International Conference on Systems, Science, Control, Communication, Engineering and Technology 2016 [ICSSCCET 2016]

ISBN	978-81-929866-6-1		**VOL**	02
Website	icssccet.org		**eMail**	icssccet@asdf.res.in
Received	25 – February – 2016		**Accepted**	10 - March – 2016
Article ID	ICSSCCET058		**eAID**	ICSSCCET.2016.058

High Power Generation on Low Wind Using Vertical Axis Type Wind Turbine

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Abstract: *Electrical power has become a prime necessity for any country for economic development. And power shortages is a dominant problem, being faced by most of the countries today. On the top of this, the conventional fuel sources for power generation i.e., coal & oil deposits are getting depleted. Statistics reveal that a large amount of wind energy remains untapped. Although more invention has to be carried out still in the use of non-conventional energy sources for power generation to reach to most economic point, but every little effort in this direction may provide a solution to power shortage problems. The goal of this project is to construct a small scale wind power plant which is capable of produce electricity even with low wind velocity. We know that there is enough wind globally to satisfy much, or even most, of humanity's energy requirements – if it could be harvested effectively and on a large enough scale. Vertical axis wind turbines (VAWTs), which may be as efficient as current horizontal axis systems, might be practical, simpler and significantly cheaper to build and maintain than horizontal axis wind turbines (HAWTs). VAWTs might even be critical in mitigating grid interconnect stability and reliability issues currently facing electricity producers and suppliers. It can be placed on the places like road divider, or remote places. The power produced by the generator can be stored in a battery and can later be used to power the street lights. These wind turbines are portable and can therefore be used on expressways or busy highways. The turbine can be used commercially for low power applications. The implementation of such project would reduce the dependence of a company or industry electricity board.*

Keywords: *Renewable Energy, Vertical Axis Wind Turbine (VAWT), Horizontal Axis Wind Turbine (HAWT).*

I. INTRODUCTION

Energy is the input to devices and improves the life cycle. Primarily, it is the gift of nature to the mankind in various forms. The consumption of the energy is directly proportional to the progress of the mankind. With ever growing population, improvement in the living standard of the humanity, industrialization of the developing countries, the global demand for energy expected to incurrence rather significantly in the near future. The primary source of energy is fossil fuel reserves and large scale environment degradation caused by their widespread use, particularly global warming, urban air pollution and acid rain, strongly suggests that harnessing of non-conventional, renewable and environment friendly energy resources is vital for steering the global energy supplies toward a sustainable path.

II. Indian Energy Scenario

India is no stranger to renewable energy, whether its solar energy, wind, hydro, or biomass. We are using all four to some extent to another hydro power where it is available (hydro power techinologically the best understood, and so among the most widely used); biomass in rural areas where the required waste is available (cost of transportation becomes prohibitive); and solar power more sporadically (usally also locally, for small domestic loads), given its high costs.

Cite this article as: K Muthusamy, R Deepakkumar. "High Power Generation on Low Wind Using Vertical Axis Type Wind Turbine". *International Conference on Systems, Science, Control, Communication, Engineering and Technology 2016*: 311-315. Print.

As glowing as this sound, however, India's wind power potential is 45,000MW, making the amount harnessed less than 7% of total potential capacity. Wind energy cost only marginally more per unit than conventional energy (RS.4-4.5crore/MW), compared with thermal power cost of RS 3.7crore/MW.

III. Vertical Axis Wind Turbine

French aeronautical engineer Georges Jean Marie Darrieus patented in 1931 a "Turbine having its shaft transverse to the flow of the current", and his previous patent (1927) covered practically any possible arrangement using vertical airfoils. It's one of the most common VAWT, and there was also an attempt to implement the Darrieus wind turbine on a large scale effort in California by the FloWind Corporation; however, the company went bankrupt in 1997. Actually this turbine has been the starting point for further studies on VAWT, to improve efficiency. Each blade sees maximum lift (torque) only twice per revolution, making for a huge torque (and power) sinusoidal output that is not present in HAWTs. And the long VAWT blades have many natural frequencies of vibration which must be avoided during operation. One problem with the design is that the angle of attack changes as the turbine spins, so each blade generates its maximum torque at two points on its cycle (front and back of the to a sinusoidal power cycle that complicates design. Another problem arises because the majority of the mass of the rotating mechanism is at the periphery rather than at the hub, as it is with a propeller. This leads to very high centre on the mechanism, which must be stronger and heavier than otherwise to withstand them. The most common shape is the one similar to an egg of the rotating mass not far from the axis. U '80 demonstrate that the 2 bladed configurations has an higher efficiency.

In summary, Vertical Axis Wind Turbines may be very beneficial in the quest for clean renewable energy because of:

A. Cost: Large arrays of VAWTs can be build on much less land, with much less cost, often using locally available materials and skills. This is increasingly important as an alternative to the cutting down of precious and irreplaceable rain forest to grow crops for ethanol production.

B. Reliability: It may be possible to install vertical axis turbines into existing conventional wind-farms where grid interconnect bandwidth is available and underutilized. This can capture more of the lower grade winds lost to the larger turbines and improve productivity of the wind-farm as a whole.

C. Empowerment: Vertical axis systems can be more easily built or cheaply purchased, making personal ownership or small community ownership practical.

D. Independence: Even very resource poor places may have good winds for energy conversion. Groups of small turbines harvesting these winds may provide local energy independence and, perhaps, a ladder out of poverty for many.

E. Availability: Currently windmills are producing only about 25% of the time. 75% of the time they are doing nothing. This means that conventional production must remain on-line to make up the difference--greenhouse gasses and other pollutants not significantly reduced at these production levels.

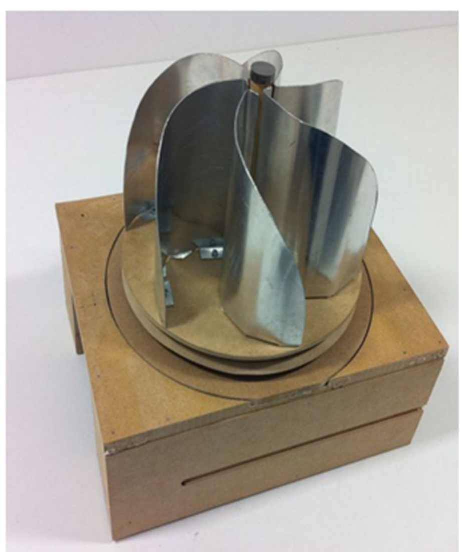

Fig 1:Vertical Axis Type Wind Turbine

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IV. Difference between Two Wind Turbines

VAWT	HAWT
In the case of VAWT,air strikes from both end.	In the case of HAWT,air strikes from one direction only.
Generator,Gear box can be placed on the ground.	Generator,Gear box,etc..cannot be placed on the ground.
Don't need yaw system.	Yaw system is required.
No reqirement of control system.	Control system is required.
Noise produced is 0-10dB.	Noise produced is 5-60dB.

V. Block Diagram

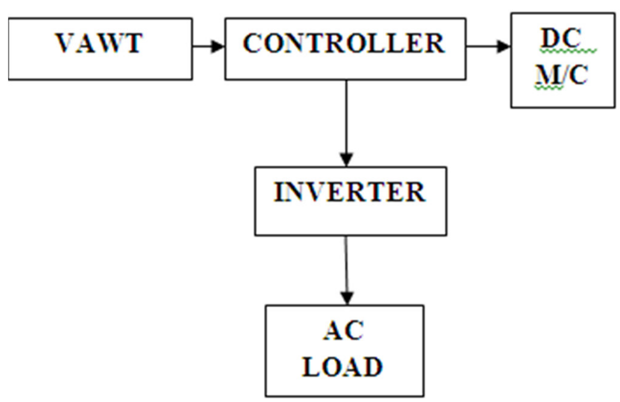

Fig 2:Block diagram for VAWT.

VI. Simulation Result

The airfoil was set to 120mm chord length and turbine radius was set to 500mm. For creating 2D model and mesh of the model, Gambit modelling software was used. Mesh for the rotating and central sub-domains were generated with triangular blocks and enough thickened near airfoil boundaries to measure flow small flow variations. The RANS equations were solved using the green-gauss node based gradient option and the sliding me-sh method was used rotate the sub-domain for the turbine blades. . For pressure-velocity coupling, the SIMPLE algorithm was used. Standard was set as pressure discretization and first order upwind was set for momentum. Time integration was done implicitly and the minimum convergence criteria were set to 1e-06.the RNGk-e model was adopted for turbulence closure. The operating speed of the turbine, expressed as tip speed ratio (TSR) was set between 0.5 and 1.5.

TSR	Wind Speed	Angular Velocity	Time step size
0.5	3	1.5	0.0116
0.75	3	2.25	0.0077
1	3	3	0.0058
1.25	3	3.75	0.0031
1.5	3	4.5	0.0017

Table 1:Flow Condition

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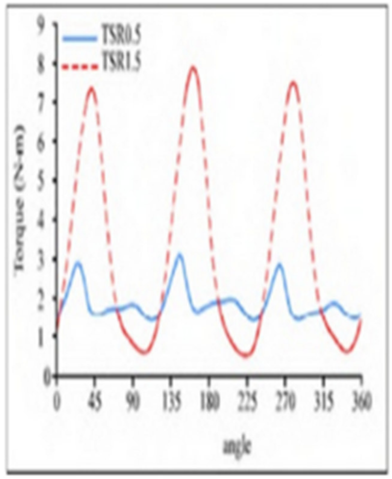

Fig 3:Torque for TSR 0.5&1.5

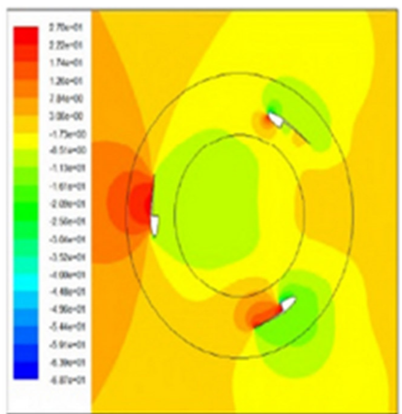

Fig 4:Turbine flow at angle=90

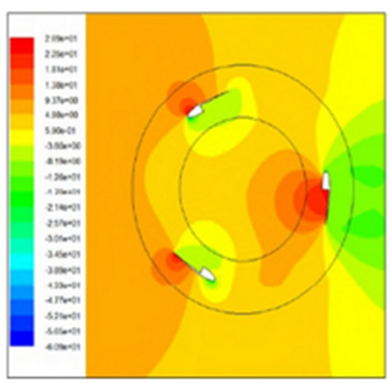

Fig 3:Turbine flow at angle=270

VII. Conclusion

The implementation of vertical axis wind turbine on road dividers would be great asset to the ministry of non-conventional energy resources as it would reduce the burden on the consumption of conventional energy sources. They can be installed on any highways with the width being the only constraints. These turbines are simple in construction and require less investment. Since, turbine is in small size, it can harness a limited amount of wind. Therefore they can be used for low power application such as for street lighting on

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any busy road. Morever it can also be use to light up the advertisement hoardings. Other application could be in diversion on highways and traffic lights. Further more, these turbines can find application in lighting up the toll plazas on highways. Since the battery is portable we can use it in some other location for any low voltage purposes. Thus there is balance between the cost and power available. Future prospect, the addition of speed governing system and control circuit may make the model much acceptable. The emerging trends in the technology have shown a way to use of non-conventional energy sources so efficiently and little effort at the site may find an effective solution for the boom of the electrical energy by society.

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