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A SURVEY ON FLOATING SOLAR POWER SYSTEM

N. Krishnaveni*, P. Anbarasu & D. Vigneshkumar*****
* Assistant Professor, Department of Electrical &Electronics Engineering, Dr. Mahalingam College of Engineering and Technology, Tamilnadu
** Assistant Professor, Department of Electrical & Electronics Engineering, Sri Eshwar College of Engineering, Tamilnadu
*** Deputy Manager (Projects), Global Wind Infrastructure Services Private Limited, Maharashtra

Abstract:
The constant depletion of the fossil fuels and high energy demand focuses us to renewableenergy sources which are not only the future unlimited source of energy, it is also eco-friendly and sustainable for theenvironment. Even though solar power generation has several advantages over other forms of electricity generation, the major problem is the requirement of land which is scarcely available inthe world and its cost. A new era in solar power i.e., floating solar power plants will solve this issue. This floating solar plant can be installed in any water bodies which will not onlydecrease the cost of the land but also will raise the amount of generation with the cooling effect of water. This paper presents the technical details of floating solar power plants. The floating solar involves solar panels and other components that are fitted onto a platform with hollow plastic or tin drums that enable it to float on water. The benefits of floating power plants will be presented.

Index Terms: Alternate Energy Sources, Floating Solar Power Plants, HDPE (High Density Polyethylene)

1. Introduction:

One of the largest challenges before India today is the power crisis. More than 300 million Indians have no access to electricity. India's power sector could supply just 124,000 megawatts for a country of more than 1.2 billion people. Even the supply is not regular for those who are accessing electricity. Shutdowns and load-shedding interrupts irrigation and manufacturing across the country. To meet the demand of India our focus should be on alternate energy sources. Renewable energy sources like hydro and wind are area specific whereas solar energy can be installed in any place. With India being the seventh largest country in terms of area and gifted with fairly well sunshine nearly 300 days in a year, solar power has lots of potential in store for us. The global solar industry has been seeing exponential growth in recent years, and that's expected to continue. After hitting about 178 GW of solar PV power capacity by the end of 2014, global solar PV capacity is expected to hit 200 GW in the end of 2016.

Solar power plays a dominant role in the world-wide effort to reduce greenhouse gases; it is considered a clean energy and an efficient source of electricity. Yet several obstacles have been undermining the expansion of this sector and many of its actors are looking for new approaches that would make solar power more practical and commercially attractive. Water utilities often have suitable water sources such as storage reservoirs for drinking water, irrigation water and open channel aqueducts where floating solar panels could be installed.

2. Solar Power Plant:

Solar energy is produced by sun created through a thermonuclear process and this process creates heat and electromagnetic radiations. These electromagnetic radiations have the energy that reaches the earth. As solar energy is an indirect source of energy, we need two components: one the collector and other the storage device. The

collector will collect the radiations coming from the sun and convert it in the form of electrical energy. One the other hand we require storage unit since the radiations keeps varying throughout the day and during night hours there will be no radiations.

There are three types of collectors like flat-plate collectors, Focusing collectors and Passive collectors. Most of the time we use flat- plate panel which is a combination of array of solar cells arranged in a simple plane. The output of these panels depends upon the size of panel, intensity of radiations and the cleanness of the panel.

A solar cell or PV cell converts solar energy into Electrical energy by the photo voltaic effect. When the sunlight is incident upon a material surface, the electrons present in the valence band absorb energy and, being excited jump to the conduction band and become free. These highly excited, non-thermal electrons diffuse, and some reach a junction where they are accelerated into a different material by a built-in potential (Galvani potential). This generates an electromotive force, and thus the light energy is converted into electric energy.

An Array of solar panels is used to generate electricity. The output of solar panel will be connected to the storage device and inverter for converting the obtained direct current into three phase alternating current. The 3 phase AC power is then given to meet the load demand or fed to grid.

Practical problem of generating power from the sun would be the expense of the silicon material that converts light to electricity, and the large tracts of land needed for solar farms.

Now with the concept of floating solar we are enchasing the availabilities of water bodies in different regions. Since with this idea we do not have to utilize a large area, the problem of land for the solar plant can be easily solved. Also, keeping in mind the fact that land acquisition in India is not an easy task, this sort of an idea keep itself away from disputes. We all know, that during summers canals face the threat of drying up due to which irrigation problems arise. With floating solar, around 70% of the evaporation could be prevented which would in turn help in the retainingsufficient amount of waters in the canals and small river bodies. Also, algae formation in the water bodies can be reduced as the amount of sunlight entering into the water would decrease which in turn reduce the photosynthesis process to produce less algae in water. This makes water less contaminated and helps the aquatic life in sustaining.

3. Floating Solar Power Plants:

A PV floating power generation results from the combination of PV plant technology and floating technology. This fusion of new concept consists of Floating System: A floating body (Structure + Floater) that allows the installation of the PV module, Mooring System: Can adjust to water level fluctuations while maintaining its position in a southward direction, PV System: PV generation equipment, similar to electrical junction boxes, that are installed on top of the floating system and Underwater Cable: Transfers the generated power from land to the PV system development. As a new generation technology, it can replace the existing PV plants that are installed on top of woodland, farmland and buildings. Figure 1 shows the outline of the floating solar power plant.

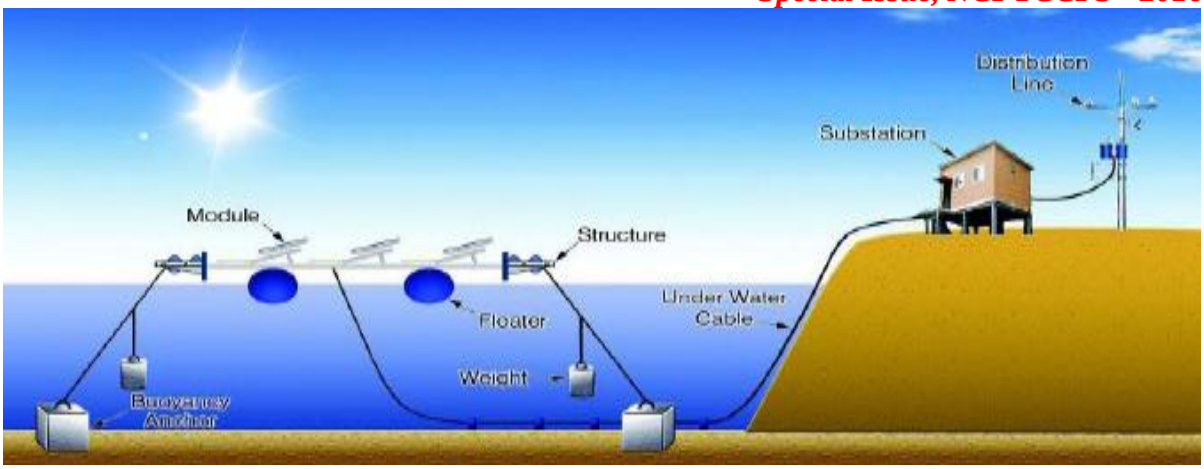

Figure 1: Floating Solar Power Plant Outline

Floating solar power plants installed on water surfaces, so these panels are naturally cooled, due to that the temperature rise of panels is less compared to roof top solar power panels. So the life time of panels increases due to less stress on panels. Floating solar panels cost is slightly higher than the roof top solar panels, but when it comes to scarcity of land problem based countries that floating solar installation cost is negligible with production profits of useful land. The floating solar power system also provides other environmental benefits like prevention of evaporation of water. The systems can also improve water quality. Solar panels acts as roof for the water bodies, so the water will not exposed to sun and atmosphere, it adds a beneficiation for drinking water plants. The organic matter growth such as algae will decrease, as solar panels acts as cover to water bodies. It will minimize the labour cost of water treatment plant maintenance.

- **Technical Facts:**

The construction of a floating system contains the major parts as floating structures, PV panels, Inverter Mechanism, Transmission of power to grid, Control Mechanism and Monitoring Mechanism [2].

The energy generated by floating power plant can be transmitted to load or grid by cable submerged in water. Proper planning is required to produce the electric power by using floating solar power plants without interrupting the works of ponds and reservoirs.

By using proper software's and remote control mechanism monitoring of plant elements like metrological parameters and floating platform parameters possible, and also controlling done by them in order to monitor malfunctions ,stop machine and actuation times

- **Features of Floating Structures:**

The structure should easily adapt to changes in water level in reservoirs. i.e irrespective of water levels the system, should float on the water bodies. The floating material should be completely recyclable.

The characteristics of these structures should be:

- The material used for structure should be completely non toxic, resistant to salt water and alkalis acids, UV rays resistant and completely recyclable.
- The structures should be able to withstand temperatures from -60°C to 80°C.
- Long life time that is 30 years withstand capability under water.

Main materials for the modules of structures are Plastic float elements and stainless steel elements. The plastic structures are made by LUPOLEN 5261Z or PEAD

materials which are used for construction of jetties both in marine and military fields. The Cost of PEAD material is high. The other material suitable for floating solar system is HDPE (High Density Poly Ethylene) material. These HDPE structures are preferred due to their low cost and high reliability.

The other type of structures is metal support structures for photovoltaic panels, they are made of tubular zinc made paint or stainless steel sections. The cost of metal structures is high and the other drawbacks of these metal bodies are less resistive to alkalis acids.

Due to drawbacks and cost considerations of other materials HDPE [4] material is most commonly used material for the floating solar systems. High Density polyethylene structure is shown in figure.2. It allows standard PV panels to be installed on large bodies of water such as drinking water reservoirs, quarry lakes, irrigation canals or remediation and tailing ponds. The Life time of HDPE structures of floating solar power plants is more than 20 years.

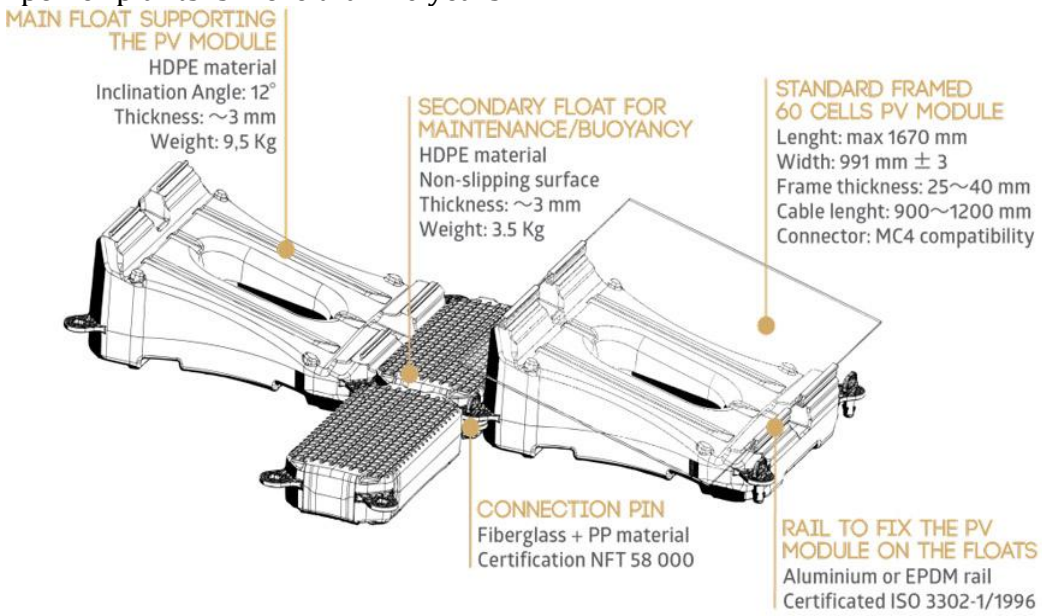

Figure 2: HDPE Structure for floating power plant

- **Properties of HDPE:**

1. Resistant to ultra violet radiation & corrosion: The structures are made of HDPE through blow mold manufacturing process. Due to their highly resistant composition, it can withstand for more than 20years.
2. Extreme wind resistant: HDPE Structures floating solar power can withstand up to 118 mph winds according to ONERA- the French aerospace lab report.
3. Safe mounting & maintenance: It has been designed to be easily and quickly deployed. The secondary floats allow easy access to the panels for maintenance and cleaning.
4. Drinking water compliant: Drinking water compliance tested by the English Independent Water Quality Control Center.
5. Cost-effective: Cost is less per module compared to LUPOLEN 5261Z and zinc coated stainless steel structures. The other manufacturing benefits of HDPE structures are easy to install, i.e easy to adapt to any electrical configuration, Scalable from low to high power generation, no need of heavy equipment for installation of HDPE structures. Recycling is possible for HDPE materials.

- **Solar Panel:**

The power generating capacity is major concern while selecting the panels. The PV panels are classified as poly, mono, thin film or hybrid panels. The panel efficiency gives the space occupied by solar panel for amount of power generation. Most crystalline modules will perform in a very similar, and will take up roughly the same space. Hybrid panels will generate a larger power from a smaller area. However, they are too expensive compared to crystalline panels Thin film modules are very well suited to dull, diffuse conditions. They take up a lot more area than other types, but durability is very less. The cost of solar panels also depends on location of manufacturing and transportation charges. There are three types of solar panels i)Mono crystalline panels ii) Polycrystalline panels iii) Hybrid panels,

i. **Monocrystalline Panels:** The solar cells in monocrystalline panels are slices cut from pure drawn crystalline silicon bars. The entire cell is aligned in one direction, which means that when the sun is shining brightly on them at the correct angle, they are extremely efficient. So, these panels work when the sun is shining directly on them. They have a uniform black colour because they are absorbing most of the light. There are unused spaces in the solar module.
ii. **Polycrsytalline Panels:** Polycrystalline panels are made up from the silicon offcuts, molded to form blocks and create a cell made up of several bits of pure crystal.[5]. The individual crystals are not perfectly aligned together and so there are losses at the joints between them, which make them inefficient. However, this misalignment can help in some circumstances, because the cells work better from light at all angles, even in low light also. The panels are little bluer as they reflect some of the light. Since they are cut into rectangular blocks, there is very little wasted space on the panel. These panels have more uniform appearance with their rectangular shape.
iii. **Hybrid Panels:** The Hybrid module has a thin layer of amorphous solar film behind the monocrystalline cells. The extra amorphous layer extracts even more energy from the available sunlight, particularly in low light conditions. These are the most efficient panels available, so they occupy the least space for roof and floating panels.

4. First Floating Solar Power Plants:

The world's first floating photovoltaic system was installed in 2007 by SPG Solar on a pond at Far Niente Winery in Napa California.[3] It contains1,000 floating panels linked to 1,300 stationary panels on land to produce a total of 4 MW. In Napa of California most of land used for wine fields, so the Floating solar system is chosen to secure the land which is used for power generation. Figure 3 shows the picture of world first solar power plant.

Indias first floating solar power station was installed at pond of Victoria Memorial. A raft like platform fitted with hollow plastic or tin drums would be floating on water. The power generating equipment such as solar panels would be fitted on this raft so that they can float on water.

This system would be able to generate 10 KW of power and would require an area of around 100 sq metres. The project was funded by ministry of power and renewable energy, it would be the first floating power system project in India. The cost of the project is 32 lakh rupees sanctioned by ministry power and renewable energy sources. The project was commissioned by VikramSolar's in cooperation with the Arka Renewable Energy College in Kolkata [2].

Figure 3: Worlds first Solar Power Plant

The installation is completely flexible and consists of ten one kW fibre glass modules, which make up the floating platform itself. The system is firmly anchored to the bottom of the lake and is connected to the grid using a submersible cable. The overall system is designed to last for 25 years and produce a minimum generation of 14 MWh/year. Fig 4 shows India's first floating solar power station will be launched in one of the Victoria Memorial's ponds commissioned in 2014

Figure 4: India's first floating solar power station installed at Kolkata

5. Future India:

Having already started on their plan to install 50 megawatt (MW) solar plants on top of several canals, India has taken the creative use of space one step further and is planning on floating a power station on one of the large stretches of water in Kerala, a state in south-western India. This floating solar power technology was developed by India's Renewable Energy College and the plant is being built by Indian energy company, the National Hydro Power Corporation (NHPC).

6. Conclusion:

With the advancement in solar photovoltaic system, the floating solar power plant plays a vital role. The advantage of the floating system is reduction of evaporation, thus helping preserve water levels during extreme summer. When panels are installed on floating platform, the heating problem of solar panel on land is solved to a great extent. This floating technology is long-lasting, cost effective, flexible and less time for installation. The advantages and technical details of floating solar power plant are presented in this paper. With this advancement, country like India can meet its power demand in future.

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