

HYBRID ENERGY HARVESTING SYSTEM FOR CHARGING STATIONS

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ABSTRACT - Harvesting Energy stands alone as one of the most promising techniques for approaching the global energy problem without depleting natural resources. Energy harvesting technologies from road infrastructure is a new research territory that encompasses technologies that capture the wasted energy occurred at pavements, accumulate and store it for later use. At recent years, using hybrid energy storage systems has become a global solution to supply continuous, reliable and clean energy to power electricals. By using these technologies, many advantages of energy storage systems can be combined properly and an adequate energy supply for specific applications is achievable. This paper is to generate electrical energy using savonius Vertical Axis Wind Turbine (VAWT) combined with leaf-shaped solar cells which is structured like a tree. The wind energy due to the vehicle motion on highways and the solar energy is utilized for power generation. The generated Electrical power from the hybrid system can be stored in the battery and it is used in automated E-charging station in roadways for charging the Electric Vehicles (EV). This system involves the integration of two renewable energy sources thus it will give continuous power and it immensely reduces the requirement of fossil fuels to generate electricity which results in greatly reduced CO₂ and CO-related emissions. The combination of this hybrid system will be beneficial in future aspects. CO₂ and CO-related emissions. The combination of this hybrid system will be beneficial in future aspects.

Keywords: Energy harvesting technologies, Hybrid system, savonius Vertical Axis Wind Turbine, leaf-shaped solar cells, E-Charging Stations..

1. INTRODUCTION

Hybrid energy system utilizes the two or more energy sources for generating electricity. Hybrid energy system has good reliability, efficiency, less emission, and low cost. In this proposed system solar and wind power is used for generating power. Hybrid system has good advantages than any other non-conventional energy sources and the energy sources have greater availability in all areas. There is no need to find special location to install this system. Solar energy is available throughout the day and the wind

energy is maximum on the highway due to the speed of the vehicle [1].

The main objective is to design a vertical axis wind turbine which effectively uses the wind energy generated by the vehicle speed on the highway. Designed and modified the savonius vertical axis wind turbine which is more efficient than old design. In modified vertical axis turbine, it twisted the blade of the turbine to gain maximum spin on low pressure of the wind. It also works under all the environmental condition. This design of the blade enables the turbine to rotate in clockwise and anticlockwise directions. Depending on the position and intensity of the sun radiation the electrical energy will produced. The arrangement of solar panels is designed in a leaf shape, which are connected in series to generate continuous power. The overall obtained energy is stored in a battery bank. The stored energy can used in the charging station for charging the Electrical Vehicle (EV) on roadways and also further applications.

2. OBJECTIVES

The main objective of project is to

- ❖ To use the maximum amount of wind energy from vehicle running on highways.
- ❖ The model of hybrid solar wind turbine in single setup(called Hybrid Tree)
- ❖ To design automated E-charging station for vehicles.

3. PROPOSED SYSTEM

The proposed system consists of following system,

- ❖ Hybrid Tree
- ❖ Automatic Electric Charging Station

The proposed system consists of savonius vertical wind turbine, PMDC generator, leaf shaped solar panel, charge controller, Battery, microcontroller ATMEGA 328, RFID reader and charging unit. The block diagram is shown in Fig-1.

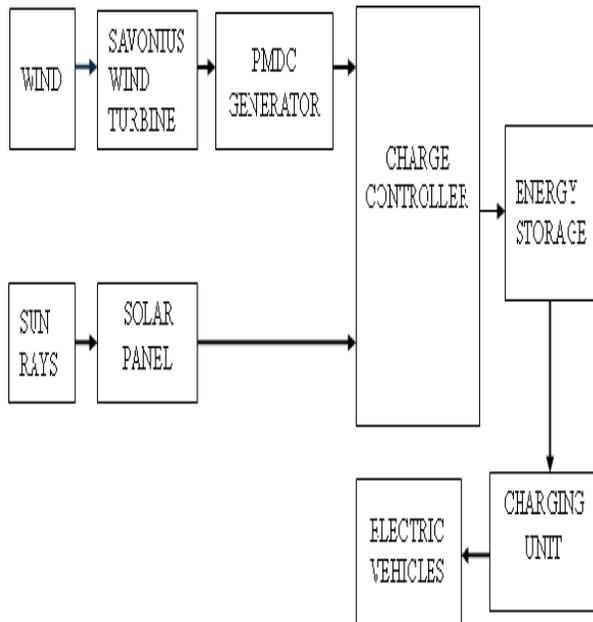


Fig-1:Block Diagram of Proposed System

3.1 Hybrid tree

Hybrid systems are the ones that use more than one energy resources. Integration of systems (wind and solar) has more influence in terms of electric power production. Such systems are called as “hybrid systems”. Hybrid solar-wind applications are implemented in the field, where all-year energy is to be consumed without any chance for an interrupt. It is possible to have any combination of energy resources to supply the energy demand in the hybrid systems[2].

3.1.1 Savonius wind turbine

Savonius turbines are one of the simplest turbines. Aerodynamically, they are drag-type devices, which 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[3].

A two blades savonius wind turbine would look like an "S" letter shape in cross section as shown in Fig -2(a). The savonius wind turbine works due to the difference in forces exert on eachblade. 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 sideways around it.

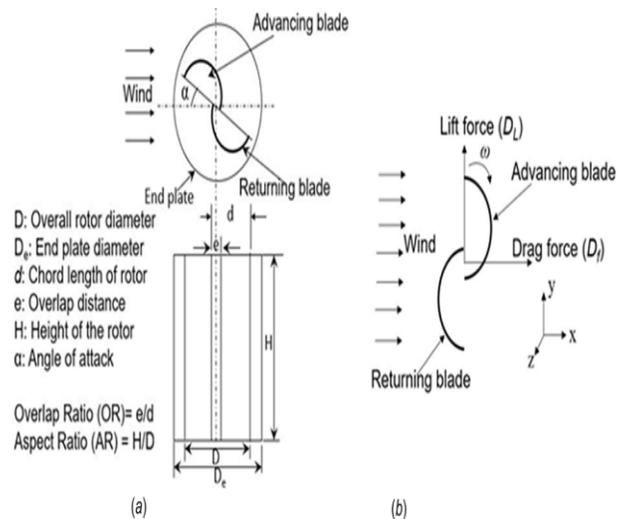


Fig-2: Savonius Wind Turbine

The Schematic drawing Fig-2(b) 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[6]. 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.

3.1.2 Leaf shaped solar collector

The plant adaptation for more energy capture to design a leaf shape that would produce more electricity and make it available for around clock use. This design appeared to be far more efficient than the traditional flat-panel structure[4]. This model appeared to be close to 50% more efficient over all during the winter. 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 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).

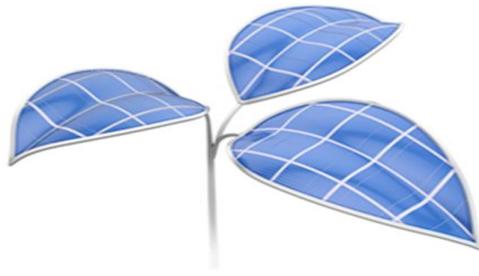


Fig-3: Solar Panel (Leaf Shaped)

Photovoltaic systems were manufactured in order to function in unfavorable conditions and it has a very small weight as shown in Fig-3. 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. Like that many of the leaf shaped solar are placed in the hybrid tree, to increase the efficiency of the hybrid tree.

3.2. Electric vehicle charging station

An electric vehicle charging station, also called EV charging station, electric recharging point, charging point, charge point, ECS (electronic charging station), and EVSE (electric vehicle supply equipment), is an element in an infrastructure that supplies electric energy for the recharging of electric vehicles, such as plug-in electric vehicles, including electric cars, neighborhood electric vehicles and plug-in hybrids. The charging time depends on the battery capacity and the charging power. In simple terms, the time rate of charge depends on the charging level used, and the charging level depends on the voltage handling of the batteries and charger electronics in the car. Currently charging stations are being installed by public authorities, commercial enterprises and some major employers in order to stimulate the market for vehicles that use alternative fuels to gasoline and diesel fuels. For this reason, most charge stations are currently either provided gratis or accessible to members of certain groups without significant charge.

There are three main levels of charging an electric vehicle.

- ❖ Level 1 charging stations,
- ❖ Level 2 charging stations, and
- ❖ DC Fast Chargers (also referred to as Level 3 charging stations).

The block diagram of charging station is shown in Fig-4.

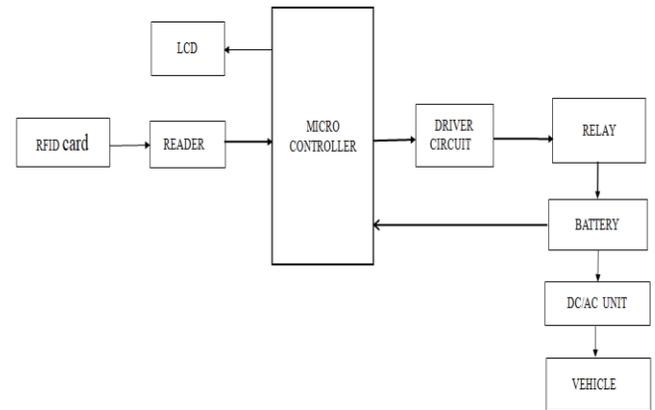


Fig-4: Block Diagram for Charging Station

3.2.1 Operation

Radio-Frequency identification refers to small electronic devices that consist of a small chip and an antenna. The RFID device serves the same purpose as a bar code or a magnetic strip on the back of a credit card or ATM card; it provides a unique identifier for that object. And, just as a bar code or magnetic strip must be scanned to get the information about the vehicle, the RFID device must be scanned to retrieve the identifying information.

The Micro controller controls the signal from the RFID that reads the stored data. The driver circuit helps the relay to start the process of ON/OFF switch. When Micro controller reads the RFID tag as input, this can access the tag and verify it to open the relay for the certain duration to starts the charging process to E-vehicles from charging stations. After completing the certain duration the relay switch to be closed and charging of E-vehicles stopped from charging stations. The process of an AC/DC unit of charging as shown in Fig-5.

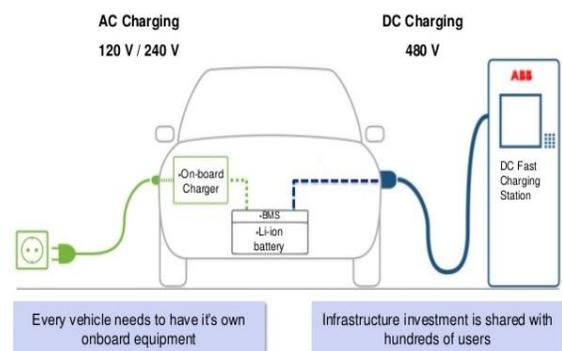


Fig-5: Charging Station

4. RESULT AND ANALYSIS

4.1 Calculation for proposed system

The total power generated by this system may be given as the addition of the power generated by the solar PV panel and power generated by the wind turbine. Mathematically it can be represented as,

$$PT = NW * PW + Ns * PS$$

Where,

PT is the total power generated

PW is the power generated by wind turbines

PS is the power generated by solar panels

NW is the no of wind turbine

Ns is the no of solar panels used

4.2 Calculation for wind energy

The power generated by wind energy is given by [8],

$$\text{Power} = (\text{density of air} * \text{swept area} * \text{velocity cubed}) / 2$$

$$PW = \frac{1}{2} \cdot \rho (AW) (V)^3$$

Where,

P is power in watts (W)

ρ is the air density in kilograms per cubic meter (kg/m^3)

AW is the swept area by air in square meters (m^2)

V is the wind speed in meters per second (m/s).

Table 1. Output of the wind turbine

WIND SPEED (IN VECHICLE)	VOLTAGE (V)	CURRENT (AMP)
8.34	18.1	0.2
12.5	23.4	0.4
13.88	30.2	0.6
16.67	41.1	0.7
19.45	48.5	0.8
22.23	51.6	1.1
25	56.5	1.4

4.3 Calculations for solar energy

To determine the size of PV modules, the required energy consumption must be estimated. Therefore, the power is calculated as

$$PS = Ins (t) * AS * Eff(pv)$$

Where,

Ins (t) = isolation at time t (kw/ m^2)

AS = area of single PV panel (m^2)

Eff(pv) = overall efficiency of the PV panels.

Overall efficiency is given by,

$$Eff(pv) = H * PR$$

Where,

H = Annual average solar radiation on tilted panels.

PR = Performance ratio, coefficient for losses.

Table 2. Angle of solar panel

Angle to sun	% output
95	98
75	92
60	84
45	70
30	61
15	32

5.4 Costanalysis

The total cost of the solar-wind hybrid energy system is depend upon the total no of wind turbines used and total no of solar panels used. Therefore the total cost is given as follows,

$$\text{Cost} = (NW * CWT) + (NS * CSP) + (NB * CB)$$

Where,

CWT is the cost of single wind turbine in Rs

CSP is the cost of single solar panel in Rs

CB is the Cost of single Battery in Rs

NW is the number of wind turbine used

NS is the number of solar panels used

NB is the number of Batteries used in Battery Bank.

Solar-wind hybrid energy systems needs only initial investment. It will compete well in generation with the conventional energy sources. When accounted for a lifetime of reduced or avoided utility costs. The cost of the system depends on the system chosen, wind resource on the site, electric costs in the area, and the battery bank required. Cost of the Wind-Solar Hybrid system is to be minimized. For minimize the cost of the system we need to increase the use of non-conventional energy sources. So that production of solar and wind power generator will be increase,that reduces cost of the whole system.

6. CONCLUSION

The utilization of renewable resources is greatly demanding in the world. The world facing the problem of global scarcity of electricity and pollution can be easily overcome with renewable energies. The combination of solar and wind hybrid system is also presented in the paper is one of the most convenient and effective solution for producing electricity as compared to non-renewable energy resources. It is not only less costly but also it does not cause any harm to the environment.

All these vehicles are running on non-renewable fuels generating pollution so green energy is the best substitute. So electric vehicles are best option to make environment free from vehicle pollution. The way of living will be altered as electric vehicles need time to charge and efficient use of time is proposed. The issues that currently exist will be solved with implementation of strategically placed proposed charging infrastructures in roadways with generation using hybrid tree.

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