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A Review on Vertical Axis Wind Solar Hybrid Power System

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ABSTRACT

Energy is essential for the economic growth and social development of any country. The quality of life is closely related to energy consumption, which has continuously increased over the last few decades in developing countries. The design of a hybrid electric power generation system utilizing both wind and solar energy for remote area is today's need. Wind power is the conversion of wind energy into a useful form of energy. Wind power, as an alternative to fossil fuels, is plentiful, renewable, widely distributed, clean, produces no greenhouse gas emissions during operation and uses little land. The effects on the environment are generally less problematic than those from other power source. The solar energy is available throughout year and it is free and clean sources of energy. The solar PV cells absorb the radiation of sun and converting it into the electrical power. The wind mill is capable to extracted energy in day and night time while the solar PV cell is capable to extracted the power only during day hours. The combination of this hybrid system will be beneficial in future aspects.

Keyword: Hybrid Renewable Energy, Solar Energy, Vertical Axis Wind Turbine

I. INTRODUCTION

Renewable energy researches, particularly wind and solar have been gaining popularity and recognized as potential sources for clean, inexhaustible and free energies. The concept of on-site renewable energy generation is to extract energy from renewable sources close to the populated area where energy is required. In the modern era, on-site energy extraction from renewable energy sources in urban settings is regarded as the next step in the process of reducing dependencies on the usage of conventional power generation using fossil fuels. A hybrid system consisting of wind and solar renewable energy sources is more beneficial than a system that only depends on one source of energy. Also, the power supply from a hybrid system is more stable and reliable. In addition, optimization of hybrid renewable energy system is crucial for researchers to maximize the energy output from the system with the lowest cost and highest reliability.

These advantages are depending on the climatic pattern and distribution of wind and solar energy resources. The benefits include:

• Supplying load demand under varying weather conditions.
• Overall costs for self-powered systems may be reduced drastically.
• High reliability without backup power sources.

Traditional methods of extracting power from the wind in urban areas using wind turbine alone is not efficient due to the uncertainty of wind speed and the turbulence generated from the surrounding buildings. Therefore, requiring methods such as increasing the oncoming wind speed before it interacts with the turbine blades. Moreover, for a wind turbine to be used in an urban area, issues such as the structural strength of the wind turbines, failures of blades, acoustic pollution (due to large wind turbine blades) and electromagnetic interference should be addressed. Due to the advantages of a hybrid system and to further improve the performance of small wind turbines, this paper presents the urban Eco-Greenergy hybrid wind-solar energy generation system. The design of the system is adopted from the larger building integrated omni- direction-guide-vane (ODGV). The ODGV was originally designed to be installed on top of a high-rise building, shrouding a vertical axis wind turbine (VAWT) that covers much of the roof area of the building. However, the large size of the system drew concerns on the structural, safety and vibration issues that would affect the building and its occupants. Furthermore, installing the system with this scale requires high capital and maintenance costs. Hence, this paper introduces a small scale Eco-Greenergy hybrid wind-solar system that employs the ODGV integrated with a VAWT and solar photovoltaic (PV) panel for on-site standalone energy generation. This minimizes the risks posed by the large scale system, and with reduced costs.

A hybrid energy system usually consists of two or more energy generating sources together to provide increased system efficiency as well as greater balance in energy supply. Here hybrid solarwind generator is used in which photovoltaic (PV) converts a part of the solar insolation into the electricity while turbine converts a part of wind kinetic energy into electricity. Such systems are extensively useful for small community, farm, optical cable transmission, and railroad communication. They also serve as useful power generating sources for remote areas and troops on desert, islands and mobile facilities. With battery storage and inverter hybrid solarwind generators can provide continuous power supply throughout the day in the remotest locations. The generators may also be connected ongrid to put energy back into a local utility’s electrical grid and actually get paid for the excess energy produced. As lifespan of the PV modules and wind turbines are nearly equal, the hybrid system can last for a longer time with higher reliability. The initial cost of solar PVs and wind turbines are higher than the diesel engine generators of comparable size but the operating and maintenance costs are always lower.

Wind power is a renewable energy source that has developed rapidly since the end of the 1970s. Wind turbines produce clean energy, don’t need any fuel transport that can hazardous to the environment. The sun, the wind and running water are all renewable energy sources, in contrast to coal, oil and gas, which depend on fossil fuels from mines or oil and gas fields. Modern wind turbines are efficient, reliable and produce power at reasonable cost. This has been achieved by an energy policy that has created a market for renewable energy and by research development. The technology in the wind turbines has developed in several ways. The control systems have become cheaper and more advanced, new profiles for the rotor blades can extract more power from the wind, and new power electronic equipment makes it possible to use variable speed and to optimize the capacity of the turbines.

1.1 Type of wind turbine

Harvesting small amounts of wind energy, on a large volume of scale provides a significant contribution toward global renewable energy. The energy conversion process through commercially available small wind turbines includes blades that convert the wind energy into rotational mechanical energy on the shaft and an electric generator that is both simple in design and manufactured in small quantities by the wind turbine developer or retrofitted off-the-shelf general purpose machine. There are several different design concepts for wind turbines. One basic classified is Horizontal Axis Wind Turbines (HAWT) and Vertical Axis Wind turbines (VAWT).

1.2 Vertical Axis Wind Turbine (VAWT)

Vertical axis wind turbines are different from traditional wind turbines in that their main axis is perpendicular to the ground. Their configuration makes them ideal for both rural and urban settings and offers the owner an opportunity to offset the rising cost of electricity and to preserve the environment. Besides, they do not need the complicated head mechanisms of conventional horizontal axis turbines. VAWTs are not affected by the direction of the wind which is useful in areas where the wind changes direction frequently or quickly. VAWTs are better able to harvest turbulent air flow found around buildings and other obstacles. This situation is more common in areas where people live. VAWTs are ideal for both rural and urban applications including roof top installations.

The generator or other devices can be installed at the ground level, making it simpler to install or maintain. VAWTs do not kill birds and wild life, it is because the slow moving and highly visible. VAWTs can be significantly less expensive to build. They produce less noise compare with horizontal ones. VAWTs are more aesthetically pleasing.

Vertical axis wind turbines are a type of turbine where the main rotor shaft runs vertically. These turbines can rotate unidirectional even with bi-directional fluid flow. VAWT is mainly due to the advantages of this kind of machine over the horizontal axis type, such as their simple construction, the lack of necessity of over speed control, the acceptance of wind from any direction of the mechanical design limitations due to the control systems and the electric generators are set up statically on the ground. Generally, there have been two distinct types of vertical axis wind turbine that is the Darrieus and savonius types. For the Darrieus, there are three common blades that are Squirrel Cage Darrieus, H-Darrieus and Egg Beater Darrieus.

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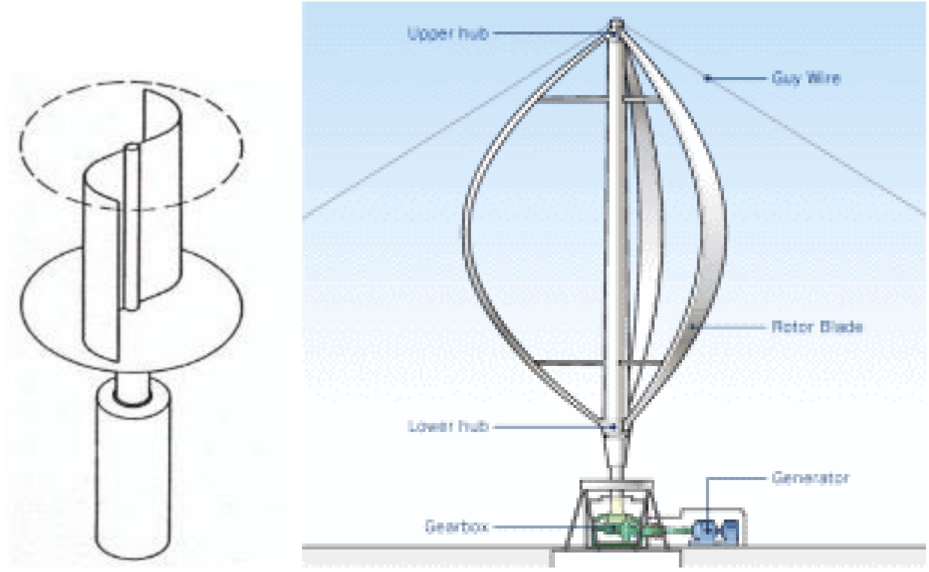

Fig 1. (a) Savonius wind turbine (b) Darrieus wind turbine

The machine is particularly suited to medium or low of wind speed which is inland area. The design of Egg Beater wind Darrieus wind turbine shown in figure 2 (b). Both designs have almost identical component.

Darrieus wind turbine	Savonius wind turbine
Advantage	
- High speed with low torque machine	- Slow rotating with high torque machine
- Generally manual push therefore some	- Shaft of the generator can be placed nearer to the ground
- External power source to start turning	- Starts at low wind speed as the starting torque is very low - Low- noise system
- Generator can be placed on the ground	- Work with any wind direction
- Easily integrated into buildings	

1.3 Savonius Turbine

Savonius is a type of VAWT, which uses a rotor that was introduced by Finnish engineer S. J. Savonius in 1922. Savonius turbines are one of the simplest turbines. Aerodynamically, they are drag-type devices. In its simplest form it is essentially two cups or half drums fixed to a central shaft in opposing directions. Each cup or drum catches the wind and so turns the shaft, bringing the opposing cup or drum into a flow of the wind. This cup or drum then repeats the process, so causing the shaft to rotate further and completing a full rotation.

This process continues all the time the wind blows and the turning of the shaft is used to drive a pump or a small generator. These types of windmills are also commonly used for wind speed instruments such as the anemometer. Modern Savonius machines have evolved into fluted bladed devices, which have a higher efficiency and less vibration than the older twin cup or drum machines.

1.4 Principles of Savonius Rotor Wind Turbine

Savonius turbines are one of the simplest turbines. Aerodynamically, they are drag-type devices, consisting of two blades (vertical – half cylinders). A two blades savonius wind turbine would look like an "S" letter shape in cross section as shown in Figure. The savonius wind turbine works due to the difference in forces exert on each blade. The lower blade (the concave half to the wind direction) caught the air wind and forces the blade to rotate around its central vertical shaft. Whereas, the upper blade (the convex half to wind direction) hits the blade and causes the air wind to be deflected sideway around it.

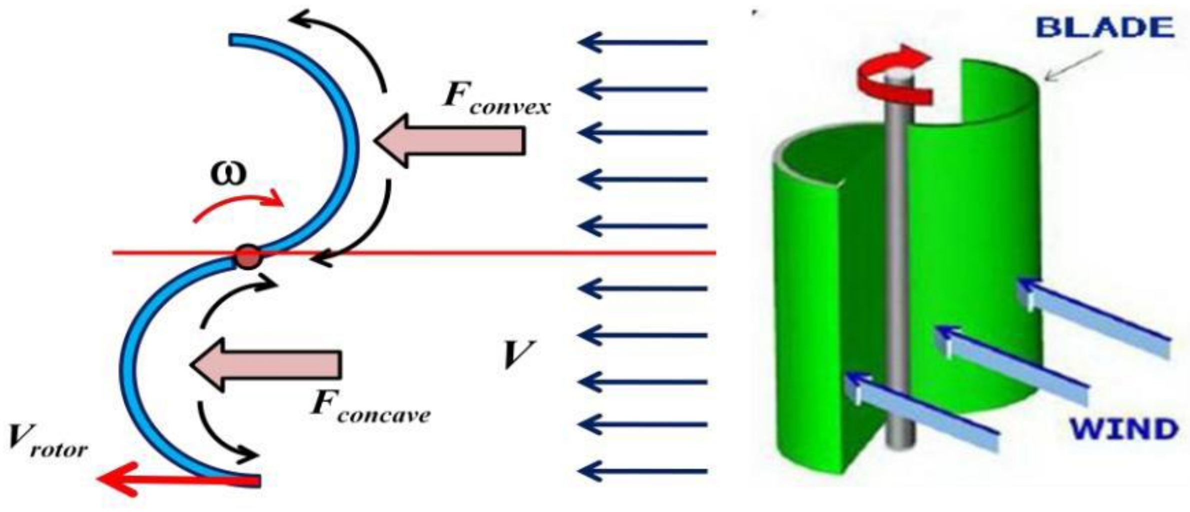

Figure 2 Schematic drawing showing the drag forces exert on two blade Savonius.

Because of the blades curvature, the blades experience less drag force when moving against the wind than the blades when moving with the wind. Hence, the half cylinder with concave side facing the wind will experience more drag force than the other cylinder, thus forcing the rotor to rotate. The differential drag causes the Savonius turbine to spin. For this reason, Savonius turbines extract much less of the wind's power than other similarly sized lift type turbines because much of the power that might be captured has used up pushing the convex half, so savonius wind turbine has a lower efficiency.

1.5 Main Principles of PV Systems

A photovoltaic cell is rarely used in single set or individually, since it is unable to supply sufficient power and voltage of electronic device requirement. Due to this reason, it needs more set of photovoltaic cells be coupled together and to be connected parallel or in series for energy production, in order to achieve the higher power output and voltage as possible.

A typical photovoltaic system is made of 36 individual 100 cm² silicon photovoltaic cells and auxiliary devices which are lead-acid batteries with a typical voltage of 12 V. This system has the capacity of producing more than 13V during cloudy days and can charge a 12 V battery.

In order to utilise the system efficiently, it is required to understand that how does it works during various electrical loads connected in the system. As aforementioned, I-V curve is the most important key for the photovoltaic cell, it is reflecting the performance and characterises a photovoltaic cell.

1.6 Advantages of PV Systems

Photovoltaic modules can easily penetrate in remote areas since the electrical power that produce comes from a reliable, free from pollution and independent source, the sun. Photovoltaic systems can be economically feasible, since it can help in a large extent the viable growth of a region. Moreover they can produce electric current during cloudy days and the current that produced is a direct current (DC). Photovoltaic systems were manufactured in order to function in unfavourable conditions and it has a very small weight. It is possible installed on the ground, on the roofs of buildings or on any other location where sun light beams can reach on the photovoltaic cell surface easily.

The principal advantages of PV systems are:

i. A long life cycle since it can provide power for more than 20-25 years

ii. Zero operation cost, because it does not consume fuel or materials.

iii. Low variability of system efficiency and more reliable results.

iv. Maintenance cost is low.

v. No sound pollution in the period of operation.

vi. Energy conservation.

vii. Keep the environment clean and away from pollution of the CO2 emissions in atmosphere.

II. FUTURE PROSPECTS

The geographical location of India is ideal for tapping solar energy effectively. There is also enormous potential for harnessing electrical power from wind. Efficiency of pv cells can be increased for better harnessing of solar energy wind power being intermittent, interconnected groups of wind turbines over extended areas can be used to ensure a guaranteed minimum power research may be undertaken to reduce the installation cost of the hybrid system substantially. Establishing techniques for accurately predicting their output. Reliably integrating them with other conventional generating sources.

III. CONCLUSIONS

Because of the somewhat complementary nature of the seasonal profile, the combination of wind and solar is better than each individually. It will get higher efficiency than individual systems. Vertical axis wind energy conversion systems are practical and potentially very contributive to the production of clean renewable electricity from the wind even under less than ideal sitting conditions. It is hoped that they may be constructed used high-strength, low- weight materials for deployment in more developed nations and settings or with very low tech local materials and local skills in less developed countries.

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