SOLAR-WIND HYBRID POWER GENERATION ON HIGHWAY DIVIDERS

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ABSTRACT

With the increasing demand for sustainable energy solutions, integrating renewable energy sources into infrastructure has become a crucial step toward reducing dependence on conventional power systems. This paper, "Wind-Solar Hybrid Power Generation in Highway Dividers," aims to harness both solar and wind energy to generate electricity, providing a reliable and eco-friendly solution for powering highway streetlights. By utilizing solar panels to capture sunlight during the day and vertical-axis wind turbines (VAWTs) to convert wind energy from moving vehicles into electricity, the system ensures continuous power generation. The generated electricity is stored in batteries and later used to operate automatic street lighting systems, reducing reliance on grid electricity and promoting energy efficiency. The integration of an LDR-based automatic lighting system further enhances energy conservation by ensuring the streetlights turn ON only when required and OFF during daylight hours. This hybrid system offers multiple benefits, including energy independence, cost savings, and reduced carbon emissions. By implementing renewable energy solutions along highway dividers, the project significantly minimizes energy consumption while ensuring improved visibility and safety for road users. The self-sustaining nature of the system makes it an ideal solution for modern highways, reducing the need for external power sources and supporting environmental conservation efforts. Additionally, the system can be further expanded to integrate smart traffic monitoring and EV charging stations, making it a scalable and future-ready solution for sustainable infrastructure. By optimizing energy use and embracing clean energy technologies, this system contributes to the global shift towards smart and sustainable transportation networks while enhancing the efficiency of highway lighting systems.

Keyword : - *Solar Panels, VAWT, Arduino, Charge Module, Dynamo Motor, Battery, LDR Module & LDR, Transistor.*

1. INTRODUCTION

The increasing demand for renewable energy sources has led to the development of innovative solutions, like wind-solar hybrid power generation systems. These systems combine the benefits of wind and solar power to provide a reliable and efficient source of electricity. One of the most promising applications of wind-solar hybrid power generation systems is on highway dividers, which offer a unique opportunity for harnessing wind and solar energy due to their high wind speeds by fast moving vehicles, high solar irradiance, limited land use, and existing infrastructure. By leveraging these advantages, wind-solar hybrid power generation systems on highway dividers can provide a renewable energy source, improve energy security, reduce energy costs, and create jobs and stimulate local economies and also develop the highways to give us more benefits like monitoring the highways etc.

In this we use the VAWT and placed it in the way of free fall so that can be rotate when ever the wind is low or high when the vehicles move and as well as natural wind. The automatic street lighting can be installed to save the energy

1.1 Concept of Hybrid Power Generation

Traditional methods for electricity generation can cause the depletion of fossil fuels and also cause the harm to the environment so we need to use the renewable energy sources like wind and solar. These renewable energies also have their strengths and weaknesses to overcome those we need to employe Hybrid Power System [1]. These are ecofriendly and in low cost to maintain.

1.2 Objective of the project

The main objectives of the paper is to generate the electricity and to generate that we need to design the hybrid power system and also make implements in the Divider based power management system and also optimized the energy efficiency through hybrid power system.

2. Overview of the Project

The wind-solar hybrid system is a renewable energy system that combines both wind and solar to generate electricity [2]. The wind-solar hybrid system is suitable for residential, commercial, and industrial applications, and can be used to power homes, businesses, and industries. The system is also ideal for remote communities and areas where grid electricity is not available.

2.1 Components used

In this we use several components they are given as

a. Solar panels: Converts light energy into electricity.
b. VAWT: These are the type of wind turbines that rotates in vertically.
c. Charge Module: Controls the charging and the discharging of battery.
d. Battery: Stores energy for further use.
e. Dynamo motor: Converts mechanical to electricity.
f. LDR module and LDR: detects the light and varies the resistance.
g. Transistor: It is act as an electrical switch.
h. LED lights: on and off as per LDR inputs.
i. Arduino Board: It is an open-source electronic platform to creates electronic projects.
j. Servo motor: Takes the digital input and work as per the code written in the Arduino.

2.2 Block diagram and Circuit diagram

The block diagram represents the overall system in understandable way.

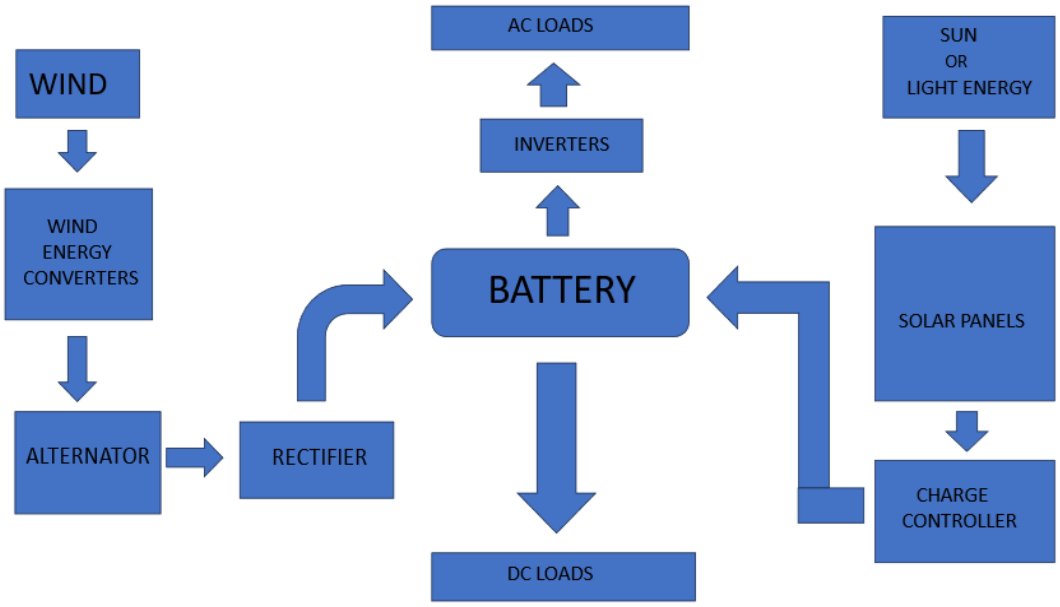

Fig-1: Block Diagram of Wind-Solar Hybrid power generation

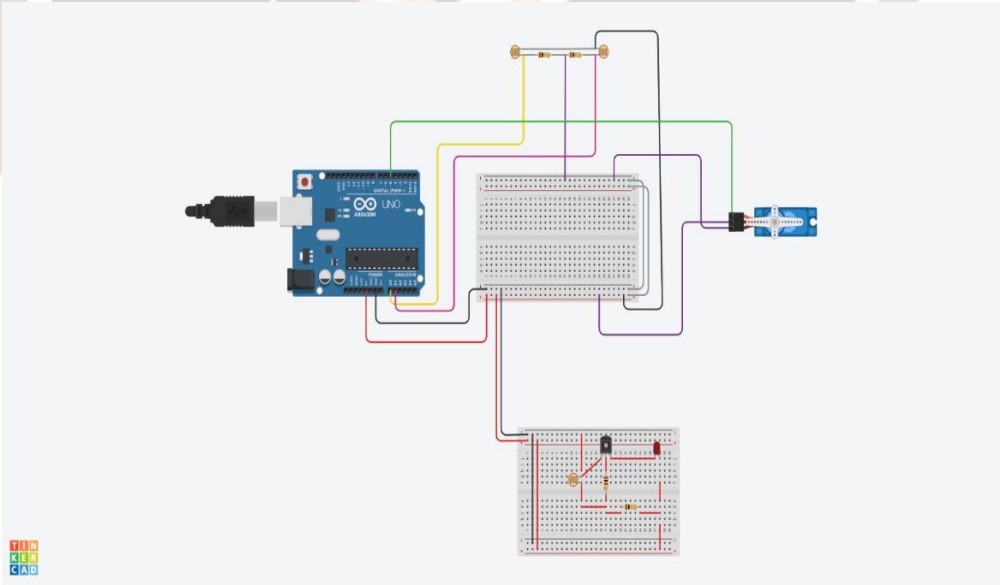

Fig-2: Circuit Diagram solar tracking and automatic street lighting

3. Working

The working of this system is mainly divided into two types they are wind power harnessing and solar power harnessing along with automatic street lighting.

3.1 Wind power Harnessing

When ever the vehicles move fast in the highways then they create a disturbance in the wind and cause the wind flows in the direction of the vehicle move. The wind that caused by the vehicles can cause the rotation of the VAWT blades then that converts nature physical energy to the mechanical energy [3]. Further this mechanical energy can be converted into electrical energy with the help of dynamo motor, the generated electrical energy can be sent to the batteries through the charge modules to store it for emergency purposes.

3.2 Solar power Harnessing & Automatic Street lighting

Solar energy harnessing is the process of converting sunlight into electrical energy by using PV cells [4]. In the first step the solar radiation from the sun is absorbed by the solar panels and then the photons can be absorbed by the PV cells. Whenever the photon is absorbed by the PV cell it excites an electron. This further creates an electron-hole pair then after this electron-hole pair can be separated by an electric field created by the PV cell then the electrons drawn towards the negative terminal and the holes towards the positive terminal. As the electrons flow towards the negative terminal they create an electrical current. The current is collected and sent through a circuit, where it can be used to power electrical devices [5].

The automatic street lighting is used in this project so that can conserve the energy. When the LDR module detects the sun light then it can adjust the resistance. This resistance can be act as the input to the transistor, here transistor can act as electrical switch, so this transistor can cause the automatic ON and OFF of the street lights.

4. CONCLUSION

The Hybrid power system combining wind and solar energy presents an innovative and sustainable solution to meet the global energy demands. By harnessing two complementary renewable energy, these systems offer continuous, reliable power with less environmental impact. This system can be very much useful to the highways to not only power up the street lights also useful to the monitoring the highways such as in emergency times like in the accident situations etc. This can also be very much useful to the Electric Vehicles like in the long highways the Electric Vehicles can face the charging problems so by this project we can solve that problem by inserting charging ports in the system.

5. ACKNOWLEDGEMENT

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