

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 10, October 2019

Go Green with Solar Roadways: - A Review

Kiran Pal Kour¹, Loveneesh Talwar²

Assistant Professor, Department of Electrical Engineering, YCET, Jammu, India¹

Head of Department, Department of Electrical Engineering, YCET, Jammu, India²

ABSTRACT: The intention of the study is to investigate the possibility of solar roads around the world. Solar road is a strained project in terms of constraint used. Solar roads are basically the roads made of high tensile strength material. Smart highways should be enhanced to develop the Nation and make the world go greener in a way that the consumption of fossil fuels would be totally eradicated. Solar roadways use solar panels, PV effect LED's and microprocessor chips with circuitry boards. It has already been implanted in some parts of the world commencing with Netherland. The idea is to make multi-functional, self-sustainable roads that require in substantial upkeep.

KEYWORDS: Solar road, LED, PV, Highway

I. INTRODUCTION

ROADWAYS are the roads made up of mainly asphalt. Solar roadway is a newly developed concept that made to search innovatively to enhance its construction and usage. Solar roadways or smart roadways or solar highways are roads which produces electricity made of silicon wafers, its perfect honeycomb structure like array, gives the durability and can easily replaced. A single layer panel of highway space could generate 61 MW of electricity. With the minimum 15% efficiency, solar roadways would generate around three times the present electricity demand. If there are two layers of solar panels one over the other, the annual energy generation of same highways, can be increased to 229 GWH and 140 GWH are respectively [2]. Solar roads work on a technology that combines transparent surface with under lying solar cells, electronics and sensors to act as a solar array with programmable capability.

II. LITERATURE REVIEW

As impact studies are the major focus of this research, detailed literature review to assess existing studies that have been undertaken to impacts associated with solar highways and PV deployment. In addition, national and international projects experiences that correlate with motorists' safety and ROW operations and maintenance are researched. The potential topics identified in the literature assessment are as follows: The working principle and background of solar array system Administrative controls over ROW management Exploring existing solar highways implemented within the US and the rest of the world Glare from solar panels Current practices and soft wares used to analyze sun glare vision impairment hazards Operations and Maintenance activities associated with PV deployment Operations and Maintenance activities associated with high way management Safety during solar array maintenance Snow drifting and deposition In addition to the literature review, several interviews with key personnel from the industry as well as site visits to existing solar array systems along highways were. The impact-related data and mitigation approaches are the key inputs to model the framework development.

III. CONSTRUCTION OF SOLAR ROAD PANELS

Solar road panels consists of three layers

- Electronic layer: This layer contains a microprocessor board with circuitry embedded for sensing loads on the surface and controlling a heating element.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 10, October 2019

- Base plate layer: With the electronic layer collects energy from the Sun, it is the base plate layer that distributes power collected from the electronics layer and data signals.
- Solar panel: Solar panel is a collection of solar cells. Although each solar cell provide a relatively small amount of power. [1,15]

IV. CONSTRUCTION AND COST CALCULATION

To cover the asphalt surface in the U.S. alone that is roughly will take five billion 12 by 12 solar road panels. Power from road is three times more energy than U.S. used as a nation and also enough to power the entire world. There are over 25,000 square miles of impervious surfaces not including actual buildings. [6,8]

Assumptions

- Solar cell use have a 15% efficiency.
- Only 4 hours of peak daylight hours per day ($4 \times 365 = 1460$ hours per year)

Solar panel offers a 200 Watt model rated at 15% efficiency. Its surface area is 15.16 square feet. If solar panels are use to covered the entire 25,000 square miles of impervious surface, we had get:

$((25,000 \text{ mi}^2) \times (5280 \text{ ft} / \text{mi})^2) / (200\text{W}/15.16 \text{ ft}^2) = 9194722955145.118 \text{ Watts} \sim 9.19 \text{ Billion kilowatts}$

If we calculate only 4 hours of peak daylight hours (1460 hours per year) this gives us: 9.19 Billion Kilowatts x 1460 hours = 13424295514511873.350 Kilowatt-hours (or) ~ 13,424 Billion Kilowatt-hours of electricity. [8]

According to the Energy Information Administration, the U.S. used just over 4,372 Billion Kilowatt-hours of electricity in 2003, while the entire world used approximately 14,768 Billion Kilowatt-hours of electricity total. On each day, hypothetical 4-lane, one mile stretch of solar roadway would produce at least 13,376 kWh of electricity. That's enough to power 500 homes completely "off grid". The solar roadways is designed in such a way that it will be three time more cost than asphalt road and will last for atleast 21 years. The total investment would be around \$48 ft². First solar road officially opened in the small town of Tourouvre-au-Perche in Normandy, France. The cost of one kilometer long (about 0.6 miles) and took \$5.2 million to produce. The double layer laminated glass used as a solar panel can withstand the weight of 250,000 lb, which is four times the weight of semi-truck. [8]

V. FUTURE SCOPE OF SOLAR ROADWAYS

USA, the department of transportation (DOT) granted \$0.1 million to solar roadways for a small business innovation research (SBIR) in 2011. In India the road network is of over 5472,144 Km, it is the second largest network in the world. As per report, India will need to invest US \$1.7 billion on infrastructure projects before 2020. [1,6] .Our hon'ble PM Narendra Modi has promised to start building hundred smart cities in India during his tenure 2014-2019. If we could start implementing solar roadway in these cities it would be far easier to test where viability instead of laying asphalt road first and solar road later and can also check their sustainability. The solar road way alternative could be made at less cost with an energy return while phasing out the old system. Whenever fiscal dilemmas become the primary motivating factor for a state, the option of solar roadway should be encouraged and opened. [6]

Solar roadway will answer our nation problem in the field of

- Transport pollution
- Waste pollution
- Coal pollution
- Transportation funding and energy

We could also embed some type of sensor in some of the panel which could aid the scientist in data collection and prediction of earth quakes.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 10, October 2019

Generally the solar roadway will

- Create a high tech infrastructure that pay for itself.
- Create decentralized, self healing power grid.
- Eradicate the need for coal fired or nuclear plant.
- End our sub ordinance on oil and other fossil fuel.
- Cut our green house gas emission by over 50%.
- Protection of wild life.
- National security.
- Provide safer driving conditions.

VI. ELECTRIC VEHICLES

Electric cars have actually being around for quiet a time. They would never been very practical due to the fact that they have to be recharged and have no infrastructure for it. The solar roadway would allow electric cars to recharge at any rest shop or places that have parking lots. Fig.2 Driver can easily recharge vehicle while eating at a restaurant or shopping at a mall. [9]. Roughly 25% of the green houses gases come from the exhaust pipes of the internal combustion engine vehicle, which we have been using for well over hundred years. Electric vehicle come with major hazard, due to short range they have to be recharge regularly. This mean that they would be fit for running to the local grocery shop and back. They survey conducted in America says that as per july,2010 EVS are not ecological in many areas due to less supply of electricity to the areas. [5]. Fig 1. Describes charging of hybrid Vehicle.



Fig. 1. Charging of Hybrid vehicle

VII. METHOD OF EVS CHARGING

Currently they are charged from electricity from power plant. With nuclear and renewable taken out of equation, it can be concluded that power from the fleets will have to come primarily from coal and natural gas is dominant, it helps in reducing CO2 emissions-in some cases as much as 40%..The roadway creates and carries clean renewable electricity. EVS can be recharged at any convenient located rest stop, or any business places that incorporates. Solar roadway panel in there lots (restaurant for instance). For instance, let say EV leaves California and embarks on a road to Florida. EV gets 180 miles on a single charge. By the most drivers would be ready for break or snack. They will try to get in the restaurant which will provide them facility of charging their cars. By the time the drivers are refreshed their cars get ready to go. They could do the same thing at a rest shop. [3,10]. In today modern days instead of non renewable sources as like petrol, diesel based vehicles are going to designed under the hybrid technology, which will includes EV, HEV, PHEV etc. Due to these technologies, hybrid vehicles come into market as like Tesla cars, Maruti Ciaz car. In case of transient conditions as like regenerative braking, speeds reversal, sudden change of load means ICE (ignition

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 10, October 2019

combustion engine) transfer to electric load by vehicle on running condition. In such case the hybrid electric vehicles uses DC motors, easy to control and also helpful for designing controller is simple. A current limit controller in transient conditions is very helpful for the protection for DC motors. The implementation of this controller is very easy and simple and reliable. But in future, it is decided to apply in any electric vehicle for checking of proper performance and life time. Due to the evolution of technology of hybrid electric vehicles in the market, field of power electronics with machine is also involve in the evolution of technology. Thus the design of controller of different types as like speed, current, torque are come into picture. Such that a current controller in DC-DC converter has great scope in the future for plug in hybrid electric vehicles applications. [11]

VIII. SMART GRID

Current grid is based on centralized power stations which include power transmission lines, transformer, relay stations. When a line goes down every one on the wrong end of the line loses power until the damage is repaired. If power station goes down, an entire section goes dark. The solar roadway on the other hand replaces on current stations including coal and nuclear powered electricity plants. With the introduction of solar roadway, solar become the power grid, eliminating the need for utility poles and relay stations. Power is generated-every road, parking lot and driveway. No more power outages, roaming or otherwise. The solar roadways is a secure energy it can be shut down deliberately. Not by terrorist, not by a power company it simply can't be shutdown. Most important the grid must get smart. The precise definition of 'smart varies from one engineer to the next'. The gist is that smart grid that would be more automated and more self healing and less prone to failures. Let us consider country like America in this country more than 150,000 miles of HV transmission lines can carry power from 5400 generating plant, owned by more than 3000 utilities. Most of these lines carry alternating current, but 1.9% of them carry direct current, which loses less power over very long distance but still power interruption cost the American economy about \$80 Billion each year. Moreover, our electricity is cleaned. Even if transmission capacity is increased, blackout will still occur. The entire power grid has to be refurbished, because the existing control technology-the key to quickly sensing a small line failure or the possibility of large instability-is antiquated. The solar roadway is completely decentralized. Every panel can generate and pass electricity to home and businesses. No loss to heat, no carbon footprint and no spent fuel roads. Each road panel measures 12 ft (about 4 m) by 12 ft and contains a micro processor board for control, monitoring and communications. A self healing transmission system would minimize the impact of any kind of terrorist attempt to take out the power grid. The roadways can't be taken out-not by terrorist, not by utility companies, not by anyone. It provides decentralized, secure intelligent, self healing power grid. [10]



Fig. 2. First freaking China solar roadway.

China has the strange distinction being both the world's CO₂ emitter and the premier solar energy producer. Despite being some previous attempts by other nation 'its being hailed as the world's first solar powered highway'. Fig. 3 The roadway is made of transparent concrete on top, solar panels underneath and an insulation material at the base. The engineer of the project claim its enough to generate about 1GW of energy over year to charge street lights running and

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 10, October 2019

snow melting system for road charged up. [12]. Solar road might seem like a novel idea turning every road into a solar energy generating platform seem downright topic. Road cost about \$458 m² far pricier than \$5 m², it cost to create an asphalt road. That creates a price tag of nearly \$2.7 million for the Shangdun project-all to generate enough electricity to power roughly 93 American homes annually. Mean while the average cost of electricity for a single American home is a little over \$1350 or \$125,000 for 93 homes. So, no, its not cost effective project so may be this is ok-particularly if it pave the way for more solar roads in the future. Except solar roads aren't particularly efficient. Even wonder while so many solar panels are installed at an angle? The orientation help optimize how much sun-light hit the panels. Solar road panel need to be laid flat. Light can't pierce through shade created by nearby tree, or buildings, or dirt that cover up the pavement. [14].Solar roads mean driving on transparent surfaces. This could mean smooth glass, or something that mixes rock and glassy material. The transparency required for light reduces the amount of gravel and rock and that could gave the road enough friction to help with smooth driving. The more glassy material you add to the road, the more you risk. Cars loosing traction on the surface especially in snow and rain. Its not totally clear. These initial test buds, in China and elsewhere like France, might key to making solar roads cheaper and efficient and verify the safety of these stretches. Solar power is clearly the future of renewable energy for the world and China advance in the realm are laudable. And who knows the solar roads will eventually lead to discover. [12,14]

IX. ADVANTAGES AND MAJOR ADVANTAGES

- Illuminated road/warning signs.
- Zebra crossing.
- Illuminated parking lot lanes.
- Indication for on coming humans or animal on roads.
- Charging can be done by plug-in by the side of road.
- Ambulance lane in case of mishaps. [1]
- Less dependency on fossil fuel.
- Environment friendly.
- Safe driving conditions.
- No accumulation of ice or snow hamper the work.
- It readily scalable and versatile. [1]

X. USES

- Parking lot
- Driving ways
- Side walks
- Bike path
- Patios/decks
- Playground
- Sport court
- Walkways

XI. DISADVANTAGES

In-spite of the advantages, initially, the start up and maintenance costs of building such roadways and parking lots may be extremely high. Another issue is to deal with the efficiency of the solar panels. Another disadvantage is that it cannot be constructed in the poorest developing nations due to 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 roads may not be feasible and economical as its initial and installation costs may be three times more compared to our convectional roads, but if this is evaluate as a long term investment this may prove to be more economical as it

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 10, October 2019

pays us back. [4,10]

XII. CONCLUSION

In order of depleting the coal, petrol and other fossil fuels, solar roadways is a boon for developing and the growing countries like India. India, instead of exploring in terms of road connecting to cover the geographical area should start implementing the higher target roads and develop solar roads so they can improve the economy with infrastructure. Its implementation not only provide us with electricity but with green energy which in turn help in reducing global warming. Solar Roadways co-founder Scott Brusaw thinks his project has such broad resonance because it ticks off so many boxes: Once installed, his smart panels will be able to generate clean energy, communicate safety and traffic information to drivers in real time, reduce the visual pollution of ugly signage and clutter, prevent accidents by melting snow and ice and even treat and transport fresh water. [4,5,10]

REFERENCES

- [1] "Solar Roadways - About".
- [2] Scott, Cameron (22 May 2014). "Following the Solar Brick Road". Singularity HUB. Singularity University.
- [3] "Solar Roadways - Company Information; Small Business Innovation Research.". Small Business Innovation Research.
- [4] "Driving on Glass Solar Roads". Scientific American. October 6, 2009. Retrieved February 24, 2015.
- [5] "Alternative Uses of Highway Right-of-Way". Federal Highway Administration.
- [6] Barry, Keith (2014-05-08). "This Parking Lot Is Paved With Solar Panels". Autopia. Retrieved 2014- 05-24.
- [7] Solar Roadways; Indiegogo; Crowd funding ended June 20, 2014.
- [8] "The Centuries-Old Technology Behind Solar Roadways, Indiegogo's Most Popular Campaign Ever". Forbes. 3 June 2014.
- [9] Maben, Scott (31 May 2014). "Star Trek: George Takei tweet boosts Solar Roadways". Christian Science Monitor. Associated Press. Retrieved 1 June 2014.
- [10] b"On the not so sunny side of the street". The Economist. 5 June 2014.
- [11] "We Could Build a Solar Powered Roadway. But Will We? Popular Mechanics. June 11, 2014. Retrieved February 24, 2015.
- [12] Carolyn Mathas (February 23, 2009). "2009 EE Times ACE Awards finalists announced". EE Times. Retrieved June 23, 2014.
- [13] "Solar Roadways named as finalist in most promising renewable energy award". Renewable Energy Magazine. 16 March 2010..
- [14] Michael Parrish Dobell (August 8, 2011). "Paving the Solar Roadway to Success". ecoimagination.com. Retrieved June 23, 2014.
- [15] "Scott & Julie Brusaw - Solar Roadways". The World Technology Network. 2013. Retrieved June 23, 2014.
- [16] Aaron Seward (2014). "Best of What's New: Solar Roadways". Popular Science. Retrieved January 6, 2015.

BIOGRAPHY

Er. Loveneesh Talwar (Head of Department, Electrical Engineering, YCET, Jammu) received his B.E Degree in Electrical Engineering from MBS College of Engineering and Technology, University of Jammu, India and also received M. Tech. Degree in Energy Management from Shri Mata Vaishno Devi University, Kakrayal, Katra, Jammu, J&k, India. He worked as academic arrangement lecturer in the Department of Electrical Engineering at GCET Jammu for next one and half year and also worked as Head of Department in the department of Electrical Engineering at I.E.C.S Polytechnic, Jammu for next Five years. Presently working as Assistant Head of Department, Electrical Engineering, Yogananda College of Engineering & Technology, Jammu. He had published 10 Research papers in different International Journal and had attended almost 30 National and International Conferences organised by various Institutes and universities. He worked as Co-convenor for 1st International conference RISET organised by YCET Jammu in the year 2015. He has attended various short termed courses conducted by different organizations like NITTTR Chandigarh, Dale Carnegie & Associates, Inc. Trainer and Wipro, Usha Automation Panchkula.





ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 10, October 2019



Er. Kiran Pal Kour received her B.E Degree in Electrical Engineering from MBS College of Engineering and Technology, University of Jammu, India and also received M. Tech. Degree in Power System Engineering from Guru Nanak Dev Engineering College, Ludhaiana, India. Presently working as Assistant Professor in the department of Electrical Engineering YCET, Jammu, India. she got Certificate of participation in national seminar on Smart Grids and Alternate sources of energy also got Certificate of participation "AICTE SPONSORED FACULTY DEVELOPMENT PROGRAMME" in waste management by additive manufacturing. she Worked as an Assistant Editor in TRB Group- The Digital world for their upcoming newspaper.