DESIGN AND DEVELOPMENT OF A LOW COST FLOATING SOLAR POWER PLANT

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Abstract— the constant rise in green and sustainable energy demand has been shifting the global focus to develop technologies to utilize the renewable energy sources to the maximum extent possible. Solar energy, owing to its availability across the globe in abundance along with its pollution free nature, is considered to be the best renewable energy source. One of the major challenges posed by solar energy systems is the requirement of large area of land to mount the PV panels. As the availability of land is becoming scarce and the cost of it is increasing day by day, technological solutions to utilize water bodies to mount PV panels are being explored. The PV panels when floating on water, are expected to stay cool and hence would generate more power than those setup on land.The floating solar panels help preserve water levels by reducing evaporation during extreme summers, they also limit the growth of algae and in turn improve the acquatic life sustainability. This work is aimed to design, develop and demonstrate a low cost floating solar power generation module, which can be utilized, in multiple ways, to boost the rural economy.

Index Terms- Algae, Floating Platform, Floating PV, Floating Solar, low cost, renewable, buoy.

1. INTRODUCTION

THE global ecological, economic and political issues in the recent decades demand for reliable and nature-friendly form of electricity derived from renewable energy sources. Out of all the renewable energy sources, solar energy has been gaining momentum as it is abundant, free of pollution and is void of any risk factors as present in the nuclear fuel technology or the hydrogen fuel cell technology. Solar power systems have a unique advantage of flexibility to design modules based on requirements from few watts to Giga watts. Also, the recent developments in photovoltaic technology have made solar energy cost competitive.

The perennial problem with solar power stations is the need for land availability to install the panels. With increasing cost and scarce availability of land, global attention is focused on using water body surfaces for lodging PV panels as an alternative to ground-mounted systems. This method efficiently utilizes the nation's soil without damaging environment which the pre-existing PV systems cause when they are installed in farmlands or forests.

Studies have shown that if the rear surfaces of solar panels are kept cooler, then their ability to generate power goes up by 16%. Solar panels installed on land face reduction of yield as the ground heats up. When such panels are installed floating on lakes, lagoons or ponds, they are naturally cooled and generate more power than those setup on land. The floating panels shade the water by reducing the amount of sunlight entering into the water body, and in turn limit algae growth and reduce evaporation during hot summers. This reduces water contamination and promotes marine life sustainability. If spate of initiatives announced by all leading nations in the recent past is an indicator, floating solar systems are bound to change the technology scenario for water bodies and Solar energy applications globally, in near future.

In this work, a low cost solution is developed and demonstrated to setup floating solar power generation module. These modules are ideally suited for village ponds and lakes to facilitate aeration, cleaning and illumination. They can also be used to power advertisement display boards, which can generate revenues for the village authorities.

2. CONSTRUCTION DETAILS

A floating solar power station is a technological concept that combines Photovoltaics technology and buoyance technology. It primarily consists of PV module, floating platform, anchoring arrangement and remote control module.

2.1 PV Module

PV module consists of a PV panel, inverter, battery, charge controller, cables and connectors. All these components are housed in a wooden box, which in turn is mounted on floating platform. A PV panel is an interconnected assembly of photovoltaic cells. A 100W PV panel with anodized aluminum frame is used for this demonstration. This panel with appropriate battery storage generates energy that is sufficient enough to power 2250W LED lighting for about 3 hours.

2.2 Floating Platform

The floating platform offers mounting space for PV module. It basically consists of a buoy, made of wooden structure fitted with STYROFOAM™ foam billets. The billet material is extremely buoyant and durable and is composed of millions of tiny non-interconnecting air cells – each serving as an independent buoyancy chamber. These billets won't lose their buoyancy, even if punctured. It takes roughly about 1 cubic foot (0.03 cubic meter) of STYROFOAM™ buoyancy billets to float 55 pounds (25 kilograms) of weight. These billets, as expected are very light in weight and are easy to install. They are resistant to the attack of destructive marine growths, are unaffected by salt or fresh water, they won't become waterlogged and they won't corrode.

LIST OF MATERIALS AND TOOLS REQUIRED TO MAKE THE BUOY:

- Handsaw
- Framing square
- Handheld drill
- Hammer
- Wrench
- Carriage bolts/washers/nuts
- Treated wood
- Nails
- Scrap of 1/2" (13 mm) plywood
- Rectangular wooden frames
- Wooden pieces
- Foam billets
- Bolts and nuts
- Gum

CONSTRUCTION PROCEDURE:
A rectangular cross section of 8′ X 4′, as shown in first figure is built with light weight wood. Three cross ties and four skirt boards are nailed to be bottom of the rectangular frame, as shown in second figure. The foam billets are then laid across the cross ties and skids are placed on the foam billets as shown in third figure. Holes are drilled through skid, foam billets and cross ties. Bolts long enough to pass through the entire hole depth are inserted and tightened to a snug fit. Lengthwise and cross braces are installed sequentially and the deck boards are nailed using a piece of ½" plywood to space boards.

WEIGHT CALCULATIONS:

COMPONENT	WEIGHT (Kg)
PV Panel	9
Battery	28
Inverter	6
Charge controller	0.2
PV Module Housing	15
Buoy	80
TOTAL	130.2

The floating platform made is capable of keeping a total weight of 300 kg afloat. Hence, an electrical component, like LED display board, pump to run a fountain or aeration unit up to 170 Kg (300-130.2) of weight can be mounted on it.

2.3 Anchoring Arrangement

The floating solar power station must be held in position, with slight allowance to move due to changes in water level and the blowing winds. The corners of the buoy are tied to the posts on the bank using nylon ropes to anchor the station.

2.4 Remote Control Module

The floating solar power station is integrated with a remote control switch to toggle the power supply from invertor to the load. This would eliminate laying the cables, necessary to operate the module, underwater.

3. FIGURES


Figure 1. Rectangular Wooden Frame

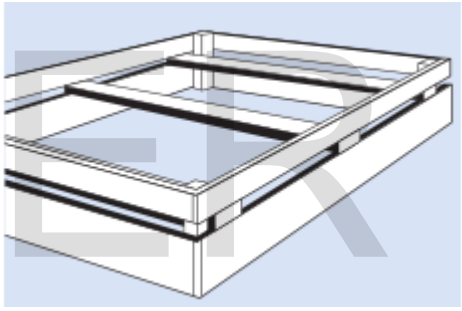
Figure 2 Wooden Frame with cross ties and skirt boards

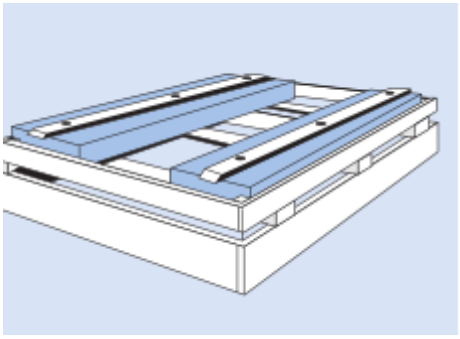
Figure 3 Wooden Frame with foam billets

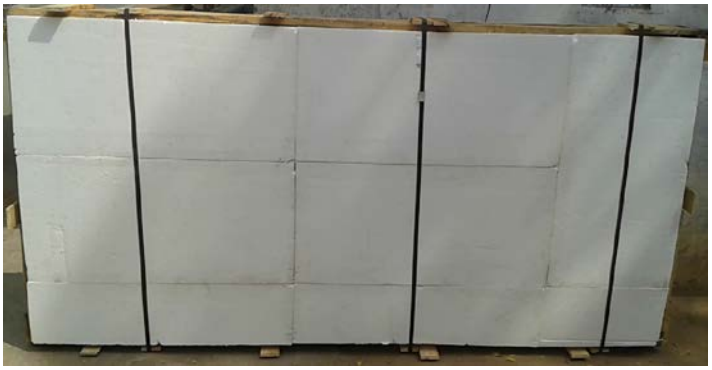

Figure 4 Completed Floating Platform

Figure 5 Testing Floating Platform

4. Conclusion

A cost effective floating solar power generation system of module capacity is designed and developed, using the materials that are readily available in rural areas. This model can be harnessed at optimum level to boost rural economy.

References

[1] M. Abdolzadeh and M. Ameri, "Improving the effectiveness of a photovoltaic water pumping system by spraying water over the front of photovoltaic cells", Proceedings of ISES World Congress, **(2007)**.

[2] H. Haeberlin and J. D. Graf, "Gradual Reduction of PV Generator Yield due to Pollution", 2nd World conference on Photovoltaic Solar Energy Conversion, (1998).

[3] J. J. Wysocki and P. Rappaport, "Effect of Temperature on Photovoltaic Solar Energy Conversion", The American Institute of Physics, AIP, (1960).

[4] K-water, Groundwork research for Commercialization of Floated Photovoltaic System, (2011)

[5] E. Radziemska, "The effect of temperature on the power drop in crystalline silicon solar cells", Renewable Energy, vol. 28, no. 1, (2003).

[6] C. Hark sun, "A Study on Development of Syntactic Foam(I)", The Korean Society of Ocean Engineers, (1992).

[7] Paritosh Sharma, Bharat Muni and Debojyoti Sen, "Design Parameters of 10KW Floating Solar Power Plant", International Advanced Research Journal in Science, Engineering and Technology, vol. 2, Special Issue 1, May 2015.

[8] Young-Kwan Choi, "A Study on Power Generation Analysis of Floating PV System Considering Environmmental Impact", Internation Journal of Software Engineering and Its Applications, Vol. 8, No. 1 (2014), pp.75-84

[9] http://www.energeticaindia.net/download.php?seccion=articles&archivo=ITUFOPleTNwHA9RLUuhL0MTbvAojhDDHXYMlnyF7B2DCzVOJFvUE9nf.pdf