Design And Fabrication of Hybrid Solar Windmill

Mr. Manjesh B C[1], Mr. John Paul Raj S[2], Mr. K Yaswanth Varma[3], Mr. Riyaz Ahamed Sheik[4], Mr. Varun M[5]

[1]Assistant Professor, Dept of Mechanical Engineering

[2, 3, 4, 5]Dept of Mechanical Engineering

[1, 2, 3, 4, 5] New Horizon College of Engineering, Bangalore

Abstract- *The main objective of this project is "Hybrid Power Generation by Solar Tracking and helical Axis Wind Turbine" wherein, design of the components and their analysis has been carried out and, the fabrication of the model has been done as per the calculations that have been obtained from the design and analysis. Electricity has helped in reducing physical efforts to a very large extent, but, the way in which it is produced is quite a matter of concern. Even today, most of the electricity that we use is produced through conventional methods. These conventional methods commonly use fossil fuels to produce electricity. Not only are these methods expensive, but also cause grave damage to the environment. The use of fuels for the generation of electricity results in increased costs and emissions of hazardous pollutants. The only alternative is a new method that is not only cheap and efficient, but also eco- friendly. The Solar Tracking - Vertical Axis Wind Turbine System is capable of satisfying both these requirements. In addition to being eco-friendly, it is also relatively cheaper when compared to the conventional methods of electricity generation. This turbine uses both Solar and Wind Energies to generate electricity. So, we have two efficient and inexhaustible sources for uninterrupted generation of electricity. The system has two basic components – one for generation of electricity through Solar Energy and another one for generation from Wind Energy. Even in the case of absence of either of the two sources, the other remaining source could be used to supplement the absence of the former. Due to all these features, the Solar-Vertical Axis Wind Turbines could be considered suitable for replacing the existing old means of electricity generation. Because, not only are they cheaper, but also economic and highly efficient. These turbines are gaining ground day by day and hopefully will be helpful in making us achieve the long sought after goal of green and cleanenergy.*

I. INTRODUCTION

The Energy markets have combined crisis recovery and strong industry dynamism. Energy consumption in the G20 soared by more than 5% in 2010, after the slight decrease of 2009. This strong increase is the result of two converging trends. On the one-hand, industrialized countries, which experienced sharp decreases in energy demand in 2009, recovered firmly in 2010, almost coming back to historical trends. Oil, gas, coal, and electricity markets followed the same trend. On the other hand, China and India, which showed no signs of slowing down in 2009, continued their intense demand for all forms of energy. World energy resources and consumption review the world energy resources and use. More than half of the energy has been consumed in the last two decades since the industrial revolution, despite advances in efficiency and sustainability. According to IEA world statistics in four years (2004–2008) the world population increased 5%, annual CO 2 emissions increased 10% and gross energy production increased 10%. Most energy is used in the country of origin, since it is cheaper to transport final products than raw materials. In 2008 the share export of the total energy production by fuel was:

Oil 50%
Gas 25%
Hard coal 14%
Electricity 1%

Most of the world's energy resources are from the sun's rays hitting earth. Some of that energy has been preserved as fossil energy; some is directly or indirectly usable; for example, via wind, hydro- or wave power. The term solar constant is the amount of incoming solar electromagnetic radiation per unit area, measured on the outer surface of Earth's atmosphere, in a plane perpendicular to the rays.

The solar constant includes all types of solar radiation, not just visible light. It is measured by satellite to be roughly 1366 watts per square meter, though it fluctuates by about 6.9% during a year—from 1412 W/m in early January to 1321 W/m in early July, due to the Earth's varying distance from the sun, and by a few parts per thousand from day to day. For the whole Earth, with a cross section of 127,400,000 km, the total energy rate is 174 pet watts (1.740×1017 W), plus or minus 3.5%. This value is the total rate of solar energy received by the planet; about half, 89 PW, reaches the Earth'ssurface.

Renewable energy is generally electricity supplied from sources, such as wind power, solar power, geothermal energy, hydropower and various forms of biomass. These sources have been coined renewable due to their continuous replenishment and availability for use over and over again. The popularity of renewable energy has experienced a significant upsurge in recent times due to the exhaustion of conventional power generation methods and increasing realization of its adverse effects on the environment. This popularity has been bolstered by cutting edge research and ground breaking technology that has been introduced so far to aid in the effective tapping of these natural resources and it is estimated that renewable sources might contribute about 20% – 50% to energy consumption in the latter part of the 21st century. Facts from the World Wind Energy Association estimates that by 2020, 160GW of wind power capacity is expected to be installed worldwide which implies an anticipated net growth rate of more than 21% peryear.

II. MOTIVATION

Wind is a clean, safe, renewable form of energy. Although the use of wind power in sailing vessels appeared in antiquity, the widespread use of wind power for grinding grain and pumping water was delayed until the 7th century in Persia, the 12th century in England, and the 15th century in Holland. 17th century, Leibniz proposed using windmills and waterwheels together to pump water from mines in the HarzMountains.

Dutch settlers brought Dutch mills to America in the 18th century. This led to the development of a multi blade wind turbine that was used to pump water for livestock. Wind turbines were used in Denmark in 1890 to generate electric power. Early in the 20th century American farms began to use wind turbines to drive electricity generators for charging storagebatteries.

OBJECTIVE

- The present work is focused on the experimental investigation on the performance of a solar tracking system. Wind power is one of the cleanest source of renewable but the noise produced by the turbines forces it to be placed in the remote areas. Our main objective is to reduce thenoise.
- In this we will be designing an small roof top wind turbine which will reduce the noise produced by the normal windturbines.
- It is also efficient in converting wind intoenergy.
- The difference in pressure is created by the spatial figure in the spiral blade results in a much better performance. Even when the wind is blowing at an angle of 60 degrees into therotor.
- The design of the blade allows it to point into the wind to capture the most amount of energy, while also producing very little sound.

III. METHDOLOGY

This project consists of solar power and Wind mill generator .Solar tracking system is attached to the model, using which the panel’s will be tilted according to the sun movement to utilize efficient energy. The wind mill generates voltage during day and night time when wind is available. This is a prototype and we can produce 12v always and charge the 12v, 2.7 AH battery which we can use for lighting purpose and water pumping. Three hours is required to charge the battery (full charge). Consequently, in this project an attempt is made to make the electric and mechanical systems share their powers in an efficientway.

And a panel cleaning mechanism will be installed, which automatically cleans the panels everyday, when the solar panel reaches the middle position. That is, a DC motor with duster arrangement will swipe the solar panel once the light detecting resistor generates the signal in the afternoon.

IV. EXPERIMENTAL SETUP MATERIALSUSED

TurbineBlades:

Wind turbine design is the process of defining the form and specifications of a wind turbine to extract energy from the wind. A wind turbine installation consists of the necessary systems needed to capture the wind's energy, point the turbine into the wind, convert mechanical rotation into electrical power, and other systems to start, stop, and control theturbine.

The present turbine used has the following specifications

- Blade width –40mm
- Thickness of blade – 1.5 mm
- Diameter of turbine – 12inches
- Length of turbine – 18 inches

Fig 1: VERTICAL AXIS WIND TURBINE

Solar Panel:

Maximum Power (Pm):1.3W

- Operating Voltage(Vmp):12V
- Operating Current(Imp):333mA
- Open Circuit Voltage(Voc):10.8V
- Short Circuit Current(Isc):363mA
- Panel color:White
- Glass thickness:3.2mm,Low iron temperedglass
- Encapsulation Methods: PV Tempered Glass Lamination
- Frame: Silver anodized aluminum and junctionbox.
- STANDARD TEST CONDITIONS(STC): AM1.5, Irradiance:1000W/squaremeters,
- Module temperature:25 degreescentigrade.

Fig 2: SOLAR PANEL

Stepper Motor:

The type of stepper motor used here is bipolar motor. Bipolar motors have a single winding per phase. The current in a winding needs to be reversed in order to reverse a magnetic pole, so the driving circuit must be more complicated, typically with an H-bridge arrangement (however there are several off-the-shelf driver chips available to make this a simple affair). There are two leads per phase, none are common. Static friction effects using an H-bridge have been observed with certain drive topologies. Dithering the stepper signal at a higher frequency than the motor can respond to will reduce this "static friction"effect.

Fig 3: STEPPER MOTOR

LDR (Light Dependent Resister):

An LDR is a component that has a (variable) resistance that changes with the light intensity that falls upon it. This allows them to be used in light sensing circuits.

A photo resistor is made of a high resistance semiconductors. In the dark, a photo resistor can have a resistance as high as several megohms (MΩ), while in the light, a photoresistor can have a resistance as low as a few hundred ohms. If incident light on a photoresistor exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electrons conduct electricity, thereby lowering resistance. The resistance range and sensitivity of a photoresistor can substantially differ among dissimilar devices. Moreover, unique photoresistors may react substantially differently to photons within certain wavelength bands.

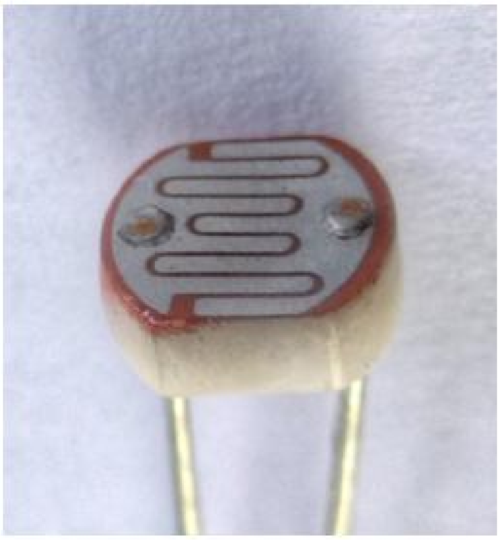

Fig 4: LDR Arduino Board:

Arduino Board:

The Arduino microcontroller is an easy to use yet powerful single board computer that has gained considerable traction in the hobby and professional market. The Arduino is open- source, which means hardware is reasonably priced and development software is free. This guide is for students in ME 2011, or students anywhere who are confronting the Arduino for the first time. The Arduino programming language is a simplified version of C/C++. If you know C, programming the Arduino will be familiar. If you do not know C, no need to worry as only a few commands are needed to perform useful functions.

Fig 5: ARDUINO BOARD

Fig 6: Experimental Setup

V. DESIGNSPECIFICATION

Wind turbine design is the process of defining the form and specifications of a wind turbine to extract energy from the wind. A wind turbine installation consists of the necessary systems needed to capture the wind's energy, point the turbine into the wind, convert mechanical rotation into electrical power, and other systems to start, stop, and control the turbine.

- The present turbine used has the following specifications
- Thickness of blade – 2 mm
- Length of blade – 1.5 feet

VI. ANALYTICAL RESULTS

Power Estimation

The electrical current produced by a wind turbine is quantified in terms of power, usually in units of watts or kilowatts. Equations have been developed for the purpose of predicting the amount of power a wind turbine will generate. The influence of variables such as wind speed, turbine radius, and rotor rotational speed on the power output has been explored in past research and the resulting equations are presented below

Equation (1) provides a means for calculating the approximate amount of power produced by a turbine; where P = Power [W], ρ = Air density [kg/m3], A = Swept area [m2], V = Wind speed [m/s], and Cp = Power coefficient.

$$P = l^2 * \rho * A * V^3 * Cp$$

Ideally, power scales linearly with the area swept out by the turbine blades, and cubically with the speed of the wind as it contacts the blades. However, these relationships have some variation depending on the design of each particular turbine21. The power coefficient at the end of the equation accounts for the efficiency of the turbine in converting the wind's kinetic energy into mechanical energy. The theoretical maximum power coefficient, or Betz limit, is 0.59. However, most wind turbines operate at a power coefficient of less than 0.45. Beyond that loss in efficiency, there are also small losses resulting from the gearbox, bearings, and generator.

As shown in (2), the power can also be estimated using the estimated torque (τ, [N*m]) and experimental data for the rotational speed of the rotor, ω, in rad/s 23.

$$P = \tau * \omega$$

For turbines which use drag forces (not lift forces), (3) can be used to estimate the amount of torque in the system, where R is the radius of turbine in meters

$$\tau = 1^2 * \rho * V^2 * A * R$$

By combining (2) and (3), the power generated Can be calculated .

$$\tau = ½ *1.22*7*0.05486*0.304$$
$$\tau = 0.0714 \text{ N/m}$$

ALL UNITS ARE CONVERTED TO METERS

The area of single blade is A=0.4*457.2

A= 0.018288 m2
So for three blades it is A*3
= 0.018288*3
=.05486 m2
Power = $\tau * \omega$ ω = 2*Pie*n/60
= 6.28radian /sec
N= 60 rpm that is average speed of turbine τ=0.0714 N/m
Power = 0.0714*6.28
Therefore Power = 0.44 kW

VIII. CONCLUSION

The hybrid power generation is an effective method to satisfy the rising demand for energy in the developing economy, we need to encourage the development of hybrid energy extraction methods from renewable resources as this is an eco friendly method and does not cause hazardous emissions such as in mining. By the utilisation of hybrid power from natural resources such as solar, wind, and water we are helping the reduction in pollution and it also enhances the development of rural areas by providing electricity. This also helps in reduction of the green house gases and nuclear waste emitted during energy extraction of energy in various power plants. The combination of various natural resources for generating energy can increase the efficiency of the system. The solar tracking and panel cleaning mechanism also help in increasing the efficiency of the device.

REFERENCES

[1] Peter J. Schubel and Richard J. Crossley, Wind Turbine Blade Design, Energies, 2012, 5,3425-3449.
[2] W. Denson, The history of reliability prediction, failure causes for electronic systems, IEEE Trans Reliab, 1998, Vol. 47, p.325.
[3] P. Gipe, Wind Power, James & James, London, 2004, p. 85- 88."FABRICATION OF HELICLE TURBINE WITH SOLAR TRACKING SYSTEM", 2018-19 Dept of mechanical engineering Page68
[4] Javier Castillo, Small-scale Vertical Axis Wind Turbine Design Bachelor's Thesis, December 2011, Degree program in Aeronautical Engineering, Tampereenammattikorkeakoulu Tampere University of Applied Sciences.
[5] T. Vishnuvardhan and Dr. B. Durga Prasad, "Finite Element Analysis and Experimental Investigations on Small Size Wind Turbine Blades", International Journal of Mechanical Engineering & Technology (IJMET), Volume 3, Issue 3, 2012, pp. 493 -503,
[6] Navin Kumar Kohli and EshanAhuja, "Performance Prediction in HAWT Wind Power Turbine", International Journal of Mechanical Engineering & Technology (IJMET), Volume 2, Issue 2, 2011, pp. 14 - 24, ISSN Print: 0976 – 6340, ISSN Online: 0976 –6359.