HBRP PUBLICATION

Journal of Emerging Trends in Electrical Engineering
Volume 5 Issue 2

Compact Portable and Restructurable Power Generation Using Wind Enegry for Multi Purpose Usage

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ABSTRACT

Renewable energy sources, such as wind energy, have gained significant attention in recent years due to their potential for mitigating environmental concerns and reducing reliance on fossil fuels. In this abstract, we present a concept for compact, portable, and restructurable power generation using wind energy, aiming to address the need for flexible and decentralized energy solutions. Traditional wind power systems often rely on large-scale turbines installed in fixed locations, which may not be suitable for certain applications, such as remote areas or temporary power needs. The proposed concept focuses on developing a compact and portable wind energy solution that can be easily deployed in various environments and quickly restructured as per requirements. Wind energy power generation is main focus to generate large amount of power to meet the requirements of power utility. There is lot of research work going on the power extraction by wind source as it is renewable and abundantly available in the nature. This helps in meeting the nationwide energy demand while the non-renewable sources are getting diminished gradually. It is considered as one of the clean source of energy used for electricity production to remote locations, for agricultural purposes etc. There are many types of wind power generation such as small scale production, utility scale production, off shore wind energy production etc. This paper gives us the outline about the portable and restructurable wind energy power generation for multipurpose utility.

Keywords: *Restructable, power extraction, off shore wind energy*

INTRODUCTION

Power generation is the process of generating electricity using many energy resources which may be renewable or non-renewable energy sources. Non-renewable sources consists of nuclear energy, fossil fuels, oil, coal, etc. are resulting in many environmental issues. To overcome these issues we are moving towards the usage of renewable sources such as wind, solar, tidal, geothermal energy.

Solar Energy

Solar energy is a type of renewable source which convert sunlight into electrical energy by using photovoltaic cells. These cells were initially used in small or medium scale applications such as calculators etc. Till date we are able to generate upto 3.6% of global electricity generation using this energy.

Tidal Energy

In this source we use tidal energy from oceans and seas to generate power by rotating the turbine. Here we convert mechanical energy to electrical energy by rotating the turbines using tides from oceans

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and seas. This energy is supplying upto 10% of the global energy consumption.

Geothermal Energy
It is the thermal energy extracted from the earth's crust which is formed from the formation of earth & decaying of radioactive materials. This uses the technologies such as steam power stations, flash steam power stations, & binary cycle power stations. This energy is supplying up to 6.9% of total global energy consumption.

Wind Energy
Wind power is generally used for many processes such as sails, windmills and wind pumps. But today, generation of electricity using windmills is the major use of wind energy which is generally grouped to form wind farms and are connected to grids. It supplies upto 6.59% of world's electricity generation.

The process of conversion of wind energy into another form of energy such as electricity is called as wind energy conversion system. WECS is classified into different types based on axis of rotation, turbine, power control & rotational speed.

Based on Rotational Axis
They are again classified into 2 types

Horizontal axis wind turbine
A horizontal axis wind turbine (HAWT) is a type of wind turbine where the rotor shaft and electrical generator are positioned horizontally to the direction of wind. The blades of the turbine are attached to the rotor, which is connected to the main shaft. The main shaft is then connected to a gearbox that increases the rotational speed of the blades to drive the generator, which produces electricity. These are used both in offshore and onshore wind fields for its efficiency and reliability.

Vertical axis wind turbine
Vertical axis wind turbines (VAWTs) are a type of wind turbine where the main rotor shaft is arranged vertically, perpendicular to the ground. Unlike traditional horizontal axis wind turbines (HAWTs), which have a horizontal rotor shaft parallel to the ground, VAWTs have their rotor blades positioned around the central shaft, allowing them to capture wind from any direction. They can be installed in lower heights.

Due to this they can install in areas with space constrain. They are independent of wind direction.

Based on Electrical Output Turbines are Classified into 3 Types
- Low power
- Medium power
- High power

Power Control
They are again classified into 2 types
- Active power control
- Reactive power control

Rotational Speed
They are again classified into 2 types
- Fixed speed
- Variable speed

In this paper we are using wind energy to produce electricity which is portable & which has multipurpose usages.

LITERATURE REVIEW
The use of portable wind energy is a useful project for the development of the nation. Here are some different studies based on the same concept.

Various structural problems were analyzed in this paper, and in the final report it was found that the maximum energy was generated due to the ratio of wide spectrum of wind speed and amplitude of blade pitch varied with the wind speed and blade tip speed. Palash Jain *et al.*, the performance prediction and basic principles of small

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Amplitude VAWT for sharp edge pitching during variable amplitude [1].

This paper gives the idea about the production of power using wind power using both current and historical technology and describes the research and development which helps to reduce the cost of the wind generated power with respect to non-renewable energy generated power. R. Gerald Nix Prepared a paper for 18th World Energy Engineering Conference Atlanta, Georgia, November 8-10, 1995 with the title Wind Energy as a significant source of Electricity [2].

This paper gives the outline about the wind innovation, where the approach depends on standards of the windmill & down to earth executions. Atul Kumar, Muhammad Zafar Ullah Khan & Bishwajeet Pandey prepared a paper titled "Wind Energy: A Review Paper" [3].
This paper gives us the idea about the design and characterization of a small-scale wind energy portable turbine (SWEPT) which can be operated below 5 m/s wind speed. Aerodynamic performance characteristics of SWEPT were broadly examined using the wind tunnel experimentation and about 14% of maximum coefficient of performance was occurred at the tip speed ratio. it has a very low cut-in wind speed of 2.7 m/s and it can produce 0.83 W of electrical power at the rated wind speed of 5 m/s. Small-scale wind energy portable turbine (SWEPT) by Ravi Anant Kishore, Thibaud Coudron, Shashank Priya n Center for Energy Harvesting Materials and Systems (CEHMS), Bio-Inspired Materials and Devices Laboratory (BMDL), Center for Intelligent Material Systems and Structures (CIMSS), Virginia Tech, Blacksburg, VA 24061, United States. [4].

In this paper, we can have a idea on contemporary portable wind energy harvesters. The power generation methods by portable wind energy harvesters are studied in three major groups i.e., piezoelectric, electromagnetic, and electrostatic-based generators. The paper also gives the idea of this area by calculating the required mechanisms for getting the wind flow from surrounding environment. Portable Wind Energy Harvesters for Low-Power Applications: A Survey by Seyed fakhreddin Nabavi and Lihong Zhang [5].

PROBLEM IDENTIFICATION AND SOLUTION

The challenge of generating sufficient energy to meet the overall global power consumption, the rapid depletion of fossil fuels, the increasing global causes due to burning of fossil fuels has brought us to think in a boarder way to generate the power using clean energy. There are many researches which are working on the clean energy sources to bring out the results so that we can reduce our dependency on the fossil fuels, coal, etc. for the production of electrical energy.

With the rise in environmental issues such as global warming, greenhouse effect, air pollution etc. due to the carbon dioxide released after the burning of fossil fuels, the use of natural resources is slowly acquiring the place of fossil fuels for energy production. Now a days people are focusing on the sources which produce less pollution with high efficiency, which is leading for the more usage of natural resources such as wind, hydro, solar, tidal & geothermal energy.

The use of windmills is one of the popular ways of production of power from the wind energy. Windmills were earlier for water pumping; sailing etc. the same concept is used here to generate electricity. Here in this paper we are aiming to make a small scale wind power generator with portable options for personal use. Our design is capable of producing power which is enough for lighting bulbs, water pumping and many other purposes.

EXPERIMENTAL SETUP

Components

Blades of windmill

It consists of rows of blades extending radially outwards along the length and around the circumference of the rotor. These are airfoil-shaped that use wind energy to drive rotor of the wind turbine. The shape is used to allow the blades to lift perpendicular to the direction of the wind.

Main shaft

It is metal tube which consists of the most important spinning part of turbine since it passes the energy from blades to other parts of the turbine. Its purpose is to transfer energy from rotor to generator & transmit the loads to the nacelle. Therefore It is designed to tolerate all these loads.

Gear box

It is usually used to increase the speed from the low-speed main shaft to high-speed which is connected with the generator. The gears are put through to severe cyclic loading due to variable wind loads from the nature. Therefore improved design of gearbox reduces the downtime of the wind turbine.

Power generator

It is device that converts other form of energy to electrical energy. That is, it takes mechanical energy and coverts it into electrical energy. There are different types of generators which can be used according to the need. Here in this model we are using permanent magnet synchronous generator.

Capacitor

It is device used to store electrical charges on 2 close surfaces which are insulated. Here in our model capacitors are connected to increase the efficiency of power factor and to boost the voltage produced.

Working

The below figure gives the outline sketch of our model in the form of block diagram. When the air strikes the blades of the turbine, they rotate and shaft connected to the gear box also rotates along. At this process the wind energy is converted into mechanical energy. This mechanical energy is converted into electrical energy with the help of power generator. This produced electricity can be stored in the batteries for the further usage. In presence of many wind mills in a field all these are directly connected to the power grid.

Block Diagram and Motor specifications

MODEL	SPECS	V	NO LOAD		RATED LOAD				
			SPEED RPM	CURRENT A	TORQUE N.M.	SPEED RPM	CURRENT A	P-OUT W	EFFICIENT η
1016Z 2	250W24 V	24	434± 5%	≤1.8	6.65± 5%	357±5%	≤13.7	250	≥76%
1016Z 2	250W36 V	36	434± 5%	≤1.8	6.65± 5%	357±5%	≤9.1	250	≥76%
GEARBOX RATIO i = 88 9 =9.778									

RESULTS

By operating this small scale wind mill we are able to produce upto 12V, 50 watts power which can be used to operate different appliances. After completion of this paper we checked the results and we were able to light 3 bulbs of 5watts each, a DC pump of 15watts and DC fan of 5watts. For more production the same concept can be used for large scale production.

Specification	Output
Current	2 amps
Voltage	24 volts
Power	50 watts

CONCLUSION

This paper gives the idea of small scale wind mill which is portable and used for personal usage, which acts as a alternate power source in extreme conditions and in remote areas. This device is handy and can be used while travelling, trekking, hiking etc. & can be easily installed in hill stations for domestic purposes.

This device is environmental friendly as there is no waste produced, this operates with little noise. This system is proved to be efficient since it can operate with some minimum wind speed enough to rotate the shaft. The produced energy can further be stored in battery & can be used when required. This is almost a very usable device which can be setup by anybody & can be used efficiently.

These systems can be easily transported to different locations, making them suitable for a wide range of applications, including remote areas, disaster-stricken regions, outdoor events, and temporary power needs.

ACKNOWLEDGMENT

We thank Dr. Sanjeev kumar R.A the mentor and guide for his valuable insights & guidance and Assistant Prof. Chandrakala Patil the project coordinator for her support, as well as Dr. Sangmesh Sakri for his motivation as a Head of EEE Department. We also appreciate the contributions of all those who supported us in this endeavor

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