

Hybrid Renewable Energy Generation using Piezoelectric and Solar

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Abstract- — The increasing demand for electrical energy and the rapid depletion of conventional energy resources have made renewable energy sources an important alternative for sustainable power generation. This paper presents a hybrid renewable energy generation system that utilizes both solar energy and piezoelectric energy for electricity generation. Solar panels convert sunlight into electrical energy using photovoltaic cells, while piezoelectric sensors generate electrical energy when mechanical pressure such as human footsteps is applied. By combining these two energy sources, the efficiency and reliability of energy generation can be improved. In this system, solar energy is used as the primary source of power during daytime, while piezoelectric sensors generate electricity from mechanical pressure created by human movement in crowded areas. The electrical energy generated from both sources is stored in a rechargeable battery and can be used to power small electrical loads such as LED lighting systems, sensors, or low-power electronic devices. This hybrid renewable energy system can be implemented in public places such as railway stations, bus stands, shopping malls, and footpaths where human movement is frequent. The system helps in utilizing wasted mechanical energy and natural solar energy effectively. The proposed system contributes to energy conservation, reduces dependence on conventional power sources, and promotes the use of clean and sustainable energy technologies.

Keywords: ybrid Renewable Energy System, Solar Energy, Piezoelectric Energy Generation, Photovoltaic Cells, Sustainable Power Generation, Energy Harvesting, Renewable Energy Technology, Energy Storage, Clean Energy, Footstep Power Generation.

INTRODUCTION

Energy plays a crucial role in the development of modern society. With the rapid growth of population and industrialization, the demand for electrical energy is increasing continuously. Conventional sources of energy such as coal, petroleum, and natural gas are widely used for electricity generation, but these sources are limited in quantity and cause serious environmental pollution. The burning of fossil fuels releases harmful gases that contribute to global warming and climate change. Therefore, it is necessary to explore alternative energy sources that are clean, renewable, and environmentally friendly. Renewable energy sources such as solar, wind, hydro, and geothermal energy are becoming increasingly important for sustainable power generation. Among these, solar energy is one of the most widely used renewable energy sources because it is abundant, freely available, and easy to harness. Solar panels convert sunlight into electrical energy using photovoltaic cells. However, solar energy generation depends on sunlight availability and cannot produce electricity efficiently during nighttime or cloudy weather conditions.

Another innovative method for generating electricity is piezoelectric energy harvesting. Piezoelectric materials have the property of generating electrical voltage when mechanical pressure or vibration is applied to them. This phenomenon is known as the piezoelectric effect. When people walk on surfaces equipped with piezoelectric sensors, the mechanical pressure from footsteps can be converted into electrical energy. This technology can be implemented in areas where large numbers of people walk every day, such as railway platforms, bus stops, shopping malls, and public pathways. In this project, a hybrid renewable energy system is developed by combining solar energy and piezoelectric energy generation. The integration of these two renewable energy sources increases the overall efficiency and reliability of power generation. Solar panels provide continuous energy during daylight hours, while piezoelectric sensors generate electricity from human movement. The generated electricity is stored in batteries and can be used for low-power applications such as LED lighting. This hybrid system demonstrates an innovative approach for generating clean and sustainable energy while utilizing natural and human resources effectively.

II. SYSTEM OVERVIEW

The proposed hybrid renewable energy generation system consists of two main energy sources: solar panels and piezoelectric sensors. These two sources work together to generate electrical energy that can be stored and used for various low-power applications. Solar panels are used to convert sunlight into electrical energy using photovoltaic cells. When sunlight falls on the surface of the solar panel, the photovoltaic cells generate direct current (DC) electricity. This electricity can be used directly or stored in batteries for later use. Piezoelectric sensors are used to generate electricity from mechanical pressure or vibrations. When pressure is applied to the piezoelectric material, such as when a person walks on a surface equipped with these sensors, an electrical voltage is produced. However, the output from piezoelectric sensors is usually in the form of alternating current (AC) and needs to be converted into direct current (DC) before it can be stored in a battery. To convert the AC output from piezoelectric sensors into DC, a bridge rectifier circuit is used. The rectified output is then combined with the DC output from the solar panel and stored in a rechargeable battery. The stored energy can be used to power small electrical loads such as LED lights, sensors, or other low-power electronic devices. This hybrid system ensures continuous energy generation because it utilizes both natural energy (sunlight) and mechanical energy from human movement. Even when solar energy is not available, piezoelectric sensors can still generate electricity from footsteps in crowded areas. Therefore, the combination of these two energy sources improves the efficiency and reliability of the system.

III. LITERATURE SURVEY

- In recent years, researchers have focused on developing renewable energy systems to reduce dependence on conventional energy sources and to promote sustainable energy solutions. Solar energy systems are among the most widely studied renewable energy technologies due to their simplicity and availability. Photovoltaic solar panels are commonly used to convert sunlight into electrical energy for residential, commercial, and industrial applications.
- Several researchers have also explored piezoelectric energy harvesting technology as a method of generating electricity from mechanical vibrations and pressure. Piezoelectric materials can generate electrical voltage when mechanical stress is applied to them. This technology has been used in various applications such as energy

harvesting from road traffic, railway tracks, and pedestrian walkways.

- Hybrid renewable energy systems have also gained significant attention in recent years. These systems combine two or more renewable energy sources to improve the reliability and efficiency of power generation. By integrating solar energy with piezoelectric energy harvesting, it is possible to generate electricity from both natural sources and human activities.
- Previous studies have shown that hybrid renewable energy systems can provide a more stable and continuous power supply compared to single-source systems. The combination of solar and piezoelectric energy can effectively utilize available environmental resources and reduce energy wastage.

IV. OBJECTIVES

- To design and develop a hybrid renewable energy generation system using solar and piezoelectric energy sources.
- To generate electrical energy from sunlight using photovoltaic solar panels.
- To generate electrical energy from mechanical pressure using piezoelectric sensors.
- To combine both energy sources to improve the efficiency and reliability of power generation.
- To store the generated electrical energy in rechargeable batteries for later use.
- To demonstrate the practical application of renewable energy technologies in real-life environments.

V. IMPLEMENTATION DETAILS

Solar Panel

A solar panel is used to convert sunlight into electrical energy using photovoltaic (PV) cells. When sunlight falls on the panel, the PV cells generate DC electricity. This electricity becomes one of the main power sources for the system. Solar energy is clean, renewable, and easily available during the daytime, making it an important component of the hybrid energy system.

Piezoelectric Sensor

Piezoelectric sensors generate electrical energy when mechanical pressure or vibrations are applied to them. In this

project, these sensors are placed in areas where people frequently walk, such as bus stands, railway stations, or public pathways. When people step on the sensors, they produce small amounts of electrical energy which can be collected and used in the system.

Charge controller

The charge controller is used to regulate and control the electrical energy coming from the solar panel and piezoelectric sensors before storing it in the battery. It prevents overcharging and protects the battery from damage. The charge controller also manages the proper flow of electricity so that the battery charges safely and efficiently.

Battery

The battery is used to store the electrical energy generated by both the solar panel and piezoelectric sensors. The stored energy can be used later when sunlight is not available or when there is no mechanical pressure on the sensors. This ensures continuous power supply for the system.

DC Load / LED Lights

The stored electrical energy in the battery is used to power DC loads such as LED lights. LEDs are energy-efficient and require very little power to operate. In this project, LEDs demonstrate how the generated energy can be used for practical applications like lighting in public places.

Hybrid Energy Integration

This project combines two renewable energy sources: solar energy and piezoelectric energy. By integrating both sources, the system becomes more efficient and reliable. During the daytime, solar panels generate electricity, while piezoelectric sensors generate energy whenever people walk over them. This hybrid approach maximizes energy generation and improves the overall performance of the system.

VI. ADVANTAGES

- Utilizes renewable and environmentally friendly energy sources.
- Reduces dependence on conventional electricity generation methods.
- Generates electricity from both natural and human activities.
- Simple and cost-effective system design.
- Suitable for smart city and sustainable energy applications.

VII. APPLICATIONS

- Railway stations\
- Bus stands
- Shopping malls
- Public footpaths
- Smart city infrastructure
- Airports and public transportation areas

VIII. CONCLUSION

The hybrid renewable energy generation system using solar and piezoelectric energy provides an efficient and sustainable method for producing electricity. By combining these two energy sources, the system can generate power continuously from both sunlight and human movement. This hybrid approach improves the efficiency and reliability of renewable energy generation. The system can be implemented in public places where both sunlight and human movement are available. It helps in utilizing wasted mechanical energy and contributes to energy conservation. The proposed system promotes the use of renewable energy technologies and supports the development of sustainable energy solutions for the future.

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