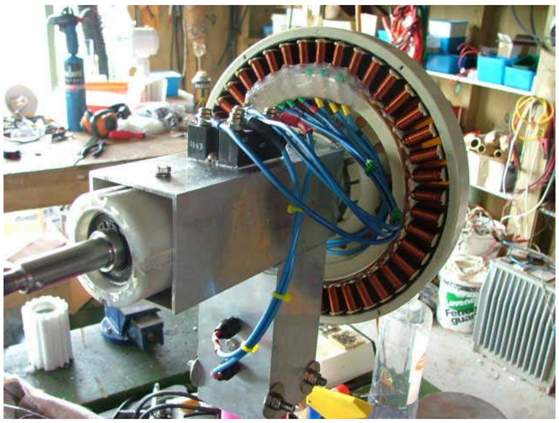
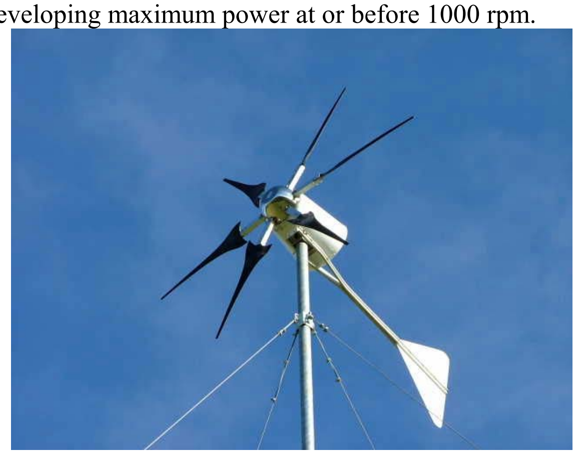
Wind turbine.

Building your own wind turbine from scratch is often a disappointing exercise. Wind turbines are difficult to build well and take much refinement and experimentation. You usually spend 5 times more building your own than if you had bought a commercial unit. If you do wish to build your own it is strongly recommended you start with an EcoInnovation kit set in the first instance. Wind turbines are difficult to build even for experienced and qualified engineers so the chance of a novice being successful is rare.

Most small wind-turbines (up to 400 W) operate at speeds from 200-1000 rpm, You need to locate a unit with a “cut in” speed around 200-300 rpm and be developing maximum power at or before 1000 rpm.



EcoInnovation Kit Set



EcoInnovation Smart 400 Turbine

Smart Drive Stators to use:

- For a 12 volt system consider a 80SP Delta
- For a 24 volt system consider a 80SP Star
- For a 48 volt system consider a 100S Star

From the above you can see that the 80SP (in either Star or Delta) is one of the more flexible units for small wind turbine applications.

Note that the EcoInnovation Smart 400 uses the new generation type 4 cog free version, so deccoging is not required. The cog free version has almost no cogging and are excellent for wind applications – Thanks F&P.

Decogging a Smart Drive

Back in issue 82 of Renew I penned an article on Smart Drive generators and in particular how these could be modified for low voltage high current applications for use in renewable energy systems.

In that article I stated that we were working on wind turbine applications but that cogging of the Smart Drives was a major problem that needed to be solved.

We now make a range of products based on Smart Drive parts and are fortunate in that Fisher and Paykel supply all the parts we use from their recycling department in Auckland. We would like to acknowledge the support that Fisher and Paykel engineers have given us in solving the cogging problem.

Cogging

Over the last year we have been trialing a number of different methods. Smart Drives suffer from cogging, and you will need to decogg the unit before it can be used as a wind turbine, cogging prevents the wind-turbine from starting in light winds.

Cogging is the resistance of the Smart Drive rotor to turn freely from the stationary position, once moving this resistance drops away to a much lower level. Cogging seriously affects wind turbine applications where the blade is reluctant to start. All wind turbine blades are reluctant to start, as the wind direction is not correct until the blades starts to move. Any resistance of the generator to start rotating compounds what is already a problem in these applications.

The picture below shows us measuring the cogging force at the perimeter of the Smart Drive rotor using a spring balance.

Cogging force in grams measured at perimeter of rotor

	Type 1 rotor (small magnets)	Type 2 rotor (large magnets)
Non modified	**1600- 1650**	**900-950**
Decogged	**600-650**	**450-500**
% Reduction	**63%**	**50%**

Wind turbines built using a Smart Drive (without a decogged stator) will not start until wind speeds are about 28-30 km/h (based on our tests with a 1.5m 6-bladed high torque prop), which is far too high to be of any use. A number of people have tried it and to my knowledge most have suffered from this problem.

Another way to overcome this problem is to use a much larger prop but this creates problems in strong winds and is not recommended. Our view is that a blade 1.5-2m in diameter is a good size for the Smart Drive unit if decogged. Using a multi-bladed prop will also assist in starting in light wind conditions.

Decogging

Connecting two Smart Drives onto one shaft and orientating one such that the positive cog of one unit cancels with the negative cog of the other unit can solve cogging. This has been done by a number of people but in my view is not a good solution. If you do this you will need to modify the Smart Drive parts.

It is difficult to mount the blades as one of the Smart Drives gets in the way and play which may develop over time in the splines of the Smart Drive rotor will cause cogging to return but with twice the resistance of before.

We decided to ask the designers of the Smart Drive. This we did and to our surprise Fisher and Paykel had done some experiments to reduce cogging (not sure why, maybe noise and vibration issues in washing machines). This led us to machine chamfers on the sides of each finger of the stator using an angle grinder. The results were impressive and made a big reduction. We then experimented with the depth of cut and angle of cut. We found that if you take off too much, cogging can increase, you do not need to remove much material but the profile is quite important.

We settled on a profile and made a machine for decogging Smart Drives for us that comprised two angle grinders that did both sides at once, the Smart Drive was indexed and the next finger ground until all 42 had been done. The whole process takes about 15 minutes.

We have since gone into production of a wind turbine in both kit set and fully assembled form using the components from a Smart Drive washing machine as much as possible. We also use a floating hub carrier for the prop to allow the blades to turn 90 degrees before the drive engages. The inertia is then able to overcome the residual cog of the unit. The blade would start rotating in wind speeds around 18 km/h (5 m/s). This we felt was acceptable as winds below this speed carry only a small amount of energy. Once the blades start they keep going until the wind drops to about 15 km/h.

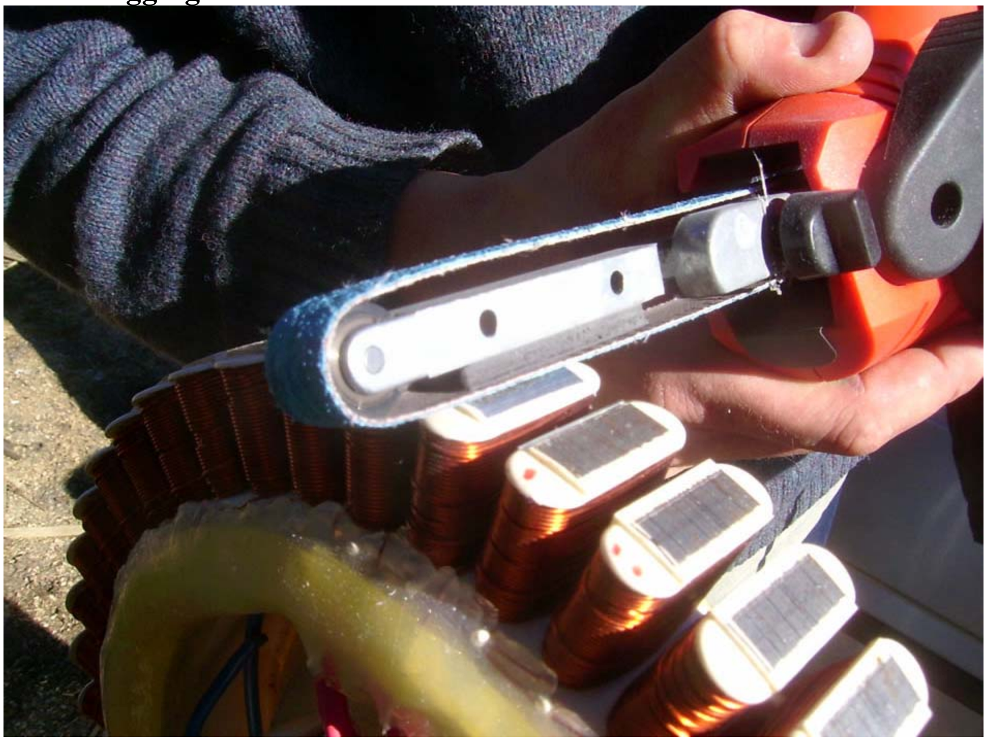
Tests were carried out with the turbine strapped to the car roof, air speed indicator attached and a 12, 24 and 48-volt system (with a diversion load regulator) in the car. The results showed that we could obtain around 400 W at 36 km/h and a maximum output of 700 Watts (over 50 km/h) after which the Smart Drive generator saturated and would produce no more power for increasing speed. We tested many different generator types during these tests and decided on the best for each voltage.

We have had a wind turbine running for well over 12 months without any major problems, wind speeds up to 120 km/h at times. A recent second visit to Fisher and Paykel made us rethink what we were doing. We have changed the profile from a flat sided to a curved profile and this reduces the cogging torque to about 50% for units that have the type two rotor. This latest refinement has made us reflect on the use of the floating hub as it complicates what is otherwise a very simple and robust design

The question that most people ask is how do we do this at home without making a machine and without filing it by hand. Hand filing is a good option but it is easy to slip with the file and damage the windings.

The solution is a power file, like a small belt sander, this gives very good control and allows fast removal of material. We managed to do one in about 20 minutes with a power file.

Power file decogging a Smart Drive stator



Tip profile you are trying to achieve

After you have decogged your unit all you need to do is reconnect it for low voltage, coat the exposed metal with polyurethane (assists in keeping the rust at bay) and you have a perfectly good generator suitable for wind applications.

Ultraviolet light

It is important that you cover the Smart Drive unit in order it keep out the rain and ultraviolet. The Smart Drive plastic rapidly degrades in sunlight and will crack so keep it covered. We have found that a heavy-duty nappy bucket is an almost perfect fit and at $6 is a great economic solution. It can be easily cut to fit.

Web sites on Smart Drives

If you are interested to find out more then you can check out the following web sites:

www.ecoinn.co.nz
www.thebackshed.com/windmill/assembly2.asp
www.watchtv.net/~rburmeister/

Out latest Smart 400 with the cog free forth generation Smart Drive unit