Bladeless Wind Power Generation

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Abstract— Bladeless Wind Power Generation uses a radically new approach to capturing wind energy. The device captures the energy of vorticity, an aerodynamic effect that has plagued structural engineers and architects for ages (vortex shedding effect). As the wind bypasses a fixed structure, it's flow changes and generates a cyclical pattern of vortices. Once these forces are strong enough, the fixed structure starts oscillating. Instead of avoiding these aerodynamic instabilities our design maximizes the resulting oscillation and captures that energy. Naturally, the design of such device is completely different from a traditional turbine. Instead of the usual tower, nacelle and blades, the device has a fixed mast, a power generator and a hollow, lightweight and semi-rigid fiberglass cylinder on top. This puts the technology at the very low range of capital intensity for such projects, it also makes it highly competitive not only against generations of alternative or renewable energy, but even compared to conventional technologies.

Key words: Spam Email, network traffic

I. Introduction

Wind power has become a legitimate source of energy over the past few decades as larger, more efficient turbine designs have produced ever-increasing amounts of power. But even though the industry saw a record 6,730 billion global investment in 2014, turbine growth may be reaching its limits.

Bladeless turbines will generate electricity for 40 percent lesser in cost compared with conventional wind turbines. In conventional wind power generation transportation is increasingly challenging because of the size of the components: individual blades and tower sections often require specialized trucks and straight, wide roads. Today's wind turbines are also incredibly top heavy. Generators and gearboxes sitting on support towers 100 meters off the ground can weigh more than 100 tons. As the weight and height of turbines increase, the materials costs of wider, stronger support towers, as well as the cost of maintaining components housed so far from the ground, are cutting into the efficiency benefits of larger turbines.

The alternative energy industry has repeatedly tried to solve these issues to no avail. But this latest entry promises a radically different type of wind turbine: a bladeless cylinder that oscillates or vibrates.

The Bladeless Turbine harness vorticity, the spinning motion of air or other fluids. When wind passes one of the cylindrical turbines, it shears off the downwind side of the cylinder in a spinning whirlpool or vortex. That vortex then exerts force on the cylinder, causing it to vibrate. The kinetic energy of the oscillating cylinder is converted to electricity through a linear generator similar to those used to harness wave energy.

It consists of a conical cylinder fixed vertically with an elastic rod. The cylinder oscillates in the wind, which then generates electricity through a system of coils and magnets.

The outer conical cylinder is designed to be substantially rigid and has the ability to vibrate, remaining anchored to the bottom rod. The top of the cylinder is unconstrained and has the maximum amplitude of the oscillation. The structure is built using resins reinforced with carbon and/or glass fiber, materials used in conventional wind turbine blades.

The inner cylindrical rod, which will penetrate into the mast for 10% - 20% of it's length (depending on the size of the mast), is anchored to it at its top and secured to the ground at its bottom part. It is built to provide highest resistance to the fatigue and allow its elasticity to absorb the vibrations generated by the cylinder.

A semi-rigid coupling allows the upper section of the turbine to flutter in the wind while a linear alternator housed in the lower section converts the movements into electricity. The bladeless wind generator generates electricity through a "classic" system of coils and magnet. The cost reductions come from reduced manufacturing costs: the tower and the generator equipment are, basically, one and the same. This allows us to bypass the need for a nacelle, the support mechanisms and the blades, that are the priciest components in the conventional wind generators. Manufacturing savings are roughly estimated at around 51 % of the usual wind turbine production cost. The manufacturing, transportation, construction and assembly are also simplified and are typical for the wind industry.

The bladeless turbine currently takes up as much as 30% of the area of a conventional generator, with maximum amplitude around a diameter at the top. It can capture about 40% of the wind power contained in the air, which is a more than reasonable capacity, and at same height as many modern wind turbines. The system does loose some electrical conversion capacity (reaching 70% yield of a conventional alternator), because the design is so focused on avoiding and wear and tear .It aims to be a "greener" wind alternative.

The impact on the bird population is expected to be much smaller, because it doesn't require the same type or magnitude of movement as the traditional wind turbine, allowing for higher visibility. With the oscillation frequency of the equipment very low, the impact sound level is nonexistent, opening the possibility to make the future wind farms completely silent.

II. History of Bladeless Power Generation

The Vortex Street effect was first described and mathematically formalized by Theodore von Kármán, the genius of aeronautics, in 1911. This effect is produced by lateral forces of the wind on any fixed object immersed in a laminar flow. The wind flow bypasses the object, generating a cyclical pattern of vortices, which can become an engineering challenge for any vertical cylindrical structures, such as towers, masts and chimneys. The issue is that they may start vibrating, enter into resonance with the lateral forces of the wind, and ultimately, collapse. One of such examples is the collapse of three cooling towers of the power station Ferrybridge in 1965.

However, it is possible that the same forces can be captured to produce energy - the idea behind Vortex. When a semi-rigid structure enters into a horizontal laminar air flow, it begins to vibrate under the influence of the lateral forces generated by the vortex street. When the frequency of vortex occurrence in the atmosphere matches the natural frequency of the structure, it enters into resonance, maximizing the amplitude of vibration and coincidentally, the power generation capability we are interested in. The natural frequency of any object is limited and would only enter resonance and vibrate at certain wind speeds.

Bladeless Turbine buses a radically new approach to capturing wind energy. Our device captures the energy of vorticity, an aerodynamic effect that has plagued structural engineers and architects for ages (vortex shedding effect). As the wind bypasses a fixed structure, it's flow changes and generates a cyclical pattern of vortices. Once these forces are strong enough, the fixed structure starts oscillating, may enter into resonance with the lateral forces of the wind, and even collapse. There is a classic academic example of the Tacoma Narrows Bridge, which collapsed three months after it's inauguration because of the Vortex shedding effect as well as effects of flattering and galloping.

Instead of avoiding these aerodynamic instabilities our technology maximizes the resulting oscillation and captures that energy. Naturally, the design of such device is completely different from a traditional turbine. Instead of the usual tower, nacelle and blades, our device has a fixed mast, a power generator and a hollow, lightweight and semi-rigid fiberglass cylinder on top.

III. BLOCK DIAGRAM

The Fig. 1 shows the block diagram representation of bladeless power generation scheme. This explains the function of each block and their specifications.

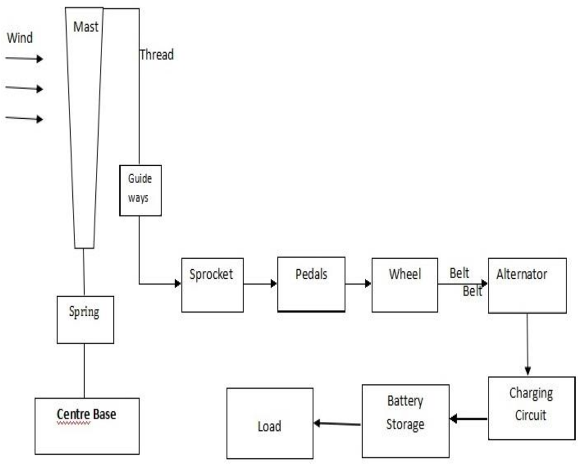

Fig. 1: Block diagram of Bladelesss Power Generation

A. *Centre Base:*

Base is made up of the rigid iron angular structure. The base provides equidistant point for the position of the mast. It is capable of tolerating the mechanical stress acting on it. This provides the strong foundation to the mast and spring.

B. *Spring:*

Spring is mounted at the centre of the mast which provides the oscillation of the mast in any of the direction. This spring is capable to withstand the weight of the mast.

C. *Mast:*

The mast is a conical shaped, rigid structure which oscillates when subjected to wind .The Mast is lighter in structure in order to increase the oscillations also decrease the mechanical stress on the suspension spring as well as the base.

D. *Thread:*

The thread is used for the conversion of the linear motion of the mast to the rotational motion of the generator. Thread used is of nylon material which as a property of the non-elasticity. This thread is connected to the chain of the sprockets. These threads are connected to the chain using the guide ways to provide proper path to the thread.

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F. *Pedals:*

G. *The bicycle pedals are connected to the shaft of the Chain drive:*

sprocket. Pedals are provided to balance the weight at both the side of the shaft of the larger sprocket as well as to increase the rotation.

H. *Flywheel:*

The flywheel is provided to increase the low RPM at the input side to higher RPM at the generation. The flywheel is provided with the counter weight to increase the speed of the rotate of the generator and it helps to rotate for the longer time. The flywheel is rotated by placing it on the hub which is connected to the small sprocket. The larger sprocket is connected to the small sprocket of the flywheel through the chain.

I. *Belt:*

The leather belt is used to drive the generator. The belt is connected to the pulley of the generator and the flywheel.

J. *Chain drive:*

Chain drive helps in increasing the speed. The sprockets are connected to the cycle hub and tightened and supported using a metallic frame. The compound chain drive is used to reduce the space required. It uses total five chains from input to the output shaft.

K. *Generator:*

The alternator is driven by the power wheel via the belt drive. The generator is design by using a ceiling fan stator which consists of 16 set of windings.. It is made to generate to electricity by replacing the metal rotor with a wooden rotor which comprises of Neodymium magnets.

L. Charging circuit:

The charging circuit use the micro controller which compare the generated voltage with a predefined value and controls the relays. The relays act as a switch which helps in charging only when power is adequate to charge the battery.

M. Battery:

The battery used here is a 12V, 7.2Ah, lead-acid battery. This battery stores the charge when the power is being generated and gives power when winding the thread. This also powers the microcontroller and wireless receiver circuit.

N. Load:

When the generated voltage is less than 12V, the power has to be dumped. Therefore a dummy load is connected. The load consists of LED bulbs.

IV. WORKING METHODOLOGY

The main principle behind bladeless wind generator is the conversion of linear oscillation of mast to rotational motion. As the mast is subjected to wind energy, it tends to oscillate due to the vortices formed around the structure of the mast, which can be converted to rotational force to generate electricity. In the bladeless wind system configuration, the mast is fixed with respect to the ground and the rib structure at the top of the mast comprising of thread arrangement is used for pulling the threads attached to it. Energy is obtained by continuously oscillation of the mast. The mast utilizes wind power to pull the threads along with the chain attached to the sprockets which drive the shaft which intern rotates the alternator to generate power. During the oscillation of the mast, the mast tries to oscillate in any direction depending on the wind direction. The rib structure at the top of the mast is attached with six threads to absorb the energy from the wind. Each set of the thread arrangement of the rib structure corresponds to one sprocket on the shaft which is driven by the chain which is pulled by the thread. Hence three sprockets are available in the shaft out of which, at least one of the sprockets is always in motion during the oscillation of the mast.

Fig. 2: Bladeless wind mill

The arrangement of the threads on the mast is such that the power is generated on all direction of oscillation of the mast. Each of the threads is joined with the chain which drives the sprocket attached to the shaft to generate the maximum amount of power. The thread joined with the chain is fixed with a spring mechanism; during the oscillation of the mast one of the six threads is pulled which make the chain to drive the sprocket on the shaft. After the maximum oscillation on one side is reached, the mast returns to its initial position and then continues the oscillation on the other side where in the other arrangement of the threads and sprocket drives the shaft hence providing the continues movement of the shaft. Such operation has been developed and tested through numerical simulations, considering a quite accurate model, which takes into account the aerodynamic characteristics of the mast and the strength of the threads, and employing self-tuning magnetic coupling system to maximize the net generated energy. So that it can operate in a wider range of wind speeds and also withstand the high wind velocities. This system allows maximizing the oscillation amplitudes when wind intensifies.

When the wind strikes the mast, it starts to oscillate due to the vortices formed around the structure and suspension spring placed at the bottom of the mast. The energy absorbed by the spring during the oscillation of the mast contributes to the increase in the amplitude of the oscillations. The rib structure with the six thread arrangement at the top of the mast is attached to the bottom chain drives through the guide ways which helps the mast to oscillate in any direction of the wind .During the back and forth oscillation of the mast, one of the six threads is pulled from the rib structure of the mast depending upon the direction of the wind. The thread being pulled due to the oscillation of the mast is connected to chain which drive the sprocket on the shaft. Each set of the thread arrangement of the rib structure corresponds to one sprocket on the shaft which is driven by the chain which is pulled by the thread. Hence t three sprockets are available in the shaft out of which one of the sprockets always is always in motion during the oscillation of the mast. The thread mechanism is provided with guide ways and pulleys for maximum transfer of the pulling force from the oscillation to the sprockets of the shaft. It also helps to increase the tensile strength of the threads which is necessary to increase the conversion efficiency to the maximum extent. The shaft driven by the sprockets arrangement rotates only in clockwise direction and restricts the rotation of the shaft in the opposite direction which otherwise may cause the threads to be pulled which may disrupt the oscillation of the mast and bring it to a halt. This shaft is welded with two bicycle pedal at the end spaced 180 degrees apart and the flywheel is provided with four counter weights 90 degrees apart, the arrangement of the pedal and the counterweight helps to increase the rotation of the flywheel. As the power is generated in the half cycle of the oscillation of the mast the shaft is subjected to a jerk motion rather than a smooth motion. Such arrangement of pedal and the counterweight helps in the smooth rotation of the flywheel trying to achieve perpetual motion. The power wheel is connected to the alternator via belt drive which increases the rotation of the alternator with a ratio of 1:10 when the shaft is in the motion. The belt drive eliminates the gear system thereby reducing the maintenance. The maximum oscillation on one side is reached with the thread pulled to maximum extent, at which the maximum energy is absorbed from the wind. After which the mast returns to initial position and continues the oscillation at other end where in the other arrangement of the threads and sprocket drives the shaft hence providing the continues movement of the shaft . Since the power output of the alternator is AC. It is rectified using a rectifier circuit, filtered and regulated using a regulating circuit to 12V. The output DC Voltage obtained via the dual output of the regulation circuit charges the battery.

V. ADVANTAGES

The wind generator does not have any moving parts in contact, which eliminates the need for lubrication and reduces the wear and tear. Also, it's known that a structure can only have a certain frequency of oscillation, which limits the number of working hours. However, thanks to a self-tuning magnetic coupling system, it can operate in a wider range of wind speeds. This system allows maximizing the oscillation amplitudes: when wind intensifies, the magnetic force of repulsion goes up, which reduces the distance between the rod and the magnet. As a result, the oscillation and the potential of generated energy increases to the maximum. With that, it can automatically vary rigidity and "synchronize" with the incoming wind speed, in order to stay in resonance without any mechanical or manual interference. The design completely eliminates mechanical elements that can suffer wear and tear from friction, leading to an estimated 53 % reduction in maintenance costs compared to traditional wind, avoiding changing oil or changing most the mechanical parts along the 20 years of the multi-blade wind turbines life cycle. Of course, it's not immune to fatigue. The wind can cause twisting and displacement of the structure, primarily in the elastic rod, especially in the lower section that has to withstand greater forces. However, studies carried out by the company confirm that, the stress on the rod is far from working limits of materials, i.e. carbon fiber. Computational modeling estimates operational lifetime of the installation to be between 32 and 96 years .It currently takes up as much as 30% of the area of a conventional generator, with maximum amplitude around a diameter at the top. It can capture about 40% of the wind power contained in the air, which is a more than reasonable capacity, and at same height as many modern wind turbines. The system does loose some electrical conversion capacity (reaching 70% yield of a conventional alternator), because the design is so focused on avoiding and wear and tear. The Bladeless Turbine aims to be a "greener " wind alternative.

The impact on the bird population is expected to be much smaller, because it doesn't require the same type or magnitude of movement as the traditional wind turbine, allowing for higher visibility. With the oscillation frequency of the equipment below 20Hz, the impact sound level is nonexistent, opening the possibility to make the future wind farms completely silent. Because it doesn't kill birds nor makes noise, several environmental advocacy groups, including the SEO Birdlife Association.

VI. DISADVANTAGES

The biggest disadvantage to Bladeless wind power generation power seems to be that it is a technology in the development phase and must rely on investors taking a risk. Of course all new technologies must go through this phase. Requires additional maintenance due to the gear mechanisms involved. The efficiency of the energy absorbed from the wind is comparatively less than that of the conventional wind turbine. The requirement of control systems for controlling the oscillation to meet the natural frequency of the mast and control of the frequency at higher velocity winds. The height of the mast can be increased based on the output required.

VII. APPLICATIONS

Bladeless wind energy can be used in a variety of industries and applications, including marine off-grid systems, industrial applications, remote telemetry and mobile base stations and for houses, schools and farms.

Bladeless energy for Agriculture: Remote power systems are needed more and more in the world of farming. Whether it's for powering electric fencing, powering water pumping, powering lighting in stables and chicken sheds or powering underwater cameras at salmon farms – bladeless energy can be built in small scale as well as in big scale to meet the bill. Small scale Bladeless wind Turbine energy for Homes: The bladeless turbine will be focused to small scale production. This system it has been designed to bring energy to an off grid locations and matching it with solar panels. This is a cost-effective solution for houses where are existing solar installations and where having a non-expensive wind device will help to storage the energy produced while the solar is not producing. Also it will work for those villages where having energy could be a matter of life. It can be used for Residential Battery Charging and Grid Connection.

Bladeless energy for Telecoms: With more and more mobile communications and broadband technology being deployed in rural and remote areas, providing power for the transmission equipment can often be a real headache. Bladeless energy can provide off-grid power solutions needed to support telecom infrastructure.

Bladeless wind energy for Off-grid Lighting: Small scale bladeless wind turbine generators are ideal for providing efficient and reliable lighting in off-grid locations. The bladeless energy generates free renewable energy which is stored in a battery ready for when it gets dark to power public street lights, car parks and playgrounds. We can combine the bladeless energy with solar panels from our advanced solar range to ensure a continuous supply of renewable energy for a sustainable off-grid lighting solution.

Bladeless energy for Signage and Signalling: There is an increasing need for off grid signage and signaling in areas where grid connection is neither easy nor cost effective. Bladeless energy can provide cost effective and reliable off grid continuous power solutions for these remote power generation needs.

Off-Grid Power for Rail Signalling: Large parts of the rail network lack convenient mains electricity. Bladeless wind power generators can be installed near railway signals to supply power to the signaling systems.

VIII. CONCLUSION

The bladeless wind generation system configuration has been considered and the obtained results appear to be very encouraging, even though they are based on simulations and model taken from the literature, which certainly can give only approximate description of involved dynamics. Tapping the wind for renewable energy using new approaches is gaining momentum in the recent years. The purpose of this paper is to provide some fundamental results on the bladeless wind system and serve as stepping stones for the future development of bladeless wind power generating system. The forces that is beneficial or useful to generate power in bladeless are different from those in conventional horizontal axial wind turbines. Our device captures the energy of vorticity, an aerodynamic effect that has plagued structural engineers and architects for ages (vortex shedding effect). As the wind bypasses a fixed structure, its flow changes and generates a cyclical pattern of vortices. Overall the project has been a success with all of the project requirements achieved. As the wind energy is powerful and consistent, the usage of conventional wind turbine for utilizing the wind energy in lesser area and cost is not possible. Hence bladeless wind energy helps us to achieve these criteria. This project has three main advantages: Utilizing less area, Generation of high power, Economical. In summary, the generation of electricity is made possible by the small structure of bladeless turbine. High efficient power is generated. This project will satisfy the need of continuous generation of electricity. The overall project uses less space area hence highly economical for the rural electrification of India.

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