

PRODUCTION OF ELECTRICITY BY SMALL SCALE VERTICAL AXIS WIND TURBINE (VAWT) AND SOLAR PLATE ON HIGHWAYS AND RAILWAY JUNCTIONS

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Abstract : In this paper the creation of model of Savonius type Vertical Axis Wind Turbine (VAWT) is made utilizing materials which are effectively accessible like half cut shaped metal sheet, dc generator, solar plate, and so forth. This Wind turbine is put in the expressways having middle breeze speed and at beginning and closure of railroad intersections. The vehicles from the two sides of highways can quicken the turbine to pivot one way. This drives the rotor which is associated with a coupled DC generator, along with these lines creating more measure of power. So, more power will be generated than the conventional type of VAWT's. Additionally power is created with the assistance of sun oriented vitality. The exertion is made to deliver power requiring little to no effort and more dependable than the non-inexhaustible assets. This power can be utilized for numerous applications like shrewd expressway framework, toll corners, and highways helping, railroad intersection lighting, railroad signals, at railroad crossing, and so forth. This VAWT additionally goes about as a hindrance for high bar center lights produced by vehicles from inverse paths, along these lines lessening the dangers of mishaps.

The diverse models that are working with various geometries, recognizing Savonius, Darrieus, crossover of both (D+S), models committed to Offshore innovation and what can be connected for the most part (D&S) on the two kinds of VAWT (controllers, electric generators, materials ...).[23][26] The principle nations that exploration and create VAWT innovation, internationally and at European dimension and the number of committed investigations and licenses each. Different applications that can be given in fields, for example, building, mechanical condition, social regions, common designing and other more.

Future patterns for VAWT, which can be found in our condition, both rustic and urban, as has as of now occurred with other sustainable advancements for power creation, as HAWT and photovoltaic (PV), winding up some portion of the blend of sustainable power source innovation and business system of things to come, along these lines adding to the decrease of CO2 generation and financial development.

IndexTerms - VAWT, Dc Generator, Vitality, Savonius, Darrieus, etc

I. INTRODUCTION

A windmill is a sort of motor. It utilizes the breeze to make vitality (Energy). To do this it utilizes vanes called blades. The vitality made by windmills can be utilized from multiple points of view [1]. These windmills were to incorporate granulating grain siphoning water and sawing wood. Present day wind control machines are utilized to make power. These are called wind turbines. Prior to present day times, windmills were most ordinarily used to pound grain into flour. The windmill has been in history for a long time [2].

A wind turbine is a gadget that changes over the breeze's active energy into electrical energy. Wind turbines are made in a wide scope of vertical and horizontal 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 [3]. Marginally bigger turbines can be utilized for making commitments to a residential power supply while offering unused power back to the utility provider by means of the electrical network [4]. Varieties of vast turbines, known as wind farms, are turning into an increasingly important source of irregular sustainable power and are utilized by numerous nations as a feature of a system to decrease their dependence on petroleum products.

The present structure of windmill probably won't be actualized in our typical environment. As it isn't appropriate for all wind heading and it gives incomplete effectiveness and furthermore increment in expense of structure, establishment, and support. To conquer every one of these issues a new special strategy for twist is to be presented.[5] This paper have kept one stage forward of windmill innovation with utilize full application

The principle point of this venture paper is to deliver energy by utilizing sustainable power source assets as such the wind is especially Eco friendly and exceptionally smaller as well as capable one. By utilizing that energy in a helpful way we can deliver a continuous power at highways and railroad network [6].

1.1 Classification of Wind Turbine

There are several ways the modern WTs can be classified, such as based on the orientations of the axis of rotation, drag or/and lift forces on the blades, and the power capacity of turbines (Figure. 1) [7]. Based on the axis of rotation, there are two main types of WTs: the HAWT and VAWT. In HAWTs, the rotor axis is parallel to the ground and in the direction of the wind. These turbines are usually equipped with self-starter and yaw system to turn the blades towards the wind. The energy outputs of these turbines depend on the site average wind speed and the turbulence in the wind. The ideal aerodynamic efficiency of these turbines is reported in the range of 40–55% under steady wind [8] [9].

HAWTs are widely used in large wind farm applications in remote and offshore locations where the clean and the undisturbed wind are available. In contrast, HAWTs are not considered an effective design for urban environments due to the high value of cut-in wind speed, chaotic nature of the wind and the public perception against these big machines [10]. Instead, VAWTs axis of rotation is perpendicular to the directions of wind and ground. These turbines are relatively simple and do not need any yaw system and a self-starting mechanism (except, Darrieus turbines). VAWTs have low cut-in wind speed and noise level and can be installed in the urban areas that restrict the installation of a tall structure. The low wind energy conversion efficiency is an area of concern of VAWTs [11] [12].

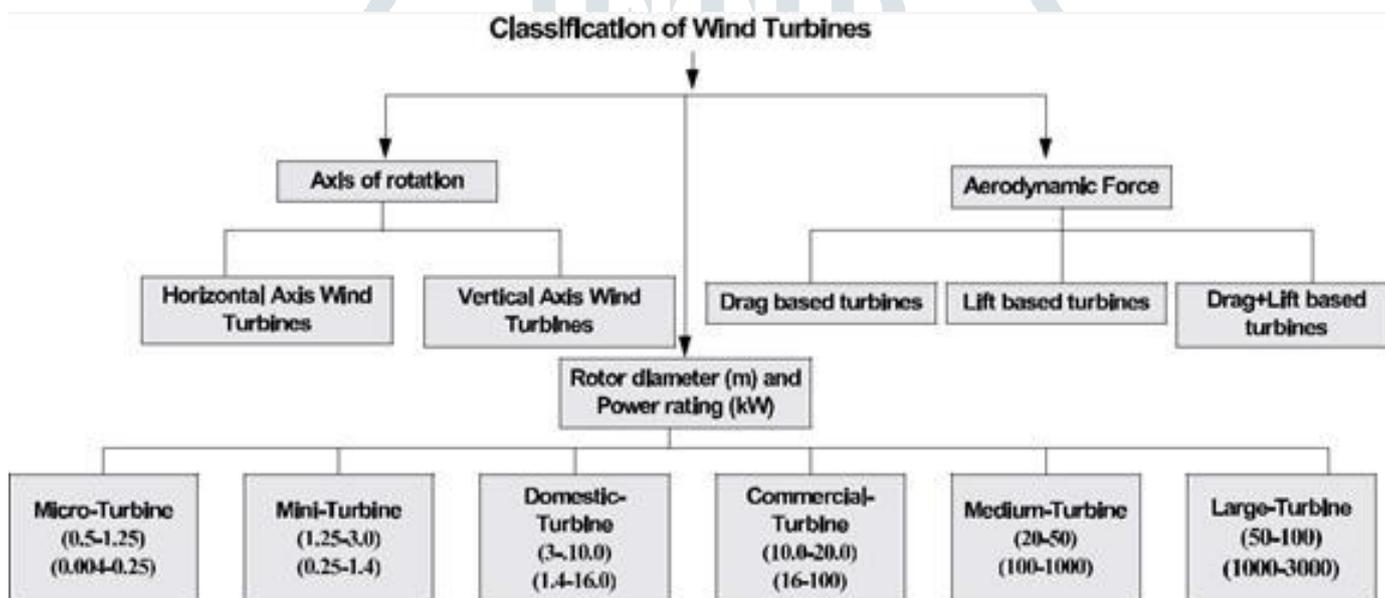


Figure 1 classification of wind turbines[18]

II. LITERATURE REVIEW

II.1 HORIZONTAL AXIS WIND TURBINES (HAWT):

HAWT is considered a traditional design of WTs and somewhat resembles the historical windmills. These turbines have two or three blades and are usually installed far from the built-up areas at a higher height to take advantage of the strong and steady wind. In order to reduce the installation, operation, and maintenance costs of projects based on HAWTs, an incredible growth has been seen since 1980 in the size of rotor diameter and the corresponding power capacity of these turbines [13]. Most commercial developments around the globe are solely based on HAWTs due to their better all-around performance [14].

Though, the performance of these turbines diminishes sharply in the low and unsteady wind causing a major hindrance in their acceptance in urban areas. Ahmed and Cameron reviewed the wind power technologies and concluded that even though a greater public awareness has been seen in the recent years about the significance of wind power as a sustainable source, the issues regarding noise, land use, avian deaths, electromagnetic interference and visual effects must be resolved to ensure continued public and political support for the acceptance of HAWTs [15]. The techno-economic viability of wind power projects is getting better each year in terms of the generation cost per kW; however, advance research on urban HAWTs will make them a feasible option for power generation in these areas. This paper has mainly reviewed the design, performance, and commercial aspects of VAWTs, and any reference to HAWTs are merely for a performance comparison [16] [17].

II.II. VERTICAL AXIS WIND TURBINES (VAWT)

VAWT is a turbine whose axis of rotation is pointed in vertical direction. VAWTs can produce electricity from wind of any direction with low cut-in wind speed. These turbines are significantly quieter than the traditional HAWTs, lightweight, and can be easily integrated into buildings [18]. These turbines are based on the aerodynamic drag forces, except Darrieus types. The research efforts on these turbines are focused on increasing the aerodynamic efficiency by reducing the drag effect and increasing the lift forces. It was predicted that they could be an efficient solution for the built-up areas where the wind is unstable. The designs of VAWT can be categorized into two groups, viz. Savonius and Darrieus [19].

II.II.I. SAVONIUS TYPES VAWTs

Finnish engineer Savonius had invented this type turbine in 1920, principally based on drag force. This is the simplest WT with low-cut-in wind speed, it usually consists of two half cylinders facing opposite directions in such a way that they have formed almost an S-shape (Figure. 2). The main drawback of this design is poor aerodynamic performance in comparison to other turbines. Savonius might be a preferred choice if power reliability is more important than turbine efficiency or COE [20] [21].



Figure 2 Savonius Turbine [56]

Concentrated efforts have been made on making Savonius as an efficient design of WTs for urban areas, which include modifications in the rotor design, blade shape, blade overlap, and the number of blades. These turbines exhibit uniqueness in terms of rotor design and torque production. The power coefficient (C_p) varies with the configurations of the rotor design. Roy and Saha conducted several wind tunnel experiments with a two-bladed Savonius turbine, mainly planned for small-scale power applications [22]. Simultaneous tests were also performed with other blade configurations to make a comparison of performances. In a subsequent study, Roy and Saha (Chart-1) applied computational methods to study the operating parameters of Savonius. It was noted that the differential drag force spins the turbine, but also primary reason for poor aerodynamic effect. Efforts have also been made to minimize the drag effect by varying the blade numbers, orientation, and blades overlapping, the variation in the blade numbers influences the C_p , and the best performance was seen with three blades [23].

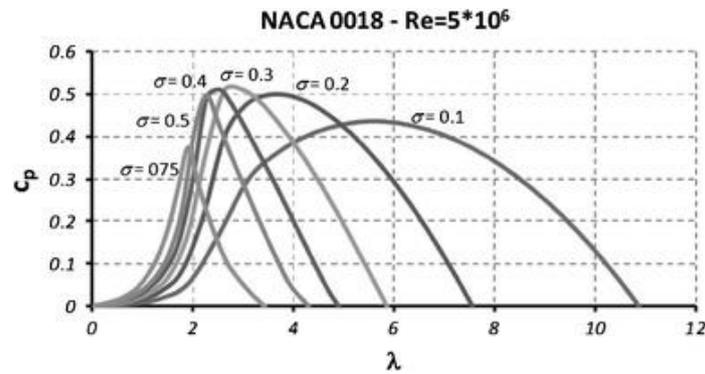


Chart 1 PERFORMANCE CURVE

The other notable studies on Savonius turbines examine the effect of end plates, aspect ratio, bucket spacing, bucket overlap, blade numbers, rotor stages, buckets and rotor shapes, rotor shaft and other accessories [24]. Investigation was also conducted to establish the Reynolds number, turbulence scales, and stators parameters. Some important conclusions were drawn from all these investigations. An all-inclusive analytical model is needed to predict the performance. Several shapes of the rotor of Savonius are a good feature of this turbine [25].

II.II.II. Darrieus types VAWTs

G.J.M. Darrieus, a French engineer, invented and patented this machine in 1931. Darrieus have better aerodynamic performance, low cost, and simpler design than the Savonius. These machines are designed based on the lift force and can extract more energy from the wind per unit swept area. [26]The airfoils of Darrieus moves forward in a circular path through the air and relative motion between the direction of wind flow and the blade airfoil creates a small net force in forward direction, which creates a positive torque to the rotor (Figure. 3) [27]. Darrieus turbine supports blades in a way that minimizes bending stress, and the force on the blades is solely due to tension. These turbines are available in two and three thin curved or straight blades with airfoil cross section or constant chord length. Darrieus turbines suffer a major drawback as they require an external power source to start spinning since their starting torque is very low [28].

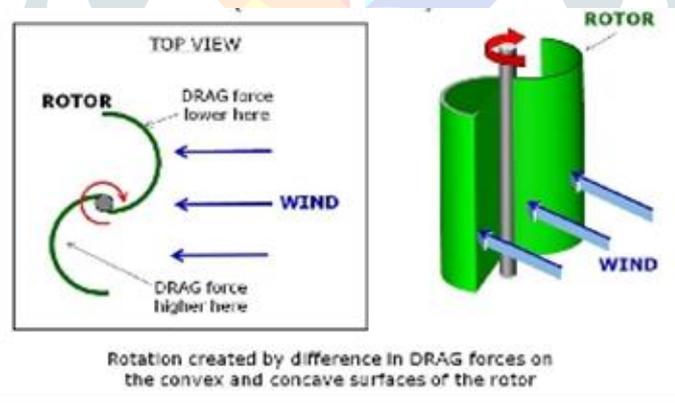


Figure 3 Savonius Turbine Concept [55]

To conquer a portion of the deficiencies of Darrieus turbines, a few alterations were performed to make these machines increasingly flexible in all circumstances as shown in (Figure 4) [29]. The greater part of these created designs has high COE and feeble money related prospect in the present market circumstance. The prerequisites of expansive solid establishment and surprising expense of assembling made them less cost-aggressive generally [30].

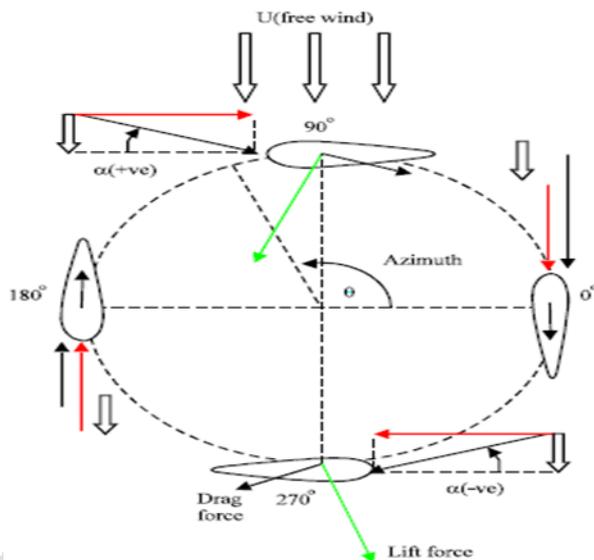


Figure 4 Darrieus turbine with direction of lift force on blade surface [20]

II.III Hardware Configuration[31]

The project and design aspect of independent modules are considered. Block diagram is shown in figure 5

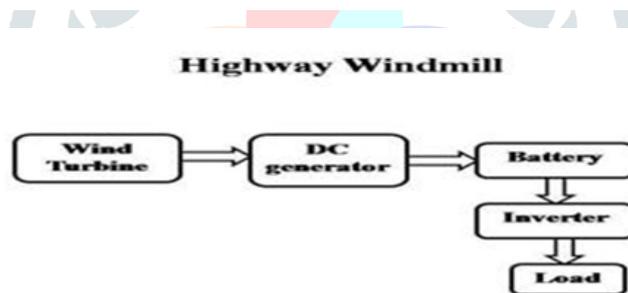


Figure 5 Flow of energy from one component to other [44]

The Main Blocks of this Project are

1. Wind turbine.
2. DC Generator.
3. Battery.
4. Inverter.
5. Load

II.IV Proposed System

The proposed system is shown in (Figure 6.). There would only be only 3 blades since the wind on the highway will be less but energy can be generated when the wind is or will be high [32].

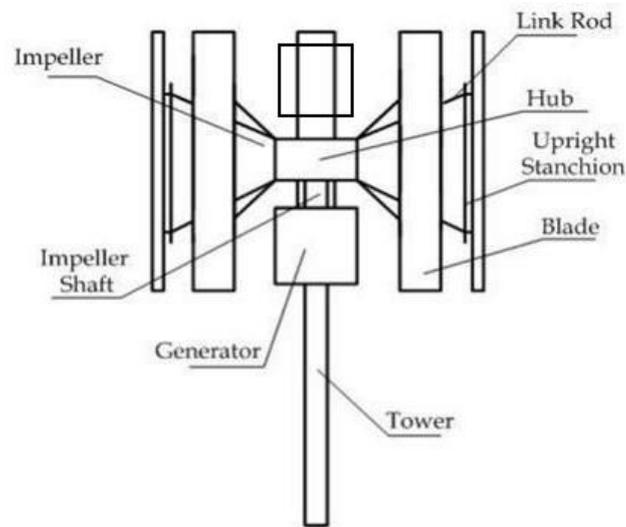


Figure 6 Model of VAWT[38]

Wind vitality is viewed as the quickest developing wellspring of clean vitality. Be that as it may, it is constrained by its variable nature. Interstates can give a lot of wind to drive a turbine because of high vehicle traffic. Because of the weight contrast noticeable all around bordering the vehicle wind will be created [33]. This venture expects to separate this vitality in the most effective way. The breeze turbines will be set out and about dividers with the goal that breeze spill out of the two sides of the roadway will act digressively in inverse ways on the two sides of the turbine. These kinds of turbines can be introduced on express parkways and other rapid traffic regions to create power [34]. This framework can be associated with the Inverter to control the electrical gadgets. The breeze control outfit through this method can be utilized for road lighting, traffic flag lighting, toll doors and so forth. This venture takes out the power request [35].

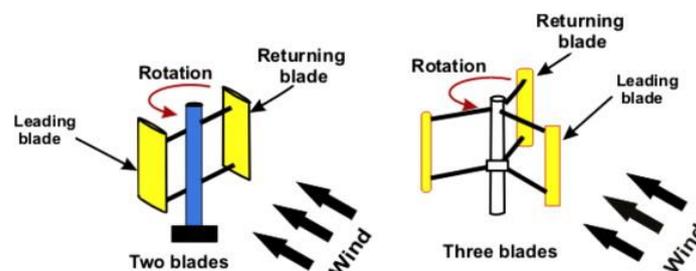


Figure 7 Wind and blade direction of 2 and 3 blade VAWT [26]

III. Advantages and Disadvantages

III.I Advantages

1. The major advantage of this design is that the rotor blades can accept the wind from all direction.
2. 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 [36].
3. Since this machine has vertical axis symmetry, it eliminates yaw control requirement for its rotor capture wind energy. This may in turn, allow easier access and serviceability [37].
4. Airfoil rotor fabrication costs are expected to be reduced over conventional rotor blade costs.
5. It is easy to fabrication and does not need higher winds easy operation for less wind also [38].
6. Compare to the horizontal type for same power production this model takes low wind energy and low cost.

7. VAWTs do not have to have a means of “yawing” (rotating about a vertical axis) to follow the changing wind direction; the generator (or other power takeoff device) can be located at ground level, reducing the structural requirements of the support tower [40].

III.II Disadvantages

1. Rotor power output efficiency of a Darrieus wind energy conversion system is also somewhat lower than that of a conventional horizontal rotor [41].
2. Although a Darrieus machine has much directional symmetry for wind energy capture, it requires external mechanical aid for startup. Tests indicate that, with small machines, the problem can be solved by attaching S-rotors at the top and bow of the vertical (rotational) axis [42].
3. The disadvantages are that producing efficient energy from winds takes twice as much time [43].

IV. CONCLUSIONS

By using this type of hybrid vertical axis wind turbine (VAWT) we can generate 100% green electricity from two different renewable energy sources (wind and solar). The solar plate on the VAWT gives some additional power to the system, and the double generator also gives more power [45]. In contrast it will increase the self-start speed of turbine, but we used the switch for extra generator which can on/off and when we don't have the quality velocity of air we simply off the extra generator it means it will be free from shaft so turbine will generate power from only one working generator, but if we have good speed of air then we can engage both generator for maximum power [46] [47]. If one system fails to supply power (either solar panel or wind turbine) the other system will continuously generate and supply the power without any side effects [50] [51]. By using this whole system on the highway medians it will also work as the barrier on highways which can prevent the high focus light to other side of road ultimately which will increase the road safety. Also, by this system we can provide electricity to the highway lights, tolls, hotels, shops and gas station beside the highway. Overall, this whole system is very environment friendly and very beneficial with the cost and maintenance [56] [58] [60].

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