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MOBILE WIND TURBINE DRIVEN BY PERMANENT MAGNET BRUSH LESS DC GENERATOR

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ABSTRACT

With climate change causing major and devastating natural disasters a lot of serious thought is going towards reducing carbon footprints and green House gases. Since 73% of greenhouse gases are generated due to energy usage and conversion process it is very important to bring changes in this sector. Renewable energy sources are the only sustainable solution looking forward. Earlier capacity factor was less and many technology limitations and cost constraints limited the penetration of renewable energy capacity in Electricity generation. But now with collective efforts from across the globe has already made considerable impact. According to Paris agreement 50% of the generated electricity needs to be from clean energy sources. India has an ambitious target of 175 GW renewable energy capacity with 100 GW from solar (60 GW from utility grade and 40 GW from rooftop) and 60 MW from wind power generation. As on July 2022 India has total installed Wind capacity of 40.89 GW. Mostly wind energy is not considered for small capacity generation but with increased electronic load penetration, availability of DC power in small capacities to charge and run mobiles, laptops and other crucial devices and systems could be very useful. We propose to build a mobile Permanent Magnet Brushless DC Generator driven by a tulip wind turbine. Tulip or flower turbine comes in as small as 1meter size so it can be carried along easily.

I. INTRODUCTION

Brushless direct current (DC) permanent magnet generators have become widely used in various industrial applications due to the advantages that define them and their ease of control. The lack of brushes in their configuration yields several benefits for this topology as improved efficiency, better reliability, longer life with less maintenance, higher power density to weight ratio.

The optimal design of a brushless DC permanent magnet (BLDCPM) generator for the considered architecture of the wind energy conversion system to be studied in order to minimize a specific objective function, i.e. total power losses over one year wind-speed cycle operation, depends on the

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appropriate selection of the multiple design parameters. Our structure presented in below can be considered as a good example of a complex wind energy conversion system as it incorporates subsystems belonging to different physical domains with strong interference between each other, imposing to consider the globalism of the system in the design process, rather than exploring them separately. Therefore, the approach based on design optimization is justified and even necessary for achieving optimal results in a short amount of time.

Due to the many operating points within the wind speed profile and because the optimization process requires many evaluations of the objective function, adapted models have to be considered in terms of results accuracy and simulation time. The most preferred is the one based on finite element analysis, because of its high precision. However, it is well known for its huge evaluation time making it a displeasing strategy to be considered in optimization. Nevertheless, it can be used outside the optimization loop as a validation model in order to refine the obtained results. But, when dealing with few initial specifications and many unknown parameters specific analytical and/or semi-analytical models are preferred over the numerical ones, as they perform much faster.

This project describes the considered optimization methodology used in the search of the optimal design of a direct driven BLDCPM generator with trapezoidal induced electromotive force voltages for use in micro-wind turbine applications.

II. PROPOSED SYSTEM

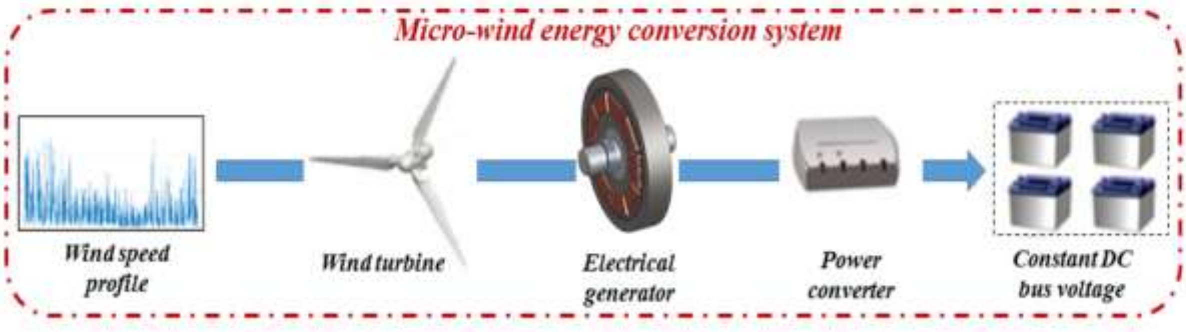

Fig. 1. Block Diagram of the wind energy conversion system

There is an air turbine of large blades attached on the top of a supporting tower of sufficient height. When wind strikes on the turbine blades, the turbine rotates due to the design and alignment of rotor blades. The shaft of the turbine is coupled with an electrical generator. The output of the generator is collected through electric power cables.

System Design Principle

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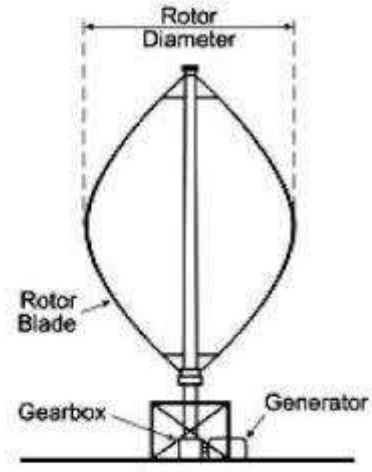

Fig 2: Architecture of Wind Turbine Driven Permanent Magnet Brush Less DC Mobile Generator

Tulip wind turbines have the main rotor shaft arranged vertically as shown in Fig 2 The main advantage of this arrangement is that the wind turbine does not need to be pointed into the wind. This is an advantage on site where the wind direction is highly variable or has turbulent winds.

With a vertical axis, the generator and other primary components can be placed near the ground, so the tower does not need to support it, also makes maintenance easier. The main drawback of a Tulip wind turbines is generally created drag when rotating into the wind.

It is difficult to mount vertical-axis turbines on towers, meaning they are often installed nearer to the base on which they rest, such as the ground or a building rooftop. The wind speed is slower at a lower altitude, so less wind energy is available for a given size turbine. Air flow near the ground and other objects can create turbulent flow, which can introduce issues of vibration, including noise and bearing wear which may increase the maintenance or shorten its service life. However, when a turbine is mounted on a rooftop, the building generally redirects wind over the roof and this can double the wind speed at the turbine. If the height of the rooftop mounted turbine tower is approximately 50% of the building height, this is near the optimum for maximum wind energy and minimum wind turbulence.

Permanent magnet generators and permanent magnet alternators do not require a DC supply for excitation circuit, nor does it need to have slip rings or contact brushes. Permanent magnets are embedded in the steel rotors creating a constant magnetic field. The stator carried windings are connected to an AC supply to produce a rotating magnetic field. Brushless Alternator are used because there is less wear and tear on the Alternator as there are very few moving parts. In Brushless Alternators slip rings and Brushes are eliminated.

These, PMBLDC machines rotor having a rare earth permanent magnets such as Neodymium or Samarium Cobalt to produce a very strong rotor field flux. There is a residual magnetism attach to the exciter rotor. Now when main rotor starts rotating, Due to faradays law of electromagnetic induction ac current is produced in coils of rotor excitor. Now, this ac current is used for exciting. This AC current is passed through bridge rectifier converted into DC. This Dc supply is given to the main rotor. This Dc current produced magnetic field. When used as permanent magnet BLDC generators, PMBLDC motors generally have to be driven a lot faster than their rated motor speed to produce anything near to their rated motor voltage so high voltage, low rpm DC machines make better BLDC generators. The main advantage over other types of DC generator is that the permanent magnet DC generator responds to changes in wind speed very quickly because their strong stator field is always there and constant.

Due to rotation of main rotor, Flux of magnetic field cut and AC Current generated in the Coil of Stationary main stator. This DC output is used for different applications. Thus, we understand here that how brushless alternator work.

III. WORKING

When the wind strikes the rotor blades, blades start rotating. The turbine rotor is connected to a high-speed gearbox. Gearbox transforms the rotor rotation from low speed to high speed. The high-speed shaft from the gearbox is coupled with the rotor of the generator and hence the electrical generator runs at a higher speed. An exciter is needed to give the required excitation to the magnetic coil of the generator field system so that it can generate the required electricity. The generated voltage at output terminals of the alternator is proportional to both the speed and field flux of the alternator. The speed is governed by wind power which is out of control. Hence to maintain uniformity of the output power from the alternator, excitation must be controlled according to the availability of natural wind power. The exciter current is controlled by a turbine controller which senses the wind speed. Then output voltage of electrical generator(pmbldc) is given to a rectifier where the alternator output gets rectified. Then this rectified output is given to line converter unit to convert it into stabilized output AC which is ultimately fed to either electrical transmission.

Tulip wind turbines: Tulip Wind Turbines is a startup creating wind energy technologies. Its tulip design offers a unique combination of beauty & power. In the presence of 'sufficient wind', tulip turbines produce more energy than solar or traditional windmills. Flower Turbines harvest the power of the wind with its patented wind tulip that comes in three sizes - small, medium, and large.

Fig. 3. Tulip Wind Turbine

As per the our project smallest model (blade Height (H): 1.15 meters; Diameter (D): 0.5 meters; and, Total height: 2 meters) is good for off-grid solutions with low energy requirements, whether off-grid or as an add-on to a solar/battery combination when sunlight is minimal. It gives a capacity in the range of 50-200 kWh.

Gear Box: A gearbox is typically used in a wind turbine to increase rotational speed from a low-speed rotor to a higher speed electrical generator.

Fig. 4. Gear Box

PMBLDC GENARATOR: An PMBLDC generator is a device that involves the conversion of one form of energy into another. This conversion of energy is usually from mechanical to electrical. Permanent magnets are embedded in the steel rotors creating a constant magnetic field. The stator carried windings are connected to an AC supply to produce a rotating magnetic field. Brushless

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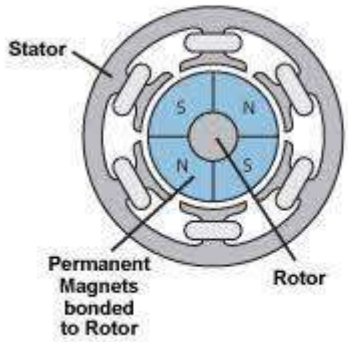

Fig.5. PMBLDC GENERATOR

Full-wave Rectifier: Rectification converts an oscillating sinusoidal AC voltage source into a constant current DC voltage supply by means of diodes, thyristors, transistors, or converters. This rectifying process can take on many forms with half-wave, full-wave, uncontrolled and fully- controlled rectifiers transforming a single-phase or three-phase supply into a constant DC level. In this tutorial we will look at single-phase rectification and all its forms.

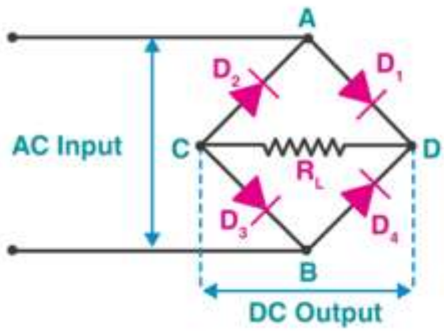

Fig.6. Full-wave Rectifier

IV. RESULT

Fig.7. Output of Tulip Wind Driven by PMBLDC generator

Output voltage: 13.32 Volts

Output current: 0.76 Amps

Output Power: 10.1 Watts

V. CONCLUSION & FUTURE SCOPE

The use of PMBLDC generators becomes more popular today. The clear advantages of the construction of the machines determine the need of these types of motors/generators in future. Different applications use nowadays this advanced technology: air conditioning and compressor applications; a PMBLDC is an excellent alternative in domestic application; wind energy sources. Progress in the field of power electronics and microelectronics enables the application of PMSMs for high-performance drives, where, traditionally, only DC motors were applied; etc. Robustness and reliability are the main goals to be achieved with PMSM like the direct-drive wind turbine solution. Because of their outstanding qualities PMBLDC machines become more and more popular as generators in Renewable Energy Systems.

REFERENCES

[1] H. E. Jordan. Energy-Efficient Electric Motors and Thei Applications, Second Edition, Printed in the United States.

[2] E. C. Lee. Applications of Brushless DC Drives in Blow Molding, Power Industrial Corporation, 2001.

[3] D. Vizireanu, S. Brisset, P. Brochet, Y. Milet, D. Laloy. Investigation on Brushless DC Appropriateness to Direct-Drive Generator Wind Turbine, Cedex, France

[4] A. Chertok, D.Hablanian. Development of a Direct Drive Permanent Magnet Generator for Small Wind Turbines, TIAX LLC, 2004.

[5] D. A. Torrey, S. E. Childs, Sjoerd de Haan. A Variable-Speed Wind Turbine Based on a Direct-Drive Variable- Reluctance Generator, Windpower, Mineapolis MN,May 1994.

[6] http://www.edn-europe.com

[7] http://www.wind-energy-the-facts.org

[8] http://www.enercon.de/en/_home.htm

[9] http://www.allaboutcircuits.co