Journal of Basic and Applied Engineering Research
p-ISSN: 2350-0077; e-ISSN: 2350-0255; Volume 2, Number 18; July-September, 2015, pp. 1632-1634

http://www.krishisanskriti.org/Publication.html

Viability of Solar Roads in India

Vipul Jain

Delhi School of Management, Delhi Technological University
E-mail: vipul311@gmail.com

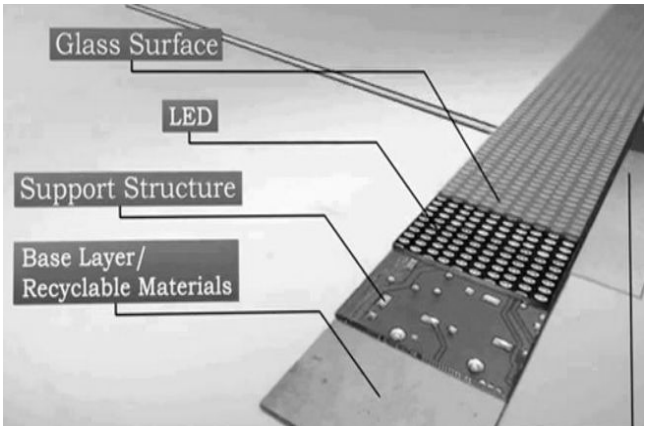
Abstract—*The aim of the study is to scrutinize the viability of solar roads in India. Solar roads is a farfetched project but certainly not a science fiction idea. Solar roads are basically roads made up of high strength solar panels. They have the strength to support automobiles as giant as 12 fire engines at a time. They would be used to generate electricity, spectacle LED indications on road and even power electric vehicles amid additional benefits. It has already been implemented in some parts of the world, commencing with Netherlands. The idea is to make multi-functional, self-sustainable roads that require insignificant upkeep.*

1. INTRODUCTION

It is no revelation that the environment is deteriorating with time and it is high time that the world starts looking at sustainable alternatives. One such alternative is *Solar Roads* instead of the regular *Asphalt*.

Solar Roads work on a technology that combines a transparent driving surface with underlying solar cells, electronics and sensors to act as a solar array with programmable capability. Solar Roadways Inc. and SolaRoad Netherlands are working to develop and commercially produce road panels which are made from recycled materials & incorporate photovoltaic cells. [10]

With the volume of roadways network India has and the amount of sunlight it has access to, India is a practicable country to contrivance this technology.



(Fig. 1)

The solar road panels are made up of 3 basic layers, as shown in Fig. 1. [12] These layers include:

1. Glass layer + LEDs
2. Support Structure/Electronics layer (programmable chips, heating and induction panels)
3. Base layer (recyclable)

India has a road network of over 4865000 kilometers in 2014. In this, national highways and state highways cover 5% of total road network. These highways can produce 450TWh of electricity according to references when they are surfaced by solar panels. But India needs 991TWh of electricity. This implies that if 10% of total road network of India is surfaced with Solar Roadway panels, it would illuminate our entire nation. [11] And in a country like India, a sustainable source of energy is in dire need.

2. LITERATURE REVIEW

A proper review of existing literature is essential and of high importance to have a proper knowledge of views and studies of the academics and researchers of the present times. It helps the researcher gain an insight into the dimensions of the possible research and the further contributions to be made. But in this case the project being in its nascent stages, the literature is next to none. What we do have are some statistics and figs.

A solar panel is sized at 12x12 feet i.e. it covers an area of 144 sq. ft. One panel costs $6912. So the solar roads cost 6912/144 = $48 sq. ft. whereas Asphalt costs $16 sq. ft. Hence ostensibly solar roads cost 3 times more than regular roads. This raises a question about the feasibility of solar roads. To answer that, this cost comes with numerous supplementary benefits. These include:

Instead of towering electricity poles, the wiring can be encased under the glass layer of the panel. Using the built in LEDs the roads can be lit up during the night to perform several functions, like: Illuminated road/warning signs, Illuminated road/lane markers, Zebra crossings, and Illuminated parking lot lanes, Indications for oncoming humans or animals on road ahead. Plug-In chargers on the sides of roads or induction charging while on the go, 20 years

life span of each panel, Individual panels can be easily replaced, Ambulance lane in case of unfortunate incidents.

Apart from these minor advantages, the major advantages include-Less import of/dependency on fossil fuels, Environment friendly, Safer driving conditions, No additional resources spent on removing ice. And there are some facts which prove that this concept is earnestly worthwhile and not just a nebulous idea. Such as-Solar Roadways has received two phases of funding from the U.S. Federal Highway Administration for research and development. Solar Roadways has raised $2,261,187 (as on Sep'15) on www.indiegogo.com (Indiegogo is an international crowdfunding website). Now a part of the "Indiegogo InDemand Program". (InDemand makes it easy to continue raising funds after your campaign deadline. Campaigns in InDemand have reached their goal, met their deadline, and are continuing to accept contributions.) [13]

3. RESEARCH METHODOLOGY

The purpose of this paper is to analyze the viability of solar roads in India. The impact of various factors was studied using an exploratory approach. Under this approach, mainly secondary research was done. Secondary research will always have second priority over primary market research. However, in many cases, secondary market research itself plays a pivotal role. Such that in the end you won't need primary market research. Hence secondary market research is the first step in conducting market research.

At the same time, if you want to conduct a primary market research, then you need to have enough background information so that you can form the right market research questionnaire. Thus, the first usage of secondary market research is to pave way for primary market research. For this purpose the solar roadways site has been most helpful in doing the qualitative research. External environment analysis was also done under this approach.

4. FINDINGS

Solar panels can be used for parking lots, driveways, sidewalks, bike paths, patios/decks, playgrounds, tarmacs, amusement parks, sport courts, walkways, pool surrounds, stadiums/arenas, basically any outdoor surface that can be walked or driven upon. Finally, they can be used in disaster relief: lowered down by helicopter after earthquakes etc. to provide needed power and light.

The most irksome factor about solar roadways is the material they are made of i.e. glass. But the misconception can be quite easily debunked. As shown in Fig. 2, glass is more than 4 times stronger than regular Asphalt.

Additionally when we temper glass, it becomes 4-5 times stronger than non-tempered glass. Bulletproof and bomb (blast) resistant glass are made with laminated tempered glass. Solar Road Panels are made of tempered glass. They are made to last for a minimum of 20 years. And even then only the panels that stop working can be changed individually without disrupting the entire roadway. Also they are so tough that they can hold a fleet of army tanks at once (250000 pounds).

Familiar objects ranked according to Mohs' Scale of Hardness:

0.7	graphite
1.3	asphalt
2.5	fingernail
3.0	copper penny
3.5	brass
5.5-6.0	knife blade
5.5-6.0	plate glass
6.5-7.0	steel file

(Fig. 2)

Now one other key point was that since these panels are individual, what's to stop people from stealing them. The answer is quite simple. Each panel is fitted with its own microprocessor, which communicates wirelessly with the surrounding panels. They monitor each other for malfunctions or problems. Even if someone was able to pull a panel out of the road and steal it, the stolen panel would continue communicating with all of the other panels in the road. The road would know exactly where it is. It was also found that to set these panels up, existing roads do not need to be ripped out. As tested in Netherlands, the panels were set down on the existing asphalt, using it as a base layer. And even after a year, they are intact and fully functional. A common misconception was also cleared during the research, that dirty panels would generate a lot less power. In real life tests the power generation difference between a clean and a dirty panel was as little as 9%.

5. FUTURE SCOPE

Our Hon'ble Prime Minister Narendra Modi has promised to start building 100 smart cities in India during his tenure (2014-2019). If we start implementing solar roadways in these cities, it would be far easier to test their viability instead of laying asphalt roads first and solar roads later. Additionally the power requirement of these cities would be self-sustained by these roads.

The future of these roads could have endless utilities like-We could embed some type of sensors in some of the panels which might aid scientists in data collection and prediction of earthquakes. As scientists get better at predicting earthquakes,

the Solar Roadways could be used as a warning system and could help direct traffic away from an earthquake area. Or, since the panels can be made pressure sensitive, they be used for security applications. E.g.: If someone steps onto one of the panels, an alarm can be tripped. This can work for homes, businesses, prisons etc. Complete removal of all electricity, telephone, cable TV, High speed internet poles/lines and instead cables running down with the road, safe from weather conditions, ice, accidents, trees or any natural disturbances. It can also be used to provide detours on the GPS of people on the roads, warning them about the traffic jams ahead.

India is also the world's leading agricultural nation, to aid this core activity, there can be an arrangement to flow the water (that would generate when snow is melted), to the nearby farms. This would help in the solving of drought problems in India as well.

6. CONCLUSION

India is a developing nation and with its progress, the population and its necessities are developing on a rapid rate too. We need to make a preemptive move to counter these emergent needs. Additionally the threat of global warming is as real as it gets and it is high time it is refuted. One of the most viable resolution to all these disquieting issues is solar roads. It will be easier in India considering that we do not have finished roads in majority of our nation. Our inadequacies on this front can be an advantage in this scenario. As revealed in the case, solar roads need a base layer and the existing unpaved roads make for a great base. Furthermore the power generated from these roads is exceedingly vital. And somewhere down the line, India with its huge pool of engineers and scientists is sure to come up with home built panels, which would jettison the high costs that we'd face now, making it a win-win situation.

7. LIMITATIONS

Solar roads being a fairly new and experimental subject, does present certain restrictions. For this research paper, the literature accessible for review was relatively inadequate. Also, a survey among the common folk at this level would be of no importance since the decision rests in the hand of the decision makers and the people specializing in correlated fields. Hence this paper is built on the secondary research done on the available articles, related to solar roads, solar panels and Indian roadways.

REFERENCES

[1] M.J. Lamb & R. Collis S. Deix, B. Krieger, N. Hautiere, *The Forever Open Road – Defining The Next Generation Road*, (2011)

[2] 2009 Online Electric Vehicle, KAIST. Pg. 9-10

[3] ERTRAC Strategic Research Agenda 2010. Towards a 50% more efficient road transport system by 2030, May 2010

[4] http://www.solarroadways.com/numbers.shtml

[5] Scott Brusaw, *Solar Roadways: A Real Solution* (2011)

[6] A. Northmore & S. Tighe, *Innovative Pavement Design: Are Solar Roads Feasible?* (2012)

[7] S. Brusaw, "*Solar Roadways: A Real Solution*" 2012. [Online]. Available: http://solarroadways.com/main.html

[8] G. Valk, "*SolaRoad: Amsterdam*" 26 January 2011. http://www.tno.nl/downloads/Presentation%20SolaRoad%20definitief_uk.pdf

[9] Remon Industrial Limited, "*Mono 125S0R2 Solar Cell*" http://www.rmsolarpanel.com/html/49/2010-12-13/content-34.html.

[10] Scott, Cameron (May 22, 2014). "Following the Solar Brick Road

[11] Alark A. Kulkarni, *Solar Roadways – Rebuilding our Infrastructure and Economy*, IJERA (May 2013)

[12] Scott Brusaw, http://www.solarroadways.com/intro.shtml

[13] https://support.indiegogo.com/hc/en-us/articles/204092046-InDemand-FAQ

[14] Adelino Jorge Lopes Ferreira, *Recent developments in pavement energy harvest systems*, Proceedings of the ICE-Municipal Engineer, Volume 165, Issue 4, 01 December 2012, Pg. 189 – 192

[15] http://solarroadways.com/faq.shtml#faqHardness