Highway electricity generation using vertical axis wind turbine

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ABSTRACT

There is a scarcity of electricity in the world. Therefore to fulfill the demand of the electricity alternate energy sources can be used now days. The objective of the project is to save the expense of lightning streets especially on the highways. A specially designed windmill is placed along the roadsides, which rotates because of the increased kinetic energy of the wind due to running of the vehicles. The demonstration phase of the project should mark the start of a larger-scale implementation. Therefore, the project will include the preparation of an implementation outline plan, which will be based on the preliminary experiences gained in the demonstration, and will include input from representatives in the sectors that are directly involved in the implementation.

Keywords: VAWT, Wind Energy, highway, Non-conventional, clean energy.

1. INTRODUCTION

Now a day's cost of electricity generation goes on increasing. To avoid this peoples are looking towards the alternative sources of electricity production. Wind energy is one of the free of cost available energy which is use to produce electricity, but it is not available continuously. That is the main reason for not using wind energy on large scale. To avoid this problem we have continuously running highways. It means when vehicle runs on road it pushes the air so that it can run. This pushed air can be utilized to rotate the small wind turbine for electricity generation.

There are many types of wind turbines are available. Depending upon its shape and size its efficiencies varies. For highway electricity generation we use Vertical Axis Wind Turbine because it can easily mounted on ground level and can rotate in less amount of air.

When vehicle moves on road depending upon its speed it can push air beside it. But the amount of air to be pushed depends upon the wind speed available naturally. If the available wind is more it can produce more power, even if the speed of vehicle is below average. The location like hill regions there are more wind speed which makes more resistance to vehicle running. For such regions our vawt is more efficient.

Table 1. Wind speed in India at different atmospheric conditions.

Wind type	Km/hr	m/sec
Normal wind	19.8-28.8	5.5-8.0
Strong Normal wind	30.6-37.8	8.5-10.5
Strong wind	39.6-48.6	11-13.5
Very strong wind	50.4-59.4	14-16.5
Stormy wind	61.2-72	17-20
Heavy Stormy wind	73.8-84.6	20.5-23.5
Heavy storm	86.4-99.0	24-27.5
Very heavy storm	100.8-113	28-31.5
Hurricane	115.2-180	32-50

2. Vertical Axis Wind Turbine

There are many types of vertical axis wind turbines are available but we use Savonius type because it is most suitable for our conditions. Also it is more economical in construction, maintenance free and the important is it does not require any pointing mechanism for shifting towards winds direction.

A wide range of materials are used in wind turbines. Generally steel, aluminium, copper, reinforced plastics are used. But we have used M.S. sheet for the blades.

Fig 1 wind turbine

Blades

The height of blade of wind turbine is 360mm and width is 120mm. The angle between two blades is 60^0. So if one Blade moves other blades comes in the position of first blade, so the speed is increases.

Shaft

The shaft is made up of steel having length 410 mm and diameter 25 mm. the shaft designed in such a way that it can properly fitted to the blade. The shaft needs to hold six blades along with all wind forces which acts on it. The blades are fixed by the help of top and bottom plate so that the blades does not slips on the shaft.

Bearing

The shaft is pivoted by bearing at top and bottom side. Also bearing mechanism helps to reduce friction between shaft and frame so that shaft can rotate smoothly. There are different types of bearings are available but we choose ball bearing because it is maintenance free and can be available easily with low cost. The internal diameter of bearing is 2.50 cm.

Specification of wind turbine

Base dimensions

Length - 260mm

Width -300mm

Blade dimensions

Height -360mm

Diameter -120mm

Thickness -2 mm

Angle -45 °

Angle b/w blades- 60°

Shaft dimensions

Diameter- 25mm

Length- 410mm

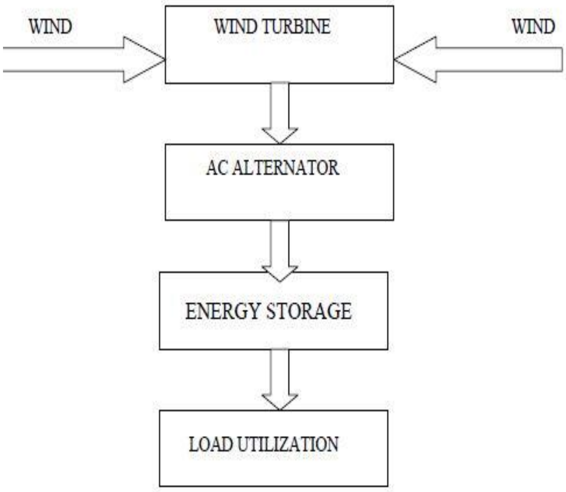


Fig 2 Block diagram of electricity generation

3. Wind Power

Wind turbine works on the principle of converting kinetic energy of wind to mechanical energy and then electrical energy.[3]

As we know that,

$$\text{K.E.} = 0.5mv^2 \quad \ldots\ldots\ldots\ldots\ldots (1)$$

K.E = kinetic energy

m = mass

v = velocity

But m **=** product of volume and density of air

$$m = \rho AV \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Put equation (2) in (1)

We get,

$$K E = ½ \rho AV.V^2$$

$$K E = ½ \rho AV^3 \text{ watts}$$

ρ = density of air (1.225 kg/m^3)

$$A = \pi D^2 /4 \text{ (Sq.m)}$$

Put this value in above equation

We get,

Wind power=$1/8(\rho \pi D^2 V^3)$ watt

By using above equation we calculate some results of trial for different wind speeds.

1) For velocity **5.5 m/s**

Pa = $1/8 (1.225^* \pi^* 0.72^2 {}^* 5.5^3)$

= 41.49 watt

2) For velocity **8.5 m/s**

Pa = $1/8 (1.225^* \pi^* 0.72^2 {}^* 8.5^3)$

= 153.15 watt

3) For velocity **11 m/s**

Pa = $1/8 (1.225^* \pi^* 0.72^2 {}^* 11^3)$

=331.92 watt

4) For velocity **14 m/s**

Pa = $1/8 (1.225^* \pi^* 0.72^2 {}^* 14^3)$

=684.29 watt

As the result we obtained are sufficient for the electricity generation for fulfill the need of street lights.

Wind force

Wind force is calculated by

$$F=0.6^*C_d{}^*A^*V^2$$

Where,

F= wind force

C_d= drag coefficient

A= area

V = velocity

1) For velocity **5.5 m/s**

$F=0.6^*0.8^*0.0791^*5.5^2{}^*6$

= 6.89 N

2) For velocity **8.5 m/s**

$F=0.6^*0.8^*0.0791^*8.5^2{}^*6$

=16.46 N

3) For velocity **11 m/s**

$F=0.6^*0.8^*0.0791^*11^2{}^*6$

=27.56 N

4) For velocity **14 m/s**

$F=0.6^*0.8^*0.0791^*14^2{}^*6$

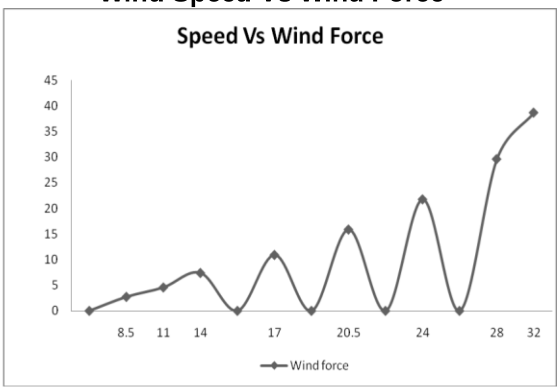
=44.65 N

GRAPHS

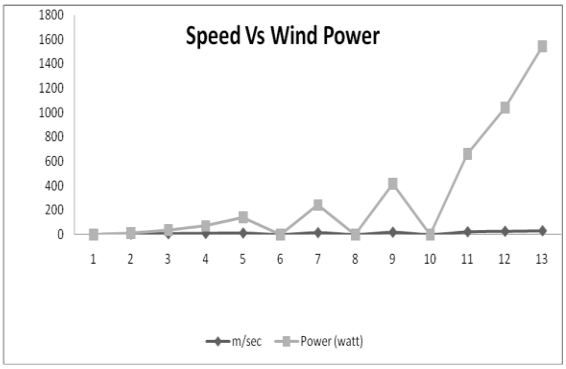
Wind type	**Km/hr**	**m/sec**	**Wind force**	**Power**

			(N)	(watt)
Normal wind	19.8-28.8	5.5-8.0	1.1434 - 2.4192	7.672-23.616
Strong Normal wind	30.6-37.8	8.5-10.5	2.73-4.16	28.32-53.39
Strong wind	39.6-48.6	11-13.5	4.57-6.9	61.39-133.48
Very strong wind	50.4-59.4	14-16.5	7.4-10.29	126.56-207.19
Stormy wind	61.2-72	17-20	10.92-15.12	226.1-369
Stormy wind	73.8-84.6	20.5-23.5	15.88-20.87	397.37-598.60
Heavy storm	86.4-99.0	24-27.5	21.77-28.58	637.63-959.25
Very heavy storm	100.8-113	28-31.5	29.63-37.50	1012.53 - 1441.67
Hurricane	115.2-180	32-50	38.70-94.5	1511.42 - 5765.62

- **Wind Speed Vs Wind Force**



- **Wind Speed Vs Wind Power**



FEATURE SCOPE

An economical, small scale Vertical Axis Wind Turbine is fabricated using mild steel materials etc.

- The assembly can be mount on the railway track, so that highly forced air strikes on the turbine blade and hence output can be increased.
- The best quality alternator can be used which produced more voltage for low rpm.
- Using gear mechanisms to increase rpm for alternator input and hence can have higher power output.
- Construction can be more accurate in order to have proper function of windmill.
- Using fixed base system to reduce the weight of the whole system.

CONCLUSION

After referring to various research work done in this area by various researchers, the fabricated model tested. Thus manufactured gave encouraging results. This model is tested in the actual field and the power output is measured which produces approximately the same energy as estimated. This shows that the idea of installing the proposed wind turbine on the road divider will be effective enough to generate the power from the moving vehicles on the road. This generated power can be used for street lights, road side farms, etc, and any other commercial use.

This is also noted that power which is generated is very commercial and free from pollution.

REFERENCES

1) A.Y. Qasim, R. Usubamatov and Z.M. Zain (School of Mechatronic Engineering University Malaysia Perlis, Perlis, Malaysia)- **Design of Vertical Axis Wind Turbine with Movable Vanes.**

2) WIND ENERGY PROJECT ANALYSIS- (Minister of Natural Resources Canada 2001 - 2004.)

3) B.Divya, S.Muthukumari, G.Vaithiynathan, G.M.Puvaneshwari And K.Mathew. (Harnessing Electrical Energy in Highways by Smart Wind Mill) *Volume 3, Issue 12 (September 2012), PP. 04-09.*

4**)** Dr.ADAPA RAMA RAO(Jawaharlal Nehru Technological University) -
Design and fabrication of Savonius vertical axis wind turbine.

5) Highway Helical Wind Turbine Project (Next Generation Highway's Potential For. (2012, November 20). (Department of Mechanical Engineering YCET Kollam. Kerala)
Retrieved February 14, 2013, from Youtube.com:
http://www.youtube.com/watch?v=8g5G0LXCNDM

6) Global Statistics. (n.d.). Retrieved from Global Wind Energy Council:
http://www.gwec.net/global-figures/wind-energy-global-status

7) Joe. (2007, April 11). Archinect. Retrieved March 15, 2013, from Arizona State University (Joe):
http://archinect.com/blog/article/21451130/here-goes-please-comment

8) B.K Hodge January 2009, John Wiley & Sons Inc.

9) http://www.popularmechanics.com/science/energy/solar-wind/4324331

10) http://learn.kidwind.org/files/manuals/ADVANCED_BLADE_DESIGN_MA
NUAL.pdf

11) http://www.microstrain.ie/pdfs/quiet/C.056quietrevolutionproductspecificatio
nandpowercurve%202010_08_24.pdf

12) http://www.maximrenewable.com.au/wpcontent/
gallery/factsheets/C.030%20quietrevolution%20power%20curve.pdf

13) http://www.bettergeneration.co.uk/wind-turbine-reviews/qr5-windturbine.
html

14) Sathyanarayanan, R.; Muthamizh, S.; Girirampprasath, C.; Gopinath, K.T. *Communication Software and Networks (ICCSN), 2011 IEEE 3rd International Conference on* Digital Object Identifier: *10.1109/ ICCSN.2011.6014909 Publication Year: 2011,*

15) New blade profile for Darrieus wind turbines capable to self-start Batista, N. C.; Melicio, R.; Matias, J. C. O.; Catalao, J. P. S. Renewable Power Generation (RPG 2011), IET Conference on Digital Object Identifier: 10.1049/cp.2011.0219 Publication Year: 2011.

16) Yanto, H.A.; Chun-Ta Lin; Jonq-Chin Hwang; Sheam-Chyun Lin, Modelling and control of household size vertical axis wind turbine and electric power generation system. Power Electronics and Drive Systems, 2009. PEDS 2009. IEEE International Conference on

17) Power converter for vertical axis micro-wind generators. Causo, A.; Dall'Aglio, G.; Sala, A.; Salati, A. Clean Electrical Power (ICCEP), 2011 International Conference on Digital Object Identifier: 10.1109/ICCEP.2011.6036303 Publication Year: 2011 , Page(s): 304 – 307.