# A Review Paper on Converting Wind Energy to Electrical Energy Using Wind-Belt Technology

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**Abstract** – *Wind belt generators have been proposed as small green power sources for battery charging applications. Some of the reported results lack detailed information about how key parameters influence the output power of the generator. We built prototypes with different architectures to study the voltage generation and power delivery as functions of belt tension, length and electrical load at various wind speeds. We also studied the maximum power delivery conditions before the breakdown of the belt oscillation occurs and we have concluded that the breakdown of the belt oscillation at lower output resistances is a primary bottleneck that will limit wind belt systems to only very low power applications.*

***Key Words***: **Wind belt generators, Aeroelastic flutter, Wind power, Green energy, Electromagnetic generator.**

## 1.INTRODUCTION

Large wind turbines can generate huge quanties of electricity very efficiently and relatively cheaply, as the size of the wind turbine is efficiency reduces and cost per Watt power jump enormously. Wind belt offers an alternative for small scale wind power generation dispensing with the turbine altogether while producing power at a efficiency of 10-30 times greater than that of a similarly rated wind turbine. Currently the Wind belt technology is new and not widely used.

The Wind belt will become a more feasible generator in the next couple of years after the technology becomes wider known and is augmented to function with greater efficiency. Our hope is that a series of Wind belts can someday be used to power larger things like computers and to charge larger batteries like that of a car or possibly defibrillator for field medics.

## 2. Principles of a Basic Wind belt Design

The design of wind belt is low cost and a small device which harness energy by the belt vibration due to wind and is used to oscillate magnets in between copper wire coils in order to create an EMF. This phenomenon is used to produce electrical energy from the wind energy.

**Fig -1**: Design of windbelt

## 2.2 Design Procedure

Wiring of the coils are critical parameter as it is important to ensure strong magnetic coupling as well as make sure the coils are wired in phase with each other. Copper wire with diameter of 36-42 AWG was used for investigating coil geometries and turn counts ranged from 2,500-4,000 turns per coil. A series electrical connection (positive-to-negative) were used to wire the coils and also connected in parallel for experiment view.

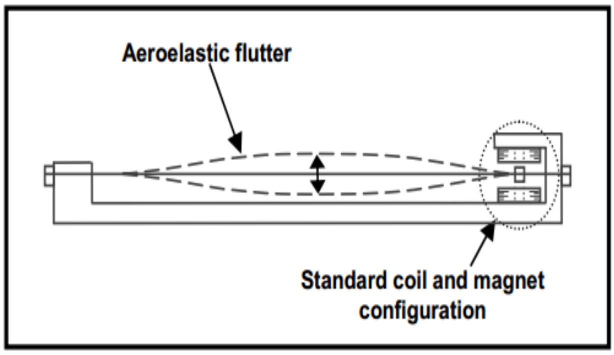


**Fig-2:** Basic windbelt design

The addition of a ferromagnetic core material can be added to increase magnetic coupling and conversion of the fluid flow into electrical power generation. Using a neodymium disc magnets of type NdFeB with a diameters of 4cm and a thickness of 10cm magnetic field strengths experienced by the coils.

The field strength denoted by B, experienced at a given point that is at some distance away from the surface of the magnet can be calculate using the theoretical model summarized in the following eq. (1) is modelled for that of a cylindrical or disc type magnet.

$$B = \frac{B_r}{2}\left(\frac{(t+d)}{\sqrt{r^2+(t+d)^2}} - \frac{d}{\sqrt{r^2+d^2}}\right) \quad (1)$$

*Br* = residual inductance (kg/A·s2);
*t* = thickness of magnet along its direction of magnetization (m);
*d* = distance from the face of the magnet along symmetrical axis (m);
*r* = radius of the cylindrical magnet (m)

### *Interfacing the Magnets and Belt*

The perpendicular configuration are more difficult to implement as having the magnetic pole move perpendicular to the coil axis necessitates having the magnetic axis from "north" to "south" in parallel alignment with the width of the belts membrane. Therefore, some adjustment to the belt needed to be made in order to achieve this orientation. One implementation tested used a T-shaped joint made out of a thin lightweight plastic material in order to get the magnetic poles axis in parallel with the width of the belts. This same alignment on the belt achieved by interfacing the magnets into the belt directly by cutting a square hole out in the dimensions of the magnets. Lightweight packing tape was used to fast the magnets to the membrane. Fig.3,

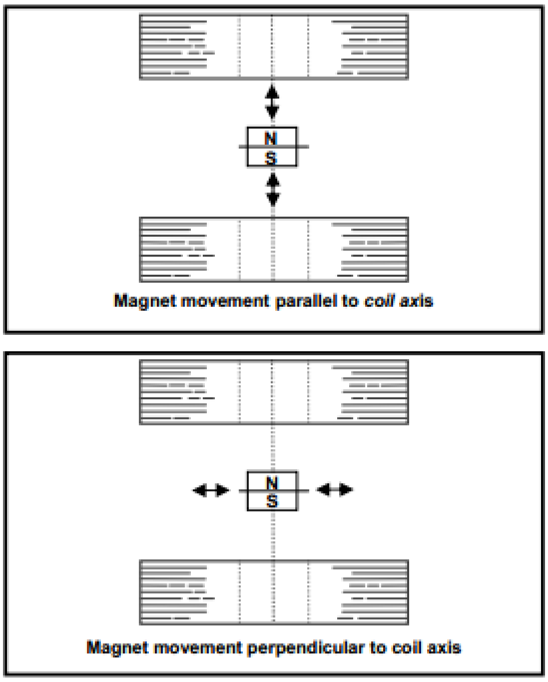


**Fig -3:** Magnets with parallel and perpendicular movement along coil axis.

show these two implementations. Alternatively, the effectiveness of using a fulcrum and pivot attachment was explored. This involved fasten the end of the belt to a wooden pivot piece that would hold the magnet with pole axis perpendicular to the coil axis and parallel to the width of the belt. A thin metal rod, which extended through the wooden pivot piece, attached to the frame of the system served as the pivot's fulcrum. This was necessary to facilitate the desired movement of the magnet in response to belts oscillation.
The magnets and coils unit was installed on the frame near one end of the belt. Adding the magnet at other points along the belt's length adds weight to the belt in the middle of its natural oscillation and creates a standing wave pattern that results in self-dampen. This type of twisting oscillation is called torsional flutter and avoided in order to maximize power generation. Longitudanal oscillation is preferred as it allows for a larger wavelength vibration where nearly the whole belt is either flutter up or down at any given moment. This looks much like half a period of a sine wave. Torsional effects can be limited by placing the magnet and coils at a distance between 1/100th and 1/10th of the entire belt length and also by twisting the tension in the membrane. The difference between the two mode of flutter is illustrated in Fig. 4 Due to its vertical nature, the parallel magnet-to-coil aligned system used gravity and added mass to allow changes in belt tension. The belt extended from the top of the frame past the coils and connected to a light weight carriage. Mass could be added to the carriage to allow different effective tensions in the belt order to maximize the oscillation frequency. Tension force could then be calculated by total the added mass and multiplied by the acceleration of gravity. The maximum belt length allowed by this system was 97.8 cm.

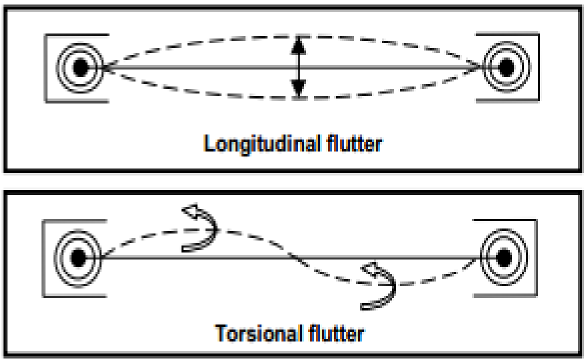


**Fig -4:** Longitudinal versus torsional flutter oscillations

### *Energy Produced*

Amount of EMF produced from the wind belt is given by
E=2πNfAB
Where,
E=EMF produced
N=Number of turns in the coil
f=Frequency with which flutter vibrates
A= Area of the magnetic core

B=Magnetic field strength
Also
f= v/d
Where,
v= velocity of the wind
d= maximum flutter distance

*Power Generated By Wind Belt*

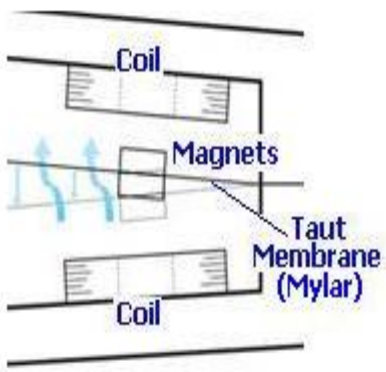


**Fig -5:** Power Generate By Wind Belt

A simple device with a taut Mylar membrane fitted with a pair of Neodymium magnets that oscillate in and out of coils of magnetic wire because of the mechanical resonance of the taut membrane with wind blowing across it. At wind speeds of 10 mph, the prototype membrane oscillates at 80-90hz – i.e. the magnets move in and out of the coils 80-90 times per SECOND, when a magnet moves in and out of a coil of wire, electrical current flows through the wire, and therefore Wind belt generates electricity.

## 2.3 Parallel versus Perpendicular Magnet-to-Coil Configurations for Maximum Flux

While the most systems previously studied feature an axis of magnetization movement parallel to the coil axis, as it is easier to implement and found in this investigation that the perpendicular orientation can actually produce greater changes in magnetic flux consequently a higher power output and this is a consequence of the small amplitude oscillations of the belt experiences. Therefore, with a parallel set-up the face of each magnets and the field strength is strongest, can only penetrate so far into the center of each coils and therefore, likely miss interacting with the deeper turns of the coil. The perpendicular magnet-to-coil configuration allow some distinct advantage. The belt can be tapered around the section nearest the magnet and coils as to allow the smallest distance possible between the magnetic poles and coil face. Although this may not penetrate the coil any deeper than the parallel orientation the back and forth movement across the diameter of the coil allows a greater amount of field interaction with solenoid. Furthermore, the oscillation with magnets inserted into the belt for the perpendicular set-up shown in Fig. 6b, is slightly more torsional than with the magnets interfaced as in Fig. 6a.

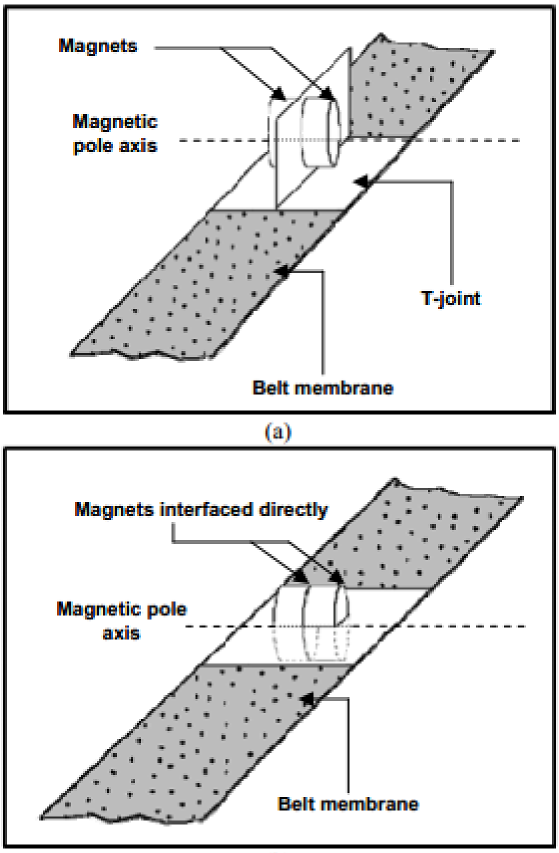


**Fig -6:** (a) Magnets interfaced using plastic T-joint; and (b) directly interfaced into the belt.

This typically limits power production using the more conventional parallel magnet-to-coil configuration, our test data have shown that the torsional effect may actually help increases magnetic flux in this situation as the magnets do not just move statically, back and forth along their line of motion, but also pivot back and forth throughout the movement along their line of motion. This promotes a greater change in flux and magnetic field interaction with the solenoid and thus increases the induced voltage in the wire.

## 3. CONCLUSIONS

A small scale design and the material which are used cheap and easily available. This can even be used in the places, where the wind potential is low or high, this design can be fixed in the coastal area continues wind supply is available.

The Wind belt has no gear or bearing making it much more efficient than scaled down wind turbines.

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