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FLOATING SOLAR POWER PLANTS

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Abstract: Unlike other things, electricity and electrical appliances had become an important part of easy way of living. But nowadays, the biggest challenge before India is the power crisis. Since the last few decades, there had been a constant depletion of the fossil fuels, whereas the energy demand has increased. This is the reason where we have started focusing towards the use of renewable energy resources. They are not only an unlimited source of energy, but also eco-friendly and sustainable. Wind and hydro are renewable energy resources, but they are area specific. On the other hand, solar power plants can be installed in any place. The solar power generation has several advantages, but the main problem with it is the requirement of land, which is scarcely available at high cost. Floating Solar Power Plants can be a great solution to the land issue. Solar panels can be installed on water bodies like canal tops, dams backwater and reservoirs, etc., which generally belongs to the government. This paper presents the technical details of the floating solar power plants with its benefits and challenges faced. It involves solar panels and other components installed on a floating platform with hollow tin or plastic drums that enables it to float.

Key Words:- FSPV: Floating Solar Power Plants,**PV**: Photovoltaic,**GW**: Gigawatt,**RPO**: Renewable Purchase Obligations,**DT**: Distribution Transformer,**CWC**: Central Water Commission,**PMSM**: Permanent Magnet Synchronous Motor,**HP**: Horsepower,**FRP**: Fibre Reinforced Plastic,**HDPE**: High Density Polythylene,**AC**: Alternating Current.

INTRODUCTION

India is facing a power crisis as the demand for energy in industrial, manufacturing, commercial and irrigation section is increasing day by day. The use of fossil fuels like coal is leading to its constant depletion. Hence, we have shifted a bit more towards renewable energy resources to fulfil the demand of electrical energy. Using renewable energy like wind and hydro plays an important role, but the problem is, they are area specific. Therefore, using solar energy for generation of electricity is the best alternative. Solar panels play major role in converting the solar radiations into electrical energy. The output of the panel is DC. The DC output of the panel can be either stepped up or stepped down using a DC to DC converter. The converted voltage can be used as an input to the inverter to be further converted to AC for transmission or to supply to the grid. Also, DC voltage can be used to charge up DC batteries used for DC supply.

Floating solar power plant is mounted on the surface of quarry lakes, dams backwater and reservoirs, irrigation canals. Some systems exist in countries like Japan, Korea, India, France, United States and United Kingdom. Floating solar power plants saves the costly land requirement. It also reduces the rate of evaporation, prevents the growth of algae. Besides this, solar panels installed on water bodies generate more energy as compared to solar panels mounted on roof-tops or ground. This is due to the cooling effect of water.

PURPOSE OF THE PROJECT

- The main purpose of the project is to explore unutilized water bodies and not use the costly land.
- To increase the efficiency of solar panels by the cooling effect of water and increase the generation of energy.
- To reduce the rate of evaporation from the surface of water bodies in order to preserve water level in extreme summer.
- • To reduce the growth of algae on water.
- • To increase the quality of water.

METHODOLOGY

Floating solar power plants results generally from two concepts i.e., PV plant technology and floating technology. The floating structure supports the solar panels, inverters, combined boxes, etc. on a floating bed, which is made up of High Density Polyethylene (HDPE) or Medium Density Polyethylene (MDPE) or ferrocement. The floating structure is anchored down to the sea bed or attached to the shore via ball floats. This will help the structure to stay afloat even in the heavy waves. The cables are connected to transfer the generated energy to the substation.

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COMPONENTS OF THE FSPV SYSTEM

1)Floating Platform

Floating Platform is the most important and crucial component of the FSPV. It supports all the components that play a major role in generation of electricity like PV panels, inverters, combined boxes, etc. Hence, the system needs to be designed using appropriate materials. High Density Polyethylene (HDPE) is popularly used in majority of FSPV plants. Besides this, floating platforms are designed using Fibre Reinforced Plastic (FRP), Medium Density Polyethylene (MDPE) or Ferro cement.

Fig pontoon structure

2) Mooring and Anchoring System

A mooring system refers to any permanent structure to which a floating structure is secured to a mooring to forestall free movement of the floating structure on the water. An anchor mooring fixes a floating structure's position relative to a point on the bottom of the waterway without connecting the floating structure to shore.

Fig Mooring structure

3) PV Modules

The basic integral part of FSPV plant is PV module. Like conventional projects, poly or monocrystalline solar panels are used in floating solar power plants. Selection of PV modules depends upon cost, space, humidity, and type of water body. A PV system typically includes panels or an array of solar modules, solar inverters, sometimes batteries and interconnecting wires.

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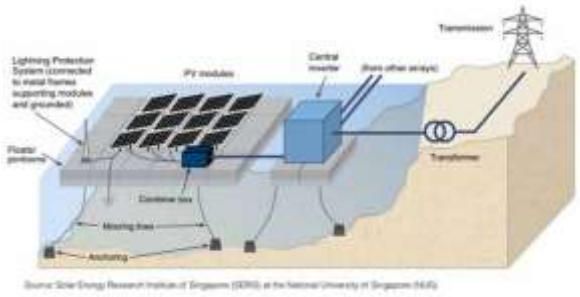
Fig Solar module

4) Cabling

Cabling is used to transfer generated power to substation. Due to their outdoor usage, cables are designed to be resistant against UV radiation and temperature fluctuations. These are generally unaffected by weather conditions and quality of water. Due to movement of floating platforms water surface causes cable length to vary. This requires to provide extra cable length in form of slack for movement of floating platforms.



BENEFITS

• Higher generation of electricity

The amount of generation depends upon solar PV array yield, solar PV temperature and local weather conditions like wind speed, ambient temperature, solar radiance, etc. The correlation indicates that low ambient temperature and high wind speed reduces the temperature of PV arrays, which leads to increase in energy yield. As the wind speed tends to be higher over the water surfaces and the ambient temperature is low as compared to land, it results in evaporative cooling effect of panels. This effect leads to lower operating temperature of PV cells, which in case increases the energy yield. However, the improvement in yield closely depends on arrangement of floating platform, gap between PV array and water surface etc.

• Reduction in evaporation of water

Loss of water resources due to evaporation is a well-known phenomenon, reported as high as 40% worldwide, and its effect is more significant particularly in dry and aired regions. As per an estimate by Central Water Commission (CWC) India, the evaporation loss in the country varies from 150-300 cm per km square per annum. As the FSPV is spread over water surfaces it reduces the amount of UV radiation reaching the water surface and limits the interaction of wind in the water surface. This leads to reduction in evaporation of water vapours from the surfaces saving the water for irrigation and other purposes specially in dry and aired regions.

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• Solve the land related issues

Since solar panels are installed on the surfaces of water bodies, it reduces the requirement of large land area which can be further used for infrastructural development or commercial purposes. FSPV is good alternative in countries like India, here land acquisition and its increasing cost creates hurdles to the growing technology in solar power plants.

• **Sharing existing electrical infrastructure at same station**

Many water bodies like dams and reservoirs used for irrigation and hydroelectric power plants have already existing grid connections. Hence, installing FSPV on such dams and reservoirs and using the already existing grid connection can save the investment cost. This makes the project inexpensive and economical.

• Reduction in growth of algae

The growth of algae mainly depends upon temperature of water and light density. Since FSPV covered on water surface provides shade to water, reducing the amount of sunlight reaching the surface. Hence, it leads to reduction in growth of algae.

CHALLENGES

Floating solar power plants seems to be easy but it faces many technological hurdles and installation challenges.

• Unavailability of water body data

Their is no exactly known data about the water surface area, local weather conditions, local biodiversity, topography inside water, water level variations and annual rainfall data of past few years, etc. Hence, it is difficult to estimate the actual potential and design the FSPV.

• Unavailability of technical guidelines and standard specifications

Though floating solar power plant technology is making huge development, the technical guidelines and specific standards for selection of panels, selection of materials for floating platforms etc. According to water body conditions are not mentioned till date. To ensure that these components can live long and can survive in harsh conditions, it is necessary to formulate the specific standards for the components of FSPV.

• FSPV components safety and its reliability

The FSPV Components are closely in contact with water body and are exposed to environmental conditions. Thus, the high humidity, rainfall, wind speed, salinity of water, etc., affects them. Hence, the risk of long run risk of FSPV is high as compared to ground based power plants. Components like, solar PV modules, floating platforms, cables float upon water bodies and thus they may lead to corrosion, bio-fouling or degradation. The unexpected fault behaviour of the components can increase the operating and maintenance cost of the project.

• Absence of local manufacturing

The floating platform and anchoring and mooring system play a major role in floating solar power plants but there are very few manufacturers providing the platforms and anchoring and mooring system. Hence, it may tend to increase in the cost. Now, since the market of FSPV is increasing in India, establishing local manufacturing market will bring down the cost but shall aid in developing local market capabilities as well.

• Environmental and Social impact

Water bodies are generally rich in local aquatic flora and fauna. They are also used for various activities like fishing, irrigation, social activities, research in aquatic life, drinking etc. In such cases, deploying floating solar power plants for long time can affect the local biodiversity.

• Transportation of floating platform

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Mostly, large water bodies are available at remote places, between the mountains, forest areas etc. Hence, it is difficult to transport floating platforms and other components at such sites. It adds the extra cost to the project. Besides this, manufacturing of such components and platforms near the project locations is also challenging and completely depends upon the capacity of plant and its location.

• Owner of the waterbodies

Waterbodies are spread over large area and hence in most cases, it is owned by two or more states / departments etc. This factor makes the process of taking clearance difficult.

• Operation and Maintenance challenges

Since, FSPV are installed on water bodies, it is difficult to deal with its operation and maintenance issues. The components like anchoring and mooring system, underwater cables are inside the water bodies and they are required to be checked on regular basis. For these purpose, divers are needed, these adds the extra cost on maintenance of FSPV. Also maintenance of cables, electrical wirings, cleaning of panels these complex things are needed to be handled by special trained persons.

LITERATURE SURVEY

Aseem Kumar Sharma Professor (Dr.) D P Kothari. April ,2016 .Floating Solar PV Potential in Large Reservoirs in India IJIRST. Volume 2 | Issue 11 | ISSN (online): 2349-6010

The target of 100GW Solar Power (by year 2022) set by Govt. Of India needs proper utilization of available area for deployment of Solar Power panels. Though land & roof tops are considered as focused areas, Floating Solar power (FSPV) on large reservoirs & other water bodies also offering significant potential. Aim of this paper is to analyse the FSPV potential in large reservoirs of India. This paper also describes the types of FSPV & benefits of FSPV. The Floating Solar Photovoltaic offers an economical, eco-friendly alternative to Land or rooftop solar PV. The savings in water & land/roof area requirement are important additional benefits. The estimates by various renewable energy organisations do not include the potential for Floating Solar PV in their estimates. This needs to be rectified

Sharma, Paritosh & Muni, Bharat & Sen, Debojyoti. (2015). DESIGN PARAMETERS OF 10KW FLOATING SOLAR POWER PLANT. 10.17148/IARJSETP10.

The high energy demand and the constant depletion of the fossil fuels lead us to shift our focus to renewable energy sources which are not only the future unlimited source of energy, it is also eco-friendly and viable for the environment. Hydro and Wind though are renewable sources but are area specific. Solar energy on the other hand can be installed in any place. The major issue with the solar energy is the requirement of land which is scarcely available in the world and even costly to get. But floating solar plants can be installed in any water bodies which will not only reduce the cost of the land but will increase the amount of generation with the cooling effect of water. This paper concentrates upon the design parameters of the floating platform but will also focus upon the effect of panel shade on the ecosystem. INTRODUCTION Solar energy is energy produced by sun created through a thermonuclear process and this process crates heat and electromagnetic radiations. These electromagnetic radiations have the energy that reaches the earth. As solar energy is an indirect source of energy so we need two components: one the collector and other the storage device initially. 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. Now let us discuss the types of collectors. These are of three types

Krishnaveni, P. Anbarasu& D. Vigneshkumar. A SURVEY ON FLOATING SOLAR POWER SYSTEM. ISSN (Online): 2455 – 5428 & Impact Factor: 3.165 Special Issue, NCFTCCPS – 2016

The high demand of energy and constant depletion of fossil fuels leads to shift focus to renewable energy sources that are not only the future source of energy, but also eco-friendly and viable for the environment. Even though solar power generation method has many advantages over other forms of power generation, the major issue with this energy resource is the requirement of availability of land which is scarcely available and costly to get.A new era in solar power i.e., floating solar power plants can solve these issues. This floating solar plants can solve this issue by installing in any water bodies which will reduce the cost of the land and also will increase the amount of cooling effect of water. This paper concentrates the technical details of floating solar plants. The floating solar consists solar panels and other components that are fitted on a platform with hollow plastic or tin drums that enable it to float on water.

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Rauf, Huzaifa & Gull, Muhammad & Arshad, Naveed. (2020). Complementing hydroelectric power with floating solar PV for daytime peak electricity demand. Renewable Energy. 162. 10.1016/j.renene.2020.08.017.

Renewable energy is the cornerstone of our future energy needs. In particular, solar energy is being utilized at a faster pace than ever. Floating Solar Photovoltaics (FSPV) has recently gained traction as a suitable alternative of land-based large scale PV installation. It is a promising technology to utilize water surfaces for placing solar plants. Not only it utilizes the water as real estate but it has several other advantages as well. For example, FSPV can use the existing transmission and distribution infrastructure that is the part of hydroelectric power plants. In this paper, we evaluate an FSPV plant and its integration with the existing hydroelectric power station of a small reservoir in Pakistan. We have investigated the 500 kV, 132 kV and 11 kV voltage levels for the integration of FSPV plant. Moreover, we have devised a hydro-solar optimization model for the efficient utilization of energy. The combined system consisting of hydroelectric and 200 MWp FSPV produces more than 3.5% additional power overall when compared with production of only hydroelectric power. More importantly the FSPV generation coincides with the daily mid-day peak load thus works as a peaker plant for the national grid.

Piyush M. Bhelkar1 Dr. Vinod. N. Bhaiswar2. Design and Finite Element Analysis of Floating Structures (Floats) for Solar Panel Installation on Water Bodies. IJSRD. | Vol. 4, Issue 08, 2016 | ISSN (online): 2321-0613

— Solar energy is the most efficient source of renewable energy, in which solar panel are used to convert sunlight into electricity. Solar energy travels from the sun to the earth in the form of electromagnetic radiation, these radiations are used to produce electricity through solar cells (photovoltaics). The use of solar energy resources is increasing rapidly. The Gujarat state has commissioned Asia's largest solar park at Charanka village. The project is spread over 4900 acres of land acquired by the government from farmers. The major drawback of a conventional solar plant is the requirement of large amount of land. In this project we design a floating solar power plant which can be installed over a water body on which the solar panels can be mounted. And analyse the design of the structure using analysis FEA software to validate and optimize the design. This project is involving designing and analysing of floating solar farm for Narayani Electricals Works, Koradi, Nagpur. With successful completion of this project, the company Narayani Electricals Works, Koradi, Nagpur will be directly benefited, this solution can reduce the water loss due to evaporation and improving water quality. This is a systemsthinking approach that may be especially beneficial in transitioning to sustainable water and energy infrastructure for Marathwada region

Patel Meet K1, Bhavsar Meet R2, Pro. Sheth Sahil B3. Floating Solar Power Plant. International Research Journal of Engineering and Technology (IRJET). e-ISSN: 2395-0056 Volume: 07 Issue: 04 | Apr 2020 www.irjet.net p-ISSN: 2395-0072

The limited fossil fuel resources and higher energy demand concentrates on solar energy, which is free of cost and unlimited source of energy, eco-friendly sustainable to the environment. But during the execution of the solar project on land, problems are faced by the government and partners of the scheme such as land availability, land development and land acquisition, substation capacities, evacuation also timely clearances for the project on land and evacuation- these are hurdles for completion of the project. Most of the locations projected by the government considering solar radiation data in the country are hot and dry regions. Though at this locations radiation appeared to be higher, the energy yield of these points is less due to heating of the solar panels and higher temperature ofthe surface ofsolar cells. To overcome this problems an innovative idea has come in front for installations of solar power plants on the water that is canaltops, water bodies, lakes dam backwater and reservoirs, which generally belongsto the government. The floating solar involves solar panels and other components that are fitted onto a platform with hollow plastic or tin drumsthat enable it to float on water. The benefits of floating power plants will be presented.

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. With this advancement, country like India can meet its power demand in future.

CONCLUSION

Floating solar concept is simple enough, and economically viable. The advantage of floating solar power plants is that it reduces the evaporation, solve the land issues, reduces the growth of algae and increase the efficiency of panels resulting in high generation of energy. Though the concept seems to be easy it faces many technological and installation challenges. Threats identified in this paper can be used for further improvements. The technical details of floating solar power plants and its benefits are discussed in this paper.

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Nexus 1 Senior Research Associate, Clean Energy Technology, Houston Advanced Research Center 2 Former Senior Research Scientist and Program Director Environmental Science and Energy Efficiency, Houston Advanced Research Center Corresponding author: cgamarra@harcresearch.org Citation: Gamarra C, Ronk JJ. 2019. Floating solar: an emerging opportunity at the energy-water nexus. Texas Water Journal. 10(1):32-45. Available from: https://doi.org/10.21423/twj.v10i1.7050. © 2019 Carlos Gamarra, Jennifer J. Ronk. This work is licensed under the Creative Commons Attribution 4.0 International License. https://creativecommons.org/licenses/by/4.0/ or visit the TWJ website. Texas Water Journal, Volume 10, Number 1 Carlos Gamarra1, Jennifer J. Ronk2.