The Road Less Polluted

Moving towards solar-powered e-roads in India

India has been moving towards advanced technologies in transport, and some key modern technologies have entered its highway network system. The government is actively planning to introduce E-roads such as E-highways and E-expressways for charging a large chunk of electric vehicles (EVs). NITI Aayog says that EVs will account for 80 per cent of two- and three-wheelers, 40 per cent of buses, and 30–70 per cent of cars by 2030 in India. As a pilot run, India's first E-highway between Delhi and Jaipur will be developed soon. India should simultaneously devise a strategy to integrate innovative solar technologies with E-roads to bring in true clean mobility.

E-roads allow electricity transfer between a vehicle (specifically heavy vehicles like buses and trucks) and the road on which it travels. To encourage people to switch to EVs, the National Highways Authority of India is actively working on setting up EV charging infrastructure along highways and expressways, which will help cut fossil fuel-based consumption and reduce the carbon footprint. At present, the government is focussing on electrifying heavy-duty vehicles, such as buses, trucks, and freight vehicles, by constructing E-roads.

Of the various methods of charging heavy-duty EVs, the pantograph method is most suitable for India, considering the government's interest and techno-commercial feasibility. Here, vehicles operate on a similar principle that trains follow to run on tracks. A retractable pantograph is attached to the top portion of a vehicle, which makes contact with the overhead cables for collecting power to charge batteries. This technique is suitable for trucks, buses, and freight vehicles, which are high enough to contact the overhead electric cables. While the overhead cables can get electricity from local utilities and solar systems for charging EVs, integrating solar power with E-roads will aid in significantly reducing the dependency on thermal electricity.

Photovoltaic noise barrier (PVNB) is a promising solar technology that can generate and supply clean energy to the charging infrastructure on E-roads. Of late, this technology, which integrates solar PVs with noise barriers, has gained attention in many countries as it serves the dual purpose of producing clean energy and protecting nearby habitats from road noise. There are more than 30 PVNB installations worldwide, and the majority of them are installed in Germany and Switzerland. The PVNB technology—which allows energy to be generated and consumed locally—can be extremely compatible with E-roads, where electricity for charging EVs needs to be supplied over a short distance. Moreover, the government can plan to set up charging stations on E-roads to charge other light vehicles through PVNBs.

PVNBs have two basic design types — a retrofit system and a vertical bifacial system. In the retrofitting option, conventional polycrystalline solar panels are placed on the existing noise barriers, whereas in the vertical bifacial system, solar panels are mosaicked between two sheets of thick toughened glass. This allows sunlight to penetrate solar cells from both sides of the barrier.

Mitrex, a Toronto-based PV provider, in collaboration with Durisol and Silentium Group, is building a PVNB for improving highway aesthetics. According to their design, the retrofit system can accommodate a PV capacity of up to 22 W per square foot, whereas the vertical bifacial system can accommodate up to 37 W per square foot. On an average, a system with 1.2 MW of PV capacity can be installed per km alongside E-roads.

To deploy PVNBs along E-roads on a large scale, it is essential to evaluate the potential of E-roads plus PVNBs in the Indian context. We can begin by identifying the existing and upcoming highways and

expressways to be considered for electrification. Next, we can select the road stretch for electrification, along with charging requirements (in kW or MW). Subsequently, the feasibility for setting up PVNBs alongside the selected stretch can be assessed. For this, we need to consider geographic coordinates, slope, orientation, and the length and width of roads. Eventually, we can determine the suitable PVNB design type. After assessing the technical viability, different costing parameters can be considered to assess the commercial feasibility of the entire infrastructure.

India should start focussing on undertaking pilot projects on E-roads plus PVNBs across different states to determine its viability. Given the rising demand of EVs and the charging infrastructure, E-roads can be ideal for India. Technologies like PVNB, by supplying cheaper electricity for EV charging, can help India meet its solar targets, create employment opportunities, improve the aesthetics, and minimise adverse environmental impacts. However, for improving the viability of solar-powered E-roads, strong vision, appropriate regulatory frameworks, and effective policies would be imperative.