



Decision Makers' Connect

SOLAR ROADWAYS: Feasible For India?

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Solar roads could put an end to India's electricity woes. But, to make these technically and financially viable, there is a long list of challenges to overcome—ranging from indigenous solar system development to infrastructure and investment

"People don't want to do that (build houses or offices) near a nuclear power plant. So, there's quite a big keep-out zone, and when you factor the keep-out zone into account, the solar panels put on that area would typically generate more power than that nuclear power plant."

—Elon Musk

India is moving full throttle on solar projects. This has set the stage for higher domestic manufacturing and thus lower cost of solar products. With consistent availability of sunlight throughout the year (for about 300 days), one of the most unique proposals is the implementation of solar surfaces for roads in India. This has the potential to generate massive megawatts of energy that can power numerous ever, developing solar panel roads is not easy and requires more clarity and planning on many aspects before implementation.

The benefits

A few years ago, ideas were invited to install rooftop solar panels on the roads of Gujarat to generate electricity from solar

energy. One proposal came from the Gujarat Energy Research and Management Institute (GERMI) to install solar panels across 205km of the Ahmedabad-Rajkot highway to generate 104 megawatts of electricity. The energy generated could be used to power the highway infrastructure, light the roads and also run a bit of the adjoining buildings. The project is in planning stage.

Roads with solar surfaces can immensely transform the Indian power situation. Bhargav Vyas, vice president, PV Power Tech, says, "Implementation of solar roadways should start from the highways in India. It will be easier to receive permission and work quickly in those areas. As the exposure to sunlight will be much stronger than in closed areas, energy generation will be substantial."

India faces the problem of electricity shortage every day. Power is yet to be introduced in some regions. Certain reports suggest around 240 million Indians still live in the dark, ranking India among countries with one of the highest unelectrified populations in the world. Implementation of projects like solar roads can substantially improve the situation. While solar street lights and solar rooftops are being deployed rapidly,

extensive solar surface on roads can become the central point for powering a larger proportion of national infrastructure.

In the long run, such projects can massively reduce the use of grid energy, cut down fossil fuel consumption exponentially and bring down the national carbon footprint dramatically.

If developed with good-quality resilient material, solar panel roads can eliminate the frequent damage-and-maintenance that is associated with pavement roads. This would save a lot of administrative fund, adding to the payback period on the investment. Issues of potholes,

Solar bike stretch in the Netherlands





Inauguration of solar roads in France (Source: nbcnews.com)

water puddles and poor-quality roads would decrease.

Solar structures for roads have not been explored much even at global scale. There have been a few cases of solar road installation in the recent years that have proved to be

In 2014, the Netherlands chiseled a small stretch of biking road with solar panel material. It was a test drive of solar panel roads, covering only 70 metres. The setup consists of durable solar trapping material, engraved inside glass coating, with more layers of materials to create friction while driving.

Annually, the 70m stretch generates 70kWh energy per square metre of road. Energy generation in the first six months was 3000 kilowatt-hour (kWh), enough to run two small households for a year. After one complete year, the total energy production amounted to 9800kWh, which is enough to power three average-scale Dutch households annually. The project was expanded by 20m in 2016 and is still under further expansion.

While this was a comparatively smaller project, solar panel roads saw a larger implementation for the first time in France in 2016. One kilometre of a highway in Tourouvre au Perche village is covered by 2800sq.m of

solar panels, protected under coats of resin, polymer and silicon. Every day, more than 2000 cars (including heavy vehicles) drive over this road. Yet, the road has been successfully able to carry this extent of load without any damage. It is also resistant to heat and generated regularly. Annual electricity generation is 280 megawatt-hours (MWh), which is sufficient to power streetlights and other adjoining infrastructure in the area. Notably, the village receives less-than-moderate sunlight throughout the year. That



Solar surface on a China road (Source: www.news.cn)

said, 280MWh electricity generation per year across 1km length is quite impressive. The French administration is planning road expansions to power a substantial fraction of the country's public properties as well as residential constructions with the help of solar energy captured by these roadways.

China has also joined the race by designing its own solar panel roads. Last year, in the Jinan region, it revealed 1km stretch of a two-way road, embedded with 5875sq.m solar surface. The road is expected to generate one million kilowatt-hours of power in a year. This energy, sufficient to power about 800 homes in China, will be used to power various infrastructures including streetlights, billboards, surveillance cameras and even toll booths in the area. An intelligent heat-capture system of the solar setup will also keep snow accumulation in check during winters.

The challenges

Solar panel road technology is in nascency with more players slowly joining the movement. All the aforementioned projects have been successful, but their execution was far from easy.

The first major challenge is the huge cost of investment. The 1km long French project cost nearly \$6 million. China's project cost \$458 per square metre, which totals to approximately



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\$2.8 million for the whole installation. These figures suggest nearly 90 times the cost of a normal solar rooftop (in China, solar panels for general use cost \$5 per sq.m).

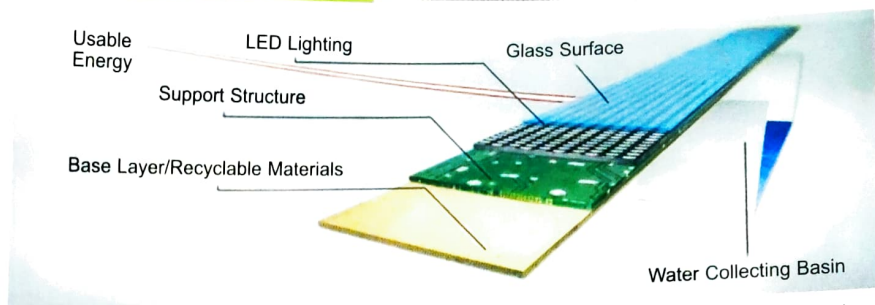
If India decides to pave the foundation of solar roadways, the country will run into similar cost burdens. Therefore the amount of energy generation in return needs to be well-calculated to ensure quick paybacks.

The second concern is about optimal solar capture. The essence of solar panels lies in the amount of solar energy captured on their bed, which is maximised by tilting panels in accordance with the direction of the sun. Solar surfaces on roads will lie as a flatbed. Therefore it needs to be verified whether these will be able to absorb enough energy in this position without the ability to tilt. Additionally, numerous coatings above the solar surface to hold the load of vehicles daily may affect its solar acceptance. If unchecked, this will have a direct impact on the ROI.

Vinesh Kumar, senior manager-projects, SunGarner Energies, says, "There will be major concern about safety and quality of panels. Efficiency depends on the cell quality. To get optimal efficiency in such technology, the cell quality has to be topnotch and protective coatings should also complement the cell."

Another focus area should be the driving safety. Vehicle tyres require a slightly rough surface to balance between acceleration, breaks and directions, aided by the friction between the tyre and the road. In the attempt to make the solar surface absorb maximum sunlight, roughness of the surface might get compromised. So constructors must pay attention to the composition of the coating material.

In addition, infrastructure might prove to be a challenge since arranging such solar structures requires some fine-tuned operation with technical knowhow. Imports may add to the cost since local



Representative image of the constitutive layers of a solar road, where the electronic support structure and the base layer help in collection and distribution of captured energy while other layers act as support elements

solar manufacturing is in developmental stages.

Vyas says, "India does not have the raw material production capacity for photovoltaic cells. This is why the percentage of imports is so high."

Time taken in legal permissions regarding land and other parameters may also add to the list. All these challenges need to be addressed before going ahead with solar road projects.

Way to go

Given all the challenges in solar panel road implementation, there is a lot to be thought out and tested before going ahead with a commercial application. The present cost estimations of such projects direct us towards generic solar rooftops and panel usage as the economical solution for now. However, with more research and mainstream implementation, these materials would become cheaper.

Vyas believes, "In terms of technology and expansion, India is doing

good. Five-seven years down the line, renewable energy utility in India will be extremely improved and technologies like solar panel roads will become feasible."

Increased domestic manufacturing would also add to the advantage. Vyas continues, "China has been providing solar structures at lower cost than India so far. With the government set to impose an import tariff on solar equipment, we will see a substantial decrease in ready-made Chinese panels usage. Indian companies will have to manufacture as well as research domestically. This will change the paradigm of solar implementation and also promote advanced applications like solar roadways".

Vivek Vashista, senior engineer, ABB India, believes solar panel roads will be viable in India. "In fact, our R&D team is already looking into such projects. The return on investment is definitely a key focus area and will be assured," he shares.

Elaborating on ROI, Vinesh adds, "The ROI will depend on the investment amount and volume of the project. The level of energy generation and efficiency of the material will also be major contributors. On an average, the payback period can be expected as eight years."

If successfully implemented, these projects can solve a lot of real-life problems in India today. It is a decision of investing big in view of long-term benefits. **EFY**



India has great scope for leveraging solar energy through its highways