All Natural homepage

Micro wind power with a Savonius rotor

by Lance Turner

This wind turbine cost nothing virtually nothing to make and can produce enough power for small applications

There are many situations where you might need a small amount of electricity, for instance running gate openers, safety lights, water level indicators and other low-power devices.

While solar would seem like the ideal solution, quite often this is not possible due to location and shading problems.

Just such a situation arose when I decided to make our new gates automatic. There were just too many trees in the way for solar power to work, and I didn't want to run power some 30 metres or so from the house, as it would have meant digging a trench for the cables, which is almost impossible in our rocky ground.

Why have automatic gates anyway? Well, our driveway and the one next door share a common

entrance, so to open the gates we have to block their driveway Also, the driveways are very steep, and starting off driving up from a standstill is not too good for the vehicle's clutch.

Besides, when an opportunity arises to install some form of new renewable energy device, how can I say no?

Anyway I decided to provide power to the electric gate openers from a small wind turbine. While we don't have many windy days, we do have one or two each fortnight where the wind blasts through for at least 24 hours solid, so I guessed that I should be able to power a device with such modest power requirements as a gate opener in this way

The gate opener system itself is a home made job, using car windscreen wiper motors driving long brass threaded shafts.These run through a nut which is attached to the gate via a steel tube, bolt and two metal brackets.

The motors are hinged, and when they are run they either push the nut away from them or pull it toward them, thus opening and closing the gates.

The control circuit for this kit purchased from Qatley Electronics in Sydney and includes a courtesy light function, remote motors are hinged, and when they are control, and motor current sensing.

Too much turbulence

I briefly thought about what type of turbine I could install and how it would look.

Safety was another factor, having curious children who can climb just about anything. For these reasons I decided against buying a small horizontal axis turbine, they are too dangerous - when close to the ground and in touching distance, so I decided to install a Savonius rotor instead.

This type of vertical axis rotor is very robust and durable if built correctly, is relatively slow turning and can be easily built at home, without the hassles of aerofoil blade design and other problems associated with horizontal axis 'propeller' type turbines.

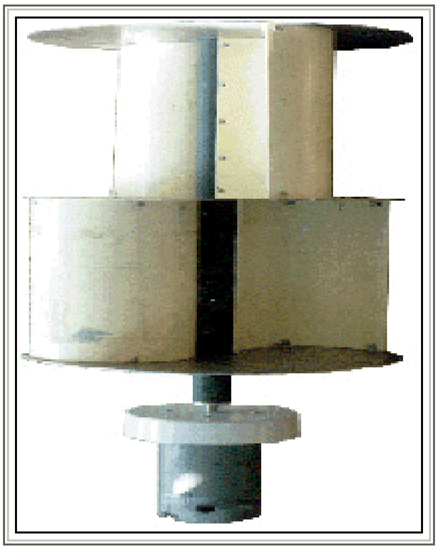
What's more, unlike a horizontal axis turbine, a Savonius is always facing the wind, and more importantly for this site, is not badly affected by turbulence, which is quite high where the turbine had to be located.

As can be seen from the photo, the turbine is mounted quite low due to it being on a residential block. While this is far from optimal, it should provide enough power for the gate openers providing it is used with a battery of relatively high capacity.

Making the turbine

The turbine was made from three disks of 1.2mm aluminium sheet 330mm in diameter and a length of 150mm diameter stormwater pipe about 600mm long.

This was cut in half in both directions, across and lengthways, to provide four vanes for the turbine. These vanes were then assembled between the three disks as shown in the photo. Small aluminium angle brackets and stainless steel pop rivets were used to hold it all together.



Here you can see the whole motor and rotor assembly before fitting to the mast and painting. Note how the vanes in the top section are rotated 90° to those in the bottom section and the motor does not yet have the plastic angle sections attached.

The two vanes in the top section of the rotor are rotated 90 degrees to the bottom ones. This ensures that there is always at least one vane in a position to catch the wind, so the turbine is self-starting.

The axle for the rotor was a length of 40mm diameter water pipe.

This runs straight through the centre of all three disks, and the inner edge of each of the rotor vanes are riveted to it.

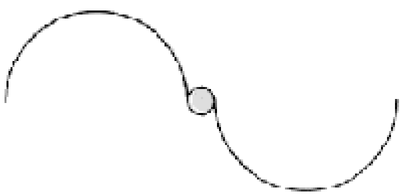
In the bottom end of the axle I pressed in (read hammered) an aluminium adapter bushing to allow the turbine to be connected directly to a generator.

The final assembly was very strong and rigid and was surprisingly well balanced

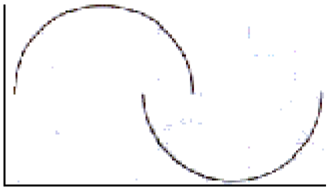
While a central axle shaft is not considered optimal design for a Savonius rotor, it does have advantages, such as increasing turbine strength and allowing easy alignment in multi-stage rotors.

Savonius design

There are several variations of Savonius rotor that I have seen, all of which work well. The efficiency of a Savonius is only around 15 per cent but they are ideal for many situations. Some variations are shown below, looking down from the top of the turbine.



This is the design I use. it is very strong due to the central shaft, but slightly less efficient than the other two. However, the extra strength allows the rotor to be supported at one end only.



This design is also very simple, and can also be made easily from metal drums or pipe sections. The design is slightly more efficient than the one above as some of the air is deflected by the second vane as it exits the first one.

This is the most efficient Savonius design. It not only has the advantage of air being deflected twice like the design above, but also that the vanes act partly like an airfoil when they are edge-on into the wind, creating a small lift effect and thus enhancing efficiency. This design is much more difficult to build. requiring vanes rolled from metal sheet instead of being cut from drums or pipes.

Generating the power

The generator I used was actually a large permanent magnet DC motor from an old vertical computer tape drive.

These are very robust, well built motors about the size of a large car starter motor. They are simple and reliable, and as generators are extremely efficient-connecting one to a torch bulb causes the bulb to be blown by a quick flick of the shaft!

The rotor slides directly onto the end of the motor shaft, and is held in place with a stainless steel bolt.

In this design, I decided to see if I could do away with having a top bearing. The bearings in the tape drive motor are at least as strong as the average car alternator bearing, and the local bearing shop gave me specs that indicate that most bearings this size will take a radial load (the load the wind would place on the bearing) of up to 450kg, and an axial load (the load from the rotor's weight) of up to 45kg.

This was heaps for my uses, so I decided to leave out the top bearing and see how the turbine went.

The mast

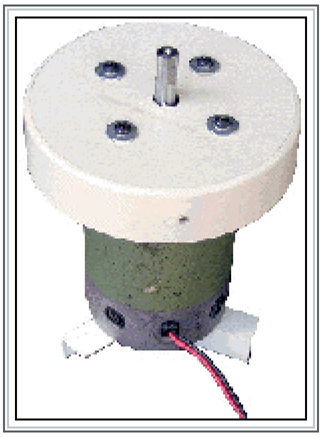
This was made from a 2200mm length of 150mm diameter PVC water pipe, just like the rotor. In sections this diameter and this length, PVC pipe is quite rigid.

The pipe was buried about 400mm into a hole and concreted into place.

The mast does still flex a bit in a strong wind and if this proves to be a

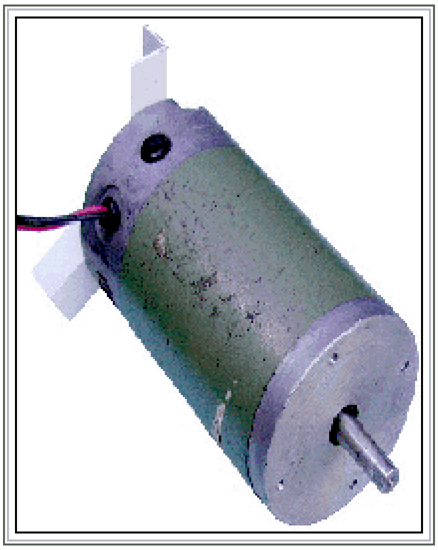
Problem it can easily be made rigid by filling with concrete.

The generator is mounted to the top of the pole by means of a stormwater pipe endcap.

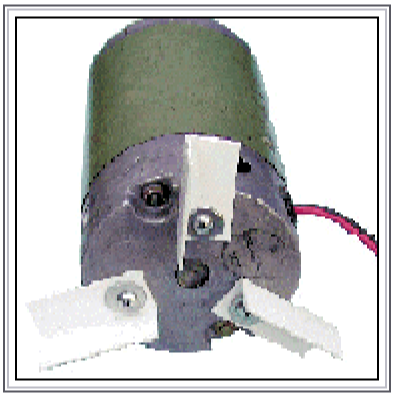


The DC motor fitted to the plastic end cap which holds it to the mast

The face of the generator has four screw holes, so it was just a matter of drilling corresponding holes into the end cap, and one much larger hole in the centre for the shaft.



Front view of the motor note the threaded holes in the face plate



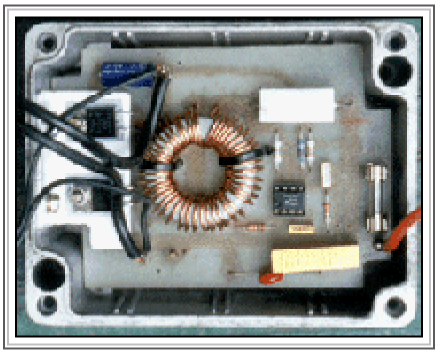
This rear view shows the three plastic angle sections used to make the motor a tight fit in the

mast

By itself, this would not have been strong enough, as the end cap would have flexed and eventually broken through, so I attached three short braces made from 25 x 25 x 3 plastic angle to the other end of the generator.

These were fixed to the motor using machine screws into the bottom end plate, and point out away from the centre of the generator. The overall diameter of the circle they make is the same as that of the inside of the pipe, so that when the generator is slid into the pipe the whole assembly is quite solid.

Hopefully this will be all that is required, but I suspect that the end cap may still not be quite strong enough, so I might have to replace it with a metal equivalent further down the track.



The step up converter built from a kit. It starts from just four volts snd outputs s regulated 14 volts to the battery

Voltage matching

The output voltage of the generator is actually quite low at the speeds it is likely to turn at attached to a Savonius rotor. At 200 RPM the output is only about four or five volts.

While this is obviously not enough to charge a 12 volt battery by itself, a bit of clever circuitry solved the problem.

Some time back a circuit was published in one of the electronics magazines that allowed a 12 volt battery to be charged from another.

This was used for charging small sealed-lead acid batteries from a car battery, and involved a switchmode step-up circuit to provide a regulated 13.8 volts or so from 12 volts from the car battery.

I have built several of these from various suppliers, and they work quite well.

The one I used I already had from another disused project, so I tested it and found that it would output the required 13.8 volts from as little as four volts in.

This kit was originally bought from Jaycar Electronics, who no longer sell it, but they do have a pre-built module called a solar power converter, cat# AA0259, that will take an input voltage from one to ten volts and charge a 12 volt battery-perfect for uses such as this.

The unit seemed ideal for my turbine so I connected it to the generator and tested it. At under

200 RPM I was getting full charging voltage, with available current increasing as rotor speed increased.

Final assembly

The circuit was housed in a box and slid down inside the tube before the generator and end cap were fitted. The cables from the output of the circuit run down inside the mast and out of a sealed hole at the bottom, through some flexible conduit to the box containing the gate opener circuitry.

The mast and turbine were both painted green to help them blend in with their surroundings. The photos show the turbine before its paint job.

To prevent water getting into the generator bearing, a skirt will be attached around the perimeter of the bottom of the turbine.

Costs

The turbine was very cheap to build, the most expensive part being the second hand tape drive motor which cost $25. The voltage conversion kit cost $24 a couple of years back, and the rest of the material was free.

The water pipe was salvaged second-hand from a building site, while the aluminium sheet was from some old signs I found in my workshop after we moved in.

The only other expenses were a dollar or two worth of paint and rivets and $5 for a bag of concrete.

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