

Smart Vertical Axis Highway Wind Turbine

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Abstract: *Energy is an important aspect of our everyday life. The resources we use are limited whereas the population consuming the same is increasing day by day. Nowadays the requirement for electricity is much higher than its generation; hence the main objective of our work is to produce electricity at low cost with no effect on the environment. The objective of the work is to design a wind turbine to recapture wind energy from vehicles on the highway. A considerable amount of wind energy is produced due to the pressure difference created by the moving vehicles on the highways. This wind energy can be utilized for the generation of electrical energy with the help of vertical axis wind turbines. This work aims to extract this energy in the most efficient manner. A vertical axis wind turbine can be installed on the median of the roads so that the wind from both sides of the median will act tangentially in opposite directions on both sides of the turbine thereby increasing the effective wind speed acting on the turbine. This wind flow will depend on the velocity of the vehicle, size of the vehicle, and intensity of the traffic. Based on the studies made an optimal wind turbine design has to be made. The wind power harnessed through this method can be used for street lighting, traffic signal lighting, toll gates, etc.*

Keywords: VAWT, HAWT, H-rotor, semi-guy-wired tower, Noise emission, Sound power level, Highway Power, Windmill, Renewable Energy.

I. INTRODUCTION

In today's life electricity has become one of the basic needs like food, water, etc to people. Power is needed in every part of life from household to industrial level. A day without electricity is compared to a nightmare. Since its inception in the very first days of the 21th century, the demand for electricity is increasing with time. Electricity reduces human labor, saves time, and provides precise output. Though the demand for electricity is increasing, the production of electricity is not adequate. Currently, around 68% of electrical power produced from the thermal power plant. By using a shaft to transfer the torque, VAWTs can have the generator and other key parts located at ground level which enables designing them focusing on performance and economy rather than size and weight. Furthermore, maintenance and modifications are made easier with these parts placed on the easy accessible tower base. Yaw motors are superfluous since VAWTs are omni-directional which allows for a design with essentially only one moving part, which is made up of the rotor, shaft and generator rotor which are all jointed. Also, the concept has shown potential for lower noise emissions. Furthermore, in it has been shown that the concept is more suitable for up-scaling than the HAWT concept. However, torque ripple on the shaft and bending moments on the blades due to constantly changing angle of attack are issues that are only addressed for VAWTs, making dimensioning for fatigue more complex. With the increase in environmental issues, the demand and utilization of renewable energy resources has increased significantly. Alongside solar energy, recent developments and research have made wind energy as the mainstream method of power generation through renewable resources. Production of power by harnessing the energy from wind has huge prospects. In today's life electricity has become one of the basic needs like food, water, etc to people. Power is needed in every part of life from household to industrial level. A day without electricity is compared to a nightmare. Since its inception in the very first days of the 21th century, the demand for electricity is increasing with time. Electricity reduces human labor, saves time, and provides precise output. Though the demand for electricity is increasing, the production of electricity is not adequate. Currently, around 68% of electrical power produced from the thermal power plant. In a thermal power plant, power generation is based on fossil fuels, diesel, which is very limited, less available, and concern is that these are



going to be finished one day. Considering Europe, more investments have been made in wind energy than any other renewable energy technology. Wind turbines are installed at carefully planned and tested sites with good wind resource to convert the kinetic energy from wind into electrical power. However, the major challenge in this regard is to find and select a site that satisfies the required working conditions of a wind turbine.

History of vertical axis wind turbines

Actually, vertical axis windmills might have been in use in the Afghan highlands as early as the 7th century BC. These early VAWTs were simple devices based on aerodynamic drag, the wind was simply pushing the blades of the turbine and thus creating torque. Darrieus patent cover both the troposkein “egg beater” shaped turbine with curved blades mounted directly to the rotating tower/shaft that is supported by guy wires at the top and the so called H-rotor with straight blades and struts connecting them to the shaft placed inside the tower. During the 1970-80s there were large research programs in North America focusing on the Darrieus concept, for example Sandia National Laboratories tested different configurations and sizes of the Darrieus turbine. A company called The FloWind Corp utilized much of the Sandia technology to build commercial wind farms using turbines ranging up to 300 kW which initially proved to be quite reliable and efficient. In Quebec, a record-breaking 4.2 MW Darrieus turbine known as Éole C was built in the late 1980s. However, during this period the blades which were designed to flex, were usually made of aluminum which is not very endurable to cyclic stress, so with time problems with fatigue on the blades started to appear which ultimately lead to failures. These problems together with withdrawal of funding finally stalled the development. Today most of the VAWT projects regard small scale turbines like Ropatec from Italy, Turby from the Netherlands or the innovative Swedish offshore concept SeaTwirl which features a floating tower and kinetic energy storage using sea water. In recent years there has been a renewed interest in larger VAWTs, not least because of findings within the VAWT research project.

Wind Energy Scenario in Bangladesh

At a glance, references show that with a population of 146.2 million electrification rate is 59.60%. Total electrical energy installed capacity is 12229 MW (2016) [1] and total installed wind energy is 1.9 MW. Wind energy potential in Bangladesh is over 20,000 MW, the wind speed being < 7 m/sec. In Bangladesh, research in the field of wind energy began only a few years ago, which had shown that some southern districts of Bangladesh have a very good potential of wind energy. Bangladesh Centre for Advanced Studies (BCAS) in collaboration with Local Government and Engineering Department (LGED) and an international organization namely Energy Technology and Services Unit (ETSU) from UK with the funding from Department of Foreign and International Development (DFID) has attempted to monitor wind conditions at seven coastal sites for a period of one year in 1996-97. They measured wind parameters at a height of 25 m [2]. At present, several wind resource works is ongoing in the country by Bangladesh Power Development Board (BPDB), Bangladesh Council of Scientific and Industrial Research (BCSIR), Local Government Engineering Department (LGED) and Bangladesh University of Engineering and Technology (BUET). They have already started measuring wind speeds at some typical locations of Bangladesh. Vesta Company of Denmark will invest 100 MW wind power plant which will be made in Patuakhali. This will be the largest wind power plant of Bangladesh [6]. Bangladesh is situated between 20.30 - 26.38 degrees North latitude and 88.04 - 92.44 degrees East [3]. Analysis of upper air data by Center for Wind Energy Technology (CWET) India shows that wind energy resource of Bangladesh for electricity production is not good enough (< 7m/s) in most of the region of the country for grid connected wind parks. This sector is under research mainly at coastal zone [28, 21]. Bangladesh has a total of 574 km long coast line in the Bay of Bengal. The strong south/south-westerly monsoon wind coming from the Indian Ocean, after travelling a long distance over the water surface, enters into the coastal areas of Bangladesh. This trade wind blows over the country from March to October.

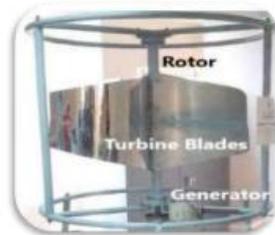


II. LITERATURE REVIEW

Niranjana. S.J [1] Inquired to generate power by fixing the vertical axis wind turbine on the highways. This paper indicates that the vertical axis wind turbine can be able to generate 1KW of power when it moves at 25m/s. Abhijit N Roy [2] et al. tried to design and fabricate and economical vertical axis wind turbine. In this experiment, the shaft of the rotor is connected vertically to the wind turbine with the generator. It uses a gearbox that can be fixed near to the ground. D.A. Nikam [3] et al. reviewed the literature and development of the blade of the vertical axis wind turbine. This paper indicates the characteristics and advantages of both HAWT and VAWT. The experimental outcome of this paper tells that design of the blade plays an essential role in the performance of the turbine. A modified blade can improve the efficiency of the wind turbine. Altab Hossain [4] et al. showed a design that investigated the development of vertical axis wind turbines. The blade and the drag devices are designed in such a way that they are at a ratio of 1:3 to the wind turbine. The calculated output if this experiment is it produces 567W and 709W power when the wind speeds are 20m/s and 25m/s, respectively.

Aim of work

The work in this thesis aims to take a closer look at the eigenfrequencies of a semi-guywired wind turbine tower as well as the characteristics of the noise emitted from a VAWT. This should be done by performing theoretical and analytical studies as well as computer simulations and experiments. In this thesis, the theory, results and conclusions is presented in such a way that the scientific contribution is pointed out. The purpose for studying the VAWT concept is to better understand its future chances of being an alternative to HAWTs. Further learning of the advantages and disadvantages of the concept can also help to find application areas that are especially suitable for VAWTs. Also, by drawing knowledge from existing VAWTs, the possibilities for building well-functioning turbines in the future increases.



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III. RESULT

As the model is design mainly for highway applications so we take a wind survey on Mumbai- Goa highway and placed model on highway divider. For testing purpose by using external fans we produced the air of required speed and



measured turbine speed. The voltage generated is also measured with respect to variation in wind speed. The following table shows the results come out from turbine.

According to test performed and the survey of wind generated on highway by moving vehicles, the operating time of wind turbine on average is 4 to 5 hours in a day at full rated output. The switching take place between solar and wind turbine according to voltage generated by them. Hence, the charging time required to charge the battery to full is reduced as compare to stand alone system. **CONCLUSION** This hybrid model of VAWT and solar on highways have good source of green power. Present work of model experimentally shows the hybrid wind and solar power generation can be used to generate large amount of power at almost all time of day. This can be an alternative source of energy to the non- renewable resources. By using this model all the highways and small villages can be lighted without the use of conventional energy sources. This can be implemented instead of single source, to gain more power almost at all times. Finally, conclude that this paper can give electricity without pollution to many highways and small villages.

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