

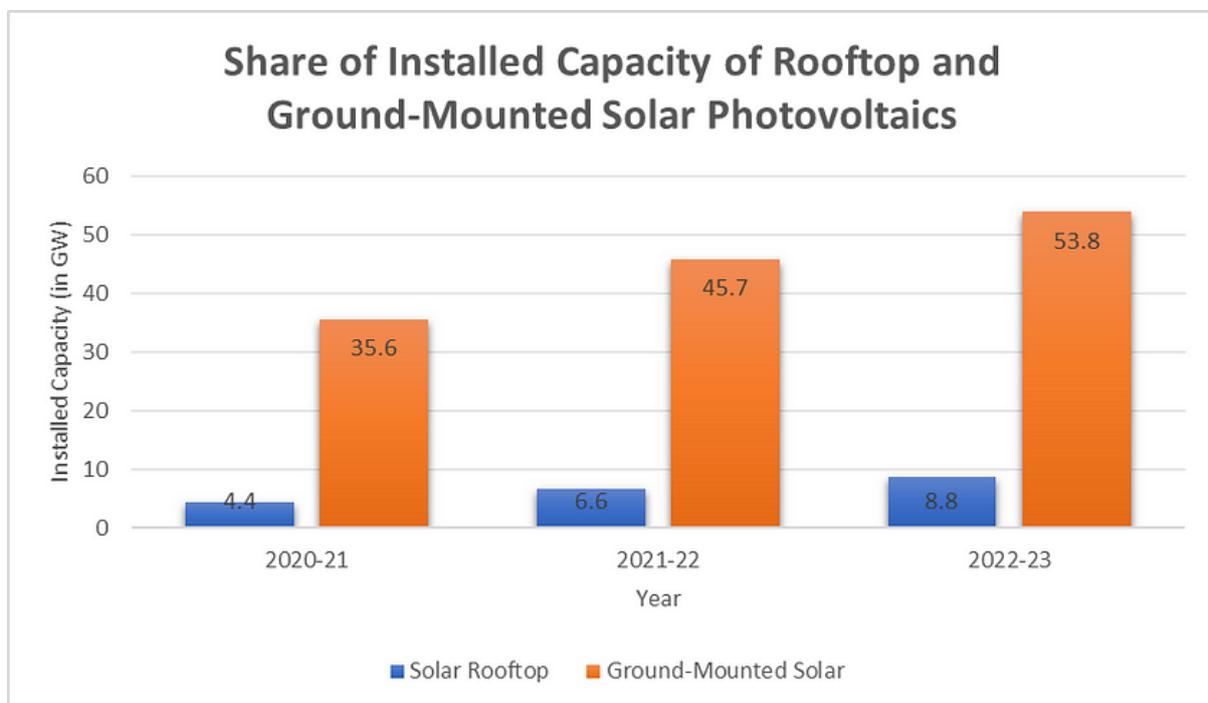
## The Solar PV Market in India: Technical Progress and Opportunities

By Bidisha Banerjee and Upasna Ranjan.

So far in this series, we discussed different aspects of India's solar PV sector, including taxation, policies, and the journey towards sustainability. In this concluding piece, we focus on popular technologies, innovations, challenges, and opportunities.

### Rooftop and Ground-Mounted Installations in India

The Indian solar PV sector has witnessed significant advancements in technology, with both rooftop and ground-mounted installations gaining popularity. Rooftop solar offers advantages such as abundant sunlight, cost savings, reduced losses, and a lower carbon footprint. It is convenient, low maintenance, and has a long service life. On the other hand, ground-mounted systems provide optimal performance, easy installation, and repair access. They can be installed in areas with favourable solar conditions, although they require more space.



Source: Ministry of New and Renewable Energy

### Innovations Introduced

The adoption of rooftop and ground-mounted solar PV systems is rising in India. There is significant research and development focused on advancing the solar PV sector, leading to the emergence of innovative concepts such as agriphotovoltaics (APV) and floating photovoltaics (FPV).

In APV, solar panels are installed above agricultural land, providing shade to crops and generating renewable energy. APV installations in India range from 3 kWp to 3 MWp, showcasing the diversity and the potential for maximising [land use](#). Some of the examples of [APV plants](#) in India are the 1.4 MW Parbhani APV Farm (Maharashtra), 1 MWp GIPCL plant (Gujarat), and 200 kWp Dayalbagh Agricultural University Plant (Uttar Pradesh).

In FPV, panels are deployed on water bodies, such as reservoirs and canals. FPV projects in India offer multiple benefits, including water conservation, improved water quality, and positive impacts on ecosystem health. Several notable FPV plants have been established and are set to be established across the country, including the NTPC Ramagundam plant (100 MW) in [Telangana](#) and the Omkareshwar Dam FPV plant (600 MW) in [Madhya Pradesh](#).

### **Overcoming Challenges and Maximising APV and FPV Potential in India**

To optimise large-scale APV and FPV projects, using advanced technologies such as bifacial solar modules and solar trackers is crucial. Bifacial solar modules capture sunlight from both sides of the panel, enhancing energy generation significantly. Solar trackers, including single-axis and dual-axis systems, dynamically track the sun's movement, maximizing solar energy yield. Floating solar trackers are also emerging as a viable option, particularly for areas with limited land availability, such as the northeastern region of India.

*However, the implementation and scalability of APV and FPV face several challenges in India, the most common being a lack of awareness. In addition, APV struggles with limited capacity, lack of a supportive policy framework, and specific land-use classification. FPV encounters technical issues, inconsistent installation standards, and unfavourable economic policies, such as subsidies for fossil fuel generation.*

To achieve the commercialisation of APV, it is crucial to focus on technological advancements and test various business strategies. State governments should implement regulations regarding land usage and categorise income from agricultural lands. In addition to standard tariff limits, states should explore diverse market mechanisms to support APV and FPV through innovative tariff structures. Addressing technical problems in areas such as material science, system optimisation, and control systems requires continuous research and development. Since APV and FPV are location-specific technologies, environmental concerns must be addressed through analysis, monitoring, control systems, and careful site selection.

### **The Way Forward**

The Indian solar PV sector has made remarkable technological strides, with advancements in rooftop and ground-mounted installations, as well as the emergence of APV and FPV concepts. However, challenges remain, which can be overcome through supportive policies, technological advancements, and research and development efforts. With collective efforts from the government, private sector, and stakeholders, India can continue progressing towards its energy security and sustainability goals.

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