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Use of Solar Panel as Wind Turbine Blades Energy Hybridization

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Abstract: The goal of this project is to model, analyse, and simulate a small-scale wind/PV hybrid power generating system. Many characteristics, such as pitch angle, rotor diameter, wind speed, and others, are considered while modelling a wind turbine. The PV module is then modelled under realistic variables like cell temperature and solar radiation. The mathematical model for a small scale horizontal axis wind turbine and PV system is solved using a MATLAB computer tool. A small-scale wind turbine with a 500 W permanent magnet synchronous generator was used for the experiment. A PV panel with 36 monocrystalline silicon cells linked in series and rated at 50 W was employed. The load uses energy, according to the results. A PV panel of 36 mono crystalline silicon cells linked in series and capable of generating 50 W of rated power was employed. The load absorbs power from both systems, but in various operational situations, such as variations in solar radiation and wind speed, there is an excess and a deficit of power supply.

Keywords: Battery, wire, solar plate, Bearing, Inverter

I. INTRODUCTION

In the year 1767 a Swiss scientist named Horace-Benedict de Saussure created the first solar collector – an insulated box covered with three layers of glass to absorb heat energy. Saussure's box became widely known as the first solar oven, reaching temperatures of 230 degrees Fahrenheit. In 1839 a major milestone in the evolution of solar energy happened with the defining of the photovoltaic effect. A French scientist by the name Edmond Becquerel discovered this using two electrodes placed in an electrolyte. After exposing it to the light, electricity increased.

In 1873, Willoughby Smith discovered photoconductivity of a material known as selenium. The discovery was to be further extended in 1876 when the same man discovered that selenium produces solar energy. Attempts were made to construct sola1r cells using selenium. The cell did not work out well but an important lesson was learned – that solid could convert light into electricity without heat or moving parts. The discovery laid a strong base for future developments in the history of solar power. During this time several inventions were made that contributed to the evolution of solar energy use. First in 1893 the first solar cell was introduced. The cell was to be wrapped with selenium wafers. Later in 1887 there was the discovery of the ultraviolet ray capacity to cause a spark jump between two electrodes. This was done by Heinrich Hertz. Later, in 1891 the first solar heater was created.

In 1908 William J. Baileys invented a copper collector which was constructed using copper coils and boxes. The copper collector was an improvement of the earlier done collector but the only difference was the use of copper insulation. The improvements of the invention are being used to manufacture today's equipments. With Albert Einstein publishing a paper on photoelectric effect in 1905 still there was no experimental evidence about it. In 1916 a scientist known as Robert Millikan evidenced the photoelectric effect experimentally.

It is an essential source of renewable energy, and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power, and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light-dispersing properties, and designing spaces that naturally circulate air.

Historically, wind power has been used in sails windmills and wind pumps. Wind power is a popular, sustainable, renewable energy source that has a much smaller impact on the environment than burning fossil fuels. Wind farms consist of many individual wind turbines, which are connected to the electric power transmission network.

Biogas can be compressed after removal of carbon dioxide and hydrogen sulphide the same way as natural gas is compressed to CNG, and used to power motor vehicles. In the United Kingdom, for example, biogas is estimated to have the potential to replace around 17% of vehicle fuel It qualifies for renewable energy subsidies in some parts of the world. Biogas can be cleaned and upgraded to natural gas standards, when it becomes bio-methane. Biogas is considered to be

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a renewable resource because its production-and-use cycle is continuous, and it generates no net carbon dioxide. As the organic material grows, it is converted and used.

II. LITERATURE REVIEW

Vertical axis wind turbine with the addition of solar power and Adriano data collection system is going to play very major part in energy savings. As we can use wind energy to glow the street light. The turbine is on the same pole of street light it will save the cost and space, simultaneously the cost cutting is also happen. Following are the overview of some related work done by respected people on the same subject.

N.Vanuatu Subbaiah Kumar et al [1] 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.

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. Inverter converts direct current into Alternating current and this is used to drive the home appliances.

A careful selection has to be made for the blade profile so that the losses will be minimum and the power generation can be enhanced. Since the wind energy is not constant at all the time so the operation of the wind machine will be intermittent and the power production rate will also vary; the component should be design in such a manner so that the losses should be at minimum. This work describes the behavior of a vertical axis Savories Wind Turbine (SWT)

Four-way lane highways during South-West and North-East monsoons. A vertical axis SWT was designed and fabricated using low-cost materials. Starting behavior of the SWT was studied by measuring and calculating the starting torque coefficient. The proposed SWT's cut-in speed was achieved at a velocity of 3.5 m/s.

Experiments were carried out on a four-way lane highway through the placement of turbine at two different positions (middle and sides of the highway). Also, the experiments were repeated during different monsoons to understand the behavior under different wind directions. Error analysis was performed on the data obtained by considering possible measurement errors and instrument accuracies. The obtained experimental data clearly illustrates that the SWT's nominal rotational speed varies at different monsoons, when located at the sides of the road. From the data analysis, it can be understood that the wind directions play a key role for harnessing maximum amount of energy in highway wind-energy generation. Maximum augmented rotational speed of around 64% was achieved by placing the SWT at the median of Four-way lane highways in different monsoon.

Palash Jain et al [8] reported the performance prediction and basic principles of small amplitude VAWT for sharp edge pitching during variable amplitude are discussed. Various structural problems were analyzed, and the final report was that the maximum energy generated by the turbine was due to the wide spectrum of wind speed and the amplitude of blade pitch varied with wind speed and blade tip speed ratio.

III. METHODOLOGY

This project works on principle of wind energy. Wind produced by rapidly moving vehicles on highways hits the curved blades of the vertical axis wind turbine, causing them to turn the generator to generate electricity. Battery under the turbine stores the energy, which can be use later applications such as street light, signaling, toll post etc.
Firstly we have to measure an average wind produced by vehicle flow. For that we use anemometer. According to the average air flow of wind we have to design a VAWT to make it rotate. After Design and analysis of different shapes of rotor blades choose most efficient. While Selection of material for blade, the material should be light weight and should have good mould ability for exp. Aluminum sheets or Plastic sheets. While Fabrication maintaining the correct curvature shape to blade is main challenge to take care of i t. Assemble the rotor shaft and generator and same shaft with some transmission system if required. The blades will convert the KE of Wind into Mechanical work which will drive the generator and converted into the Electric energy which can be stored in Battery. A Battery rectifier circuit is required for charging the battery. The form of electricity generating is DC. WE can use a DC to AC convertor to use it to AC application also.

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Grid connected photovoltaic power system is an electricity generating system which is linked to the utility gird (energy.gov, n.d.). This photovoltaic system contains solar panel, inverter and the equipment to provide connection to the grid. Grid connected systems are feasible for various setup such as residential. Commercial and larger scale grid tied system different than the off grid solar power systems. Usually grid connected system does not need battery backup, because when system generate the energy more than the load it will automatically transfer to the linked utility grid.

Flowchart:

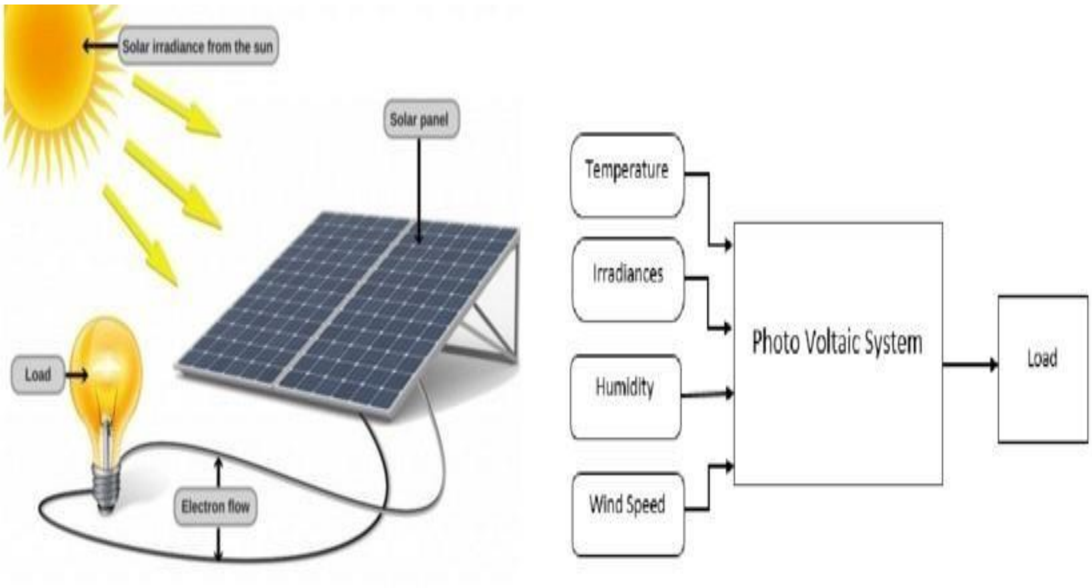

Fig.1 Flowchart

Fig. Installation of Solar Panel.

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Loading Conditions and Analysis:

Loading Conditions: 3.2.1 Static: The following major loads act on the chassis: 1) Kerb Weight : 250 Kg 2) Engine Weight : 22.4 Kg 3) Gear Box Weight : 14.9 Kg 4) Driver's Weight : 100 Kg Three load cases have been considered here [Table 1]. Kerb weight, engine, gearbox and the driver weight remain constant while passenger load and the ground reaction vary for the respective cases. 3.2.2 Dynamic: For dynamic analysis, the model is simulated when the vehicle is moving at 40 kmph over a speed-breaker. In practice, the vehicle is subjected to various other forms of excitations. Loads are simulated in the form of displacement excitations at the locations of the " three wheels. In the present modeling, two types of excitation patterns are studied: "1-cos ". Dimensions of a typical speed breaker is taken as: Height: 150 mm, Length: 1000 and "sin mm. At 40 kmph, the vehicle takes approximately 0.09 sec to pass over the speedbreaker. The excitations are applied at the Connection DOF in the vertical direction. Three load-cases are simulated for dynamic analysis

Boundary Conditions: 3.3.1 Static: The individual assemblies are attached to each other by relevant displacement constraints, which specify interconnection with the adjacent assembly. Following displacement constraints are used in the present modeling: 1. Revolute joint at the front eye of the leaf spring. 2. Revolute joint at the rear end of the frame where the rotating link is attached. 3. Constraints at the bearing locations where the steering column and the frame are joined. All rotations are kept free and all the displacements restrained. 3.3.2 Dynamic: The constraints used in static analysis are not suitable for dynamic analysis.

Dynamic analysis is carried out using "Modal Analysis Technique". Mode shapes and natural frequencies are determined and used for the Response Evaluation under various excitations. For the frame excitations, Connection degrees of freedom (DOF) are specified at the nodes where the axle is attached to the frame. The DOF specified are: 1. One vertical DOF for the ground reaction at the wheels. 2. Two inplane DOF for the frictional reaction force between the wheels and the ground. 3.4

Analysis: Pre-processing includes the entire process of developing the geometry of a finite element model, entering physical and material properties, describing the boundary conditions and loads. This is carried out in SDRC - IDEAS software Version

MS 8. The solution phase is followed by Post-processing using the software's module, which involves plotting deflections and stresses, comparing the results with governing design failure criteria such as maximum deflection allowed and the material strength.

3.4.1 Static: The present analysis has been carried out

IV. IMPLEMENTATION

Test data:

Wind is caused due to uneven heating of earth's surface, atmosphere, irregularities of earth's surface and rotation of the earth about its own axis. The amount of wind flow depends on various factors such as earth's rotation speed and difference in temperature of places. Energy produced by this Flowing wind is called as Wind Energy. Electricity plays and important role for development of the country, so the production of electricity is one of the main aims of the country. About 68% of the production of electric energy is based on thermal power plant, where fossil fuels, coals, diesel are used for power generation and which is very less available and this fuels also creates pollution, greenhouse effect and global warming.

Therefore power generation with the help of non-conventional resource such as wind is increasing day by day and this type of power generation is very clean and safe. The wind turbines are basically of two types 1) Horizontal axis wind turbine (HAWT). 2) Vertical axis wind turbine (VAWT). HAWT has successfully evolved in making of electricity from wind. However, recently working on VAWT has also been started due to its additional advantage over HAWT such as it does not require yaw mechanism because it can produce power independent of wind direction. VAWT can be produced at low cost and compact then HAWT and also affordable maintenance cost.

Calculations:

Calculation of the PV Solar Panel Output of the System

E = A * r * H * PR

Equation B1

Area(A) = 1.6368 m^3

Solar Panel Yield(r) = 0.15

Annual Average Irradiation of Panel (H) = 296.38 kWh/m^2*yr

Performance Ratio (PR) = 0.75 From Equation B1,

E = 55 kWh/year

E(total) = E * n

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Equation B2
Energy (E) = 55 kWh/year
Number of PV Solar Panels (n) = 8 From Equation B2,
E (total) = 440 kWh/year

Advantages:

- They can catch wind from any direction.
- They are produced less noise.
- They start sat low wind velocity.
- Towers can be much lower.
- Low installation costs.
- They are Bird and bat friendly.
- It is a renewable Energy Source

Disadvantages:

- Large effective area required.
- Can't use in very height.
- It is used in wind season only. (Common disadvantage of wind turbines)

CAD DESIGN:

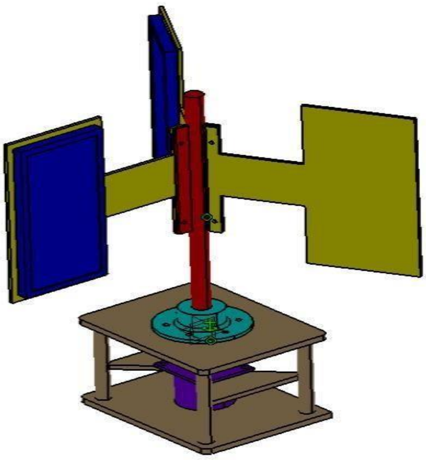

Fig.3D Model Catia

The purpose of this thesis was to design a 3D model for the portable hybrid power system which combines four solar panels with one wind turbine. The hybrid model will be more beneficial in all kinds of seasons. It is easy to transport from one place to another with the help of a trailer. The portable system is useful for outdoor activities and emergencies like floods, earthquakes, and landslides and where electricity is not easily accessible. Once installed, it does not need to be looked after, however, the solar panels need to be cleaned occasionally if used in a dusty place.

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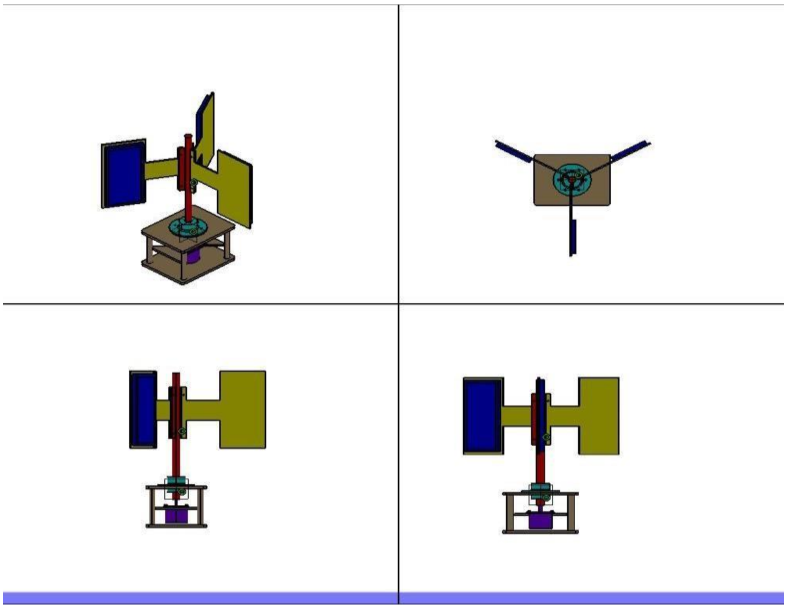
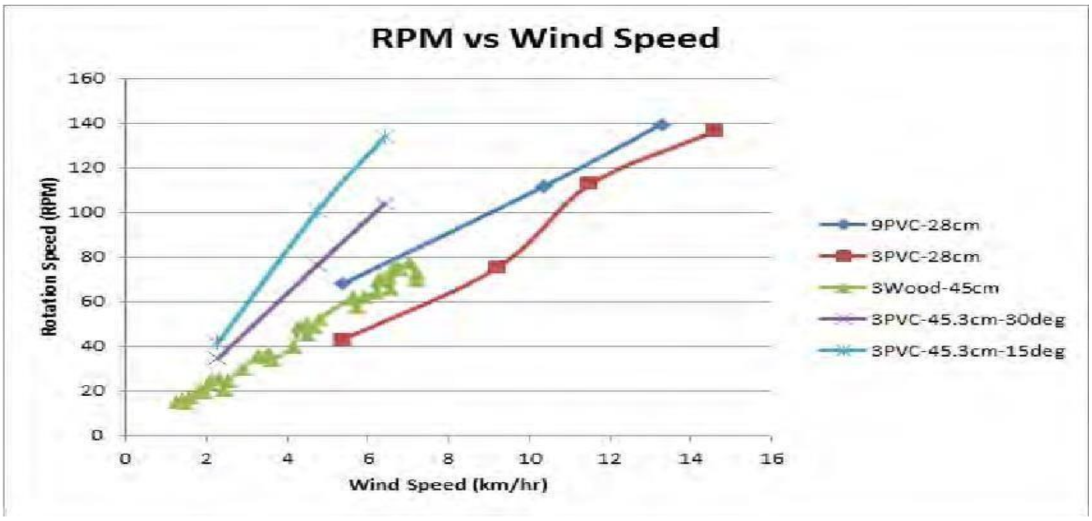


The hybrid system can generate electric energy during the whole day when compared with single wind and solar energy system. To support the idea of taking advantage of the weaknesses of each system, the hybrid system is connected in a parallel circuit controlled by two switches. Hourly variations of the electricity generation by wind turbine, by panels and by the hybrid system consisting of a combination of the two systems. As it can be seen, the wind turbine produces more electricity during the night compared to the daytime hours. Similarly, the PV panels generates energy only during daytime hours and reaches its maximum value at noon hours. Wind power can be integrated with solar power successfully resulting in the better continuity of electricity generation.



V. RESULTS

The experiment was performed to prove the concept of the hybrid solar panel. It showed expected results, but modifications of components could reduce the uncertainties that occurred in the experiment. In summary, based on the data gathered from the experiment, it is feasible to make a hybrid solar wind turbine as source of electrical power.

VI. FUTURE SCOPE

Based on the facts stated from the previous sections, the Hybrid Solar Wind Turbine is a really good investment for a renewable energy source. Further research could be done to improve the overall design of the system. This includes increasing the size of the model for more energy production. Another improvement could be researching for another

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possible location of installation, like highways or expressways, wherein the slipstream produced by the passing vehicles can rotate the turbine enough to produce mechanical energy that will be converted into electricity. Some modifications can be implemented to improve the actual system efficiency for a much better price to performance ratio.

VII. CONCLUSIONS

The combination of photovoltaic solar panels and wind turbine can be possible based on the study conducted. For a single household, it might be a risky investment because of the total cost of the actual system but, in the long run, that investment will be worth it because it is a clean and renewable source of energy.

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