

POWER GENERATION FROM SMALL WIND MILL

P. Balashanmugam¹, R. Dhanasree²

¹Assistant Professor, Department of Mechanical Engineering, Annamalai University, Tamilnadu, India
(On Deputation)

²Lecturer (Part-Time) Department of Electronics and Communications, Central Polytechnic College, Tharamani, Chennai-113, Tamilnadu, India

Abstract - Energy is an important aspect in our everyday life. The resources we use are limited, whereas the population consuming the same are increasing day by day. Therefore, there is a need of finding a way to establish a relationship between a natural resources and growing populations. In this context wind energy plays the vital role in maintaining the relationship between human being and a energy requirement. Wind energy is free of cost and available with ease. Wind energy has been harnessed for centuries, but it has only emerged as a major part of our energy solution quite recently and this project focuses on utilizing wind energy by using a vertical axis wind turbine. This energy is available in the highways; this highway can provide a considerable amount of wind energy to recapture this wind from vehicles while in moving. To generated power, this power developed by the VAWT is stored in the battery, the power is used for road lamps and many different application some useful application. Aero turbines convert wind energy into rotary mechanical energy. A mechanical interface, consisting of a step-up gear and a suitable coupling transmit the energy to an electrical generator. The battery is connected to the inverter. The inverter is used to convert DC voltages to AC voltages. The load current is drawn from the inverter. Wind power ratings can be divided into three convenient grouping, small to 1kW, medium to 50 kW and larger 200 kW to megawatt frame size.

Key Words: Wind turbine, Alternating current, Micro controller, Yaw control, Darrieus rotor and Single pole tower.

1. INTRODUCTION

Wind energy offers another source for pumping as well as electric power generation. India has potential of over 20,000 MW of power generation and ranks as one of the promising countries for tapping this source. The cost of power generation from wind farms has now become lower than diesel power and comparable to thermal power in several areas of our country especially near the coasts. Wind power projects of aggregate capacity of 8 MW, including 7 wind farms projects of capacity 6.85 MW have been established in different parts of the country of which 3 MW capacities has been completed in 1989 by DNES. Wind farms are operating successfully and have already fed over 150 lakes units of electricity to the respective state grids. Over 25 MW of additional power capacity from wind is under implementation. Under demonstration programmer 271 wind pumps have been installed up to February 1989. Sixty

small wind battery charges of capacities 300 watts to 4 kW are under installation. Likewise to stand-alone wind electric generators of 10 to 25 kW are under installation. The main aim of this project is fabrication of a highway windmill. This project converts wind energy into electrical energy. The electrical energy produced here is used to drive the home appliances.

A windmill is a type of engine. It uses the wind to make energy. To do this it uses vanes called sails or blades. The energy made by windmills can be used in many ways. These include grinding grain or spices, pumping water and sawing wood. Modern wind power machines are used to create electricity. These are called wind turbines. Before modern times, windmills were most commonly used to grind grain into flour. The windmill has been in history for many years.

A wind turbine is a device that converts the wind's kinetic energy into electrical energy. Wind turbines are manufactured in a wide range of vertical and horizontal axis types. The smallest turbines are used for applications such as battery charging for auxiliary power for boats or caravans or to power traffic warning signs. Slightly larger turbines can be used for making contributions to a domestic power supply while selling unused power back to the utility supplier via the electrical grid. Arrays of large turbines, known as wind farms, are becoming an increasingly important source of intermittent renewable energy and are used by many countries as part of a strategy to reduce their reliance on fossil fuels. An electrical generator is a machine which converts mechanical energy into electrical energy. Induced EMF is produced in it according to Faraday's law of electromagnetic induction. This EMF causes a current to flow if the conductor circuit is closed. An inverter is an electronic device or circuitry that changes Direct Current (DC) to Alternating Current (AC). The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific device or circuitry. The inverter does not produce any power; the power is provided by the DC source. It just converts direct current into alternating current.

In this project wind turbine uses wind's kinetic energy and converts into mechanical energy. This highway windmill uses wind energy generated by the moving vehicles and converts into mechanical energy. The DC generator converts the mechanical energy into electrical energy. The Inverter converts direct current into Alternating current and this is

used to drive the home appliances. The Wind is quite simply moving air, and is generated by the sun, which heats the surface of the earth at different rates. During the day, the air above the land heats up more quickly than the air over water. The warm air over the land expands and rises, and the heavier, cooler air rushes in to take its place, creating winds. At night, the winds are reversed because the air cools more rapidly over land than over water. As long as the Sun keeps heating the Earth and as long as this process continues to occur, there shall be wind. The wind has been used by the human race as a source of energy for a long time {1} {2}. As long as 5,000 years ago the ancient Egyptians used the wind to power their sailing boats. The next significant use of the wind by man was for windmills {3}. A windmill is a machine that is powered by the energy of the wind. It is designed to convert the energy of the wind into more useful forms using rotating blades. The term also refers to the structure, it is commonly built on {4}. In America windmills and turbines have been used since the days of colonization. Initially they used windmills for grinding, but later they used windmills to produce electricity, even today it has still seen the evidence of them using wind mills on remote ranches and farms. Wind has been used for centuries to propel ships and the wind routes were well known and used by explorers such as Magellan and Columbus {4}, {5}. Wind power was used as a source of mechanical energy on the land for thousands of years. The Babylonians constructed windmills for irrigation as early as 1700 BC and Europeans were using windmills by 1000 AD. The Dutch used windmills to drain the land and used eight basic types. Dutch settlers introduced windmills to the United States in the early 1600's. Daniel Halliday invented a new style of windmill, which many believe encouraged the rapid settling of the American West. More than 6.5 million windmills were sold in the US between 1880 and 1935. They were used to pump water, grind grain and cut lumber. Some small electrical generating systems were used to produce direct current by 1900. Cheap electricity was introduced in the 1940's and most of the wind powered generating systems in rural areas were considered obsolete and fell into disuse {6}. The first wind powered electricity was produced by a machine built by Charles F. Brush in Cleveland, Ohio in 1888. It had a rated power of 12 kW (direct current - dc). Direct current electricity production continued in the form of small-scale, stand-alone (not connected to a grid) systems until the 1930's when the first large scale AC turbine was constructed in the USA. There was then a general lull in interest until the 1970's when the fuel crises sparked a revival in research and development work in North America (USA and Canada) and Europe (Denmark, Germany, The Netherlands, Spain, Sweden and the UK). Modern wind turbine generators are highly sophisticated machines, taking full advantage of state-of-the-art technology, led by improvements in aerodynamic and structural design, materials technology and mechanical, electrical and control engineering and capable of producing several megawatts of electricity. During the 1980's installed capacity costs dropped considerably and wind power has become an economically attractive option for commercial

electricity generation. Large wind farms or wind power stations have become a common sight in many western countries {7}

2. LITERATURE REVIEW

D.A. Nikam et al. analyzed the on design and development of vertical axis wind turbine blade. This paper explains that the wind mill such as vertical and horizontal windmill is widely used for energy production. The horizontal windmill is highly used for large scale applications which require more space and huge investment. Whereas the vertical wind mill is suitable for domestic application at low cost. The generation of electricity is affected by the geometry and orientation of the blade in the wind turbine. To optimize this by setting the proper parameter for the blade design. The experimental result indicates that the blade plays critical role in the performance and energy production of the turbine.

Altam Hossain et al. Investigated the design and development of A 1/3 scale vertical axis wind turbine for electrical power generation. In this paper the electricity is produced from the windmill by wind power and belt power transmission system. The blade and drag devices are designed in the ratio of 1:3 to the wind turbine. The experiment is conducted by different wind speed and the power produced by the windmill is calculated.

M. Abid et al. Analyzed the design, development and testing of a savonius and darrieus vertical axis wind turbine. This paper shows that the vertical axis windmill is more efficient when compare to the horizontal axis windmill. The darrieus turbine consists of 3 blades which can start alone at low wind speed. When savonius turbine is attached on the top of the existing wind mill which provide the self-start at low wind speed. The result indicates that the darrieus vertical axis wind turbine acts as a self-starter during the testing.

3. COMPONENTS AND DESCRIPTION

This project is designed with,

Hardware Requirements

- PIC Microcontroller
- Resistors
- Capacitors
- Diodes
- Voltage Regulator
- Relay
- Input Supply (12 to 24v)

Software Requirements

- MPLAB IDE
- Language: Embedded C

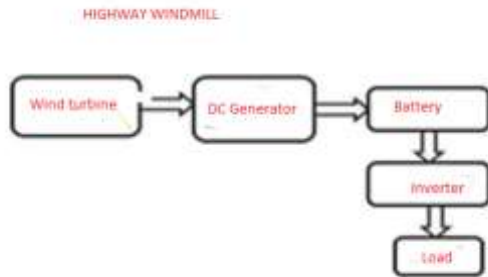


Fig-1 Highway windmill

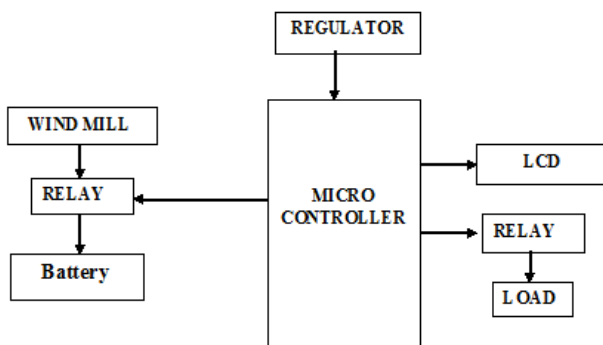


Fig-2Block diagram of power generation from windmill

3.1. Vertical Axis Wind Turbine Design – VAWT Design

A **Wind Turbine Generator (WTG)** is a device that extracts the kinetic energy from the wind using a rotor consisting of two or more blades which are mechanically coupled to an electrical generator. Therefore wind turbine power production depends on the interaction between the rotor and the wind. But there is an upper limit on the amount of energy that can be derived from the movement of the wind. No wind turbine can produce more electrical power than the amount of power in the wind itself. To do that the wind turbine would have to stop the wind from blowing by extracting 100% of its kinetic energy. The power generation from wind mill is shown in figures 1 and 2.

The amount of power converted by a horizontal wind turbine is proportional to the area swept out by the rotor (rotor swept area). So in order to capture as much of the wind’s kinetic energy as possible, the wind turbine blades should be the longest possible. Also to increase this further, wind turbines are mounted on towers that are as high as practicable and most often are mounted on towers that

exceed 80 metres (260 feet) in height. This is because in an open, unobstructed landscape, the wind speed relative to the ground can increase by a considerable amount as the elevation above the ground increases.

Most modern wind turbines use a horizontal axis wind turbine or HAWT design in which the turbine blades are mounted on a horizontal shaft with the rotor blades of a HAWT kept perpendicular to the flow of the wind to capture the maximum energy. This shaft is connected to a gearbox or transmission, and the gearbox is placed between the wind shaft (the axle to which the blades are affixed) and the electrical generator to ensure that the generator turns at an optimal speed in order to produce electricity suitable for the electric grid, typically in the 1,200–1,800 rpm range. One disadvantage of the horizontal wind turbine generator is that in order for the rotor blades to rotate, the wind turbine body has to continuously rotate to orient the rotor in the direction of the oncoming wind. This “yaw” control can be as simple as the tail vane on small wind turbines, or more complex motor control on modern towers. However, there is another type of wind turbine design called the Vertical Axis Wind Turbine, or VAWT Wind Turbine for short, which has the advantage of accepting the wind from any direction.

The “vertical axis wind turbine” has turbine blade designs either vertical or in the shape of an egg beater, and similar in many ways to the wind powered centrifugal ventilators seen on the chimney’s and flue’s. The *vertical axis wind turbine* blades are attached to a central vertical shaft and which has specific advantages over the horizontal wind turbine designs. When the blades spin, the shaft spins, which is attached to an alternator generally located at the bottom of the shaft, often at ground level. Except for the shape of its rotor blades, all other components used in the VAWT wind turbine are the same in both designs, with some minor differences in their placement.

Vertical axis wind turbine blades may be of either a drag-driven or lift-driven rotor design. The most common drag-driven vertical axis wind turbine design is that of the Savonius rotor, which has been used for hundreds of years for water pumping and other such mechanical applications. The Savonius VAWT wind turbine has an S-shaped rotor when viewed from above and operates as a drag device, and hence, the angular velocity of the turbine cannot exceed the ambient wind speed.

The power from the Savonius turbine design is based on the difference in air pressure across the blades as one set of blade retreat from the wind and the other set of blades advance into the wind. This is in turn related to the difference in the drag coefficients associated with the convex side of the blade and the concave side of the blades. Generally, compared to other forms of wind turbine designs, the Savonius rotors have fairly low efficiencies.

Lift-driven vertical axis wind turbine rotors however, are more commonly used for electrical power generation. These VAWT rotor blades are called lift-driven turbine blades because when the wind is blowing across the turbine, the rotor blades will experience a lifting force. Typically lift-driven rotors have long curved blades and are often called a Darrieus rotor design after its inventor.

There are several advantages associated with the Darrieus Wind Turbine. First of all, the Darrieus turbine is unidirectional and does not require any special yaw mechanisms to continuously orient itself toward the wind direction. Secondly, its vertical drive shaft simplifies the installation of the gearbox and the electrical generator on the ground, making the structure and maintenance much simpler. On the negative side, the vertical axis machine has not been widely used because its output power cannot be easily controlled in high winds simply by changing the blade pitch as shown in figure 3.



Fig-3 VAWT Turbine with Savonius and Darrieus Turbines Combined

3.2. HOW TO DESIGN A GOOD SMALL VERTICAL-AXIS WIND TURBINE

- Although different from a HAWT, the core technology of a VAWT remains a wind mill structure with blades. After choosing an airfoil, it is necessary to calculate a concave orientation, angle, width, and quantity because each of these factors determines the performance of the VAWT. So a first step is to choose a low-speed airfoil. A second step puts the concave orientation to outside; a third step chooses a small blade angle (8° works well) and a suitable blade width as shown in figure 4. The best blade quantity is five. And then the blade connection method is important. Its best is to use socket structure for easy installation and reduced the drag forces. These factors determine the power generation performance of the VAWT.
- A HAWT turbine must yaw – redirect itself into the wind – but the VAWT need not. So VAWTs must use the “positive pitch attack angle regulation”. This feature

uses centrifugal force to control the blade angle when the rotation speed exceeds the rated speed.

- A good vertical axis wind mill has to remain stable when it is spinning it. If not, the turbine will “shake its head” when the rotor is turning. That will reduce the turbine’s life and cause other problems such as noise and mechanical wear. So the best solution is to use a coaxial structure for the wind mill and generator. The coaxial arrangement of wind mill and generator ensures a reliable seal, safety and stability, free of mechanical noise, a reasonable bearing for windmill, and a long useful life.
- Damage may occur to wind turbines when the wind speed exceeds 25 m/s. So vertical axis wind turbine needs an automatic brake system. As a wind turbine starts to brake, it must overcome the rotational inertia and the driving force from the wind. So a good design calculates the torque in the rotor at survival wind speed and chooses a suitable disk brake for that amount of energy.

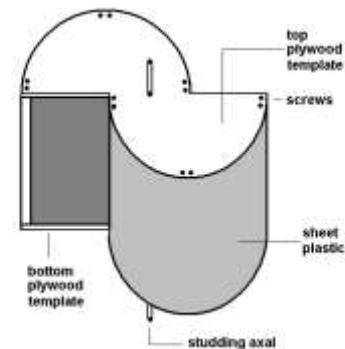


Fig-4 Wind turbine blade

4. VERTICAL-AXIS WIND TURBINE WORKING PRINCIPLE

The Vertical-Axis Wind Turbine (VAWT) is a wind turbine that has its main rotational axis oriented in the vertical direction.

VAWTs were innovative designs that have not proven as effective in general as HAWTs, but they have a few good features, including quiet operation.

Because they are not as efficient as HAWTs, they are rarely used in large units. Most VAWTs are smaller units that can be located in residential and commercial locations because they are much quieter than the horizontal-axis turbines.

4.1. Vertical-Axis Wind Turbine Types

The two types of vertical-axis wind turbines are the **Darrieus wind turbine**, which turns a shaft using lift forces,

and the Savonius wind turbine, whose cups are pushed by direct wind forces as shown in figure 5.

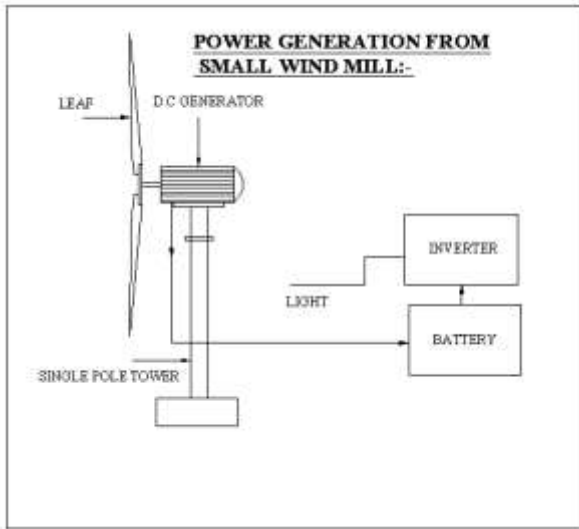


Fig-5 Small generation from small wind mill

4.2. Advantages of Wind Energy Conversion System

- a) The major advantage of this design is that the rotor blades can accept the wind from any compass.
- b) Another added advantage is that the machine can be mounted on the ground eliminating tower structures and lifting of huge weight of machine assembly, i.e. it can be operated close to the ground level.
- c) Since this machine has vertical axis symmetry, it eliminates yaw control requirement for its rotor to capture wind energy. A dual purpose and relatively simple shaft axis support is anticipated as well as ground level power output delivery due to presence of vertical shaft. This may in turn, allow easier access and serviceability.
- d) Airfoil rotor fabrication costs are expected to be reduced over conventional rotor blade costs.
- e) The absence of pitch control requirements for synchronous operation may yield additional cost savings.
- f) The tip speed ratio and power coefficient are considerably better than those of the S-rotor, but are still below the values for a modern horizontal-axis, two-bladed propeller rotor.

4.3. Disadvantages Of Wind Energy Conversion System

- a) Rotor power output efficiency of a Darrieus wind energy conversion system is also somewhat lower than that of a conventional horizontal rotor.

- b) Because a Darrieus rotor is generally situated near ground proximity, it may also experience lower velocity wind compared to a tower mounted conventional wind energy conversion system of comparable projected rotor disc area. This may yield less energy output

4.4. APPLICATIONS

4.4.1. Direct heat applications

Mechanical motion derived from wind power can be used to drive heat pumps or to produce heat from the friction of solid materials, or by the churning of water or other fluids, or in other cases, by the use of centrifugal or other types of pumps in combination with restrictive orifices that produces heat from friction and turbulence when the working fluid flows through them. This heat may then be stored in materials having a high heat capacity, such as water, stones, eutectic salts, etc.,

A home heating system that uses a wind powered pump and a restrictive orifice to derive direct heat for a building, without first generating electricity also has been developed.

4.4.2. Electric Generation Applications:

Wind power can be used in centralized utility applications to drive synchronous A.C. electrical generators. In such applications the energy is fed directly into power networks through voltage step-up transformers.

WECS units can be integrated with existing hydro electrical networks and used in a "water-saver" mode of operation. When the wind is blowing, electrical an amount equal to the being can reduce generation at the hydroelectric plants in the network produced by the WECS units. Thus, the wind turbines supply part of the network load that is ordinarily produced by the hydroelectric generators. Under these conditions, some of the water that would have been used by the hydroelectric plant to supply the load is saved in the reservoir and made available for later use when the wind is not blowing.

CONCLUSION

This system is environmentally friendly. The working model of our project is combined energy source with a solar system and vertical axis wind turbine system which is a good and effective solution for power generation, basically this system involves the combination of two energy system, suppose anyone source fails to generate another source will keep generating the electricity and will give the continuous power to the load. The renewable energy sources such as solar and wind energy are used to generate the electricity.

REFERENCES

- [1] Sanjib Kumar Nandi. Designing of a Small Scale Vertical Axis Wind Turbine & Its Performance Analysis in Respect of Bangladesh. International Journal of Renewable Energy Research, Vol. 4, No. 4, 2014.
- [2] Ramadoni Syahputra, Imam Robandi and Mohammed Ashari. Performance Analysis of Wind Turbine as a Distributed Generation Unit in Distributed System. International Journal of Computer Science & Information Technology (IJCSIT), Vol. 6, No. 3, June 2014.
- [3] Chakkor Saad, Baghoury Mostafa, Hajroui Abderrahmane. Performance Analysis of Faults Detection in Wind Turbine Generator Based on High-Resolution Frequency Estimation Methods. (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 5, No. 4, 2014.
- [4] Francisco Javier Gomez-Gil et all. Feasibility of a Simple Wind Turbine with Variable-Speed Regulation Made of Commercial Components. Energies 2013, 6, 3373-3391.
- [5] S, Dunnett. Small Wind Energy Systems for Battery Charging. Practical Action Technical Information Leaflet.
- [6] Hugh Piggott, It's a Breeze, A Guide to Choosing Windpower. Centre for Alternative Technology, 1998.
- [7] E. W. Golding. The Generation of Electricity by Wind Power. Redwood Burn Limited, Trowbridge, 1976.
- [8] Mithun K K and Ashok S "Wind Turbine for Highway Wind Power Generation" IJEEE, Volume 07, Issue 01, Jan- June 2015.
- [9] Dhiraj Varma and Ajitabh Pateriya "VAWT and Solar Panel Combine System Based Generation of Electricity through Highway" IJRISE, Vol.3, 2017. pp: 137-140.
- [10] S.Selvam, Edison Prabhu .K, Bharath Kumar M.R, & Andrew Mathew Dominic "Solar and Wind Hybrid power generation system for Street lights at Highways" International Journal of Science, Engineering and Technology Research (IJSETR), Volume 3, Issue 3, March 2014.
- [11] Scheurich, Frank, and Richard E. Brown "Modelling the aerodynamics of vertical axis wind turbines in steady wind conditions" Wind Energy 16.1 (2013): 91-107.
- [12] Shweta Singh, Sarita Singh and Priyank Srivastava "Vertical Axis Wind Turbine for Generation of Electricity through Highway Windmill" S-JPSET: Vol. 7, Issue 2, ISSN: 2229-7111
- [13] Krishnaprasanth.B , Akshaya.P.R , Mr.Manivannan.L, Ms.Dhivya.N "A New Fangled Highway Wind Power Generation" International Journal for Research in Applied Science & Engineering Technology (IJRASET) Volume 4 Issue I, January 2016