

SOLAR PAVEMENT: SMART MEANS OF TRANSPORTATION

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Abstract

Roadways are major infrastructure for connecting people and providing access and mobility. The traffic induced strains and stresses generated by the vehicles can be potentially used for energy harvesting purposes. Piezoelectric devices are ideal candidates for harvesting energy in asphalt pavement roadways as they convert mechanical strain energy into electric voltage. Considering the best combination of variables, the piezoelectric devices could be ideal candidates for harvesting energy in asphalt pavement roadways. Photovoltaic pavement is a form of pavement that generates electricity by collecting solar power with photovoltaics. Parking lots, footpaths, driveways, streets and highways are all candidate locations where this material can be used. This paper highlights the working and benefits of solar panel roadway.

Keywords:

Infrastructure;
Photovoltaics;
Traffic;
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Streets;

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1. Introduction

With increasing concern of global warming and the depletion of fossil fuel reserves, many are looking at sustainable energy solution to preserve the earth for the future generations. Other than hydro power, vibration and photovoltaic energy holds the most potential to meet our energy demands [1]. The vibration energy is capable of providing large amounts of power but its presence is highly uncertain as it can be here one moment and gone in another. Similarly, solar energy is present throughout the day but the solar irradiation levels vary due to sun intensity and unpredictable shadows cast by clouds, birds, trees, etc [2]. The common inherent drawbacks of vibration and photovoltaic systems are their intermittent natures that make them unreliable. However, by combining these two intermittent sources and incorporating maximum power point tracking (MPPT) algorithm, the system's power transfer efficiency and reliability can be improved significantly. When a source is insufficient, the load demands some other energy sources to compensate for the difference [3]. Several hybrid vibration power systems with MPPT control have been proposed and discussed in works [4-5]. Due to advancement in the field of technology in recent years, wireless data transmission techniques are commonly used in electronic devices. For powering them we rely upon power supply through wires charging, else power may be supplied from batteries [6]. But while travelling for longer distances continuously we may not be able to obtain power supply for these devices to operate or to recharge their batteries. So in order to operate them continuously we need a power source that provides continuous energy to operate these devices [7-8]. The mechanical vibrations which are produced by the automobiles can be utilized as a source of energy for generating electrical energy that can be utilized by this electronic equipment to operate [9-10]]. These vibrations are produced by different vehicles around us which are going as a waste. Piezoelectric materials is used by this technique, where deformations done by the vibrations are directly converted into the electrical charge via piezoelectric effect and principle of electromagnetic induction between coil and magnetic field that produces Electromotive force (EMF) in the coil and so it provides displacement to the performance magnet by the vibrations[11]. All the piezoelectric materials and magnets are used as the energy conversion devices for converting mechanical vibrations into electrical energy. In this context, we introduced two methods and considered its output performance provided input vibrations, by using piezoelectric materials such as piezoelectric for electromechanically conversion using Mass- spring system as medium of conversion of force

from vibrations applied on piezoelectric materials and by using spring-magnet system where relative displacement of magnet with respect to coil, provided input vibrations generates Electromotive force in coil. Figure.1 [12].

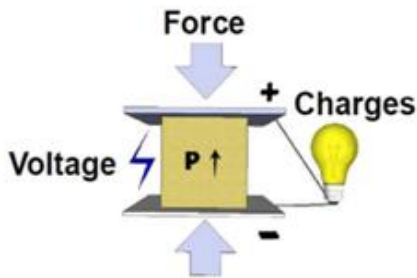


Figure 1. Piezoelectric effect [12]

2. Working of Solar Panel Roadway

The main purpose of solar roadways is to replace asphalt roads with Solar Panels which generate energy through the sun that can be used by local houses or businesses that are connected to the system from either the house's driveway or the businesses parking lot. The panels will also increase the number of charging stations for electric cars if that station is connected to the solar roadway. Each panel is roughly 12' by 12' of interlocking panels that have their own LED lights that will be used as the road lines, and can also be used to spell out words like "Reduce Speed" or "Traffic Ahead" to help the flow of traffic [13-14].

There are 3 layers that make up the solar panels as shown in figure 2[13]:

a. The Road Surface Layer - The Road Layer is the High Strength layer that has the photovoltaic cells which attracts the sun's rays, it has traction so vehicles don't slide off the road, and it's waterproof to protect the layers below.

b. The Electronic Layer - The Electronic Layers contain a mini microprocessor board that helps control the heating element of the panels, this technology can help melt the snow that lands on the panels so that hazardous road conditions will no longer be an issue in the more northern regions. This layer can sense how much weight is on the panels and can control the heating element to melt the snow.

c. The Base Plate Layer - The Base Plate Layer is the layer that collects the energy from the sun and distributes the power to the homes or businesses that are connected to the solar roadways. This will also be used to transfer the energy to cars as they drive over the strip to recharge the battery[14].

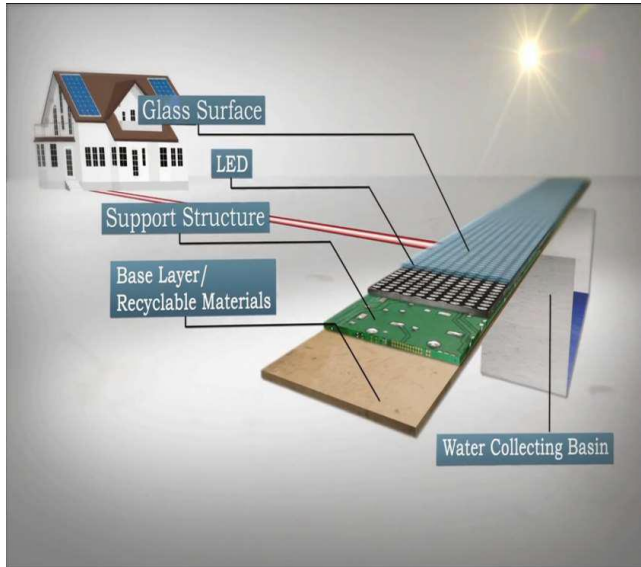


Figure 2. Basic 3 layers of solar panel roadway [13]

3. Features of Solar Roadways

a. Accident can be avoided: The roadways can protect wildlife and motorists. The load cells in the solar panels can detect if something is on the surface of the panel. It acts like a weigh machine[15].

b. Illuminated roads : The solar roadways will have leds which will illuminate the lanes. The leds can be programmed to show the instructions such as - slow, stop, go, speed limit, etc.

c. Electric Vehicles: Electric vehicles are on the way. More and more car manufacturers are offering electrical option. EVs can be rechargeable at any convenient located rest stop or at any parking lots. Owners can plug their car in and recharge while not driving.

d. Snow/ ICE Management : The roads heat themselves with their embedded heating elements and melt away all the snow.

e. Intelligent Highways: It pays for itself. Telephone, cable TV, and high-speed internet, Intercommunication between road and cars to avoid collision. It is an Embedded Tracking system [16-17].

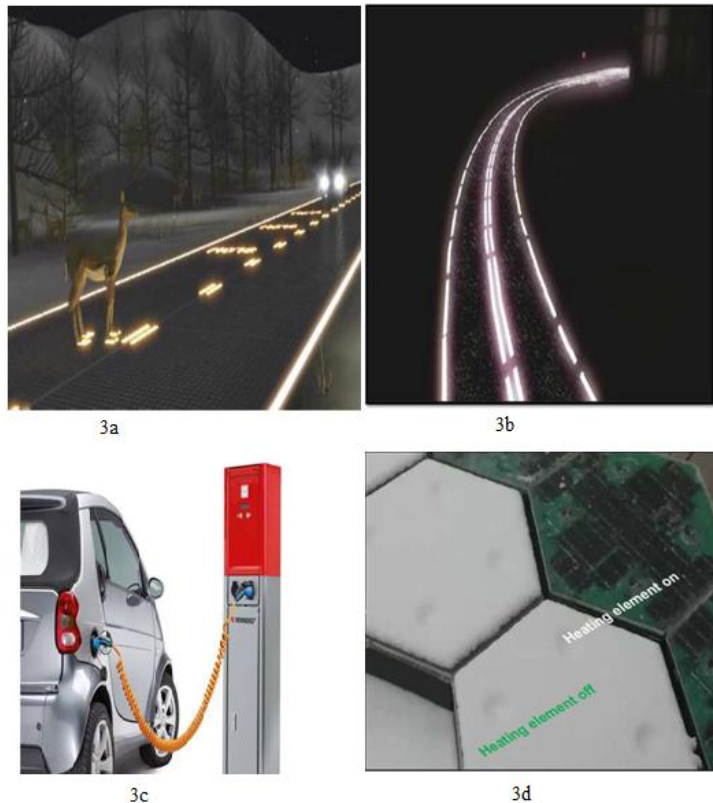


Figure 3. Different features of Solar Roadways [14]

4. Conclusion

Solar Roadways has taken the first step to creating the world's largest solar panel. For roughly the same cost of the current systems (asphalt roads and fossil fuel burning electricity generation plants), the Solar Roadways can be implemented. There would be no more Global Warming in solar roads. No more power outages (roaming or otherwise). When compared to conventional roads, solar roads have safer driving conditions. Solar roadways are having far less pollution when compared to other roads. Even though the initial cost is high, as it is a system that pays for itself it is a better choice. For under developed and developing countries, it might seem impractical now. But it can be adopted in stages, in future. With technological upgradation in this field, jobs, clean energy and a safer transportation system can be made.

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