Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 7, No.1, July : 2024

A REVIEW-ANALYSIS OF THE FLOATING ROOF STRUCTURE OF THE SOLAR SYSTEM

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ABSTRACT
A plentiful and clean alternative energy source is solar energy. Solar technologies use mirrors to focus solar radiation or photovoltaic (PV) panels to convert sunlight into electrical energy. Because solar PV energy has the ability to meet the world's energy needs, it is playing a major part in the switch to renewable energy. However, producing energy requires a lot of land, which restricts the uses that can be used for agriculture.These clashes with the growing issue of land shortage as well as the argument over food vs energy. Installing solar PV systems on bodies of water, such as lakes, irrigation ponds, dams, canals, and oceans, can be a desirable solution to this issue. Floating solar photovoltaic panels provide advantages over land-installed solar panels, including fewer impediments to deflect sunlight. Because the plant shades the surrounding area, less water evaporates, less algae grows, and possibly even improves the quality of the water, the aquatic environment benefits from the solar installation. The current state of floating photovoltaic technology and its range of design alternatives are discussed in further detail in this study
Keywords: photovoltaic solar energy, floating solar system, tracking solar energy from floating structures, and Internet of Things.

1.Introduction

These days, one of the main energy sources used worldwide is fossil fuel. Nonetheless, the global community faces the same environmental issues brought on by the overuse of fossil fuels. In order to meet these demands, sustainable or renewable sources of energy are prioritized, and numerous large-scale photovoltaic (PV) energy producing systems are being planned and built. But because these facility zones are primarily on land, there have been some issues as well, like an increase in overall building costs because of the high cost of land use, and environmental disruptions like the destruction of the natural system [1]. A floating type photovoltaic energy generation system is being researched and developed to address or lessen these issues based on earlier studies. In Aichi, Japan, the first floating photovoltaic power plant was erected. Then, in the USA, Italy, Spain, France, Korea, and other countries, different kinds of floating photovoltaic power plants are established. A contemporary idea for producing renewable energy, floating photovoltaic systems (FPVSs) combine the current PV systems with a floating frame. PV modules can achieve a better efficiency because to this combination[2]

2.Floating photovoltaic system:

An emerging concept is the floating solar photovoltaic (FPV) system, which uses solar photovoltaic (PV) technology installed directly on top of a body of water rather than on land or on building rooftops. The solar panels are installed on moored floating platforms [8]. When solar panels are submerged in water, their bottom surfaces can cool more effectively, extending their lifespan. Additionally, by shading the water they float on, the solar panels can reduce evaporation by up to 70% and increase their power generation capacity by up to 16%.

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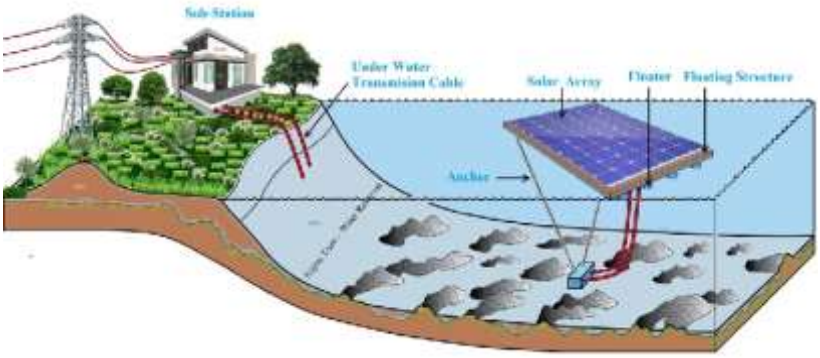

Fig1.layout of floating solar power plant

Pontoons (floats), mooring systems, PV panels, and electric cables and connectors are the primary components of FPVSs, as seen in this diagram. Pontoons are devices that float on their own, coupled with PV panels, and include an area for human access to allow for maintenance. The anchoring and mooring system is a permanent framework that keeps the floating platform in its chosen location and position while preventing it from drifting away[7].

Connectors and cables are needed to move electricity from the FPVS to the land, where it can be fed into the grid or stored in batteries, in addition to PV panels, which produce the energy. As per the following expression, the PV module's conversion efficiency may be determined by dividing the generated electrical power by the incident solar radiation intensity.

$$\eta el = \frac{Pmax}{SXAPv} x100\%$$

where S is the solar radiation intensity incident on the PV module (W/m2), Apv is the front PV module surface exposed to the solar radiation intensity (m2), P_{max} is the power generated by the PV module (W), and η is the electrical efficiency (%). PV systems known as floating solar arrays are installed on the surface of cleanup and tailing ponds, quarry lakes, irrigation canals, and drinking water reservoirs [4].

3.Components of the Floating System

A generic FPV system is commonly consisting of: PV modules that capture solar energy, floats that provide buoyancy, a structure that supports the PV panels, a mooring system that prevents the plant from moving freely, electrical components, and optional efficiency systems. These components are explained in the following sub-headers.

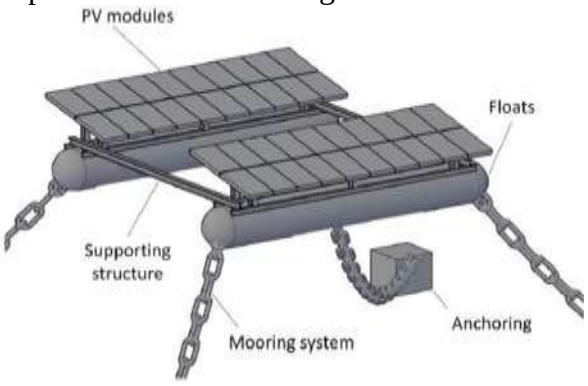

Fig.2 Components of the Floating System

3.1. PV modules.

Solar PV modules are an essential component of the FSPV plant, and as with traditional solar projects, polycrystalline, monocrystalline, or thin film solar panels are used for installation. When choosing PV modules, consider solar panel performance, solar panel quality, solar panel durability, quality assurances from the solar panel manufacturer, and warranty.

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3.2. Supportive Structure

Most FPV designs contain a metallic structure to support the PV modules and transmit stresses between components; these structures are typically composed of galvanized steel, high-durability steel, aluminium, or fibre-reinforced polymers (FRP). The supporting structure was utilized to keep the panels at a safe height from sea level [7].

3.3. Inverters-

DC power generated by solar PV modules is routed to the inverter via a series of combiner boxes and then converted to AC power. A developer can use multiple-string inverters or central inverters. Inverters can be put on a separate floating platform or on land, depending on their size and distance from the shore[6].

3.4. Anchoring and Mooring Mechanism-

A floating structure is held in place by a permanent structure called a mooring system. The terms "mooring systems" refer to jetties, piers, quays, wharves, anchor buoys, and mooring buoys. All floating structures on the water can move freely thanks to the mooring. A floating structure can be fixed in place using an anchor mooring in relation to a spot on a waterway's bottom without being connected to the shore. This enables it to accommodate variations in the water level while keeping its southerly location. Additionally, there are four types of mooring systems: stiff, compliant, taut, and catenaries moorings [3].

4. Categorization of FPV Designs Organization:

FPV categorized according to their structural configuration, with an evaluation of their appropriateness for the aquatic environment and application examples included

4.1) Superficial structure:

Some plants were constructed to have the PV modules lying on the water's surface or even partially submerged in order to fully profit from these advantages. The PV modules are immediately installed over the water's surface. This construction could be flexible or stiff.

4.2) Pontoon structure:

This type of structure has a middle floating platform set up. This technique uses high-density polyethylene HDPE cylinders as floats and steel and aluminium components as the supporting framework to design a raft or pontoon that creates a stable floating platform for the installation of the solar panels. The contact surface of these structures with the water is modest [10].

5. Solar PV Installation Types

A classification of different solar PV installations.

5.1) Conventional land-based solar system-

Racks or frames fastened to ground-based mounting supports hold their solar modules in place. Pole mounts, Foundation mounts, and Ballasted footing mounts made of concrete or steel bases are examples of ground-based mounting supports that employ weight rather than ground penetration to hold solar module systems in place.

Fig.3. **Conventional land-based solar system**

5.2) Rooftop Installation -

Installing photovoltaic panels on the roof of a residential or commercial building or structure produces power. This type of system is known as a rooftop PV system. Such a system comprises photovoltaic modules, wires, mounting systems, solar inverters, and other electrical accessories, among other components [6]. You can employ an off-grid or on-grid rooftop solar power plant in addition to other power sources such as wind turbines and diesel generators.

Fig.4 Rooftop Installation

5.3) Solar system at the top of Canal-

Typically, solar plants are installed on the ground, needing a sizable plot of land. The novel idea of building a solar PV plant on the Canal was created in order to avoid having to purchase a sizable tract of land. Deforestation is prevented and reforestation is promoted through landscaping when land use is eliminated [9].

Fig.5 Solar system at the top of Canal

5.4) Offshore photovoltaic system-

Over 70% of the earth's surface is made up of oceans, which also absorb a significant quantity of solar radiation. Using solar PV technology, the available solar resource might be used to offset the existing energy generation. Owing to the shortage of land onshore, installing PV plants is best done offshore, where the sun's rays are maximized during the day[9].

Fig.6 Offshore photovoltaic system

6. Analysis and Design:

When establishing a floating photovoltaic solar system, various studies and design parameters are taken into account.

- *Meteorological data* - knowing the local resources about FSPV, such as solar radiation, wind direction, wind velocity, wave height and amplitude, humidity, ambient temperature, rainfall, etc., requires an understanding of meteorological data[5].
- *Material Selection:* This involves the use of Floaters, whose job it is to ensure the system's buoyancy. There is a support structure that joins the floaters to the frame, and there is a frame that

houses the solar panels. The material selected for the support structure has outstanding technical qualities and a high level of resistance to corrosion from a variety of chemical agents.

- *Data on water quality*- is essential for choosing materials for cables, floating platforms, and anchoring and mooring systems as well as for estimating potential long-term impacts on the lifespan of FSPV plant components.
- *Simulation* – For designing the layout, angle of tilt, plot size, designing of anchoring and mooring lines, placement of inverters, plant capacity, balance of system, estimates of energy generations for the entire project life, etc.simulation software such as PVsyst, HelioScope, ANSYS, OrcaFlex, CFD, etc., can be used.The finite element method (FEM) is applied to the analysis of the structural systems resting on the buoys and supporting the solar panels [11].
- *Choosing a photovoltaic panel:* The goal is to choose a panel with the maximum efficiency feasible while minimizing platform costs and maximizing panel power output

7. System of Tracking -

There is a solar panel alignment that maximizes performance for every time and place. As a result, the tracking system's goal is to optimize energy gains during the duration of the PV system. There are several types of sun tracker driving systems: manual, semi-passive, active, passive, and chronological. Given that the panels are floating, certain alignment errors should be anticipated, and the effect on the production of power needs to be investigated. The trackers can revolve around two axes: tip-tilt or azimuth-altitude, or around a single axis (horizontal or vertical)[8].

8. Internet of Things (IoT) technology:

The proliferation of linked things on the Internet has been sped up by IoT technologies, economies of scale, and advancements in hardware, software, and network technologies. An Internet of Things platform can be used to remotely control a connected object, which can also send, receive, and process a wide range of data. the use of IoT technologies to provide a straightforward and affordable IoT solution for the control and monitoring of an intelligent dual-axis solar tracker system for performance assessment[12]. The solar tracker itself, as well as its ability to receive commands from the IoT monitoring, can be immediately monitored online and data from it may be supplied with ease and properity. Users of the Internet of Things-based solar tracker can readily and simply access a basic monitoring application[10].

9. Floating Power Plant Benefits

- An eco-friendly, renewable energy source.
- Because of the water's cooling impact, which raises solar panel efficiency, floating solar power plant systems often produce more electricity than ground-mount and rooftop systems.
- Protecting the resources of land. The possible use of floating photovoltaic systems in fish farming Improving the quality of the water by inhibiting the formation of algae by allowing less sunlight to penetrate the body of water.
- Minimizing evaporation to conserve water.
- Floating platforms are made entirely of recyclable high-density polyethylene that is resistant to corrosion and ultraviolet light.

10.Floating Solar's Impact on Society and Environment-

Inland bodies of water are frequently the site of FSPV plants, which are utilized for a number of things like irrigation, drinking water, energy production, and leisure. Large-scale FSPV plant deployment could have a significant effect on human social evolution, as these water bodies are frequently designated as lifelines. Effect on nearby marine farming as a result of less sunlight reaching the water's surface causes high amounts of dissolved organic carbon, which inhibits the decomposition of

pollutants and may raise the cost of water treatment. It also has an impact on migratory birds' habitats and by leaching from materials[7].

11. Conclusions-

A clean, pollution-free, and sustainable energy source is solar power. Clean electricity production and sustainability are two benefits of solar photovoltaic technology. This paper discusses the idea of a floating photovoltaic (PV) generation system, how one operates, what makes up a floating solar panel, how to analyze and design a floating PV system, how to use a tracking system, how to design floating structures, and what the mechanical characteristics of the floating structure that supports the solar panels are. An inventive step would be a floating solar technology, which could address the enduring issue of land. Since these solar panels will be submerged in water, they should remain cool and produce more energy than ones mounted a top.

12 Future Scopes:

- ❖ Further investigation is needed into the design of roof structures and anchoring mechanisms to ensure that floating PV systems can fully float on the buoyancy system.
- ❖ The creation of a solar tracking system that can adjust a floating PV system's direction and tilt is necessary.
- ❖ Research on flexible thin film technology for such difficult conditions is necessary because the majority of existing projects use rigid crystalline PV modules, which cannot tolerate hostile water environments.
- ❖ The potential of floating solar PV projects can be assessed using IoT, remote sensing, and GIS-based methods. It is necessary to implement suitable safety precautions in order to transfer power from water bodies to land.

13 References

1	Spain M. L´opez a,*, F. Soto a, Z.A. Hernandez b, “Assessment of the potential of floating solar photovoltaicpanels in bodies of water in the mainland", Journal of Cleaner Production 340 (2022) 130752 Elsevier Ltd.28-01-2022
2	.-H. Kim, S.-J. Yoon, and W. Choi, “Design and Construction of 1 MW Class Floating PV Generation tructural System Using FRP Members,” Energies, vol. 10, no. 8, p. 1142, Aug. 2017.
3	ampedusa A.Ghigo, Emilio Faraggiana, Massimo Sirigu , Giuliana Mattiazzo and Giovanni Bracco, “Design nd Analysis of a Floating Photovoltaic System for Offshore Installation: The Case Study”, Energies 2022
4	Aboubakr El Hammoumi,Abdelilah Chalh , Amine Allouhi a, Saad Motahhir [4],Abdelaziz El, "Design and construction of a test bench to investigate the potential of floating PV systems", science Direct Journal of Cleaner Production 278 (2021) 123917- 27 August 2020
5	eok Min Choi, Chang-Dae Park, Sung-Hoon Cho, Byung-Ju Lim, "Effects of wind loads on the solar panel n array of a floating photovoltaic system” Energy 256 (2022) 124649 Published by Elsevier Ltd. 30 June 2022
6	. Ranjbaran, H. Yousefi, G. B. Gharehpetian, and F. R. Astaraei,“A review on floating photovoltaic(FPV)power generation units,” Renewable and Sustainable Energy Reviews, vol.110. Elsevier Ltd, pp.332–347, 01-Aug 2019.
7	. Claus, M. L´opez, "Key issues in the design of floating photovoltaic structures for the marine environment Renewable and Sustainable Energy”, Reviews164(2022)112502 Elsevier Ltd 21 April 2022

8	.-K. Choi, “A Study on Power Generation Analysis of Floating PV System Considering Environmental mpact,” Int. J. Softw. Eng. Its Appl., vol. 8, no. 1, pp. 75–84, 2014.
9	oung-Geun Lee a,1, Hyung-Joong Joo b, Soon-Jong Yoon, “Design and installation of floating typephotovoltaic energy generation system using FRP members” ScienceDirect Solar Energy 108 (2014) 13–27Elsevier Ltd.
10	. YIN, Y. Zeng, X. Chen, and Y. Fan, "The Internet of Things technology: An overview," Journal of IndustrialInformation Integration, vol. 1. Elsevier B.V., pp. 3–13, 2016.
11	itin Ingole1, Aniket Kelzarkar2, Pratik Rathod3, Ashish Bandewar4, “Floating Solar Power Plants: A Review”International Research Journal of Engineering and Technology (IRJET), Volume: 07 pp.775-77912010 Issue: 01Jan 2020
12	Jian Dai, Chi Zhang, Han Vincent Lim, Kok Keng Ang, Xudong Qian, Johnny Liang, “Design and constructionof a floating modular photovoltaic system for water reservoirs”, 2019 Published by Elsevier Ltd. 13 November2019