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Floating PVs – are floating solar installations the future of photovoltaics?

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Electricity generated by photovoltaics (PV) is an essential pillar of the energy transition and the fight against climate change. Solar modules have therefore become a familiar sight around the world. Some facilities, such as the 2050-megawatt Pavagada solar park in India, occupy large outdoor spaces; others are installed on the roofs of buildings. However, solar installations do not necessarily have to be built on land. To circumvent the problems of land acquisition for large outdoor systems, project developers are increasingly focusing on the installation of PV systems on bodies of water.

What are floating PVs?

Floating PVs (FPV) are PV systems that are installed in peaceful waters such as lakes or in bays on floating platforms that are firmly anchored to the ground. The PV systems are usually connected to the mainland by floating power lines. Since the first commercial solar power system with a capacity of 175 kWp went online in California in 2007, the size and capacity of new floating PV installations have multiplied. In Anhui Province in China, for example, the two largest-ever solar installations with a capacity of 150 MWp were commissioned in 2018. Globally installed capacity rose from around 10 MWp in 2014 to around 2,087 MWp in 2020. This is enough electricity to supply over 500,000 households in Germany[i]. The largest share of the world's installed capacity, at over 73%, can currently be found in China, Korea and Japan. Further projects already announced in Bangladesh, India, Indonesia, Laos, Malaysia, Sri Lanka, Thailand and Vietnam will be added to the other projects in more than 20 countries.

Importance for expanding renewable energy

FPV systems are a relatively new concept for harnessing photovoltaics, but there is considerable potential for electricity generation worldwide because there are still so many water surfaces that would be suitable for the installation of these systems. FPVs can be installed in reservoirs of hydropower plants, for example. Depending on the climate conditions, FPV systems reduce evaporation from the reservoir to a certain extent and can therefore help to reduce water loss. In addition, the combination of hydro- and solar-based electricity generation makes it possible to compensate for the seasonal fluctuations of hydropower and the volatile feed-in of solar installations and, overall, to establish more stable energy production with better utilisation of the capacity of the grid connection.

Opportunities and challenges

Unlike land-based PV systems, FPVs only need small areas of land for some secondary facilities and the grid connection, thus reducing land use significantly. The easy scalability of the systems and their flexible handling on water also allow for efficiency gains during installation. During operation, energy output increases compared to land-based systems because the systems are cooled by water evaporation. Lowering the temperature by just 2.5°C increases energy output by 1%.

Owing to the lack of long-term studies, a large number of the assumptions are based on initial empirical values of the capacities already installed, which means the durability of FPV installations and their effects on the ecosystem still need to be investigated further. Critical challenges in this context include the electrical operational safety, the more complicated maintenance and repair of the individual components as well as the anchoring system. Anchoring in particular can entail complex site investigations of the water bodies and sediment and ultimately significantly increase the overall costs. In addition, floating installations are generally exposed to greater corrosion, potentially strong cable movements and the risk of damage from wind, waves and wildlife.

Socio-economic hurdles can arise from competing interests in tourism, fisheries or nature conservation; the first two in particular stand to lose economically viable areas as a result of FPV installations. When it comes to nature conservation, initial observations show that the installations can even serve as refuges for fish and therefore make a positive contribution. When assessing economic returns, both the investment costs and the operating costs of FPV systems are generally higher than comparable land systems due to the more complex installations. This is why they are still used relatively rarely. However, experience with installed FPVs shows that the higher costs can usually be offset by better performance. With a view to the future, FPV systems still face various challenges, but with increasing experience they could become established in the long term as a sensible and technically and economically feasible supplement to "standard" PV systems.■

[i] Based on consumption of 4,000 kWh/year of a 4-person household