Development of Novel Hybrid Windmill

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Abstract

In this research article is windmill hybrid with solar energy hence they get uninterrupted reliable and quality power output in both daytime and night time throughout the year. An independent solar system developed was observed to have higher efficiency due to proper consideration of battery sizing based on state of charge and depth of discharge. Also, the system is optimized by considering the days of autonomy for the target area. In the paper, it is intended to include coating of Nano Coolant material on PV cells to reduce the operating temperature and enhance the power output. The hybrid windmill will deliver a nominal power of 300W even at minimum wind speed which will be sufficient to cater for the need of around five coastal houses with an average energy demand of 5.25 Kwh/day. The utilization of the generated power of the proposed model can be extended if the usages of energy efficient electrical appliances in the households are encouraged.

Keywords: *Energy, windmill, solar panel, hybrid, battery, inverter.*

1. Introduction

According to the US Department of Energy, the world energy consumption is projected to more than double, from 13.5 Terra Watts (TW) in 2001 to 27.6 TW by 2050, and then to more than triple to 43.0 TW by 2100. This will translate to setting up and commissioning of power plants with an average capacity of 1GW per day from now on. This is a very difficult but not impossible task if energy from renewable sources are tapped very aggressively by employing transformative technology. It is significant to observe here that the total energy falling on the earth's surface from the sun is a whopping 1,74,000TW per year (Theoretical energy) even if a tiny fraction of this is harvested and put to practical use, all the energy requirement of the human race can be met in an environmentally safe and economical manner. Within the basket of Renewable Energy resources, Solar Photovoltaic Power plays an important role. Photovoltaic offers customers the flexibility to get electricity in a very clean, quiet and reliable means. India has one amongst the very best potentials for effectively mistreatment renewable energy sources. larger reliance on renewable energy sources offers monumental economic, social, and environmental benefits.

On the other hand, wind which is also derived from the sun's energy has also a great potential in meeting the increasing energy demand of our country. The current data on renewable energy says generation of 31GW, out of which nearly 90% happens to be wind energy. It is expected to touch 60GW of energy generation by wind power alone by 2020.

A combination of wind and solar energy – hybrid system – is likely to be winning combination in generation of renewable energy. The conventional small scale hybrid systems are

costlier and are designed to operate only at high cut in wind velocity leading to highly seasonal wind power generation. On the other hand, large scale wind farms cause a serious trouble in power evacuation to the load centers and often involve cycling of fossil fuel based spinning reserves. To overcome the limitations in these conventional models, a novel and the cost effective and robust collapsible blade hybrid windmill and solar system shall be fabricated for benefits of houses in coastal areas which do not have any access to the electric grid. The hybrid system will be a viable proposal as it integrates the dual technology which fulfils the shortcoming of each other. Based on the experience in setting up the savonius windmill systems as well as performance enhanced solar system, the combined hybrid system is a viable proposition to generate required power that are suitable in coastal areas that have abundance of natural resources.

2. Literature Survey

Wind energy and Solar energy are the rapid growing energy technology in the 1990s, in terms of percentage of yearly growth of installed capacity per technology source. Wind energy is predicted to play progressively vital role within the future national energy scene [1][2]. Greenpeace states that concerning 10% of electricity can be provided by the wind by the year 2020.

There are two types of wind turbines: those whose rotors spin a few horizontal axis and people whose rotors spin a few vertical axis. Vertical-axis wind turbines (VAWT) is divided into 2 major groups: those who use mechanics drag to extract power from the wind and people that use raise. the benefits of the VAWTs are that they'll settle for the wind from any direction. This simplifies their style and eliminates the matter obligatory by rotating mechanism forces on the rotor of a convectional machine because the rotary engine tracks the wind. The vertical axis of rotation conjointly permits mounting the generator and drive train at ground level [3]. The disadvantages of this kind of rotors is that it's quite tough to manage power output by pitching the rotor blades, they're not self – beginning and that they have low tip-speed magnitude relation [4].

Horizontal – axis wind turbines (HAWT) are convectional wind turbines and unlikely the VAWT don't seem to be position. because the wind changes direction, HAWTs should amendment direction with it, that is thought as yaw management. they need to have some suggests that for familiarizing the rotor with relation to the wind. in a very HAWT the generator converts directly the wind that is extracted from the rotor. The rotor speed further because the power output is controlled by pitching the rotor blades on their longitudinal axis. A mechanical or associate electronic blade pitch management mechanism is employed in order to attain this. a vital advantage for HAWT is that blade pitching acts as a style of protection against extreme wind conditions and over speed. These rotor blades are formed to attain most rotary engine potency, by exploiting the lift to the most.

The performance of small savonius rotor (i.e. of low power) style was studied by Menet et al. [5]. They designed, developed and ultimately designed a example of such a rotor, that was a whole mechanical device system. associate degree optimized configuration was chosen for the pure mathematics of the example. The building information were calculated on the idea of the nominal wind rate 10 ms-1. They gift a call matrix for opting the fabric for the rotor, the selection of pure mathematics, shaft and generator details etc. They contemplate nominal parameters and gift an explicit relationship of the ability constant with angular rate. This was interpolated to a relationship between wind rate and angular rate. but the interpolations square measure done neglecting the electrical and mechanical losses.

A novel curtain arrangement was placed ahead of the rotor preventing the negative torsion opposite the rotor rotation by Burcin Deda Altan et al. [3]. The geometrical parameters of the curtain arrangement were optimized to get associate degree optimum performance. The rotor with totally different curtain arrangements was tested out of a structure, and its performance was compared thereupon of the traditional rotor. the utmost power constant of the wind rotor was accrued to regarding thirty eight.5% with the optimum curtain arrangement. Gupta et al. [6]

claimed that the combined rotor while not overlap, that showed fifty one potency, was the best potency of a Savonius turbine at any overlap condition below these take a look at conditions process Fluid Dynamics (CFD) analysis of a Twisted Savonius rotor. Simulations were performed in a very CFD software system Flow-3D, victimisationpainter Averaged Navier-Stokes Equations (RANSE) problem solver with structured rectangular mesh were conferred within theanalysis work of Md. Imtiaj Hassan et al. [7]. Expected performance of the twisted Savonius rotor has been determined, this includes beginning characteristics, static torsion and movement speed of the rotary engine. Simulation results showed higher performance of twisted Savonius rotor as compared to the opposite typical Savonius rotors.

Performance analysis of "Perturb and Observe" and "Incremental conductance" algorithms was done by Rasoul Faraji et al. [8] in their analysis work. Boost sort DC/DC convertor topology is employed and sculpturesque and simulation models for "P&O" and "Incremental Cond" algorithms area unit made. The simulation results presented in this paper show that both of the algorithms have almost the same efficiencies (η>90%) under identical illumination conditions. consistent with the results, the IncCond algorithmic rule has shown a rather higher performance in pursuit the utmost outlet of the module. it's conjointly determined that the output power of the IncCond algorithmic rule reaches to the utmost purpose in a very shorter fundamental quantity compared with the P&O algorithmic rule.

3. Salient feature of Wind Technology

In this paper, Windmill will be designed using **savonius type windmill coupled with solar system** by which the resistance to operate is negligible as shown in Fig.1 The current available design used in the blades creates a backlash due to contact in air on the surface of the blades and hence the angular velocity of the blade is reduced.

Presently, the Windmill blades are made up of composite materials. The proposed model of the windmill will be operated by using lightweight materials which are cost effective, corrosive free and more life span when compared to composite materials.

The existing technology of windmill has few disadvantages like less efficiency, needs an external source to initial startup, required guy ropes to hold up the windmill, robust construction, need vast area to install, more installation and manufacturing costs.

In this system, there are no traditional blades and hence low manufacturing costs for the blades. No need for the Guy ropes, the occupied area is less and hence more number of windmills can be installed and the most important factor is it operates at low wind velocity.

In this article finds its importance because of its novel technology and design which has the advantages that the conventional horizontal axis windmills does not possess and also it constitutes the advantages of vertical axis windmills. It contains the credited features of both the HAWTs and VAWTs.

Fig. 1 Savonius windmill

4. Salient feature of Proposed Solar Technology

The usage of PV modules along with this novel model of wind turbine will greatly enhance the reliability of power generation as shown in Fig. 2. The intended Solar PV module has a temperature co-efficient of 0.44% decrease in the output power, for every degree rise in temperature above the standard temperature of 25˚C. In order to prevent this loss in output of the PV module, a novel cooling technology is proposed by using a Carbon Nano tube impregnated with Nano silver on the dorsal surface of the module. This will greatly increase the conductive heat transfer from the panel so that the power output can be greatly increased. Furthermore, the proposed "PV Wind hybrid charge controller" deploys a maximum power tracking system using *Incremental Conductance* with integral voltage control. The PI team has worked on the simulation of this algorithm which is more robust on rapid changes in irradiation due to partial shading caused by cloud covers. The pure sinewave DC – AC inverter will be designed in such a way to avoid power quality issues due to highly varying input from both solar and wind.

Fig. 2 Solar Panels

5. About Hybrid Technology

The Proposed Charge Controller will be a hybrid controller where both the DC inputs from Wind Generator and the Solar Panel are added up at the same voltage level using a DC –DC converter which will have a wide range of input voltage window so as to capture even the power generated at low wind speeds as well as maximum allowable speed. The output of the Charge Controller will be charging the batteries in more efficient manner so that the battery health can be extended. The charge controller will also be designed so as to maintain the State of Charge of the wet lead acid batteries at the optimum level with permissible Depth of Discharge.

The output from the batteries will be converted into AC Voltage of line frequency in by a Sine Wave Inverter. The Inverter will be designed in such a manner so as to reduce the major power quality issues such as harmonics induced in the output power. Since the system is designed to support a local Micro-grid (a cluster of rural homes) the reactive power sharing will be facilitated.

In this research article intends to develop a hybrid model that has novel blade design as well as optimized power generation from PV cells. The design of the windmill, in addition to being unique and novel, has the advantages of overcoming the drawbacks of conventional Horizontal axis wind turbines. Similarly, performance of solar power generation is enhanced by using nano coolants as well as by ensuring a robust Maximum Power Point Tracking. Hence, it is expected that the proposed model is advantageous than most of the existing models.

6. Methodology of novel hybrid windmill

In this paper, solar and wind system is combined together such that the power generation supplements each other. They can work individually and simultaneously too.

The schematic block diagram of the system is shown below in Fig 3. It shows the combined output from the solar-wind system. The output is transferred to the hybrid charge controller for voltage regulation. The constant output voltage from the controller is then stored in wet lead acid batteries and inverted by using a full-bridge sine wave inverter as shown in the block diagram.

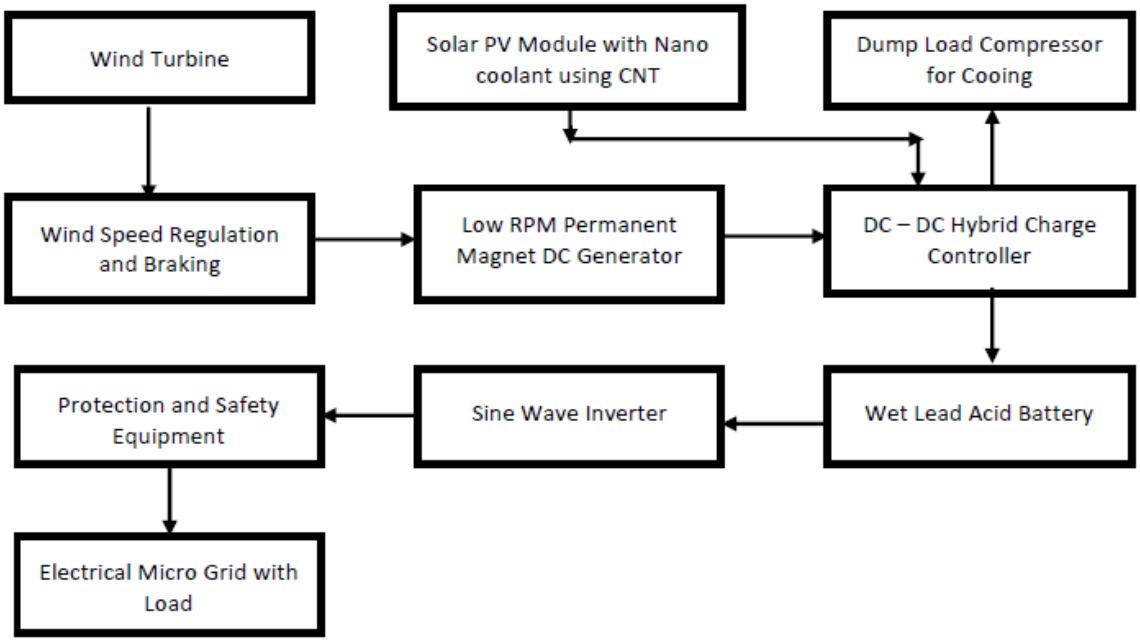

Fig. 3 Block diagram of Novel hybrid windmill

In this system will generate electric power even with minimum cut in wind velocity of 4ms-1. It is intended to overcome the yawing effect, normally found in conventional system and operate the system effectively on both upstream and downstream bidirectional wind flow. In the proposed system,

savonius type windmill blades and aluminium frames are used that result in cost effective and highly corrosion resistant windmill. Since the wind power resource is highly variable and seasonal this system also incorporates a novel design of Mono Crystalline PV Module with Carbon Nano Tube based coolant for supplying quality reliable power to the target areas throughout the year.

7. Results

The fabricated prototype model of the windmill generates minimum power of 300W with the average wind speed of 7ms-1. This project hybrid windmill with solar energy hence they get uninterrupted reliable and quality power output in both daytime and night time throughout the year. An independent solar system developed was observed to have higher efficiency due to proper consideration of battery sizing based on state of charge and depth of discharge. Also, the system is optimized by considering the days of autonomy for the target area. In the proposed project it is intended to include coating of Nano Coolant material on PV cells to reduce the operating temperature and enhance the power output.

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