FLOATING SOLAR PV PLANT

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Abstract - *Floating photovoltaic is a new design option for photovoltaic (PV) power plants; floating photovoltaic systems (FPVS) are often installed in bodies of water such as natural lakes or swimming pools, and external solutions are also being explored. The cost effectiveness of FPVS can be greatly improved if the floating structure also performs other functions, such as reducing water evaporation. The purpose of the is to evaluate and compare the electrical and thermal performance of the FPVS with an onshore photovoltaic system (OPVS) of similar capacity. Therefore, this study primarily deals with the development of photovoltaic systems, then examines the energy production of photovoltaic systems and finally analyses the ability to complement the advantages and disadvantages of floating photovoltaic systems. Also found that FPVS has up to 2.33% more daily energy than OPVS. Also, an experimental test was performed in this study to compare the power of the FPVS at different tilt angles.*

Test results confirm that the FPVS produces the highest power when installed on the best annual slope. Therefore, it is recommended to set the PV modules at a good angle for FPVS. also discusses the role of other factors in FPV heat, such as PV equipment or frequent biofouling. Finally, an estimate of the economic impact of thermal behaviour on FPV value and competition is presented.

Key Words: photovoltaic system; floating system; water basin; evaporation, Cooling system, dams' reservoirs. overland PV system

1. INTRODUCTION

Land use by photovoltaic(PV) shops can be incompletely or fully avoided by enforcing an arising solar technology known as floating PV, which seeks to break the paradigm that mounting solar panels on bodies of water is a expensive and complicated process stationed in systems around the world(1). FPVSs generally correspond of a rack assembly mounted on floating structures(FS) similar as rafts or pontoons that are installed in enclosed bodies of water similar as budgets, ponds, and small lakes. Due to the novelty of these PV results, utmost systems are personal and small to medium sized. still, numerous different models and systems of different scales(up to the megawatt scale) have been created, with indeed bigger plans for the future. In the once decade, floating photovoltaic systems(FPVS) installed on water bodies similar as natural lakes or levee budgets have attracted more and more global attention and have formerly been stationed in several countries including Japan, South Korea, and the USA. The floating PV power factory is an arising technology proposed by the authors nearly 10 times agone, and several studies confirm their rapid-fire growth(2). How important water would be lost without FPVS depends on the point and original climate and must be precisely calculated to estimate this critical benefit. On the other hand, it should also be mentioned that this effect physically contradicts the former one, that is, the lower the evaporation in the force, the lower the evaporative cooling caused by the water body and the lower the increase in photovoltaic effectiveness. field. In this report, we will explore how combining FPVS with standard wastewater treatment tanks is a veritably intriguing integration with environmental benefits and profitable benefits for both sectors energy product and water conservation. Technological inventions and advancements for harvesting energy from renewable sources similar as solar, wind and water are crucial factors that determine the future of renewable energy systems(1). FPVS have multitudinous advantages compared to OPVS, specifically 1) FPVS don't bear any space on the ground which represents a huge profitable advantage. They can be installed in unused space on water bodies, similar as hydroelectric levee budgets, wastewater treatment ponds,etc.(Cazzaniga etal., 2018);) Floating structures give shade to a body of water which it reduces water evaporation and thus maintains the volume of stored water(Qin etal., 2019). Clot etal. reported in their work that FPVS could reduce water evaporation losses by 15,000 to 25,000 m3 for each MWp installed(Rosa- Clot etal., 2017). Overall, the literature reports that water loss can be reduced by 25 to 70 with FPVS(Do Sacramento etal., 2015; Sahu etal., 2016);) The shade that floating structures produce can help help algae growth and thereby ameliorate water quality(Pringle etal., 2017);) Since solar panel effectiveness decreases with adding temperature, bodies of water that host floating structures can help cool the solar panels, meaning that FPVS can profit from the natural cooling effect of water and operate. with advanced effectiveness compared to OPVS(Rosa- Clot and Marco Tina, 2020; Song and Choi, 2016). In general, FPVS can increase the effectiveness of photovoltaic modules by over to 12(Ranjbaran etal., 2019);) The natural reflectivity of the water face increases the prevalence of solar radiation in the PV modules, therefore adding the product of PV energy(Rosa-Clot etal., 2017). In addition to environmental goods on FPV performance, consideration must be given to the impact that FPV installations themselves can have on the terrain. FPV can be anticipated to affect wind speed and water temperature. Indeed, PV modules inescapably induce tones and reduce the quantum of visible sun reaching the water. This reduced incoming radiation can be anticipated to lead to cooler water bodies. still, Armstrong etal.(Armstrong etal., 2020) refocused out that the presence of modules could also reduce gregarious heat fluxes, leading in some cases to warmer face water. In addition, it should be considered that the FPV modules could act as windbreaks. thus, while lower radiation would lead to lower temperatures, reduced winds may beget reduced wind mixing, adding water position and therefore water face temperature. These two factors were also lately studied by Exley etal.(Exley etal., 2021). The authors estimated that the presence of FPV is likely to reduce face water temperature, but also stressed the possibility of advanced water temperatures when wind speed is reduced significantly further than solar radiation. The magnitude of the convinced changes would vary with FPV face content lower temperature changes should be anticipated at small contents(50). Yang etal.(Yang etal., 2021) conducted precious exploration on the energy budget of floating photovoltaic systems and concluded that their heat balance is dominated by long- surge radiation. Indeed, the authors set up that while the presence of the modules reduces the shortwave radiation entering the water, the incoming longwave radiation increases due to the high temperature of the FPV modules during the day. In addition, nightly radiative cooling is affected. Overall, they set up advanced air and water temperatures under the modules compared to open water. set up advanced air and water temperatures under the modules compared to open water.

2. INOVATION: -

2.1. Self-Cleaning Solar

Self-cleaning means that the cleaning operation does not require any manual labor, movable mechanisms or robots to be attached to the solar panel for cleaning purposes. Thus, the surface the panels can keep clean by repelling all contamination, or actively clean themselves as needed and when needed, independently of time of the day, availability of sun or rain.

2.2. Fish Food Funnel

Due to mass reduction in aquatic life we have used fish food funnel method in our floating module to maintain rich aquatic life. Bottom of the floating module consist of a funnel pipe through which fish food is sprayed in water.

2.3. Evaporation Reducing Liquid

There are some types of chemicals used evaporation reducing in water bodies. Hexadecanol or acetyl alcohol and octadecanoyl or stearyl alcohol or a mixture of these two chemicals is commonly used for suppressing evaporation from lakes and reservoirs. We have provided small pipe duct to spread this liquid in water bodies to reduce the water evaporation at some extent. This chemicals doesn't harms aquatic life.

Fig.1.Model of Floating Solar

2. DICUSSION: -

PV and renewable energies in general have higher land requirements than conventional sources (Capellán-Pérez et al., 2017). This means that large-scale deployment of PV could deduct agricultural land and/or pose risks to biodiversity if PV is built on land available at low cost but with high ecological value (Serrano et al., 2020). Therefore, the photovoltaic community has been looking at alternative solutions, such as floating photovoltaics (FPV), to avoid achieving global energy targets at the expense of biodiversity and/or food production. In FPV, PV modules are installed on bodies of water instead of on land. This will prevent competition for land use and generally ensure lower rents. As shown in Fig. 1, FPV has reached a global capacity of 2.6 GW in just ten years (Haurwitz, 2020), which is expected to double by the end of 2022 (Deloitte, 2022). In addition, recent forecasts predict 13 GW of FPV capacity by 2025 (Deloitte, 2022), which could provide up to 2% of global electricity generation by 2030. Understanding the proper thermal behaviour of FPV systems is essential to support the development and deployment of this technology. In fact, FPV systems are usually mounted at low pitch angles compared to LPVs to limit wind loads on the floating structure (Silverio et al., 2018). Although these angles are close to the optimal bank angles in regions around the equator, at higher and lower latitudes, low angles can generate more reflection and angular losses, reducing FPV yield. Lower operating temperatures can at least partially offset losses due to low pitch. A techno-economic analysis (Campana et al., 2019) showed that FPV with an 11% efficiency increase due to cooling could achieve significantly higher reliability and lower levelized electricity costs compared to LPV in Thailand. A more recent study conducted in the same country (Cromartie Clemons et al., 2021) showed that a 10% higher efficiency due to better cooling could cut FPV electricity costs in half compared to LPVs and achieve similar payback periods. Similarly, a study published in 2020 (Padilla Campos Lopes et al., 2020) found that a 5% increase in power output due to cooling could make FPV cost-competitive with LPV in Brazil. Furthermore, another work (Michele, 2021) showed that if the expected lower operating temperatures were confirmed, FPV could already compete with LPV in Spain in terms of lifetime electricity costs and profits.

2.1. Effect of temperature

PV modules directly convert sunlight into electricity. However, most of the incident solar radiation cannot be used by the modules and is therefore converted into heat, which increases the temperature of the PV cell. The efficiency of PV modules decreases with increasing temperature, so it is important to keep it to a minimum. In addition, cell temperature is one of the main precursors of PV module degradation (Ascension-Vásquez et al., 2019). Indeed, high absolute module temperatures can, in combination with other specific conditions, cause hydrolysis and photodegradation, while high temperature changes can lead to thermomechanical stress. PV modules are made of different semiconductor materials and they do not all have the same response to temperature. Their behaviour is typically expressed by temperature coefficients, which describe the rate at which the various electrical outputs of the modules change with respect to temperature (King et al., 2000). These are negative if the value of a parameter decreases with increasing temperature, such as open-circuit voltage and maximum power. Otherwise, they are positive as far as the short circuit current is concerned. As shown in Fig. 2, different materials have different temperature coefficients. Typical performance values range between -0.45%/°C for crystalline silicon technologies and -0.20%/°C for amorphous silicon (Theristis et al., 2018).

2.2. Floating photovoltaics

FPV has already been the subject of a number of reviews. Trapani and Santafé (Trapani and Redón Santafé, 2015) described the state of the technology in 2014, listed offshore FPV power plants installed in the period 2007-2013, and also described new FPV designs capable of withstanding harsher offshore conditions. They reported that the owners of the 500 kW power plant in Bubano, Italy claimed a 20-25% increase in electricity output due to the cooling effect of the water. The first comprehensive review was presented in 2016 by Sahu et al. (Sahu et al., 2016). In this work, the authors discussed the advantages and disadvantages of this technology compared to other PV applications. Among the pros of FPV, they cited increased efficiency due to the lower ambient temperature due to the cooling effect of water. In addition, they analysed the economics of FPV and reviewed commercially available designs.

2.3. Literature review

From a thermal point of view, FPV systems can be divided into two groups based on whether the rear surface of the module is in contact with air or water. Each group is discussed separately in one of the two following subsections (3.1 for air) and (3.2 for water). Tilted FPV modules are generally air-cooled, although some partially submerged designs have been presented (and are discussed in 3.2). Horizontal FPV modules are usually in direct contact with water. However, in some cases the horizontal modules have been suspended above the water surface and are therefore air-cooled.

2.4. Air cooled FPV

Many case studies on the thermal and electrical performance of FPV have been reported in the literature. However, most studies are site and/or design specific and difficult to generalize. Choi (Choi, 2014) investigated the performance of various FPV systems in Korea. First, the author found that the 100 kW and 500 kW FPV systems at Hutcheon Dam produced yields 10% to 13.5% higher than the LPV system installed 60 km away. In addition, the author compared the performance of the FPV system and the LPV system, which are located and installed with a tilt of 11 degrees also in Korea. FPV showed a consistently better capacity factor during the study period (January to July 2012).

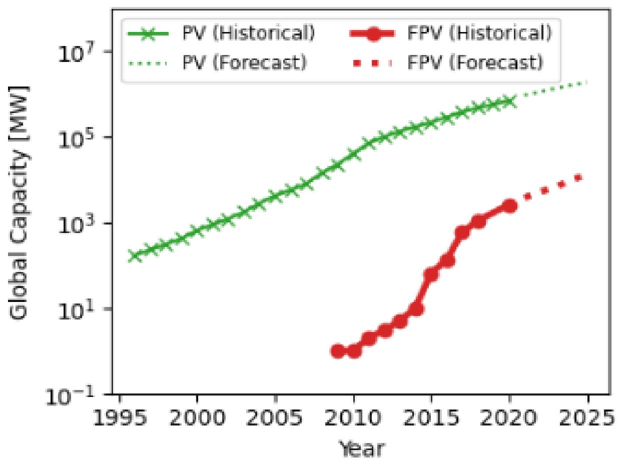

Figure1: Global capacity growth per year

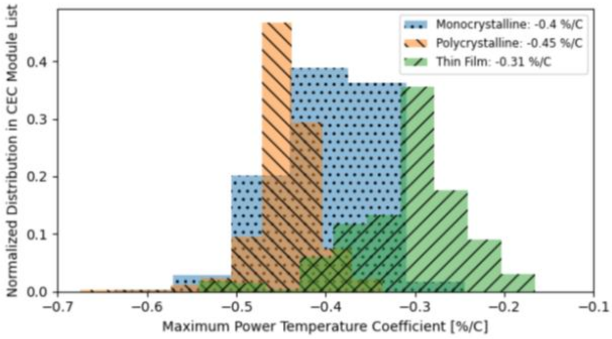

Figure2: Maximum power generated at different temperature.

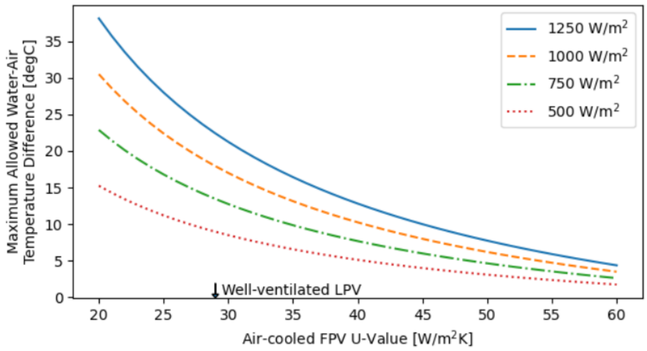

Figure3: Floating Solar Input value at different temperature.

3. CONCLUSIONS

Floating photovoltaics is one of the emerging solutions capable of mitigating competition in urban planning for photovoltaics. In addition to limited land requirements, FPVs are often attributed with lower operating temperatures than LPVs and are therefore expected to operate with higher efficiency. If confirmed, the improved thermal behaviour could help make this technology cost-competitive and successful. In this light, this work evaluates the current knowledge on the thermal behaviour of FPV systems and reviews in depth the literature available on thesubject.

To date, publications on FPV have often been site or design specific, making it difficult to identify universal conclusions. However, the current review points out that in order to better describe their thermal behaviour, FPV systems should be classified as water-cooled or air-cooled. According to the available literature, the former can be expected to reach lower temperatures than LPV, due to better water heat transfer. Additionally, the data suggests that these lower temperatures could also be recorded for water temperatures higher than air temperatures. Also, air-cooled systems can achieve better thermal performance than LPV, but examples of higher temperatures than LPV have been reported in the literature. Some initial comparative experimental studies have been presented, showing that some designs favour heat exchange (open structure and/or small footprints), while FPVs with closed structures and larger footprints can be hotter than LPVs. The results are explained by the role of wind speed in air cooling; the highest heat transfers are found in structures that support air flow. However, by the same token, some local conditions may impede FPV heat transfer, such as low wind speed, a system installed below ground level, and/or the presence of vegetation and buildings around the watershed.

(1) Due to water cooling, the average ambient water temperature is approximately lower than that on land with all other conditions being equal. This paper created a finite element model and found a difference in operating temperature between a floating photovoltaic cell and a terrestrial cell.

(2) Based on the water cooling effect, the study found that the efficiency of floating photovoltaic systems can an increase of approx. 1.58-2.00% compared to traditional terrestrial PV systems.

(3) The potential of floating photovoltaic systems can reach 160 GW, covering about 2500 km2 of water Surface. This would help save 2*1027 m3 of water from evaporation per year. If the saved water can be used with hydropower, it would further contribute to an indirect water saving of approx. 1.25*1012 m3. In addition, floating PV systems can greatly facilitate competition for land.

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