Make A Home Made Power Plant

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Preface

Are you growing increasingly concerned about the rising energy costs, wondering how you'll be able to pay your bills?

How would you like to cut your electricity costs by 80%? What about making your power company pay you? At the same time, wouldn't it feel good to know that you are doing your part to save the planet from pollution?

If this all sounds too good to be true, read on. Allow your conventional ideas to be challenged, because what you'll read in the following pages can potentially have a huge impact on your future.

You'll learn how simple and easy it is to create your own solar panels or build your own windmill - for as little as $200! Not only is it economical to get started, you'll then be able to save hundreds of dollars each month. It's all about learning to harness the enormous potential available in alternative energy sources that nature offers all of us: the power of wind, sun, biodiesel, and ethanol. And you don't have to have a degree in engineering or be a licensed electrician to implement any of the ideas I'll share with you.

By adopting a green technology for your home your children and grandchildren will be forever grateful to you for leaving them the rich legacy of a healthy planet.

INTRODUCTION

Why HomeMadePowerPlant?

People are finally waking up to the disturbing realization that we cannot completely depend on fossil fuel to provide our energy for much longer. The price of oil continues to rise at an alarming rate worldwide. Wars are being waged over our planet's limited oil reserves. Irreversible damage has already been done to our earth and the effects on our climate are more noticeable all the time.

In a nutshell, if we don't take action now about our dwindling energy sources, future generations – our children and grandchildren – will be forced to deal with some very serious challenges. But even if we want to change things, what really can we do? Few alternative energy choices are affordable for the majority of people. Can you and I really make a tangible difference?

This book will provide answers these questions and many others. You'll discover some practical things you can begin doing today. This book will empower you to take action and play a part in solving our world's energy crisis.

This is your call to action. Change can happen today, and it can start with you. You'll learn the facts, and then you'll be

introduced to simple strategies you can implement now. You'll discover where you can find cost-effective (even free!) solar panels or – if you're a do-it-yourselfer – simple and easy plans to create your own solar panels. We'll show you where to find batteries for free, too.

These are uncertain times – energy costs continue to soar, natural resources are being depleted at an alarming rate, and pollution and global warming continue to worsen. While it can all seem distant and overwhelming, the solution to each of these issues actually lies within each of us. Our actions today *can* create change. Our daily decisions *do* have an impact on the world at large. How do I know this?

Do I have a series of degrees after my name from prestigious universities? No. Do I represent large conglomerates that make a profit from marketing "green" products? No again. I'm just a normal person who, along with my family, made a choice over twenty years ago to create a lifestyle that would no longer contribute to global warming, pollution, and an overconsumption of our planet's limited resources. Has it worked? Yes!

This is the primary message you'll find in this book: Each of us must take personal responsibility for the energy crisis or nothing will change. Nothing will change for the better, that is. Growing up in the sixties, I was among those who thought the earth's resources were unlimited; I had no idea that there were consequences for consuming them. **I was wrong.**

Chapter 1

Some Helpful Tips

Essential Facts About Saving Energy

Right now, even though renewable energy is not exactly affordable and often not very accessible in its current state, there are still plenty of ways you can cut down on energy costs. Here are just a few:

- Turn off your appliances when you're not using them. Computers and televisions continue to use energy even when they're in standby mode.

- Instead of always using your dryer or dishwasher, consider air-drying your clothes and dishes at least some of the time, and only run your dishwasher, dryer, or washing machine with full loads.

- Use energy-efficient fluorescent lightbulbs in your household lamps.

- Set your thermostat at a comfortable but moderate temperature – not too warm in the winter, not too cool in the summer.

- Take shorter showers and avoid baths.

- Maintain your vehicle – regular tune-ups insure that you get maximum fuel efficiency. When you drive, be aware that excessive speeds and rapidly accelerating and braking uses more gas.

- Seal your windows and doors. Preventing warm or cool air from escaping will make a significant difference in your utility costs.

If you are seriously considering using renewable energy sources like wind or solar power to heat and cool your home, then you MUST implement these suggestions.

I didn't just include them to look good.

There's simply no value in using a wind or solar generator if you continue to leave lights and appliances on when not in use, use more water than is necessary, etc.

Chapter 2

Electricity for Dummies

"What's Watt? I'm No Electrician!"

Let's examine how electricity works in daily life. Unless you are a licensed electrician or work in the electronics industry, you probably could use a refresher course on the basics. We'll start with a definition of the most common electrical terms and an explanation of how this relates to your home.

Watts

You're probably familiar with the term ***watt***, but do you really know what it is?

A ***watt*** equals the power produced by the current (amps) flowing through a wire multiplied by the pressure (voltage) at which it flows.

Volts

Similar to the water pressure in a pipe, the pressure of electricity flowing through a wire is known as ***volts*** (voltage).

Amps

This is the amount of electricity flowing through a wire.

Power Rates

We've all seen the term KWH (kilowatt hour) on our electric bills. This refers to the rate of power flowing through a wire. For instance, if a 100-watt lightbulb burns for ten hours, its ***power rate*** is expressed this way: 100 x 10 = 1,000 watt hours, or 1 kilowatt hour (kilo stands for 1,000).

Direct Current (DC)

This book will cover both ***Direct Current (DC)*** and ***Alternating Current (AC)*** power as resources for your renewable energy system. AC current is commonly used in homes today.

What is the difference between these two currents? First of all, DC currents can be stored in a battery, while AC currents cannot. There are many other advantages to using

DC appliances, but the key thing to remember is that DC motors are more efficient than AC motors. Common DC voltages are 12, 24, and 48. DC power has many applications, but the most important for our purposes in creating an off-grid home is that we can use this form of energy, while there's no way to implement it in today's average home.

When you design your own renewable energy system, you'll use DC power produced by solar panels or a wind generator. Using an inverter, the DC power will then be converted to AC power. Don't worry – you'll learn all about inverters later.

Converting DC power to AC power is beneficial because it allows you to use many of the same appliances that you already own. Even if you decide to purchase new AC appliances, it would still make sense because they are so much more economical due to mass production. As you make the transition to DC power, isn't it reassuring to know that you will be able to continue using some of the appliances you now own?

AC Current

Alternating current just means that the current changes direction constantly. AC is the most common form of electricity in use today because up until now it has been easier to work with than DC currents.

Chapter 3
Your Very Own Solar Generator

What Is Solar Power?

When you stop to think about it, solar power is really incredible. The sun creates enough energy each day to provide more than enough power to sustain everyone on the planet. So why isn't it more common today? Why don't more people use solar energy?

Well, one reason is that solar power is still very expensive. The technology hasn't quite been developed enough yet either. We can expect both of these limitations to change, hopefully in the near future.

To use solar power to make electricity, the sun's energy is collected over a large, designated surface area. Next, this energy is converted into electricity. This process is called "photovoltaics."

What Is PV, and How Does It Work?

"Photovoltaic" (PV) is made up of two Greek words: "photo" (which means light) and "volta" (taken from Alessandro Volta, the Italian physicist who invented the battery in 1800).

The PV process converts solar energy into electricity. Unlike hot water systems that utilize solar energy (heating a swimming pool, for example), PV does not generate a lot of heat. The solar thermal process is also different; here solar energy is concentrated and used to produce steam, which is then used to activate a turbine connected to a generator.

The Advantages of PV Power Systems

PV power systems have many benefits. They are quiet. They don't produce any pollution. They are reliable – there are no moving parts to worry about, so they require minimal maintenance. Another great advantage of a PV system is that it's modular. The cells (or building blocks) are available in a wide variety of wattage, ranging from a mere fraction of a watt to more than 300 watts. Large PV power plants have higher megawatts, but most individual systems are much smaller. You can choose the PV modules required to deliver the power you desire for your system.

One downside of solar energy is that much of the sun's energy is lost during the process of transferring sunlight to electricity. To solve this challenge, larger and more efficient panels continue to be manufactured all the time. And while they are still less efficient than they ultimately might be, they are still the renewable energy system of choice because they require so little maintenance and are quite durable.

A solar panel system should last around fifty years, as long as it was properly installed. A pretty wise investment, all things considered!

If you choose to install your own PV power system, you will appreciate its quiet, low-maintenance, pollution-free, safe and reliable operation, as well as the degree of independence it provides.

Other Reasons to Use a PV System

Maybe you live in an area that is not located near an electrical grid. In this case, you might find that it's more economical to generate your own power than to pay to extend transmission lines to your house from the grid.

Some other alternatives include diesel gasoline, fossil fuel, or propane generators. However, unlike PV systems, these are noisy, costly to run, costly to maintain, and cause pollution.

Using a 5-kW generator to provide power for a few 100-watt lightbulbs or your television doesn't make much sense either. With a PV system, a generator is more practically used as a backup.

If money is an issue (or in situations where photovoltaics alone are not enough to replace an existing generator), you

can use a wind generator as part of your hybrid PV system. This combination is more efficient than a generator running continuously at low speeds. You'll have fewer maintenance issues, you'll save fuel, and you'll lengthen the life of your generator.

Perhaps the greatest advantage is this: Because PV panels and battery banks are modular, your system can expand gradually to correspond with your budget and needs.

PV Power Systems Do Have Limitations

The biggest drawback to PV power systems is the cost. By comparison, utility power in North America is much less expensive. Because of this, you'll want to use the electric power produced by your PV modules, inverter, and storage system with your most energy-efficient appliances, tools, lights, etc.

Heating your home with photovoltaics is generally not recommended, although it's technically possible. Solar thermal systems are much more efficient and easier to use as a heating system.

As I mentioned earlier in this chapter, a solar water heater or swimming pool heater is able to generate much more hot water at much less cost than any PV-powered heater.

Cooking is another area where it is generally more cost-effective and convenient to use a stove powered with propane or natural gas rather than solar electricity.

In the case of stand-alone PV-powered homes, wood cook stoves provide an economical alternative for cooking and space heating.

Because refrigerators have become more energy-efficient, it's now cost-effective to operate them with PV power. You can find many good ones on the market these days.

Different Types of Solar Panels: Customizing Your PV System

There are three main types of panels:

- ***Monocrystalline***
- ***Polycrystalline***
- ***Thin Film*** (also known as ***Amorphous***)

Monocrystalline Solar Panels

For years, tried-and-true monocrystalline solar modules have been the workhorses of the solar market. If you've ever noticed iridescent blue-faced panels on someone's roof, they

have most likely been monocrystalline solar panels. Most of you reading this book will choose this type of solar panel, because these types of PV cells are readily available.

Monocrystalline panels have distinctive solar cells that can be seen from every angle. These individual rounded cells are stacked in very uniform rows. Produced from a single silicon ingot or crystal, the manufacturing process makes these the most expensive solar modules on the market. However, because they are also the most efficient type of solar panel, they are the right choice for you if space is an issue for you.

Monocrystalline cells last a very long time – a minimum of twenty-five years and more likely over fifty years. Aside from the cost, the only real issue with this type of cell is that it's very fragile, so it has to be mounted in a very rigid frame.

Polycrystalline Solar Panels

Polycrystalline modules are manufactured from a block of multicrystalline silicon. These are square panels, and they have a varied, mosaiclike appearance.

Although polycrystalline modules are slightly less efficient than monocrystalline modules, they are simpler and more economical to manufacture, so they are less expensive for the end user. They last just as long as monocrystalline cells.

Thin Film Solar Panels

Thin film solar panels are a recent addition to the solar panel market, providing some very welcome answers for solar power users. Also known as amorphous silicon PV, the innovative thin film technology could make rigid solar panels a thing of the past with ongoing research and development.

To create thin film solar panels, silicon material is applied to glass or stainless steel. It's also commonly inserted between two pieces of flexible laminate material.

Solid (or rigid) thin film panels are available, but they are not as popular as flexible laminated thin film panels. These flexible panels are very versatile – they can be applied to any surface and are sometimes used as roofing material.

Flexible thin film panels blend almost seamlessly on rooftops, which consumers love. Using thin film solar panels are a good choice because you don't have to pay for regular shingles or steel roofing.

However, these panels are only half as efficient at converting light to electricity as monocrystalline or polycrystalline solar panels. In addition, they require twice the space to install. On the manufacturing side, they do absorb light more efficiently; they are thinner and thus require less material to produce them.

Because less material is needed, the real benefit lies in a simplified manufacturing process and thus lower costs. Thin film panels have taken the lead in terms of price per watt of output.

This means that even though the panels are slightly larger, the homeowner pays less for every watt of power production. Thin film panels are flexible, lightweight, and rarely damaged during shipping. When you consider their reasonable price, thin film panels are a great choice if you're not concerned about space. However, there is some question about the lifespan of these panels. While some say they can last just as long as monocrystalline panels, others have experienced decreased efficiency after only two or three years.

Further research will address these concerns, but for now monocrystalline solar panels work well for us, and we are happy with them – even though we do have a couple of smaller thin film panels that seem to work fine for now. You must make your own choice.

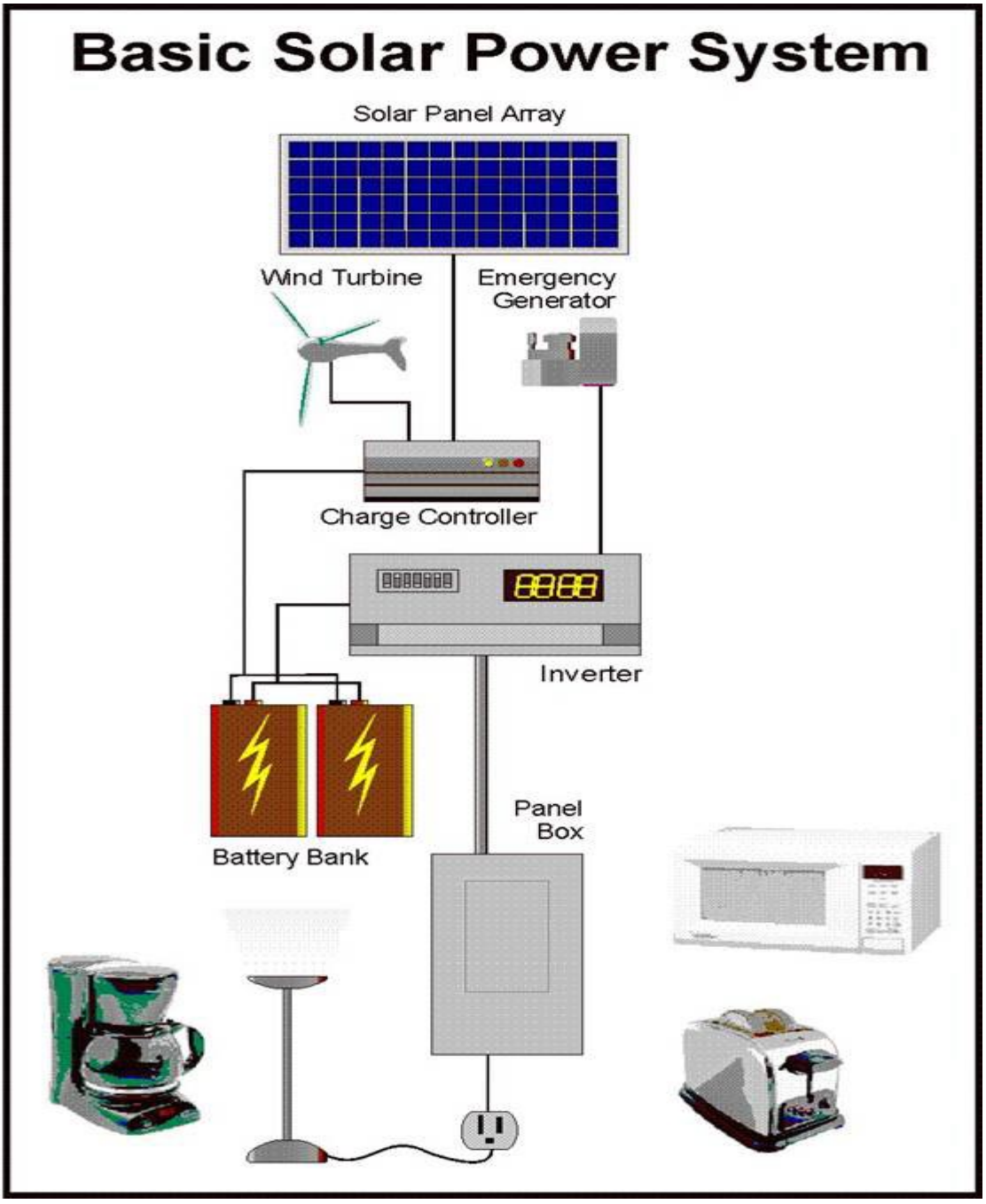
New Technologies

New forms of solar panels continue to be introduced, from spheral solar to liquid paint on solar panels. These are all very innovative, but more testing is required before we can recommend them.

To be economical, you might want to consider purchasing energy-efficient electric AC appliances first, and then design your PV system based on actual energy consumption. For example, if you use compact fluorescent lights you will reduce your electricity consumption by 80 percent or even more.

The cells are made up of semi-conductors, with silicon currently the most widely used. The sun's rays hit the surface of a semiconductor, causing a reaction. The chemical makeup of the solar panel absorbs the energy, and this energy causes electrons to break free of their atoms. This creates electricity.

New advances in semiconductor technology are making it possible for solar panels to absorb and retain an increasingly growing percentage of the sun's energy.



Basic diagram of a solar power system

Various Uses for Solar Generators

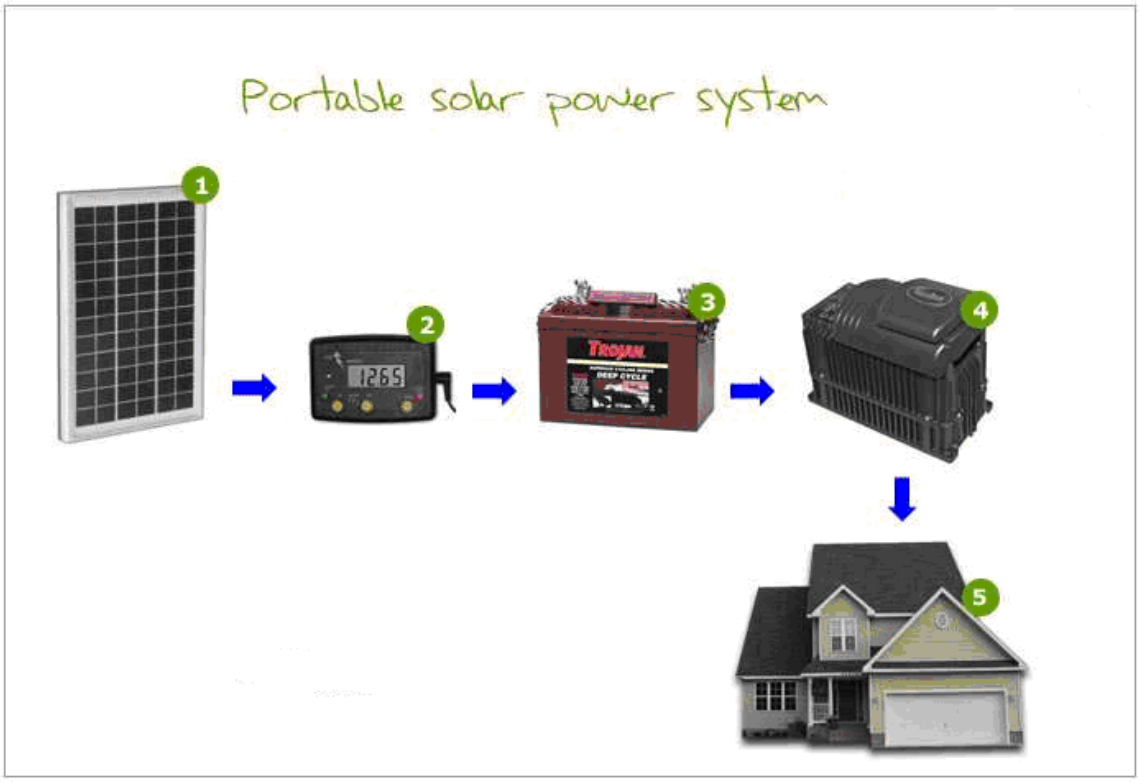
Building your own solar generator is easy and extremely cost-effective! To begin, I'll show you various applications for your solar power system.

The first solar power generator is a portable system that you can use to power just about anything. This is a great system to take on a camping trip. You can create this portable unit for approximately $200. (At the end of this chapter, you'll find definitions for the various parts mentioned.)

Portable Solar Power Generator

This solar generator will literally pay for itself within the first few weeks of use. I describe the most basic setup, but there are additional features you can add as well. You can use multiple solar panels and batteries to add to this basic system. How this is done will be covered later in the book.

Please see the diagram on the next page:



1. Energy source – solar panel(s) (12V is fine)
2. Charge controller
3. Battery
4. Inverter
5. Household loads (laptop, TV, DVD player, etc.)

You can create this simple solar power system for less than $200. You can make your own solar panel, or purchase one. (We will discuss the process of building an actual solar panel later on in the book.)

This type of system is ideal for outdoor use. You can

store the batteries and other electrical equipment in your garage or shed, where you can then run your appliances right from your inverter. Refrigerators work really well with this type of system, and you will be amazed at how much energy you'll save.

Batteries work best at warmer temperatures, so you might want to invest in a battery box. This keeps your system organized; it's especially a good idea if you have pets or children. You can also add a system meter that will be inserted between the battery and the inverter. The system meter lets you know how full your battery is and how much power is being used.

Grid-Intertied Solar Power System

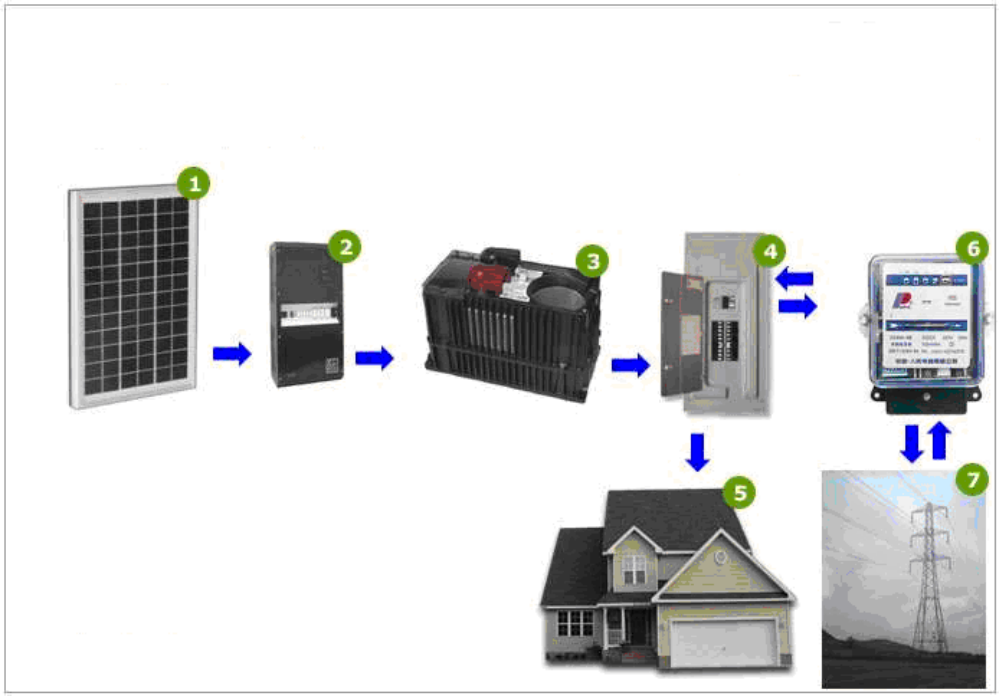
If you are still using power from a grid, this is the type of solar power system you should use. This is also known as an on-grid, grid-tied, or utility-interactive solar electric system.

If your solar system is producing more electricity than your household requires, this system actually turns the electric meter backwards. This means that your account is credited, and you can use the power during future months when less electricity may be produced (during periods of cloudy weather, for example).

This arrangement is called net metering or net billing. Please consult your local electric company or your state

regulatory agency for further information.

Here is a diagram of a simple grid-intertied solar power system:



1. Energy source – solar panels
2. Array DC disconnect
3. Inverter
4. AC breaker panel
5. Household loads
6. Kilowatt per hour meter
7. Grid

Grid-Intertied Solar Power System with Battery Backup

Below is a diagram of a grid-intertied solar power system with a battery backup. The backup is used for times of cloudy weather or when the system requires maintenance.

1. Energy source – solar panels
2. Array DC disconnect
3. Charge controller
4. Deep cycle battery
5. System meter
6. Main DC disconnect

7. Inverter
8. AC breaker panel
9. Kilowatt per hour meter
10. Grid
11. Household loads

Off-Grid Solar Power Setup

Below is a diagram of an off-grid solar power setup. This setup calls for a generator to keep the battery charged when the sun can’t.

1. Energy source – solar panels
2. Array DC disconnect
3. Charge controller
4. Deep cycle battery
5. System meter
6. Main DC disconnect
7. Inverter
8. Generator
9. AC breaker panel
10. Household loads

A Description of the Parts and Their Functions

Solar Panels

Also known as PV panels, solar panels are the main component of a solar-electric system. PV panels capture the sunlight, which creates direct current (DC) electricity.

PV panels are rated in watts based on the maximum power they can produce when performing under ideal sun and temperature conditions. You will need to know the rated output of your PV panels to determine how many panels you require to meet your electrical needs.

You'll then be able to combine the PV panels in a series, called an array. Different wiring configurations will be explained later in this book.

Array DC Disconnect

The DC disconnect plays an important role in system maintenance. Using a DC disconnect makes shutting off the power much easier.

Charge Controller

A charge controller greatly increases a battery's life. The charge controller prevents the battery from being overcharged. When the battery is fully charged, the charge controller will interrupt the charging process. Some charge controllers also keep the battery from discharging during the night.

Deep Cycle Battery

This is the type of battery you'll use in your system. A deep cycle battery stores all the energy that's produced by the PV panels. Here's a tip: You can often find *free* deep cycle batteries in old golf carts or forklifts.

System Meter

A system meter monitors how full the battery bank is. It lets you see how much power is being used at any time. A system meter monitors your whole solar electric system.

Main DC Disconnect

This unit is placed between the battery bank and the inverter. Using a main DC disconnect allows you to disconnect the inverter when it requires servicing.

Inverter

The inverter transforms direct current (DC) into alternating current (AC). Most household appliances use AC current (e.g., refrigerators, TVs, VCRs, computers, etc.). If

none of your appliances use AC, you can just use a DC input. A DC input costs around $10 and can be purchased at any auto parts store.

Generator

Setting up a solar electric system for off-grid living requires a generator. A generator produces electricity during overcast days or when you are performing maintenance on your solar electric system.

AC Breaker Panel

Whether you have a grid home, a solar electric system, or a wind-powered electric system, the AC breaker panel is where the energy provider and your home's electrical wiring connect. This panel is normally installed in the basement, the garage, or sometimes mounted outside the house in a metal box.

Each country (and each state or province) has different standards and requirements for the way solar energy is connected to the AC breaker panel. For instance, most countries require grid inter-tied solar electric systems to be hooked up to the AC breaker panel only by a licensed electrician. It's a good idea to ask your local power company about the laws in your area.

You can also run your appliances straight from the AC inverter instead of connecting your system to the breaker panel. This option is easy and extremely economical.

Kilowatt per Hour Meter

Grid-tied homes all have a kilowatt per hour meter. This monitors the electricity coming to and from the grid from your solar electricity system. If you produce more electricity then you use, you'll actually ***turn this meter backwards!***

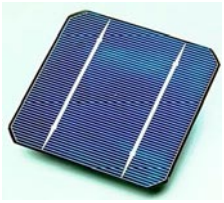
Grid (Utility Grid)

Unless you are living off-grid, the utility grid provides the main power supply to your house.

Household Loads

Household loads refer to anything in your home that uses power from your AC breaker panel. This includes any item that you plug into the wall.

Let's Get Started: Parts and Tools You'll Need



Material Required	**Cost**
Wood	Free
Glass	Free
Solar cells	$160
Caulking	$3
Solder	$2
Two-sided tape	$6
Electrical box	$4
Screws and fasteners	$7
UV varnish	$13
Total	$195

Depending on where you live, prices will vary. However, the Internet can be a good source for materials. Solar cells, the most expensive item on the list, can be found for a very reasonable price on eBay these days. A silicon shortage is predicted, but even if that occurs, you'll still save a lot by building your own system.

"But I've Never Used eBay..."

eBay is an online auction Web site, where buyers and sellers worldwide exchange goods and services. Prices are usually competitive, although there are some sellers with totally unrealistic pricing.

All you have to do is set up a free eBay account, and

you'll find all the advice and instructions you need to make your first purchase. Before you know it, you'll be bidding like a pro and you'll soon be the owner of solar cells in great condition to use in your solar panel construction project.

Just take your time and shop wisely – prices fluctuate wildly depending on the condition and size of the equipment you're looking for.

Setting Up Shop

Your first order of business will be to find those solar cells and gather together the materials mentioned in the material list above. Once you've acquired the solar cells and all the other materials listed above, the next step is to set up an organized, convenient work area. Now you're ready to begin building your first solar panel!

Building Your Solar Generator Step-by-Step

The Base

The solar cells will be placed on a base. You'll need about eighty cells, which will create a fairly large surface area. Notice that these solar cells have two distinct sides. The front of a solar cell is a bluish color, and the back of the cell is similar to the back of a mirror. It's very important to make sure that the blue side of the cell is the side facing toward the sun.

An individual solar cell only creates about a half volt of DC power. The voltage remains the same; as the size of the cells increase, the current or amperage will increase.

In my experience, it works well to lay all the solar cells out on the floor before beginning – you can think of it like a deck of cards. Leave a quarter inch space between each cell, and arrange the cells in rows until you have a shape that works for you. I usually make the finished panels a slightly narrower width so they are easier to handle, but this is a personal preference.

Once the cells are laid out, the next step is to measure the outside dimensions of the rows. This will tell you how big to make the backing board. You'll be attaching the solar panels to the backing board so it must be the correct size.

With eighty cells, you should end up with a panel that produces about 100 watts of power.

We usually use our own lumber that we cut to size, but for this project a local contractor gave to us some plywood left over from some window crates. The nice thing about the plywood was that we didn't have to join it together, but any strong lumber will work just fine.

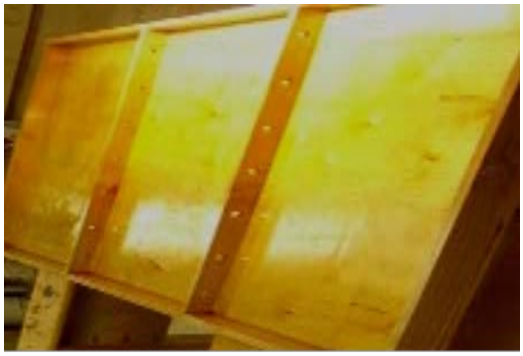
Once you have the outside measurements, you can determine the size of the glass you'll need to cover the upper portion of the panel. I usually put two-inch spacers on the

top, as well as a ventilation space around the panels.

The glass typically needs a support in the middle, so be sure to leave room for that. For example, let's say that the layout of the cells added up to twenty-four inches wide and forty inches high (including the spaces between the cells).

If you plan to put a two-inch spacer in the middle and all the way around the outside to support the glass, then the plywood should be cut to thirty inches by forty-six inches. Now you can fit the cells onto the plywood and still provide support for the glass.

Before you begin to place the cells on the plywood, you should treat it with an epoxy sealer that is specifically designed for UV protection. This type of sealer absorbs right into the wood and provides long-term protection from the elements.



Notice the holes in the dividers where the wires from the cells will meet and then join to form the panel's circuitry. Another reason for the holes is that they provide a certain amount of ventilation.

You'll want to use at least three coats of the epoxy, because your panel will be exposed to some rough weather over time.

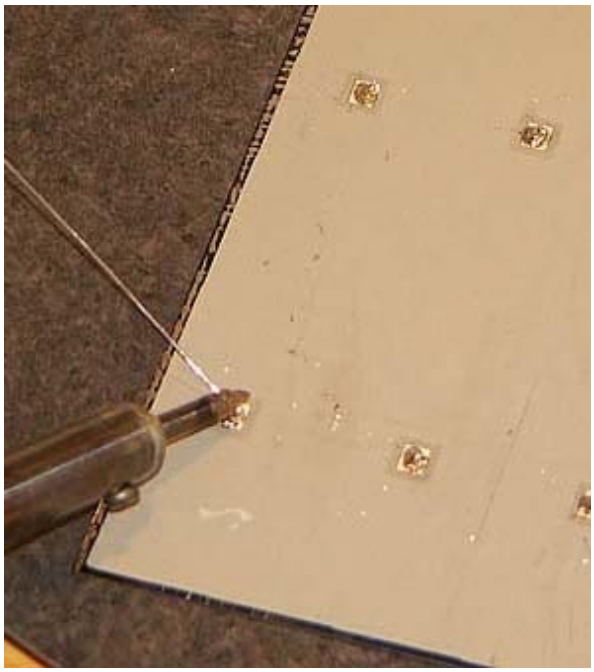
Next you are ready for the soldering gun. Make sure to clean it with a soft rag. You can use a gun like the one shown, or the pen model below (which is my personal favorite).

You can also find portable soldering guns without cords. The most important thing is to get one that is comfortable for

you to use and at least 25 watts. Make sure to use silver bearing solder for this project.

Connecting the Solar Cells

Locate the little tabs on the back of the cells. Heat your soldering iron, and then touch the tip of the gun to the tab, gently placing a drop of solder onto the heated surface of the iron. Make sure you follow this procedure for all four or six tabs you locate.



On the back of the cells, the tabs create a line – one on top, one on the bottom. The ones on the top have a negative lead, while the ones on the bottom are positive. Once you

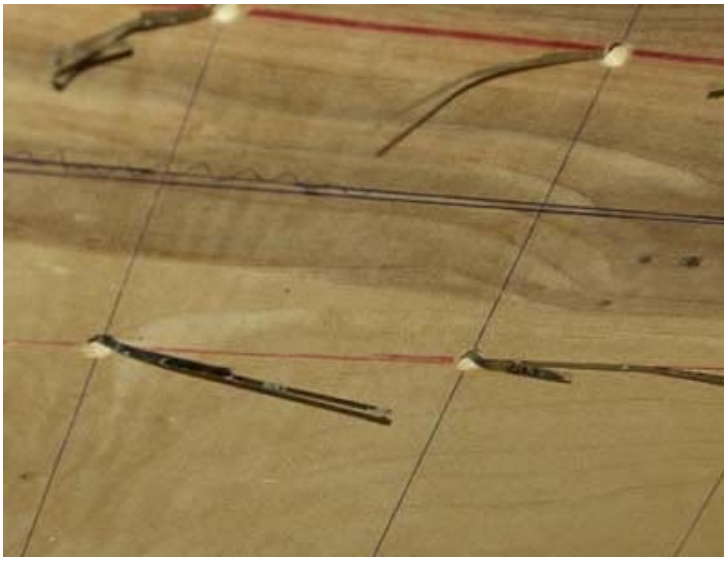
have placed a drop of solder on the backs of the tabs, very gently place a copper wire lead onto the tab and heat it up. As the wire bonds to the tab, the negative tabs connect. Do this for each of the tabs. A great way to avoid confusion is to use different colored wire for the negative leads than you do for positive leads.

Now that the cells are attached to your base according to your pattern the next step is to carefully feed the wires through the back of the plywood.

Use some caulking to make sure that the cells are securely adhered to the base, but be careful not to use too much. Silicone caulk is pliable and long-lasting.

Use one hole for two cells: one cell facing right and the other facing left. This way the lead wires will thread more easily through the holes. One caution: don't press too hard on the cells as you attach them. I've learned that using a little piece of wood on top of the cell allows me to apply pressure evenly, which prevents any breakage.

Now all the solar cells are attached to the backing. The next step is to wire all the negative wires together. This is easier when all the negative wires are the same color, as I mentioned earlier.

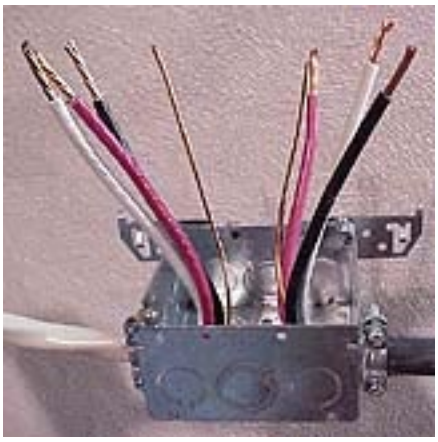


Make the leads long enough so it's easy to join the ends later. It's a good idea to test-fit one or two cells before you actually begin.

Be sure all the negative leads are connected together separately from the positive leads, which should be connected together, because if you mix them up your panel will not work correctly.

All of the wires, both negative and positive, will get connected to a junction box on the outside of the panel. I've

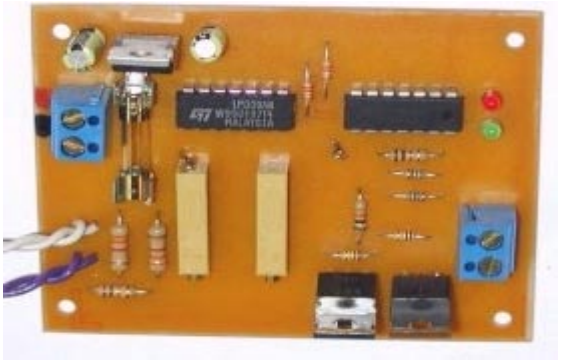
started to place an additional piece of plywood on the back of this backer piece to protect the junction box from the weather. This box should be coated with three coats of epoxy for extra protection.



In the end, all your negative leads will be joined and all your positive leads will be joined, and both your negative and positive leads will be connected to just *one* wire going to the batteries.

Next, place the glass over the front of your box. You can fasten the glass to the box with aluminum sealer strips, or you can make your own sealer strips from wood. Carefully seal all the edges, and be sure to make a drain hole in the bottom of the panel to allow any accumulated moisture drain out.

Charge Controller

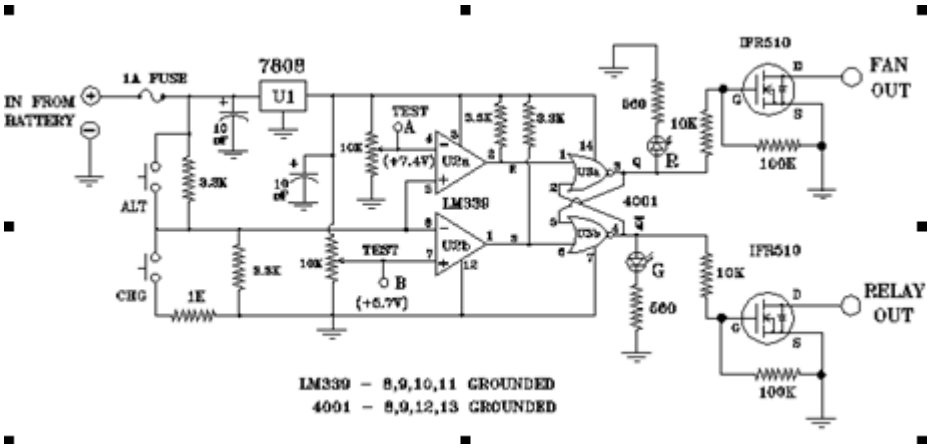


Once your solar panels are ready, you'll need a charge controller, because you'll ruin your battery bank by continuously overcharging it – which is an expense you don't want.

There are charge controllers specifically designed for solar panels. They monitor the battery voltage, and once the

battery is fully charged, the controller actually shorts the solar panel leads together. The solar panels aren't damaged by this, but whatever power they are generating at the time is wasted. The transistors in the controller end up being heated by this wasted power instead.

Simple Charge Controller Circuit

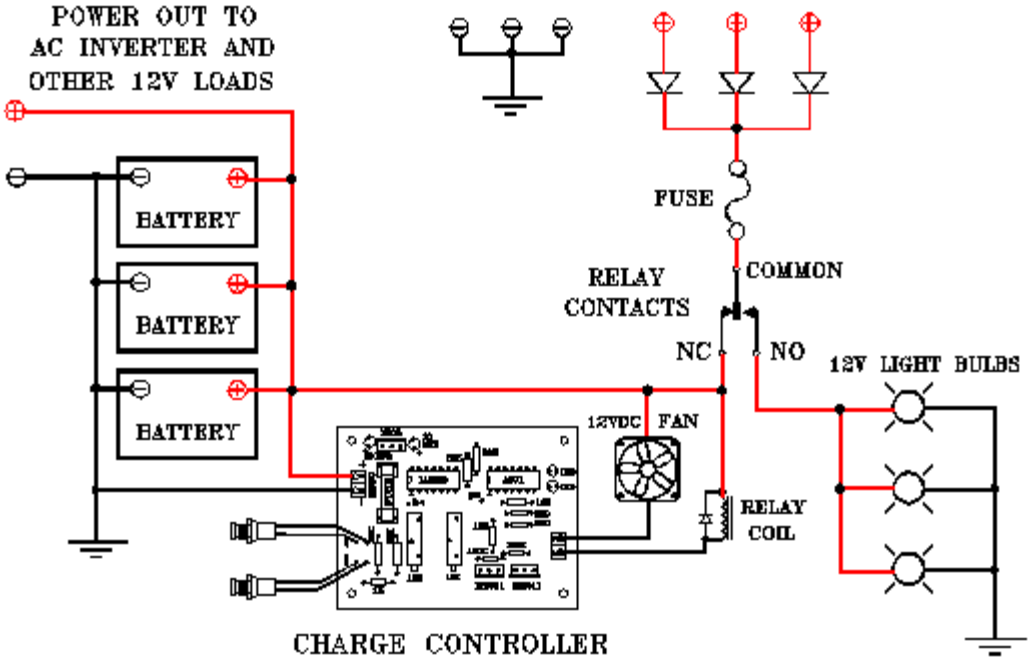


The above diagram shows the simple charge controller circuit. Because the incoming battery voltage is divided in half by a pair of 3.3K resistors, the trip points are adjusted to one-half the desired levels. You should begin at 14 volts for the trip points, depending on your particular battery.

A good starting point is 14.5 volts for a full charge, and 11.8 volts for a discharge. In this scenario, you should adjust the trim pots to read 7.25 volts at TP-A and 5.9 volts at TP-B.

It will usually take monitoring your battery's voltage through several charge cycles determine the ideal trip points for your system.

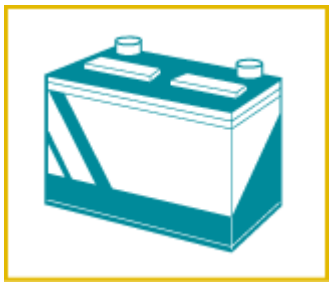
Simple Wiring Diagram Showing the Charge Controller and Batteries



All About Batteries

Your battery bank is the heart and soul of your renewable energy system. Batteries store DC electricity during your daily charging cycle for future use.

Housing Your Batteries...



Where you decide to keep your battery should comply with your the electrical code in your area. This is the case whether you store your batteries inside or outside.

Wherever you choose to store your batteries, the location should be able to keep the batteries warm (25°C is ideal), because their efficiency decreases below 25°C. So if you choose to keep your batteries in an unheated space, you must insulate that area properly. You will also require more battery capacity to compensate for the losses due to lower temperatures. It's wise to let your supplier know where you plan to store your batteries.

Two other important considerations are 1) choosing a

location that is easily accessible for maintenance and inspection and 2) the safety of the particular location you choose.

Batteries often give off hydrogen gas during the charging process, which can be a source of electric shock. This is why the area where you keep your batteries must be properly vented. For additional safety, keep it locked.

It’s also important to keep other electrical components separate in a different area from your batteries, because they can set off sparks otherwise. Keep your battery housing away from any sources of heat or open flame.

Lastly, take the time to read the manufacturer's recommendations and warnings about the safe usage, handling, and storage of batteries.

Inside Locations

If you choose to locate your batteries inside your home, keep them in a specially designed battery box and make sure that it’s properly vented to the outside. For example, a small cottage system with two 12-VDC (volt direct current) batteries requires a vent with a diameter of at least one inch.

Note: For summer cottages, batteries should be kept fully charged to prevent them from freezing in the off-season.

Outside Locations

If you plan to keep your batteries outside your home, put them in a box or shed. In extremely cold climates, you might want to store the batteries in a buried container in order to better monitor the temperature.

No matter what, you should make sure that your batteries are properly vented to the outside and well protected from the elements (wind, rain, snow, heat, cold, etc.). Remember, different types of batteries call for different types of maintenance.

Basic Battery Maintenance

No matter what type of battery you have, basic maintenance requires physically checking the electrolyte levels and regularly testing the gravity level of your batteries with a hydrometer. As necessary, add distilled water and keep your batteries clean. You'll want to tighten them as well.

It's very important to regularly check your batteries for any leaks or physical damage. Follow the instructions for your type of battery concerning regulating and charging.

Selecting the Correct Voltage

Congratulations! You have a good understanding of the

basic components that make up your renewable solar energy system. You're now ready to make your first decision: what voltage your system will run on. What voltage will guarantee an efficient, long-term setup?

It's important to make this decision early on, because if you choose to expand your power generation at a later date, it will be very expensive to change the voltage at that point. Your decision basically will depend on the size of your renewable energy system and how much power you'll require during peak times.

Choices, Choices...

12 volts

If you have a really small system – for instance, a weekend cottage or cabin in a remote area, or a small backup power system – I recommend that you go with a 12-volt system (a low-voltage system). You most likely will not have the room for further expansion.

You can set this size system up fairly inexpensively. To be efficient, the charging source must be within 40 feet of your battery bank. The maximum amount of power for a 12-volt system is about 3000 watts. However, heavier, more expensive wire must be used to carry a 12-volt current. Let's review how this works; remember Electricity for Dummies?

With a low voltage system of 12 volts, the amperage current increases. Higher amps result in higher resistance to flow. As an example, think about water flowing through a pipe. As more water flows, a larger pipe is required to handle that flow.

Low Voltage = Larger Wire = Higher Cost

24 Volts

For typical renewable energy production in the average home, my recommendation is 24 volts. This voltage is widely available. In addition, with 24 volts, there's plenty of room to expand your system down the road. You'll also be able to run a 4000-watt inverter, and this means that you can utilize more AC equipment in your home.

Just keep in mind that when voltage increases, amperage (or current) decreases. If you have a 24-volt system, you can use smaller wire, and this will result in lower installation costs.

Another benefit is that you'll have the option of setting up your energy system farther away from your house. Especially with wind towers or micro-hydro setups (which tend to be site-specific), this is a good feature.

Of course, when deciding where to place a wind tower, you can't change how high the elevation is on your property.

You also don't have any control about where a stream flows to coordinate with where you've built your home.

How do you maximize your power output? Usually you'll run a higher voltage system to accommodate greater distances to your power source. This is where 24 volts is ideal.

48 Volts

If you place your power output source really far away from your home, a 48-volt system might be appropriate. Besides being more efficient, it allows you to run a 6000-watt inverter.

While 24-volt systems are definitely more common, larger manufacturers now carry higher voltage systems designed especially for special large-scale or high-performance systems. Special projects – i.e., grid intertie inverters or deep well water pumping – can be set up to run very efficiently with higher voltages. I'm familiar with more than one micro-hydro setup where the power generating system (the water flow) is over two miles from the home it powers. Even given this distance, it is still more economical to install this type of system rather than run power lines to the site.

It's the size of your system and how you intend to use it that will determine the voltage you'll use. Take some time

right now to digest this information, and then make the decision about the proper voltage for your system. Don't forget to take into account the *maximum* amount of power you'll need on a daily basis and then, based on that number determine what size of inverter you'll require. If you are having trouble making up your mind, the distance to your power source is often the deciding factor.

Wiring Your Solar Panels to Your Batteries

There are three types of wiring configurations, and all three are relatively easy to master. Once you learn them, it will be easy for you to tackle the job of wiring your batteries and/or solar modules. The three configurations are:

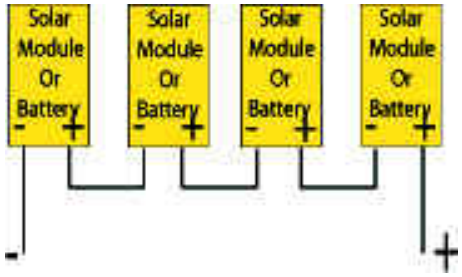
- Series Wiring
- Parallel Wiring
- Series/Parallel Wiring (a combination of the above)

Remember that a DC-generating device like a battery or a solar module always has both a negative (-) terminal and a positive (+) terminal. Electrons (or currents) flow from the negative terminal through a load to the positive terminal.

Series Wiring

Series wiring involves wiring any device in a series by connecting the positive terminal of one device to the negative

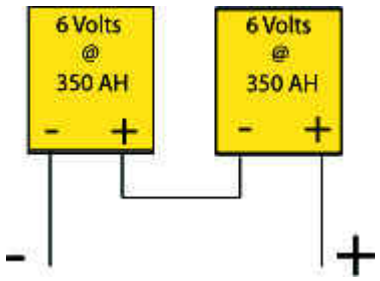
terminal of the next device (a battery, for instance), and so on.



Wiring them in a series this way, each battery's voltage is "additive." So, in the above example, if each battery or solar panel had the potential of producing 12 volts, then 12 + 12 + 12 + 12 = 48 volts.

Another important rule to remember about series circuits is that the current always stays the same. Again, using the above example, if each battery in the series had a rating of 12 volts @ 220 amp hours, the total value of this particular series circuit would be 48 volts @ 220 amp hours.

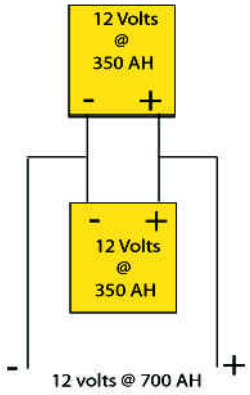
In the following example, two 6 volt, 350 amp hour batteries have been wired in a series that yields 6 volts + 6 volts = 12 volts @ 350 amp hours.



Remember: the voltage in a series circuit is additive, and the current always stays the same.

Parallel Wiring

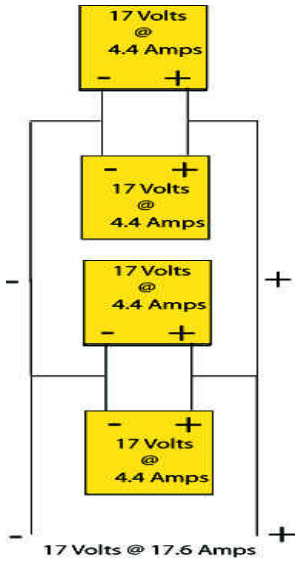
With parallel wiring, you must connect the positive terminal of the first device to the positive terminal of the next device, and you must connect the negative terminal of the first device to the negative terminal of the next device.



When devices are wired this way, the resulting voltage and current is the opposite of series wiring. Instead, with parallel wiring the voltage stays the same, and the current is additive.

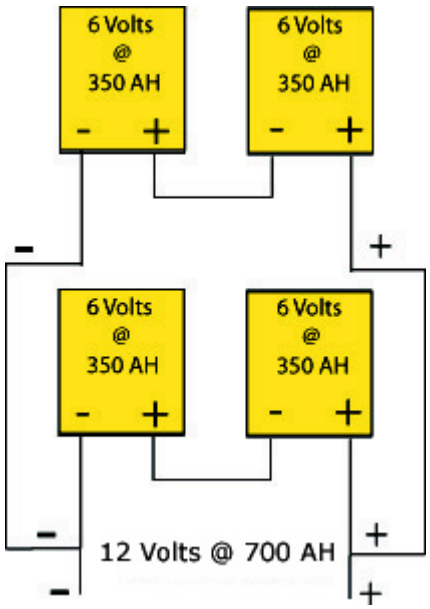
If each device in the above example had the potential of producing 350 amp hours, then 350 + 350 = 700 amp hours, and the voltage would remain the same.

In the next example, four 17 volt @ 4.4 amp solar panels are wired in parallel. This results in 4.4 amps + 4.4 amps + 4.4 amps + 4.4 amps = 16.6 amps total @ 17 volts.



Series/Parallel Wiring

Series/parallel wiring just refers to two or more series circuits that are wired together in parallel.



In the above example, two separate pairs of 6-volt batteries have been wired in a series. Then each of the series of pairs is wired together in parallel.

What is the reason for doing this? One scenario might be that you want to increase the amp hour rating of your battery pack so you can run your appliances longer – but you wanted to keep the battery pack at 12 volts. The above diagram accomplishes this.

Or let's say you want to increase your solar array's charging capacity, but you also want to keep the solar array at 24 volts. Using series/parallel wiring makes this possible.

A good way to begin is by wiring the batteries in individual sets that provides you with the voltage you want. For example, if you need 24 volts and you have 6-volt batteries, you would first wire four of the batteries in a series to get 24 volts.

Practical Ways to Lower the Cost of Your Generator

Solar Panels – Free for the Taking

Let's face it – solar panels are expensive! A 170-watt panel usually runs around $800, which means it will take over $10,000 to provide solar power for the normal off-grid home. I don't know about you, but that's a lot of money for my family – for any family in this economy, actually.

I was determined to find a source for inexpensive (preferably free!) solar panels somewhere. But where?

In my search, I was excited to discover not one, but two sources for free solar panels! Not only that, I found a source that provided really inexpensive solar panels.

An Accidental Discovery

Finding our first source of free solar panels happened quite by accident... a car accident, that is! Here's what happened.

Our family was driving on Highway 401 (one of Canada's largest divided highways). We were on our way to visit our relatives, who lived in the town where I lived as a child.

At dusk, we suddenly noticed up ahead that unwelcome sight: a long line of brake lights – some kind of traffic jam, perhaps an accident. Sure enough, traffic slowed down to a crawl.

Twenty minutes passed, then forty, then fifty minutes, bumper-to-bumper traffic. Finally we reached the source of the traffic jam – a tragic accident. Police cars and tow trucks were still on the scene.

It was obvious what caused the crash. Due to construction work, there was a sign indicating a lane change.

One driver somehow missed the flashing portable sign and slammed right into it.

The twisted wreck told the story. There was metal and tires and solar panels scattered all across the highway.

Wait! Solar Panels?

Right then and there, I had an “aha” moment. Here was the free source of solar panels I’d been searching for. I asked my wife to write down the name and phone number of the rental company listed on the sign.

When we returned from our family visit, I called that company up to ask about the solar panels. I was told that the signs were often hit, and the receptionist went on to say that the cracked solar panels could in all likelihood be made available for free once the insurance company saw them.

I found out that the company typically installs five 65-watt solar panels on each sign. After getting permission from the company I was able to haul away thirteen slightly damaged solar panels!

The employee I spoke with at the equipment yard said that because the panels were mounted on the top of the mobile signs, they rarely took a direct hit; frequently they were only cracked or shattered, but still intact. The question was whether or not they would still work.

After getting the panels home, I wanted to know the answer to that very question. Would they still work? To find out, I placed them in full sunlight at high noon so I could measure the current to determine if they were still capable of producing power.

Of the thirteen panels, only two of them were unable to be fixed. The remaining eleven panels produced about 20 to 24 watts of power each in full sun. So here we had over 200 watts of solar panels, about $1000 worth, just for the small price of time it took to go get them!

I don't think there's a better source for free solar panels out there. I would encourage you to find out what company in your area rents signs to the highway department, and see if you can get your own free solar panels.

More Free Solar Panels

My good friend Bill deserves the credit for discovering the following source for free solar panels.

Bill realized that solar panels are improving all the time. New manufacturing processes have made them more efficient and more affordable. Because of this, homeowners who have used solar panels for years (some for over twenty years) are choosing to upgrade, much like buying a new vehicle after several years. Installers and dealers often get calls from individuals who want to install a new solar panel array.

So what do they do with the old solar panels? They take them to the dump!

Call all the local solar panel dealers or installers and ask them if they'd be willing to save the old solar panels that have been replaced. How simple is that?

Inexpensive Solar Panels

The dealer may have more good news for you. Solar panels are very fragile, which means they can frequently get broken during shipping (and occasionally during installation). What happens to these damaged panels?

Sometimes they are returned to the manufacturer, and other times they are taken to the dump. Even though they are damaged, though, you probably won't get them for free. However, most of these solar panels will cost you a quarter of their wholesale price.

Before you buy, it's important to test the solar panels first so you know how many watts they produce. Usually the price is determined by the amount of watts they produce now compared to the actual amount they were supposed to produce before they were damaged. In any case, there won't be a warranty, so be clear about what you're buying.

There's also one more source of inexpensive used solar panels: eBay! Get yourself an account if you don't already

have one and start shopping. You'll typically find some really good deals here.

Here again, you must be clear on what you're purchasing. Make sure the shipping is included in the price, so there are no expensive surprises. A responsible seller should agree to guarantee the solar panels' condition for thirty days.

Do-It-Yourself Solar Panels

As mentioned earlier, you'll need a few good tools and a comfortable, organized workspace. Make sure you have a workbench and a comfortable stool or chair. You'll be working with both electronics and wood.

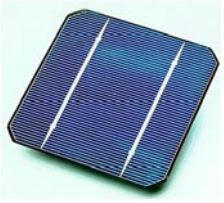
The Right Tools

- Cordless drill
- Soldering iron (small pen type)
- Pliers
- Hammer
- Caulking gun
- Miscellaneous nuts and screws

The Solar Panel

This image shows the back of a solar cell, known as the building blocks of solar panels. These small cells are about the size of your hand, and it takes several of them to create a solar panel. Typically I recommend using monocrystalline solar cells.

Here you see the component parts of a solar cell. These tiny cells are very delicate until you mount them.



Before you begin, let's review the different forms of solar power and go over basic electrical terms to make sure you're aware of all the processes involved.

Finding Free Batteries

You'll be amazed at how many goods and services you'll be able to find just for the asking. All you really need is a bit of persistence. Free batteries are a great example. I can suggest two terrific sources for free batteries that you can use in your energy system.

Right in Your Own Backyard...

For several summers, my oldest son worked at a golf course. He was responsible for cleaning and maintaining the golf carts. Some of them were powered by gas, and some were electric.

Occasionally I would drive him to work, and one particular morning when I dropped him off I happened to notice one of the electric golf carts in the repair shop. The body of the cart had been taken off in preparation for replacing the batteries.

I saw large batteries labeled on the sides as "Deep Cycle." Because they still seemed to be in good shape, I came away with an idea.

I began doing some research, and I discovered that golf cart batteries were often recommended for use with renewable energy systems. While they might not be the best batteries this purpose, but they certainly can work.

I went back to the golf course and asked if I could have the old golf cart batteries. The owner of the golf course was happy to have me take the batteries away, because otherwise he would have to pay to have them removed.

What I discovered, though, was that while it was great to discover a source of free used deep cycle batteries, most of them didn't work. However, more research revealed that the batteries could be brought back to life with something called a desulfator. I had met an expert on batteries through installing renewable energy systems, and he was very familiar with how to revive these batteries and willing to explain each step to me.

How to Maintain Your Solar Panels

It's important to clean your solar panels at least once a year (but more frequently is recommended) to insure their maximum performance. Here are the steps you'll need to follow:

1. Make sure you have selected the correct battery type.

2. Check that the current levels of the PV (photovoltaic) array and load do not exceed the recommended ratings.

3. Tighten all terminals and inspect them for any loose, broken, or burned-out wire connections. It's important that no loose strands of wire touch other terminals.

4. Be sure that the charge controller is mounted securely. Inspect the environment for dirt, insects, and corrosion.

5. Check to see that the airflow around the charge controller is not blocked in any way.

6. Protect your solar panels from direct exposure to sun and rain. Make sure that no water is collecting under the cover.

7. Make sure that both the charge controller functions and the LED indicators are set correctly for the system conditions.

8. When you clean the panels, use a nonabrasive cleanser and paper towels.

While your solar panels should be cleaned at least once a year, the determining factors are the environment surrounding your system and the amount of dust from the road. Typically, you should plan to clean the panels on a monthly (or even bimonthly) basis.

In order to maintain your solar-powered battery charging system, it's very important to keep the panel clean. The

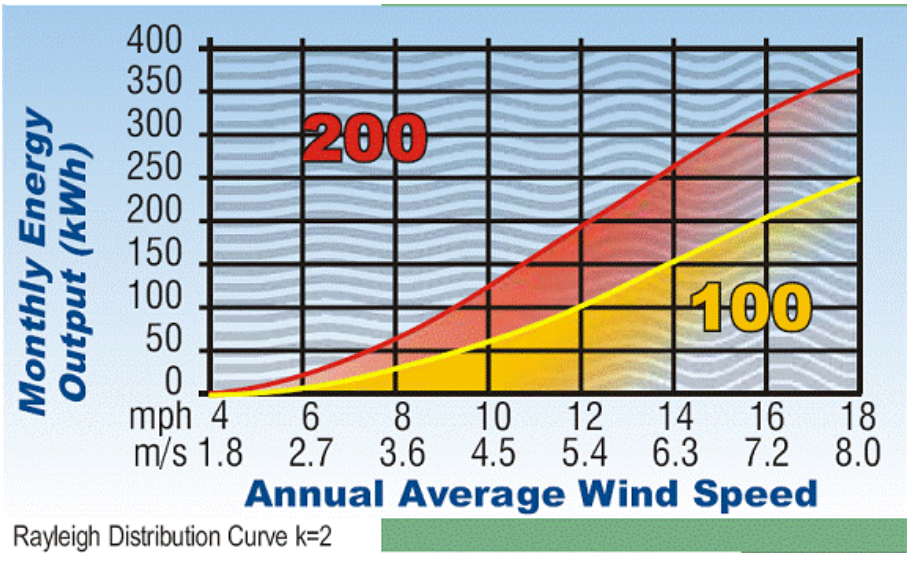
amount of power a panel produces is directly related to the amount and intensity of sunlight that reaches the internal crystals. If your panel is dirty, less light will reach the crystals and so the power output will be less. To be more specific, a layer of dust or road dirt can reduce the amount of power output by 15 to 25%. In addition, if leaves and debris cover two or three of the individual cells, the energy output power can be reduced by 50 to 75%!

Just follow these basic maintenance tips, perform regular inspections, and schedule regular cleaning, and you'll get the maximum performance from your solar charging system.

Chapter 4
Harnessing the Wind's Power

How Does a Wind Generator Work?

Wind power actually works a lot like hydroelectric power. Both of them simply require a driving force that creates kinetic energy. With hydroelectricity, it's water that creates a driving force. With a wind generator, or turbine, wind is the driving force.



A wind generator consists of three basic parts:

- **Rotor blades:** Rotor blades transfer energy from the wind and turn it into kinetic energy.

- **Shaft:** When the rotor blades rotate, they turn the shaft, which transfers mechanical energy into the generator.

- **Generator:** Generators utilize the principle of electromagnetic induction. When the magnets are rotated around a conductor, they generate electricity.

Wind generators are really that simple. Electricity is generated by magnets rotating around an electrical coil.

The power of the wind is used to rotate the magnetic field around the coil, and this causes the atoms and electrons to be displaced. Kinetic energy is created, and this energy is then turned into electricity.

Build Your Own Wind Generator or Buy One?

All wind turbines (generators) utilize five things:

- a generator
- blades

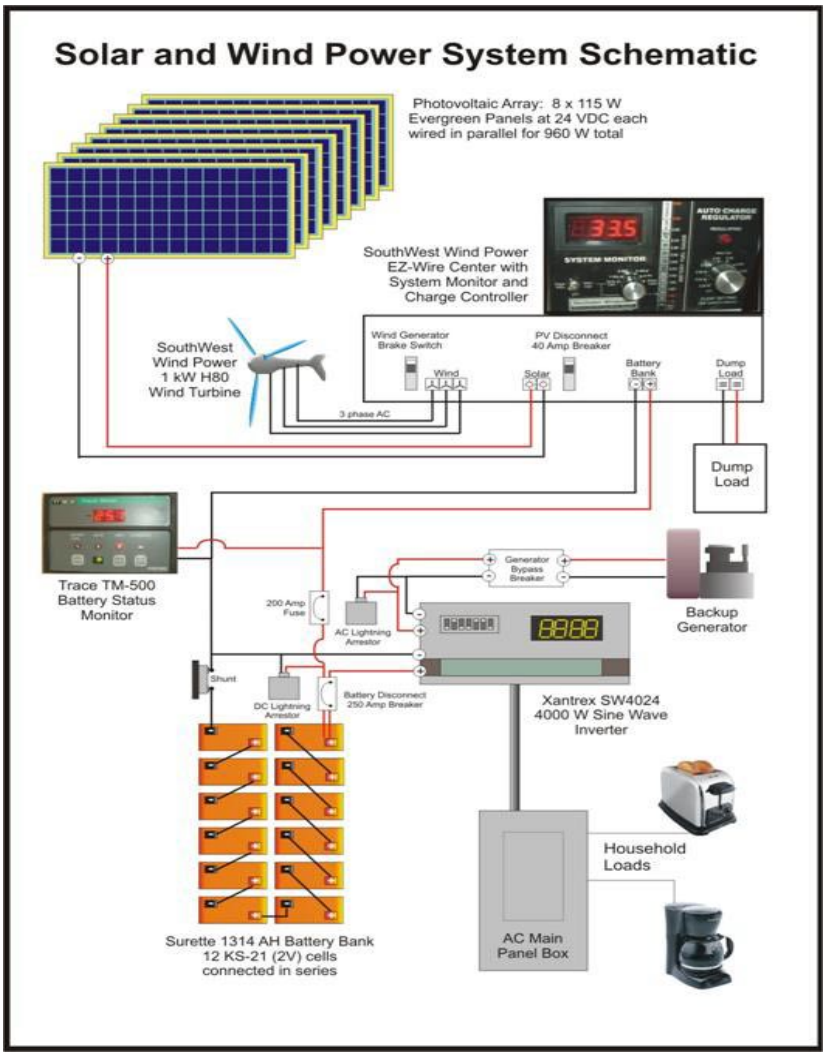
- a mounting (to keep them in the wind)
- a tower
- a control system

You might want to check out prefabricated wind turbines if you want a viable solution to replace the majority of your energy needs. This can cost between $6000 and $20,000 (or even more); you want to get a turbine that can generate enough energy to supply power to an average-sized home.

While this can be a substantial investment up front, you can expect to reduce your current utility bills by 50 to 90% on average. Therefore, your new wind generator will typically pay for itself after eight to fifteen years. Another option is to build one yourself, or purchase several windmills that will give you similar results for a lot less than $6,000.

When you're trying to calculate the cost-effectiveness of a wind turbine, you must consider two things: energy costs and wind speed. The basic rule of thumb is that the average wind speed in your area should be be at least 10 mph. If finances are a concern, wind turbines begin to make economic sense at about 10 cents per kilowatt hour.

Today, wind turbines are becoming more economical to produce, as well as more and more efficient all the time. You can expect to see wind turbines powering rural homes and being used more often in windy areas – even turbines used in the ocean will soon become a common occurrence.



Wiring diagram of a wind generator

Commercial wind generators start at several thousand dollars, many cost far more. By comparison, this book will show you how to build your own wind generator for as little as $200.

You can use windmills to run any of your household appliances. However, even though you can build a windmill for next to nothing, remember that you must be in a windy location for it to be worth the effort. If there's not enough wind available, you should consider solar power.

Ready to Get Started?

Here's the list of what you'll need:

- DC Power Motor
- Body Assembly
- Tail Assembly
- Blades to Collect Wind Energy
- A Hub to Connect the Propeller to the Motor
- A Tower
- A Battery Bank
- Nuts and Bolts
- Miscellaneous Hardware

You should be able to find the majority of the above materials on eBay or at your local hardware store, and they are all relatively inexpensive.

Make sure you also have these tools:

- A Socket Set
- Several Screwdrivers
- A Grinder
- A Jigsaw
- Some Sandpaper

In the next section, I'll provide information on the most economical options to get everything you need.

A Step-by-Step Guide: How to Build Your Wind-Powered Generator

Tips on Lowering the Cost of Your Generator

Finding Inexpensive Batteries

A wind generator needs a good deep cycle battery to store its power. You can find them on Ebay, and they are usually very cheap, but there are ways to find free batteries too.

Old golf carts and forklifts are both good sources for free batteries. These batteries are often replaced long before their shelf life is over, and they are perfect deep cycle batteries for wind generator projects.

If you don't already have a deep cycle battery, consider going to your local golf club or a local forklift company. If you tell them you are building a windmill (or solar system), they usually won't mind giving you a few of their old batteries.

Finding a DC Motor

To find a DC motor, look on eBay, or do a search for inexpensive power tools. Drills, screwdrivers, and other tools are a great way to find inexpensive DC motors. Even though they don't generate much energy, they are perfect for smaller projects.

DC motors generate power if the motor is spun in the opposite direction. In this case, the power goes out the same wires it usually enters. This simple principle makes DC motors perfect for do-it-yourself wind generators.

What Kind of DC Motor Should You Use?

Surplus permanent magnet DC motors are what you want to find. Pay attention to the RPM, shaft size, amps, and voltage. The DC motor you want should have a LOW RPM rating, because when used as a generator, the motor has to spin much faster than the standard RPM to produce the rated voltage. You want a DC motor with a HIGH voltage (over 12 volts), a HIGH current, and a LOW RPM rating.

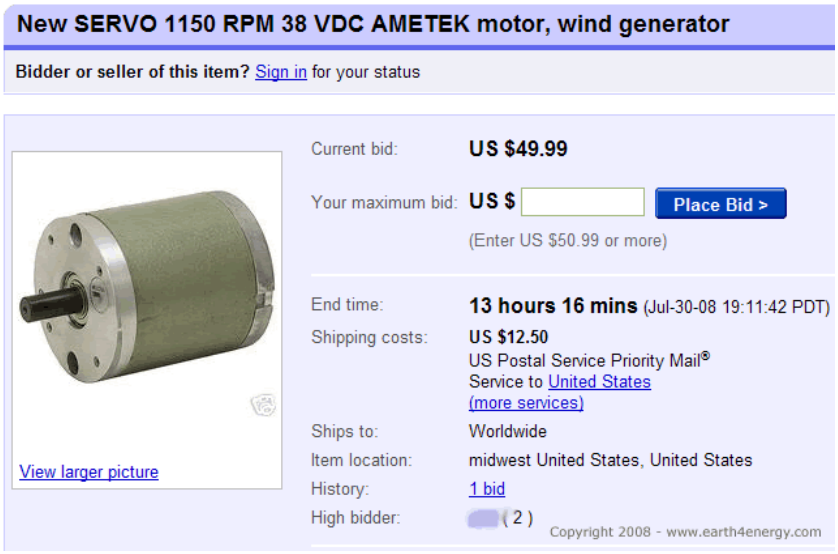
Ideally, your motor should be rated under 400 RPM at 30

volts. This rating will give you an expected 12v at a low RPM when the motor is used as a wind generator.

Without strong winds, you'll want a motor with a very low RPM rating. Obviously though, strong winds are your friend – they are the key to high generator output.

Below is a picture of a DC motor that I purchased on eBay for just $35!

A good DC motor that you can find quite easily from ebay is The 1150 RPM 38 VDC Ametek motor is a good DC motor, and it's usually readily available on eBay. This motor generally produces about 13 volts at about 390 RPM – ideal for a homemade wind turbine. The cost is usually about $50. It's pictured below in the following eBay ad.



Finding a Tower

For your wind generator, an old satellite TV tower works well and so does a standard 2 to 3-inch thick steel pipe. Really, any sturdy, approximately 8 to 12-feet tall object that can easily be anchored in the ground (using concrete) can make a great tower. If you are proficient at welding, you can build your own tower. Below is an inexpensive satellite tower found on eBay - ideal for a backyard windmill.

Making the Blades

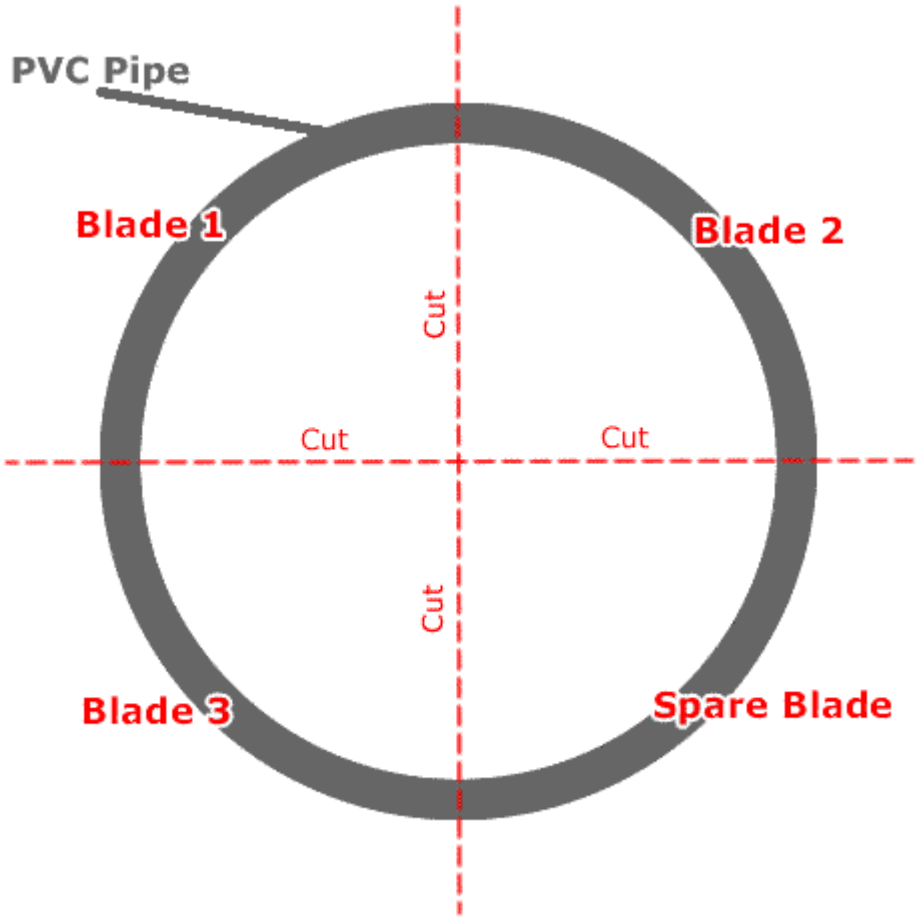
The most efficient wind generators have a total of three blades, each with a diameter of around 8 feet. If 8 feet is too large for the size of your backyard, just cut it to the size you want. Just make sure you retain the same shape.

Remember, the goal is to produce 1000 watts of power. In order to achieve this, you'll want to use blades of about 8 feet in diameter, and you're looking for wind speeds of at least 20 miles per hour.

ABS or PVC pipe is the ideal material for your homemade blade. Pipes that are between 8 inches and 12 inches in diameter are best. Note: Be aware where your pipe will be used underground. Painting the pipe with a UV inhibitor will definitely prolong the life of your wind generator.

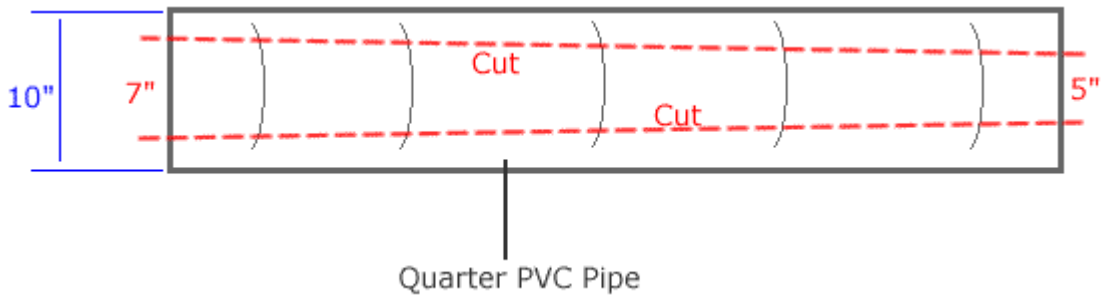
Cutting the Blades

Use a jigsaw to cut the blades. Each of the blades should be 4 to 5 feet long, which means that the total span will be about 8 feet. Cut the pipe into quarters (see diagram below):

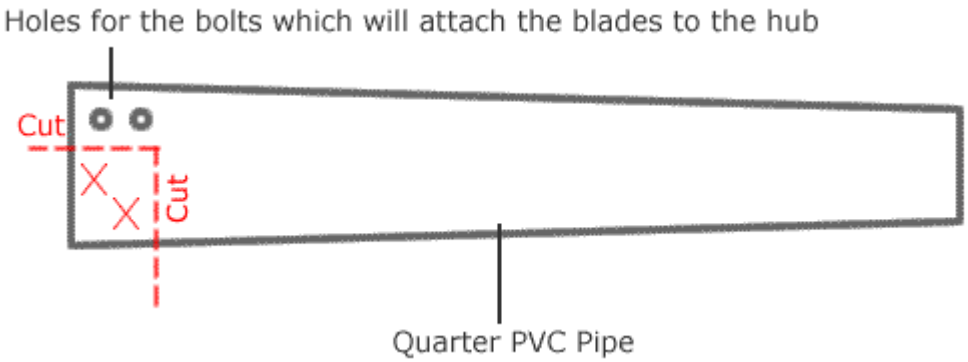


Half of the diameter of the blades should be left at the base, with the blades forming a rounded point at the outer edges.

If you are using a 10-inch diameter pipe, the blade should be 7 inches wide at the hub and 5 inches wide at the tip. The below diagram illustrates this:

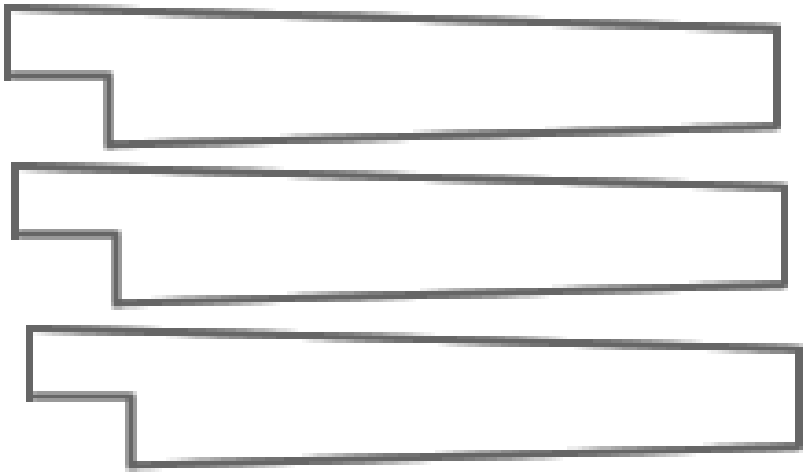


Next you'll make some extra cuts and holes, as shown in the next picture:



Cut one blade, and then use it as a template for the rest. After you cut the blades, you might want to sand them down for increased efficiency. The smoother the leading edge of the blade is, the easier it will be to cut through the wind, which will increase speed, so you'll want to this edge of the blade.

By this time, you should have 3 blades that look like this:



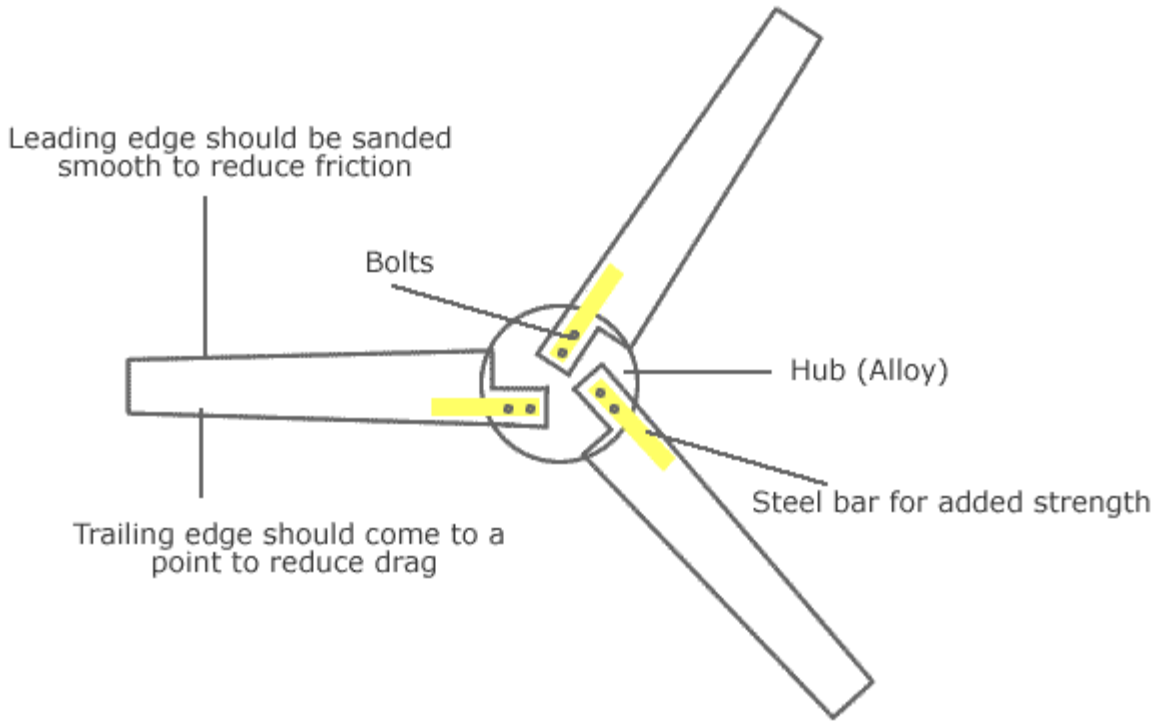
Building Your Hub

The hub connects the blades to the generator. You can easily find hubs at your local hardware store, on Ebay, or even the local junkyard.

The hub should fit securely on the DC motor shaft; this enables the motor to turn when the hub turns. All you need to do is to drill a hole in the very center of the hub, making sure it's the same size as the motor shaft. Later, you'll attach the hub assembly to the motor.

Note: When you drill a hole in the center of the hub, be sure the hole is dead center. If it's even a tiny bit off, the whole assembly will shake wildly when the blades start spinning.

Next you will attach the blades to the hub, and then secure the hub to the motor shaft. You can use flat steel bars, approximately a foot long and two inches wide, to attach the blades to the hub. These bars are ideal because they will add lots of necessary strength to the blades, especially crucial for high winds. The next diagram illustrates how your project should look at this point:



Balancing the Blades and the Hub

It's very important that everything is balanced properly. If your system is imbalanced, it won't produce the output you desire, and over time the motor shaft and bearings will be ruined. Getting everything correct in the beginning will prevent serious problems later on. Fortunately, it's easy to test how balanced your system is.

1. The first step is to number each of the blades with a pen.

2. Put the hub assembly on a pole and spin the blades.
3. Make note of the number of the blade on the bottom.

Repeat these steps ten times. If the same blade ends up on the bottom each time, it means that this blade is a bit heavier than the others. To remedy this, using a metal grinder just shave a tiny bit of the metal off the bars that hold the blades to the hub.

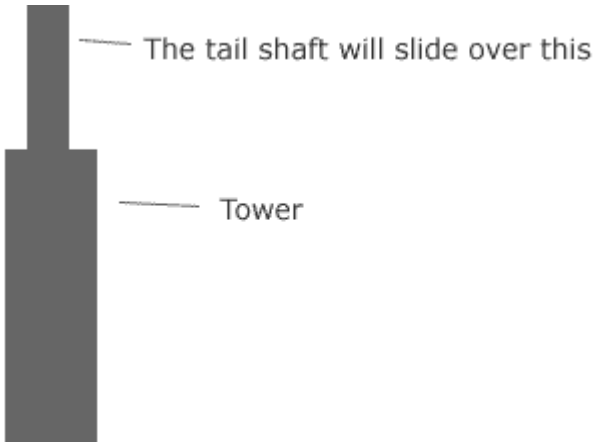
Mounting the Hub Assembly to the DC Motor

The hub assembly must be tight and secure on the DC motor – this is crucial. Slide the shaft of the DC motor into the hole in the middle of the hub that you drilled previously.

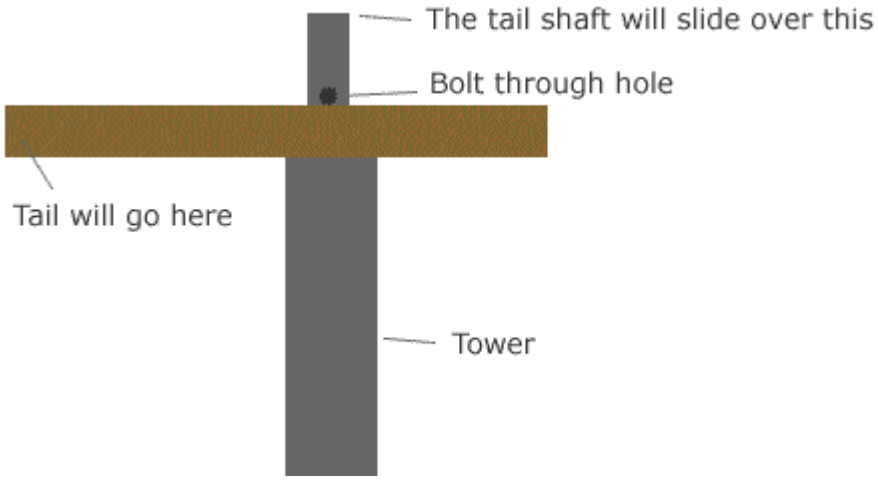
To make sure the hub doesn't slide back out, drill a hole through the end of the motor shaft and insert a small bolt. Drill the hole as far down the shaft as you can (with the hub on) to make sure the hub doesn't shake back and forth.

Building the Axis

The blades on your generator should always face the wind. Because of this, the generator should rotate on a horizontal axis when it's mounted to the tower. Let's take a look at what the top of your tower should look like.



If the small section on the top of your tower is missing, you'll have to weld this metal section onto it. The diameter of this piece should not be wider than the diameter of the tail shaft, because you'll drill a hole in the tail shaft that will enable the shaft to slide over the top of the tower. See the following diagram:



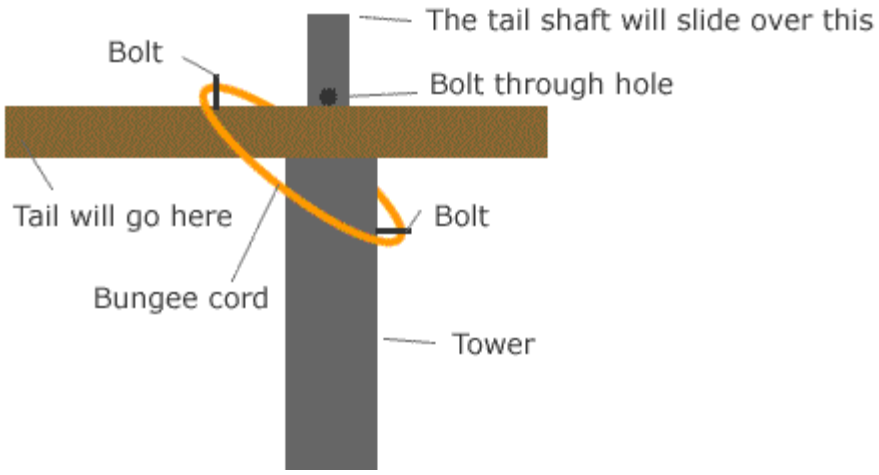
Carefully measure the height of the tail shaft. Drill a hole through the top piece of the tower (just as you see in the diagram). Make sure that you drill the hole deep enough so that when you put a bolt through it, the windmill's tail shaft will be held securely in place.

When the shaft is secure, it should be able to freely spin around the top of the tower. If it seems too tight, try applying a small amount of grease on the top of the tower where the shaft spins around.

Your windmill now can spin around with the blades facing the wind, but what will prevent it from rotating wildly during high winds or severe storms? This situation could cause the wires to become tangled and/or damaged.

Guess what? The simplest solution for this is a bungee cord!If you think this sounds like a cheap little fix, you're right! The best part is that it works amazingly well.

See the following diagram:



To make sure the bungee cord doesn't slip – causing it to tighten around the tower when it spins – you'll want to use a couple of bolts. The bungee cord should fit loosely to allow the windmill to spin 180 degrees without being restrained by the bungee cord.

Building the Tailpiece

The tailpiece maintains balance and ensures that the blades operate at maximum efficiency. My experience has taught me that a tail length of between 3 and 4 feet works best. All you have to do is cut out a tail shape from the metal and attach it to the back of the assembly. You can make the tail any shape you want, but make sure it's large enough to catch the wind. Attach it to the shaft by using a flat bracket; it's very simple to do.

The Charge Controller

To keep the battery pack from becoming overloaded from too much energy, a charge controller is absolutely essential.

You can build one from scratch, but it's even more economical to find an inexpensive one on eBay. You should be able to get one for around $25.

Set up your controller to defer any extra power to the dump load (you'll learn more about this later in the book).

The Dump Load

Extra power is transferred to the dump load. You can use an appliance (i.e., a hot water heater, a backup battery pack) or a simple ground wire to function as your dump load.

AC Inverter

If you want to use AC power instead of DC power, an AC inverter is necessary to convert the power. Again, you can find these inexpensively priced on eBay. For more information about inverters please refer back to the end of Chapter 2.

Wiring Everything Together

The materials that you'll use will determine the gauge of wire you'll choose. A local electrician should be willing to provide advice over the phone.

Make sure that you wire everything in the following order:

DC Motor > Charge Controller > Battery Pack > AC inverter

That's really all there is to building your own self-sustaining wind turbine. Be creative – any parts of the windmill can be modified to suit your specific needs.

Good luck, and remember, safety first!

Chapter 5

How Much Energy Do You Require?

I'll provide a general overview in this chapter about the amount of energy you'll need to produce in order to reduce your energy bills. From household to household, this amount will vary obviously, but there are some general guidelines you can follow.

For instance, a solar or wind power system that produces a mere 450 watts can have a huge impact on your electricity bill. A 450-watt system is sufficient to provide electricity for all your lights, television, DVD player, microwave, and toaster.

If you decide to create a 450-watt system, you'll need five solar panels that produce 24 volts with 4 amperes each. This would give you 480 watts of renewable power that will last for many years.

Examples of Household Appliances and the Energy They Consume:

Appliance	Watts
Toaster Oven	1500
VCR	35
Well Pump	800
Sewing Machine	87
Satellite TV	50
Refrigerator/Freezer	460
Vacuum	1125
Circular Saw	1500
Hair Dryer	1500
Jigsaw	300
Desktop Computer	100
Laptop Computer	60
Monitor	60
27” TV	200
DVD Player	14
Drill	800
Microwave Oven	1245
Compact Fluorescent Bulb	13
Battery Charger	25
Blender/Mixer	350
Belt Sander	800

Chapter 6

Become Oil-Independent

One of the biggest challenges individuals face when they try to reduce personal energy consumption is reducing the amount of fuel they use for personal transportation.

More and more cars on the market today are reducing the consumption of fossil fuels. Fuel-efficient hybrid vehicles are becoming more popular, and they do make a significant difference.

Another alternative are grease-powered conversion kits; these are readily available as well. These kits convert standard diesel engines so they can run on filtered vegetable oil, which has many benefits. Vegetable oil is:

- A renewable form of energy
- It's less costly than gasoline
- It burns much cleaner than gas

However, there are some drawbacks. The engines still require diesel fuel to start, and they have to warm up before running on the vegetable oil. For these reasons, they aren't practical for individuals with short commutes or those that don't drive on a daily basis.

Presently, in addition to riding a bicycle, walking, or using public transportation, hybrid vehicles are one of the best alternatives available to the general public on a large, affordable scale.

In the near future, electronic cars will continue to become more mainstream, and cars that run on solar energy and alternative fuel sources such as hydrogen will become commonplace.

Transitioning to electric vehicles is going to be an increasingly critical issue over the next few years. If cars can run efficiently on electricity, a wide variety of renewable options will be available to power them.

Batteries could be charged by solar power, wind power, hydroelectric power, and other groundbreaking technologies as well. There continue to be rapid advancements in technology all the time, and this means that we're getting closer and closer to finally reducing our dependence on fossil fuel.

Chapter 7

Tomorrow's Self-Sustaining Home Is Here Today

It's already possible today to create a completely self-sufficient home that is "off the grid." There are currently thousands of such homes around the world. You can build your own from scratch, or you can modify a traditional home to be powered by a variety of renewable energy sources.

The benefits are obvious. Less money will be spent on electricity in the long-term. As a society, we will consume less fossil fuel, create less of a negative impact on the environment, and drive the value of our homes up too.

There are many ways a home can function on renewable energy. Factors like wind speed, amount of sunlight, or whether you live near a stream or river will influence what types of energy sources are appropriate for your home.

Most self-sufficient homes run off a combination of energy sources. Solar power is sometimes combined with gas; wind power is often combined with hydrogen. It all comes down to your location.

Most people struggle with the fact that one energy source alone – or even a combination of alternative energy sources – still cannot generate enough electricity to maintain the level of energy consumption most of us have grown accustomed to.

Because of this, many homes still using partial power off the grid, and/or people cut back on their energy consumption. Here are some common ways to reduce energy consumption:

- Purchase energy-efficient appliances
- Use a laptop computer instead of a desktop
- Eliminate television or watch a smaller one
- Drastically reduce or completely eliminate air conditioning

By and large, the biggest barrier for most people is the cost associated with moving off the grid. This is heavily dependent on what type of power you're going to use, but it still generally costs $100,000 or more to make enough modifications to a home to have a significant impact, even though the value of the home will increase.

As technology advances, costs will continue to go down, but completely converting a home to "off-grid" is still out of reach for the majority of the people on the planet.

If you want to learn more about whether a self-sustaining home is a good option for you, here are a few resources that will assist you.

http://www.greenpowergovs.org/ – General information regarding renewable energy sources

http://www.akeena.net – The world's largest installer of solar technology

http://www.solarenergy.org – A nonprofit organization dedicated to the education and advancement of solar power as a sustainable energy source

http://www.HalfWaterHalfGas.com – The world's largest distributor of alternative fuel solutions for vehicles

Chapter 8
Look at the Big Picture

Imagine Large-Scale Renewable Energy

True changes in energy generation and consumption won't seriously change until large corporations and world governments get involved on a larger scale. Without the financial resources and political influence these organizations generate, advancements won't happen fast enough to keep up with the world's energy demands.

This book is meant to be practical, not political, but right now the governments of the world (particularly the U.S. government) aren't doing enough to remedy the situation. While it's true that millions of dollars are spent on research programs for alternative energy sources such as ethanol derived from corn and tax breaks are offered to those driving hybrid vehicles as well as to corporations who invest in researching renewable energy sources, compared to the billions of dollars spent "elsewhere," it simply is not enough.

To be fair, just the fact that governments are doing SOMETHING is a good thing, but they can and should do much more. If even a small amount of the money spent on the U.S. military every year went into the development of renewable energy sources, there would be amazing advances

in technology and the cost of renewable energy would begin to go down almost instantly.

Looking on the bright side, public outcry has caused many large energy companies to begin investing in the research and development of alternative energy sources. From hybrid vehicles, large-scale wind farms, and energy-efficient appliances to the ongoing research of environmentally friendly technologies, change is occurring – more slowly than we wish perhaps, but taking place nonetheless.

In the future, the combination of public demand, a diminishing supply of fossil fuels, skyrocketing oil prices, and advances in technology will spark a revolution in the way major corporations and world governments view the importance of researching and developing alternative energy sources.

The cost of energy affects the cost of everything, from the food you eat to the clothes you wear. Transportation and manufacturing costs affect every industry, which means that energy plays a huge part in the price we pay for every commodity that we use.

Energy consumption is not merely a personal problem or a regional problem. Rising energy costs is a global concern. Those who have access to the technology and the resources to invest in solutions have a responsibility to do so.

And this is not only an issue in the developed world. Higher energy costs have made delivering aid to impoverished nations much more difficult. The limited resources these countries do have will become more expensive and therefore out of reach to more and more people.

The emerging energy crisis is truly a worldwide problem. We can't expect our governments (or large corporations) to solve the energy crisis. Ultimately, each of us must take responsibility and be proactive.

Chapter 9
Ethanol Energy

Energy from sugar and corn

Ethanol is an alcohol-based energy source typically made from sugar or corn. The United States and Brazil are currently ethanol and gasoline for fuel in vehicles. Ethanol burns cleaner than gasoline, and due to its chemical composition it can reduce or even eliminate the output of carbon monoxide when it burns.

It's not a perfect solution, however. While its use and production are widespread, the jury is still out about whether it's a viable alternative to gasoline, and there is a question about how economically stable it is.

Large quantities of ethanol require large supplies of either sugar or corn. This makes sense in the U.S. because there are adequate amounts of these crops. But because farmers are being paid subsidies to grow the corn, the farmers are being forced to allocate more land for the cultivation of corn to accommodate both food and energy consumption.

This has had an impact on corn prices and has negatively affected the bottom line of farmers nationwide. Corn is produced and sold for human consumption, and it's also fed to

cattle. Allocating more corn for ethanol production not only affects corn prices, but beef and dairy prices as well.

The production costs of ethanol are another issue. Calculating the cost is difficult and hard to quantify. To figure out the actual cost you must determine:

- How much land is used
- What the total manufacturing and transportation costs are
- How much environmental benefit there really is
- The percentage of ethanol that will be used
- How many positive by-products (such as alternative cattle feed) will be produced
- Other impacts on the environment

Despite the controversy, the fact remains that ethanol is indeed a renewable source of energy that burns a lot cleaner than gasoline. Production and distribution of ethanol is well underway on a large scale. Several states in the U.S. already require that all fuels contain at least 10% ethanol.

As further advances in technology are made, the cost to produce ethanol will drop, and the demand for it as a fuel source will become greater. This will lead to a greater demand for vehicles to run on higher mixtures of ethanol. Some cars on the market are already designed to run on 100% ethanol.

Actually, ethanol isn't really a new technology. It's ironic that when Henry Ford created the Ford Model T, he designed it to run on ethanol, calling it the "fuel of the future." Visionary that he was, he just may have been right.

If the first car ever created was intended to run on ethanol, why are we just getting around to using it more now? The answers aren't clear, but one factor is that the large energy companies have greatly influenced our beliefs and habits. People have become accustomed to being dependent on fossil fuels. And it was true that in the early 1900s, it made more economic sense to use fossil fuels as opposed to food supplies for energy.

Today, we have a more mature perspective. There are now cars, trains, buses, and even airplanes that run efficiently on 100% ethanol. The truth is that we have the technology. We have the resources. It's only a matter of time before the mainstream becomes less dependent on fossil fuels and embraces the widespread use of ethanol as a viable alternative.

Chapter 10

All About Hydroelectricity

A Widely Used Source of Renewable Energy

Used the world over to power entire cities, hydroelectric power is the most common form of renewable energy. Hydroelectricity is a much cleaner form of electricity than using fossil fuels.

There are a few drawbacks, however. While hydroelectric dams create a renewable source of energy, the actual creation of those dams can have severe consequences on the environment. Constructing a dam often displaces large groups of people, and large sections of land must be flooded, which drastically changes entire ecosystems.

Large dams also are a serious threat to human life. They are often bombed during wars, they are potential terrorist targets, and a catastrophe occurs whenever a dam is damaged or destroyed.

For example, in 1975 the Banqiao Dam in southern China collapsed under the weight of record floodwaters, resulting in over 171,000 deaths and leaving millions homeless.

Despite its hazards, hydroelectric energy is extremely important. Once dams are built and are functioning correctly, millions of homes rely the relatively clean hydroelectric power they provide.

Chapter 11

Why Not Start Today?

It's Time to Face the Facts

If we take a serious look at the issues surrounding energy, there are some undeniable facts.

Fact: Fossil fuels are in short supply, and they are becoming increasingly expensive.

Fact: There are already solutions to the energy crisis in place.

Since this is the case, why aren't more of us driving water-powered cars and heating our homes with renewable energy?

Simply put, the world has been very slow to catch on. Until recently, most of us didn't fully understand just how depleted our fossil fuel supply has become. We weren't conscious of the huge impact their use has had on our environment.

This shortsightedness led to a lack of interest in the advancement of renewable energy technology. Although energy sources such as hydroelectricity and ethanol have been around for a long time, newer technologies like solar

power and cars powered by electricity have been forced to play catch up.

As more and more of us become aware of the issues surrounding energy, technological advances will occur and alternate sources of renewable energy will be less costly to produce as well as more widely available to the general public.

At the same time, as the price of fossil fuels continues to rise governments, corporations, and individuals will have to turn to renewable energy sources in order to solve the energy crisis.

Chapter 12
Energy for the Future

Today's Fantasy Is Tomorrow's Reality

We live in uncertain times, but one thing is clear: We can't maintain our current fossil fuel consumption; it's unsustainable. There's no choice but to explore alternative energy sources. Here are a few of the concepts being tested now that are likely to be implemented in the near future.

Solar Power from Space

Scientists are exploring the use of large solar panels to orbit around the earth. The panels could escape the limitations of the planet (such as exposure to clouds) and remain in direct contact with the sun's rays twenty-four hours a day, 365 days a year.

Scientists have concluded that the earth gets enough energy from the sun in a single day to power the entire planet for a year. The most challenging aspect of this discovery is figuring out how to get the energy back down to earth. The most logical option proposed so far seems to be "beaming" the energy back down to earth via a collection station. However, this solution is still in the future due to technological limitations.

Floating Wind Farms

The average wind speeds in certain oceans are much higher than those on land. Engineers have been experimenting with massive wind farms, miles long, to harness all of this extra energy. Testing is ongoing, and this technology may be closer than we think.

Nanotechnology

Advances in nanotechnology hopefully will increase the efficiency of current alternative energy technologies. Increasing the strength-to-weight ratio of wind turbines and maximizing the ability of solar panels to absorb energy are two promising examples.

Nanotechnology may even cause electricity to be more efficient, which would mean that we could use less amounts of energy but output greater amounts of power.

The impact of nanotechnology on renewable energy is still in the experimental stages. However, this technology is rapidly advancing so it may impact energy consumption in the very near future.

Geothermal Energy

The earth itself is a huge energy source. If it could be effectively harnessed, it might even be all that we'd ever

need. Volcanoes, seismic activity, storm systems, and even waves all contain vast amounts of energy that hopefully can be utilized sometime soon.

The future holds limitless possibilities; we've just grazed the surface here. We live in an exciting time, with new technologies constantly being developed and old technologies continuously being improved. Only time will tell how successful humankind will be in providing realistic and cost-effective energy solutions.

Chapter 13

Frequently Asked Questions

Why doesn't my solar panel generate the energy I expect?

Make sure that the glass on top of your panel is clear. Remember that the energy produced by the solar panel is proportionate to the energy of the sun's rays that reach the solar cells.

How do I get more amps or volts?

Review the chapter on connecting the batteries (series or parallel). You'll find the answer there.

The device seems to work, but the energy doesn't reach my house at all, or only a very small amount does.

Simply verify the thickness of the wire you use. Remember: the lower the voltage, the thicker the wire.

My windmill generator is extremely noisy.

This problem occurs when the blades are not centered correctly. Rebuild the blades, placing them at equal distances.

I live in a small home. How much energy do I require?

You can easily add up the total amount of watts in your appliances, using the table provided in this book. Typically this is around 450 watts.

Can I use both the grid and the devices?

Of course, but make sure that you inform your electric company and they confirm that there is absolutely no problem. If you produce more electricity than you consume, the electrical company will be in your debt – not the other way around.

Do I need electrical expertise?

No! Anybody can build these devices. An electrician is only necessary when you are ready to connect the devices to the grid. To be on the safe side, you'll want to enlist the services of an electrician for this.