ISSN: 2278-4632
Vol-11 Issue-01 March 2021

Floating Solar Cell Power Generation, Power Flow Design and its Connection and Distribution

V.SATHISH[1]
Professor Department of Electrical & Electronics Engineering, Raajdhani Engineering college, Bhubaneswar, India

Abstract- While placing solar power in sea water has advantages over installing it on land, including a good and unshaded solar source, better cooling, and higher surface utilisation than lands, it also has disadvantages, including sea water corrosion and wave and tidal interruption. The current study's subject is a project for the creation of solar energy from sea water. A marine solar power system's design is examined. The design of solar cells, connections, power distribution, protection, the influence on the environment, and shore side power control are all topics of discussion. It is advised to distribute power using V2X.

Keywords-Solar power, sea water solar power, floating solar system, Photovoltaics,

I. INTRODUCTION

Electricity is produced by mechanically coupling an electrical generator to a fuel source, such as coal, natural gas, or another fossil fuel. This method is not very effective and releases greenhouse gases. Because they require minimal maintenance, have a long lifespan, and are extremely reliable, solar power cells, also known as photovoltaic (PV) cells, are no longer commonly used to supply alternative energy sources [1-2]. Relying on seasonal elements like wind power is uncommon. Due to its semi-conductor nature, which makes it easy to put on top of a structure, a curtain wall, or a plot of land as a solar farm, it is also known as a static power source. Since the electricity produced is connected to the grid, grid-connected solar power has gained interest as a study issue. Aside from being immediately used on the grid, electricity can also be stored in energy-storage devices such batteries, water tanks, superconductors, or supercapacitors [2]. Additionally, it has a grid connection option, which can reduce the need for costly energy storage.

Solar power is utilised to create energy through the series and parallel connections of solar cells. Since the total connection may be raised to a high enough voltage, the DC-AC power inverter can be operated by a series connection. A DC-DC power converter is used to adjust the voltage before the solar panel is linked to the inverter. To provide MPPT (Maximum Power Point Tracking), which adjusts the input voltage to the DC-DC converter to produce the maximum power under a variety of solar illumination intensities, a second DC-DC converter is also necessary. The topic of project and efficiency development in seawater environments has received very little documented research up to this point. Given how simple it is to regulate the environmental factors affecting freshwater, fresh water reports are more prevalent [3–4]. The corrosion is less, there is no tidal or wave movement consideration.

In a marine environment, a floating unit is used to fix the solar panel above the water's surface. This is essential since extended exposure to seawater could reduce the solar panel's lifespan and the electrical connections' ability to function. On the surface of the ocean, the flat floating object floats. The solar panel must be designed with a specified tilt angle toward the horizon. When selecting this tile angle, the solar power and wind speed circumstances must be taken into account.

The current study aims to provide the best design strategy for a system of floating solar panels in seawater. We'll talk about the design parameter for this experiment.

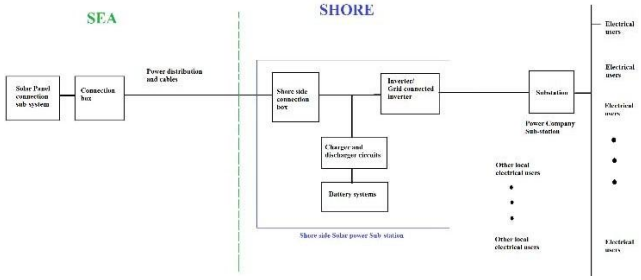

Fig. 1: The configuration of the floating sea water solar power system

II. SOLAR PANEL CONNECTION SUBSYSTEM

To provide the required voltage for each solar panel, a number of solar cells are connected in series on the solar panel. The output voltage of each panel is 50V. But the voltage depends on how bright the light source is. In the absence of sunshine, the output could be zero. A DC distribution of the electrical energy generated by the solar panels is made from the sea to the coast through an electrical distribution network. Armor cable is used for the distribution. Energy storage underpins the DC voltage stability, noise filtering, buffer, and transient noise absorption. When there is no sunshine or shade, it also functions as a sort of energy storage. Users receive grid distribution of power. To help the MPPT (Maximum Power Point Tracking) system, which is able to extract the maximum power from the solar panel utilising voltage and/or current mode control, the solar panel is coupled with a sub-circuit DC-DC converter. A solar panel array is made up of panels that are connected in series and then in parallel, as seen in Fig. 2.

Several solar panels are often joined in a rectangular array that resembles a matrix to form a solar array. Utilizing, adhering to safety standards, or cable rating

ISSN: 2278-4632
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The best option is to connect solar cells in series utilising the greatest DC distribution voltage of 1000V available in the current configuration. Eight to ten panels are connected in series to create the 50 V required by each panel. Panels connected in series can be connected in parallel for large output power ratings.

Power distribution from the shore side is delivered to the grid. Power mobility—using a battery-powered vehicle to carry charged batteries to other locations—can be employed because grid installations are expensive. To distribute power, the vehicle can be driven to a designated location. As a result, the method is not bound by the grid connection and may distribute power anywhere with minimal design and construction labour.

In reality, while selecting how to distribute power to customers without the use of grids, the concepts of Vehicle to Home (V2H), Vehicle to Building (V2B), and Vehicle to Vehicle (V2V) are taken into consideration [5–6]. Grid setup, maintenance, and planning are pricy and time-consuming. For speedy and effective utilisation of sea water solar power, the V2X idea, which uses a battery vehicle as a moving battery, offers a simple method of transferring electricity to clients.

The concept of power mobility everywhere, which relies on electric or battery-powered cars rather than the grid, offers an alternative method of supplying electricity.

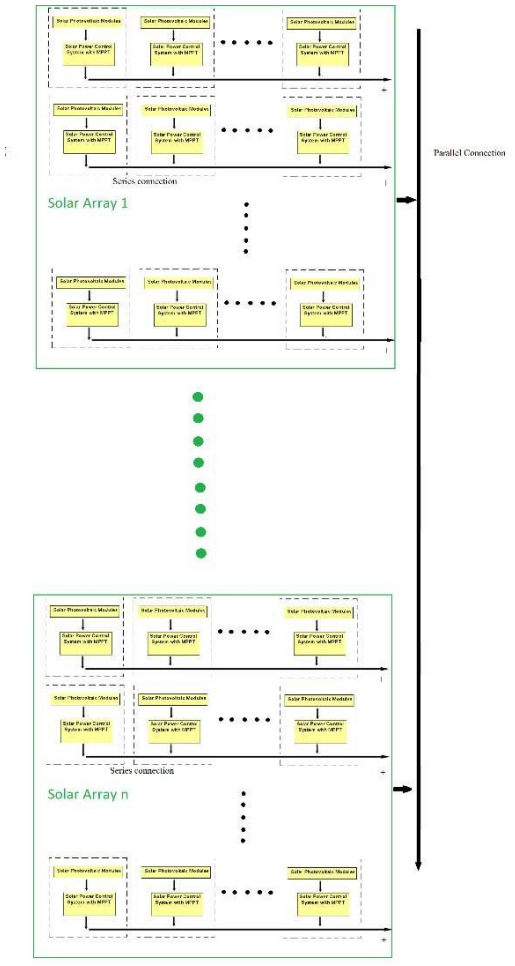

Fig. 2: The schematic of Solar panels connected for solar system.

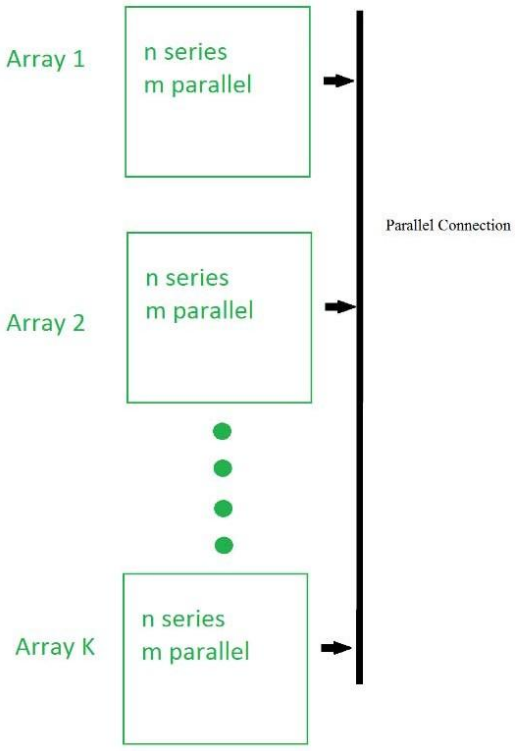

Fig. 3: The Solar array connection in parallel

The internal controller of the solar panel must have a local subcircuit MPPT in order to optimise power. Since all of the panels together make up an array, each array should be the product of an amount in n panels in series and an amount in m panels in parallel (m). Fig. 3 shows the overall structure, which is built up of K arrays. The maximum cumulative power of the PV farm is indicated below. Ptotal is hence the total power output, which is:

$$P_{total}=nmKP_{PVp} \quad (1)$$

where P_{PVp} represents each PV panel's peak power. The electrical protection must be installed in the system. A semiconductor diode is used to stop electrical current from entering into the solar panel and instead merely leaving it. This is carried out to stop damage from reverse current. This is represented by Du, which could be a diode or an electronic circuit, to guarantee unidirectional power flow.

Another sub-circuit is the by-pass circuit, which is also referred to as diode DB. This is done to ensure that, in the event that one panel is destroyed or open-circuited, the matching electrical current channel won't be cut off. Current can still flow through the by-pass diode/circuit, which is linked in parallel with the panels. Of course, a power transistor or power converter can also be used as a by-pass diode or circuit. Figure 4 depicts the set up. It shows how a subcircuit of the MPPT is connected in series and parallel with the panels (shown in yellow) for the purpose of power optimization.

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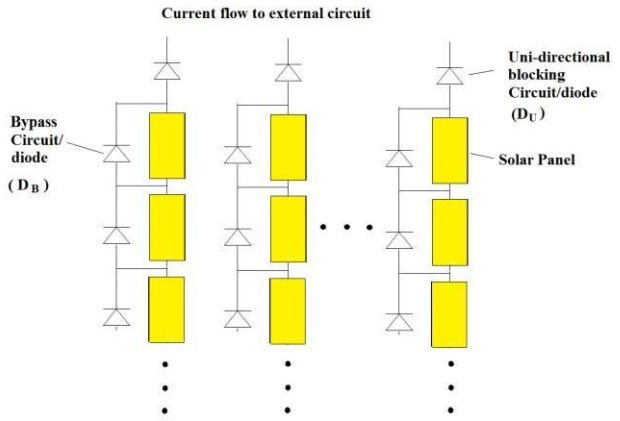

Fig. 4: Protection sub-circuit for uni-directional blocking and bypass

III. Maximum Power Point Tracking

MPPT, or maximum power point tracking, is a popular method for generating more power from a given amount of sunshine. The maximum power production will be determined by the sensors using searching algorithms in this approach, however it may produce uncertainty and lead to a poor course of action. Therefore, an open loop strategy is recommended. It is effectively using 80% of the maximum voltage Vpx at this moment, which is normally the maximum power point. This can be done while performing offline measurements, and then a DC-DC power converter can be used to adjust the operating voltage to the design. The MPPT function is carried out by the MPPT controller, also referred to as the DC-DC power converter. In a regulated DC-DC power converter, the mark-space ratio of the switching devices is used to regulate the necessary current and voltage. The MPPT design of a solar panel is shown in Fig. 5. The characteristics of the solar curve are best described by a typical i-v trajectory. The highest power point is what the MPPT control algorithm seeks.

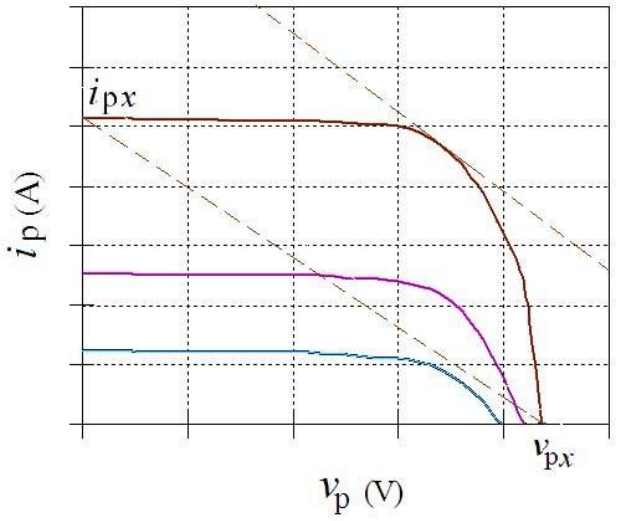

Fig. 5: A typical MPPT of solar cells

The MPPT will convert energy for the solar panel. In Fig. In step 6, the connection mechanism is shown. The solar panel has two output terminals. Suppose one is positive and the other is typical. The common terminal for MPPT is linked to the common connection. For maximal power processing, the other positive terminal is linked to the MPPT. Other series networks are connected to the MPPT's output. Figure 6 illustrates the relationship. As previously stated, an MPPT circuit is merely a DC-DC power converter.

Fig. 4 can be utilised as the connecting method if MPPT is unavailable or not being used.

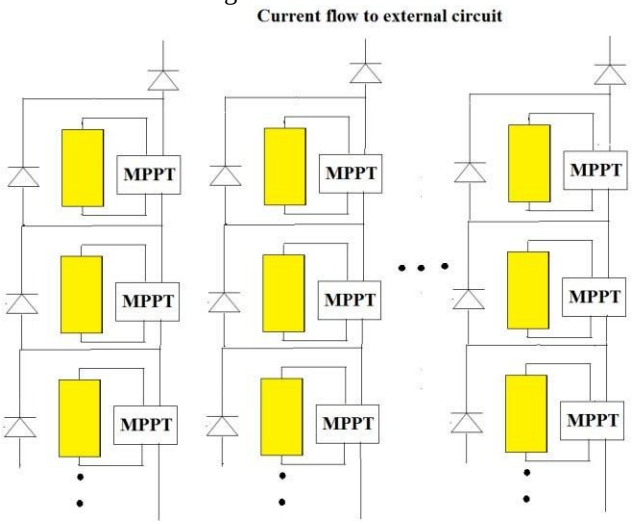

Fig. 6: MPPT connection to solar panel.

IV. Tile Angle of Solar Panel

The solar panel is mounted on a floating device for use in seawater environments. The solar panel on the flat floating unit is made to have a tilt angle with respect to the horizon. The latitude angle is equal to the theoretical optimal tile angle. the location's. For instance, Hong Kong has a tilt inclination of 22.3 degrees toward the south. The solar power and wind speed conditions must be taken into consideration when choosing this tile angle.

The wind force F_w is given by the empirical formula:

$$F_w = 0.5\ \theta\ V^2\ A \qquad (2)$$

where θ is the air density that is estimated to be 1.18 kg/m^3 at around 25 degree. A is the effective area of the solar panel under the wind direction. Because of the angle tiled, the effective area is estimated to be A_s sin 0 where A_s is the area of the solar panel as seen in Fig 7.

However, the wind speed is not always horizontal, the above estimation gives empirical method for the estimation, the safety tiled angle is therefore:

$$0\ \Sigma\ 0\ \Sigma\ \exists. \qquad (3)$$

Experimental results shows that in order to protect the solar panel from damaged due to strong wind, gust or typhoon, the tilt angle should be reduced:

$$0\ \Sigma\ \exists/2. \qquad (4)$$

The reduction on tilt angle depends on many factors and it is governed by the geographical location.

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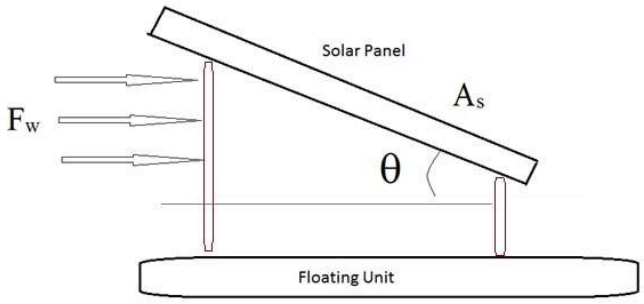

Fig. 7: The angle between solar panel and floating unit

VI. Integrated Alternative Energy Sources

One advantage of the floating solar PV system is the ability to use the water for cooling. A mechanism for the thermal electric generator is created by the significant temperature gradient, with one side being hot when facing the sun and the other side being colder with water cooling (TEG). TEG is inserted between the solar panels to increase power production. It's an additional resource.

Another type of alternative energy is wave power. Waste energy from ocean wave and tide motions can be collected using linear motion generators or modified rotating electric generators. Even though the additional power is usually negligible, it can be a helpful power boost.

V. Environment Issues

The influence on the environment is a worry when the solar system is situated on the ocean floor. The current form of floating solar power resembles a ship. As a result, there is little environmental concern. The floating units and solar panels are fixed using anchors. Similar to a ship or boat, the anchor is fixed. The seafloor has not been installed with any changes or disturbances.

The electrical wire for distribution floats on the water. But as a result of a compromise with the boat passenger, a portion of the cable dips into the water to provide room for the boat to pass. Once the cable reaches the beach, it is deployed similarly to how power is typically distributed on lands. No special worry exists.

One of the most important parts of the development is the battery storage, which serves as an energy buffer. When a battery is getting close to its life expectancy, there is cause for concern. It's a problem to dispose of spent batteries. It is currently anticipating the new government strategy for managing spent batteries. Since the energy density is unimportant in this application, used or retired batteries from electric cars can be utilised. When an EV battery is retired, its health is still between 70 and 80 percent, making it viable to repurpose it for solar energy storage. Naturally, another option is to create new recyclable batteries that do not require the loading of used batteries..

VI. Conclusion

The goal of the proposed project is to create a solar panel setup that can be used in saltwater environments. The panel is held up by floating components that keep it apart from the ocean. For solar power to produce the most power possible from a given amount of sunshine, MPPT must be implemented. For improved power management, the MPPT circuit incorporates a control and power connection that matches the solar panel. To create a series and parallel connection, the panels are joined together in a rectangular pattern using a fixed multiple of two numbers. The current arrangement is a long rectangle and is based on the geographical requirements and sea water environment. The voltage required for the input side of the inverter is determined by the series power connection.

The solar panel's tile angle should be chosen to be less than the location's latitude angle. Typically, this represents 50% of the latitude angle. For locations with a greater latitude angle, the wind speed is used to determine the tile angle. In order to allow the draught and dirt to be discharged, a suitable space must exist between the lower end of the solar panel and the floating unit as well as between the solar panels.

The current system, which will be constructed in Hong Kong's New Territories, is anticipated to be among the largest and first floating solar power systems in the region.

Acknowledgement

The authors gratefully acknowledge the support of the sponsor Solarever Holdings Limited and the Hong Kong Polytechnic University.

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