ENERGY SOURCES AND ENERGY CONSERVATION SELF START VERTICAL AXIS WIND TURBINE

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ABSTRACT

In the attempt to reduce the global warming effect, small wind turbine (SWT) is expecting to play more and more important role in the upcoming future. The traditional small wind turbine technology has been dominated by Horizontal Axis Small Wind Turbine (HASWT) for decades. Vertical Axis Small Wind Turbine (VASWT) is considered as a good solution to overcome the noise nuisance of SWT application. The industry is looking for Good VASWT to expand the market of VAWT.
Index Terms— Self Start Vertical Axis Wind Turbine, Power Generation, Viable Technology, Non Renewable Energy, Power Source.

INTRODUCTION

With the recent surge in fossil fuels prices, demands for cleaner energy sources, and government funding incentives, wind turbines have become a viable technology for power generation. Currently Horizontal Axis Wind Turbine (HAWT) dominate the wind turbine commercially over Vertical Axis Wind Turbine (VAWT), However Vertical Axis Wind Turbine do have some advantage over Horizontal Axis Wind Turbine. In the attempt to reduce global warming effect small wind turbine is excepting to play more and more important role in upcoming future. The traditional small wind turbine technology has been dominated by HAWT for decades. However the noise nuisance and questionable practical power performance have been reported in two key problems of the traditional Horizontal Axis Wind Turbine application very much. VAWT is considered as a good solution to overcome the noise nuisance of Small Wind Turbine application.

HORIZONTAL VERSUS VERTICAL AXIS WIND TURBINE

The HAWT is the most common turbine configuration. The propellers and turbine mechanisms are mounted high above the ground on a huge pedestal. It is a matter of taste as to whether they enhance the landscape. However, there is no denying that the height at which their mechanisms are located is a disadvantage when servicing is required. Also, they require a mechanical yaw system to orient them such that their horizontal axis is perpendicular to and facing the wind. As potential power generation is related to the swept area (diameter) of the rotor, more power requires a larger diameter. The blades experience large thrust and torque forces, so size is limited by blade strength. Larger wind turbines are more efficient and cost effective.if they are poor quality when we receive them.

The perceived disadvantage of the VAWT is that they are not self-starting. However, it could be argued that the HAWT is also not self-starting since it requires a yaw mechanism for orientation. Currently, VAWT are usually rotated automatically until they reach the ratio between blade speed and undisturbed wind speed (Tip Speed Ratio or TSR) that produces a torque large enough to do useful work. Through the use of drag devices and/or variable pitch blade designs, it is hoped that a VAWT will be able to reach the required TSR without the use of a starter.

HOW WIND ENERGY IS HARNESSED

Turbines relying on drag, such as the anemometer and Savonius models, cannot spin faster than the wind blows and are thus limited to a TSR of less than 1. Other turbines, such as the Darrieus, rely on lift to produce a positive torque. Lift type wind turbines can experience TSR as high as 6. This is possible because the natural wind is vector summed with the wind opposing the forward velocity of the airfoil. This combined velocity is known as the relative wind.

HOW TURBINES WORK

The wind imposes two driving forces on the blades of a turbine; lift and drag. A force is produced when the wind on the leeward side of the airfoil must travel a greater distance than that on the windward side.

The wind traveling on the windward side must travel at a greater speed than the wind traveling along the leeward side.

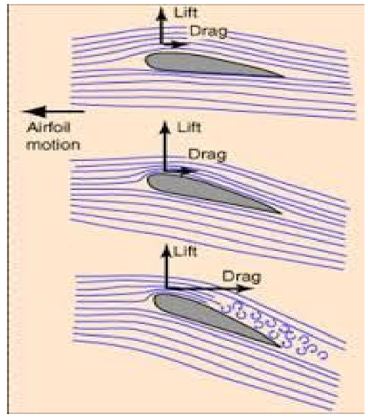

Figure 1. How Turbines Work

This difference in velocity creates a pressure differential. On the leeward side, a low-pressure area is created, pulling the airfoil in that direction. This is known as the Bernoulli's Principle. Lift and drag are the components of this force vector perpendicular to and parallel to the apparent or relative wind, respectively. By increasing the angle of attack, as shown in figure 1.2, the distance that the leeward air travels is increased. This increases the velocity of the leeward air and subsequently the lift.

Table I. Input for the Turbine

Sr No.	INPUT	
1	Undisturbed Wind Speed	6 m/s
2.	TSR	4
3.	Number of Airfoils	3
4.	Blade Height	2 feet

Table II. Output For the Turbine

Sr No.	OUTPUT	
1	Requiredswept area	0.24 m2
2.	Diameter	2.20 feet
3.	Chord Length	0.55 m
4.	Estimated weight/blade	7.67 Kg
5.	RPM	179
6.	Reynolds Number	204625

WIND AS A RESOURCE

By the end of 2011, it was reported by the World Wind Energy Association, that there are over 238,351 MW of wind power capacity in the world.

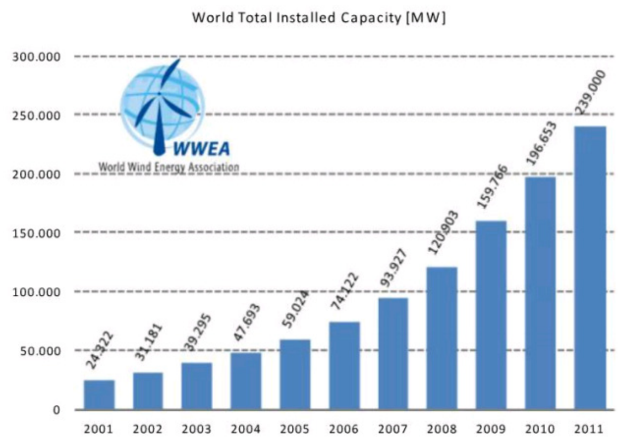

FIGURE 2: Chart of Global Installed Wind Power Capacity [1]

HISTORICAL BACKGROUND

Wind energy has been used for thousands of years for milling grain, pumping water and other mechanical power applications. Wind power is not a new concept. The fist accepted establishment of the use of windmills tenth century in Persia [1]. Today, there are several hundred thousand windmills in operation around the world. Modern windmills tend to be called wind turbines partly because of their functional similarity to the steam and gas turbines and partly to distinguish them from their traditional forbears [2].

Wind energy was the fastest growing energy technology in the 1990s, in terms of percentage of yearly growth of installed capacity per technology source. The growth of wind energy, is not evenly distributed around the world. By the end of 1999, around 69% of the worldwide wind energy capacity was installed in Europe,

A further 19% in North America and 10% in Asia and the Pacific [3]. Wind energy is expected to play an increasingly important role in the future national energy scene [4, 5]. Wind turbines convert the kinetic energy of the wind to electrical energy by rotating the blades. Greenpeace states that about 10% of electricity can be supplied by the wind by the year 2020 [6]

PHYSICS OF WIND TURBINES

The power in the wind is the total available energy per time unit. The power in the wind is converted into the mechanical-rotational energy of the wind turbine rotor, which results in a reduced speed of the air mass. The power in the wind cannot be extracted completely by a wind turbine, as the air mass would be stopped completely in the intercepting rotor area. This would cause a `congestion' of the cross-sectional area for the following air masses. The theoretical optimum for utilizing the power in the wind by reducing its velocity was first discovered by Betz, in 1926. According to Betz, the theoretically maximum power that can be extracted from the wind.

ENVIRONMENTAL IMPACT AND RELIABILITY OF WIND TURBINES

Wind energy can be regarded as environmentally friendly; however, it is not free of emissions. The production of the blades, the nacelle, the tower, etc., the exploration of the material and the transport of equipment leads to the consumption of energy resources; hence emissions are produced as long as these energy resources are based on fossil fuel. These emissions are known as indirect emissions. In addition, the noise and the visual impact of wind turbines are important considerations for a public acceptance of wind energy technology, particular if the wind turbines are located close to human settlements. The noise impact can be reduced with technical means, e.g. variable speed or was in the Reduced rotational speed. The noise impact as well as the visual impact can also be reduced with appropriate sitting of wind turbines in the landscape [9].

FEATURES AND COMPONENTS OF WIND TURBINES:

Depending on the blade design features, power extraction can be controlled in order to avoid the turbine from running too fast. For this reason there are three main types of blades:

- Pitch Controlled Wind Turbines: On a pitch controlled wind turbine the turbine's electronic controller checks the power output of the turbine several times per second. When the power output becomes too high, it sends an order to the blade pitch mechanism which immediately pitches (turns) the rotor blades slightly out of the wind. Conversely, the blades are turned back into the wind whenever the wind drops again.

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- Stall Controlled Wind Turbines: (Passive) stall controlled wind turbines have the rotor blades bolted onto the hub at a fixed angle. The geometry of the rotor blade profile, however has been aerodynamically designed to ensure that the moment the wind speed becomes too high, it creates turbulence on the side of the rotor blade. This stall prevents the lifting force of the rotor blade from acting on the rotor. The basic advantage of stall control is that one avoids moving parts in the rotor itself, and a complex control system.
- Active Stall Controlled Wind Turbines: Technically the active stall machines resemble pitch controlled machines, since they have pitch able blades. In order to get a reasonably large torque (turning force) at low wind speeds, the machines will usually be programmed to pitch their blades much like a pitch controlled machine at low wind speeds. One of the advantages of active stall is that one can control the power output more accurately than with passive stall, so as to avoid overshooting the rated power of the machine at the beginning of a gust of wind. Another advantage is that the machine can be run almost exactly at rated power at all high wind speeds [13].

VAWT TECHNOLOGY

VAWTs are wind turbines that rotate about a vertically-oriented axis that is perpendicular to the wind direction (sometimes termed a "cross-flow" turbine). In typical, modern designs, the center axis is a vertical shaft (tower)‡ that is connected to a speed-increasing transmission (gearbox). The transmission's output shaft, in turn, drives a motor/generator that converts the mechanical torque of the rotor to electrical power. Typical designs include the full-Darrieus (or eggbeater), the "H", the "V" (or "Y" or "sunflower"), the "Delta", the "Diamond" and the "Giromill" configurations, all of which may be seen in Figure 1. Many additional configurations have been proposed, even some that turn the turbine on its side (a "squirrel cage" configuration).

- The significant distinction between a HAWT and a VAWT is the orientation of their rotational axis relative to the wind direction. The HAWT's propeller type rotor is aligned with its axis of rotation essentially parallel to the direction of the wind and the VAWT'S

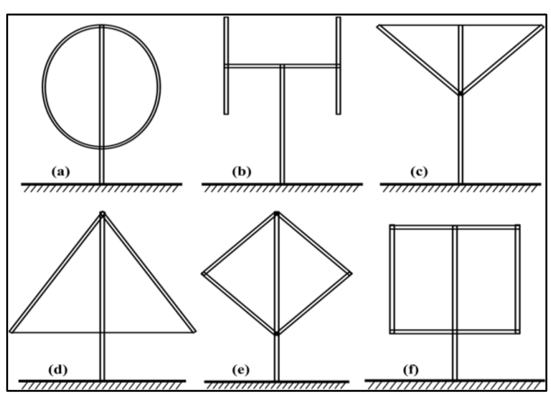

FIGURE 3:
(a) Full Darrieus, (b) "H" , (c) "V",(d) "Δ", (e) "Diamond" and (f) "Giromill".

PROJECT OBJECTIVE

The objective of this project is to design and build a self-staring vertical axis wind turbine that is capable of producing power in real world situations. The design of the turbine will include exploration of various self-starting options, as well as construction of both model and full-scale turbines. The full-scale turbine will be designed such that it can be connected to a generator and a torque transducer to measure the output power, torque and rotational speed of the turbine. The design will also allow for data collection regarding the effects of blade pitch angles.
After the text edit has been completed, the paper is ready for the template. Duplicate the template file by using the Save As command, and use the naming convention prescribed by your conference for the name of your paper. In this newly created file, highlight all of the contents and import your prepared text file. You are now ready to style your paper; use the scroll down window on the left of the MS Word Formatting toolbar.

DESIGN REQUIREMENTS

- The VAWT will be an self-starting H-Type
- It will self-start using wind power only
- It will have blade dimensions of 1.5m (4.9') high by 2.5m (8.1') diameter
- It will be made of lightweight components like aluminum
- It will be designed to connect to an electrical generator to measure power output
- It will be rated to produce 50W at average Nova Scotia wind speeds (5-7 m/s).

Figure 4: Desired Turbine.

ADAVNTAGES:

1) VAWT are Omni-directional means they do not need to be pointed in the direction of the wind or accept wind from any direction to produce power.
2) Components can be mounted at ground level which makes easy for service.
3) Can theoretically use less material to capture the same amount of wind.
4) Lower constructions cost & start up speed.
5) Yaw drive is not needed.
6) Can be mounted at lower height.
7) Maintenance is Easy.
8) Less Noisy.
9) Micro generation of electricity in vast quantity is possible.

DISADVANTAGES:

1) Poor self-starting capabilities.
2) Requires support at top & bottom of turbine rotor.
3) Requires entire rotor to be removed to replace bearings.

4) In ground level wind are fluctuating in nature.
5) Have never been commercially successful.
6) Chances of fatigue are more.

APPLICATIONS:

1) Installed on roofs.
2) Can be used over street lamps.
3) For domestic use.
4) For lights before home.
5) Installed on surrounding the road.
6) Can be installed on hilltops & Farms.
7) Can replace solar panels were used.

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CONCLUSION

GO GREEN! – is a widely used 'buzzword' of these days for most of the companies and even for the policy makers. But how far are we in the journey to 'going green'? In the year 2013 only in which only 12% of the energy is from the wind energy government has a plan to obtain 20% of the total electric energy supply from renewable energy sources by the year 2030.

Wind energy offers a promising renewable energy source and wind turbines are the only way to extract energy from the wind. The main objective of this project is to design and build an H-type, vertical axis wind turbine that has the capability to self-start. In addition, this turbine will be designed to allow a variety of modifications such as blade profile and pitching to be tested.

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REFERENCES

[1]. Indian Department of Energy. "Wind and Hydropower Technologies Program".Retrieved from http://eerewe..gov.in/windandhydro/wind_how.html in November, 2012.
[2]. Wikipedia Encyclopedia. Retrieved from http://en.wikipedia.org/wiki/Image:HDarrieus-Rotor.png.jpg on November 28, 2013.
[3]. Chang, Professor L..(2013)"Advanced Topics in Environmental Engineering-Wind Power," Ch.4. University of Brunswick. Retrieved from, http://www.ece.unb.ca/powereng/courses/EE6693/index.html in October, 2013.

[4]. EarthLink . "See How it Flies – A new spin on the perceptions, procedures, and principles of flight." Retrieved from http://www.av8n.com/how/htm/airfoils.
[5]. Kirke, Brian Kinloch, 1998. "Evaluation of Self-Starting Vertical Axis Wind Turbines for Stand-Alone Applications". Griffith University, Australia. Retrieved from http://www4.gu.edu.au:8080/adt-root/public/adt QGU20050916.120408.
[6]. Sheldahl, Robert E., Klimas, Paul C., 1981. "Aerodynamic Characteristics of Seven Symmetrical Airfoil Sections Through 180-Degree Angle of Attack for Use in Aerodynamic Analysis of Vertical Axis Wind Turbines", Sandia National Laboratories, Albuquerque, NM., USA.
[7]. Reuss, R.L., Hoffmann, M.J., Gregorek, G.M., December 1995. 'Effects ofSurface Roughness and Vortex Generators on the NACA 4415 Airfoil, The Ohio 48 State University, Columbus, Ohio, USA. Retrieved from http://wind.nrel.gov/OSU_data/reports/7x10/N4415_7x10.pdf on November 3, 2014.
[8]. Pawsey, N.C.K., 2013. "Development and Evaluation of Passive Variable-Pitch Vertical Axis Wind Turbines", School of Mechanical and Manufacturing Engineering, The University of South Wales, Australia.
[9]. Science Reporter magazine, 2013. Volume 24 "Wind Power," Green Publishing Company, Page 17
[10]. Group 2, (December 2005). MECH 4010 Design Project Report: "Self-Starting Vertical Axis Wind Turbine."
[11]. MECH 4020 Design Project - "Revised Build Report:Self-Starting Vertical Axis Wind Turbine."
[12]. Global Wind Energy Council, (2005). "A Global Power Source." Retrieved fromwww.gewc.netin January 2014
[13]. Peace, Steven, (2004). The American Society of Mechanical Engineers, Feature Focus: Advanced Energy Systems. "Another Approach to Wind." Retrieved from http:// www.memagazine .org/back issues/ jun 04/ features /apptowind/apptowind.html