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Do-It-Yourself Wind Turbine

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Introduction

Affordable “Green” energy has rapidly become a topic of great interest these days, as the cost of energy and its potential damage to the environment have become a cause of concern. New innovations and alternative methods to develop energy in affordable and clean ways are being developed on a daily basis.

The Do It Yourself movement is also becoming popular as a result of the high cost of sustainable technology, and as a way to create affordable energy at home. We’ve created an instructional manual that will assist you in building your own affordable wind turbine out of inexpensive, new, or recycled materials through sensible purchases.

Wind power is a smart investment that will provide excellent returns for years to come. By following the instructions in this guide and constructing your own wind turbine out of affordable materials, you will experience great savings over the purchase of a retail wind turbine system which would cost thousands of dollars.

We will provide you with numerous ideas, ranging from the best types of generators, to the cutting and shaping of the wind turbine blades. Because there are many crucial elements to wind turbine construction and production, we have also provided you with diagrams that help to explain these construction methods as well as images that depict how the turbine functions overall. Note that all measurements are based in inches (2”x4” is 2 inches by 4 inches in size).

The Six Important Components

Wind turbine assemblies share six (6) common attributes:

1. Generator
2. Blades and Blade Hub
3. Mounting (the turbine body)
4. Tower (the mast assembly)
5. Battery(s)
6. Control Panel

The wind turbine in our example will provide a few hundred Watts of power. Understand that it wasn't designed to produce enough electricity to power an entire house. However, integrating it into an existing electrical system can significantly lower your energy bills by taking pressure off of your household loads.

Parts List

Qty.	GENERATOR	Source
1	Ametek Motor/Generator	EBay
1	Blade Hub	EBay
1	Blade Hub Arbor	EBay
	BLADES	
1	6'' x 24'' PVC Pipe	Hardware Store
6	1/4'' x 1'' Plated Blot, Washer, & Nut	Hardware Store
	OPTION 1: ABS Pipe Mounting	
1	4'' x 24'' ABS Cut Pipe	Hardware Store
1	4'' x 4'' x 2'' ABS San Tee	Hardware Store
1	4'' x 2'' ABS Reducing Adapter	Hardware Store
1	2'' x 1-1/2'' ABS Threaded Reducer	Hardware Store
1	2'' x 24'' ABS Cut Pipe	Hardware Store
1	2'' ABS Slip Cap	Hardware Store
1	1-1/2'' x 1'' Galvanized Bushing	Hardware Store
1	1'' x 10'' Galvanized Pipe Nipple	Hardware Store
2	1-1/4'' Conduit Reducing Washer (pivot bearing)	Hardware Store
1	Tail Fin (11'' x 14'' Acrylic Sheet or Aluminum Scrap)	Hardware Store
2	5'' Worm Drive Clamps (to Secure Generator Body)	Hardware Store
1	ABS Cement (can)	Hardware Store

Qty.	OPTION 2: 2” x 4” Wood Mount	Source
1	2’’ x 4’’ x 36’’ Lumber (can be scrap wood)	Hardware Store
2	¾’’ x 1’’ x 9’’ Wood for Generator Saddle (can be scrap)	Hardware Store
1	1’’ Pipe Galvanized Floor Flange (pivot bearing)	Hardware Store
1	1’’ x 10’’ Galvanized Pipe Nipple (pivot bearing)	Hardware Store
2	Conduit Reducing Washer (for friction reduction at pivot bearing)	Hardware Store
6	1’’ Plated Wood Screws	Hardware Store
4	1 ½’’ Plated Wood Screws	Hardware Store
5	#8 ½’’ Machine Screws & Nuts (tail fin attach)	Hardware Store
1	Tail Fin (acrylic sheet or aluminum scrap)	Hardware Store
2	6’’ Worm Drive Clamps (to secure generator body)	Hardware Store
1	28” piece of 1/16’’ x 1’’ x 1’’ Angle Aluminum (for tail fin)	Hardware Store
	TOWER	
1	1-1/4’’ x 10’ Conduit	Hardware Store
1	30 foot piece of 1/8’’ Wire Rope	Hardware Store
6	Cable Thimble for 1/8’’ Wire Rope	Hardware Store
12	Cable Clamp for 1/8’’ Wire Rope	Hardware Store
3	¼’’ Plated Turnbuckle	Hardware Store
3	¼’’ Anchor Shackle	Hardware Store
3	3/8’’ x 24’’ Rebar	Hardware Store
1	3/8’’ x 4’’ Threaded Rod	Hardware Store
1	½’’ Rubber Grommet	Hardware Store
3	Galvanized Fence Clamps (1-1/2’’)	Hardware Store
3	5/16’’ Plated Carriage Bolts, Washers, & Nuts	Hardware Store
1	Old Power Cord (used)	Hardware Store
	MISC.	
1	Can White Spray Paint (any type or brand)	Hardware Store
1	Light Bearing Grease	Hardware Store
1	Tube Silicone Caulk	Hardware Store

Generator

The generator is the most critical part of the wind turbine. It's responsible for taking power from the blades and turning it into usable energy.

Pictured above is the 30 VDC Ametek motor. There is no need to go through the complication of building your own generator, since there are several DC motor options available that can be purchased inexpensively and straight off the shelf through various suppliers.

At this point you may be wondering how a motor can function as a generator. The answer is simple: These permanent magnet motors are designed in such a way that when spun in reverse they actually generate DC voltage. When used as a generator, a motor rated for 325 RPM at 30 Volts could be expected to produce 12+ Volts at a reasonably low RPM.

We have found that the best and cheapest option for locating a motor is to look for Ametek motors. We have listed the most common Ametek motors below along with specifications and how well they may work for your wind turbine.

The Ametek motors listed below are no longer being manufactured, but there is a good supply of used and new motors still available in the secondary market. We have found that EBay is a good place to find most of these Ametek motors.

Below is a list of Ametek motors that are suitable for Wind Turbine Systems along with their specifications:

Ametek 20VDC	Nominal Voltage 20 VDC 10/15 VDC No load amps 0.47 5/8" x 11/16" Shaft 4" x 7" **550 RPM @ 20 VDC** Weight: 13 lbs.
Ametek 30VDC	Nominal Voltage 30 VDC 12/24 VDC No load amps 0.15 5/8" x 1 7/8" Shaft 4" x 4 7/8" **325 RPM @ 30 VDC** Weight 7 ¾ lbs.
Ametek 40 VDC	Nominal Voltage 40 VDC No load amps 0.50 5/8" x 1 1/4" Shaft 4" x 4 7/8" **1050 RPM @ 40 VDC** Weight 11 lbs.

Ametek 50 VDC (1/2” x 1 ¼” Shaft)	Nominal Voltage 50 VDC No load amps 0.40 4” x 4 7/8” **1200 RPM @ 50 VDC** Weight 11 lbs.
Ametek 50 VDC (5/8” x 1 7/8” Shaft)	Nominal Voltage 50 VDC No load amps 0.60 4” x 7” **1700 RPM @ 50 VDC** Weight 12 lbs.
Ametek 50 VDC (5/8” x 2” Shaft)	Nominal Voltage 50 VDC No load amps 1.0 4” x 7” **1800 RPM @ 50 VDC** Weight 12 lbs.
Ametek 72 VDC	Nominal Voltage 72 VDC No load amps 0.41 4” x 7” 1800 RPM @ 72 VDC Weight 12 lbs.

The motor you select should have the following specifications for optimum performance:

- High DC Voltage
- High Current
- Low RPM rating

Ametek Motors

4” x 4 3⁄4”	4” x 7”	4” x 9”
40 VDC	50 VDC	99VDC

While the above Ametek Motors will be suitable for your project, the following motors do not meet required specifications and should be avoided:

- Ametek 37VDC (also known as Ametek 36 VDC and 38 VDC)
- Ametek 40 VDC – 5/8” x 2” Shaft
- Ametek 50VDC–1⁄2”x1 1⁄4Shaft
- Ametek 60 VDC

In addition to the Ametek Motors described above, there are several other options to choose from. We suggest the following options:

- Permanent magnet alternators (these are more expensive, but they are designed for wind turbine use).
- Old computer tape drive motors (surplus relics from the days when there were big reel-to-reel tape drives)
- Electric lawn mower motors
- Floor buffer motors
- Servo motors

Important Note:

Car alternators and AC motors have been used for wind turbines, but they generally do not produce the necessary DC voltage. Therefore, they are not recommended.

Before you make a final decision about which motor to use as your wind turbine generator, go to the manufacturer's web site and research the motor's specifications.

Also, avoid motors that require high RPM's to produce voltage. If you're browsing the internet, EBay is a good source to make a purchase. Be sure to ask the seller if they've tested the motor as a generator, or if they can test it for you. If they will not, pass on that motor and keep looking. If they can guarantee it, then it's even better.

Blades and Hub

Blades are another crucial element to a wind turbine's functionality and performance. They work by transferring energy produced by the wind into kinetic energy. We have developed a simple and effective blade form and method to produce inexpensive blades that work.

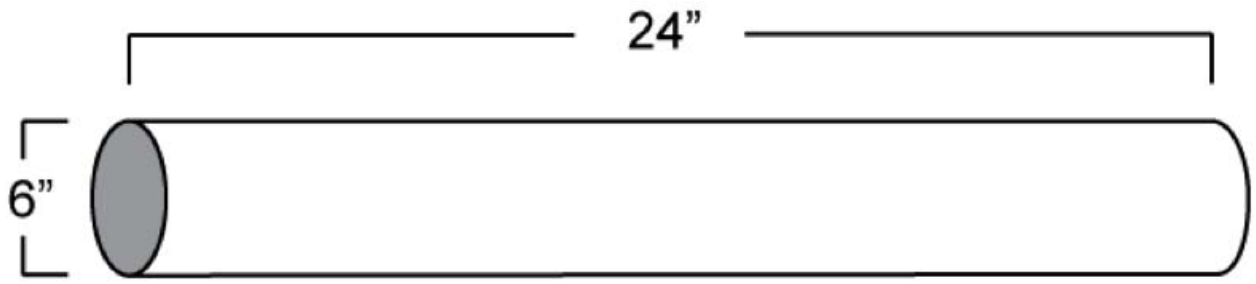
Research has shown that the optimum number of blades is 3, and you'll find that most commercially made wind turbines have 3 blades. Testing has found that turbines with an even numbers of blades tend to suffer from vibration problems. Single-blade turbines have also been researched and tested, however they require a very large counterweight opposite the single blade to aid in balancing.

There are diminishing returns to adding more blades. Expense and complexity go up quickly, but performance only improves marginally. Also, adding more blades tends to increase torque, but this comes at the expense of speed. Remember that speed is the key to an efficiently functioning wind turbine.

Generators produce most efficiently when they are run fast, which is why you rarely see a wind turbine with more than 5 blades. In applications where torque is important, you may see turbines with a higher number of blades, like the ones pumping water on farms and ranches, but they don't make efficient electrical generators unless their output is geared way-up in order to create enough speed. Gearing up would create complexity and higher costs to produce.

Layout and Cutting the Blades:

Acquire a 6 inch diameter, 24 inch long ABS or PVC pipe.



PVC Pipe

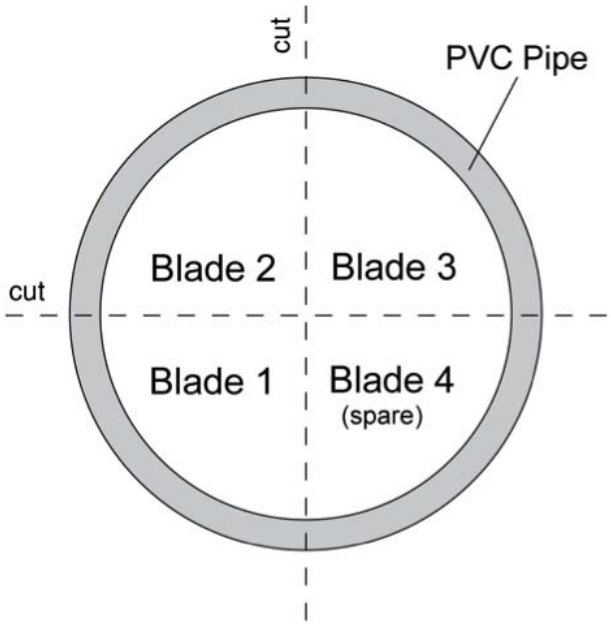
Quarter the piece of pipe around its circumference, cutting it lengthwise into four pieces (diagram on the next page). This is easily accomplished by cradling the piece of pipe on a workbench horizontally. Measure up 3 inches from the bench on both sides and both ends of the pipe, to find the mid-point or center of the pipe, and place a reference mark with a permanent marker at those four points.

You now have horizontal reference points at both ends to work from. Rotate the pipe 90 degrees while still being cradled on the bench. Using a small torpedo level, you can now line up the vertical reference points that were once horizontal and bring them into plumb with the level.

Once you have the pipe plumb, you can repeat the process of measuring up from the bench and placing four new marks, two at both ends. Next, connect the points at one end to the points at the other end using a straight edge and a sharpie marker.

The pipe is now ready for cutting into four equal pieces. There are many ways to accomplish the cutting of the pipe into individual identical sections. We have found that using a circular saw with a thin carbide toothed blade works nicely. You can utilize what works best for you, such as a jigsaw, handsaw, band saw etc. Whatever you choose, the results will be the same.

The following diagram is an excellent illustration of the pipe after it has been marked and sectioned.

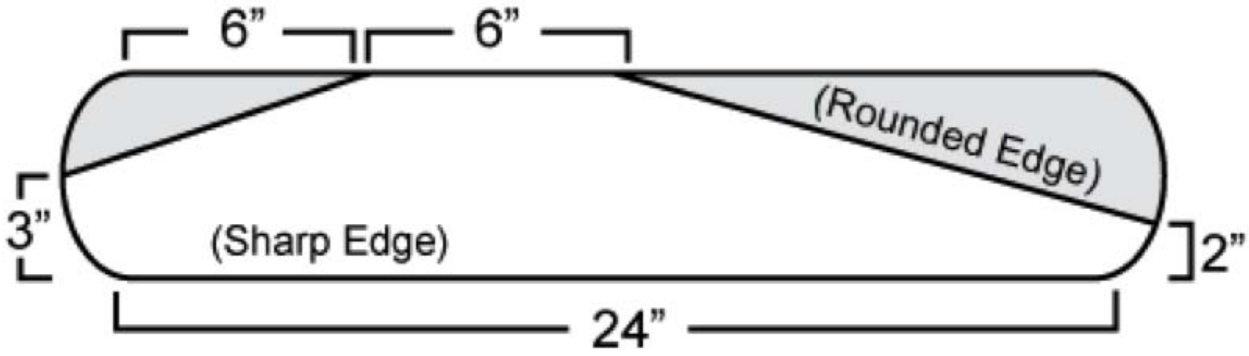


Shaping the Blades

Using the illustration below, cut one blade and use it as a template for the others (standard measurements are provided). We have found that the best way to complete this next step is to again, lay the quartered piece on the bench. Layout the measurements per the diagram, and mark the blade section where the cuts will be made. The shaded areas will be the cutoffs.

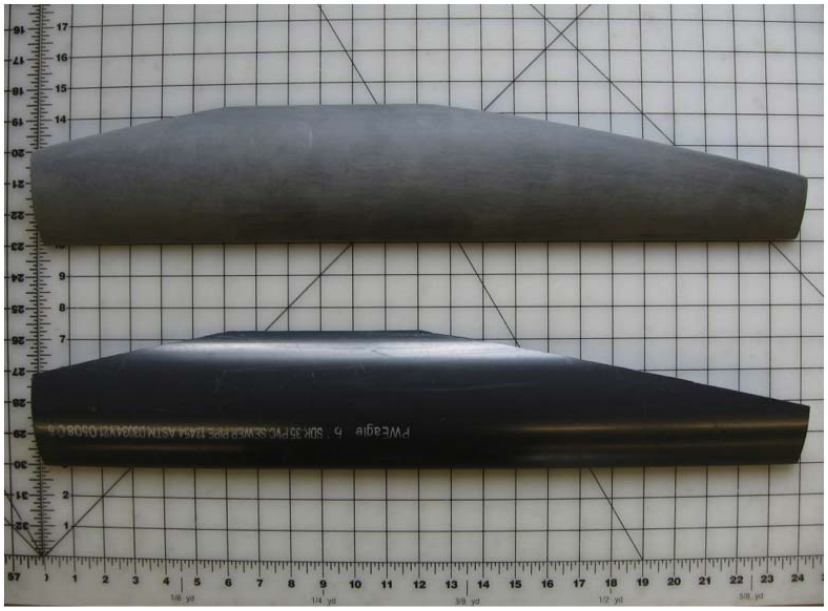
To aid in joining the points at all of the measurements, we stretched masking tape to the marks to get a straight line as it wraps around the curvature of the pipe. Trace the edge of the tape with a marker where the cut will be made. The tape can remain for now, and it helps to give

you a more visual reference as you make the cuts. However, it's not necessary to leave it in place. See example below:



Quarter of PVC Pipe

Now cut the blade as you did when you quartered it from the pipe. Try to cut as accurate to the line as you can to aid in the balancing process later.



The image above shows two wind turbine blades. The one below has been rough-cut to its proper shape per the dimensions in the previous illustration. The one above has been properly shaped and sanded, and is ready for mounting and balancing.

Once the blades are cut to their rough shape, you can now use a belt or palm sander to smooth and shape the edges of your ABS or PVC pipe quarter-pieces. While shaping and smoothing, pay attention to the leading and trailing edges of the blade. This is recommended for optimal performance. Per the illustration, the rounded edge is the leading edge, and the sharp (long) edge is the trailing edge. If you can imagine how an airplane wing airfoil is shaped, the leading edge is rounded (bulbous), and the trailing edge is a clean crisp straight line. Shape all three blades to get them as close to identical as possible.

It is critically important that all the turbine blades are the exact same size and weight.

Assembling the Blades:

Now the blades will be assembled to a blade attach hub. We chose to use a pre-made hub that is readily available online. Be sure to trial-fit the blades to the hub before you drill any holes in any of the blades to make sure that they line up correctly with the hub and are equally spaced from each other. Mark and drill one blade and test-fit it to the hub. Once satisfied with the fit, you can mark and drill the other two blades.

Below is a picture of the prefabricated blade hub that we used, which can be easily purchased online. We found this one on EBay.

If you've chosen a prefabricated blade hub as we did, it will be necessary to adapt the blade hub to the motor/generator shaft with a hub arbor, since the generator shaft is 5/8" and the hole in the blade hub is 1⁄2". This can be purchased online the same as the blade hub. Below is an image of the hub arbor that we used on our wind turbine project.

Once the blades have been attached to the blade hub as shown below, it's time to check for balance:

The Balancing Process:

Follow this 5 step process to quickly balance your wind turbine blades:

1. Mark each of your blades with a number.
2. We found it best to assemble the blade/hub assembly directly to the generator, with the generator clamped to our work bench since the blade/hub assembly is mounted to a shaft that is carried by bearings. You may find it easy to accomplish this by using another method. If not already attached to the motor/generator shaft, do so now.
3. Hand spin the blades a few times, and let the blades come to a stop.
4. For each spin, document the blade number that stops at the bottom. If the same blade ends up at the bottom each time. This is an indication that it is the heavier blade, which could offset the entire turbine's productivity.
5. If you find a blade to be heavy, which you usually will, you can sand a bit more off of the heaviest blade's curved edge. Once you've sanded a bit, retest it for balance again by using the same process. Continue with this process until you achieve a balanced blade assembly.

Once you are convinced that the blade/hub assembly is balanced, you can now reattach the assembly if you chose to balance it separate from the generator. Once complete, you're now ready to create the generator mounting, or wind turbine body.

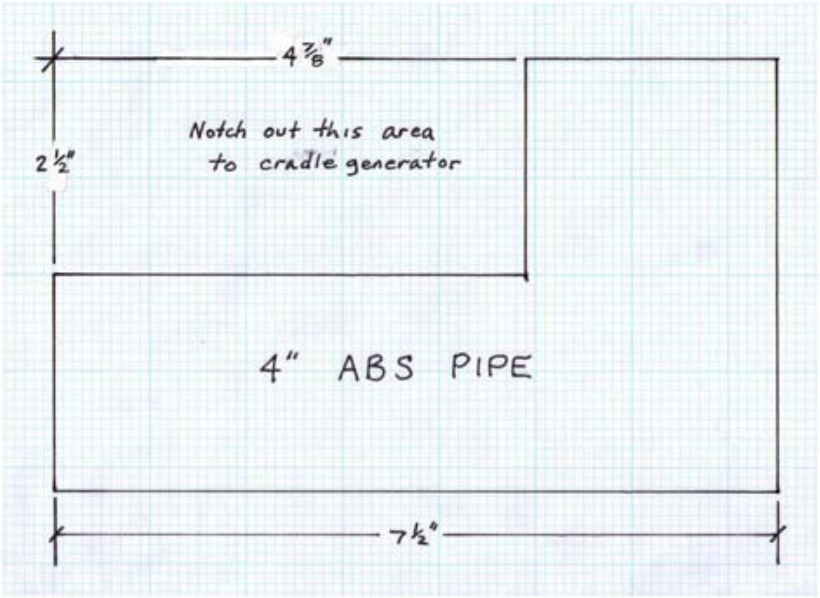
Mounting

Mounting ABS Pipe Method

There are two methods of mounting your wind turbine described in this guide; ABS (plastic) Pipe and 2"x4" Wood. The first method we'll discuss is the ABS Pipe Method.

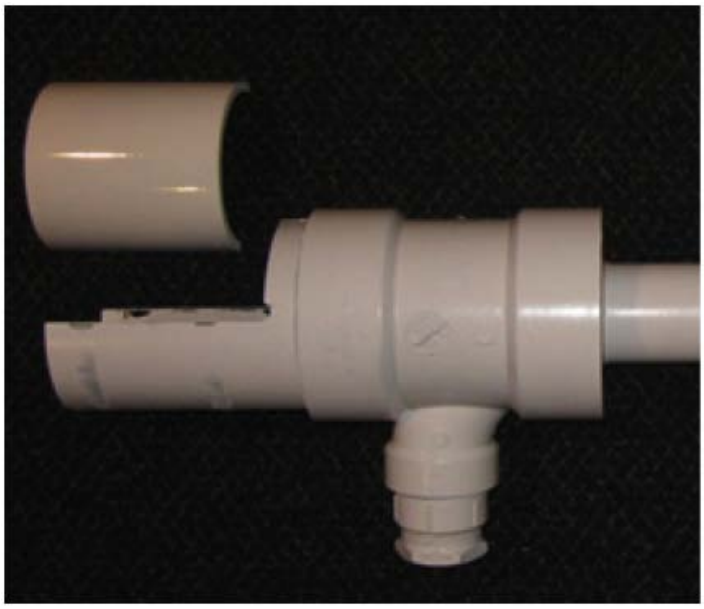
To create an ABS mounted turbine complete the following:

- Gather the ABS plastic components together that are described in the list of materials.
- Begin by cutting off a 7 1⁄2" section of the 4 inch diameter x 24" long ABS pipe. Reserve the remaining 16 1⁄2" for future if you choose to build another turbine.
- Now cut a notch in the 7 1⁄2" long 4" ABS pipe as shown in the illustration below. The notch creates a cradle to support the Ametek motor generator. Save the piece that you cut out for covering the generator and providing a shield that will protect it from the weather.



Assembly of the ABS Parts:

For assembly, begin with the 4”x4”x2” ABS San Tee, and the generator cradle that you previously made. Be sure to properly orient the generator cradle to the San Tee in a dry fit before gluing. The San Tee must have the 2” part of the Tee facing down, and the open side of the cradle facing up, as shown below.



Important Note:

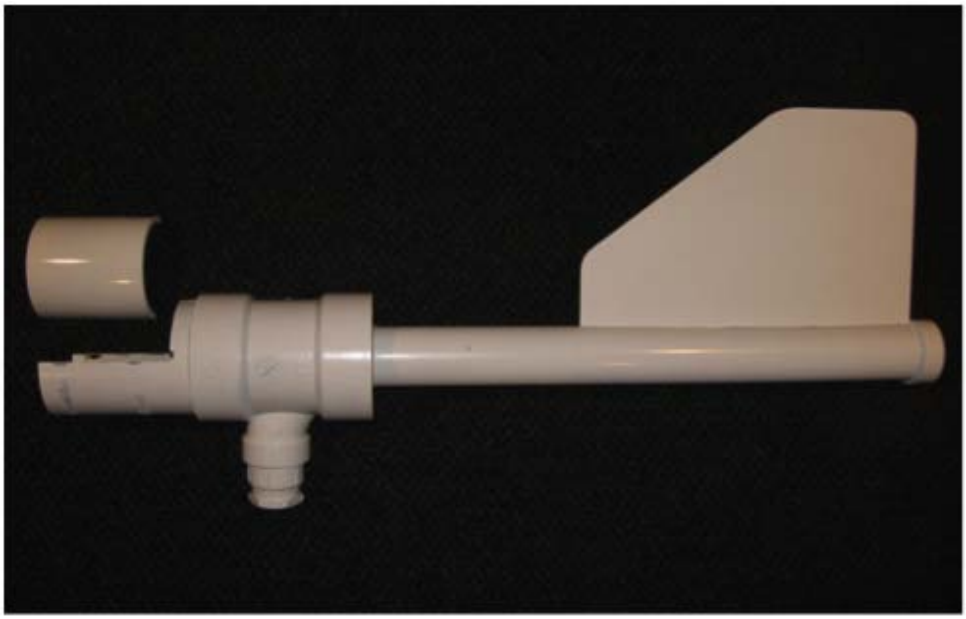
Once glued, there’s no turning back. If you install the cradle to the San Tee incorrectly, you’ll most likely be forced to remake the cradle and purchase another San Tee.

After you are sure you have the proper positioning of the San Tee with the cradle, separate the cradle from the San Tee, and with ABS cement (glue), join the generator cradle to the San Tee.

Then you can cement the 2”x1 1⁄2” ABS FIP Pipe Adapter into the 2” part of the San Tee and cement the 4”x2” ABS Flush Bushing into the remaining 4” opening of the San Tee.

Next you will attach the 2”x24” ABS pipe but first you must determine the positioning of your tail fin and create the slot that will hold the fin. Using the acrylic tail fin as your guide, mark where the tail fin will be attached. The measurements of the acrylic sheet that we purchased were 11”x14”, so the tail fin will be 11” tall and 14” long. Mark a line 1” from the end of the 2”x24” piece of ABS pipe extending 14” along the length of the pipe.

Secure the pipe to your workbench and using a circular saw with an 1/8” thick blade (to fit the width of your acrylic tail fin), cut a notch in the pipe along this mark. This will become the slot that holds the tail fin.



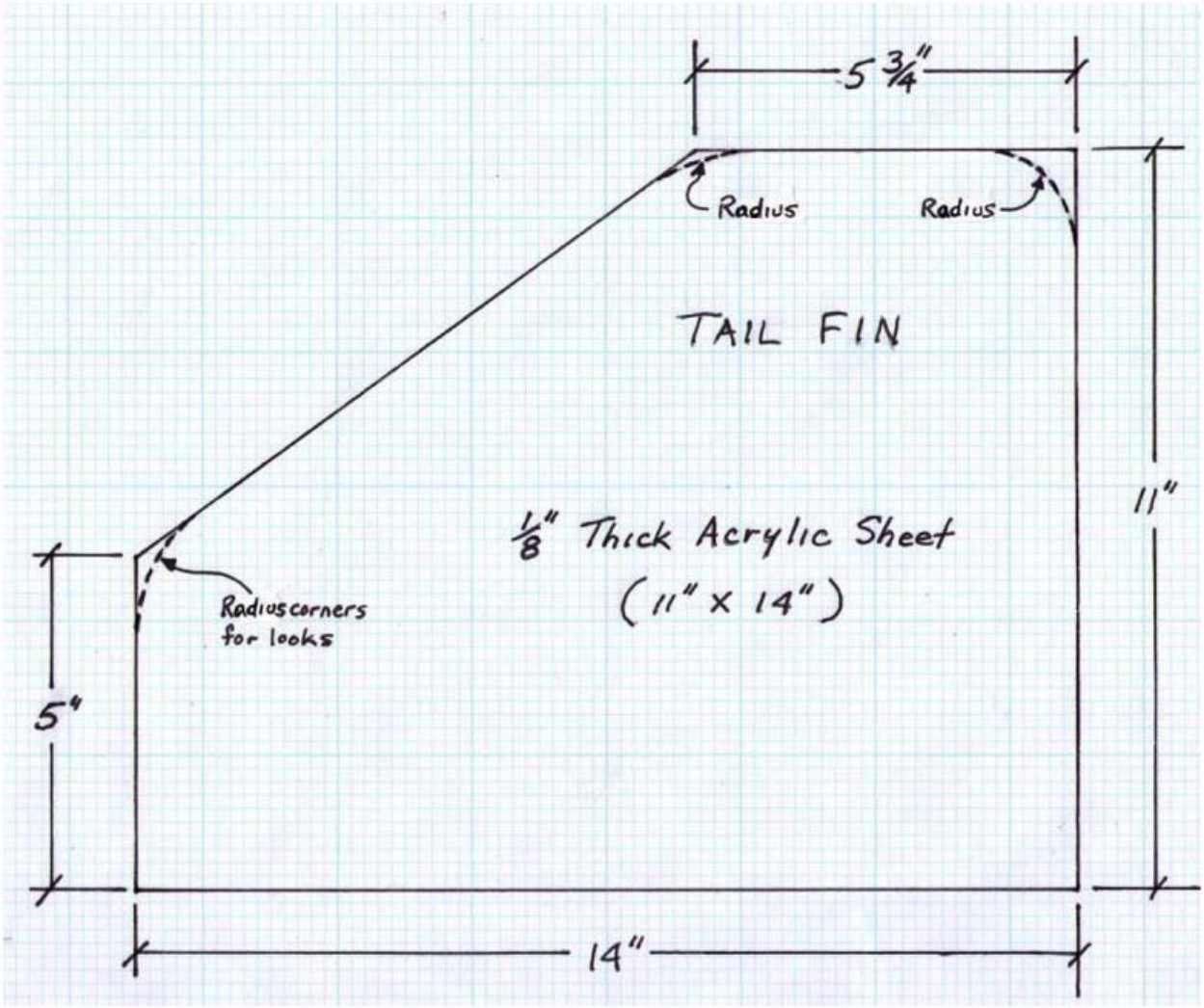
Cement the piece of 2”x24” long piece of ABS cut pipe into the 4”x2” ABS Flush Bushing. Be sure to orient the tail fin slot up, to ensure that the tail fin will be vertical when finished.

Cement the 2” ABS Slip Cap onto the end of the 2”x24” long piece of ABS Cut pipe.

Hand thread the 1 1⁄2”x 1” Galvanized Bushing into the 2”x1 1⁄2” ABS FIP Pipe Adapter. No sealant or glue is necessary. Tighten with a pair of channel lock pliers.

Fabricating and Installing the Wind Turbine Weathervane Tail Fin:

Construct a Tail Fin with a piece of acrylic sheet or aluminum to keep the blades turned into the wind. Tail shape varies by preference, below is the design we created. Lay out the acrylic sheet per the dimensions in the following illustration.



Important:

The tail fin can be made to your personal shape, or follow our basic shape recommendation. But note that if you go smaller, your wind turbine may struggle to bring the turbine around so that the blades face into the wind. You want your wind turbine to snap around when the wind comes up.

Cut the tail fin to shape. We found that a straight edge and a razor utility knife works best. Acrylic sheeting cuts nicely and easily.

Once the tail fin is cut to shape, radius the three corners at the top of the fin using the utility knife, and some medium sand paper. The following image shows the completed tail fin after it was painted.

Final Assembly:

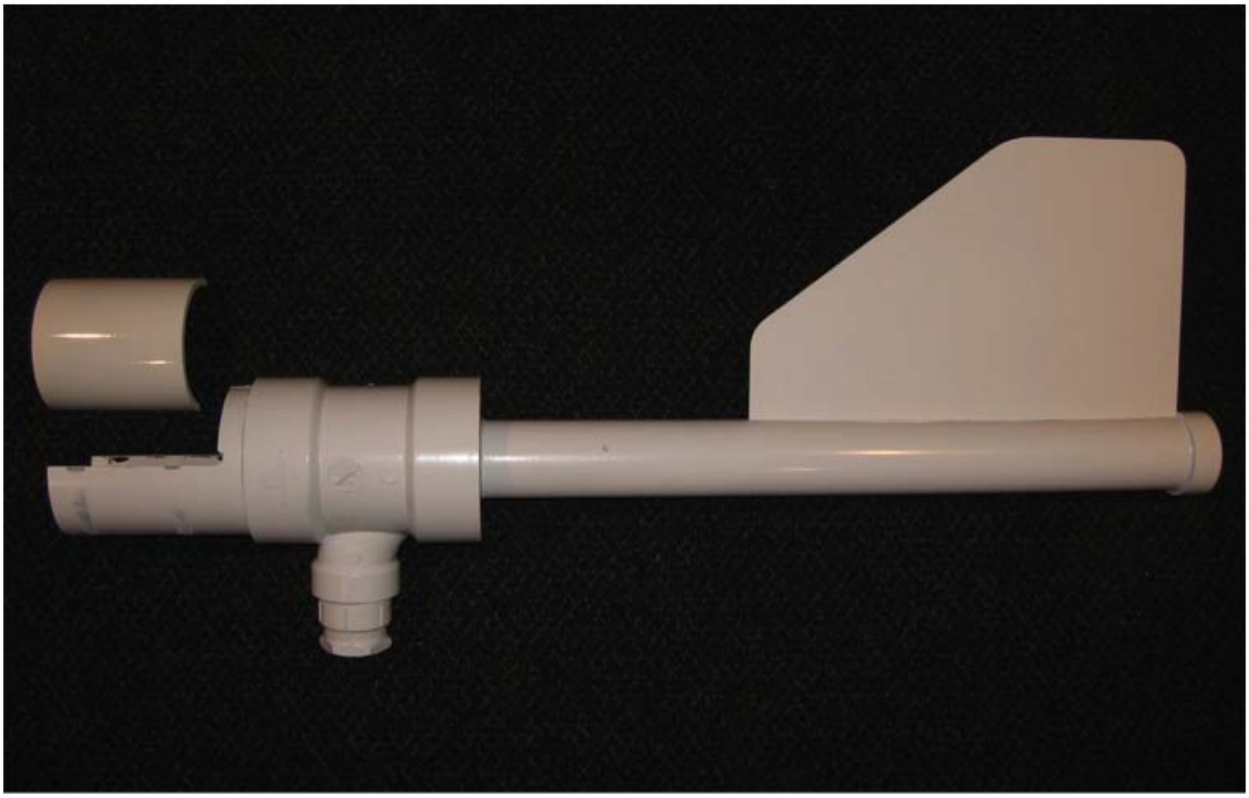
Insert the tail fin into the slot that you previously cut into the 24" long 2" ABS tail piece. Check for alignment, and be sure that the tail fin hits the bottom of the inside of the pipe. Once satisfied, run a bead of white silicone caulk around the perimeter at the base of the fin where it meets the pipe. Set it aside to cure.

Painting the ABS Wind Turbine Parts:

Collect the ABS Wind Turbine parts that you've now built. Hopefully, you remembered to save the cutout piece where the generator sits in the cradle. This piece will serve as a weather cover. You're now going to paint the ABS Turbine body; the generator weather cover; and the Wind Turbine Blades.

The turbine blades can either remain attached to the blade hub, or you can remove them and paint them separate of the blade hub for a nicer look. We painted ours separate of the Hub. You can hang the blades from coat hangars for painting. Below are pictures of our blades painted and reassembled:

A view of the painted ABS Wind Turbine body:



Shown above is our ABS plastic pipe turbine body mounting with tail attached, and weather cover painted.

Installing a Pivot Bearing:

To make sure that the turbine blades are functional and always facing into the wind you'll need to create a pivot. Although bearings are available, and there are plenty of other options, we've chosen to keep it simple. With a little lubrication, it will work just fine.

Thread a 1"x10" long piece of galvanized threaded iron pipe into the 1 1⁄2" threaded bushing at the base of the wind turbine body.

Slide the two 1 1⁄4”x1” galvanized conduit washers onto the 1” pipe. Secure them with a piece of tape for now so they won’t fall off or be lost. The image below shows how this should look.

The ABS wind turbine body is now complete and ready for installation of the generator!

Mounting 2x4 Wood Method

Although we prefer using ABS pipe to construct the turbine body, we've included another version which includes the use of wood. While the wood version may not last as long or look as nice, for some people this is a cheaper alternative and works well.

First gather the wood components together that are described the list of materials. Below is a view of what you should have.

Creating a Wood Mounting

Begin with a length of 2”x4” wood, cut to 36”.

Measure 7 1⁄2” from one end of the 2”x4” and drill a wire routing hole. We used a 5/8” wood paddle bit. You just need to drill it large enough to pass the power wire through.

Cut two generator cradle blocks from scrap wood (3/4”x1”x9” long).

Place a cradle block on each side of the end that you drilled the wire routing hole. Orient them, so that the 1” face of the blocks are facing the 2”x4”. Butt them to the end and secure with clamps.

Pre-drill a hole to allow for wood screws, approximately 1 1⁄4” to 1 1⁄2” inches in from both ends of the blocks.

Secure the cradle blocks with 2” plated wood screws. It should now look like this:

Center the 1” pipe galvanized floor flange over the hole on the face opposite the generator cradle blocks. Drive four 1 1⁄2” long plated wood screws into the floor flange to secure it to the 2”x4” as shown below:

Fabricating and Installing the Wind Turbine Weathervane Tail Fin:

Fabricate a tail fin per the instructions found in the ABS Mounting section.

Cut two lengths of the 1”x1” aluminum angle to 14” long.

Clamp the two pieces of aluminum angle together, being sure to make them flush at each end, and drill five (5) 5/32” holes centered and evenly spaced through both pieces along the length of the sandwiched together pieces. You can mark a line that you can follow while doing this, but complete accuracy is not absolutely necessary.

Remove the clamps and insert the acrylic sheet tail fin that you previously made, between both pieces of aluminum angle. Realign the holes and clamp the pieces together, sandwiching the tail fin between the aluminum angles.

With the same drill bit, drill each hole through the acrylic sheet.

Remove the clamps, and rotate the aluminum angle pieces to drill the opposite sides. Clamp the pieces together again and drill three (3) holes with the same drill bit; one at each end, and one in the middle.

The tail fin components should look like this:

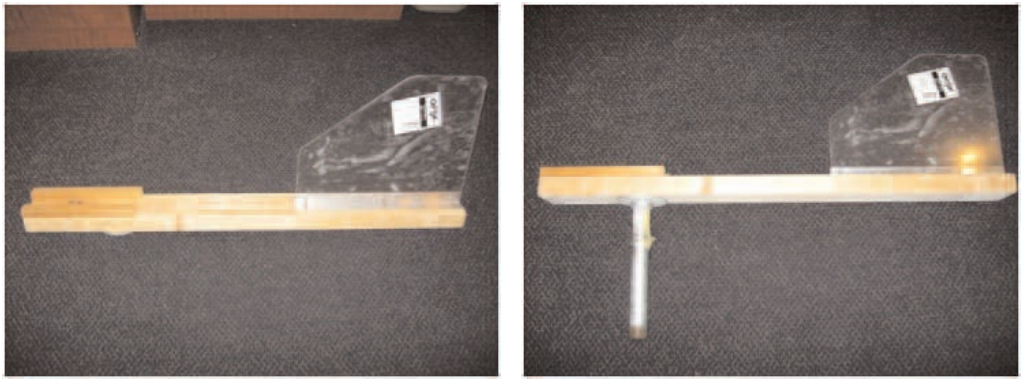
Assemble and attach the tail fin to the wind turbine body. With five 8-32 x 3/8” machine screws and nuts, join both the aluminum angle and the tail fin pieces together, and secure the nuts.

Here's how it looks:

Beginning at the aft end of the wind turbine body, mark a center line 15" long. Center the tail fin assembly over the line, and flushed to the end of the 2"x4". Mark all six (6) holes with a pencil. Set the tail fin assembly aside.

Drill six (6) small pilot holes to accept 1" long plated wood screws. Reposition the tail fin assembly centered over the pencil line. Insert the six (6) 1" long plated wood screws to secure the tail fin assembly to the wind turbine body.

Below is the completed 2"x4" wood wind turbine body:



Installing a Pivot Bearing that Allows for Ample Mobility in the Wind Current:

Thread a 1”x10” long piece of galvanized threaded iron pipe into the 1” pipe galvanized floor flange, at the base of the wind turbine body.

Slide the two (2) 1 1⁄4”x1” galvanized conduit washers onto the 1” pipe. Secure them with a piece of tape for now so they won’t fall off or be lost. The following photos show how the newly constructed wood wind turbine body, tail fin, and bearing pivot prior to painting.

Painting the Wood Wind Turbine Body Parts:

We suggest making a weather cover to protect the Ametek motor generator from the elements. The ABS Wind Turbine body construction method shows a cover made from 4” ABS pipe, and can be easily made from a piece of scrap pipe. You’re now going to paint the 2”x4” Wood Turbine body; the generator weather cover; and if you haven’t already done it, the Wind Turbine Blades.

The turbine blades can either remain attached to the blade hub, or you can remove them and paint them separate of the blade hub for a nicer look. We painted ours separate of the Hub. You canhang the blades from coat hangars for painting.

Disassemble the 1" pipe from the generator body and completely coat all parts with paint to protect it from weather and UV damage. Two to three coats is ideal to protect it from harsh weather.

The above photo shows the fully assembled wood turbine body mounted to the tower and ready to generate energy.

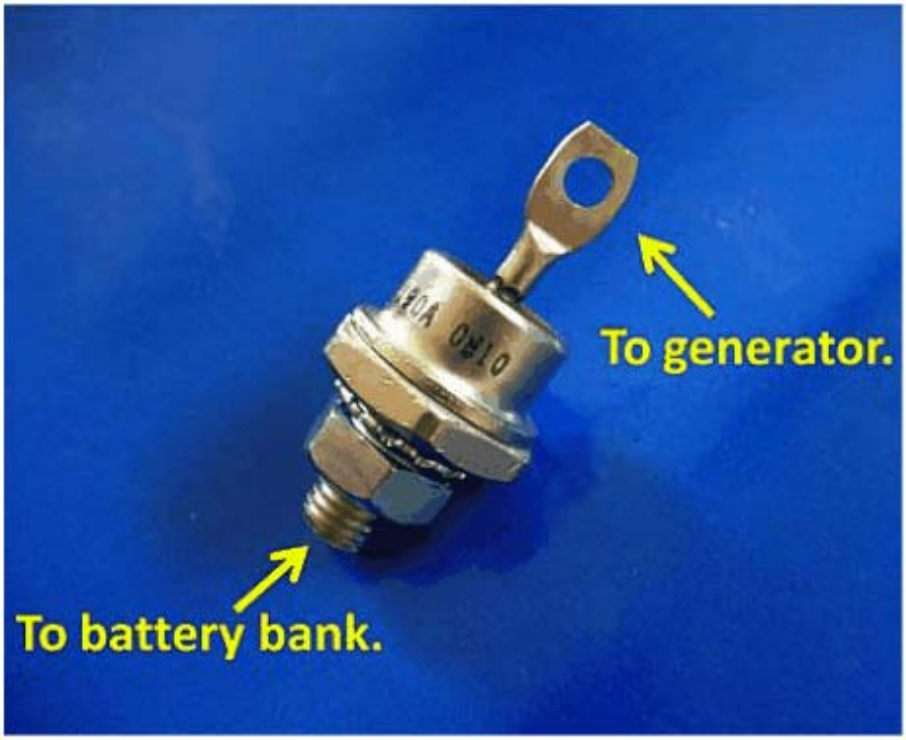
Batteries

It is necessary to collect and save the power that is created by your new wind turbine. This is accomplished by the use of batteries, and requires the following items:

- A charge controller
- A blocking diode to prevent power from the batteries being wasted by spinning the motor/generator the opposite direction. Depending upon the motor/generator you've chosen, this may have been its original purpose. Without the blocking diode, the blades

would always be fighting the backflow of electrical energy to the motor/generator. This would be counter-productive, and it would be an enormous waste of good clean energy.

Blocking Diode:



- One or more "deep cycle" batteries to store power produced by the turbine. The more batteries, the more storage capacity to handle larger loads.
- A secondary load to dump power from the turbine into when the batteries are fully charged.
- Power Inverter

On the surface, it may seem like a good idea to recycle car batteries for wind turbine utilization, but they are not a good choice for a wind or solar power installations. They just don't have the necessary range of cycles. If allowed to be drained down and discharged too deeply, they will become damaged.

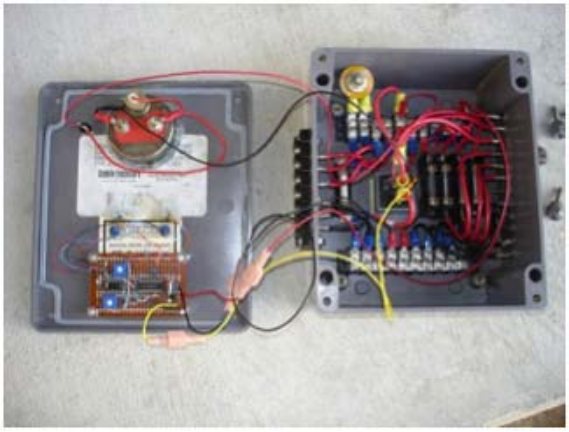
Recycled golf cart batteries and other types of “deep cycle” batteries work much better with wind turbines and solar systems, and will not be destroyed quickly from over-usage or over-cycling.

Charge Controller:

Whether you build your own or buy one, a charge controller for your wind turbine is crucial.

- Monitor the Voltage of the battery(s) in your system.
- Either send power from the turbine into the batteries to recharge them, or dump the power from the turbine into a secondary load when the batteries are fully charged (to prevent over-charging and destroying the batteries).

If you did not have a charge controller, your battery would overload from an abundance of energy, which would shorten its useful life. A charge controller is an absolute necessity for your wind turbine, as it will interrupt the system before it overcharges. Without a controller, you would need to constantly monitor the voltage on your batteries to avoid overcharging, and you would need to connect and disconnect them from the wind turbine manually. This is not humanly possible, so incorporating a charge controller solves this problem.

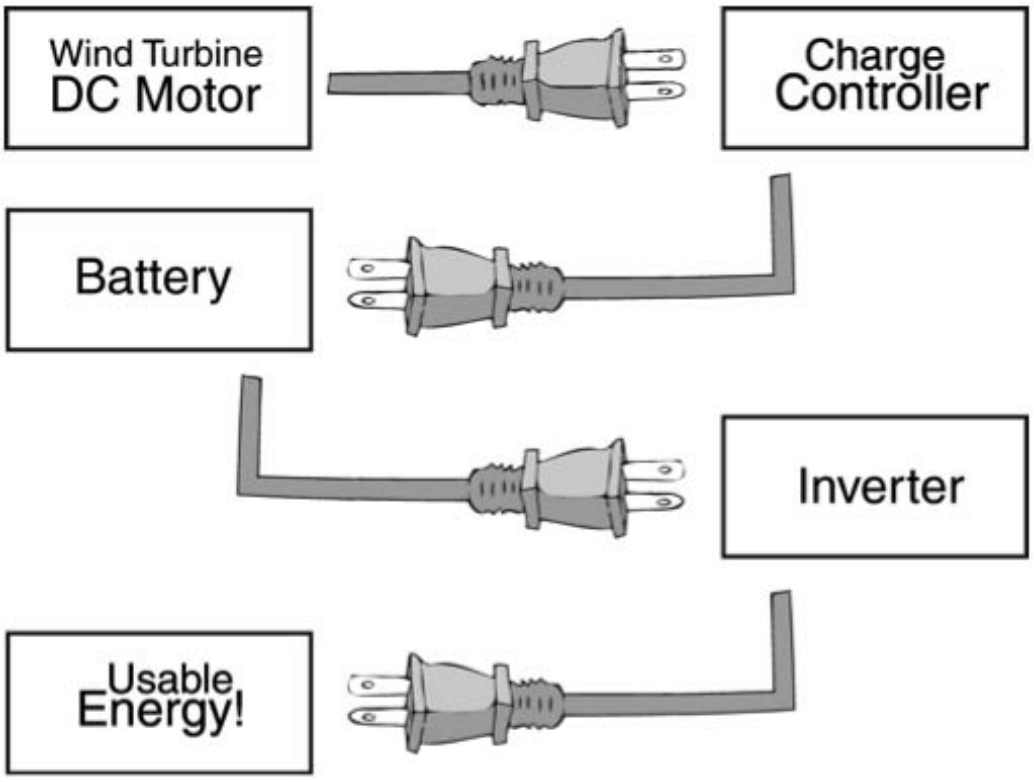


Pictured above is the inside of a charge controller. You can easily purchase a charge controller online at EBay, or through other electrical and electronics suppliers.

Before wiring everything together, speak with an electrician about the best size gauge of wire to ensure maximum wind turbine performance.

Voltage output from a wind turbine varies wildly with wind speed. Without a battery bank and charge controller in the system, connecting directly to the wind turbine could cause damage to an inverter or another appliance. The load from the battery bank smoothes out the Voltage to something the inverter can handle, providing power during periods of little or no wind. Stored power is a very good thing.

Your wind turbine should flow and function as depicted in the diagram presented below:



How the System Flows:

1. The wind turbine generates DC voltage, sending it to the charge controller. Depending upon the condition of the batteries, the charge controller either sends the DC voltage directly to the batteries to bring them up to peak charge, or if already fully charged, the charge controller diverts/dumps the power generated by the turbine into a secondary load (to prevent over-charging and destroying the batteries).
2. The batteries store all of the DC voltage that is sent to them until a demand (load) is called upon them to deliver the stored energy.
3. Once the demand for energy has been called, the inverter inverts the DC (direct current) volts into AC (alternating current) volts, which nearly all homes use.
4. Finally, the free energy that was generated and stored for future use is put to work.

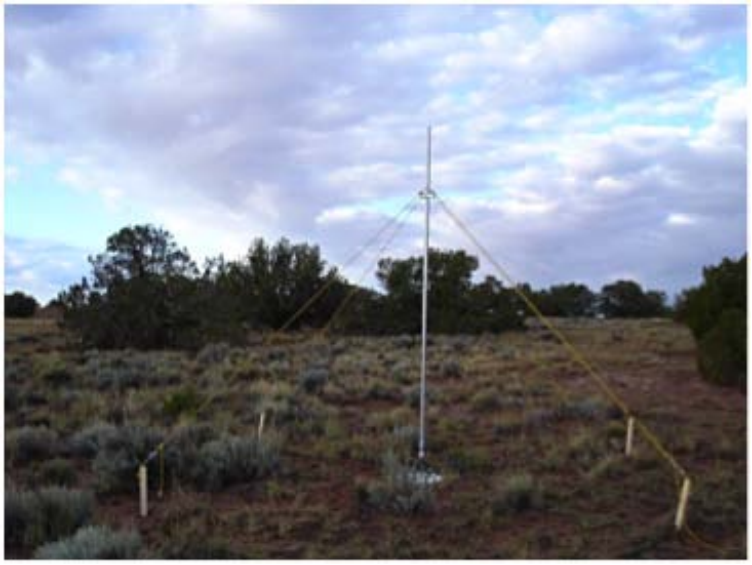
For more information about parts or pre-assembled wind power kits, check out our Power4Patriots shop at http://www.power4patriots.com/shop.

See
www.power4patriots.com/shop

Tower

You must now construct a sturdy tower assembly that will support the new wind turbine that you've created. We recommend you do some testing to find the perfect height for your location. We'll show you how to construct the example tower in this guide with our recommended minimum height of 10 feet.

The images below show how simple the tower can be:



Any obstructions to the wind, such as buildings and trees, can have a substantial negative effect on the wind turbines performance. You may find that you'll need to increase the height of the tower to get your wind turbine into clean, unobstructed wind.

To Assemble the Tower Upright:

Here are the components you'll need.

Use a 10 ft long piece of 1 1⁄4" in conduit.

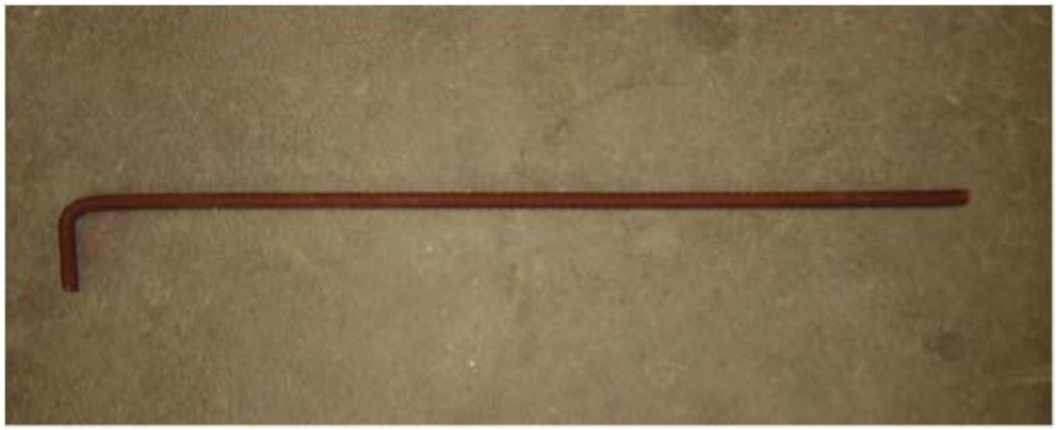
Drill a hole 15" down from the top of the tower, and insert a piece of threaded rod approximately 4" long, through the drilled hole, and secured it with nuts on both sides. We used a 3/8" threaded rod, however, any size works. Then install three chain link fence brackets above the threaded rod. The threaded rod performs the job of keeping the fence brackets from slipping down the tower pole once the guy wires are installed and tensioned.

Threaded rod 15” down from top

Drill another hole 3” up from the bottom of the conduit, to insert a rubber grommet large enough to pass the power wire through.

Hole with rubber grommet installed at bottom

To securely anchor the conduit pipe tower, we utilized three 24” long pieces of 3/8” rebar that we purchased from Home Depot. We bent the first two inches of the top of each rebar anchor over to create a J-hook that looks like this:



The simplest and most effective way to connect guy-wires to the tower is to use chain-link fence brackets near the top, as shown here.

Guy wire & clamp assembly

Guy wire assemblies in place

Assemble the guy wire cables. Each cable assembly has a finished length of 10’ long, including the cable thimbles. Be sure to use thimble clamps, and not simply wrap the cable around the bolt at the attach points at each end. If you do, you risk creating a sharp bend in the cable, and the result would be a stress point.

A stress point could weaken the cable, and possibly break in the future. Once complete your cable assemblies should look like the following image:

Slide each guy wire and chain link fence bracket assembly over the conduit down to the threaded rod that was installed earlier. Let them hang loose for now. You're now ready to erect the tower.

Determining the Best Location and Erecting the Tower:

Determine the optimal location of your wind turbine. To do this, you might try placing a few 3 or 4 foot tall wooden stakes around your property with ribbons attached. The best location will be the stake with the ribbon that is moving in the wind the most.

Once you've determined an ideal location, mark the ground where the tower will be placed. A can of spray paint or small stakes will work fine. Measure out 5'-6" from the mark where the base of tower will be, and place three equally spaced marks on the ground around the perimeter of the tower base.

At the three perimeter marks, drive the rebar anchors into the ground with the 2" pre-bent section above ground, but do not drive them all the way yet, stop an inch or so short of touching ground. Be sure to drive them in slightly canted outward from the tower approximately 10 to 15 degrees for optimum security.

Connect a turnbuckle to the cable thimble at each loose cable end. Be sure to thread the turnbuckle out at both ends, to make it as long as possible without running out of thread. Attach an anchor shackle to the turnbuckle. Let the completed cable assemblies hang loose for now.

Base of Tower:

You have many options for setting up your tower. Consider how permanent you want the wind turbine to be in its location and decide the best way to secure the base of the tower to the ground.

For a more permanent wind turbine installation, you can mount the base of the tower into a poured cement footer. You could also mount a larger piece of pipe in the footer and cut it close to the ground. Then simply slide the tower pole into the larger pipe.

An easier and more mobile method is to use a plate and stake it to the ground as seen below:

Standing the Tower:

With assistance from a helper, stand and hold the tower assembly directly over the spot where the base of the tower will sit, that was previously marked on the ground. While the helper is steadying the tower assembly, attach a completed cable, turnbuckle, and anchor shackle to each rebar anchor that you previously driven into the ground.

Don't tighten the turnbuckles yet. After attaching each cable, completely drive the rebar anchors to the ground. Once each cable assembly is attached you can begin to tighten each turnbuckle until there is a slight tension on each cable. Be sure that your helper is holding the tower as vertical as possible during this process.

Getting it Level:

Using a small level, check to see if the tower is plumb (vertically level). If not, adjust each turnbuckle until you achieve perfection. If your tower leans at all, it would create a high point as the turbine rotates into the wind. The turbine assembly would then have to overcome this high point, making it less efficient.

Installing the Wind Turbine to the Tower and Connecting the Power:

You can use an economic method in connecting your wind turbine electrically. We chose to cut off both ends of an old extension cord (to connect between the turbine and the controller).

Threading the power wire through the tower is fairly easy, but you may have to use a fish-tape or string line to pull the cord through the conduit. We found it easy to push the power cord through without assistance.

Install spade connectors to the wires exiting the top of the tower. This allows for quick connecting and disconnecting as needed, and for time efficiency as you test your new wind turbine installation. Finally, install the spade connector mates to the wires exiting the generator.

Important Note:

Connecting the wires will be different for the ABS Wind Turbine body and the Wood Wind Turbine body. The wires will be visible at the top of the wood turbine method making it easier to make the connections. However, the ABS turbine method requires the wires be connected inside the body housing. To connect wires inside the ABS body, you'll need to make the connections with the generator removed from the ABS turbine body. Once connected, the wires will be concealed within the turbine body housing. The generator would then be reinstalled; the weather cover is put in place; and finally everything is securely clamped. This can all be done with the blade assembly removed for ease of installation.

Being sure the conduit washers are in place, lightly grease the washers and the outside of pivot bearing pipe in the bottom of the turbine body. Slide the pivot bearing pipe into the top of the conduit while feeding the power wire through the turbine body.

Connect the wiring at the spade connectors. Wrap each connection with electricians tape. If you're using the wood turbine body method, you're done. If you built your wind turbine body using the ABS method, you'll need to reinstall the generator as described above.

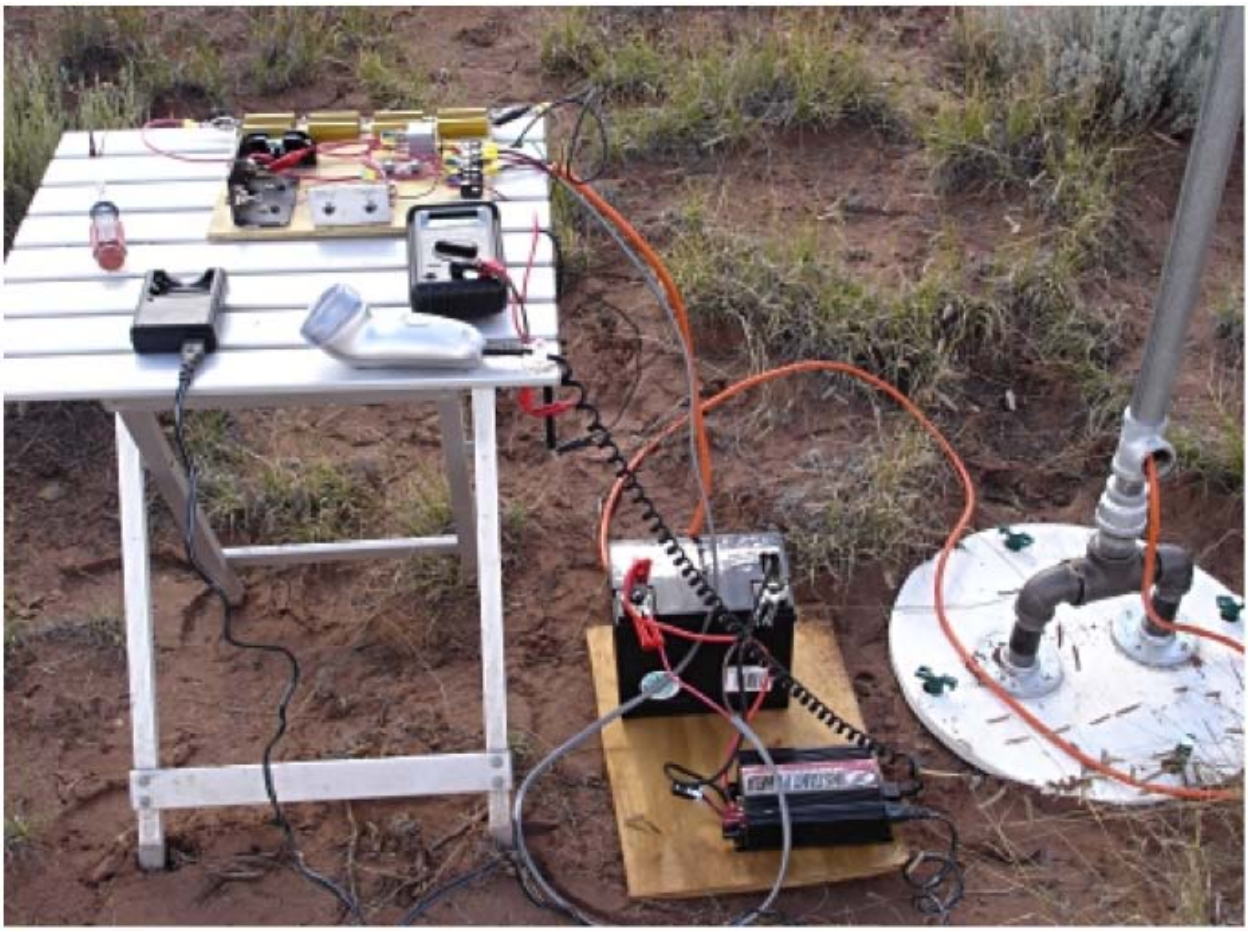
To ensure that the generator remains dry and completely weatherproof, we recommend sealing any areas that you think might allow water to enter the generator motor. To do this, simply apply silicone sealer to all holes and joints. Better safe than sorry. Once you've completed that, you're ready to test your wind turbine project.

Testing

It's time to test your wind turbine project. But just for fun, give the blades a spin to see the wind turbine in action.

Testing the Installation:

Whenever the wind begins to blow, the turbine head should easily turn around into the wind, and begin spinning up fairly quickly until the output Voltage exceeds the battery Voltage and the blocking diode drop combined (which is around 13.3 Volts, depending upon the current state of the battery charge).



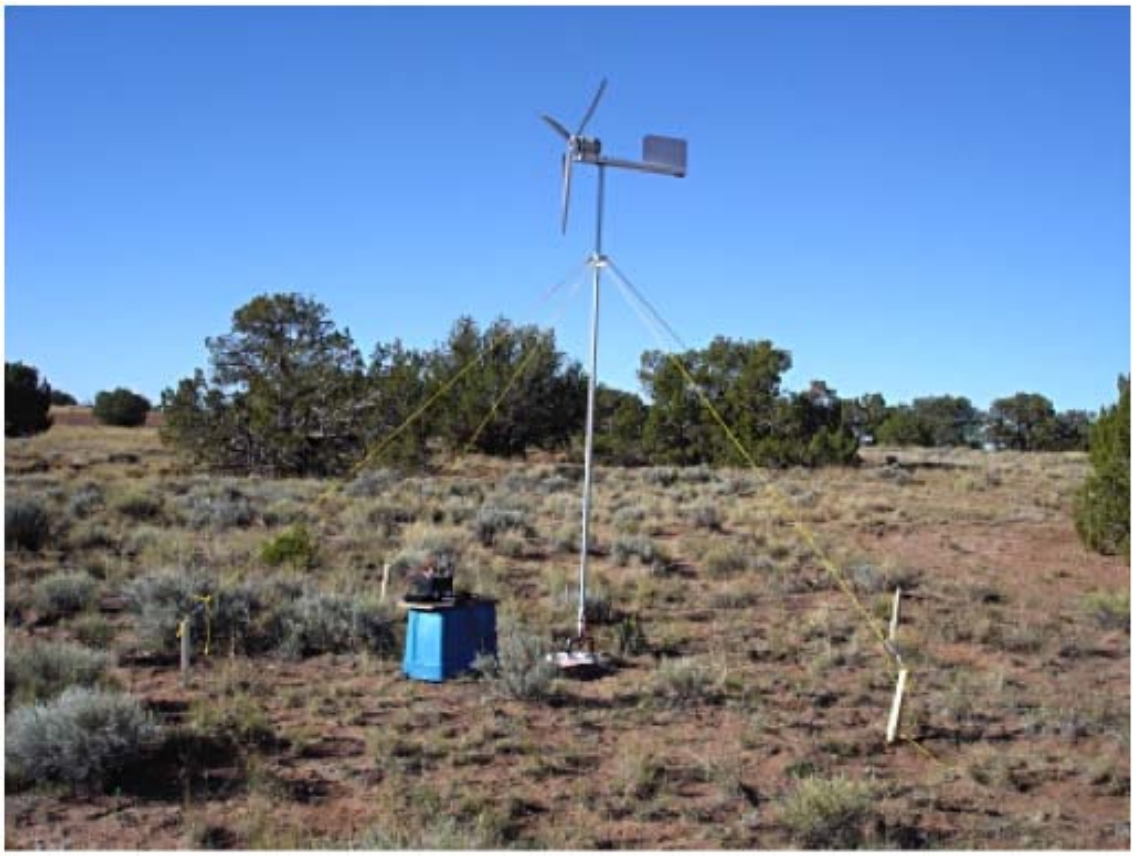
This photo shows a charge controller, battery, inverter, and various electrical components wired up to the turbine.

Once maximum Voltage is exceeded, the turbine suddenly has a load as it begins dumping power into the battery. Once it has a load (demand) to power, the Voltage from the turbine only goes up a little as wind speed increases. RPMs only slightly increase as wind speed increases. Remember: More wind = More Current into the battery = More load on the generator.

Cautions and Safety

To perform maintenance on or experiment with your wind turbine (or even in cases of extremely high wind), you will need to shut down the wind turbine by shorting the turbine output. This will halt the blades and make the turbine safe to work with.

As long as the blades are turning, your wind turbine is generating electricity. This is an unsafe condition, and arcing, burns, or electrocution could occur. Be safe! In order to make the system safe to work on, you'll need to secure the blades. An easy method to accomplish this is to use a bungee cord, or some other item such as rope. Simply wrap a bungee cord around one blade and secure it to the tower pole. Now the blades cannot spin, and the generator cannot create voltage.



Suggested Additions and Options

If you are interested in investing a bit more time and money into your wind turbine, you have numerous options available to you. Here are just a few suggestions:

- Add meters to monitor battery voltage and charge/discharge current.
- Add a tachometer to track RPM speed of your generator.
- To increase the reserve storage capacity: add more batteries. The more batteries, the more storage ability. The more you can store the better, to overcome the times when the wind has been calm for many days.
- To increase power production, add a second wind turbine or install solar panels. Both of these in combination would create a very robust and efficient system.
- Install a nose cone to the blade hub assembly as seen below for aesthetics and performance.

That completes the Do It Yourself Wind Turbine project. We hope you enjoyed putting it together, and also learning how easy it is to save money on a wind turbine, and your energy bill, while creating your own green energy. We're certain you'll enjoy your creation for years to come.

ABS Plastic Turbine

Wooden Turbine

Energy Efficiency – What You MUST Do Before Even Thinking About Solar and Wind Power

So why are we talking energy efficiency in a solar and wind power book? *Because the two are absolutely inseparable.* Here's why:

- Producing your own clean energy makes no sense if you just turn around and waste it.
- Putting in a solar or wind power system will have a much greater impact on your power bill if you first reduce the size of the power bill.
- Reducing your consumption will also mean you will need a smaller and cheaper system to cover your energy needs.
- Most solar rebate programs require you to do an energy audit before you can get your money.
- Finally, money you spend on energy efficiency improvements are subject to the same 30% tax credit and most other rebates programs. Check out the Database for State Incentives for Renewables & Efficiency (DSIREUSA.org) site for more in energy efficiency rebates in your area.

Convinced? OK, lets get started. Or you can skip to the next chapter if you are an "Energy Star" already.

The Building Envelope

There are several things you can do in conjunction with solar panels and wind turbines to create an extremely efficient, comfortable home. This article will teach you about the energy efficiency of your "building envelope", which is a fancy way of saying everything that separates your home from the elements: windows, doors, walls, and insulation.

Windows

Windows are one of the most important components of your home. Not only do they let in light and scenery, but they can let out your precious interior air and let in cold exterior air. Double and triple pane windows have gained in popularity in the past few years as their costs have come down. The gaps between the window panes are often filled with argon gas, which transmits heat less than normal air. They are also coated with a glaze that allows less solar energy to pass through, which is why they are called "low-e" for low emitting.

Windows are important for the look and performance of your energy efficient home.

If you can't afford new windows, you can still improve your existing windows' performance. There are coatings that tint your windows that will allow less sun and heat in. You can caulk around your windows to fill gaps where air can enter and escape. These caulks even come in a wide variety of colors to match your existing paint. Window treatments are a great way to save energy too. A set of adjustable blinds can retain heat on the winter nights, let in the warm sun on cold winter days, and block the scorching sun on hot days. True energy conservationists find themselves opening, closing, and adjusting window coverings throughout the day to adjust or maintain the indoor air temperature.

Doors

Your Dad probably yelled at you for letting out the "bought air" when you were a kid didn't he? Well, what if that precious air is escaping even when the door is closed? For less than $20 you can weather strip an exterior door and prevent leakage. And new, heavily insulated, weather-stripped doors are more affordable than ever, especially with the housing slowdown.

And don't forget about your interior doors. If you are closing off interior doors to seldom-used rooms (which you should be) be mindful that air can be leaking under and around these doors. A well placed blanket or a "door shoe" (which attaches to the bottom of the door) will prevent this leakage. Also check that the door is properly hung and level in the doorway as this may also cause large gaps between the door and the jamb.

Walls

For most folks, the insulation embedded in their walls is pretty much there to stay. But with new kinds of blown and pumped insulation, you can still improve your wall's efficiency. Some of these materials are made of recycled plastic bottles, newspaper, and even blue jeans. Some insulation companies specialize in cutting small holes in your walls, pumping in insulation, and then covering the holes so that you never knew they were there.

A contractor installing blown-in insulation, a nice way to add additional insulation to an existing home.

Walls are just as likely to leak as windows and doors. Caulking and sealing around outlets, switches, and corners can prevent this leakage.

Roofs and Ceilings

You probably know that heat rises. This means that the most important place to have insulated is your ceiling and roof. If you have an attic, this may be the easiest place to add an extra layer of insulation. You should have a minimum of R-50, which is a measure of insulation, the higher number the better. And don't forget to seal leaky areas where the walls meet the ceiling.

Blown-in insulation in an attic.

Temperature Control

Temperature control is one of the easiest ways to reduce energy consumption and waste.

Heating

Using gas (e.g. propane or natural gas) to heat your home is very efficient compared to electric furnaces. And using hot water heat, such as floorboard and in-floor heating is much more efficient than forced-air. Whatever your heat system is, regular maintenance is key to efficient energy usage. Often components such as filters, valves or burners must be replaced periodically. Cleaning ducts can also improve overall efficiency.

Ewwwwww!

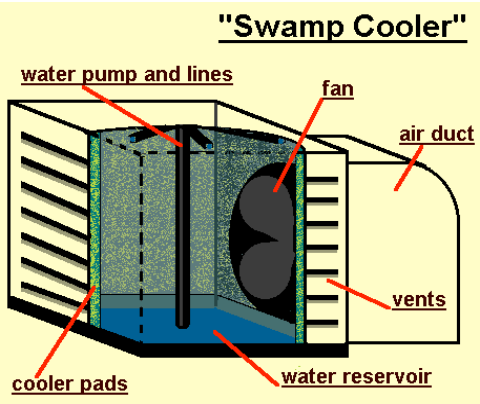
For smaller spaces that are far away from the central heating unit (such as garages or basements) kerosene heaters can provide cheap, fast heat without the expense of heating the space every day. Closing doors, vents or valves for seldom used rooms also reduces consumption significantly.

Something else to consider is your temperature setting. Try lowering the temperature setting by one degree each week for four weeks. By the fourth week, chances are you won't notice that your house is four degrees colder. And if you are colder, doesn't it make sense to throw on a sweater instead of heating the entire house?

Hair Conditioning

Cooling air in hot climates is a huge drain on our electrical grid. This kind of consumption can be partially blamed for the rolling blackouts in California and other states a few years ago. Again, maintenance on these units is key. Have a trained professional check the refrigerant levels and performance. For new units, look at for the Energy Star logo. This government program certifies the best energy performers. New air conditioning units are often 200% more efficient than their old counterparts.

In arid climates, swamp coolers (also called evaporative coolers) are a wonderful option for cooling. Swamp coolers work best when they are placed in shady areas, as opposed the roof mounts we are used to seeing. And the same holds true for cooling: don't cool seldom used spaces and keep filters and ducts clean.



No, you won't have to listen to Zydeco to use this appliance.

Try the temperature experiment for cooling your home as well. Raise the thermostat by one degree each week for four weeks. Also, try simply opening the windows at night to let in the cool air. Chances are the night air is enough to cool your house while you sleep.

Thermostat

How often does your system run? Is it running all day while you're at work? Many people believe that it is inefficient to shut the system off while they are gone for the day and then have the system kick on right before they get home. This is almost always untrue. A well-sealed, insulated home will maintain a comfortable temperature within 5-10 degrees over an 8 hour workday. Try it out for a few days and see for yourself.

Going down?

A programmable thermostat, and a homeowner who knows how to use it, is an absolutely essential piece of an energy efficient home. Turning your system way down while you're away on vacation, even for a weekend, will have a significant impact on your electrical consumption. Take 15 minutes and read your owners manual for your thermostat, or go out and get yourself a new one. New thermostats cost as little as $20 but can have a huge impact on your energy usage.

Passive Solar

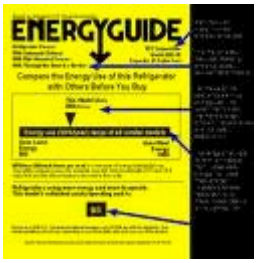
What is passive solar? Passive solar is using the sun and your window treatments to heat or cool your home. Simply opening your blinds on the south side of your home during the day can raise the temperature inside by 10 degrees. Likewise, adding shade trees, window treatments, or awnings to the south side of your home can lower the temperature inside significantly. Plus these additions can add beauty and aesthetics to your home. An architect and a landscape architect can

help you add beautiful and functional components to your home that will pay off with lower utility bills.

Appliances and Lighting – Be An Energy Star

In this section we'll talk about energy-efficient lighting and appliances.

One of the best things you can do is to start putting energy efficiency high on your requirements when shopping for new appliances. Look for the ENERGY STAR logo. This is a government program intended to help consumers find the most energy efficient units. This program also puts the average consumption on each unit so that you can compare two appliances side by side.



Pay close attention to Energy Guide stickers, they will help you save money.

Drying and Cooking

Generally creating heat with electricity is less efficient than creating heat by burning gas. Heating with electricity requires that the electrical current heat a coil, which then gives off heat. Gas appliances burn gas and discharge the heat directly to its intended use. This means that for cooking and drying, the best bang for your buck is with gas appliances. You'll notice with gas appliances that your clothes tend to dry quicker and your food cooks faster.

Washing Machines

With the emphasis on energy efficiency in the last few years, high-efficiency (HE) washers have gained in popularity. Many HE washers use 70% less water in each load. They use a side load feature, instead of top load, which means less water is needed since the clothes spin through the water sitting at the bottom of the drum.

Side load washing machines save energy AND water.

Conventional top-load washer need to fill the drum up with water for the clothes to get wet. The HE units spend less time and energy filling the tub, draining the tub, and rinsing the clothes. It also means there is less weight for the drum to spin, saving energy. In arid areas, some water companies are offering rebates for water efficient appliances. Remember, saving water and saving energy go hand in hand.

Power Strips & Electronics

Most electronic devices draw a "phantom load" of up to one-third of their operating power. This means that even when your DVD player is technically off, it is drawing electricity. This electricity is often intended to allow remote controls to work (if your DVD player was

completely off the remote would not work).

This may not sound like much, but if every electronic device is drawing a little power 24 hours a day this can add up. The best way to get rid of this waste is to get a power strip for each area of the house that has several of these devices (e.g. the home office, the entertainment center, the kitchen). At the end of each evening, and as you leave for work, just make a habit of going around and shutting off the all the power strips.

Lighting

By now you've probably heard of Compact Fluorescent Lights (CFL's) and Light Emitting Diode (LED's). These lights can use up to 80% less energy than conventional incandescent light bulbs. Remember how electricity uses a current through a coil to generate heat? Conventional light bulbs work much the same way. You can see the coil in an old incandescent light bulb. With CFL's, a gas is heated to generate light, using far less electricity and in most cases lasting much longer. These lights should be standard issue in every home these days. Just make sure to get the low-mercury bulbs. And don't forget, solar garden and security lights can handle virtually any outdoor lighting needs you have.

CFL light bulbs use a fraction of the energy that traditional bulbs use.

Disposal

When getting rid of your old appliances, don't forget about the environment. Many appliances, especially refrigerators, contain harmful chemicals and gases. Call your local waste management company for proper methods of disposal for older units. Even better than disposal is recycling your old fridges, stoves, and washers. Many companies will come and take them off your hands for a minimal charge, and they strip down the metal components for scrap and rebuild parts that can be reused. Another great way to recycle: Craigslist, Freecycle or your local classified ads. Many first time home buyers, landlords, and dormitories take old appliances and use them.

Yes, these men are recycling. I think.

Waste

Finally, stop the energy waste! How many families leave the TV on from the minute they get home until bed time, even if no one is watching? You probably have light on in the yard or the garage that stays on constantly. What about that empty freezer in the basement? Unplug it! Do you really need to crank the stereo while you're vacuuming? I bet you'd hear it better with an energy-sipping iPod and earphones.

Try these tips for a couple months and compare your previous power bill to your current. If you institute all of these practices, you'd probably see saving of 30-50%. This means lower bills, and a smaller, cheaper solar or wind power system will suit your needs.