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Electricity Generation by Waste Material with Pollution Control

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Abstract The project titled "Electricity Generation by Waste Material with Pollution Control" presents an innovative approach to sustainable energy generation by utilizing waste heat and renewable resources while simultaneously environmental pollution. The system integrates addressing thermoelectric generation, solar energy harvesting, and air purification into a compact and efficient setup controlled by a microcontroller**.**

Index Terms **– introduction, working, types, objective, problem statement, material, electronic components, block diagram, advantages and dis-advantages, faq's, result, conclusion, reference, project photo.**

INTRODUCTION

In the modern era, the demand for electrical energy is increasing rapidly due to industrialization, urbanization, and technological advancements. Conventional sources of energy such as coal, petroleum, and natural gas are depleting at an alarming rate and are also major contributors to environmental pollution. This has created an urgent need to explore alternative and sustainable energy sources.

One of the most promising approaches is the utilization of waste energy, which is often lost in the form of heat during various industrial processes, domestic activities, and waste disposal methods. A significant amount of energy is wasted daily without being utilized effectively. Converting this waste energy into useful electrical energy can help improve overall energy efficiency and reduce dependence on non-renewable resources.

OVERVIEW OF THE SYSTEM

The project "Electricity Generation by Waste Material with Pollution Control" is designed to generate electrical energy using waste heat and solar energy while simultaneously reducing pollution levels. The system is based on a hybrid energy generation model consisting of:

- **Thermoelectric Generation (TEG):** Converts waste heat into electricity
- **Solar Energy System:** Generates power using sunlight
- **Energy Monitoring System:** Displays real-time voltage data
- **Pollution Control Unit:** Reduces harmful emissions using a fan-based mechanism

A **TEC12706 Thermoelectric Generator module** is used to convert temperature differences into electrical voltage. When one side of the module is heated (using waste heat) and the other side is cooled (using a cooling fan), a voltage is produced due to the Seebeck effect.

In addition, **solar panels** are used to capture solar energy, ensuring continuous energy generation even when heat sources are not available. The generated voltages from both sources are monitored using voltage sensors and displayed on an LCD using an embedded system based on the Arduino Nano.

WORKING PRINCIPAL

The system operates on two main principles:

1. Thermoelectric Effect (Seebeck Effect)

When there is a temperature difference between two sides of a thermoelectric module, charge carriers move from the hot side to the cold side, generating an electrical voltage. This principle is used to convert waste heat into electricity.

2. Photovoltaic Effect

Solar panels convert sunlight directly into electrical energy using semiconductor materials. This provides an additional renewable energy source.

The Arduino Nano reads analog signals from voltage sensors connected to both the thermoelectric generator and solar panels. These values are processed and displayed on a 16×2 LCD screen for monitoring purposes.

OBJECTIVE OF THE PROJECT

The main objectives of this project are:

- To design and develop a system that generates electricity from waste materials
- To utilize thermoelectric generators for converting heat into electrical energy
- To integrate solar energy for hybrid power generation
- To monitor voltage outputs using Arduino Nano and display them on an LCD
- To implement a pollution control mechanism using a fan-based system
- To create an eco-friendly and cost-effective energy solution

SCOPE OF THE PROJECT

This project has a wide scope in various fields, including:

- **Industrial Applications:** Recovery of waste heat from machines and furnaces
- **Domestic Applications:** Small-scale power generation from kitchen or household waste
- **Rural Areas:** Providing alternative energy sources in remote locations
- **Environmental Protection:** Reducing air pollution from waste burning.

OBJECTIVE OF THIS PROJECT

The main objective is to harvest and recapture the maximum amount of wind energy from the automobiles running on the highways. The unused and considerable amount of wind is used to drive the vertical wind turbine, which will use the kinetic energy of the wind to produce the electrical energy. Increased turbulence levels yield greater fluctuations in wind speed and direction. Unlike traditional horizontal axis wind turbine (HAWT), vertical axis wind turbine effectively captures turbulent winds which are typical in urban settings. Our aim is to design the turbine which will capture the maximum of wind in any direction by placing it at optimum place and height by considering both the cost and safety of the system. This system can be used in huge number to generate the huge amount of useful electrical energy. This energy can be stored and transferred to nearest rural places where we can fulfill the demand of electricity. The thought of design directs us to look into the various aspects such as manufacturing, noise, cost which leads us to our additional aim of analyzing the system to overcome the usual technical glitches. The project brief involves the design of a small scale wind turbine that can be easily mass produced and fitted on every highway medians to aid electricity consumption.

PROBLEM STATEMENT

A major hindrance in the growth of wind energy is fluctuation in the sources of wind. Highways appear to be a sufficient source of potential wind energy. An in-depth analysis of fluid flow due to traffic on highways must be performed to acquire boundary limits for the wind turbine design. The turbine must be able to store energy for use when there is low traffic, bumper to bumper or stop and go traffic. The design must be sustainable and environmentally friendly.

MOTIVATION AND OBJECTIVE

The motivation for designing a highway wind turbine is to contribute towards the global trend in wind energy production in a feasible way. Wind turbines are traditionally employed in rural areas, the goal of this project is to design a wind turbine that can be used in cities. In particular, the turbines will use the wind draft created by vehicles on the highway to generate electricity. The idea is to offset the amount of pollution created by burning fossil fuels by introducing a potential source of clean energy.

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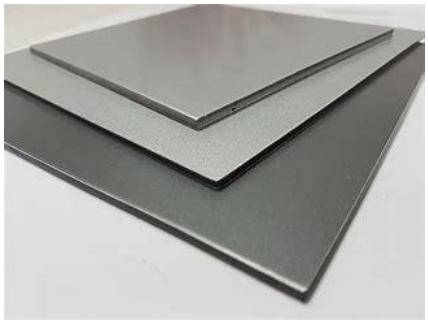
Materials used in this project

1)ALUMINUM COMPOSITE PANNEL :



Aluminum composite material and ACM panel manufacturing process made them suitable construction materials for various industrial projects. Thanks to the current equipment and technology, manufacturers improved their characteristics.

2)STURDS :

Nuts and bolts are the smallest tools with the most incredible benefits. There would be no mechanical construction if these two tools were not there. They are very small in size, but they are the ones holding the whole machinery together.

3)BIRLA PVC-U PIPE :

Birla PVC-U (Polyvinyl Chloride Unplasticized) pipes are commonly used in plumbing, irrigation, and construction applications due to their strength, durability, and corrosion resistance. These pipes are made from rigid PVC material, which does not contain plasticizers, giving them a hard, non-flexible structure.

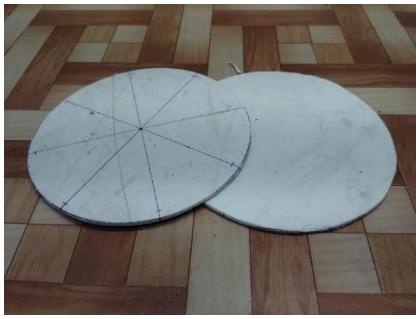
With the help of this pipe we made blades of our turbine.

For making blades we cut this pipe vertically in centre

4)SHAFT :

A shaft is a rotating machine element, generally of circular, which is used to transmit power from one place to another and to support the loads imposed by gears, pulleys, or sprockets. It is a crucial component in many machines.

5) ALUMINUM FOAM COMPOSITE SHEET :

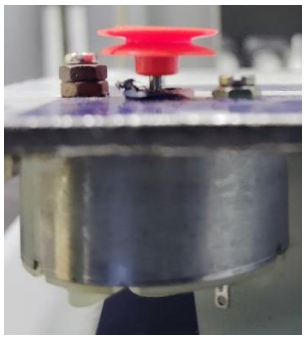


Aluminum Foam Composite Panel combines foam with materials like marble, PVC, and wood, offering fireproof, waterproof, and high-strength properties. Its lightweight, multifunctional design is ideal for furniture, construction, and vehicle interiors.

6) Z809 BEARINGS :

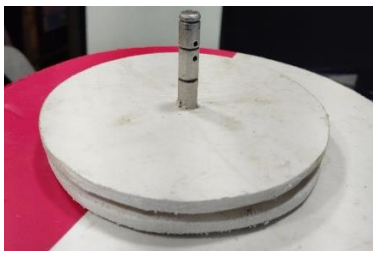
Industrial machines consist of small parts. In general, all types of machines have a supporting device for rotating shafts. This supporting device is called a bearing. The bearings are most widely used all over the world. They are installed to assist, guide, and limit the rotating parts of a vehicle. The bearings are static elements that carry the load. They reduce the friction between the moving parts.

7) 24 VOLT DC GEN. :



DC generator is an electromechanical energy conversion device that **converts mechanical power into DC electrical power** through the process of electromagnetic induction.

8) PULLY :



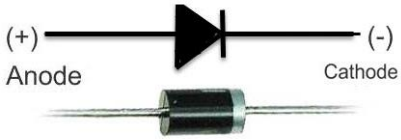
"A pulley is a mechanical component that helps transfer motion and power through a wheel turned by chain, rope, cord, or belt."

9) V-BELT DRIVE SYSTEM :

A V-belt is a **flexible and efficient power transmission device**. It is used to transfer power from one shaft to another. The V-belt has a trapezoidal shape that wedges securely into the sheaves of a shaft. The V-shape design of the pulley allows for efficient power transmission.

ELECTRONIC CIRCUIT COMPONENTS AND THEIR FUNCTIONS

1)RECTIFIER :



A rectifier diode is a semiconductor device specifically designed for rectification, meaning it allows current flow in one direction while blocking it in the opposite direction. This unique property is essential in power conversion circuits, where AC (alternating current) is converted to DC (direct current).

2)VOLTAGE BOOSTER AND CHARGE CONTROLAR :

A boost converter or step-up converter is a DC-to-DC converter that **increases voltage**, while decreasing current, from its input (supply) to its output (load).

3) BATTERY BANK :

3.7V lithium batteries are rechargeable cells that **store electrical energy** using a chemical reaction between lithium ions and the battery's electrode materials.

4) LED :

An LED, or Light Emitting Diode, is defined as a semiconductor device that emits light when electrically energized through a process called electroluminescence.

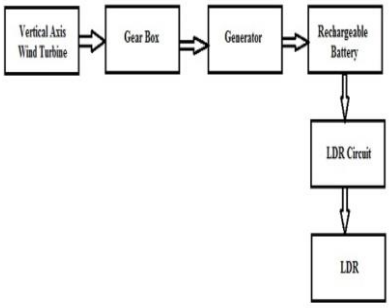
5) CHARGING PORT :

The charging port, also known as a power or charging connector, is a crucial component of any device that requires battery charging. Whether it's a smartphone, tablet, or laptop, these ports are responsible for delivering electrical power to the device's battery.

6) CONNECTING WIRES :

Connecting wires are **flexible strands of metal that are used to establish electrical conductivity between two devices of an electrical circuit**. They are one of the most important components in an electrical circuit because they allow electricity to flow from one electrical component to another. Wires possess negligible resistance to the passage of current and are covered by an insulated coating of different colours.

BLOCK DIAGRAM OF HIGHWAY WIND TURBINE



ADVANTAGES OF HIGHWAY WIND TURBINE

- They can produce electricity in any wind direction
- Strong supporting tower in not needed because generator, gearbox and other components are placed on the ground
- Low production cost as compared to horizontal axis wind turbine
- As there is no need of pointing turbine in wind direction to be efficient so yaw drive and pitch mechanism is not needed
- Easy installation as compared to other wind turbine
- Easy to transport from one place to other
- Low maintenance cost
- They can be install in urban area
- Low risk for human and birds because blades moves at relatively low speed

DISADVANTAGES OF HIGHWAY WIND TURBINE

- As only one blade of wind turbine work at a time so efficiency is very low
- They need a initial push to start, this action use few of its own produce electricity
- When compared to horizontal axis wind turbine they are very less efficient with respect to them. this is because they have an additional drag when their blades rotates.
- They have relative high vibration because the air flow near the ground creates turbulent flow
- Because of vibration bearing wear increase which result in the increase of maintenance cost
- They create noise pollution
- Guy wires which hold up the machine, need some area to install.

Q. WHY HIGHWAY WIND TURBINE BLADES ARE PLACED VERTICALLY ?

Highway wind turbine blades are often placed vertically (in a vertical axis wind turbine or VAWT design) for several reasons, especially in the context of installation along highways or in areas with varying wind conditions:

1. **Space Efficiency**: Vertical-axis turbines are more compact and efficient in terms of space. Since highways are narrow areas, these turbines can be designed to fit without taking up too much room, especially in areas where horizontal-axis turbines (HAWTs) might not fit well.

2. **Omni-Directional Wind Capture**: VAWTs can capture wind from any direction without the need to be oriented towards the wind, unlike horizontal turbines, which must be pointed into the wind to operate optimally. This is particularly useful along highways, where the wind direction can change frequently due to the high-speed movement of vehicles and varying terrain.

3. **Lower Impact of Wind Shear**: At highway height, the wind can have turbulence or varying speeds due to the movement of vehicles. Vertical turbines tend to handle these variable wind speeds better because their design allows them to keep spinning efficiently, even in less consistent winds.

4. **Reduced Noise and Visual Impact**: VAWTs tend to be quieter than traditional horizontal-axis turbines, which is important in areas with a lot of traffic, like highways. Additionally, the design is often less visually intrusive and can blend better with the surrounding environment.

5. **Durability and Safety**: Vertical-axis wind turbines tend to have fewer moving parts at higher elevations, reducing the likelihood of damage due to debris (e.g., rocks, dirt) from the highway or the wind. They also reduce safety concerns related to high-speed traffic by keeping the turbines at a safer height.

These factors make vertical-axis wind turbines ideal for environments like highways where space, safety, and functionality are important.

RESULTS

In this project highway wind turbine i.e. vertical axis wind turbine using we generate electricity and generated electricity stored in battery.

CONCLUSION

Conclusively, extensive data is collected on wind patterns produced by vehicles on both sides of the highway. Using the collected data, a wind turbine is designed to be placed on the medians of the highway. Although one turbine may not provide adequate power generation, a collective of turbines on a long strip of highway has potential to generate a large amount of energy that can be used to power streetlights, other public amenities or even generate profits by selling the power back to the grid. This design concept is meant to be sustainable and environmentally friendly. Additionally, a wind turbine powered by artificial wind has a myriad of applications. Theoretically any moving vehicle can power the turbine such as an amusement park ride. The highway wind turbine can be used to provide power in any city around the globe where there is high vehicle traffic.

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PROJECT PHOTO