$30 DIY Wind Turbine

Description:

This is a Vertical Axis Wind Turbine which uses wind energy to drive things like an alternator/generator for producing electricity, or air and water pumps for cooling, irrigation and similar. The turbine uses the 35-40% mechanically efficient Lenz2 lift+drag design. It is made almost entirely from scrap materials, and should cost about $15-$30 for the six vane version, which can be made by two people in four hours without much effort.

The three-vane version has been successfully survival tested to 80 km/h sustained winds and the six vane version to 105 km. Both will do more, but exactly how much has not yet been ascertained. The current longest running version has been up since early 2014, through reasonable storms, with no noticeable wear and tear as of yet.

Full power curves have yet to be calculated for this particular build, but according to Mr. Ed Lenz's calculations a six vane at 0.91 meters diameter and 1.1 meters high with a 90% efficient alternator should produce at least 130 watts of electricity in a 30 km/h wind, and 1 kilowatt at 60 km/h.

The materials listed in this tutorial are to make the three-vane version. Double everything except the bike wheel for six vanes.

Tools:

- **Power drill**
- **Metal Drill Bits**
  4mm, 6mm, 10mm
- **Box Cutter**
- **20mm x 20mm angle aluminum**
  About 1 meter long, an extra 30cm length is also handy.
  To be used for ruling and bending
- **Tape Measure**
- **Pop Riveter**
- **Marker Pen**
- **Sticky Tape**
- **(4) Clothes Pegs**
  Springy or the other kind
- **7mm Socket / Nut Driver**
- **Computer and printer**
  Low quality black and white is fine.
  And 2 pieces of A4 or US Letter paper

Materials:

- **(11) Aluminum lithographic offset printing plates**
  These are pure aluminum sheets used in a printing process fairly common with newspapers and packaging. A medium sized printing company may recycle hundreds of plates every week, so it's usually easy to pick them up cheap. Ring around any local companies offering offset printing. Any size, thickness, or type is fine as long as they're larger than 67cm on the long axis.
- **(150) 4mm Diameter Pop Rivets**
  About 6-8mm long
- **(18) M4 Bolts / Machine Screws**
  About 12-20mm long, hex heads are best
- **(18) M4 Nylocs / Lock Nuts**
  These are nuts with a ring of nylon to stop them rattling loose. If you can't find these a normal M4 nut with a spring washer will do the same job
- **(24) Small Washers**
  4mm inner diameter to fit the pop rivets and bolts, outer diameter about 10mm
- **(27) Large/Penny/Repair Washers**
  4mm inner diameter to fit the pop rivets and bolts, outer diameter about 20mm
- **26 Inch Bike Wheel**
  Exactly how bike wheels are measured is slightly complicated, basically you want one which is about 58cm total outer rim diameter, give or take
  The wheel should:
  ~ Not be quick release
  ~ Have a normal thick axle (about 10mm diameter)
  ~ Have 36 spokes (No Gears)
  ~ Run reasonably smoothly
  ~ Have enough axle showing to attach to your pole mount, at least 3-4cm
  It may be helpful to take the wheel hub apart using spanners and a bike cone spanner and give the bearings a bit of a clean and re-grease, and to extend the axle as much as possible on one side for attaching. If you've not done this before take it along to your local bike servicing place and they'll be happy to show you how. Shouldn't be necessary if the wheel runs nicely enough and has enough axle showing.
- **(12) bike wheel spokes**
  Any length, type, or condition is fine
- **(2) Strips of Steel**
  Roughly 20cm x 3cm x 3mm
- **Spare Bike Wheel Axle and (3) Nuts to Fit**
  Anything as long as it's the same thread as the axle on your wheel.
- **(3) M6 x About 60mm Bolts and Nuts**
  You'll want them with small hex heads

Step by Step Build Instructions:

STEP 1:
Download and print the two template files. Make sure they're printed at 100% (200 dpi). When printed measure the distance between the dimension arrows, it should be 10cm on both pages. If it's a couple mm off that's probably ok.

Tape the pages together so that the 10cm dimension marks overlap as closely as possible. Best way to do this is on a window pane during the day, so you can see both pages showing through. With a craft knife and the angle aluminum as a straight edge, cut out the outer border of the template. Any time you're cutting, always make sure your other hand is never in front of the knife, so if you slip you're not going to slice yourself. The angle aluminum is good for this, as the vertical bit effectively shields the hand holding it.

STEP 2:
Take an aluminum sheet and measure a box 42cm x 48cm. Draw a line halfway up the 48cm length so you have two boxes measuring 42cm x 24cm. Score the outer lines with the Stanley knife and straight edge. You're not trying to cut through the metal, just create a line that can then be popped out later. A good method is to score once lightly, then a second time a bit deeper. Do not score the 24cm halfway line. Flex the metal so that it bends at a score line, then flex back the other way. Do this a couple times and it should split. Do the same for the other score and remove the outer metal. Keep it for later.

STEP 3:
Tape the template to the metal rectangle (from now on to be referred to as a 'former') so that the long edge of the paper sits on the middle line and the right-hand edges of both line up. Don't worry if the other edges don't align perfectly.

With blade and straight edge, score out the template curve, including the triangles at each end. It's not essential that this be 100% perfect, but try to get the first one reasonably nice as you can then use it as a template for the rest. Score, flex, and remove the two triangles of metal outside the template.

STEP 4:
Mark the centers of the little circles on the paper template with a marker pen so that they're visible from the other side and flip the paper over so that the printed side is down on the other half of the former, keeping the long edge on the middle line. Retape so it doesn't shift.
Give the curved score a couple of flexes and tear it out. Remove the two small triangles. Be careful not to bend the unscored metal too much as you're doing this as it may weaken it.

You now have your first former. Repeat steps 2 through 3 so that you have a total of 6 formers. You can use the first former as a cutting template rather than the paper. On three of the formers have the 24cm line drawn on the front, the other three on the back.

STEP 5:
Take all six formers and peg them together so that they are as nicely aligned as possible.
Use tape to attach them if you don't have clothes pegs.

Drill each of the 16 holes through all six formers with a 4mm bit. Drill the center hole first, as this is the only one that needs to be reasonably accurate. It can help to put a bolt through that first hole to keep the formers from shifting around as you drill.

If the holes on your template are laid out a little differently than those in the animation it'll be because the template is more up to date.

Remove the template and unpeg the formers.
Place a former with the 24cm line slightly overhanging the edge of the table. Place the straight edge on the middle line and bend up to 90 degrees. Repeat with all six, with three formers bent shiny side up and three bent shiny side down. Put the formers aside.

STEP 6:
Take an aluminum sheet and flatten out any bends in the metal. Cut the long edge down to 67cm.

Draw a line 2cm from one of the 67cm edges, flip the sheet over and draw another line 2cm from the opposite edge on the other side of the metal.

Repeat with 2 more sheets and peg all 3 together so that each drawn line is aligned to the edge of the sheet above it.

Mark the edge at 4cm, 6, 8, 10, 18, 26, 34, and then every 2cm up to and including 64cm
Keep in mind that one side has a score at 4cm from the edge, the other at 3cm.

Flip the sheets over, making sure they don't lose their alignment. Mark and score the same as the first edge. Make sure both have the 4cm gap on the same edge.

STEP 7:
Tap the sheets on the table so that they are aligned on top of each other.
From the 4cm end draw a vertical line at 19cm from the edge, and one at 33cm from the edge.
Mark each line at 3cm and 20cm from both ends.

Drill all 3 sheets with 4mm holes at all 8 marks. If you're making a six-vane turbine rather than three you can drill all six sheets at once as easily.
Unpeg the sheets.

STEP 8:
Place a sheet so that the second 3cm edge is overhanging the table. Place the straight edge on the second score mark in and triangulate the edge as shown in the animation.

Triangulate the 4cm edge in the same way.

Pre-bend the sheet so that it'll be easier to place in the formers. Don't bend it so tightly that you crease the metal.

STEP 9:
Flip the sheet upright and insert into the curve cut into a top former (the uncut half of the former should be pointing upwards).
The best way to do this is to first place the 4cm edge triangle into its slot, then the 3cm edge, push in the inner flap, then work the rest of the sheet through the cut.

Fold down the tabs so that the first three at each end fold out, then alternate. You will probably need to give the score marks a couple of flexes before tearing them, or use pliers if they're being particularly stubborn. If you find that you've bent a tab the wrong way leave it as it is, bending it back the other way will weaken the metal. Make sure the three long tabs alternate to each other.

Push up the former so that it's level with the bent flaps.

Place 2 bike spokes in the fold of the former and bend it closed. If you squish the edge of the metal around the spoke with pliers or similar it'll stop it from falling out.

Flip the vane, place the other former, and fold down the tabs in the same manner.

STEP 10:
Slice and remove the former's two outer corners. Cut the smaller triangle level with the edge of the other former half, but give the larger triangle a 2cm offset, so that it overlaps.
Repeat for the other former.

STEP 11:
Take one of the offcuts left over from cutting a former. Cut out a strip which is 7cm wide and then cut 4cm off the long length.

Triangulate the strip as shown.

Mark the rough middle of each end of the 3cm wide face with a line a couple of centimeters long.

STEP 12:
Place the triangulated strut inside the vane so that the 3cm face sits on the row of drilled holes closer to the back edge. Sight the drawn lines through the top drilled hole to check that it's centered.

Drill the strut through the hole in the vane and attach with a rivet. Repeat for the bottom hole, then the two in the middle.

STEP 13:
Take a fresh sheet, smooth out any bends, and cut the long length down to 67cm, then cut in half so you have two pieces 33.5cm wide.

Cut off 4cm from one of the short edges of both pieces.

Repeat so that you have four 33.5cm sheets (though you'll only need three of them). Align and peg all three together.

From one of the long edges, draw three vertical lines at 1cm, 9cm, and 19cm.
Mark these lines in from both ends at 1cm and 20cm.

Drill a 4mm hole at each of the twelve marks.

STEP 14:
Mark the sheet at 5cm in from the opposite edge.
Triangulate the edge as shown.

STEP 15:
Place the half sheet inside the vane so that its un-triangulated edge is aligned with the vane's back edge. It's ok to have a small gap or bowl at either end if it doesn't fit perfectly in the vane.

Drill and rivet the row of holes in the half sheet closest to the back edge.

STEP 16:
Stand the vane upright. Push the half sheet's triangulated edge in and forward so that it's against the other sheet and somewhat tight over the strut.
Drill through the row of holes on which the half sheet's triangulated edge is sitting and rivet in place.

STEP 17:
Drill through one of the middle holes in the half sheet's back most row, making sure to keep the drill reasonably straight, and attach with a rivet and washer, so that the washer is on the inside of the vane. This bit is much easier with a second pair of hands. Try to keep the washer fairly flat on the metal.

Repeat for the other three holes.

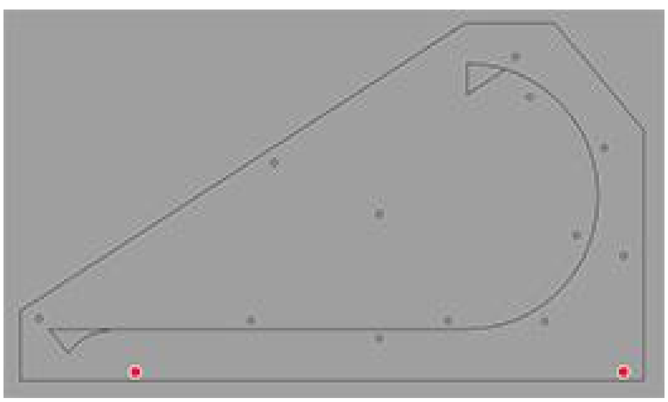
Drill, rivet and washer the remaining row. The half sheet should be tight across the strut. You should notice that the vane is now a lot stronger and more rigid.

Fold up the overlap on both formers to 90 degrees.

STEP 18:
Drill through all the holes on the former which will be attached to the bike wheel. If you're making a three-vane version this will be the bottom former. If you're making a six vane then three of the vanes will attach to the wheel at their bottom, and three at their top. The vanes are otherwise identical.

Drill into a small block of wood or rolled up tube of aluminum offcut so that the metal doesn't get pushed in and so that you don't risk drilling your hand.

Rivet each of the holes except for the ones marked:



as these will be bolted to the wheel rim.

It's very easy on some of the holes to just push the inner layer of metal away with both the drill and rivet, so check that each is properly holed and attached. If any aren't you may need to drill out and replace the rivet.

Drill the holes in the opposite former, the one which doesn't attach to the wheel, and rivet all except the center one.

STEP 19:
Take your bike wheel. Drill three 4mm holes evenly spaced around the rim. Your wheel should have 36 spokes, so drill a hole every 12 spokes. The hole should be fairly close to the rim edge.

Poke an M4 bolt up through one of the holes in the wheel and through the back most unriveted hole in the bottom former of a vane.
Place a large washer and a nyloc on the bolt. Make sure the bolt is against the bike spoke you put inside the former's folded edge, and the washer is over it. This is so the bolt, and therefore the whole vane can't rip either sideways or upwards off the wheel.
Don't fully tighten the nyloc yet.

Align the vane so that the other unriveted hole sits near the edge of the wheel rim and mark with a pen through the hole, and also the unriveted hole in the middle of the former.

Rotate the vane away so that you can drill the two marks.

Move the vane back and lock down with two bolts, large washers, and nylocs. Fully tighten all three. This is where the 7mm socket / nut driver comes in handy, as tightening these by hand is a bit of work. You'll also want to use hex head bolts as they'll hopefully lock in against the wheel rim and not turn when you're tightening them. If they do just grab the head with a pair of pliers or a 7mm spanner. Trying to get a screwdriver on these if you use Phillips head bolts or similar is a bit of a nightmare at best, and kind of impossible if you're making a six-vane turbine.

STEP 20:
Repeat twice from step 8 to assemble two more vanes from your remaining formers and sheets and attach them to the wheel.

STEP 21:
Take another sheet offcut and slice out a strip 9.5cm wide and 62cm long.
****The animation says 67cm for this length but that needs to be updated, 62cm is the correct dimension****

Draw lines long ways at 3.5cm from one long edge, and at 1cm from the other long edge on the other side of the metal.
Bend the 1cm width to 45 degrees. Flip back and triangulate as shown.

Drill a 4mm hole 1cm in from each end of the strut in the middle of the 1cm flat area. Drill and rivet a hole at the midpoint.
Repeat twice more so you have three struts.

STEP 22:
Place an M4 bolt with a large washer up through the unriveted center hole in the top of one of the vanes, and through the end holes in two of the struts. Add a large washer and nyloc. Repeat with the other two vanes and the last strut. Don't fully tighten yet.

The top of the vanes need to not be twisted relative to their base. Place the turbine on the ground so you can look down on it, stand over one of the vanes so that you can see the long edge of both formers. Twist the top former so that it lines up with the bottom one.
Drill a hole through one of the struts and the former 1-2cm from the edge. Add large-washered bolt, large washer, and nyloc. Recheck the alignment, drill the other strut and nyloc bolt etc. Tighten all three. Repeat for the other two vanes.

Optionally, you can add an extra three vanes to the underside of the wheel. This will give you twice as much power, and also make the turbine more stable as it effectively moves the contact point to the center of the turbine rather than the bottom.

STEP 23:
To make a brace for bolting your turbine to wherever it's going, take two pieces of steel more or less 18cm and 20cm long, by about 3cm wide, by about 3mm thick. These numbers are not vitally important, as long as they're about that size and the metal is reasonably strong.

Mark each piece 3cm from one end and in a bench vice or similar bend the metal to a right angle. Make sure that all the various angles are pretty close to 90 degrees or the turbine won't be straight.

Nest the two pieces so that the 18cm length is sitting inside the 20cm. Drill a10mm hole (which should be the diameter of the axle of the bike wheel on your turbine) through both 3cm tabs of metal. Make sure the pieces don't slip from each other while you're drilling.

Take a spare bike axle which is the same thread as that on your wheel, and wind on a nut. Insert this through the 20cm steel piece, add and tighten another nut, add the 18cm piece, then another nut.

Drill a 6mm hole in the gap between the two pieces, as shown, and then another through both about 1cm down, and a third hole near the other end.

Take everything back apart.

STEP 24:
On the length of axle on the underside of your turbine wheel place first the 20cm steel piece with an M6 bolt through its top hole (if the nut you're using isn't particularly fat you may need to file down the head of the bolt so it fits between the two steel pieces), then the nut and tighten, then the 18cm piece, then the last nut and make super tight, and finally two bolts through the remaining holes. **Congratulations, you've made a wind turbine!**

Configurations:

These are some potential ways to attach applications to your turbine so that it can do useful work. There's not really a one size fits all answer to exactly what or how you should go about this, as it will depend heavily on your particular situation, and these possible solutions are meant only as a guide. If and when you get to this part of the process please email us directly or check out the Facebook group, where the community can help you build what you need and you can follow what others have done already.

A: DC Generator
This turbine can be plugged into and used to power a variety of applications, such as mechanically attaching a pump in order to move water and compress air, but you're probably going to be using it to generate electricity to charge batteries.
One of the easiest to source solutions for this is to use a permanent magnet (as in, it uses actual magnets rather than electromagnets) direct current motor in reverse as a generator. What type of motor you end up using will depend on how much wind you have, how much power you need, and your budget, but attaching them is largely the same process regardless. Good options include motors from car windscreen wipers, mobility scooters, electric motor bikes, and treadmills, in more or less that order of increasing power output. These can be salvaged from items getting thrown away, or bought online.

Attaching is mostly just a matter of stripping everything off the motor, attaching a pulley to the shaft, running a toothed timing belt around the wheel rim (with a layer of nylon strapping bolted to the wheel to protect the belt and give it something to grab onto) and attaching the motor to the pole frame as shown, with long bolts so you can easily adjust the tension on the belt.

B: The Pole
There's various things you can attach the turbines to, including the roof of your house, a boat, a van, or a radio mast, but the most standard option especially if you're in a rural area, is a metal pole with guide ropes.
This is pretty much just a matter of plugging the various components together as shown in the video and getting everything tight and secure. You'll want the holes for your ground anchor pieces of wood at least half a meter to a meter deep, or attach to any other strong fixed points you may have.

The only wrinkle on this configuration is that it's hinged near the ground so that the whole pole and turbine can be dropped for maintenance or in the event of a wind storm. This is just a matter of removing the D shackle from the anchor point assembly to which the horizontal boom arm is attached, and using the boom carefully lowering the entire assembly to the ground. You might want to have some kind of stand where it comes down to hold up the turbine. Raising it again is just the reverse of this process, making sure after that all the cables are nicely taught and the pole is vertical. You'll want to use four cables rather than three as it will make the whole thing more stable and secure while being raised and lowered.

C: Bike Chain and DC Generator(s)
This configuration will be updated in the new tutorial as it essentially makes no sense.

D: Electric Bike Wheel
The perfect solution for generating electricity from the turbine is to use an electric motor hub bike wheel. If you can find one. The design uses a wheel anyway, and pretty much every aspect of power inputs, outputs, rpms etc. fit quite nicely into a direct drive ~300 watt eBike wheel. All you do is build the turbine on it and plug the wires into your electrical system. Unfortunately however, outside of a few countries they can be difficult and expensive to source.

E: Home Made Alternator
This option will give you by far the most control over you power generation in terms of voltage, rpms, and overall wattage. It's also probably the most labor and knowledge intensive.

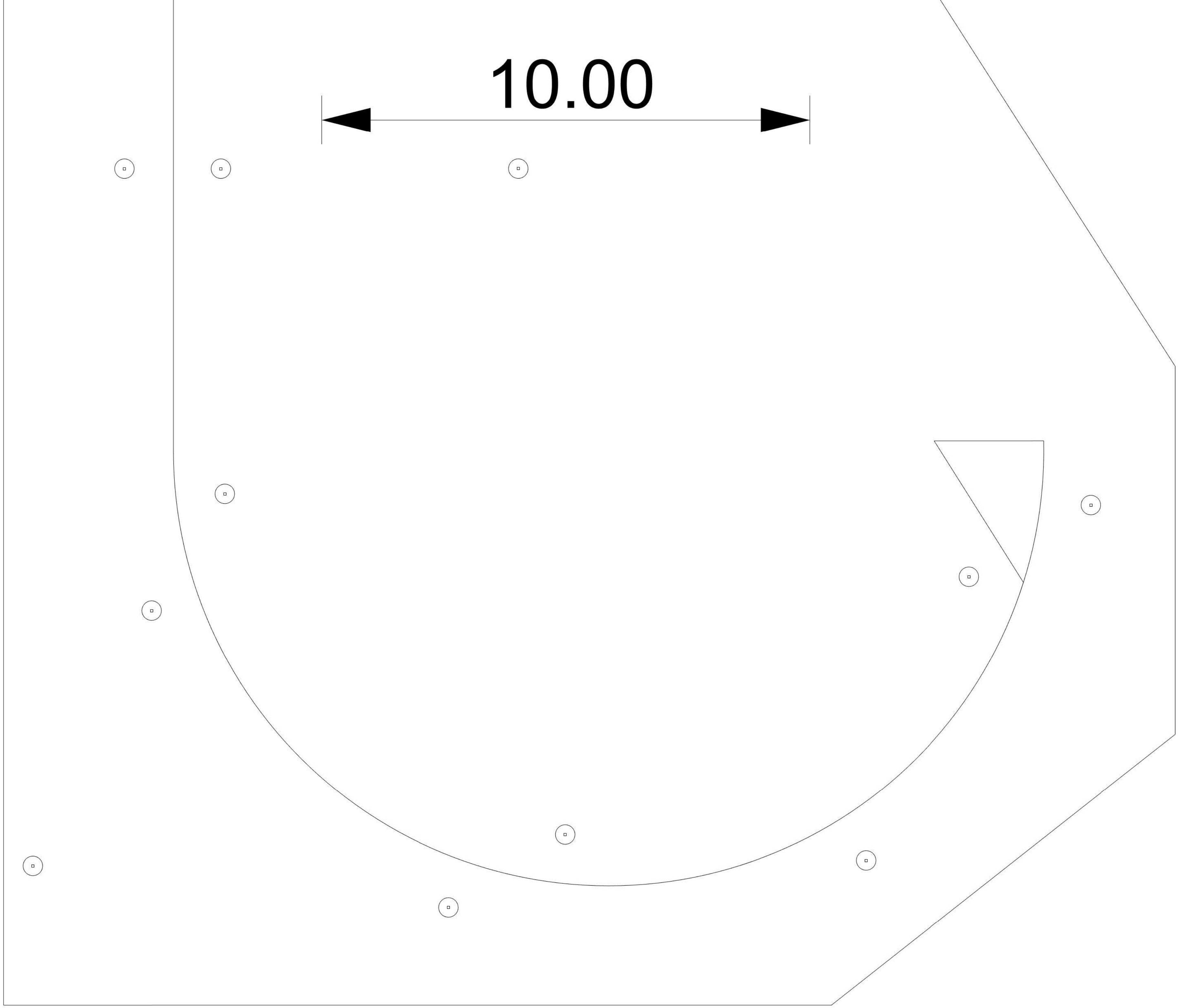
Essentially, it's just a circle of magnets passing over a circle of copper wire coils, but exactly what configuration of these will depend on various factors. It is, however, a problem which has been solved a thousand times before, and there is a heap of good information about it all online. The Facebook group is a good place to ask questions and find resources on this.

F: "The Hardcore"
This configuration will also be updated in the next version of the tutorial.

G: Daisy Chain
About half the total cost for a standard installation of the turbine is in the pole and its various fittings. But there's no reason why you can only have one turbine per pole. The lower ones will get less wind and so put out less power than the top ones, but it should still be worth doing to basically cover the entire length of the pole. And you can have some generating electricity, some pumping water, whatever you like.

If you have any questions, please email me at solarflower.org@gmail.com


10.00


10.00