Feasibility of Floating Solar Power Projects in the Konkan Region of Maharashtra

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ABSTRACT

The Konkan region of Maharashtra—encompassing districts like Thane, Raigad, Ratnagiri, and Sindhudurg—presents a mix of high technical potential and distinct operational challenges for Floating Solar Photovoltaic (FSPV) projects. [1, 2]

Key Feasibility Factors in the Konkan Region

- Water Body Availability: The region features major water bodies, municipal lakes (such as Tansa and Modak Sagar in Thane district), and backwaters, where state-backed entities like Mahatma Phule Renewable Energy and Infrastructure Technology (MAHAPREIT) have actively pushed for large-scale tenders (e.g., a 100 MW project planned across Tansa and Modak Sagar lakes). [1, 2, 3]
- Land Savings: Konkan is geographically constrained by Western Ghats slopes and high population density, making floating solar over idle reservoirs an attractive alternative to acquiring scarce land. [1, 2]
- Evaporation Reduction: Covering portions of water surfaces helps reduce evaporation during dry spells while the cooler microclimate can marginally improve solar panel efficiency. [1, 2]

KEYWORDS-Konkan, Maharashtra, floating solar power projects, feasibility

INTRODUCTION

- High Monsoonal Rainfall and Winds: Konkan receives intense seasonal rainfall during the southwest monsoon, alongside high humidity and strong coastal/gusty winds. Floating platforms, moorings, and anchoring systems must be engineered to withstand severe water-level fluctuations and cyclonic/storm surges.
- Corrosive Coastal Environment: Proximity to the Arabian Sea introduces high salinity and moisture, increasing the risk of rust, salt deposition, and degradation on electrical components, framing, and inverters, which requires specialized anti-corrosive materials (C5-M certified or marine-grade alloys).
- Execution Delays and Stalled Projects: Broader state experiences in Maharashtra show a gap between policy ambitions and on-ground execution, with several major floating solar tenders facing delays or sluggish rollout due to tariff constraints and logistical bottlenecks. [1]

- Grid Connectivity & Bathymetry: Detailed bathymetric surveys (mapping underwater depths and terrain) and proximity to high-voltage substations are mandatory, as transmitting power from remote or hilly reservoir sites across Konkan can inflate balance-of-system (BOS) costs.

Floating solar power projects (also known as floatovoltaics or FPV) involve mounting solar photovoltaic panels on buoyant platforms placed over water bodies such as reservoirs, lakes, dams, and irrigation canals. [1, 2]

Key Benefits of Floating Solar

- Land Conservation: Uses underutilized water surfaces instead of valuable agricultural or forest land. [1]
- Higher Efficiency: Cools solar panels naturally via water contact, increasing energy generation efficiency by up to 15%. [1]
- Water Preservation: Reduces water evaporation from reservoirs by shading the surface and curbing algae growth. [1, 2]
- Dual-Use Synergy: Can be co-located with existing hydroelectric dams to share grid infrastructure and balance power supply. [1]

Major Floating Solar Projects in India

- Omkareshwar Floating Solar Park (Madhya Pradesh): India's largest and most ambitious project with a targeted capacity of 600 MW (spanning over 1,631 acres; partially commissioned with 287 MW active). [1, 2]
- NTPC Ramagundam (Telangana): A 100 MW utility-scale floating solar plant commissioned on July 1, 2022. [1]
- Kayamkulam Floating Solar (Kerala): A 101.6 MWp capacity installation operating over local backwaters. [1]
- Pradhan Mantri Surya Sarov Yojana: A national initiative aimed at deploying 5,000 MW of floating solar PV capacity backed by central financial assistance. [1]

Key Challenges & Concerns

- Livelihood Impact: Large installations on reservoirs (such as the proposed Damodar Valley Corporation project at Panchet Dam) face local resistance from fishing communities whose livelihoods depend on those waters.
- Higher Initial Costs: Engineering requirements for corrosion resistance, heavy anchoring, and mooring systems make initial capital costs higher than land-based solar.
- Maintenance & Durability: Systems must withstand wind loads, water currents, biofouling, and long-term moisture exposure. [1, 2, 3]

DISCUSSION

Floating solar or floating photovoltaics (FPV), sometimes called floatovoltaics, are solar panels mounted on a structure that floats. The structures that hold the panels usually consist of plastic buoys and cables. They are then placed on a body of water (e.g., Reservoirs, quarry lakes, irrigation canals or remediation and tailing ponds).[1][2][3][4][5]

The systems can have advantages over photovoltaics (PV) on land. Water surfaces may be less expensive than the cost of land, and there are fewer rules and regulations for structures built on bodies of water not used for recreation. Life cycle analysis indicates that foam-based FPV[6] have some of the shortest energy payback times (1.3 years) and the lowest greenhouse gas emissions to energy ratio (11 kg CO_2 eq/MWh) in crystalline silicon solar photovoltaic technologies reported.[7] FPV can be used to generate electricity for any application as well as to make green hydrogen via electrolysis on the same water they are floating on.[8]

Floating arrays can achieve higher efficiencies than PV panels on land because water cools the panels. The panels can have a special coating to prevent rust or corrosion.[9] Floating SPV also provide shade, slow evaporation and inhibit the growth of algae.[10]

The market for this renewable energy technology has grown rapidly since 2016. The first 20 plants with capacities of a few dozen kWp were built between 2007 and 2013.[11] Installed power grew from 3 GW in 2020, to 13 GW in 2022,[12] surpassing a prediction of 10 GW by 2025.[13] The World Bank estimated there are 6,600 large bodies of water suitable for floating solar, with a technical capacity of over 4,000 GW if 10% of their surfaces were covered with panels.[12]

The US has more floating solar potential than any other country in the world.[14] Bodies of water suitable for floating solar are well-distributed throughout the US The southeast and southern US plains states generally have reservoirs with the largest capacities.

RESULTS

Floating Solar mounting, also known as floating photovoltaics (FPV), refers to Solar panels installed on floating platforms of structures such as lakes, ponds, and others. The technology enables energy companies to expand solar power without taking up more land. The potential for energy generation and climate protection is huge—largely unexploited yet—with floating plant technology. While other solar systems are attached to the ground, in the case of a floating system, the photovoltaic modules are mounted onto floating structures and operate on a body of standing water or the sea.[7,8,9]

Key findings

The Ministry of Jal Shakti has released the report of India’s first water bodies census in 2018, a comprehensive database of ponds, tanks, lakes, and reservoirs in the country.

The census enumerated more than 2.4 million water bodies across all states and Union Territories, out of which 97.1% (23,55,055) are in rural areas and only 2.9% (69,485) are in urban areas.

A report by The Energy and Resources Institute (TERI) has found that India's water bodies have 18,000 sq. km of area with the potential to generate 280 GW of solar power through floating solar photovoltaic (PV) plants.

The Role of Floating Solar Panels in the transition to a Sustainable Energy Mix
Floating solar is likely to be one of the most important approaches in the transition to sustainable hybrid energy while also being a renewable energy solution to environmental, economic, and major social challenges.[10,11,12]

- The use of floating solar panels prevents the depletion of reservoirs and aquifers and contributes to water conservation efforts. Floating solar panels also save land use and preserve natural habitats by reducing water use, while preserving biodiversity.

- The cooling water improves the efficiency of the solar panels; this increases energy production and reduces greenhouse gas emissions that cause climate change. Floating solar panels open opportunities for distributed power generation, providing communities with clean and sustainable electricity.

- By freeing up land for other purposes such as agriculture and habitat protection, the use of floating solar panels helps to better conserve fertile land and support local economic development.

It is sometimes hard for traditional ground installations to harness the low levels of sunlight that bounce back into space when the Earth is excited during the day, especially when it's cloudy. However, these varieties of sunlight can still be collected in abundance even on cloudy days. During periods of abundant sunlight, the hours of abundant sunlight will not be interfered with by remaining conditions. They are pointed upward from a light source beyond their maximum radiative capacity.
Overview of the Indian government's initiatives and subsidies for floating solar panels
The government of India has earnestly promoted the development of solar energy projects, including floating solar panels, through several programs and subsidies. Examples include significant financial support by the MNRE for large-scale renewable energy projects; and manufacturing incentive programs to build domestic manufacturing in the solar industry.[11,12,13]

The government of India has taken a few initiatives and subsidies to support the deployment of floating solar panels which include Viability Gap Funding, Performance-based incentives, renewable purchase obligations and other state-level initiatives.

- MNRE offers incentives through Performance-Based Incentives for floating solar projects to encourage the adoption of renewable energy. The incentives are payments made to solar system owners based on the amount of electricity the system generates.

- The incentives given to a floating solar project are different from other incentives, for example, Solar Renewable Energy Certificates, since they focus on rewarding actual energy production and not an environmental benefit.

- MNRE's PBIs for a floating solar project can, therefore, boost demand for solar systems, ensure appropriate installation and maintenance, and provide jobs in the solar industry.[12,13]

- The duration of MNRE's Performance-Based Incentives for floating solar projects usually lasts for a specified term upon system generation validation, or around six years. Incentives are paid upon the actual energy production amount of the solar system, where the incentive amount is set by the utility company and approved by the state regulators.

Advantages of floating solar panels over traditional land-based installations
Environmental benefits - reduced water evaporation and carbon emissions:

One of the main advantages of floating solar panels is that they reduce water discharge from tanks and other bodies of water.

The floating platforms and solar panels have a shading effect that reduces the water surface temperature. This can significantly reduce water temperature, especially in areas with high humidity and sunlight.

By reducing evaporation and transpiration, floating solar installations help conserve precious water, especially in areas where water scarcity is a challenge.

Floating solar panels do not release greenhouse gasses such as carbon dioxide from electricity generation, as fossil-fuel plants do.

By migrating fossil fuels to generate electricity, floating solar farms significantly reduce carbon emissions and are strong mitigators of climate change.

Economic benefits - reduced land requirements and increased energy production:

They can be used on any body of water, such as ponds or lakes, thus maximizing the use of space without sacrificing terrestrial resources. In areas where land is scarce or expensive, floating solar farms are an innovation in renewable energy.

Thus, floating solar can be installed with minimal land acquisition costs, saving the overall investment. Specifically, it would be very attractive in most densely populated areas or expensive land, where conventional ground-mounted solar farms are not possible.

Floating solar reflectors are more efficient compared to their ground-mounted counterparts due to the cooling properties of the water.

The water lowers the operating temperature of the solar panel and can increase energy efficiency by up to 13%.

Increased efficiency refers to increased energy density per square meter of the solar panel, thus maximizing the benefits of a floating solar installation.

Disadvantages of Floating Solar Panels

Limited applicability and higher capital costs:

The floating platforms, anchors, cables, and special equipment create complexity and higher expenses compared to the ground-mounted solar; however, some studies show comparable lifetime costs when efficiency gains offset the initial.

It is only relevant for water bodies with calm conditions and can't find universal use. Waves, tides, or high winds can challenge the stability and functionality of floating solar installations. Moreover, not all water bodies will be suitable because of environmental concerns or other uses like navigation, recreation, or fishing.[12]

Potential Disruption of Aquatic Life:

The spatial extent of floating solar panels might be able to change the rate at which sunlight penetrates the water column. This may affect all levels of the aquatic food chain and may interfere with biogeochemical cycles, such as the water, carbon, and nitrogen cycles.

Solar panels may decrease photosynthetic activity from reduced availability of sunlight, hence loss in the phytoplankton—microscopic plants—and macrophytes, or aquatic plants. This is likely to cause cascading effects throughout the entire aquatic food web.

Lowered photosynthesis and loss of aquatic plants would cause depletion of the dissolved oxygen in the water, very important for the survival of aquatic fauna like fish.

Decomposition of the dying plants can release nutrients such as phosphates and nitrates, which might lead to eutrophication, thus favoring the growth of shade-tolerant cyanobacteria or so-called blue-green algae. This can further disrupt the aquatic ecosystem.

The loss of aquatic fauna and plants can impact migratory and resident bird species depending on these feeding grounds.

Mitigation Plan for the Disadvantages
Disadvantages such as disruption in aquatic life might also affect the food chain. To minimize these risks, a mitigation plan is needed.

Environmental impact assessments should be thoroughly conducted (before floating solar panel installations) to identify sensitive areas and risks that may be posed by the projects to aquatic ecosystems. Identification of sites with minimal impacts on biodiversity and aquatic life.

It can be ensured that floating solar arrays are very carefully planned in terms of layout and positioning to minimize shading effects and guarantee sufficient sunlight penetration into the water. In this way, disruptions to the aquatic food chain and biogeochemical cycles will be kept to a minimum.

Implement measures to protect and conserve important habitats of aquatic plants and animals. When designing floating solar projects, avoid important areas where fish and birds breed or feed to minimize habitat loss or fragmentation.

Strategies for minimizing thermal disturbances by using floating solar panels, can be developed. This could include incorporating design features that allow for the maintenance of natural thermal gradients in the water body.

National level projects

The 100-MW Floating Solar venture is a substantial renewable energy project at Ramagundam, Telangana, developed at the backwaters of the NTPC Ramagundam Thermal Power Station Reservoir, Telangana.[13]

It has a monetary implication of Rs. 423 crores through an EPC agreement with Bharat Heavy Electricals Limited. The venture covers 500 acres of the Reservoir with the 100M.W. The output is divided into 40 blocks, with each block able to produce 2.5 M.W. strength. The 25-MW floating solar assignment at NTPC Simhadri in Andhra Pradesh is an important initiative of renewable power developed with the aid of NTPC on the

reservoir of its Simhadri coal-fired strength station in Visakhapatnam. Commissioned in 2021, this is one of the largest floating sun energies, spreading over seventy-five acres within the Simhadri reservoir.

This undertaking is made with an environmentally friendly layout and over 1 lakh solar PV modules installed on the reservoir's floor. This floating solar installation is likely to generate enough electricity to illuminate 7,000 households annually.

The 25-MW Floating Solar venture at NTPC forms a fundamental part of NTPC's large ambition to feature 60 GW of renewable energy capability by the year 2032. This, in flip, will guide India's ambition to add 450 GW of renewable strength potential by 2030.

The future of floating solar panels in India looks promising and has the potential to make significant contributions to the country's renewable energy goals. With the government's initiatives and subsidies, there is a strong foundation for the widespread adoption of floating solar technology. The Solar Park Scheme, along with other supportive measures, aims to accelerate the deployment of solar projects and meet the renewable energy targets. By leveraging underutilized water surfaces and enhancing energy production through the cooling effect of water, floating solar panels can play a crucial role in India's transition to a sustainable energy mix.

As the country continues to prioritize renewable energy, floating solar panels are poised to be a key player in achieving a more sustainable and greener energy future for India.

CONCLUSIONS

Floating Solar Status in Konkan and Maharashtra

- Konkan Focus: Major floating solar initiatives in Maharashtra are currently concentrated primarily in the Krishna and Godavari river basins and specific reservoirs like Veer (Satara district), Ekrukh, Mulshi (Pune district), and Tansa / Modak Sagar (near Mumbai), rather than major commercial floating solar farms directly deployed in the coastal Konkan region. [1, 2, 3, 4, 5, 6]
- Key Maharashtra Projects & Initiatives:
  - Veer Dam (Satara): An integrated 11-MW Floating Solar PV and 5.5-MW Battery Energy Storage System (BESS) project floated via PPP by MKVDC (targeted for FY 2028–29).
  - Mulshi Reservoir: A 300 kWp floating solar pilot by Tata Power using Norway's Ocean Sun membrane-based technology.
  - Tansa and Modak Sagar Dams: A proposed 100-MW grid-connected floating solar PV project tendered by MAHAPREIT / BMC.
  - Ekrukh Reservoir: An upcoming up-to-59 MW floating solar project paired with a 29 MW/59 MWh BESS. [1, 2, 3, 4, 5]

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