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The Need for Renewable Energy

Currently, the world functions around the commercial need for energy, whether it is renewable or non-renewable. However society tends to utilize non-renewable sources of energy more often than renewable. This trend is detrimental to the longevity of environment society thrives in.

- 11% of the United States energy comes from renewable sources such as wind, hydroelectric, solar, etc.
- Renewable sources of energy such as Solar Panels have been very expensive.
- An $18,000 solar roof can take as long as 20 years to pay for itself.
- Warming effects caused by the greenhouse gases on earth has increased by 37% from 1990 to 2015.
- 30% of that increase is due to carbon dioxide alone.

Solar panels, while one of many types of renewable energy that is becoming more readily available, is one of the most promising, and will be the solution that is focused on by their implementation into roads and other impervious surfaces.

Photovoltaic Cells

History

Solar energy dates back to the 1800s when W. Adams and R. Day discovered that selenium produced electricity when exposed to light. The first solar cells were made available to the public in 1956, and over the next 50-60 years a 1 Watt cell went from costing $300 to $20.

How They Work

Photovoltaic cells are made of a thin layer of phosphorous-doped (N-type) and boron-doped (P-type) silicon. When the two are put together they create an electric field that allows a flow of electrons when light strikes the cell. When these two slabs of material are brought together, free electrons from the N-type jump to the P-type, and then form a barrier to prevent any further movement of electrons between the sides. This is called the P-N junction. The photons of energy hit the junction, knocking electrons loose. The electrons are attracted to the N-type and forced out through the connecting wire, creating a current which can be harnessed. The power output from a cell depends on efficiency, surface area, and intensity of the light striking.

Solar Roadways

Solar Roadways is a company based out of Idaho that was founded by a husband and wife, Scott and Julie Bursaw. They founded the company Solar Roadways in 2006 with the idea that if every impervious paved surface in the United States were replaced with a solar panel, it would not only provide unprecedented amounts of renewable energy back to the people, but also revolutionize and modernize the power grid and infrastructure of the United States. They have received about $1.6 million from the US Department of Transportation to help progress their project and make their idea a reality.

Design

The first design for the panels was a 12-foot by 12-foot panel, but they have since created a third generation panel, the SR3. This smaller 48-Watt panel, which covers 4.39 square feet and weighs about 110 pounds, can be installed much more easily and can more easily accommodate the irregular shape of roads. Each panel is designed to last about 20 years, while each solar cell are not meant to last more than 30 years.

Glass

The glass used for the panels has to meet 4 criteria: hardness, strength, durability, and transmittance.

- There are currently two textures for the glass, one that can stop a vehicle traveling 40 mph and another that can stop a vehicle going 80 mph in the required distance.
- The glass is rated to withstand up to 250,000 pounds, which is approximately the load of oil companies moving refinery equipment.
- The glass is much stronger than asphalt, and because is panel is hermetically sealed, no water can get in to damage the panels.
- Any dust that accumulates on the road will either be swept away by the draft of cars or can be easily removed with a street-sweeper.
- Skid marks do not adhere to the glass, allowing them to come off with ease.
- The glass can be treated with titanium oxide every few years which would make any oil spills on the road turn into dust.

LEDs

Each panel is embedded with an LED light system, eliminating the need to paint road lines. This will save an estimated $2 billion a year in costs. This improves vision at night and during inclement weather, with the ability to vary light intensity at different points of the day. Each panel is also equipped with a microprocessor in order to sense weight changes. When a pedestrian crosses a road, the system will cause the LED lights to flash.

Heating

Each panel is embedded with a heating system designed to maintain a temperature above freezing to protect the panels. These are also implemented to ensure safety of the drivers in snowy regions (70% of the population). This saves money, snow removal time, and enhances safety.

Cable Corridor

The Cable Corridor offers a home for the wires that transport the energy harnessed by these cells. This eliminates the need for the typical power lines, enhancing safety of workers and the possibility of damage caused by high winds. The corridor also offers a water management system, collecting storm run off, improving safety and collecting the pollution from the run-off water.

Energy

Decentralized System

After collection, the energy harnessed is stored in a virtual grid. The power can be drawn back as needed. Typical power systems use a centralized system, causing the power to be transported long distances. Solar Roadways uses a decentralized system, the energy is used at the point it is collected. The power can then be stored in the grid or in rechargeable batteries.

<table>
<thead>
<tr>
<th>Numbers</th>
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<tbody>
<tr>
<td>Total Watt Hours in United States</td>
<td>8,766,000 miles</td>
</tr>
<tr>
<td>Wattage of Panel</td>
<td>45 Watts</td>
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<tr>
<td>Total Impervious Surface Area</td>
<td>32,569 square</td>
</tr>
<tr>
<td>Peak Hours of Day/night per Year (hours * 365)</td>
<td>1650 hours</td>
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<tr>
<td>Efficiency due to Angle</td>
<td>60%</td>
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<tr>
<td>Efficiency due to Odors</td>
<td>88.85%</td>
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<tr>
<td>Energy Used for Lighting</td>
<td>6,167 kWh (line volts * circuit)</td>
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<tr>
<td>Energy Used for Microwaves</td>
<td>106.511 kWh (line volts * circuit)</td>
</tr>
<tr>
<td>Total Energy Generated After Efficiencies (Total Impervious * 3.33*10^6)</td>
<td>1,022,317 kWh (line volts * circuit)</td>
</tr>
<tr>
<td>Power of Area (P * Total Energy Converted)</td>
<td>0.823 kWh /12 kWh (2,933 billion kWh)</td>
</tr>
<tr>
<td>Net Energy (Energy Collected - Energy Converted)</td>
<td>9.85% (0.71 kWh (823 million kWh))</td>
</tr>
<tr>
<td>Approximate Net Energy (Energy Collected - Energy Converted)</td>
<td>7.23% (0.71 kWh (2,717 billion kWh))</td>
</tr>
</tbody>
</table>

The numbers in the table above explain the calculations that were taken to approximate the amount of energy that could be harnessed if all of the impervious paved surfaces in the United States were replaced with SR3 panels. To put the 7 billion kWh into perspective, the United States uses about 3.5 billion kWh of electricity each year. A note about the calculation though; the heating elements are not included because it is impossible to estimate with any degree of accuracy how often they will be used and how long they will be on.

Costs

Wide scale implementation of Solar Roadways is very expensive, and difficult to get an estimation on because right now they do not exist. However, the money saved each year will add up over time, giving the panels a return on investment. They will also decrease the cost of maintaining infrastructure over time.

Jobs

The implementation of the SR3 will create many jobs. People will be needed to install, maintain, and improve the conditions of the SR3. There will also be many jobs lost because the roads maintain themselves and there will be a significant decrease in the need for jobs within the fossil fuel industry.

Environment

Approximately 30% of greenhouse gases produced from the production of electricity is due to fossil fuels. Adding these panels would virtually eliminate that contribution. It is also hoped that these panels can be modified to charge electric vehicles as they drive over them.