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Floating Solar Power Plants: A Review

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Abstract - *Energy demand in this era has increased which led us to go for renewable energy sources; solar energy with this respect can fulfill the energy demand. This paper aims at review of the existing floating solar plants worldwide with respect to their capacity. Floating solar plants can save the area for generation. Limitations to such power plant are land availability, land development & 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 these locations the radiation appeared to be higher, the energy yield of these points is less due to heating of the solar panels and higher temperature of the surface of solar cells. To overcome these problems an innovative idea has come in front for installation of solar power plants on the water that is canal tops, water bodies, lakes, dam backwater and reservoirs, which generally belongs to the government. This paper reveals review regarding the floating solar PV power plants installed in the world.*

Key Words: Renewable energy, solar photo voltaic, solar power plants, floating Solar System, floating solar PV installations in the world, advantages of floating solar power plants, types of floating structures for solar power plants

1. INTRODUCTION

The biggest problem in our country is power crisis. Around 70% coal is used for generation of electric energy. Irrigation and industry production is get affected due to load shedding, daily shutdown, etc. So we need to move towards renewable energy sources to generate electricity.

Now a days renewable energy sources are growing fast not in just India but many other countries. Solar energy is clean, efficient and abundant source of alternative energy. The use of solar energy Solar energy decreases greenhouse effect. Area wise seventh largest country is India and has good sunshine. 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. Solar energy is the indirect source of energy so we need two main components: firstly the collector to collect radiations which are coming from the sun and convert it into the electrical energy form, secondly storage unit as radiations are varying in nature. To solve the energy crisis solar energy will be an excellent solution but to use land mounted solar system is the requirement of land which is very costly and less available to get it. India will generate up to 1.75 GW solar powers from renewable energy sources and 1 GW of solar power in upcoming 10 years. As per the Jawaharlal Nehru National Solar Mission around 5000 MW has been commissioned till date in different parts of the country. To make the country consuming green power in world, the progress is not just sufficient and needs hard efforts by every state and state departments.

Floating solar system has PV concentrator which is very light weight and it floats on water bodies, mounted on anchored rafts float on the surface of irrigation canals, water reservoirs, quarry lakes, and tailing ponds. Some of systems exist in France, India, Japan, Korea, the United Kingdom and the United States.

The floating solar system reduces the need of costly land area, it also saves the drinking water that would otherwise be lost due to evaporation, reduces the growth of algae. The solar system shows a higher efficiency as the panels are kept in cooler temperature than they would be on land area. The floating platforms are 100% recyclable, utilizing high density polyethylene which can withstand ultraviolet rays and corrosion. Floating solar is also called as 'SOLAR ARRAY 'or 'FLOTOVOLTAIC' or 'FLOATING PV'.

2. BASICS AND OVERVIEW OF FLOATING SOLAR POWER PLANTS

These floating solar plants are installed on water reservoirs like dams, lakes, rivers, oceans, etc. The solar panels are mounted on floating platforms which are anchored tightly to so that it will not get damaged even under the worse weather conditions. Moreover, research suggests that solar panels installed on land surfaces results in the reduction of yields, as the ground gets heated up and affects the rear surfaces of solar panel. Studies also suggests that if the rear surfaces of solar panels are placed on the top of the water, the solar panels will be able to cool themselves more efficiently which means they will last longer and they can shade the water they float on which reduces evaporation by up to 70%, also their ability to generate power goes up as high as to 16%. The combination of PV plant technology and floating technology gives a photovoltaic (PV) floating power generation. This fusion of new concept consists of floating system which is a floating body (structure + floater) that allows the installation of the PV module, PV system i.e. PV generation equipment, similar to electrical junction boxes, that are installed on top of the floating system and underwater cable which transfers the generated power to the PV system development.

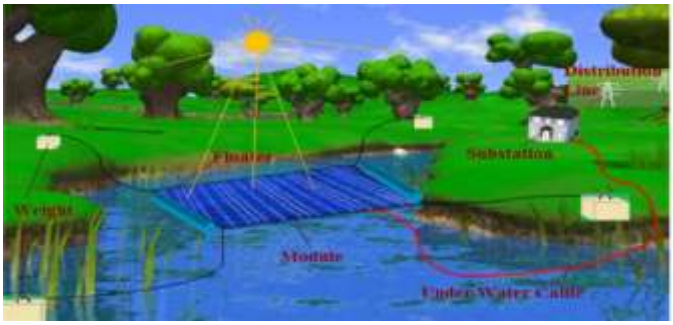

Fig -1: Layout of floating solar power plant.

Floating solar arrays are PV systems that float on the surface of drinking water reservoirs, quarry lakes, irrigation canals or remediation and tailing ponds. A small number of such systems exist in France, India, Japan, South Korea, the United Kingdom, Singapore and the United States. The systems are said to have advantages over photovoltaic plant on land. The cost of land is more expensive, and there are fewer rules and regulations for structures built on bodies of water not used for recreation. Unlike most land based solar plants, floating arrays can be unobtrusive because they are hidden from public view. They achieve higher efficiencies than PV panels on land, because water cools the panels. The panels have a special coating to prevent rust or corrosion.

3. PARTS OF FLOATING POWER PLANT

Floating Solar Power plant is an innovative concept in energy technology to meet the needs of our time. The floating PV system is a new method of solar-energy generation utilizing water surface available on dams, reservoirs, and other bodies of water resulting from the combination of PV technology and floating technology The floating PV plant consists of a floating system, mooring system, PV system and underwater cables.

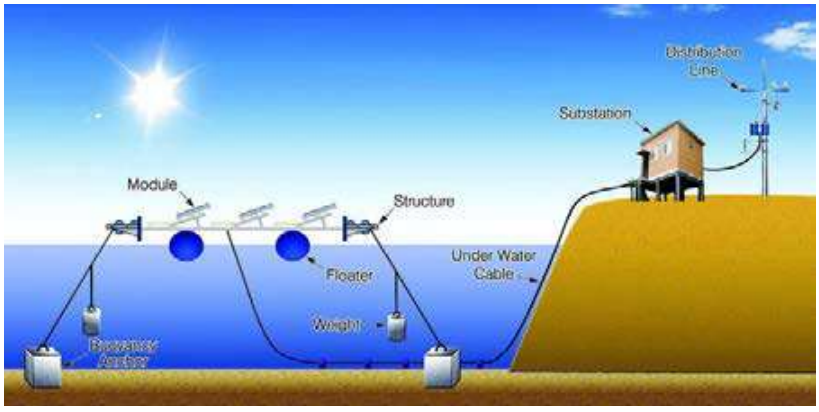

Fig -2: Floating PV plant outline

3.1 Pontoon/Floating Structure - A pontoon is floating structure. Pontoon has buoyancy enough to float on water and support a heavy load. The structure is designed such as it can hold number of panels. Floating structure allows installation of PV module.

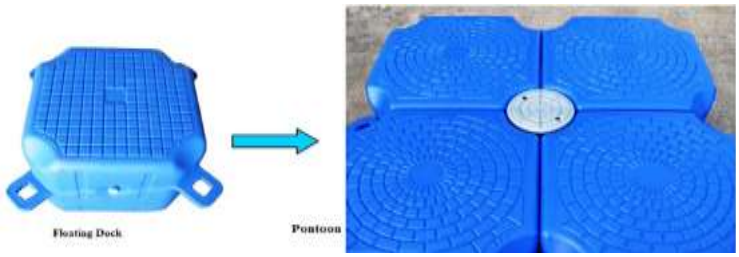

Fig -3: Pontoon structure

3.2 Mooring Structure - A mooring structure is the permanent structure which secures floating structure. The mooring gives forestall free movement of floating structure on the water. An anchor mooring fixes a floating structure's position relative to a point on the bottom of a waterway without connecting the floating structure to shore. This allows adjusting water level fluctuations while maintaining its position in a southward direction

3.3 Solar Module - It is PV Generation equipment, similar to electric junction boxes, which are installed on top of the floating system. A single solar module can produce only a limited amount of power; most installations contain multiple modules. A photovoltaic system typically includes a panel or an array of solar modules, a solar inverter, and sometimes a battery and/or solar tracker and interconnection wiring. Mostly crystalline solar PV modules have been used for the floating solar systems.

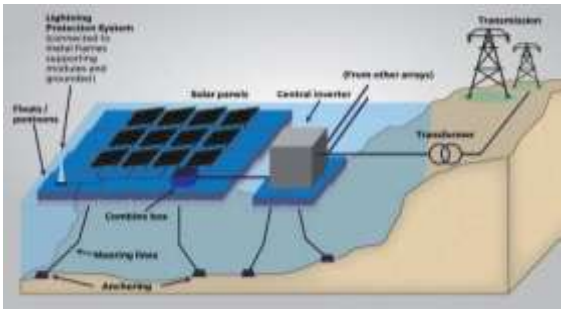

Fig -4: Floating Power Plant

3.4 Cabling - Cabling is to transfer generated power from water bodies to the substation. Due to their outdoor usage, solar cables are specifically designed to be resistant against UV radiation and extremely high temperature fluctuations. These are generally unaffected by the weather.

4. OVERALL ANALYSIS OF FLOATING POWER PLANT

Overall analysis includes business and environment factors. Generally analysis is the foundation for evaluating the probable opportunities i.e. future scope and danger from the external environment and the internal potential and the changing trends. It views all positive and negative factors inside and outside the project that affect the success. It helps in the decision-making process and helps in forecasting/predicting the success of the project. The merits, demerits, future scope and danger of Floating solar plants are highlighted in the following section.

4.1 MERITS OF FLOATING POWER PLANT (INTERNAL, POSITIVE FACTORS)

a) Floating solar power plant system typically generates more electricity than ground-mount and rooftop systems due to the cooling effect of the water.
b) The floating platforms are designed and engineered to withstand extreme physical stress, including typhoon and storm conditions.
c) These installations reduce water evaporation and algae growth by shading the water.
d) Geographically any water bodies with abundant sunlight can be used to install floating plants.
e) Floating platforms are 100% recyclable, utilizing high- density polyethylene, which can withstand ultraviolet rays and resists corrosion.

f) Number of module install compares with the other system.
g) Non-use (and disturbance) of land which conserves the local environment.
h) Easy to erect and faster deployment.

4.2 DEMERITS OF FLOATING POWER PLANT (INTERNAL, NEGATIVE FACTORS)

a) Long-term maintenance requirements and durability of floating solar PV is yet to be seen.
b) Ecological and adverse impacts on water ecosystem.
c) Relatively young and immature technology.
d) Lack of experience and knowledge.
e) Lack of cooperation from local distribution utility.
f) Solar energy concentration levels on floating platform.
g) High waves and salt water possibly damage the solar panels over time.

4.3 FUTURE SCOPE OF POWER PLANT (EXTERNAL, POSITIVE FACTORS)

a) Growing innovations in Floating technology
b) Increasing concerns about land neutral energy generation and energy independence
c) Great potential and increasing awareness for floating PV.
d) Availability of water bodies and land issues are main accelerators for floating PV Solar Panels.
e) Increased efficiency of Floating PV over Land PV installed
f) Availability of trained manpower and Govt. Policies has boosted the confidence of investors.
g) Stable floating PV platforms results in minimum operation & maintenance cost.
h) The emergence of new markets and investments in India, China, Thailand, Malaysia and other developing countries.

4.4 DANGER OF FLOATING POWER PLANT (EXTERNAL, NEGATIVE FACTORS)

a) Large dependency on land-based PV generation.
b) Lack of testing and standard procedures of floating solar.
c) Untested Technology for long run.
d) No promotion and support through a separate policy.
e) Cost concerns and lack of financial resources.
f) Bulky maintenance and repair.

5. ENVIRONMENTAL EFFECTS OF FLOATING SOLAR

Floating solar platform 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. simple and affordable floating solar platform is particularly well suitable for energy and water-intensive industries who cannot afford to waste either land or water. Wineries, dairy farms, fish farms, mining companies, wastewater treatment plants, irrigation districts and water agencies are industries which can benefit from the synergy that floating solar system creates between sun and water

6. CONCLUSIONS

Floating solar concept is simple enough, but there are major technological hurdles. Floating solar application with challenges and opportunities has been discussed.

a) The analysis presented in this paper can be utilized as tool for future development of floating photovoltaic systems
b) To revolutionize floating solar, threats identified need to be tracked appropriately. However, the future seems bright for the floating solar technology.
c) In the near future, the surface of the water bodies associated with hydroelectric dams, pumped storage installations, and cooling ponds of electric power plants—locations that typically have existing power grid connections will be totally covered with the floating system.

d) Floating Solar system is technically feasible and economically viable.
e) Floating solar technology would prove to be an innovative step as it could solve the perennial problem of land.
f) In India large water bodies are available in Eastern, Southern and South-eastern part of the country in states such as West Bengal, Assam, Orissa and Andhra Pradesh, Tamil Nadu and Kerala. This technology can be adopted in these states leading to considerable savings on land prices and bring down power generation expenses, thus reducing the gap between thermal and solar power.
g) Continued research on designing anchoring system for floating PV system is needed to completely fix the buoyancy system.
h) The effect of salt water on the PV structure and the module performance has to be researched.
i) Development of solar tracking system that can change the tilt and azimuth angle of floating PV system is required.
j) Most of the projects in existence in corporate rigid crystalline PV modules which are incapable of withstanding harsh water environment therefore research on flexible thin film technology for such harsh condition have to be explored.
k) Developments of large megawatt scale floating solar farms in near future may pay way for the off shore solar technology development.
l) Maximum speed of wind, water current, temperature limit, snow load, cyclone and typhoon has to be considered while designing the solar panel.
m) The efficiency of floating solar plant is 11% higher and reduces the water evaporation by 70%, however the investment of such power plant is 1.2% times higher than the conventional solar power plant.
n) Appropriate safety measures to transport the power from the water bodies to the land have to be carried out.

7. REFERENCES

[1] Hyder Farhan, Sudhakar K, Rizalman Mamat. Solar PV tree design: A review. Renewable and Sustainable Energy Reviews. 2018;82(2018):1079–1096.
[2] Kumar NM, Sudhakar K, Samykano M. Techno-economic analysis of 1 MW grid connected solar PV plant in Malaysia. International Journal of Ambient Energy. 2017;1–26.
[3] Sahu AK, Sudhakar K. Effect of UV exposure on bimodal HDPE floats for floating solar application. J Mater Res Technol. 2017.
[4] Akshay Suhas Baitule, Sudhakar K. Solar powered green campus: a simulation Study. International Journal of Low-Carbon Technologies. 2017;1–11.
[5] Akash Kumar Shukla, Sudhakar K, Prashant Baredar, et al. BIPV in Southeast Asian countries – opportunities and challenges. Renewable Energy Focus. 21;25–32.
[6] Arun Kumar V, Rashmitha M, Naresh B, Bangararaju J, Rajagopal V. "Perfor- mance analysis of different photovoltaic technologies".,In: Proceedings of the international conference on advanced electronic systems (ICAES), 2013.
[7] Deepak Bishoyi, Sudhakar K. Modeling and performance simulation of 100 MW LFR based solar thermal power plant in Udaipur India. Resource-Efficient Technologies. 2017;10:216–226.
[8] Sreenath Sukumaran, Sudhakar K. Fully solar powered airport: A case study of Cochin International airport. Journal of Air Transport Management. 2017;62:176–188.
[9] Sreenath Sukumaran, Sudhakar K. Fully solar powered Raja Bhoj International Airport: A feasibility study. Resource-Efficient Technologies. 2017.
[10] Debbarma M, Sudhakar K. Thermal modeling, exergy analysis, performance of BIPV and BIPVT: a review. Renew Sustain Energy Rev. 2017;73:1276–88.
[11] Akash Kumar Shukla, Sudhakar K, Prashant Baredar. Recent advancement in BIPV product technologies: A review. Energy and Buildings. 2017;140.
[12] Akash Kumar Shukla, Sudhakar K, Prashant Baredar. Renewable energy resources in South Asian countries: Challenges, policy and recommendations. Resource-Efficient Technologies. 2017;3(3):342–346.
[13] Mary Debbarma, Sudhakar K, Prashant Baredar. Comparison of BIPV and BIPVT: A review. Resource-Efficient Technologies. 2017;3(3):263–271.
[14] Dayal Singh Rajput, Sudhakar K. Effect of Dust On The Performance Of Solar PV Panel. International Journal of Chem Tech Research. 2013.
[15] Akash Kumar Shukla, Sudhakar K, Prashant Baredar. Design, simulation and economic analysis of standalone roof top solar PV system in India. Solar Energy. 2016;136:437–449.
[16] Akole Harshal,"Floating Solar Plant" 6th International Conference On Emerging Trends In Engineering ,Technology, Science And Management, Issue 7, October 2017
[17] "Solar on Water", The New York Times, April 20th 2011.
[18] Patil (Desai) Sujay S., Wagh M. M., Shinde N. N, "A Review on Floating Solar Photovoltaic Power Plants" International Journal of Scientific & Engineering Research Volume 8, Issue 6, June-2017.
[19] Divya Mittal, Bharat Kumar Saxena, K.V.S. Rao, "Floating Solar Photovoltaic Systems: An Overview and their Feasibility at Kota in Rajasthan", 2017 International Conference on Circuits Power and Computing Technologies [ICCPCT].