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Hybrid Tree Using Maglev Vertical Axis Wind Turbine

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Abstract – This Report presents the fabrication of hybrid solar wind turbine system for the power generation system by utilizing both solar and wind renewable energy. The hybrid tree can be used where, the domestic household in the remote area which is unable to connect to the grid and its use can be extended to city streets lights. The study was started by investigating the availability of both solar and wind energy in Haveri district Karnataka state. The basic requirement of electric primary load is determined in 1.2 kW per day for single household which is included the essential load demand such as lighting, fan and household appliance. The optimization analysis is conducted for generating most feasible system configuration and determines the quantity of components in the hybrid energy system, in order to meet the load demand of household and achieve the autonomy power supply with storing excess power generated in batteries storage for the sustainable energy storage.

Key Words: Renewable energy sources, Wind, solar,

1. INTRODUCTION

In the initial stage of power energy system development, the electricity is supplied to the users in a type of bulk electric transmission system. Due to the technology of power system is improved, the traditional type of power system operating pattern seems to occur some weak points in the field of flexibleness and securities. Besides that, fossil fuel price is fluctuating due to the global economic and limited resource, it found that producing electricity with conventional fossil fuel will lead to the environment pollution. In order to overcome all these issues, the hybrid solar wind turbine system based on renewable energy such as solar and wind is taken into account as the alternative method to produce and supply electricity power energy to the users. A hybrid energy system is defined as the component combination of two or more types of power generation system. For this research, solar energy system is integrated with wind turbine system to form a hybrid renewable energy system i.e. Hybrid tree. Since the power output of these renewable energy is ultimately depends on climatic conditions such as temperature, solar irradiance, wind speed and etc., the instability of the system output is compensated by adding a suitable energy storage system to the hybrid energy system. The power autonomy is greatly relied on the perfect balance exist between power demand and generated power. The benefits of utilizing renewable energy sources such as hybrid solar wind turbine systems are increased the reliability of the hybrid energy system because it is based on more than one electricity generation source. Besides that, it is a free from the pollution and environmental friendly system, since it does not use any fossil fuel to drive the generator. The solar energy also becomes one of the most promising alternatives for conventional energy sources and has been increasingly used to generate electric power from sunshine. Moreover, the hybrid solar wind energy system is suitable to use in remote areas with inaccessible to utility grid. However, there is also disadvantage of using hybrid systems such as in most cases the system is over- sized because it contains different types of power generation system.

1.1 Objectives

i. To Fabricate a hybrid solar vertical wind turbine model.

ii. To Optimize the design of renewable energy component in hybrid energy system configuration.

iii. To Performance analysis of hybrid system in accordance with weather record by hourly based data collected from internet.

iv. To examine a hybrid solar vertical wind turbine system that capable to secure at least 24-hour autonomy power supply for household in remote area and sufficient batteries as support of sustainable energy storage.

v. To compare the power output of the hybrid system with the required electric load demand of domestic household.

1.2 Literature Review

- Global warming and energy policies have become a hot topic on the international agenda in the last years. Developed countries are trying to reduce their greenhouse gas emissions. For example, the European union has committed to reduce their greenhouse gas to at least 20% below 1990 levels and to produce no less than 20% of its energy consumption from renewable sources by 2020.

- Most of the PV power generation comes from grid-connected installations, where the power is fed in the electricity network. In fact, it is a growing business in developed countries such as Germany which is world leader in PV power generation followed by Spain, Japan, USA and Italy.

- Lehman [2] compiled the data of modern horizontal-axis wind turbine. The first megawatt-class wind turbine was synchronized in 1941 to a utility grid in Vermont.

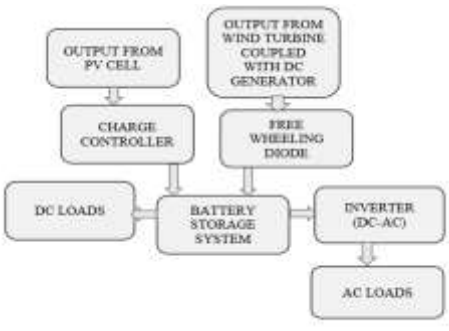
- John Brown and Company operated the first utility grid-connected wind turbine in 1954 in the Orkney Islands.

- Vertical Axis Wind Turbines have the capability of operating in turbulent wind because of which they can be installed at lower heights. As the gear bomechanism is located at ground level, their maintenance is not cumbersome. No pitch and yaw mechanism is required for vertical axis wind turbine. Due to these advantages of VAWT, makes it best suited for generating power for domestic Purpose. In 1927 the first aerodynamic vertical axis wind turbine was developed By Darrius in France. The turbine was based on the principle that its blade Speed was multiple of wind speed.

2. MATERIALS AND METHODOLOGY

The fabrication of the hybrid tree is achieved with the use of maglev VAWT and PV panels. For designing the VAWT we may use light weight material for Example. PVC pipes, MS sheet etc. the turbine designed by the use of such materials is most likely able to rotate the dc/ac generator coupled to the central shaft of the turbine. Here we used dc generator to generate the electricity. We can also use doubly but their use is limited for low speed wind power applications. The main advantage of using permanent magnet dc/ac generator is that, even for a small rotation of the turbine permanent magnet (neo-dynamic magnets) can able to produce more output voltage. Due to rotation and weight of the turbine, the bearing may suffer from frictional force. To avoid this phenomenon, we are placing two magnets in between bearing and underneath of the turbine and we call this mechanism as maglev technology. So Maglev VAWT is liable to generate electrical energy with the help of kinetic energy available by low velocity wind and which is usually in the range of 5-6 m/Hr. And the Solar Energy is harnessed by fixing the Solar PV panels on the tree branch structure of the pole. By using Suitable charge controller, the energy output from PV and VAWT is stored in Batteries

2.1 Block Diagram



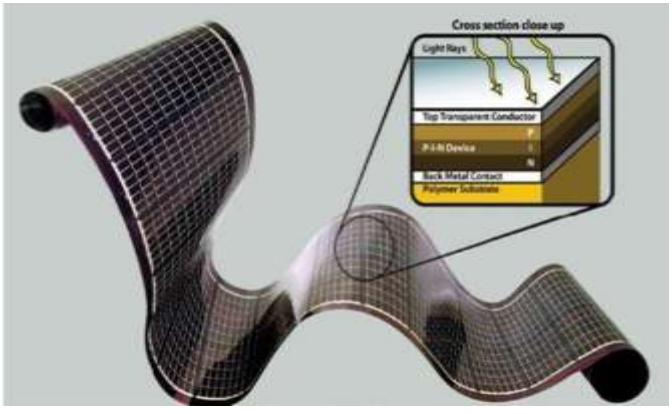
Block diagram of Hybrid tree using Maglev Vertical axis wind turbine

The above figure depicts the block diagram of Energy harvesting scheme using Hybrid tree. The solar energy available in day time is effectively collected by using the Solar PV cells. And as we know that solar irradiation not always constant due to variation in temperature and rotation of earth. So, due to this reason the energy output from PV cell is varying nature. To get a constant output a special device is used, that we call it as Charge controller. Nowadays, various types of charge controllers are developed to harvest maximum sun energy. The output of the charge controller is given storage battery.

Similarly, the Power output from the DC generator coupled with VAWT is given to storage battery or we can use solar/wind charge controller to combine the output of solar and wind. Here in this case we used charge controller for solar and dc generator output is directly given to battery. The electrical energy stored in battery may directly use to feed dc load. In case of ac load, it is necessary to use the inverter to feed ac loads. At wind energy conversion and collection stage, the output of wind is directly connected to battery. So, there is a chance of flow of stored energy back to dc generator, which may cause damage to the dc generator. To avoid this, we can make use of free-wheeling diode. The diode blocks the flow of stored energy back to dc generator and allows current to flow when there is a generation available from wind

2.2 Photovoltaic Structure

The photovoltaic cells structure is quite straightforward. It consists of 6 different layers of materials as shown in Figure 2.1. First of all, the efficiency of photons absorption is increasing due to the assistance of black cover glass surface, the glass is protecting the cell from the elements of atmosphere. The reflection losses of the photons are reduced to less than 5% by the anti-reflective coating. The travelling distance of the Photons was minimized by contact grid, so that it able to reach the semiconductors. The heart of the photovoltaic system is consisting of semiconductors p and n in the form of two thin layers. Lastly, the back contact is contributing for the better conduction



Basic structure of a generic silicon PV cell

Advantages of PV Systems

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.

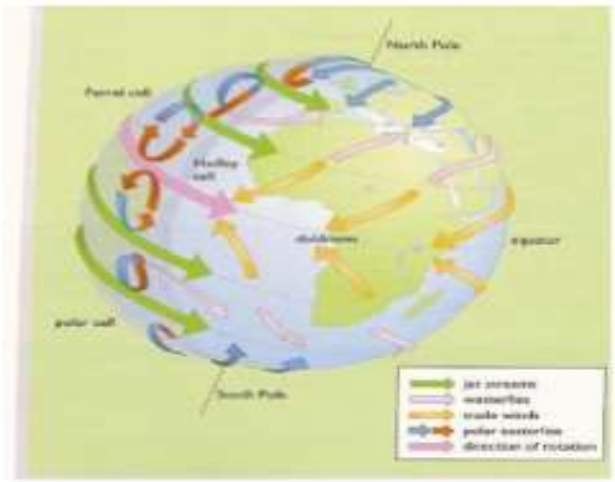
vi. Energy conservation.

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

WIND ENERGY

Wind is the continuous movement of atmospheric air masses and is determined by its speed and orientation. This movement derives from the changes and the different values of the atmospheric pressure while these values are the result of the solar heating of different parts of the earth's surface. Despite the fact that the atmospheric air moves horizontally and vertically as well, only its horizontal movement is actually considered as wind.

The wind energy derives from the air as a result of its movement which is depicted in Figure 2.6. Wind energy is the conversion of a small percentage, about 0.2%, of the solar radiation that reaches the surface of the earth. The wind power around the globe is estimated in 3.6×109 MW while, according to valid estimations of the world meteorology organization, the percentage which is available for energy exploitation in various parts of the world is only 1% and it is estimated around 0.6Q (175×1012 KWh).

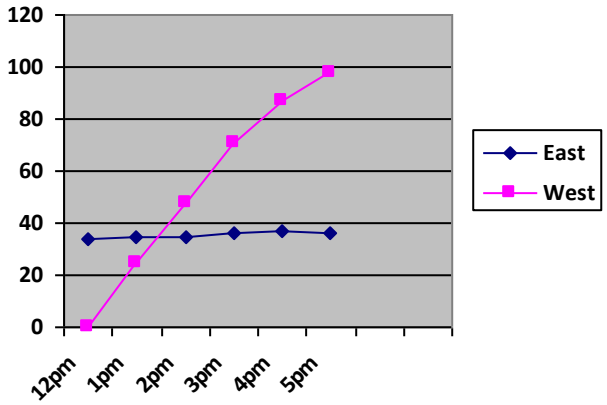


The global wind circulation

RESULT AND DISCUSSION

Thursaday25-	12pm	1pm	2pm	3pm	4pm	5pm
Temp in ^{O}C	34	35	35	36	37	36
% Charging of battery	0	25	48	71	87	98

Based change in temperature and charging rate of battery

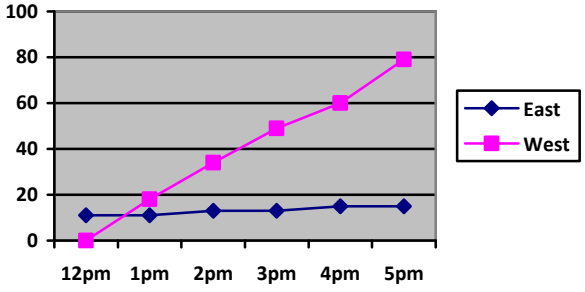


Percentage Charging of battery using PV cells

From the experimental data's available during observation period is tabulated and corresponding graphs also plotted. From the graphs, Solar PV output is non-linear in nature and depends on temperature and irradiation. Therefore, output of PV panel is non-uniform throughout the period considered. So that battery charging rate will also vary as a function of PV panel output

Charging of Battery using only Wind Energy

Friday	12pm	1pm	2pm	3pm	4pm	5pm
Wind speed Km/h	11	11	13	13	15	15
% Charging of battery	0	18	34	49	60	79



Percentage Charging of the battery using Wind energy

From the experimental data's available during observation period is tabulated and corresponding graphs also plotted. Initially fully discharged battery was kept for charging and percentage charging of battery was observed for every one hour and corresponding readings are noted. By doing so we come to know that, the battery charging rate will depend on the wind velocity and we cannot expect constant wind velocity at all the times of day, so complete charging of battery using wind alone is possible and requires more time compare to solar energy.

CONCLUSION

There are number of sources for generation of power but in the recent years wind and solar energy shown its potential as the clean source of energy and contributing to the high energy demands of the world. Hybrid tree is the best option for the remote area peoples. The output from the hybrid tree is use to charge a heavy duty battery. This can be beneficial than inverter back up. Following are the same conclusions drawn from this project:

1.At least 20% power of the consumption can be fulfil by this set up.

2.Gear arrangement can increase the number of rpm in case of low wind speed.

3.The VAWT is generally suitable for 8 to 10m of height above ground level. Because at ground level velocity of air is very less

4.Combination of alternator with gear arrangement can be used to increase output but unnecessarily it will increase the cost of machine.

5.The alternate option for turbine blade material is reinforced glass fibre because of its more elastic nature .

6.The cost of the machine should be as minimum as possible. So that it will be economical for everyone to purchase.

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