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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 electrical. By using these technologies, many advantages of energy storage systems can be combined properly and an adequate energy supply for specific applications is achievable.

The proposed system 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.

Keywords: Solar Energy, Savonius Vertical Axis Wind Turbine, E-Charging Stations, Electric Vehicle (EV).

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.

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 Savonius 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.

EXISTING SYSTEM

In this method use the maximum amount of wind energy from vehicle running on highways. The unused considerable amount of pressurized air used to drive the vertical axis wind. The generated energy by VAWT and solar system are stored in a battery and this stored energy which can be used street lighting, toll gates or in future to provide the charging node to the electrical vehicle [1].

Darrieus vertical wind turbine

The principle of Darrieus Vertical Wind Turbine operation depends on the fact that its blade speed is a multiple of the wind speed, resulting in an apparent wind throughout the whole revolution coming in as a head wind with only a limited variation in angle. From the prospective blade, the rotational movement of the blade generates a head wind that combines with the actual wind to form the apparent wind. If the angle of attack of this apparent wind on the blade is larger than zero, the lift force has a forward component that propels the turbine. An angle of attack between zero and 20 degrees requires a sufficiently high blade speed. A Darrieus turbine can't self-starting; it needs to be brought to a sufficiently high blade speed by external means.

Solar panel

A photovoltaic cell is rarely used in single set or individually, since it is unable to supply sufficient power and voltage of electronic device requirement. Due to this reason, it needs more set of photovoltaic cells be coupled together and to be connected parallel or in series for energy production, in order to achieve the higher power output and voltage as possible. A typical photovoltaic system is made of silicon photovoltaic cells and auxiliary devices which are lead-acid batteries with a typical voltage of 12 V. This system has the capacity of producing more than 13V during cloudy days and can charge a 12 V battery. In order to utilize the system efficiently, it is required to understand that how does it works during various electrical loads connected in the system.

OBJECTIVES

- The main objective of project is to use the maximum amount of wind energy from vehicle running on highways
- The model of hybrid solar wind turbine in single setup and then investigate the feasibility of the hybrid solar vertical wind turbine system, energy output and storage.
- The generated energy by using Hybrid tree is stored in a battery and this energy can be used to provide the charging node to the electrical vehicle.

PROPOSED SYSTEM

The proposed system is consists of following system are,

- Hybrid Tree
- Automatic Electric Charging

HYBRID TREE

Savonius 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.

Principles of Savonius rotor wind turbine

Savonius turbines are one of the simplest turbines. Aerodynamically, they are drag-type devices, consisting of two blades (vertical – half cylinders). A two blades savonius wind turbine would look like an "S" letter shape in cross section as shown in Fig 1. The Savonius wind turbine works due to the difference in forces exert on each blade. 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 sideway around it.

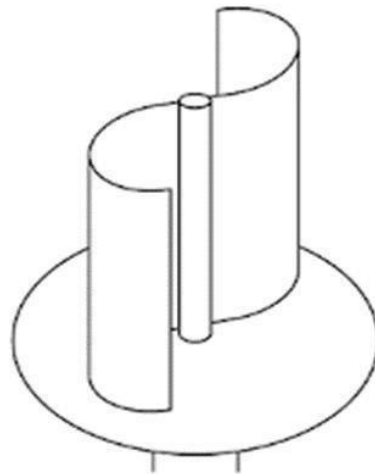


Fig 1. Savonius Wind Turbine

The Schematic drawing 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. 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.

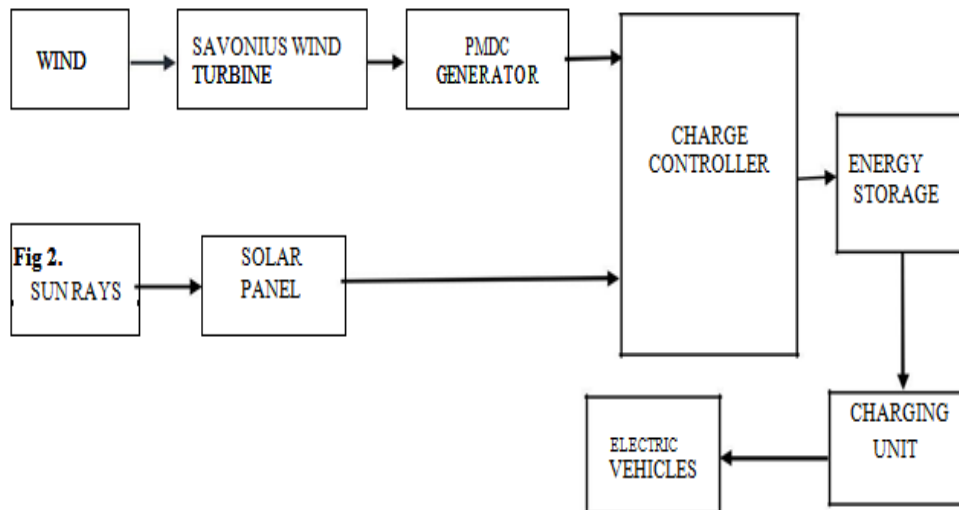


Fig 2. Block Diagram of Proposed System

PV Systems

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. 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.



Fig 3. Solar Panel (Leaf Shaped)

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). 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.

Advantages of PV systems

A long life cycle since it can provide power for more than 20-25 years

- Zero operation cost, because it does not consume fuel or materials.
- Low variability of system efficiency and more reliable results.
- No sound pollution in the period of operation.
- Keep the environment clean and away from pollution of the CO₂ emissions in atmosphere.
- Maintenance cost is low.

Battery bank

The batteries in the system provide to store the electricity that is generated from the Hybrid energy system. Any required capacity can be obtained by serial or parallel connections of the batteries. It is connected to the bidirectional polarity controller for its protection.

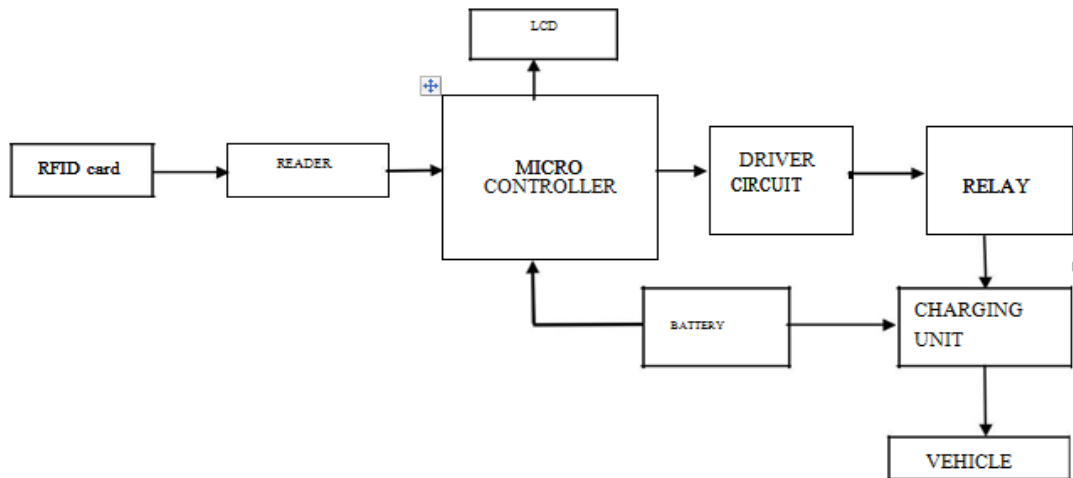


Fig 4. Block Diagram of Charging Station

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.

Operation

The Micro controller controls the signal from the RFID that reads the stored data. The LCD is controlled by driver circuit through Micro controller. The driver circuit helps the relay to start the process of ON/OFF switch. When Micro controller reads the RFID input the relay switch open for the certain duration to starts the charging process of 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 as shown in Fig 5.

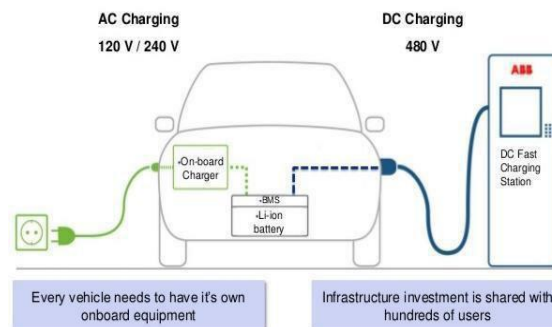


Fig 5. Charging System

RESULT & DISCUSSION

In the case of designing or choosing the blade, the diameter of the wind-rotor is very important. And the energy produced by wind turbines depends on the swept area of the blades. So as the swept area of the rotor increases, the area it covers also increases with the square of the radius. Thus, doubling the length of a turbine's blades results in an increase of four times its area which allows it to receive four times as much wind energy. The shapes of the blades are important near the tip but much less than near to the root (the larger, inner

end of the blade). However It can convert only up to 25 -35% of the wind pressure to make a mechanical movement with blades. [5]

FUTURE PROSPECTS

The hybrid system reduces the usage of fossil fuels and reduces the pollution. There is no huge power loss in the Hybrid system. There is no requirement of fossil fuels. The hybrid system is further used for street lights, electric vehicles, home appliances etc.

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