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Energy Generation Using Hybrid System of Vertical Axis Wind Turbine and Solar Panel

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Abstract—

This paper discuss about the construction of a vertical axis wind turbine that will be combined with a solar panel to create direct current (DC) electricity that will be used to charge a battery. This system will meet the house's basic electrical needs. A variety of designs were examined in terms of wind turbine was selected based on literature. The major goals of this project are to decrease pollution and preserve the environment by reducing the use of fossil fuels, increasing windmill power output, and developing hybrid machines to create more electricity with zero emissions.

Key Words: Blade, renewable energy, generator, inverter circuit, vertical axis wind turbine, wind energy

I. INTRODUCTION

In the pursuit of sustainable and renewable energy sources, the integration of multiple technologies has emerged as a promising solution. One such innovative approach is the hybrid system of vertical axis wind turbines (VAWT) and solar energy generation. Harnessing the power of both wind and sunlight, this hybrid system offers a synergistic and efficient approach to energy production. By combining these two renewable sources, we can achieve a more reliable and consistent energy supply while minimizing the environmental impact.

The vertical axis wind turbine is a unique design that sets it apart from traditional horizontal axis wind turbines. Its vertical orientation allows it to capture wind energy from any direction, making it highly adaptable to various environments. Unlike horizontal turbines, the vertical axis design doesn't require wind alignment, making it an excellent choice for urban and densely populated areas.

Solar energy, on the other hand, is a well-established and rapidly advancing technology that converts sunlight into electricity. Solar panels utilize photovoltaic cells to directly convert solar radiation into usable energy, providing a clean and abundant source of power. With advancements in solar panel efficiency and cost reduction, solar energy has become increasingly accessible and viable for widespread adoption.

By integrating vertical axis wind turbines and solar panels into a hybrid system, we can take advantage of their complementary characteristics. Wind power tends to be more prevalent during certain seasons or times of the day, while solar energy generation is maximized during daylight hours

Fig 1. : 3D model of the Project.

Furthermore, the hybrid system of vertical axis wind turbines and solar energy generation contributes significantly to sustainable development and environmental preservation. By utilizing renewable energy sources, we reduce greenhouse gas emissions, air pollution, and dependence on fossil fuels. This clean energy solution plays a vital role in mitigating climate change and promoting a greener future.

II. Description Of Proposed Model

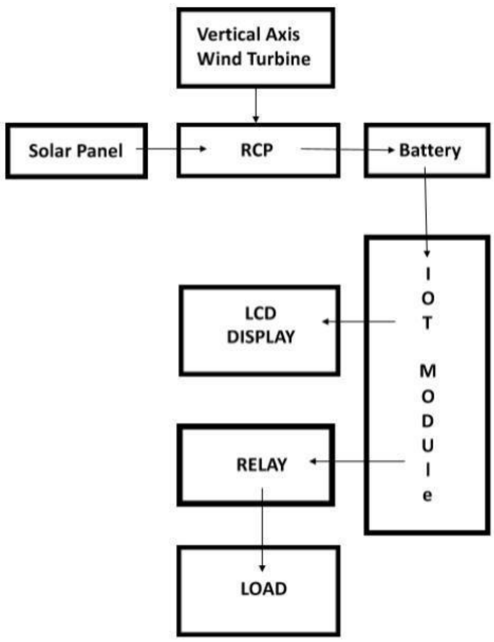


Fig. 2: Block Diagram of the system

Solar Panel:

Photovoltaic solar panels absorb sunlight as a source of energy to generate electricity. A photovoltaic (PV) module is a packaged, connected assembly of typically 6x10 photovoltaic solar cells. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications.

Fig No 3 : Solar Panel

Vertical Axis Wind Turbine:

In this proposed system we are using vertical axis wind turbine. Vertical axis wind turbine have various advantage over the horizontal axis wind turbine. The main advantage of VAWT is that it does not required to be pointed out in the direction of wind. Wind coming from any direction will cut the blades and power is generated. Also it has low cut in speed up to 2-3 m/s.VAWT has also the advantage is that, its gearbox and other assembly can be placed on the ground, also its maintenance is easy as compared to HAWT. Some of the other advantages are as follows,

1. It has ability to operate in wide range of wind conditions.
2. High starting torque.
3. Low noise emission.
4. It is compact in size.
5. Construction is simple and less costly

.

Fig no 4: Vertical Axis Wind Turbine

Battery:

A rechargeable battery, storage battery, secondary cell, or accumulator is a type of electrical battery which can be Charged, discharged into a load, and recharged many times, as opposed to a disposable or primary battery, which Is supplied fully charged and discarded after use.

Fig 5: Battery

Generator:

The generator is a device that converts the rotational kinetic energy captured by the blades into electrical energy. We are using 24 volt DC motor as a generator which is much efficient and is suitable for the project. It can produce current on low rpm.

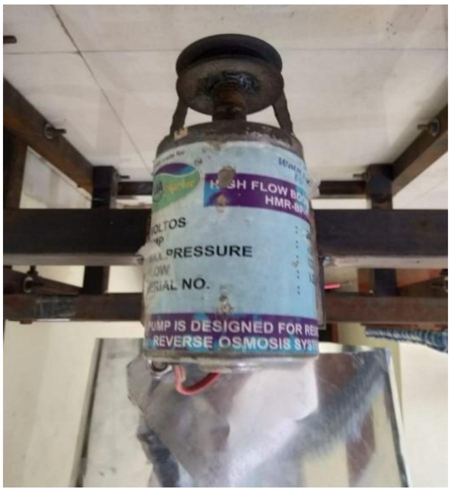


Fig no 6: Generator

Inverter:

Inverter is used to convert the DC power into AC power. Though the system uses inverter some DC load does not required it, such as street lights. So as per the application, both types of load arrangement is needed. Inverter must be high rated and quality so to avoid any breakdown in the system and as per requirement of load

IoT module:

The ESP8266 is a system on a chip (SOC) Wi-Fi microchip for Internet of Things (IoT) applications produced by Espresso Systems.Given its low cost, small size and adaptability with embedded devices, the ESP8266 is now used extensively across IoT devices. The module has a full TCP/IP stack and provides the ability for data processing, Calculations:

Wind Power Generation Unit Calculations:

Kinetic Energy of Wind:

P=1/2*ρ*A*V3

P=Power,

ρ=density,

A= swift area,

V= velocity of wind

P = ½ * 1.125 *0.04575 * 53 = 3.21 kg m2 /s3

Multimeter Reading:

I = 0.2 amps/min

Power (P) = V*I =12*0.2

Power (P) =2.4 W/min

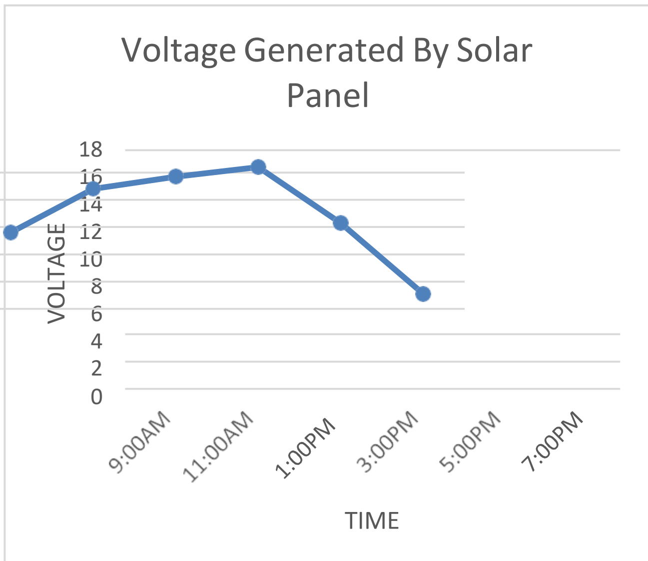
(if Wind Flow is continuous and V = 5 m/s)

Result:

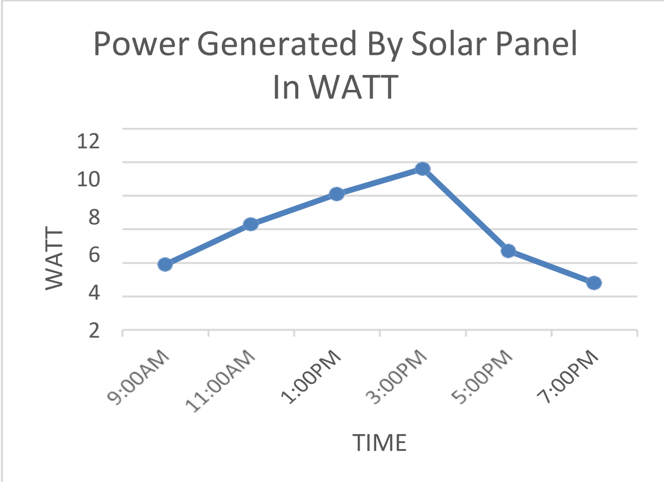
A series of experiments were carried out on the turbine and the generator. The results and experiments have been shown in the tables and through graphs.

Time	Temperature	Sunlight	Voltage	Watt
9:00 AM	28	Moderate	11.6	3.9
11:00 AM	31	High	14.8	6.3
1:00 PM	32	High	15.7	8.1
3:00 PM	33	Peak	16.4	9.6
5:00 PM	30	High	12.3	4.7
7:00 PM	29	Moderate	7.1	2.8

Table 1:Energy Generated By Solar Panel



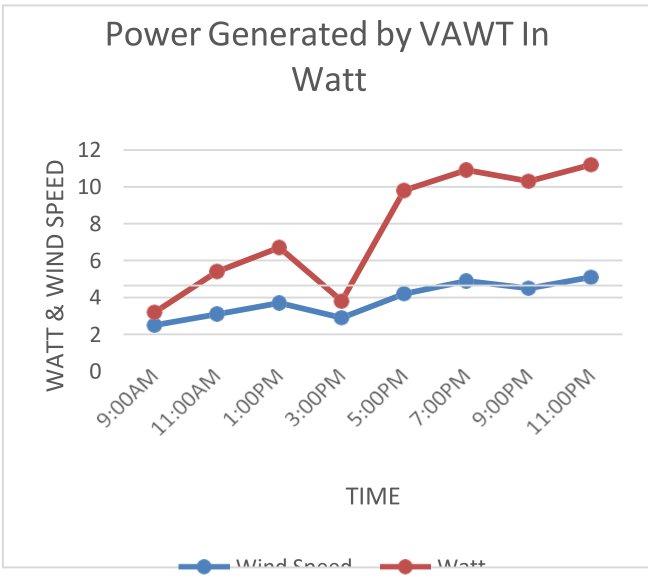
Graph 1: Voltage Generated by The Solar Panel



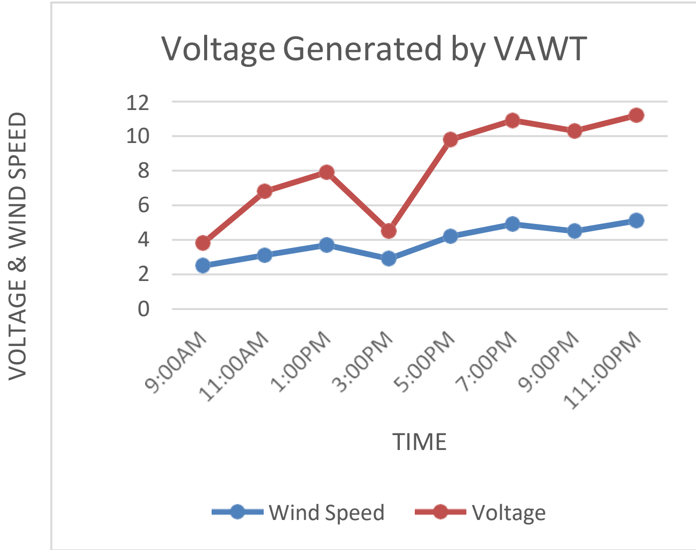
Graph 2: Power Generated By Solar Panel in Watt

Time	Wind Speed	Voltage	Watt
9:00 AM	2.5	3.8	3.2
11:00 AM	3.1	6.8	5.4
1:00 PM	3.7	7.9	6.7
3:00 PM	2.9	4.5	3.8
5:00 PM	4.2	9.8	9.8
7:00 PM	4.9	10.9	10.9
9:00 PM	4.5	10.3	10.3
11:00 PM	5.1	11.2	11.2

Table 2: Energy generated by VAWT



Graph 3: Energy Generated by VAWT in Watt



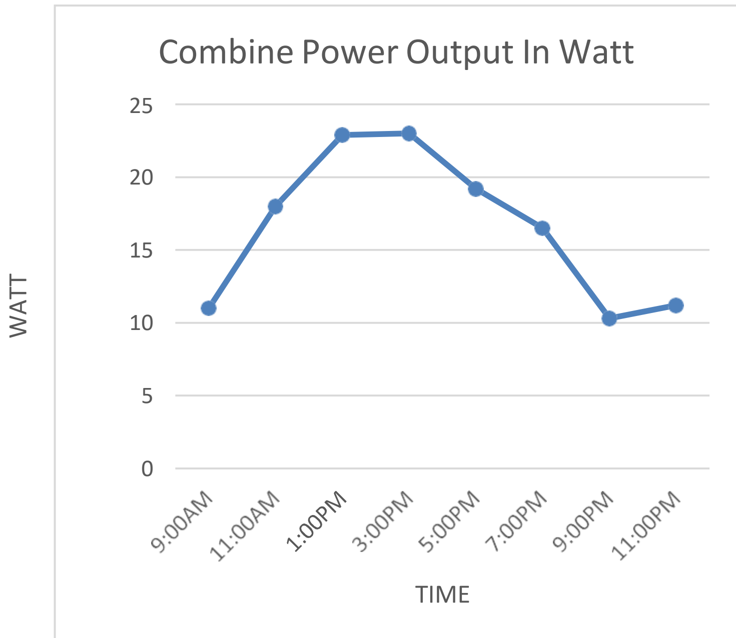
Graph 4: Voltage Generated by VAWT

Literature Review:

Khare,et al,investigated the power generation by vertical axis wind turbine. In this paper the power is generated by fixing the windmill on the road highways. when the vehicle is passed through the road at high speed the turbine of the windmill rotates and generates the power sources. This analysis indicates that the vertical axis wind turbine can be able to attain the air from all the direction and produces the power of 1 kilowatt for a movement of
25 m/s. The efficiency of vertical axis wind turbine can be increases by modifying the size and shape of the blade.[1]

VAWT	Solar	Combined
3.2	3.9	7.1
5.4	6.3	11.7
6.7	8.1	14.8
3.8	9.6	13.4
9.8	4.7	14.5
10.9	2.8	13.7
10.3	-	10.3
11.2	-	11.2
Total		
61.3	35.4	96.7

Table 3: Combined Energy Generated by VAWT and Solar



Graph 5: Combined Power Output In Watt

Alqatawneh,et al,analyzed the design and fabrication of vertical axis economical windmill. This paper indicates that vertical axis windmill is one of the most important types of windmills. In this main rotor shaft is connected to the wind turbine vertically with the generator and gear box which can be placed near the ground. Performance characteristics such as power output versus wind speed or versus angular velocity must be optimized in order to compete with other energy sources which make the process economically and eco-friendly. The experimental result shows that wind turbine is placed on the top of the building in an ideal position to produces electricity. The power generation becomes easy, and it is used for various applications such as streetlight, domestic purpose, agriculture etc.[2]

Matera Mazzeo,et al, analyzed the literature review on design and development of vertical axis wind turbine blade. This paper explains that the windmill 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 windmill is suitable for domestic application at low cost. The generation of electricity is that the blade plays critical role in the performance and energy production of the turbine. The optimized blade parameter and its specification can improve the generation of electricity.[3]

Elkadeem, 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 produce 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. The experimental result indicates that 567 W power produced at the speed of 20 m/s while 709 W power produced at the speed of 25 m/s. From this, the power production will increase when thevelocity is high.[4]

Mazzeo, Matera et al,analyzed the design, development and testing of a savonius and darrieus vertical axis wind turbine. This paper shows that vertical axis windmill is more efficient when compared to 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 existing windmill 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. The function required the starting mechanism which can be provided by the combination of NACA 0030 aerofoil and savonius turbine. The high blade thickness of the NACA 0030 aerofoil will improves the selfstarting capability of the turbine.[5]

Shobole , et al,analyzed a review on combined vertical axis wind turbine. In this paper, the increased efficiency is achieved based on the characteristics such as aspect ratio, tip speed ratio, velocity and other geometry parameter. The experiment is conducted to increase the power production and efficiency of a wind turbine. The development of design is optimized by combining the blade structure and the flow performance. The result indicates that the efficiency of turbine is always based on the wind speed and climatic conditions. The lowest aspect ratio improves the power coefficient of the turbine. The power generation of combined rotor is high compared to the singlesavories and darrieus rotor.[6]

Ricci, Vitali et al, investigated a brief research, study, design and analysis on wind turbine. This paper evaluates the aerodynamic performance of variable speed fixed pitch horizontal axis wind turbine blade using two- and three-dimensional computational fluid dynamics. The primary objective of the paper is to increases the aero dynamic efficiency of a wind turbine. The blades are designed using different type of airfoils which are associated with angle of attack. The blade design is responsible for the efficiency of the wind turbine. The design of the blade is done using Q- blade software. The result indicates that the power output is determined using blade elemental theory. The power output of designed blade design is higher when compared to existing design of the blade.[7]

Georges,et al, analyzed the design and construction of vertical axis wind turbine. This paper indicates that vertical axis wind turbine is more efficient than horizontal axis wind turbine because it requires compact space for producing same amount of electricity and less noise. The result of the paper indicates that the efficiency of wind turbine may reduce due to manufacturing error and frictional losses. It will be rectified by précising the design of the blade more aerodynamically.[8]

Conclusion:

As mentioned in the paper this combination of solar and wind is better than each individually. with safe and free energy to save the planet. Because of the somewhat complementary nature of the seasonal profile, It will get higher efficiency than individual systems. Vertical axis wind energy conversion system are practical and potentially very contributive to the production of clean renewable electricity from the wind even under less than ideal 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. Which can lighten many houses in urbans well as in rural areas for agriculture purpose small factory educational institutions, etc.

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