Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 57 Issue: 06:2024
DOI: 10.5281/zenodo.12516221

SUSTAINABLE ELECTRICAL ENERGY GENERATION USING CONCRETE BARRIERS APPROACH

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Abstract

Harnessing renewable energy sources is crucial in our fight against climate change. This paper introduces a novel approach to sustainable energy production by harnessing wind energy from traffic and ambient air currents on public roads. The world is now moving towards exploiting sustainable resources that make the world a better place without pollution. However, this paper presents a new idea that shows how traffic can generate energy, what compounds we need, and how to use it.This article focuses on finding a new way to generate energy from underutilized resources. And reviews the literature on this topic. The paper aims to understand the importance of natural resource exploitation, which will save many costs and help maintain environmental conservation to reduce the effect of climate change.The proposed system offers solutions for interconnected problems by advocating for integrating sustainable energy systems into highway safety equipment.

Keywords: Sustainable Energy, Clean Electrical Power, Alternative Energy, Roadside Infrastructure, Energy Production.

1. INTRODUCTION

This paper proposes a new way to generate clean electricity by capturing wind energy from traffic and air currents along highways. This new method combines civil engineering, transportation, and sustainability to create a multifaceted advancement in infrastructure design. By merging construction equipment for public roadways with traffic safety mechanisms, the creation represents a multifaceted advancement in infrastructure innovation.

Global energy demands are rising, coupled with growing concerns about air pollution from traditional energy sources.

Electricity is generated using environmentally friendly alternatives, including sunshine, wind, water, and other natural processes in renewable energy systems.

This paper will focus on evolving the energy source from the concrete barriers that produce electrical energy.

The structure of the article will be as follows. This section offers an introduction. The second section provides a literature review of this paper. The third section presents background information on the topic. The fourth section describes the purpose of the system structure. Finally, the fifth section is the conclusion of the paper.

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2. LITERATURE REVIEW

There is a significant number of research articles in the subject of solar energy due to its status as a green and sustainable energy source.

This is attributed to several factors:

- **Renewable and Sustainable:** The sun's energy is constantly replenished, unlike fossil fuels, which take millions of years to create. This makes solar power a sustainable solution for our energy needs.
- **Clean:** Solar panels themselves don't produce any emissions during electricity generation. This means they combat climate change by reducing reliance on fossil fuels.
- **Maturing Technology:** The efficiency and affordability of solar panels is constantly improving, making them a more attractive option.

Researchers constantly look for ways to improve green energy technology, increase efficiency, and reduce costs. This includes things like:

- Developing new materials for solar panels
- Improving energy storage solutions for solar power. [1].
- Creating more affordable and efficient ways to install solar systems.[2].
- The Environmental Consequences of Manufacturing and Disposing Solar Panels [3]

City streets in developed countries have resources that are not used. Cars constantly transfer energy to the unused pavement, while sunlight heats the roads, creating a temperature difference that also holds energy. More than 50% of the world's population lives in cities today. In a study conducted by researchers from the Korea Institute (Kang, Won, & Korea, 2010), they examined the possibility of harvesting solar energy from road pavements using solar cells embedded in the pavement infrastructure. They have determined that current thin-film solar cells are not easy to use on surfaces that receive a mechanical load and that environmental conditions can cause premature wear and tear. Because of these reasons, researchers are experimenting with the development of a new type of thin-film solar cell that fulfils the demands of use on road surfaces [4].

In recent years, researchers have developed numerous methods to reduce environmental wasted energy. Researchers are exploring various methods to harvest electricity from roads, focusing on capturing the mechanical energy from vehicles due to its high efficiency. Piezoelectric materials are particularly promising for this application. They generate electricity that can be embedded in different shapes within the pavement. While they offer high power density and voltage, some types can be brittle and degrade over time under constant pressure. Considering these factors is crucial when designing a piezoelectric energy harvester for roads. Special materials called piezoelectric can turn road vibrations into electricity. These come in two main Flavors.

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Piezoceramics: These are strong and produce more electricity, but they are also brittle. A common example is lead zirconatetitanate (PZT). Piezopolymers: These are flexible and easier to work with, but they do not generate as much electricity. Polyvinylidene fluoride (PVDF) is a type of piezopolymer. Piezoelectric materials can shaped like discs, plates, or beams and placed in different ways on roads. Discs seem promising for asphalt because they work well at low vibration frequencies. However, the constant pressure from traffic can damage them over time. When designing these energy harvesters, we need to consider how the materials will hold up under long-term use.[5]

Hengwu Hu and Domenico Vizzari state the importance of renewable energy to replace fossil energy sources. The concept of solar pavement, which harvests energy sustainably and is environmentally friendly, has captured a lot of attention as a potential new highway transportation infrastructure. The goals include turning the road system from an energy consumer to one that provides energy and reducing or eliminating pollution at the energy source. Nevertheless, the advantages earned from solar pavements are only enough to cover the cost over a 20-year lifetime, and it would be more economically appealing if the total cost of solar was lower than 0.2 $/kWh. Energy harvesting is one of the most challenging processes that exists that can help solve the global energy demand without consuming natural resources. Solar roadways are special pavements that use solar panels to generate electricity, powering traffic lights and other roadside equipment. They can even help reduce pollution and cool down our cities. Thanks to advancements in solar power technology, the cost of solar panels has dropped dramatically. This paves the way for solar pavements to become a reality. There is a lot of research going into how much power these pavements can generate, but there are still some challenges. The upfront cost is high, and we need to figure out the best way to design and build them. By understanding these issues, we can move forward and make solar roadways a success. [6]

Gholikhani said that to address safety and energy generating in transportation simultaneously you should use the electromagnetic-based technology, as it is one of the most promising technologies to generate electrical power. He has developed the technology named Dual Electromagnetic Speed Breaker Energy Harvester (DESE). DESE is a novel speed bump that lowers vehicle speeds like conventional speed bumps. In addition, it captures the energy wasted between the vehicle and the speed bump to generate electrical power. The proposed device will be implemented in a roadway structure and perform as a speed bump to capture wasted energy from passing vehicles and generate power for safety devices and real-time traffic monitoring systems. Consequently, the demand will decrease for energy for road infrastructure. Moreover, we can achieve the goal of generating electrical energy [7].

Researchers are developing innovative ways to transform roadways into mini power plants. While electromagnetic harvesters take the crown for power output ideal for powering lights and amenities. Their impact on traffic flow and maintenance costs makes them a less widespread option. Piezoelectric harvesters are weatherproof and embedded in the pavement, but their lower power and higher cost make them suitable

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for low-power applications like sensors. Thermoelectric and solar PV (Photovoltaic) harvesters offer a mid-range power option and are relatively cheap and easy to install, but their dependence on weather conditions restricts their output. They are best suited for low-power applications. Another method is by using ASC (Asphalt Solar Collector) to capture energy from roads by using them as giant solar collectors. Instead of just absorbing sunlight, the road can be made to collect heat like a solar panel. Pipes and pumps would place under the road to capture this heat. Similarly, "Green Roads" are another concept in development. Its design would capture wasted heat from cars and sunlight to generate energy, while also lasting longer. To achieve this, the road surface would need special materials that absorb and store heat better [8].

3. BACKGROUND

Over the past decade, Climate change and global warming have brought serious challenges to the world. This necessitates the urgent development of innovative solutions for sustainable energy generation. Here are some problems with the traditional way:

(a) Unsustainable power sources limit the effectiveness and autonomy of safety equipment, especially in remote areas.

(b) Remote locations with limited access to power grids struggle to operate safety equipment for highways.

(c) High costs of supplying power to remote areas or building grid connections limit safety equipment deployment, especially in struggling economies.

(d) Traditional power sources for safety equipment pollute the environment And climate change.

Overall, the invention offers solutions to these interconnected problems by advocating for the integration of sustainable energy systems into highway safety equipment. By addressing these challenges, the proposed approach has the potential to improve road safety, enhance infrastructure resilience, reduce environmental impact, and promote economic sustainability.

Clean energy is on the rise, and global economies are changing. This has a big impact on fossil fuels. For the first time, a major energy report predicts that demand for coal, oil, and natural gas will hit its peak sometime this decade, assuming current policies stay in place. This means fossil fuels will make up a smaller share of the world's energy mix, dropping from around 80% today to 73% by 2030. Even better, carbon dioxide emissions linked to energy use are expected to peak by 2025. Rising global energy demand, fuelled by fossil fuels, has led to increased greenhouse gas emissions and environmental damage. The IEA predicts a significant increase in global energy demand by 2030 (45%). Despite this, fossil fuels expected to remain dominant, supplying 60% of the world's energy needs [9].

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Cities will overgrown with 2.5 billion more people expected by 2050; we urgently need to make them sustainable. Since Cities are being hit with a double whammy by climate change. They cause most of the pollution that is warming the planet, but they are also particularly vulnerable to the resulting extreme weather. Therefore, the perfect solution is sustainable cities. We need to use less energy, especially in buildings and transportation, and rely on clean, reliable renewable sources like solar and wind. While technology advancements are promising, challenges like cost and policy need to be addressed to make these sustainable cities a reality [10].

4. THE PROPOSED SYSTEM

A concrete barrier has side cavities Fig. 1. (a), that work to suck out the air resulting from traffic movement on highways. Inside is an axis wind turbine generator Fig. 1. (b), to supply road safety equipment with electrical energy necessary for sustainable operation. As shown in the fig.1

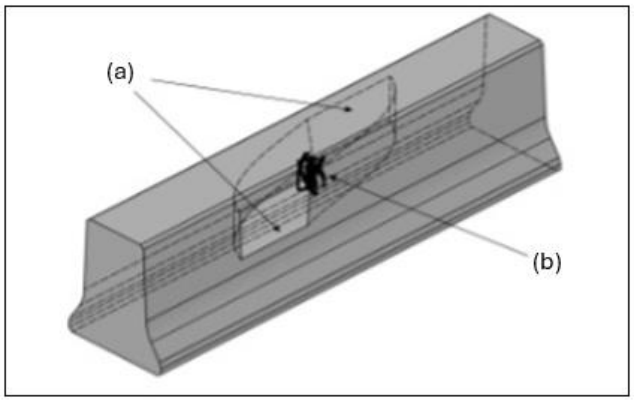

Figure 1: Concrete barrier structure

The proposed system represents integrating construction equipment designed for public infrastructure with alternative energy systems, facilitating the sustainable operation of traffic safety devices and equipment. The system bridges multiple disciplines, including civil engineering, aerodynamics, and renewable energy, to create a synergistic solution The concrete barrier Fig.1 includes cavities that suck out air resulting from the movement of cars on highways or low air currents resulting from natural winds on public roads. It is designed in an engineering shape that ensures the dynamic movement of air entering the helical wind turbine Fig.2.(a), which generates electrical energy from the movement of wind. The concrete barrier that produces electrical energy contains:

An alternative energy generator Fig.2 (b), wind energy, to convert kinetic energy into sustainable electrical energy.

A Helical wind turbine Fig.2. (a) One of its properties is that it rotates efficiently at low wind speeds.

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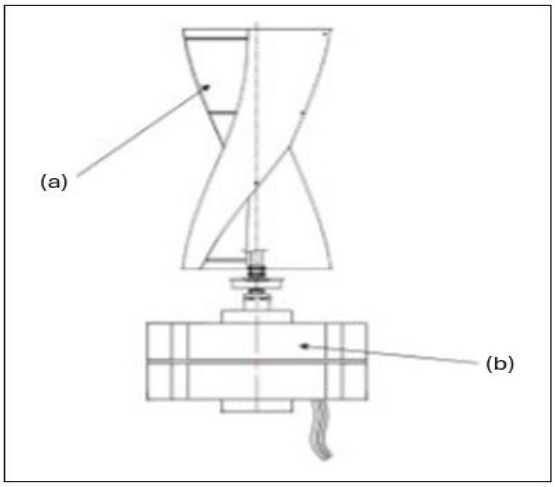

Figure 2: Shows the helical wind turbine and alternative generator.

A simple electrical circuit to store electrical energy at the source (dry batteries) to supply cat eyes and other safety equipment with the necessary electrical energy Fig.3. The concrete barrier that produces electrical energy is made of Cement and metal corsets and contains geometrically designed cavities.

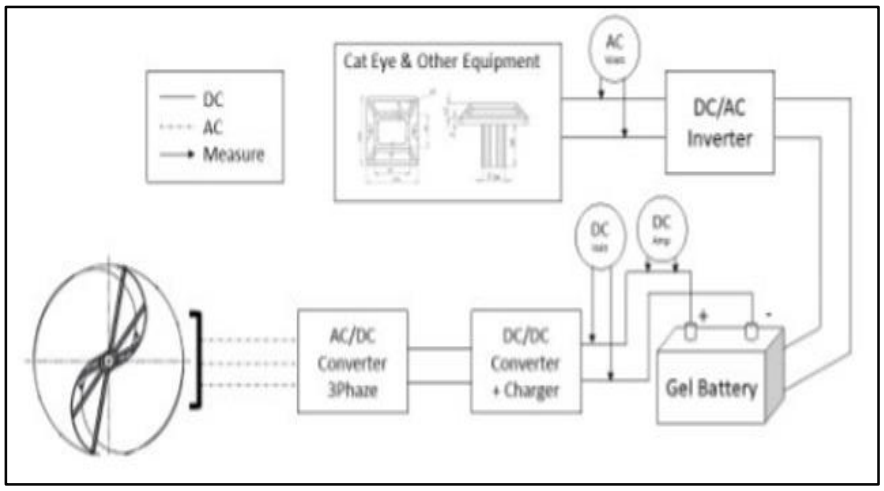

Figure 3: The proposed system's electrical circuit

5. CONCLUSION

To sum up, Harnessing wind energy from traffic and air currents. These barriers can generate clean electricity to power safety equipment, eliminating reliance on unsustainable sources and reducing environmental impact. This approach is particularly beneficial in remote locations where the grid connection is limited, improving safety and resilience while promoting economic feasibility for developing regions. By integrating renewable energy into highway infrastructure, this invention paves the way for a greener

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and safer future for our transportation systems. The literature review explores existing methods to harvest energy from roads. Solar panels, piezoelectric materials, and electromagnetic speed bumps are promising solutions, but all have limitations. The focus then shifts to the need for sustainable energy for highway safety equipment, highlighting challenges in remote locations. This design offers several advantages like Sustainability, Self-sufficiency, Cost-effectiveness, and Multi-functionality. However, further research and development needed to address potential challenges like efficiency to optimizing the design to maximize wind capture and energy generation is crucial. Cost analysis to comprehensive cost analysis, including installation and maintenance, is necessary for economic feasibility assessment.

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