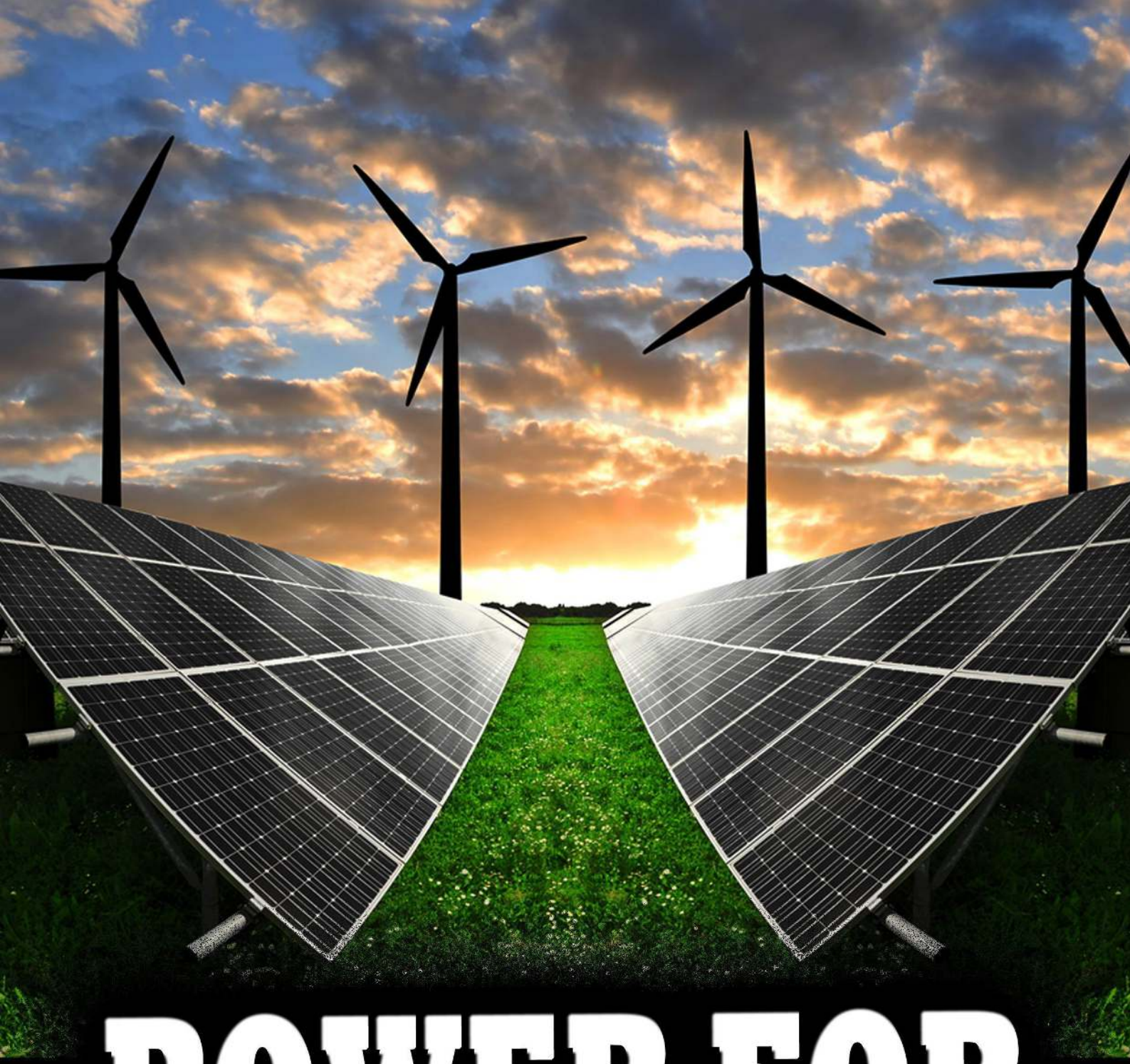

POWER FOR FREEDOM:

How To Create Solar Panels and Wind Turbines

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Introduction

While the idea of eliminating the power bill and independently generating your own electricity is appealing, the truth is this is an enormous and expensive goal. This guide and complementing instructional videos are designed to help you work towards that goal, taking small, inexpensive steps that, over time, will slowly convert your home or business into a green energy-generating factory. In the long run, you will save money and do your part for the planet. In the short term, however, making the switch to green energy might seem overwhelming and expensive. This is why it is vital to make realistic goals, and not try to tackle everything at once.

Refine your goals

Everyone will have slightly different goals when it comes to generating green power, and it is important to define and refine yours. Do you want to save money? Learn about green energy technologies? Lessen your environmental impact? Do you eventually want to take your property completely off grid, or sell your excess power back to others, helping them to also benefit from green power? What are your goals over the next month, year, and decade? What kind of budget do you have to begin with, and how much can you supplement that with regularly? How much time do you have to devote to things like building panels and maintaining them? Is a DIY approach best for you? These are all questions you will need to ask yourself and have an answer to before continuing. This guide is designed to provide you with information and skills you need to slowly work towards your goals, and is not necessarily a step by step guide on how to achieve them.

Reduce, Reuse, Recycle

The path to clean, green energy is a challenging, long-term commitment, and there may be actions you can take that will make this easier. If your objective is to do well for the planet, would car pooling, recycling and reducing your waste do more than building a second solar array? If you're trying to save money, why not get rid of the dryer and hang your clothes outside? Considerations such as

this will also help you to reach your goals, don't limit the solutions to generating green power through solar or wind.

Baby Steps

Say you're working towards making taking your home and property off the grid. An up-front off grid system can cost tens of thousands of dollars and require hundreds of hours of work. This alone is enough to discourage many individuals from pursuing this lucrative opportunity. However, an alternative would be to build a mini off grid setup, designed to power one or two particular appliances solely off green power. For example, you could build a couple solar panels, a wind turbine and a portable off grid system, all of which are detailed in this guide, and set it up to power your TV and DVD player. This will also give you a better idea of how appropriate an off-grid system would be for you, without making a very big commitment. Another very practical application of a mini off grid system would be to add power to a garage or shed, and would most likely end up being costing less than hiring an electrician to wire it into your home's electrical. If you are interested in eventually setting up a large scale grid tie system, consider first building a few panels and buying an AC grid tie inverter that plugs the panels directly into an AC outlet. This doesn't require any complex wiring, and you will immediately notice a small reduction in your monthly bill. (Be sure the power output of the panels isn't too much for the inverter, and always check local zoning regulations.)

Wind and Solar Integration

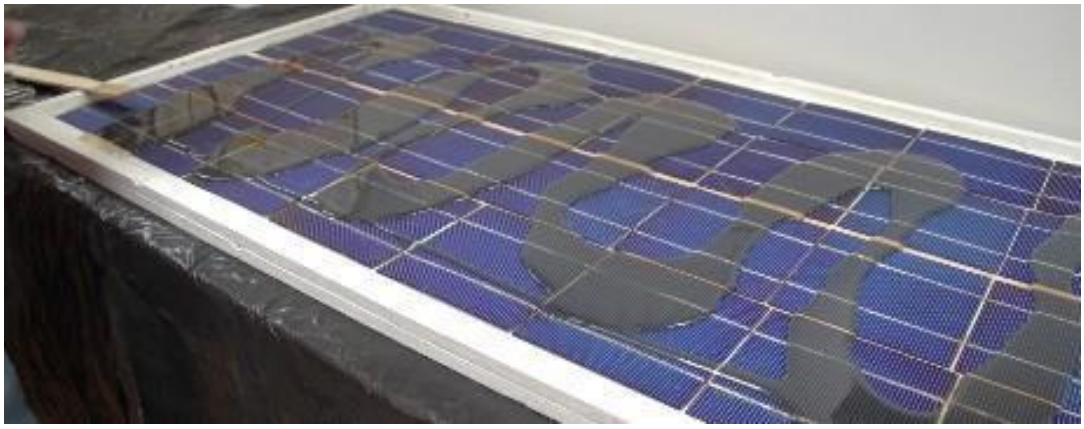
Once you have established and outlined some clear goals for your green energy endeavors, you will need to figure out your required energy production in watts and determine how many panels and turbines you will need to build. The convenient thing about a green power system is that it's modular, so if you are not generating enough power it is easy to add another panel or turbine. You should also determine an appropriate ratio between wind and solar generation. If your property is almost always windy but not always sunny, build enough turbines to get the majority of your power generation from wind, or vice versa.

Solar Power

Why Solar?

Solar power is a great way to take a real stab at your home electricity bill. The sun shining is regular and predictable, and while it might dwindle on stormy days or in the winter, it is usually windy if not sunny so a green power system that integrates turbines and solar can almost always be counted on. The one serious disadvantage of solar is the initial investment. Solar panels are expensive.

This is largely due to the fact that they are assembled overseas, and due to their delicacy, transportation of the panels is costly. This unnecessary cost, along with the costs of assembly and retail mark-up can easily be averted by purchasing the raw materials and assembling them at home, as this guide will show you how to do. While the cost of setting up a large solar panel system is still expensive, think of it as paying for years of energy upfront, and getting a huge discount because of that. Once established, solar power is free and unlimited, and as we will discuss later in this manual, sometimes can even be sold back to power companies to generate a return on your initial investment.



Components

Cells – the photovoltaic cells are the most important part of the project, as they are what actually create a useable current from the sun's energy. There are a number of different approaches to finding the cells, and this is your biggest opportunity to save money. Often, photovoltaic cells are sold inexpensively at surplus stores or at auctions. There is also the possibility of buying broken or damaged cells, which still produce useable current and usually are just a fraction of the price of undamaged cells.

For larger-scale projects, buying a large quantity of cells bulk from the manufacturer results in substantial savings. Also, check out online auction sites for last minute deals. There are several types of cells, varying between price, size and efficiency. Pick a type of cell that is the right fit for your green energy goals. Smaller cells put out less wattage, however are cheaper and more portable. Cells that are more efficient are more expensive but put out more power over less area. Damaged cells are cheaper, however could lead to unseen expensive issues down the road. Consider your initial budget, long-term goals, and planned use when choosing the photovoltaic cells for this project.

You will also have the option of buying pre-tabbed or un-tabbed cells. Typically, un-tabbed cells are cheaper, however you will need to buy tabbing wire, do more soldering and also account for cells

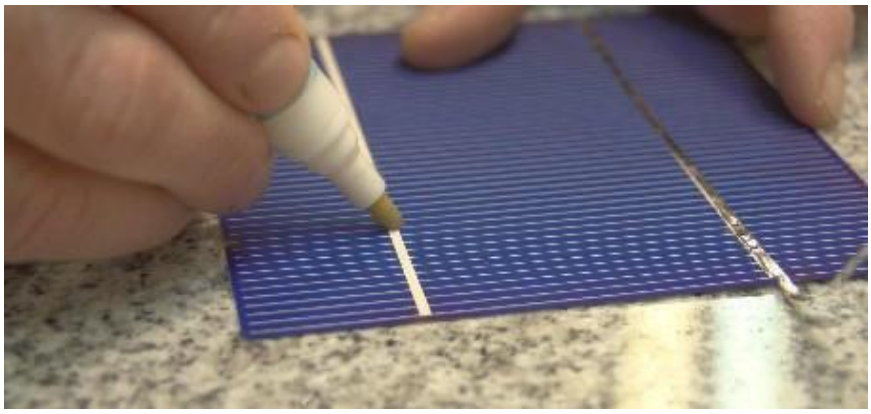
that will break during the tabbing process, which could make buying un-tabbed cells more expensive in the long run.

Panel – The back of the panel is an important part of a solar panel because if provides the photovoltaic cells with structural support, without which they would break or crack. The panel can be made out of plywood, which would need to be UV protected to prevent breakdown, lexan, Plexiglas or any stiff, durable board.

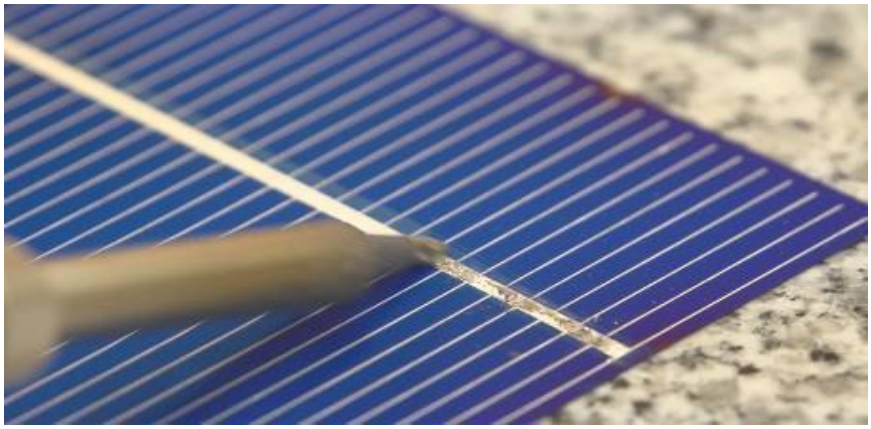
Resin – We will be encasing the cells in epoxy resin to protect them from the elements. Use a high-quality, clear drying, UV resistant epoxy resin to do this. You will need about 1oz per cell. Most epoxy resins like this are predominantly used in the marine industry as waterproof coating for boats and ships. It is vital to ensure the resin is clear
drying, as any coloration will decrease the efficiency of the cells. It is strongly recommended you mix a sample of the resin before using to check its opacity.

Step 1 – Tab the cells

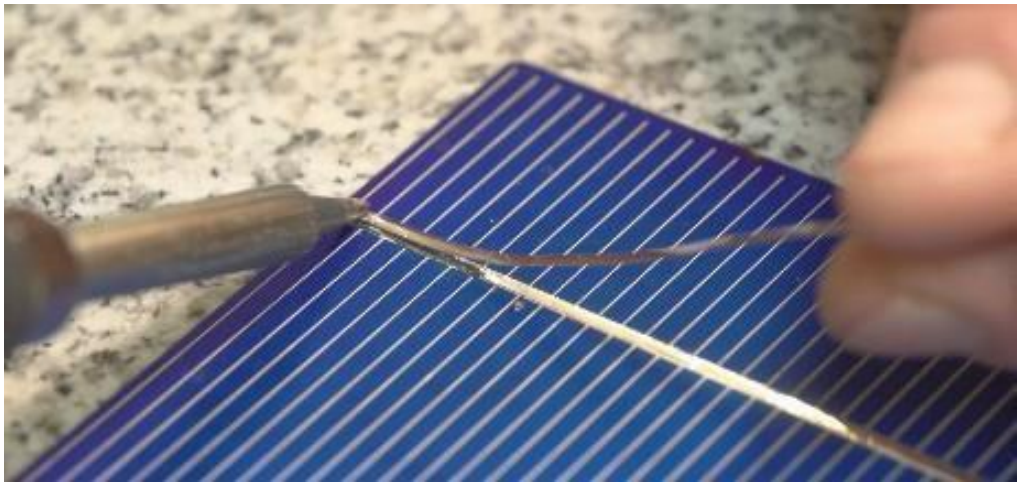
If you have purchased un-tabbed cells, you'll need to tab them before continuing to the next step. This simple process involves first cutting tabbing wire to a length of twice the size of the cell, and then soldering the wire to the conductive strips on the front of the cells. There are 2 conductive strips on the front of each cell, and you will need to solder 1 piece of tabbing wire to each. For this step, you will need a soldering iron (capable of reaching 900f), a flux pen and some rosin-core solder. Begin by applying some flux to the conductive strips on the cells.



Next, tin the strips by applying a thin layer of solder. Be careful not to press too hard or overheat the cells, as they are very delicate. It is also important to avoid touching the surface of the cells more than is necessary because the oils on skin can interfere with current flow. Avoid creating any bumps in the solder by applying the tinning layer in one fluid motion, without stopping.



The tabbing wire is usually tinned, so there is no need to apply any solder to it. Press the tip of a piece of tabbing wire to the end of one of the conductive strips with the iron and allow the solder to melt. Slowly move the iron along the conductive strip, pushing down the tabbing wire as you go. Move slowly enough that the solder on the wire and the cell has a chance to melt and bond, but not too slowly as to damage the cell.



Minor damage to cells is very likely during steps that involve soldering.

Damage as is shown here will not have an enormous effect on the overall functionality of the panel, however takes away from the professionalism of the completed job. It is a good idea to have a few extra cells on hand to replace damaged ones.

Step 2 – Construct the Stringers

A “Stringer” is the name given to a row of cells. A good base size for a solar panel is 36 cells, which are arranged in the form of 4 stringers, each consisting of 9 cells. This is how we will be laying out the cells in this tutorial, as it is a standard size for many solar panels. The cells in a stringer are soldered together in such a way that the tabs on the top of one cell are attached to the conductive strip on the bottom of the next cell. (Note: some cells only have conductive points on the back.)

Begin by laying out all 9 cells face down on a flat surface. Align them with a straight edge, and position them so they are as close together as they can be without touching directly. Fold the tabs over and to the side, and apply a piece of tape over all the cells to hold them in place while you are working on them. Avoid putting too much tension on the tape, as it will cause the cells to curl inwards. Now, use the same procedure as in the previous step to solder the tabbing wire onto the back of the next cell, first applying flux, tinning the conductive strips and finally soldering the wire to the cells. You will also need to solder tabbing wire onto the back of the first cell. Check that there are no shorts by measuring the voltage output of the stringer and covering the individual cells with a piece of paper or cardboard one at a time. You should notice a decrease in voltage as you cover each cell.

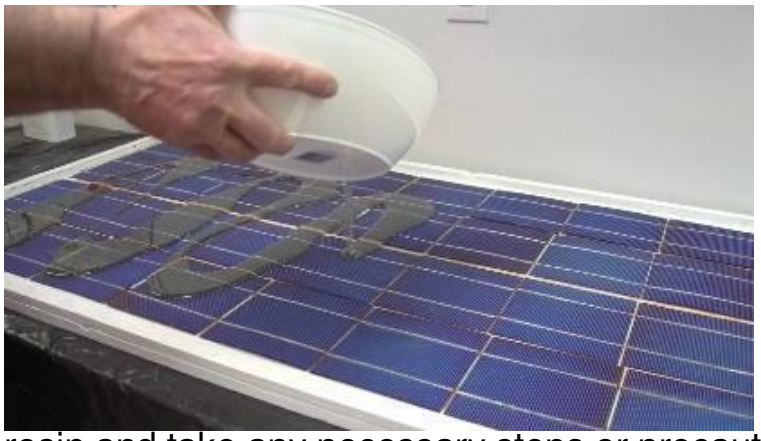
Step 3 – Mount the Stringers

Once you have created enough stringers for your panel, (4 in the case of this tutorial) you'll need to mount them to the back panel. The back panel can be made out of anything from plywood to Plexiglas, as long as it is stiff and won't break down. The dimensions of the panel will depend on the size and number of cells you are using, and can be calculated by accounting for ¼" between and to the side of the stringers, and 1" on the top and bottom. The cells we are using are 5"x5", and the stringers are approx. 48" long, so we are going to make a back panel from a piece of plywood about 21.5"x50." First, the plywood is sanded and primed with an outdoor primer. It is also helpful to make a frame that goes around the edges out of some longer pieces of plywood.

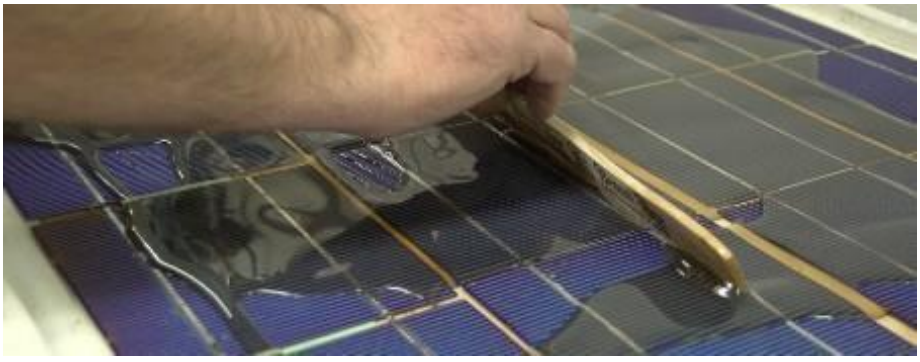
Next, lay the stingers along the plywood in an alternating pattern, so that the tabbing wires from the stringers along one side of the panel alternate between top of the cell and bottom of the cell. Finally, use bus wire (or tabbing wire) to solder together the first and second, and third and forth stringers along one side, and the second and third stringers together along the other. The first and fourth stringers on this side will be your power hookups.

Step 4 – Apply the Resin

Before applying the resin, it will be important to check the power output of your solar panel. The exact output will vary, depending on the type and number of cells you are using. The output per cell is always provided by the manufacturer, usually in the form of watts. Before continuing, take the panel into bright sunlight and check the wattage matches the manufacturer specifications of the given number of cells. (Watts are equal to voltage multiplied by amps.) It is also important to ensure the cells are clean and free of any debris or dust.



Once this is done, pour your resin into a clean plastic container and mix it thoroughly. All resins are different, so make sure you read the instructions for your particular resin and take any necessary steps or precautions. You will need roughly 1oz of resin per cell. Pour the resin on the panel and use a clean piece of wood to spread it around. The resin will level itself out to a degree as well. It is important to check the panel is level and use plastic to protect against spills.



Step 5 - Setup and Maintenance

After the resin has hardened, inspect the panel carefully to make sure there are no breaks in the resin surface. If there are, it may be necessary to add another coat.

At this point, the panel itself is completed. It can be installed in several different ways, the simplest of which is a ground mount constructed out of plywood, however it can also be attached to the roof of a house or shed.

The optimal tilt of the panel will be determined by your latitude and the time of year. Adjust your panel so that at midday it is perpendicular to the sun, which generally means a tilt towards the equator.

Adjusting the tilt twice a year (usually in March and September) has been shown to have the greatest impact on output. As there are no moving parts, there is very little that can go wrong with the panel. Ensure the panel is kept clean and watch for signs of wear. If maintained properly, a solar panel will continue to produce electricity indefinitely.

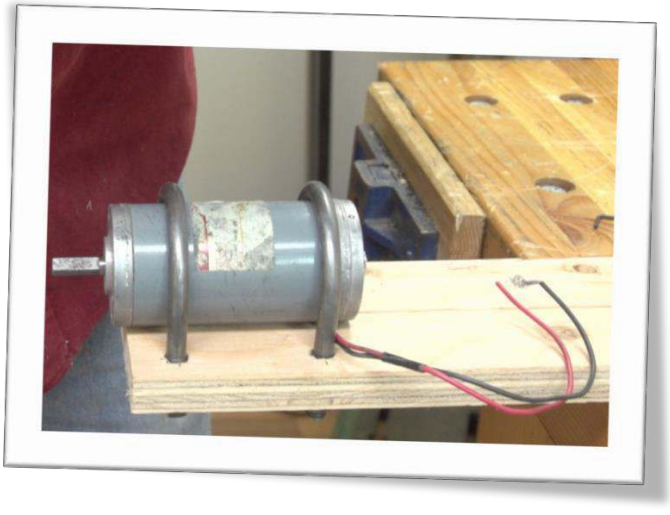
Wind Power

Why wind?

Wind power is an ideal way to begin generating green electricity at home. A simple wind turbine like this guide will show you how to build costs almost nothing with a little bit of scrounging around, and in only a few simple steps you‟ll be turning free wind energy into power you can use. While a small wind turbine like this is not likely to substantially decrease your power bill, it is great to generate electricity on remote property and when camping, or to power garages, sheds, garden lights, etc. without being tied to the grid.

Components

Generator – Low RPM DC (direct current) motor, rated to return approx. 1v per 25 rpm and can run at upwards of 10 amps. For example, a 12v automotive motor that runs at around 300rpm. You can also use an AC motor, (such as a treadmill motor) and run the wires from it into a device called a bridge rectifier, which will convert the voltage to DC. A good rule of thumb to make sure the motor will provide useable current at the speeds it will reach in this application is to



try turning the motor when the wires are shorted – if it becomes more difficult to turn by hand, it likely will work to generate power.

Vehicle alternators typically do not produce useable current at speeds this wind turbine is going to reach, however by scaling up the project an alternator could be made to work. Some good sources for motors that can be used as a generator include automotive applications (window motors, fans, RV, etc.) treadmills, saws, power tools (these motors will be AC and would require the use of a bridge rectifier to convert to useable DC voltage), electric weed-wackers, lawnmowers and garden tools, wheelchairs, powered scooters, tape decks etc.

Blades – Will be cut from plastic piping (PVC or ABC). For a smaller motor like the kind you‟re likely to find in any automotive application, a 3-4 foot section of 5-7” diameter plastic pipe will make blades of a suitable size. For a larger motor, (like a treadmill motor) you can easily scale up the blades by increasing the size of plastic pipe used while maintaining the original ratio.

Buying vs. Making - Commercial wind turbine blades are sold from a variety of sources online as replacements parts for kits. A set of blades can be purchased for around $50, while the cost to make the blades in this tutorial is only a few dollars, providing you already have the tools to do so. These commercial blades will outperform

homemade blades in several key areas – efficiency, durability and safety (as they are less likely to break off during strong winds.) Depending on budget and proposed use of the turbine, buying premade blades might be a suitable alternative.

Hub – Will be used to adapt the blades to the shaft of the generator. The blades will be bolted to the hub and then the hub and blades are fastened to the shaft. In this tutorial, we will be making a hub out of plywood and a plastic wheel that fits on the shaft of our motor, however other possibilities for hubs exist, ranging from sprockets, discs, flywheels, pulleys, etc.

Tail – The tail catches the wind as it changes direction and swings the turbine to face the wind head on, maximizing power output. The material and shape of the tail are not particularly important; pretty much any flat, durable surface will do, ranging from cardboard to light gauge sheet metal. Try to find a balance between price, ease of use and durability to best match your planned use of the turbine. In this tutorial, we will be using a plastic „sale" sign, however if the turbine is going to be exposed to extreme elements, such as gale-force winds, heavy rain or snow, hail, temperature, etc. a thin metal might be more appropriate.

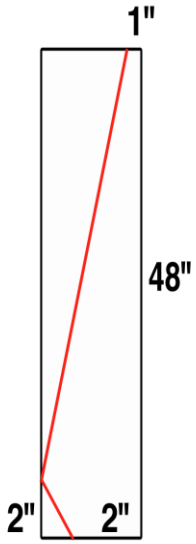
Bearing swivel – The bearing system allows the turbine to swivel. We will be using the bearings in an old roller blade wheel for this. Roller blade wheels are easy to come across and have very smooth bearings.

Tower – The stand for the turbine should be made out of steel pipe or pressure treated wood. Ideally, the stand will have a flat base made of plywood, or if the turbine is going to be permanently located in one spot, cement. Rope supports should also be set up as to allow for leveling of the turbine, and prevent it from being unstable. The height of the stand will vary based on location, however typically the higher the turbine is off the ground, the more wind it will catch.

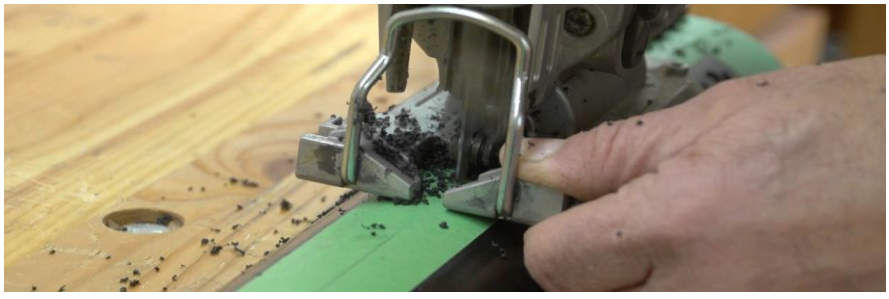
Step 1 – Cutting the Blades

Begin by cutting the pipe in thirds. Wrap masking tape around the base of the pipe and cut it so it represents the circumference. Remove the tape and measure it, then mark off thirds with a pen and place it back on the base of the pipe, and transfer the marks to another piece of tape on the top.

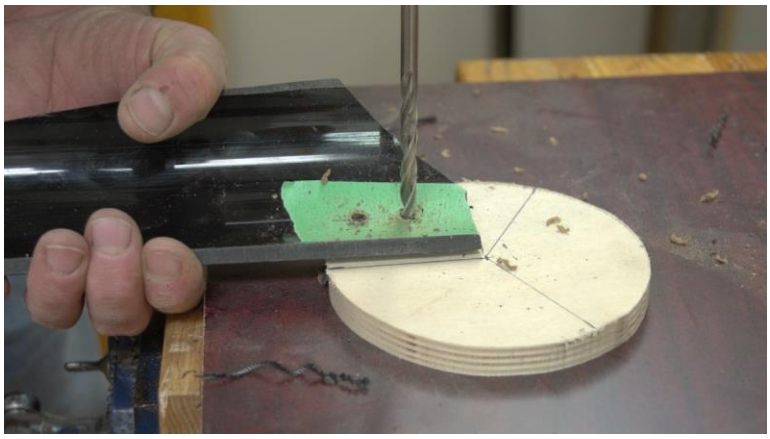
Place more tape along the length of the pipe, from the marks on the top to the bottom and use a straight edge to make a line directly down the pipe. Ideally, the pipe can easily be cut with a jigsaw, however it is also possible to use a handsaw.



Once the pipe is cut in thirds, draw the following lines on the pieces of pipe and cut these out with the jigsaw as well. Depending on the size of generator and blades it may be necessary to adjust slightly the final measurements. Generally, you will achieve optimal results by keeping the ratios shown in this diagram, however some experimentation many be required to get blades that well match the wind speed your turbine is exposed to and the resistance of your generator. Finally, clean up any rough edges with a file.



Step 2 – Installing the Hub



Once you have all the blades cut and filed down, you will need to bolt them to the hub. The hub we are using in this tutorial is a flimsy plastic wheel, so we will also be bolting a round piece of plywood on to give it some strength.
First, divide the hub in thirds. Use a compass to mark thirds along the edge of the hub, and then mark the center. Draw 3 arc lines by connecting the marks to the center. You will be bolting the blades on to the hub aligning the straight edge of the blade with these arc lines.

Once you have bolted the blades to the hub, fasten the hub on the motor and balance the blades by spinning the turbine several times and marking the top point where it stops. If there is a correlation of marks, it means that the blades on this side are light and the ones below it are heavy. Use a file to
remove material from the sides of the heavier blades. Continue doing this until spinning the turbine results in it stopping randomly, with no correlation.

Step 3 – Turbine Body

The body of the turbine will be made out of a piece of wood that is roughly 4 inches wide and 20 inches long, however these dimensions are not especially important. Begin by creating the mount for your generator. This will require 2 automotive exhaust clamps with the same dimensions as the diameter of your generator. Mark and drill 4 holes and install the clamps as demonstrated in the photo below:

Next, cut a tail shape from your choice of material. In this tutorial, we will be using a sale sign, however you can use anything from cardboard to sheet metal. The shape of the tail isn"t important, however must have enough surface area to catch the wind and turn the turbine towards it. Remove the generator and cut a slit down the middle of the turbine body. Apply a glue or epoxy, and slide the tail in place.

Step 4 – Bearing Swivel

The bearings allow the entire setup to turn when the tail catches the wind, and are a very important component of any wind turbine. For this step, we will be turning a salvaged rollerblade wheel into a high quality bearing system.

Begin by cutting a round piece of plywood slightly larger than the diameter of the wheel. Drill two holes through the wheel and into the piece of plywood. Put 2 flathead bolts through the wheel and check to ensure they are long enough to mount the wheel to the plywood.

Countersink a hole in the top center of the plywood large enough for the head of the bolt that goes through the wheel to turn freely without any resistance. Also, drill and countersink a hole in the turbine body a few inches from the tip of the tail.

With the flathead bolts in place, screw the wheel to the body of the turbine and ensure it spins freely. You might also need to use washers between the wheel and the body to prevent the flathead bolts from rubbing against the wood. Finally, bolt the wheel to the piece of plywood and make sure it still is spinning freely. If necessary, make any final adjustments. If you removed the exhaust clamps for this step, ensure they are reinstalled and don"t touch the wheel or the plywood base.

Step 5 –Choosing a Tower

There are several considerations to make when choosing a stand for your wind turbine. If the turbine needs to be mobile, which would be the case if it is being used in a residential setting or for portable power, the stand should consist of a flat base, with a tower made of steel pipe or pressure-treated wood. It would also be ideal if the tower height could be adjustable, which would allow for adjustment of the turbine to reach heights with the most wind. A mobile stand also needs to be tied down, to prevent it from falling over in gusts or storms. Tie downs can be as simple as 3 ropes that are attached to the ground several meters away with tent poles. If the wind turbine doesn‟t need to be mobile, it could be mounted to a fence or permanent metal pole. If done properly, a stationary wind turbine won‟t need tie-downs.

(The plywood base can easily be attached to any type of tower you choose to build)

Another consideration when building your tower is wind direction. Typically, wind in most areas predominantly switches between two regular directions. If this is the case, tangling of the wires coming down from the turbine isn‟t a concern. If the wind changes directions erratically and frequently, a device to prevent the wires from becoming tangled is necessary. This can be as simple as a mechanical stop, such as a bungee cord that tightens as the turbine completes several rotations, or as complex as a wire system that transfers power from the turbine through brushes to rings on the stand, which would allow the turbine to spin indefinitely without concern of tangled wires. A system like this is ideal if the turbine is going to be located in a remote location where it will not be checked on regularly.

Step 6 – Setup and maintenance

Once you have selected an appropriate stand and tower system, you will need to install your turbine. If you are doing so in a residential area, be sure to first check out any local zoning requirements and obtain all necessary paperwork. Also, consider the fact that blades can break and fly off in heavy winds or after a lot of use.

Any damage to property or injury to individuals would be a liability of installing a turbine in a city or town. Make sure the turbine is at a height that reaches enough wind to generate power, and ensure the tower is stable and straight. Use a voltmeter to check and see if your turbine is generating power. We will talk more about how to integrate the power generated from the turbine later on in this manual.

Maintaining your turbine regularly is mandatory for it‟s safety and long term functioning. Always check the blades for any signs of stress around the bolts. If there are signs of stress, replace the blades before they break and cause damage to your turbine or nearby property.

Tighten the bolts regularly. Keep the turbine and blades free of snow, ice and dirt. If the motor your using isn‟t designed to be exposed to the elements, consider encasing it in some kind of protective casing, such as an old plastic container or can, but make sure there is still some airflow around the generator to prevent it from overheating.

Troubleshooting

Common problems and their solutions

Symptom	Fix
• Turbine is not turning, or requires substantial winds to turn	This is likely an issue resulting from using the wrong sized blades. Different generators require a different amount of force to turn, and therefore there is not one set blade size. Try making a set of blades with a larger diameter pipe, or purchasing manufactured blades.
• Turbine shakes or wobbles while spinning, requires significant force to set in motion	Blades are not balanced properly. First, check to ensure the nuts holding the blades to the hub are tight and there are no cracks in the blades. Clean the blades to remove any debris, and as a last resort, rebalance according to the directions in step 2.
• Turbine spins properly, but there is no power output	Try turning the blades by hand while shorting the motor to see if there is any resistance. Check for continuity in the wires running from the generator. If this doesn‟t solve the problem, the generator may need to be replaced.
• Turbine doesn‟t move when wind direction changes	Tail is too small or bearings are tight. Check by hand to see if the bearings are still moving freely. It is possible that they could be seized or some of the screws shifted and are rubbing. If this doesn‟t address the issue, install a larger tail.

Integration

Once you have finished your solar panel and wind turbine, there are a few important notes on how to integrate them into your home electrical grid. There are 2 approaches here, the first is an off-grid system and the second is a grid tie system.

An off grid system involves a battery bank and relies solely on your electrical production to power your home. This can be a disadvantage, and may require a backup generator to occasionally supplement your green power production. It is also expensive and does require more maintenance.

A grid tie system allows you to supplement your home power consumption through green energy production. You are still able to draw power from the grid when necessary, and in some cases excess power you generate can even be sold back to others. Generally, a grid tie inverter is required and due to code requirement installation of this unit must be done by a professional contractor. However, it is possible to purchase an AC grid tie inverter that plugs your solar panel or wind turbine directly into an AC outlet to immediately create a small reduction in your power bill.

A mini off grid system is a great way to start, and can allow you to take a few select appliances off the grid. It consists of some relatively simple components:

Charge Controller – Very important to ensure your batteries don"t get over charged. Make sure you choose a charge controller that can handle the power output of your panels or energy source.

Deep Cycle Batteries – NOT Car Batteries. Vehicle batteries are not designed for deep discharge, try to find batteries that are specifically for deep cycle. Often, marine batteries work well for this, as do batteries for golf-karts, wheelchairs and electric scooters. Buying batteries new with a warranty can save you a lot of time in the long run, however if you are on a tight budget you can also approach shops that maintain electric wheelchairs and scooters, or golf-karts,

etc. and ask if you can have or purchase cheaply old batteries from them.

Inverter – Converts the DC voltage from the battery bank to AC voltage that you can power just about anything with.

POWER FOR FREEDOM

How To Create Solar Panels and Wind Turbines

The Power For Freedom guide and its complementing instructional videos are designed to help you work towards the goal of power independence.

This guide will give you the power to slowly convert your home or business into a green energy-generating machine. We would like to take the time to thank you for putting your trust in our product, Power For Freedom, and I assure you will not be disappointed.

Inside *Power For Freedom* you will discover:

- *A step-by-step guide to building your own solar panels & wind turbines*
- *How to set them up & everything you need to know about their maintenance*
- *How to integrate them into your home electrical grid*