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PERFORMANCE ANALYSIS OF MODIFIED FLOATING SOLAR PANEL

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ABSTRACT: Energy demand in this area has increased which led us to go for renewable energy sources; solar energy with this respect can fulfil the energy demand. This project 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. 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. In this project is installation of one string floating solar (photovoltaic) power plant at 1301.4 m2 area and also analysis performance of solar panel power generation in water bodies.

INTRODUCTION: FSPV also known as floatovoltaics is a solar PV application in which PV panels are designed and installed to float on water bodies such as reservoirs, hydroelectric dams, industrial ponds, water treatment ponds, mining ponds, lakes, and lagoons. In this, solar panels are usually mounted upon a pontoon-based floating structure and to keep its location fixed, floating structure is anchored and moored, Floating solar photovoltaic (PV) installations open up new opportunities for scaling up solar generating capacity, especially in countries with high population density and competing uses for available land. They have certain advantages over land-based systems, including utilization of existing electricity transmission infrastructure at hydro power sites, close proximity to demand canters (in the case of water supply reservoirs),and improved energy yield thanks to the cooling effects of water and the decreased presence of dust. The exact magnitude of these performance advantages has yet to be confirmed by larger installations, across multiple geographies, and over time, but in many cases they may outweigh any increase in capital cost.

1.1 NON-CONVENTIONAL ENERGY SOURCES

While fossil fuels will be the main fuels for thermal power, there is a fear that they will get exhausted eventually in the next century. Therefore other system based on non-conventional and renewable sources are being tried by many countries. These are solar, wind, geo-thermal, sea and bio mass.

1.1.1 SOLAR ENERGY: Solar energy can be major source of power. Its potential is 178 billion MW which is about 20000 times the world's demand but so far it could not developed on large scale. Sun's energy can be utilized as thermal and photovoltaic. The former is currently being used for steam and hot water production.

1.1.2 WIND ENERGY: Wind energy which is indirect source of solar energy conversion can be utilized to run wind mill which in turn drives a generator to produce electricity. Wind can also be used to provide mechanical power such as for water pumping. The energy available in winds over the earth's surface is estimated to be 1.6X107 which is of same order of magnitude as present energy consumption on the earth.

1.1.3 GEOTHERMAL ENERGY: Geothermal energy drives the heat in the Centre of the earth. According to various theories the earth has a molten core. The facts that volcanic action takes place in many places on the surface of the earth, supports these theories. The steam

and hot water comes naturally to the surface of the earth in some location of the earth.

3 1.1.4 OCEAN ENERGY: Energy from seas can be utilized as wave tidal or ocean thermal energy. About 13 kW per meter height of wave can be generated. A plant to make 445000 kWh/yr of energy is being set up in Kerala State. Ocean thermal energy conversion utilizes the temperature difference between warm surface water at about 28°C and the cold deep sea water at 5-7°C at depth of 800-1000 meter in tropical areas. In India the Gulf of Kutch, Gulf of Cambay and Sunder bans are potential sites.

1.1.5 BIOMASS ENERGY Biomass is another renewable source of energy in the form of wood, agriculture residues, etc. The potential for application of biomass as an alternate source of energy in India is very great. We have plenty of agriculture and forest for production of biomass. Biomass is produced in nature through photosynthesis achieved by solar energy conversion.

LITERATURE REVIEW

TRAPANI, K [1]: a review of the various projects that have been realized in throughout the years. These have all been in enclosed water bodies such as reservoirs, ponds and small lakes. The main motivation for the floating photovoltaic (PV) panels was the land premium, especially for agricultural sites were the land was more valuable for growth of the crops (in these cases, grapes because the sites were wineries). The PV panels of the existing projects are mounted on a rigid pontoon structure and vary between horizontal and tilted installations. Future concepts proposed for marine and large lacustrine sites are envisaged to incorporate laminated thin film PV, which would allow the structure to be flexible and able to yield with the oncoming waves, and submergible arrays, which would be submerged in harsh weather conditions. Interest and research has been developing in this niche field throughout the years and has currently reached the megawatt scale with even bigger plans for the future.

UEDA, Y [2]: Floating PV systems are developed and installed on the water surface of the "Aichi ike" balancing reservoir in Aichi, Japan. Floating systems are fixed by anchors and DC cables are connected to the inverter which is mounted on the ground. Systems are grid connected and those outputs are monitored every minute. PV module cooling system with intermittent watering is installed in one of the floating systems and performance is compared with the other systems. As a result, loss ratio due to the module temperature rise is reduced from 17.0 [%] to 7.4 [%] in August 2007. The cooling effect becomes smaller in winter but still has approximately 3 [%] improvements. This paper describes the overview and analysis result of the PV systems on the water.

TINA G. M [4]: the photovoltaic geographic potential (PVGP) is defined as the fraction of the solar irradiation received on the land available for a photovoltaic facility. The area of this usable land is calculated by a suitability factor which is determined by a variety of different geographical constraints. We extend this kind of analysis to floating photovoltaic (FPV) structures and consider the use of water surfaces with the same definitions and notations used to define the PVGP for systems installed on the ground. Results are very promising because of the large water surfaces available and because of the possibility to build floating structures which are more compact than land based photovoltaic plants.

Yadav, N [8] :the noticeable rise in the electricity demand, fast depletion of fossil fuels, along with environmental concerns throughout the world has led to the requirement of commissioning Solar PV plants in large scale. Solar photovoltaic (PV) installation has the burden of intense land requirements which will always be a premium commodity. To conserve the valuable land & water, installing Solar PV system on water bodies like oceans, lakes, lagoons, reservoir, irrigation ponds, waste

SI. NO	MEAN WIND SPEED (m/s)	ANGLE OF TILT (^{O})
1	>35	5
2	25-35	10
3	<25	15

water treatment plants, wineries, fish farms, dams and canals can be an attractive option. Floating type solar photovoltaic panels have numerous advantages compared to overland installed solar panels, including fewer obstacles to block sunlight, convenient, energy efficiency, higher power generation efficiency owing to its lower temperature underneath the panels. Additionally, the aquatic environment profits by the solar installation because the shading of the plant prevents excessive water evaporation, limits algae growth and potentially improving water quality.

ENVIRONMENTAL CONSIDERATIONS

3.1 CLIMATE CONDITIONS Solar Crystalline series modules may be installed in the following conditions for more than 25 years. In addition to the required IEC certification, solar products have also been tested to verify resistance to ammonia fumes that may be present around barns sheltering cattle, as well as suitability for installation in humid (coastal) areas and areas of high sand storms.

Environment

• Ambient temperature: -40°C to 50°C

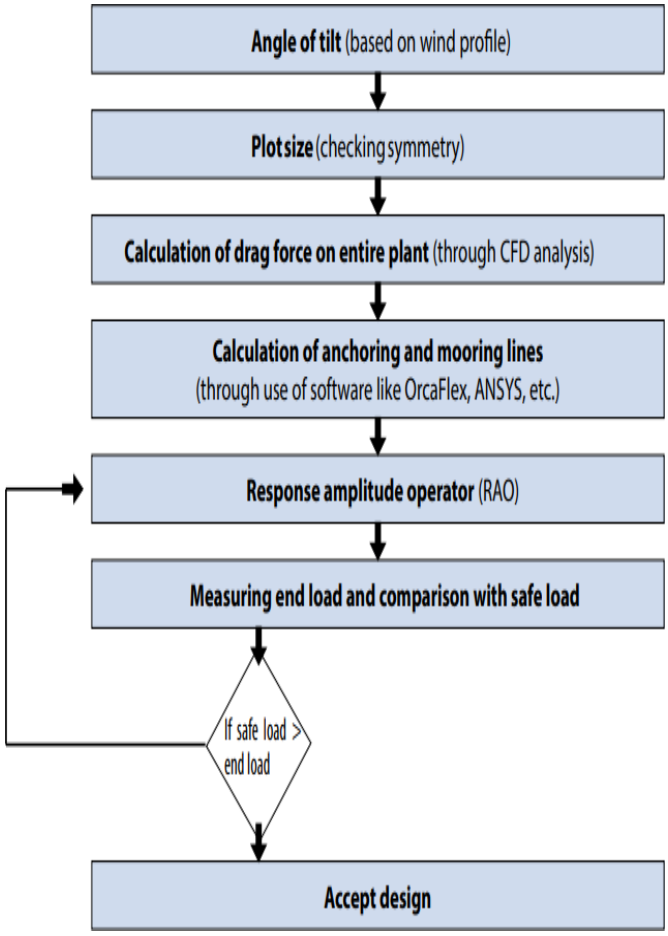
• Operating temperature: -40°C to +85°C

• Storage temperature: -20°C to +50°C

• Humidity: < 85RH%

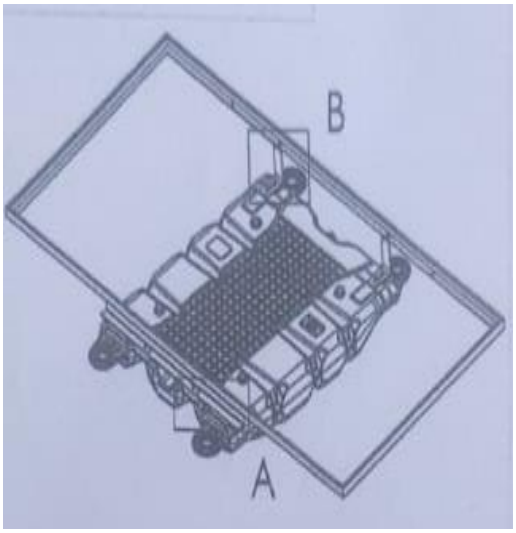
3.2 SITE SELECTION: Solar Modules can be mounted in landscape or portrait orientation however the impact of dirt shading the solar cells can be minimized by orienting the product in landscape.

3.3 PROJECT DESIGN: Designing of FSPV plants can begin. For the sake of simplicity, the entire project design needs the following three components –



3.4 ANGLE OF TILT: Dependencies of PV modules angle of tilt on the location of the plant and wind speeds are well known. In fact, the wind load plays a vital role in deciding the quantum of drag force being induced on the mounting structure. In case of FSPV plants, this is even of much importance, as an incorrect angle of tilt can induce higher drag forces causing severe damage to the entire plant.

BLOCK DIAGRAM OF MOUNTING



Main Floater

Long Secondary Floater

MAIN COMPONENTS

5.1 FLOATER HDPE is a hydrocarbon polymer prepared from ethylene/petroleum by a catalytic process. It is a kind of thermoplastic which is famous for its tensile strength. Its unique properties can stand high temperatures. HDPE is a boon to developing countries like India where it is used to prevent groundwater pollution. It can be easily molded and welded together. Due to its high chemical resistance property, it is used in piping systems. HDPE pipes are used to both carry potable water and hazardous waste. It has other applications also like in making backpacking frames, bottle caps, food storage containers, vehicles fuel tanks, folding chairs etc.

TYPES OF FLOATER

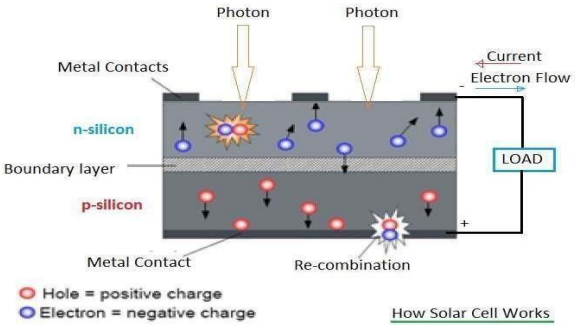
- MAIN FLOATER
- LONG SECONDARY FLOATER
- SMALL SECONDRAY FLOATE

Small Secondary Floater

5.2 SOLAR PANEL

A solar cell is a device that directly converts the energy of light into electrical energy through the photovoltaic effect. Solar cells or photovoltaic cells are made based on the principle of the photovoltaic effect. They convert sunlight into direct current (DC) electricity. But, a single photovoltaic cell does not produce enough amount of electricity. Silicon crystals are laminated into p-type and n-type layers, stacked on top of each other. Light striking the crystals induces the "photovoltaic effect," which generates electricity.

PHOTOVOLATIC EFFECT



Photovoltaic (PV) is a term which covers the conversion of light into electricity using semiconducting the photovoltaic materials that exhibit effect, a phenomenon in physics, photochemistry, and electrochemistry. Studied A typical photovoltaic system employs solar panels, each comprising several solar cells, whichgenerate electrical power.

Types of Solar Panel

1. Monocrystalline Solar Panels.
2. Polycrystalline Solar Panels.
3. Thin Film (Amorphous) Solar Panels.

POLYCRYSTALLINE CELLS

PolyCrystalline or MultiCrystalline solar panels are solar panels that consist of several crystals of silicon in a single PV cell. Several fragments of silicon are melted together to form the wafers of polycrystalline solar panels. In the case of polycrystalline solar panels, the vat of molten silicon used to produce the cells is allowed to cool on the panel itself. These solar panels have a surface that looks like a mosaic. These solar panels are square in shape and they have a shining blue hue as they are made up of several crystals of silicon. As there are multiple silicon crystals in each cell, so polycrystalline solar panels allow little movement of electrons inside the cells. These solar panels absorb energy from the sun and convert it into electricity.

Front side

Back side

SOLAR PANEL SPECIFICATION

- Non back sheet polycrystalline solar panels.
- Solar panel size =2187 × 1102 × 35 mm
- Maximum power (P_{MAX}) = 495 W
- Maximum power voltage (V_{mp}) = 43.1 V
- Maximum power Current (I_{mp})= 11.49 A
- Short circuit current (I_{SC})=12.09 A
- Open circuit voltage (V_{OC})=5103

INSTALLATION

The installation process starts at the anchors. These are installed on the seafloor. Holes are dug and the anchors installed deep enough into the soil for enhanced support. Anchoring the solar panels is one of the most crucial steps of the installation process. Floaters are installed on the water surface, ready to receive the solar panels. A mooring line is used to connect the anchor to the floaters.

The combine box, central inverter, and transformer are installed and connections are made from the solar panels to the combine box, inverter, then to the transformer, and finally to the transmission system. Lastly, floating walkways are installed alongside the solar panel system. This is very crucial as it allows easy access to the solar panels when they need servicing.

Installation

ADVANTAGES

- No need for land space:
- Shade avoiding:
- Increase the power generation:
- Less evaporation and algae bloom:

DISADVANTAGES

- Weather-Dependent
- The initial cost is extremely high
- Interfere with the natural look of water bodies.
- Sunlight does not reach the deeper parts of the water bodies.
- Cleaning the solar panels is not easy.

BENEFITS

- Higher gains in energy production
- Reduction in water evaporation:
- 100% inexhaustible energy, which is renewable and free;
- No toxic or polluting emissions into the air;
- Reduces the use of fossil fuels

CONCLUSION

Thus the utilization of floating photovoltaic cell arrangements will reduce land size usage and gives promising power output of 4.456 kw per day for one solar panel. This reservoir or lake based power production will be more economic and best suited for small scale industry power needed in future.

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