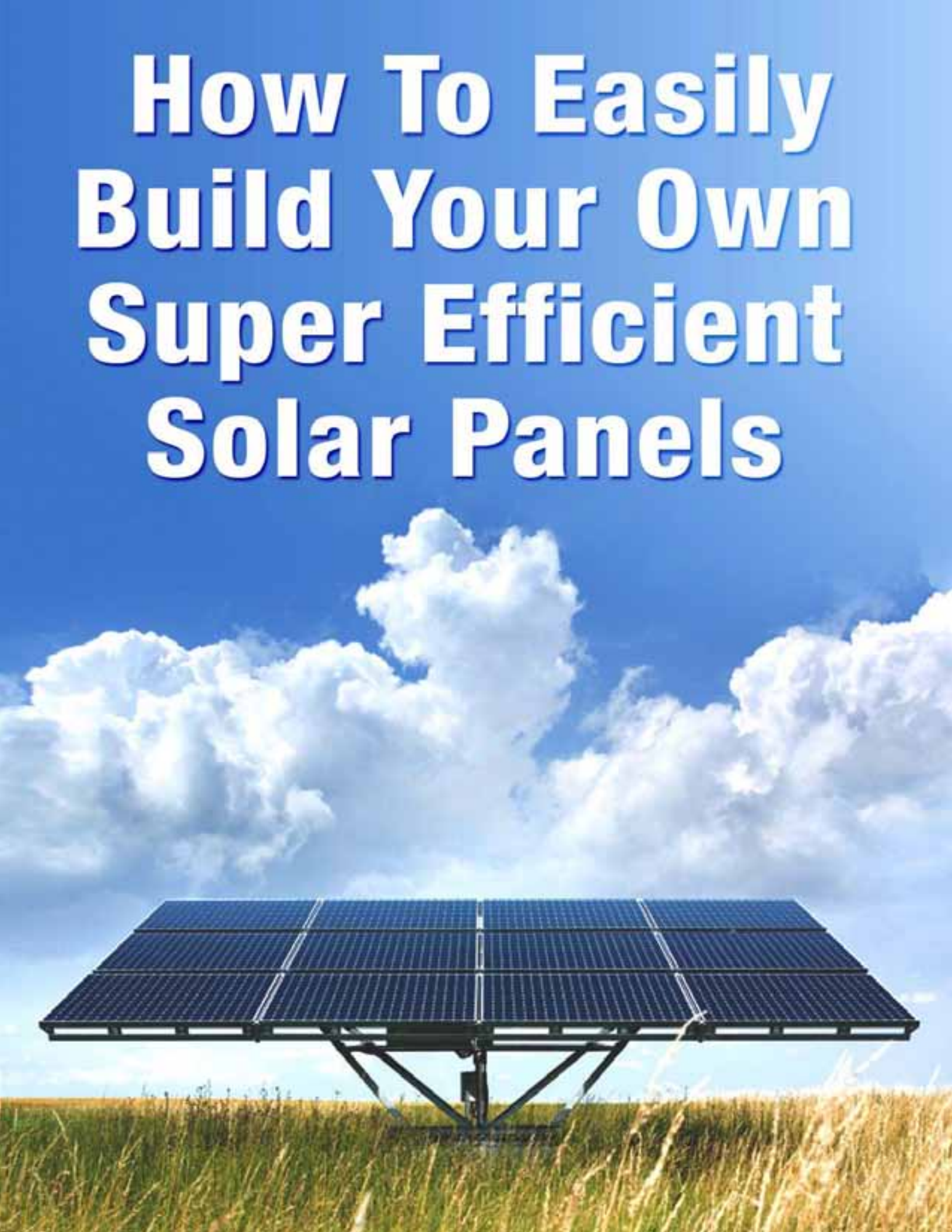
How To Easily Build Your Own Super Efficient Solar Panels



Solar Power

This Manual covers:

Solar Power Dynamics

Setup Options

PV Panel Construction

Maintenance

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Power4Home.com will NOT BE RESPONSIBLE for any mishaps that occur during the build, test and application phases of your construction. We are also not responsible for a partial or complete system that has problems or causes injury. You have all the information included in this manual to safely manage and handle solar and wind generators. Common sense goes a long way. Please, if your knowledge of household electrical is not par with a certified & licensed Electrician, call your local Electrician to wire your system into the electrical breaker panel and please inform your utility company of your new system.

PLEASE READ THE ENTIRE MANUAL & ALL THE EBOOKS BEFORE DOING ANYTHING. THERE ARE TASKS AND TESTS TO BE DONE THROUGH OUT THIS BOOK

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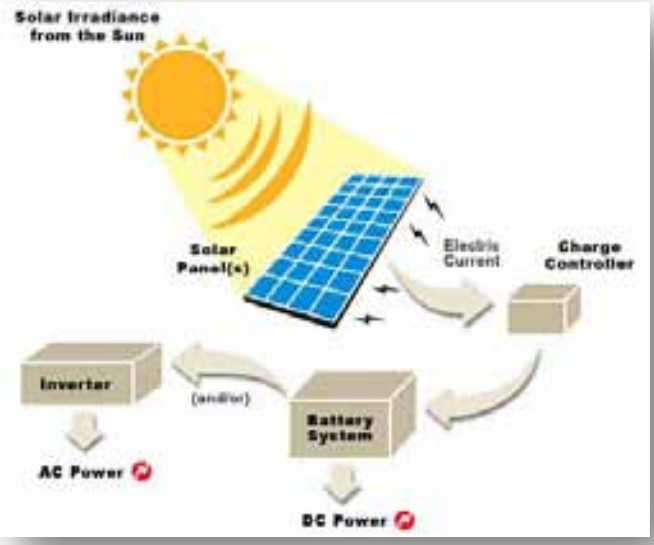


SOLAR POWER

Solar power has the extraordinary ability to give us an abundance of energy just by hitting the earth's surface.

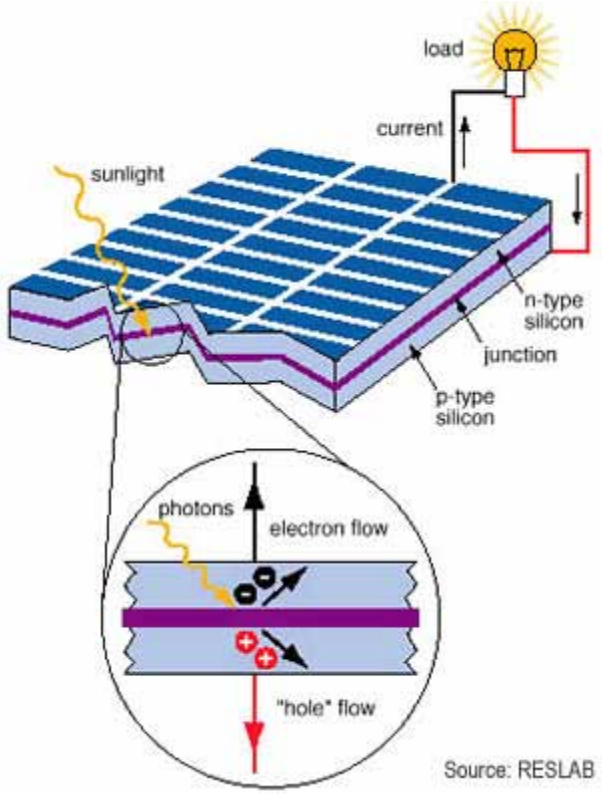
Today, the main reasons that we don't use solar power for most of our energy needs is due to the fact that it is expensive, but also because there are technological limits as to what we can do with solar energy that is available. However, the good news is that this will not always be the case.

So how does solar power work?

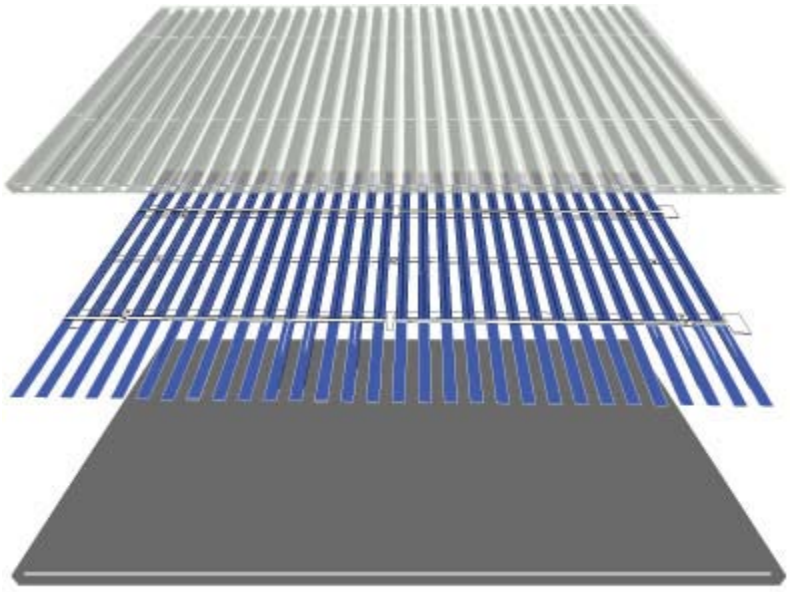
Well, energy from the sun reaches a particular earth surface and we then convert this energy into the usable form called electricity. Solar panels are used to collect the solar energy and convert it to usable energy.

In order to do this solar panels use photovoltaic cells (PV). The word photovoltaic actually means light electricity. Photovoltaic cells are composed of semi-conductors. Although there semi-conductors can be made from many materials, the most common is silicon.

Energy from the sun's rays cause a reaction when they hit the surface of the semi- conductor. The chemical composition of the solar panel allows for the energy hitting the surface to be absorbed, which in turn, causes the electrons to move away from the atoms creating electricity.



Currently, the technology used in semi-conductors is limited allowing only a percentage of energy from the sun to be absorbed. Fortunately, everyday advances are being made in this field which will allow for more solar energy to be absorbed and converted.



SOLARIA CELL CONSTRUCTION

It's helpful to know that your choices regarding how you decide to go about designing and building your PV system will rest largely on what skills you possess and the confidence you have in those skills. If you aren't comfortable working with electricity then by all means, hire an electrician to do the hookups for you. You don't save any money when you shock yourself and end up in the Emergency Room.

Better to spend a few bucks on a qualified professional than to find yourself in a hospital bed. Also, be aware that in many locations while there are tax incentives and other benefits to putting up an alternative energy supply source and even selling excess back to the utility, these often come with details you'll need to be aware of. One of the big ones will be “compliance” issues which will inevitably require that you hire a professional to at least inspect your work to certify it as being up to code.

Some states or provinces will require that you have a qualified, licensed professional do all of the installation. Check your local codes to be sure. Finally, while it is going to cost you some money to put a realistic and viable PV system in place on your home, you can often recoup the money spent in a few short years of power savings and, in today's market, this is an upgrade that can ad its cost (or more) directly to your home's value.

Why You Need Solar Power

Before you even begin considering your solar options, it's important that you know why, exactly, solar is right for you. Without getting into any of the humanitarian reasons for doing it, like the environment or cleaner air, let's look at real, measurable reasons. First off, the cost to power your home, cabin, RV, and other things is rising. Electricity is hitting more and more of us squarely in the pocket book.

So more and more people, like you, are looking into alternative ways to generate electricity to cut down their bills. Guess what? This is not the best reason to get into solar. I know, seems counter-intuitive for someone writing a book about solar power and PV panels to tell you that solar may not be the right answer for you. But it's the truth.

Solar is a great way to generate electricity and is perfect for the situations its best suited for. There are times, however, when other alternatives may be better but not often.

When Solar is a Good Option

If you're looking to supplement your home's power or cut down your monthly utilities, you might want to look at wind as a solution rather than solar. It has a cheaper startup cost and is often more effective in rural or sprawled suburban environments. In the compact city or the close neighborhoods of many suburbs, wind is not a good option, however. It's in those situations that solar really, well...shines.

If you have a rural property and need only to power a few specific applications, such as a water pump, electric cattle fence, a few specific appliances, etc. and don't need 100% reliable, 24/7 energy for use, then solar is a cheap alternative to running long utility lines or building towers for windmills.

Other applications for which solar PV is particularly well-suited:

- Remote vacation/occasional use sites such as cabins, cottages, etc.
- Recreational vehicles such as campers, boats, “sheep rancher” trailers, etc.
- Farm/ranch applications.
- Remote, outdoor, or security lighting uses.

If you aren't sure whether your intended use for a solar PV array is a good choice, don't worry. A good part of this guide is determining whether solar is right for your purpose and how to most economically get that need filled. If solar photovoltaics weren't at least a possible solution to your problem, you wouldn't be reading this guidebook, so we will continue on the assumption that solar is a possibility for your project. With that in mind, let's move on and see if solar can fill your need.

Before we can determine that, you'll need to understand the basics of how solar panels and PV systems work and what the up and down sides to this solution are. With this information, you'll be better prepared to make a more informed decision.

How Solar (PV) Panels Work: In Depth

This isn't going to be a nitty-gritty science guide to how photovoltaic's work on an atomic and molecular level and you won't find equations or big scientific words in this chapter either. This guide is meant for the everyday person and the hands-on do-it-yourselfer, so advanced theories and calculations aren't needed. Instead, let's look at how solar electric power is generated and how a small system, such as the one you're considering, will function on a day-to- day basis.

The word "photovoltaic" is actually a mixture of two Greek words: "photo" (light) and "Volta" (the Italian physicist who is credited with inventing chemical batteries). So photovoltaic means "light into electricity." Remember this, because you'll see a lot of literature on solar energy, solar panels, and solar heating that are not systems to create electricity from the sun, but instead are other solar applications, such as water heating, home heating, and so forth. It's also important to note that while photovoltaics apply to the creation of electricity from sunlight, there is more than one way to do it.

Those "solar panels" we all think of automatically are only one way that the sun's rays are being captured and turned into electricity. Regardless, we're talking about smaller-application systems which utilize those solar panels you're familiar with seeing and not "solar collectors" or "solar hydro-electric systems" that boil water using intensified sunlight and then convert the boiling water into power. All those aside, let's look at the basics of how those black solar panels you've seen and read about actually work.

Each panel is made up of cells, usually lined up in a grid or honeycomb pattern. Each cell captures light from a specific spectrum (or range of) and converts that into electricity. The material used to make each cell can vary a bit from panel to panel, depending on the technology used, but it's usually a semiconductor material of some kind. The light in the spectrum(s) they're tuned to agitates the electrons within the cell, causing them to move. The freed electrons travel through the material and become electricity in a direct current (DC), flowing in one direction (due to the design of the solar cells).

This electricity can then be manipulated to be used in applications like lighting, heating, etc. In today's technology, panels are improving almost daily and can

catch and utilize a much wider spectrum of light than panels of only five years ago could. In fact, your latitude is no longer the major issue it once was in determining whether PV is right for you because these much wider spectrums of capture mean that even places with limited peak sunlight exposure can get great results from their solar PV system.

Solar Systems for Electrical Generation

There are three basic types of solar-electric generation systems for use in small and residential applications: autonomous, hybrid, and grid-connected. Each system is unique in how it applies solar power to the application it's intended for, but each has the common characteristic of using solar PV systems to generate the electricity in the first place.

The Autonomous System of solar PV is merely a solar-electric system that is used as the only means of generating electrical power for the application. This is often the choice when powering a specific appliance or process that does not need to be active 100% of the time, such as night lights, road signs, water pumps, and so forth.

Autonomous systems are used in everything from the simple little patio lights you buy at your local hardware or home improvement store to automatic livestock water trough pumps and electric fencing. This is one of the cheapest and fastest ways to set up a solar PV system.

The Hybrid System of solar PV is a system that relies on solar electric generation as the primary means of generating electricity for the application, but has some kind of backup generator for ensuring the system is powered as close to 100% of the time as possible.

This is usually the setup for remote cabins, recreational vehicles, and some security applications. The backup generator is usually gasoline or diesel fuel powered and will automatically start up whenever the power in the system reaches a specified low point or when a bank of batteries for power storage reaches a low charge.

Finally, the Grid-Connected system is the most common residential setup for solar PV. In this application, the house or building to be powered by solar is also connected to the utility power grid, which supplies the electricity not supplied by the PV system. In most residential applications, the solar PV does not supply enough power to run the entire household, but is instead a supplement to the power purchased from the local utility.

In times of peak production, extra power from the solar panels not being used by the home is returned to the power grid and credited, while in times of low production, power is mainly derived from the grid while the PV system lies dormant. Solar PV systems use batteries to store excess power for later use, with the exception of many grid-connected systems. Since batteries can often make up nearly half the cost of the solar PV system itself, it's no wonder they get left out when they aren't really required.

The Pros and Cons of Solar

Solar power generation has definite advantages and a couple of strong limitations as well. Before you make a decision as to whether solar is right for your application, let's look at those pros and cons. Solar's advantages are many. The creation of electricity with PV requires no moving parts or loud motors, so it is quiet, and safe.

It is also very versatile and can be utilized in a number of applications where other forms of electrical generation are not feasible or would require great cost to implement. Solar PV systems are also easily built to be modular, so adding to them for future expansion is very simple once the system is in place.

Solar has a few disadvantages as well. First, the initial costs of solar are more expensive per watt generated than most other forms of alternative electrical generation. Solar is also not 100% reliable 100% of the time and can only generate electricity during specific times of the daylight hours. Solar electricity is also not as efficient as some other means of generating power when you consider the losses incurred through conversion and storage of the power generated.

So the advantages and disadvantages should be weighed against your needs and budget. If solar is still an option for you, then let's look at what your needs really are and how much solar PV system you're going to need to meet that need.

The Power4Home PV Solar Panel

The Power4Home solar panel was designed with only one person in mind… YOU! The only reason why you haven't purchased an "Off the shelf" pre-made kit is because it was too expensive in the first place and it doesn't include installation. Also, you purchased these books to learn about and to build solar and wind generators so you don't have to go into debt to pay for a system that works.

Use the parts list to source your parts so that you can build a wind generation system for a 5th of is retail value. Now, there are a couple of items that don't have to be exact. You may need a different sized picture frame because you have purchased differently sized cells. Just get a frame with enough glass area for the cells. You can over-size it if you wish but it makes it heavier.

If your system is bigger or smaller, just adjust it to scale like using longer/shorter pickets, wood backing and frame.

You are to use a 30 cell arrangement for this build. You will need to reach an open voltage of 15 volts. So, if each cell is .50 volts (Industry Standard) and times that by 30, you get 15 volts. This cell arrangement is also a "SERIES" wired as we have to stack each cells voltage collectively. Soldering solar cells is easy as pie so don't fear it. **Anyone can do it.**

I use a picture frame because it has all the right stuff and it can be super cheap! It has a frame, the glass we need, recessed grooves to lay the panels with wires which allows us to silicone all the edges and we can drill it to a mounting system.

Parts for the Power4Home PV Solar Panel

Here, you will find all the parts you will need to complete your wind generator. You will notice that I do not add a price to each item. That is because you will get a different price then what I had to pay. The more expensive items can change in price depending on the source (eBay or kijiji) so do your homework on the big ticket items.

Keep In Mind: Google, EBay, Kijiji and Craig's List are your friends

Fasteners & Paint Materials:
Home Depot or Lowe's carry all of the items listed above. You should still see if you can get a good deal online. You may even have some at home.

Wood:
You or a friend may have the pieces that you will need. If not, Try construction sites or wood workshops and take some scrap pieces. Wood is cheap anyways.

Solar Cells, Flux & Copper Wire:
I picked up 650 cells for $400 off of kijiji. That's less than a $1 a cell. Even though you may not want that many, I have seen 30 2 watt cells go for $40. This is the single most expensive item out of all the things you need. Retail, 30 2 Watt cells would go for $160 or something close to that. Take your time and find a good deal. The good thing is that DIY (do-it-yourself) wind and solar market is hitting hard with hundreds of thousands of people gathering materials. That alone brings the prices down… down… down… www.siliconsolar.com

Picture Frame:

This item was sitting in my basement for YEARS collecting dust. Now it's time for it to work for me and for free! Go online, to garage sales or store shopping. You will find something you can use.

Refer To Your Parts List for Part Descriptions & Quantities

How to Build The Power4Home PV Solar Panel

At this point, you should have gathered all the necessary parts to build the Power4Home solar panel. Before cutting, drilling or assembling, make sure you check that all your parts work with each other to avoid frustration and extra expense.

"No returns on damaged goods" is what your retailer will say if you tamper with an item that's the wrong size. Even if you get a part for next to nothing, if you have almost completed the build and find out that you have the wrong part which means you have to disassemble the whole thing; avoid the frustration. ***It happened to me***.

There are 4 Phases to Complete:

1. *Picture Frame Disassemble*
2. *Solar Cell Arrangement*
3. *Sealing & Panel Assembly*
4. *Mounting Hardware to Solar Panel*

Perform each phase in the order stated above. Each phase has a step by step process with full illustrations in case you are a little confused. You can print out only the pages you need so you can build in your garage with a manual right beside you as oppose to having to go inside the house every 15 minutes.

Once the panel is complete, you can clean the exterior with soap and water. Allow 24 hours for water to dry then apply your paint.

Do not forget to mask the glass before you paint
NO LIGHT = NO POWER

Phase 1: Picture Frame Disassembly

Step 1

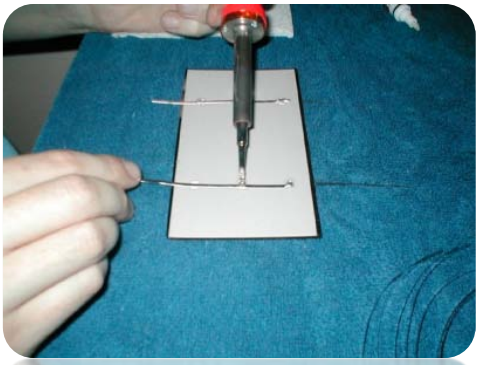
Take the picture frame and lay it on its front side

Remove the paper backing, wall mount string & staples that hold the frames internals in place

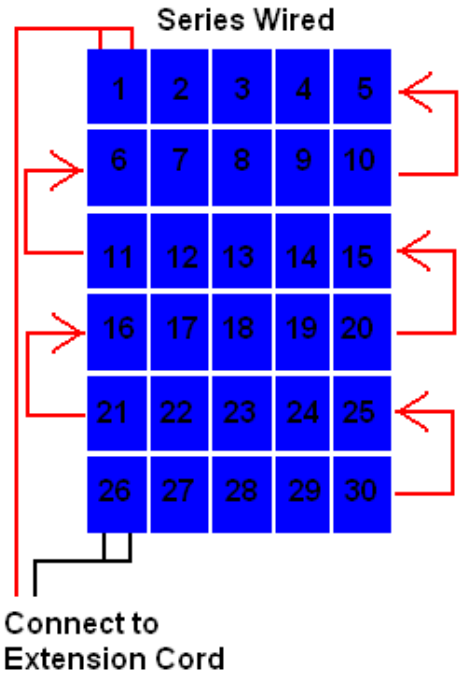
Remove the contents of the picture frame

Phase 1 Completed

Phase 2: Solar Cell Soldering and Arrangement



So now its time to arrange the cells on the glass pane we removed from the frame. **Remember that the bottom of the cell is negative and the top is positive.** All the soldering points must be attached when connecting. Here is how I arranged my panel.



Start at #26

The bottom of 26 is negative & will be used to connect to the extension cord. Solder the top of #26 to the bottom of #27. Now solder the top of #27 to the bottom of #28. Continue till you have reached #1.

Cell #1 will connect to the positive side of the extension cord. You can solder regular automotive wire to cells 1 and 26 so that you can connect the extension cord correctly

Watch These Videos:

How to Solder

http://www.youtube.com/watch?v=7iFFD-a7Qig
http://www.youtube.com/watch?v=NpZwtIixElQ&feature=related
http://www.youtube.com/watch?v=t7jjHX7XqQg&feature=related

How to arrange the cells

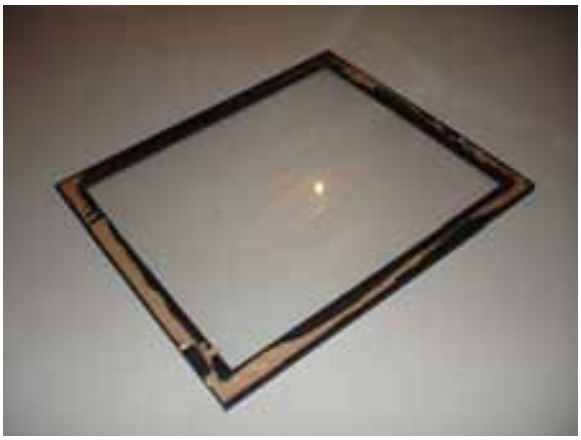
http://www.youtube.com/watch?v=eE-X8qUzi7E&feature=related
http://www.youtube.com/watch?v=p1-OYH9kL7s&feature=related
http://www.youtube.com/watch?v=QKZNftf9t0Q&feature=related

Phase 3: Sealing & Panel Assembly

Step 1

Lay the picture frame face first on the ground. Clean the channel that the glass sits in and apply a bead of silicone all around the channel

Install the glass and lightly press down on all the edges of the glass. Clean the glass after 24 hours of curing



Step 2

Lay the picture from the frame itself on top of the solar cells. Then slowly feed the cardboard under the cells. Flip the cells over (Bottom's up ;)) and line up the edges of the picture and cells perfectly. Now add silicone all over the back of the cells and place the cardboard on top and press lightly. Allow 24 hours to fully cure.

Step 3

Once all the silicone has cured, you can take the cells and place them on the glass

Now measure your frame and cut the plywood

Step 4

Measure out the corner of the plywood that you are going to insert the extension cord from and drill out a hole

Cut the female end off of the extension cord and feed it through the wood. Give yourself 6 feet of slack and place the wood up on a wall. Splice your extension cord ends to the positive & negative wires of the cells (White positive & Black

negative). Place the picture frame and butt it up with the plywood but face down on the ground. Silicone the entire out frame where the wood will mate with a bead and slowly tilt the plywood on top of the frame. The tricky part is pulling the cord out while you're tilting down so have an extra set of hands for good measure.

Silicone seal the hole. Allow the panel to cure for 24 hours.

Step 5

Once cured, you may start pre-drilling your holes around your panel. Drill 4 holes along the width end of the panel and 5 along the length. How deep you drill does not matter

Now take the 1 inch wood screws and begin screwing the plywood to the frame

Phase 3 Completed

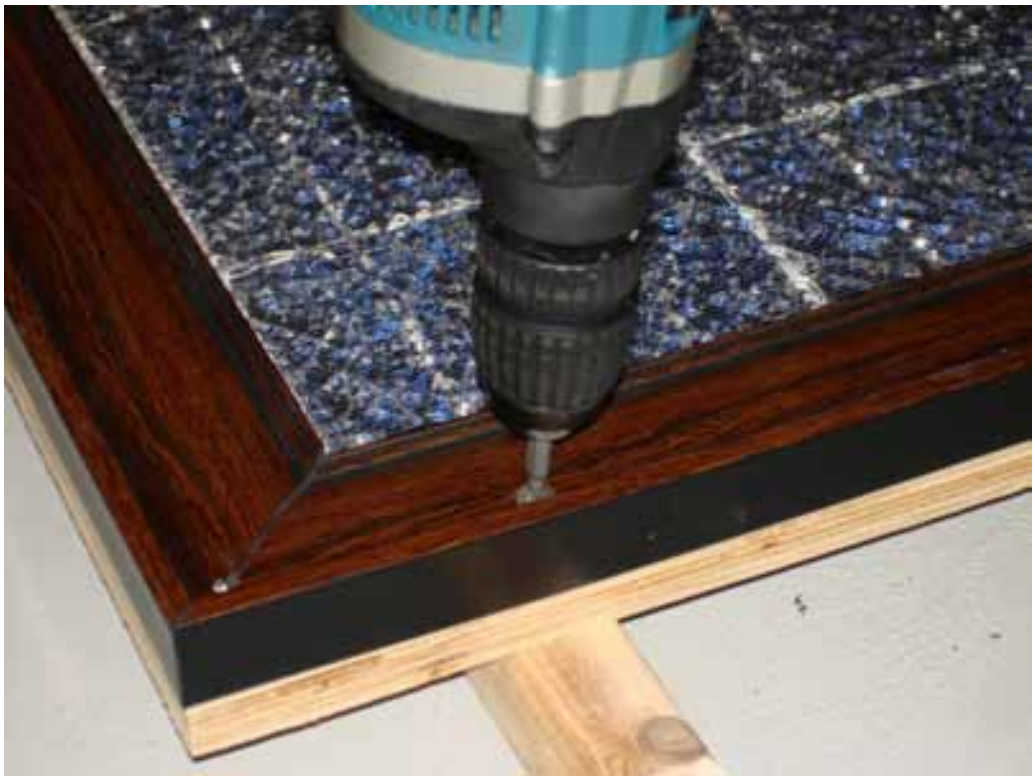
Phase 4: Mounting Hardware to Solar Panel

Step 1

Flip the panel over and lay it on its back. Line up the wood pickets to the ends length wise

Set the pickets 6 to 8 inches in and begin pre-drilling your holes

Now screw in the 2 inch screws from top to bottom



Make sure the pickets are even all around

Phase 4 complete

Note: You can now mask and paint the panel

Estimating Your Power Consumption and Need

Before you can get started building, buying, or installing a photovoltaic system, you're going to need to know how much of a system you're going to need, to do what you want it to do. There is more than one way to go about this estimation and some ways are less accurate than others.

We'll focus on the methods that are accurate enough for most people as well as simple enough to do yourself without needing a big knowledge base or expensive equipment. Just remember that the numbers you generate here will not be set in stone and could change with your situation, budget, or the availability of equipment.

Estimating Consumption for a Grid-Tie Connection System

We're starting with this one first as it is by far the easiest to estimate. Since you're already connected to the utility's power grid and are therefore getting billed every month, you've already got the numbers you'll need to work from to estimate your PV system's requirements.

This method also works for currently grid-connected buildings or housing that you plan to disconnect from the grid. Using your most current electric bill, you can usually get everything you need without any more research. Most electric utilities now include not only the current month's usage (usually measured in kwh or kilowatt hours), but also your average usage, per month, for the past year.

If your bill doesn't include this information, you can either ask the power company to supply you with it (often this comes with a fee) or go through your files of past bills and put the information together yourself. Once you know what your average monthly power usage is, you'll want to go through those months

and see what your peak, or highest-usage, month was. Make a list of these numbers for handy reference.

You'll need to know: your average monthly usage, your peak monthly usage, and your lowest month's usage. If you want to do cost-estimation and a Return on Investment (ROI) crunch, you'll want to write the current cost per kilowatt and average monthly costs as well. It wouldn't hurt to create a column next to each to write down a per-day estimate either (just take the number and divide it by thirty, so if you're average monthly kwh usage is 30, then you use 1kwh per day).

Now you have an idea how much power you need to meet you're lowest, highest and your average monthly requirements. This gives you a best-case to work from, as replacing all of your energy needs with PV.

Now, hopefully you've already got your budget range for how much you're ready to spend on your new PV system. So now you've got all the numbers you'll need to get started designing a PV system that's right for your situation.

Estimating Consumption for a Multi-Source or Off-The-Grid (Stand-Alone) System

If you're estimating for something that isn't currently powered or not even installed yet, then you're in for a little more work to get the numbers you'll need. If you're application is a single item or system (like a water pump or heater), then the numbers you'll need are probably right on the manufacturer's specs.

You're probably not that lucky, though, so you're reading this instead of a spec sheet to figure out what you're going to need. Let's assume that you're going with the biggest project possible and are planning to set up a system to power a cabin daily, all year round.

So what you'll need to know is what in that cabin will you be powering. Make a list of all of the appliances, lighting, tools, and other items that will be powered off the system. Use the chart provided as "Appendix I" at the end of this book for an easy start. Be sure to list every item you'll be using that runs on electricity, no

matter how small or infrequent. There are two ways to get the rated watt hours for an item.

If you already have the item or have access to its manufacturer's information sheets (spec sheets or ratings), then you can use the numbers they provide. If you're buying new appliances, now is the time to consider spending the extra money to get the most efficient model possible. Some items will have two numbers listed, one for “running” and another for when it's just plugged in.

Many items use power even when they aren't “on.” Your television, AC to DC conversion plugs, and similar things are examples of this. If you don't have access to the manufacturer's information and can't find a UL (United Laboratories) sticker or spec plate on the item, you'll need to figure it out on your own. Most common items are relatively the same, so you can find out what the item uses by going to a store and comparing the specs from a new item that is similar to yours.

Another way is to measure the item's usage with a meter, which you can buy from a local hardware store or PV supplier. These little devices plug into a wall socket and provide a new socket, which you plug the appliance into. It measures the power usage and gives you a reading.

Whichever method you use to gather the data, make sure it's as accurate as possible. If you own the appliance and have a meter to test it, then measure that way rather than going off the spec sheets.

Over time, older appliances tend to lose some of their efficiency and the spec sheets may be a “best case” number. Once your worksheet is filled out, you now have a base line number to go from. If you're planning to run the entire household or building from just PV, then you'll want to add at least ten percent (10%) as a cushion in case any of your numbers are wrong. Next, we'll discuss how you're going to estimate what you're really going to be using and how much it will cost to set it up.

Estimating Costs

Now that you know you're needs, you're ready to start figuring out how much your system will cost to purchase and install. The information you compiled about your usages and needs will be your beginning guideline towards pricing the components of the system. At this point, since you haven't fully fleshed out a design for your system, you're after ballpark figures and estimates to get an idea what it will cost per kilowatt, per panel, or however you'd like to break it down.

This is also the stage where you'll be finding out more about what the components of a solar PV system are. We'll cover that in the next chapter in more depth. Before we do that, however, let's consider some of the ways you can find out what your cost will be. There are a lot of ways to do this and many of them require only that you get online.

Most reputable solar system dealers have lots of useful information on their websites. Visiting their store, if you can, is usually better as there you'll find someone who can talk to you one-on-one about your proposed setup and get some more information about your system's price tag.

Regardless of how you get the actual dollar figures, make sure you get the following if you plan to purchase full setups (systems) from a dealer: what is the price per kilowatt hour per day or per month and do their prices include installation?

Most of the time, you'll find that their prices do not include installation—which is fine if you're a do-it-yourselfer and just want to purchase the setup and install it yourself. If you plan to have someone install it, find out if they have a recommended person in your area and then find out what their price tag is. Also, make sure the system includes more than just panels (conversion boxes, installation brackets, wiring, and so forth).

If the system they're proposing includes only the panels and nothing more, and you don't plan to install it yourself, either make sure your installer knows then

when giving you a bid, or find another dealer to get your solar system from. Regardless, at this stage you're only getting general numbers so you have an idea what your budget is likely to be like. Before you can set your numbers in stone and be ready to install, you're going to need to know more about the various components of a solar PV system.

Tricks for Getting Free PV Panels & Cells

Although solar or PV panels can be bought, we will now discuss how you can get them at no cost! The following advice can end up saving you thousands of dollars. An easy place to look for free panels is at a panel supplier.

Often when people purchase new panels the old ones, although in working condition, will get thrown away because they have been replaced by newer models making resale not an option. By calling the supplier, you can find out if they have any panels that will be thrown out.
Another place to get free panels is at construction sites.

Next time you drive by a construction site pay attention to whether or not the signs are solar powered as many are today. If you see that the construction site signs are solar powered, you may also notice that they have been damaged.

On the sign you will also find a phone number for the company that is renting the signs.

By calling that number and speaking to the maintenance manager, you will be able to ask for the damaged panels at no cost and even give them your contact information in case they have more panels to throw away at a later date.

This is also a great way to recycle slightly damaged solar panels that would otherwise be thrown away. Most of the panels that they are throwing away still work fine but

keep in mind that they are damaged and may not work at full capacity.

An easy fix for damaged panels includes soldering wiring that has come apart and using silicone for cracks.
For those of you who would rather purchase the panels, a great place to find panels at discount prices is at:

www.ebay.com
www.kijiji.com
www.criagslist.com

Google

You can find so much stuff just by using Google. This is becoming such a hot market because so many of you are using alterative means for power and saving big on cash. Search “Solar Panels” or “Solar Cells” in the Google search engine and begin your search for cheap cells.

angle of your panels. So if you live in Florida or Southern California, you likely won't need to change the angle of your panels at all, or will only need to make two small adjustments per year. For most of us, though, some angle changes will better our solar arrays output.

In the spring and fall, for most of North America, an angle of 40-50° is optimal while a shallower angle (30- 40°) is best for summer and 50-60° is optimal for winter.

Steps for Making Your Own Custom Solar Panels

1. First you must decide on how many solar cells you will use. It is recommended that you use 80 solar cells which create 100watts of power.

   If you want more power than this you will have to wire several panels together and will be discussed later in this chapter. Once you know how many cells you are using you can cut the plywood to the correct size.

2. Put 4 coats of the UV protector on the plywood.

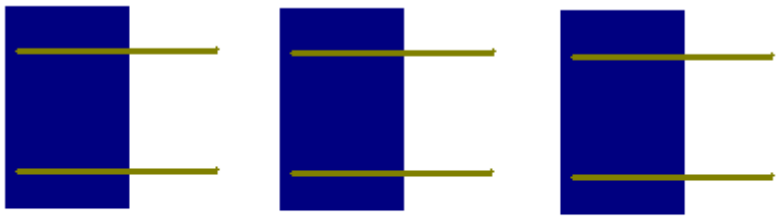
3. In order to bring all the solar cells together make the circuitry for the panel and put all of the cells face down on the ground. Always remember to handle the cells with care as they can be very fragile.

   Then place a small quantity of solder on the tabs on the back of the solar cells using a pencil style solder iron if possible to get it ready for the copper wire to be soldered on.

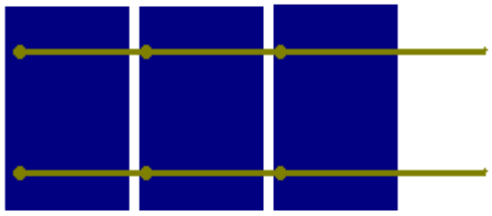
Parts of the Solar Cells

Front:

Cut the copper wiring so that it is double the length of the cell. Then solder the copper wiring to the front of the solar cells.



Solder the excess copper wire to the back of the next cell.



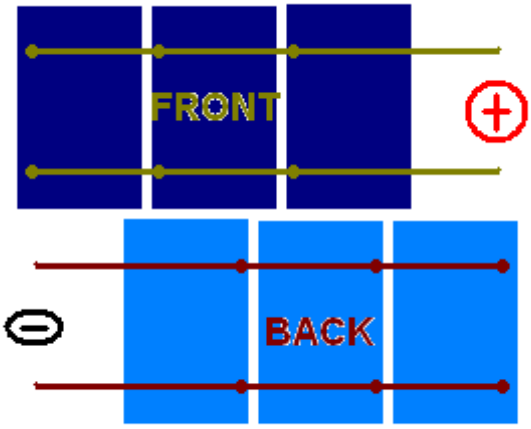
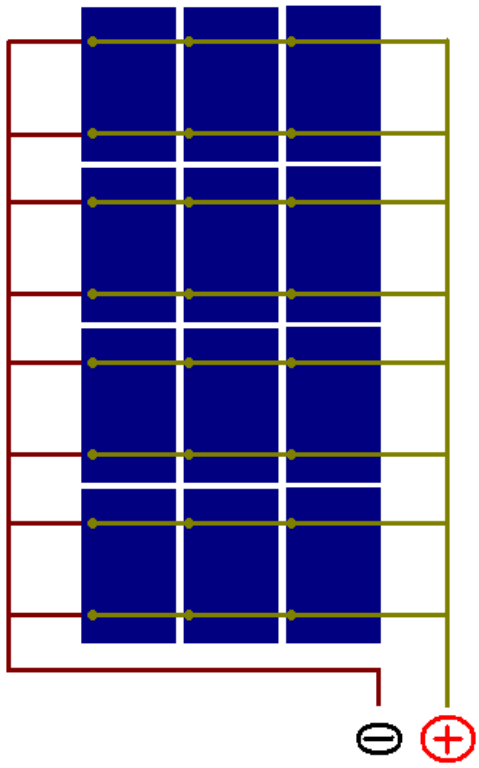


Diagram of the back and front of the cells once connected.

After the cells are joined in rows, all of the rows can be connected using thicker wire along the sides. The cells are wired together in a series to maximize the voltage.



Hint:
"It is recommended that you scratch the surface of the cells where you will be soldering with a butter knife or scraper before the cells are connected. In this case, you would have to scratch the tabs on the front and back if they are white because they should be silver."

4. Use the silicone to bind the cells to the plywood. It is not necessary to use a large amount.

5. Drill 2 holes in the plywood where the copper wire ends. Place the excess copper wire though the holes in the plywood (one wire per hole to avoid contact with each other). Refer to the previous cell diagrams if necessary.

6. Use the silicone to join the wood to the front plywood so that it creates a border for the cells and creates the place where the glass will be put. Once silicone is holding the unit in place, screw the wood down from the back.

7. Use the silicone to secure the glass to the wooden border.

8. Use the silicone to fill in any gaps or openings in the solar panel including the gaps around the copper wiring and the hole in the plywood.

9. Towards the bottom of the panel not near the wires, it is important to drill a hole to let the moisture escape.

10. Connect the copper and electrical wires together which in turn connects to the charge controller/batteries.

11. When you are ready to secure all the parts with glue make sure you test the panel in the sun using a volt meter. This will tell you the amount of power the cells are emitting.

General Construction Considerations

The solar panels you see on the rooftop or mounted on stands in a field are only one part of the total photovoltaic array. Those panels are just the beginning point of the whole sunlight to electricity pathway. They get all the glory, but like any good team, the unsung heroes in the background are the ones most responsible for the team's success.

The solar photovoltaic (PV) team usually consists of most of the following members:

- The solar (PV) panels
- The supports, framework, and brackets which hold the panels in place
- The wiring and connectors which move the electricity generated
- The conversion box for converting the DC power generated to AC for home use
- The diligent user who adjusts the tilt of the panels two or three times yearly to maximize
- power generation

These components all work together to facilitate power generation and use in your home. We've already looked at the panels themselves, so let's look at the other components that will likely make up your solar array.

Supports, Framework, and Brackets For Your Panel Array

Solar panels can consist of one cell or many cells grouped together into a series. A panel is usually one small series of cells that connect to a larger circuit. Panels can also be combined together to make a larger series that ads to a circuit. This seems

confusing, but it's not really once you understand how the system will work. For now, just know that a panel is several cells grouped together into one unit and that several panels make an array. Your solar panels will be housed inside a frame, sort of like the pictures on your wall.

This frame provides stability for the cells and their connections plus protection for the panels from the elements as well as from extreme temperature and other conditions. These frames, for durability reasons, are usually made of metal and have some kind of protective glass covering them (leaded glass is recommended, similar to the glass used for your car's windshield).

These frames also facilitate the electrical conduits needed to house and connect wiring from your array to the series or circuit they are a part of. These panels are attached to framework and supports (or brackets) which position them to face the sun.

Framework, Supports, Brackets

These are usually made of steel or of wood, and good ones are adjustable to at least two positions to face the panels at their most efficient angle. These frames can be simple wooden boxes with an angle or angles cut to allow for the positioning of the panels, complex lattices of cables and metal framing, or anything in between.

Usually, they are metal L- or U-shaped pieces bolted or welded together to make the support for the panel frames that will be attached to them. These are built to attach to your rooftop, the ground, or wherever you're planning to put your solar array. They could include things like concrete footings, rubber or tin “washers,” or facing to attach to the shingled roof, or other components for mounting.

No matter what they are made of or how they're connected, they should be:

- Strong
- Stable

- Durable
- Able to handle the load they're to carry

Optimum Angles

If you're designing or building your frames and supports yourself, you'll want to know a few things about optimum angles first. The best brackets and supports will allow you to adjust your solar panels' position at least three ways, though two is the norm.

Permanently affixed is all right if you have no choice, but you'll get better performance from your array if you can adjust the angle it faces with the seasons. The exact angles your panels should face at different times of the year is ultimately decided by your location.

The closer you live to the equator, the less often you have to change the angle of your panels. So if you live in Southern States, you likely won't need to change the angle of your panels at all, or will only need to make two small adjustments per year. For most of us, though, some angle changes will better our solar array's output.

In the spring and fall, for most of North America, an angle of 40-50° is optimal while a shallower angle (30- 40°) is best for summer and 50-60° is optimal for winter.

Glossary of Solar Panel Parts

The following is a list of the parts necessary for building your own solar panels:

1. Copper Wire: It connects the cells and can be purchased in different colors making it easy to color code the negative and positive.	
2. Glass: This part of the solar panel should be bought last because you need to have the measurement for the entire unit in order to know what size of glass to get at any glass store. The glass is placed over the solar cells connecting all of the components into one unit. If you are not able to get glass, acrylic can be a cheap alternative.	
3. Silicone: This is used to secure the glass to the border of the unit and the plywood and cells together.	

4. Solar Cells: These are the main parts of the solar panels. These can be found on eBay at a discount. You can find some that are in excellent condition or if you are able to repair them, you can find damaged solar cells that will cost next to nothing to fix. Hint: use words such as damaged, chipped, or broken in your solar cell eBay search.	
5. Solder: Used to bind the copper wire to the solar cells.	
6. Strong Plywood: Used to support the cells and is the backing for the entire unit. You will need to purchase between 10 and 15 mm.	
7. UV Protector Coats the plywood in order to extend the life of the plywood in the sun. You can use any type of deck or fence UV protector.	

8. Wood Used to create the border surrounding the cells that will hold the glass with silicone.	

Performing Maintenance on Your Solar Panel

Once your system is in place and functioning, you're going to need to maintain it to keep breakdowns from happening and to keep it running at peak performance. This guideline will give you a day-to-day checklist for maintenance.

The simpler your solar system is, the less often you'll need to do checkups and maintenance on it. For this checklist, we'll assume a full hybrid system with batteries, controllers, a backup generator, and so forth. You can cut things off this list to match your needs as necessary.

Daily

These checks are performed daily and basically consist of just keeping aware of your system. You don't need to climb up ladders, crawl into attics, or even open closet doors to do these checkups. Just stay aware of the system and how it's running on a daily basis.

- Is everything operational and functioning? If your lights don't come on, there's obviously a problem.
- Is the backup generator running right now? How long has it been running and is that unusual?
- Are the panels in good, visual shape? Any obvious cracks, breakages, etc.?

Weekly

These checks are performed weekly and require close looks and simple measurements or record keeping, but no crawling into nooks or up ladders to perform. They should be done every week to ensure your system is functioning properly.

All daily checks plus:

- How is the voltage level and other information on the controller's readout looking? Any major changes or unusual spikes it's recorded? Most models of controllers/inverters at least keep a short memory of spikes or drops in your battery bank's performance.

- Is access to the battery room easy and clear? Is there anything stacked near the controller, regulator, or other components that could be a problem or cause interference, like old televisions, radios, batteries, or magnets? These should be moved.

- Has anything been tampered with, changed, or otherwise been accessed by someone who's not authorized to do so? Kids, pets and other animals can find their way to improper places.

- Is any of the wiring or other components exposed that shouldn't be? What about water leaks and other hazards, are they contained?

Monthly

These checks should be performed monthly and will require a ladder, flashlight, and other things to get to where your core components like batteries and panels are located. These are simple inspections that don't require much other than visual checks, up close.

- Are the panels in good condition, no visual cracks or warping, etc.?

- Are all connections tight and sealed to prevent problems?

- Is the glass on the panels clear and unobstructed? Remove any leaves, limbs, snow, or wash the panels to get the dust and spots off. A simple squirt down with the garden hose will cover this. Don't do this in the coldest times of year to prevent ice buildup, however.

- Are the batteries OK? Any odd smells or strange corrosion on connectors?

- Any obvious leaks, bubbles-over, etc. with your batteries?
- Are the batteries clean and free of debris and dust? Use a light broom or a jet of compressed air to clear them off. A shop vac is also a good solution for dust and particles. Don't be too concerned about every small spec and be careful you don't disturb connections while you clean.

Bi-Yearly (Spring and Fall)

These checks should be done twice yearly, usually in the Spring and Fall, to ensure optimum performance.

- Do a manual cycle (drain and recharge) of your battery bank using your controller or exerciser, if the option exists. This will show you any trouble spots with battery leakage, loss of charge, etc.

- Clean the solar panels thoroughly. Use a mop and soapy water (after a hose-down) to get the glass truly clean. This optimizes performance and will show you where any cracks or breaks have occurred so you can fix them before they're a real problem.

- Check all wiring from one end to the other, making sure the whole system is intact and in good shape. Replace any wiring that is becoming frayed, loose, or otherwise compromised.

- Test each battery individually, whether your original battery test came up with a problem or not. While you're at it, you may as well take daytime readings from your solar panels, individually, as well. Make sure you aren't losing power or having power storage or delivery problems somewhere in your system.

- Replace batteries that are showing a problem now, rather than waiting for them to completely fail. A battery that is no longer holding a full charge or that is having a problem delivering its load should be replaced. It's still a

useful battery and, if it's the right size, can be used in your car or pickup truck or motorcycle or ATV until it completely fails. It's possible to get another year of use from a battery that isn't good enough for the heavy loads of your solar PV system, but can work fine under your car's light requirements.

- All components with self-tests should have those tests run now. Those that don't, follow manufacturer's testing suggestions.

Maintaining a solar array isn't difficult or time-consuming, it just needs to be done regularly. The biggest amount of real work you'll need to do for yours is likely just keeping the panels clear and clean. This is not hard and if you use the garden hose on them monthly during the spring, summer, and fall, you'll find that you may only have to really clean them once a year (springtime).

Since a solar system has no moving parts, it has very little that can break down and cause failure. Your problems are likely to all center around broken panels (weather, random events like baseballs, and so forth) and your batteries, which lose their abilities over time.

Cleaning the Panels

- Materials: Paper Towels or cloths, non-abrasive cleaners

- Clean panels once a month or more frequently if there is a lot of dust in the area.

- Keeping the panels clean is absolutely necessary because the more sun light that reaches the internal crystals, the more power that will be created. Even a small layer of dirt can reduce the amount of power by up to 25%.