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Solar Power Roads: Revitalising Solar Highways, Electrical Power and Smart Grids

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Abstract—when the phrase "Global Warming" began gaining popularity, The researchers started batting around the idea of replacing asphalt and concrete surfaces with solar panels that could be driven upon. The solar Roadways can save the world from energy crisis and climate change. The day by day the human beings are looking for the answers to our deteriorating highway infrastructure, our crumbling power grid, and the climate crisis. For all such questions the answer is "SOLAR ROADWAYS". An intelligent highway infrastructure and a self-healing decentralized power grid will eliminate our need for fossil fuels and also it will lead to less investment in antiquated technology and overhead power lines. As the day by day the price of petroleum products are getting huge hike & resources are very less there will be no longer feasible material such as asphalt for our road surfaces. When Solar Road Panels are refurnished, the solar cells will be upgraded to newest technology, which will allow keeping up with population growth and increased energy needs.

In 2009, 'solar roadways' in U S received a contract from the Federal Highway Administration to build the first ever Solar Road Panel prototype. During the course of its construction, the technocrats learned many lessons and discovered new and better ways to approach this project. Using this technology No more power shortages, no more roaming power outages, no more need to burn coal (50% of greenhouse gases), Less need for fossil fuels and less dependency upon foreign oil and Much less pollution. How about this for a long term advantage: an electric road allows all-electric vehicles to recharge anywhere: rest stops, parking lots, etc. They would then have the same range as a gasoline-powered vehicle. Internal combustion engines would become obsolete. Our dependency on oil would come to an abrupt end.

Keywords— Global warming, Solar panels, Solar roadways, power generation, Much less pollution, Eliminating fossil fuel

INTRODUCTION

Limitation of petrol, diesel and other fossil fuels in nature will create a resource crisis in near future. It's hazardous pollution and global warming is creating severe environment problem even for the survival of human. So this has attracted attention all around the world and alternative resources and technologies are becoming significant today. Solar energy collected from radiant light and heat from sun had given a range of ever-evolving technologies such as solar voltaic, solar heating, solar thermal energy, solar architecture, satellite based solar power plants and artificial photosynthesis.

The concept of solar roadways is to replace the all traditional fuel driven power generation system by using solar energy plates providing eco-friendly environment and an ultimate infrastructure to meet the energy challenges. The Solar Roadways consists of structurally engineered solar panels that we drive on. Each Solar Road Panel (roughly 12' by 12') interlinks with neighbouring panels to form the Solar Roadways system. The Solar Roadway replaces the traditional crumbling petroleum-based asphalt highway infrastructure with an intelligent road that pays for itself through the generation of electricity. The Solar Roadway generates electrical power from the sun and gives decentralized power, intelligent and self-healing power grid, replacing our current deteriorating power distribution infrastructure.

The Solar Roadway can distribute its electrical power to all businesses and homes connected to the system via their parking lots and driveways (made up of Solar Road Panels). In addition to electrical power, data signals (cable TV, high-speed internet, telephone, etc.) also travel through the Solar Roadways, which acts as a conduit for these signals (cables). This feature eliminates the power lines, utility poles, and relay stations we see all over the countryside. It also eliminates power interruption caused by fallen or broken electrical lines or poles. Solar roadways enabled driving infrastructure would produce three times total electricity demand. There are additional benefits as well, which is a built-in smart grid, major new investment and job creation and the most important clean energy using solar radiations available without cost. The Solar Roadways system would might, at present, cost about three times what it costs to install an asphalt road, but would be more durable more easily replaceable in modular fashion, and able to pay for itself by generating more electricity than our economy can consume. The solar roadways are also driver friendly which can communicate smartly with drivers and alerting drivers with visual messages to the presence of pedestrians in its path. Solar Roadways can pay dividends for the public budget, making our spending on infrastructure more efficient and significantly reducing electricity costs to

consumers and businesses. They can make the emerging electric vehicle far more affordable, and easier to manage. They can help us to eliminate costs of burning fossil fuels by a powerful clean energy technology, capable of rolling back massive pollution and climate change problems. Solar power sources are rapidly becoming cheaper and more reliable , making it feasible to talk about solar power becoming the leading cost-reducing trend in the energy sector, expanding rapidly and have still more potential for major long-term growth.

Figure 1: Solar highway
Source : www.sustainablebrands.com

SOLAR ROADWAYS TECHNOLOGY

The Solar Roadways consists of structurally engineered solar panels. Each Solar Road Panel uses some of its own power to light up embedded LEDs, which "paint" the road lines from beneath the road surface. This feature also allows the traffic controlling messages to be spelled out on the road surface, such as "SLOW DOWN", or "ACCIDENT AHEAD". Road lines can be instantly "repainted" to direct traffic to a single lane or to detour. This eliminates the need for cones or flares. Better visibility at night with the road lines illuminated, it will be like driving on a well-lit runway. The Solar Road Panels heat themselves for snow and ice removal in northern climates. These features give safer driving conditions. The Solar Roadway, being an "electric road", will also make all-electric vehicles more practical. All additional power, unused by the panels themselves is sent to electricity consumers. We could produce three times the total electrical power used by the country and almost enough electricity to power the entire world.
The Solar Roadway produces clean, renewable energy. No pollution, no greenhouse gases, no by-products, and the Solar Road Panels are completely recyclable or reusable. The main cause of global warming is creation of electricity by fossil fuels which will contribute to production of green house gases and effect on ozone layer. The Solar Roadways eliminates this entirely.
The solar panels are divided into three basic layers:-
(a) Road Surface Layer.
(b) Electronics Layer.
(c) Base Plate Layer.

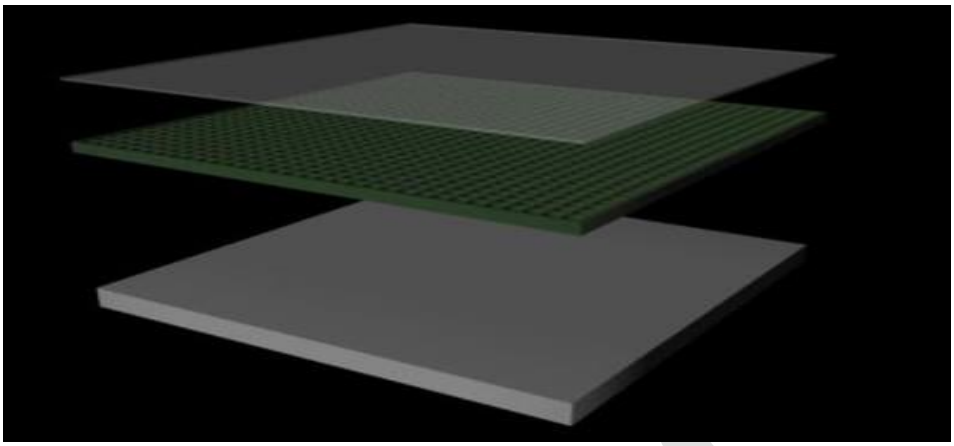

Figure 2: different layers of solar panel
Source : ingenieriaenlared.wordpress.com

Road Surface Layer

As this is the top most layers of the assembly and also from this layer the solar rays will reach up-to the photovoltaic cells; they should be translucent and should have very high-strength. Also this is made in such a fashion that it is rough enough to provide great traction to avoid the skidding of vehicles. As the material is made rough but the material used is translucent, it still passes sunlight through it to the solar collector photovoltaic cells embedded within it, along with LEDs and a heating element. And it is tough enough for handling today's heaviest loads under the worst conditions and it is made water-proof so that it can prevent electronics layer beneath it.

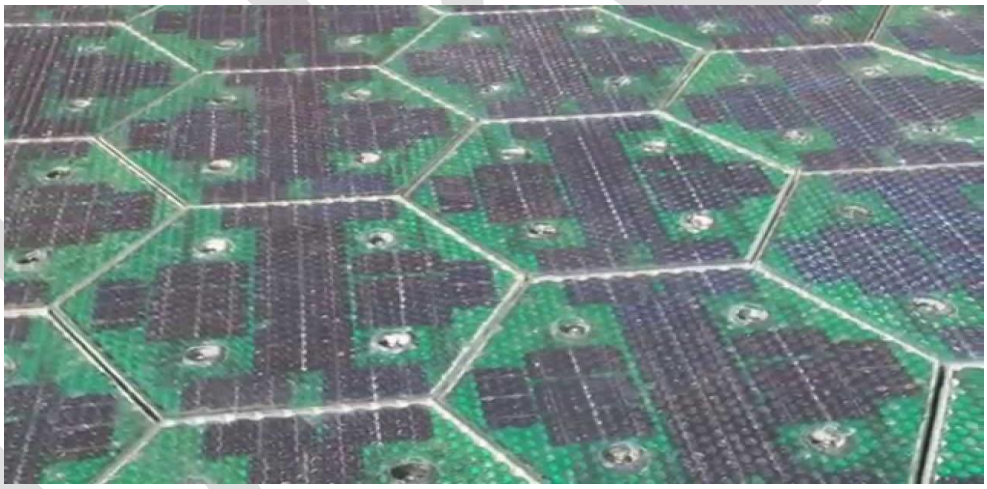

Figure 3 : hexagonal solar panel
Source : www.smartweek.it

Electronics Layer

Electronics Layer Contains a microprocessor board with support circuitry for sensing loads on the surface and controlling a heating element. By implementing this technology there will be no more snow or ice removal problem due to inclement weather in the snow falling regions. A recent study shows that the solar-road studs to light-up the lines of roads during night time in an area of England, which has reduced night time accidents by 70%. There is no need to expend energy lighting desolate roads when no cars are travelling, so the intelligent roadways will tell the LEDs to light up only when it senses cars on its surface - say 1/2 mile ahead and 1/4 mile behind the vehicle as it travels. This way, drivers will know an oncoming car is ahead when they see the lights on the other side of the road begin to light up ahead. The LEDs can also be programmed to move along with cars at the speed limit and it gives warning to the drivers instantly when they are driving too fast or the speed of the car increases beyond the speed limit. The LEDs will also be used to paint words right into the road, it gives warning to drivers if an animal arrives on the road, a detour ahead, an accident or construction

work. Central control stations will be able to instantly customize the lines and words in real time, alleviating traffic congestion and making the roads more efficient. The on-board microprocessor controls lighting, communications, monitoring, etc. which are fitted at every 12 feet distance makes the Solar Roadways as an "Intelligent Highway System".

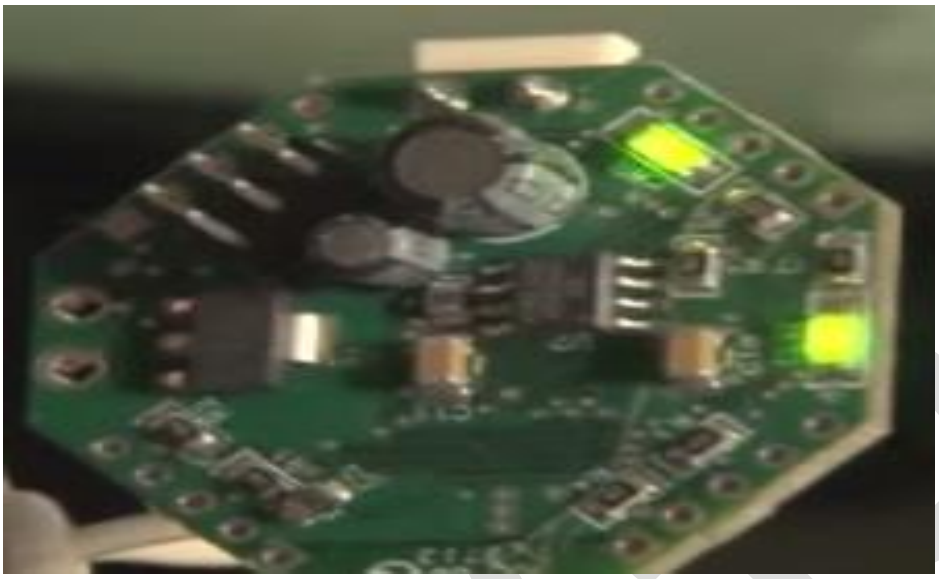

Figure 4 : electronic arrangements in solar panel
Source : thespiritscience.net

Base Plate Layer

While the electronics layer collects energy from the sun, it is the base plate layer that distributes power (collected from the electronics layer) and data signals (phone, TV, internet, etc.) "down-line" to all homes and businesses connected to the Solar Roadway. The base layer is made weatherproof so that it can provide the electronic layer above it.

SOME APPLICATIONS

ILLUMINATED ROADS

Accidents drastically reduced unlike the dark roads we drive on by night today, the Solar Roadways will have LEDs which will "paint" the lanes, and can be instantly customized as needed. Many people face the problem during the night driving as they face the trouble seeing the road lines at night, particularly when the oncoming headlights are blinding them or when it's raining. By implementation of these illuminated roads, the country can over come from this problem & also accidents at night time will get reduced henceforth the night-time driving will be safer for all.

ELECTRIC VEHICLES

Since the Solar Roadway creates and carries clean renewable electricity, EVs can be recharged at any conveniently located rest stop, or at any business places that incorporates Solar Roadways Panels in their parking lots for. Owners can plug-in their cars in and recharge while they're eating or shopping. Engineers are even investigating ways to use mutual induction to charge EVs while they are driving down the Solar Roadway. By the way using electric cars would eliminate most of the other half of the cause of global warming and could virtually wean the world off oil entirely.

SMART GIRD

The Solar Roadways replaces all current centralized power stations including coal and nuclear-powered electricity generation plants. With the Solar Roadway, the road becomes the power grid, eliminating the need for unsightly utility poles and relay stations. Power is generated everywhere - every road, parking lot and driveway. No more power outages, roaming or otherwise. The Solar Roadways generates "secure" energy; it can't be deliberately shut down. Not by terrorists, not by power companies, it simply can't be shut down.

A smart grid would be more automated and more "self-healing," and so less prone to failures. It would be more tolerant of small-scale, variable power sources such as solar panels and wind turbines, in part because it would even out fluctuations by storing energy.

RECENT PROJECT STATUS

This innovation begun in early 2009 and later the company was established by name Solar Roadways in U.S. and awarded a contract by federal government. They started the project by name 'solar roadways' in Idaho, U S. The phase 1 has been completed and second phase also under completion and opened for testing in December 2014. Some latest facts are..

Figure 5: ongoing solar roadways project, Sagle, IDAHO, United states

Source : www.indiegogo.com

- Solar Roadways has received two phases of funding from the U.S. Federal Highway Administration for research and development of a paving system that will pay for itself over its lifespan. They are about to wrap up Phase II contract (to build a prototype parking lot) and now need to raise funding for production.
- The glass surface has been tested for traction, load testing, and impact resistance testing in civil engineering laboratories around the country, and exceeded all requirements.
- Solar Roadways is a modular system that will modernize United State's aging infrastructure. On August 21, 2013, Solar Roadways was selected by their peers as a Finalist in the World Technology Award For Energy, presented in association with TIME, Fortune, CNN, and Science.
- Solar Roadways has given presentations around the country including: TEDx Sacramento, Google's Solve for X at Google's NYC Headquarters, NASA, Keynote Speaker for the International Parking Institute's Conference and much more...
- Solar Roadways is tackling more than solar energy: The FHWA tasked it with addressing the problem of storm water. Currently, over 50% of the pollution in U.S. waterways comes from storm water. So they created a section in their Cable Corridors for storing, treating, and moving storm water.
- The implementation of the concept on a grand scale could create thousands of jobs in the U.S. and around the world. It could allow all the ability to manufacture economic crisis.
- A solar roadway structure with an intelligent system can become the new Smart Grid using wireless power transmission.

CHALLENGES

In spite of these advantages, initially, the start up and maintenance costs of building such roadways and parking lots may be extremely high. (However, advances in this technology will (hopefully) cause the costs to fall.) Another issue to deal with is the efficiency of solar panels. The average efficiency is currently a matter of concern. Another disadvantage is that it cannot be constructed in the poorest developing nations due to the high initial start-up costs. Road surfaces also accumulate rubber, salt, etc., which block sunlight. Salt might be easy to wash off, but not rubber. It would also be quite costly.

Solar roadways may not be feasible and economical as it initial and installation cost may be three times more compared to our convectional roads, but if this is evaluated as a long term investment this may prove to be much more economical as it pays back.

CONCLUSION

Solar Roadways has taken the first step to creating the world's largest solar panel: The Company uses tempered glass and photovoltaic cells to create intelligent, energy-harvesting pavement, complete with built-in heating elements for melting ice and LEDs for signage. The technology is still in its infancy, but with funding from the Federal Highway Administration and an Indiegogo campaign, the company finished a prototype parking lot in Idaho last year. Solar Roadway has released the first pictures of their new Solar Roadways prototype parking lot. Initial installation is complete, with some additions still to come (i.e., covers for mounting holes, mastic between panels, software for LED patterns).The parking lot is fully functional with solar cells, LED's, heating elements, and the textured glass surface. The prototype results show the significance of solar power roads uniquely. However installation cost is very high this new technology is capable of replacing the costly fossil fuel system and can give us clean energy without any climate change.

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