POWER GENERATION ON HIGHWAY USING HYBRID ENERGY

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Abstract: The next generation of energy sources to fulfill rising electrical demand and replace dwindling fossil fuels are considered to be renewable. Renewable energy sources including solar, biomass, geothermal, hydroelectric, and wind can generate enormous amounts of power, measured in megawatts. The least expensive renewable energy source is wind. Utilizing this rapidly expanding wind energy resource is necessary. Solar energy and vertical axis wind turbines can be used to create electricity. The goal of this project is to use wind and solar energy as efficiently as possible to generate the highest amount of electricity possible, so we choose a highway as the location for our installation in order to benefit from the moving automobiles on both sides of the highway. The turbine in this work has been designed and constructed. Solar power is accessible during the day time. The solar irradiation level varies during the day as a result of the sun's intensity and the unpredictably long shadows cast by clouds, birds, trees, etc. In order to produce energy, the vertical axis wind turbine (VAWT) shaft gear is connected to the generator via the gear mechanism. The battery stores both energy produced by solar panel and the vertical axis wind turbine electrical output. The stored hybrid energy can be used efficiently for household, street lighting, and other highway applications, domestic purposes.

Keywords: Hybrid energy, Solar panel, Vertical axis wind turbine, Highway, Voltage sensor, Battery, Fabrication.

1. INTRODUCTION

Unevenness in the planet's atmosphere, surface imperfections, and rotation of wind flow are all elements that contribute to wind generation. These factors include the rate at which the world rotates and regional temperature variations. Wind energy is the term for the energy this blowing wind produces.

One of the key goals of the nation is to produce electricity because it is essential for the development of the nation. Thermal power plants, which rely on expensive fossil fuels like coal and diesel to produce energy, are responsible for producing about 68 percent of the world's electricity. These fuels also contribute to pollution, the greenhouse effect, and global warming. Therefore, the amount of power produced from unconventional resources like wind and solar is growing daily, and this kind of power production is particularly clean and secure. The process of turning sunlight into electricity is known as solar power. Using concentrated solar power, photovoltaic (PV) directly, or using a combination of both PV cells, the photovoltaic effect is used to convert light into electrical current. The wind turbine is Basically of 2 types Horizontal axis wind turbine, Vertical axis wind turbine.

In successfully generating electricity from the wind, HAWT has advanced. However, because to VAWT added benefit over HAWT, development on it has also recently begun. For instance, it doesn't need a mechanism since it costs less to operate than a HAWT and can produce electricity regardless of the direction of the wind. A hybrid energy system that uses both renewable solar and wind energy is preferable to one that solely uses one type of energy. A hybrid system's power source is also more dependable and stable. We have

adopted hybrid systems for power generation since they offer various advantageous features, which includes: providing for load demand across a range of weather scenarios, There may be significant cost reductions for self-powered systems overall, superior dependability without a backup power supply.

The Eco- Greenery hybrid wind- solar generation system is presented in light of these benefits of a hybrid system and to further enhance the performance of small wind turbines.

The roadway was chosen as the installation site because maximizing the utilisation of wind energy is the project's main objective. The wind turbine will be positioned inside a divider to take use of the tangential airflow produced by moving vehicles on each side of the road, aiding in the turbine's rotation. The blade angles are changed to achieve the highest output, the blades are fixed, and the solar panel is positioned above the VAWT. The solar panel receives heat energy from the sun, converts it to electrical energy, and stores it in the battery.

2. OBJECTIVES

Our project main goal is to make the most of the wind energy generated by moving vehicles on highways. The substantial volume of compressed air that is not being used powers the vertical axis wind turbine, which transforms the kinetic energy of the turbine into electrical energy. This project major goal is to lessen the pollution that comes from burning fossil fuels and producing electric energy by using renewable energy. In order to power future toll gates, street lights, and other residential uses, the energy generated by solar panels and vertical axis wind turbines is stored in a battery.

3. SYSTEM COMPONENTS

3.1. Design of blades

Figure 1 Blades

In our project design the blade is shaped semi-circularly to allow for first-blade succession when one blade passes another. To make the use of wind produced from the automobiles running on the highway , 8 blades are used. As the number of blades increases the rotation of speed increases.

$$A = d \times h \quad (1)$$

Where,
d - diameter of the rotor in m
h - height of the blades in m
Hence,
Area = (0.1×0.64)
= 0.064 m^2

This because there isn't enough room to install larger rotor diameters on highways, this height and diameter was chosen. Wind turbine blades feature a changeable pitch and a cross section like an aerofoil. Eight blades with vertical shafts, measuring 64 cm in height and 18 cm in width, are employed in the project. A 60 degree angle is formed by two blades. The blade is made from PVC pipe. Given its low cost and the light weight of the pipes, this material was chosen.which reduces the project's overall weight and boosts output as well as rotational speed. Each blade weighs 0.564kg/g, hence the weight of 8 blades is 4.512 kg/gas a whole.

3.2. Design of Shaft

Figure 2 Shaft

The shaft should be correctly fitted to the blade when it is being designed. The shaft is 67 cm tall to allow for simple installation between the wheels.

3.3. Design of Pulley

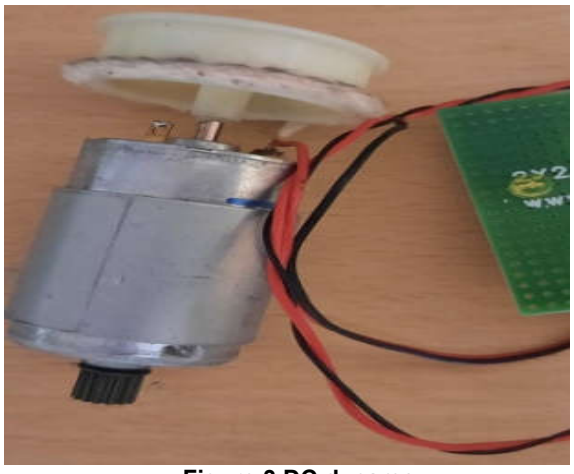

Figure 3 DC dynamo

An electrical generator called a DC dynamo uses electromagnetism to generate direct current electricity. Dynamos, the earliest electrical generators capable of delivering power for industry, served as the foundation for succeeding electric power conversion technologies such as the rotary converter, electric motor, alternating-current alternator, and others.

3.4. Solar panel

Figure 4 Solar panel

Green energy that is readily accessible during the day is solar energy. PV cells can be used to generate power. It is a massive, endless source of energy. When sunlight strikes a solar panel, photovoltaic materials inside of it start to produce electricity. The amount of electrical energy produced will depend on the sun's position and light intensity.

3.5. Solar Charge Controller

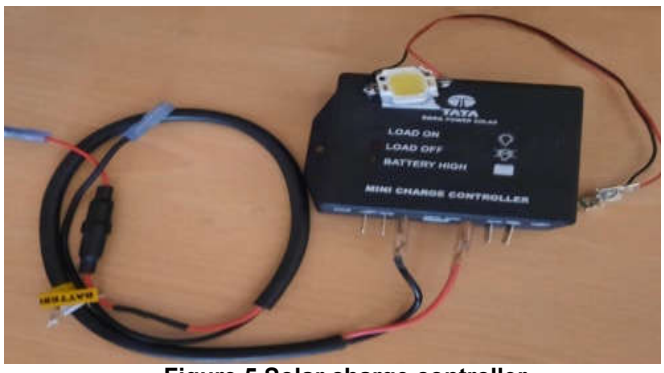

Figure 5 Solar charge controller

In order to prevent overcharging of the batteries, the charge controller controls the amperage and voltage given to the loads and directs any excess power to the battery system. Battery power is utilised to run the load at night when there is no sunlight. The most fundamental charge controller essentially manages the device voltage and, whenthe battery voltage increases to a predetermined level, opens the circuit, stopping the charging. More charge controllers stopped or started power going to the electric storage devices by using a mechanical relay to open or close the circuit.

3.6. Battery

Figure 6 Battery

A maintenance-free battery, a gel cell, a sealed lead-acid (SLA), a valve-regulated lead-acid battery, etc. VRLA products of the Gel and Absorbent Glass Mat kinds can be positioned in any orientation because, to their architecture, don't require regular upkeep. They frequently work with large electrical apparatus, off-grid power systems, and related fields

because they are more affordable than other low-maintenance technologies like lithium-ion and can accommodate massive volumes of storage.

3.7. LCD Display

Figure 7 Display

Display is used to observe the voltage produced by the project model and it is displayed.

4. EXPERIMENTAL SETUP

The component connections are depicted in the block diagram. Any form of moving vehicle, including little and heavy trucks, is possible on a roadway. Every time a car moves on either side of the highway barrier. Then, pressurized air is produced due to the speed of the vehicle.

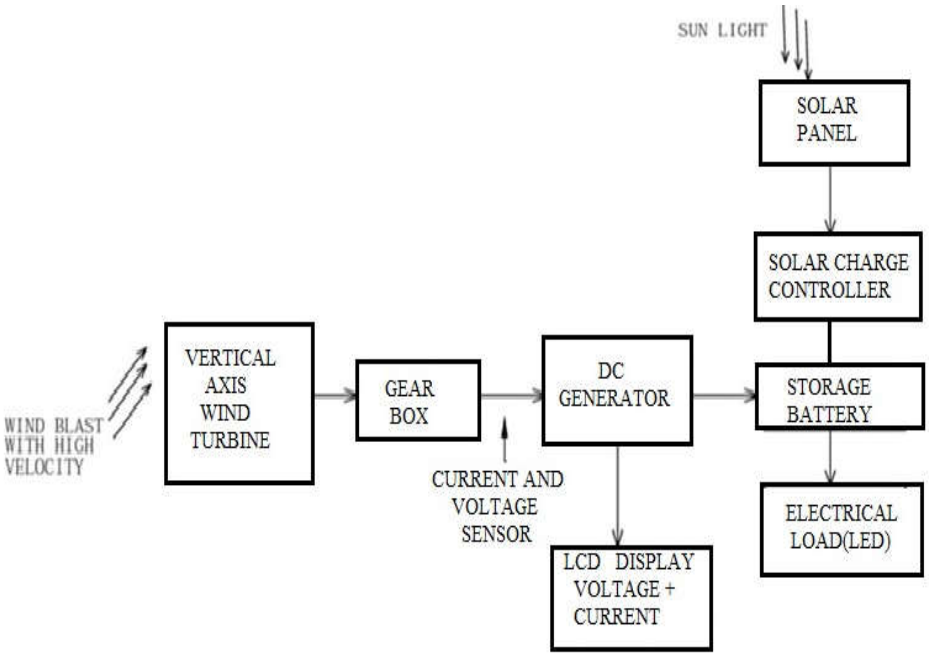

Figure 8 Block Diagram

The compressed air impacting the blade causes the vertical axis wind turbine to revolve. A gear mechanism is used to connect the vertical axis wind turbines shaft to the generator. The output of the generator is stored in the battery. Alternately, the vertical axis wind turbines top is also covered by a solar panel. A device that directly converts the energy of light into electricity is a solar cell or photovoltaic cell. The output of the generator is stored in the battery by the physical and chemical process known as the photovoltaic effect. Through a solar charge controller, the energy generated by the solar panel is also stored in the battery. Future domestic uses for the stored energy include operating toll booths, lighting streets, charging electric automobiles, and other such activities. The proposed model is shown in *Figure 9.*

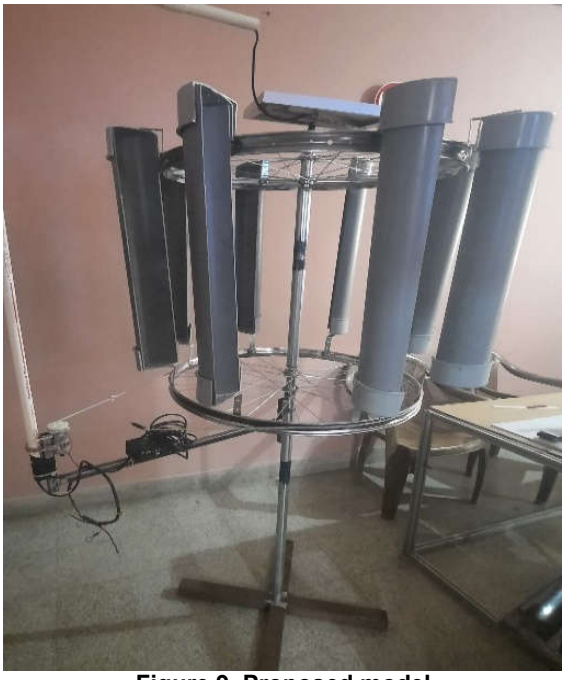

Figure 9 Proposed model

5. THEORITICAL ANALYSIS

The wind mill operates under the theory of transforming wind kinetic energy into mechanical energy. Kinetic energy is determined by multiplying its mass by the square of its velocity(½ mv^2).

$$KE = ½\ mv^2 \quad (2)$$

KE - Kinetic energy
m - mass
v - velocity
Mass is equal to Volume multiplied by its density ρ of air,

$$Mass = \rho\ AV \quad (3)$$

Substituting equation (3) in equation (2)
We get,

$$K\ E = ½\ \rho A V^3 \quad (4)$$

ρ = (1.225 kg/m^3) density of air
V= wind velocity(m/s)

Let us take equation(1)
$A = dh(m^2)$
Where,
d = diameter of the blade
A = 0.1×0.64
A = 0.064m^2

Wind power obtaining:
Pa = (½ ρ π D^2 V^3)/4
P = 1/8 ρ π D^2 V^3

$$P=(½\ \rho\ A\ V^3) \quad (5)$$

From equation (5) power generated for different velocity of the wind can be calculated,
Case -1

For velocity-2m/s
Pa = (½ ρ A V3)
Pa = (½×1.225×0.064×8)
Pa = 0.3136 watt
Case -2
for velocity-3m/s
Pa = (½ ρ A V3)
Pa = (½×1.225×0.064×27)
Pa = 1.0584 watt

Solar panel specification
Solar panel of 12 V, 5W
Current of 0.4167A
Size is 9.75× 9.33 × 1.31

From solar panel :
Daily watt hour = Solar panel (W) × Avg hour of the sunlight × 22% (6)
= 5W × 5hrs × 0.22
= 5.5 daily Watt hour

6. RESULT

As it a prototype model for testing purposes, we created air at the needed speed using external fans and monitored the turbine speed using a model that was primarily created for highway applications. The following table displays the outcome of the turbine's measurements of the voltage produced with relation to variations in wind speed.

Table 1. Obtained output

Speed of turbine (RPM)	Output voltage (mV)
235	2.7
342	2.9
453	3.2

In a typical day, a wind turbine operates for 4 to 5 hours at its maximum output (full rated output) . Switching to a solar or wind turbine depending on the amount of energy produced. Therefore, compared to a stand-alone system, the charging time required to charge the battery is less.

7. CONCLUSION

This system is favorable to the environment. The project model for our project is a efficient alternative for power generation on highway sides is a combined energy source with solar and vertical axis wind turbines. In essence, this system combines two energy sources, and if one of them is unable to produce electricity, another source will continue to do so and continue to supply the load with electricity. As a result, non-conventional energy sources like solar and wind energy are used for the generation of electricity.

8. FUTURE SCOPE

1. Since, the cost of this system is thought to be lower than the use of both separate technologies, using a hybrid power generating system that combines PV and wind energy can be the answer in many situations.

2. Utilizing a hybrid VAWT and PV system offshore to generate power has benefits.

3. The solar system can be positioned so that it directs the air from the car toward the turbine in a highway application.

4. Enhancing the blade's design for improved aerodynamics

5. Utilising a top alternator that generates higher electricity at low RPM

6. Increasing alternator input rpm through the use of the right gear mechanism will result in high power output.

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