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Techno-Economic Feasibility of the Use of Floating Solar PV Systems in Oil Platforms

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Abstract: Offshore facilities have high energy demands commonly accomplished with local combustion-based power generators. With the increased commercialization of the marine renewable energy sector, there is still a need for research on floating photovoltaic installations on their performance and economic perspective. This paper investigates the techno-commercial feasibility of installing a battery-integrated floating solar photovoltaic (FPV) system for an offshore oil platform facility in Abu Dhabi. The performance analysis of two floating PV design schemes has been evaluated using the PVsyst design tool. The proposed system's annual solar energy availability from the PVsyst 7.2.21 output was validated with MATLAB Simulink R2022b with a deviation of 1.85%. The optimized solution achieved the Levelized Cost of Electricity (LCOE) of 261 USD/MWh with a Discounted Payback Period of 9.5 years. Also, the designed system could reduce carbon emissions by 731 tons per year. Furthermore, it was recognized that the contribution of the marine sector to the construction of floating platforms influences the success of floating PV systems. Independently authorized floating PV system designs would guarantee insurability from the viewpoints of investors and end users.

Keywords: floating photovoltaics (FPV); marine renewable energy; offshore oil platform

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1. Introduction

Combustion-based power generators commonly accomplish the energy required to operate offshore oil rigs. Considering the continuous operation of oil rigs, greenhouse gas emissions keep raising the burden on the atmosphere. It is estimated that about 3% of global greenhouse gas emissions are from offshore facilities and ships [1]. This necessitates using sustainable energy resources to support the operation of offshore oil rigs, which would be a fundamental step toward reducing emissions and making the world's polluting oil rings an environmentally friendly location. Wind energy has been the predominant renewable energy type for the marine environment. Although other renewable energy technologies exist in oceans, such as waves and tides, solar PV technology is seen as a prospective technology to be commercialized in regions like the Persian Gulf, where wind resource potential is weak and annual solar radiation potential is substantial [2]. As of 2020, there are 2.6 GW of floating solar PV installations globally and there is a projection that it could reach 4.8 GW in 2026 [3,4]. The current trend is to move toward offshore applications considering the space availability and potential of the future energy mix, energy security, and decarbonization goals. This positive trend toward offshore PV installations requires robust technology to cope with the marine environment.

This paper focuses on investigating the technical and economic feasibility of a solar floating system to power specific electrical demands of an oil rig platform, such as office workstations, living quarters, and other accessories.

2. Literature Review

A review of existing literature shows that many studies of floating PV systems have been conducted globally. However, studies on the offshore environment, particularly its technical and economic feasibility, are still limited. This literature review focuses on a critical understanding of the floating PV panel performance in the marine environment, followed by the current research status of floating PV technologies suitable for the offshore environment. Further, it examines the methodologies adopted by the researchers in the design and performance analysis of floating PV systems.

A typical floating PV system installation for offshore installations consists of PV panels, inverters, a floating structure, a mooring, and an anchoring system, as depicted in Figure 1. It is highlighted by various researchers that critical challenges in marine solar applications, compared with the freshwater environment, are coping with severe wave and wind loads and resistance to seawater salinity [5].

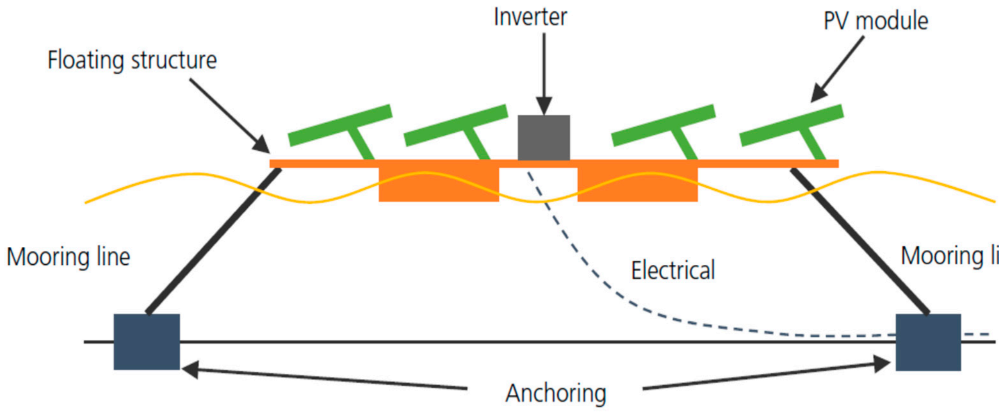


Figure 1. Typical floating solar PV system components.

From a performance perspective, a floating solar system is demonstrated to be efficient due to the cooling effect of PV panel surfaces connected to the water surface. Increases in PV panel temperature reduce the power output and the panel's life. Therefore, evaluating the PV panel temperature rise is significant for the overall electrical performance. The electrical output of PV panels concerning PV cell temperature is given with Equation (1) [6].

$$P_{mod} = P_{STC} \cdot (1 + \gamma \cdot \Delta T) \quad (1)$$

where P_{mod} is the PV module's electrical output, P_{STC} is the PV panel's power at test conditions (W), γ is the temperature-specific coefficient of the PV panel power (K^{-1}), and ΔT is the temperature gradient between the operating temperature of the solar PV panel and the temperature at test conditions, which is 25 °C (K).

Sara Oliveira et al. investigated the means of accounting for the water-cooling effect on PV panels in the PVsyst 7.2.21 tool [5]. The PVsyst 7.2.21 application tool considers the default heat loss factor 29 W/m^2 K for the ventilated type and 15 W/m^2 K for insulated installations [7]. The research study examined the changes to the default heat loss factor for a free-standing well-ventilated FSPV system and based on a field experiment conducted, the default heat loss factor was changed to 46 W/m^2 K [8].

Despite the benefits of the cooling effect, not all PV array configurations or types avail the full advantage of improved PV panel performance output. Hence, choosing the PV type based on the intended application and location (besides the offshore oil rig platform) is essential. Table 1 summarizes the design features of the four established floating PV design schemes set to be commercialized. The key findings of the earlier research conducted by various scholars are depicted in Table 2.

Table 1. Summary of floating PV design schemes for offshore installations.

Design Scheme	Design Reviews
SwimSol Solar Sea Floaters [9]	Aluminum-framed Styrofoam floaters with 10° tilt. Designed to withstand loads up to 2 m wave height. Suitable for near-shore locations to power islands. Equipped with 25 kW marine-grade solar PV panels that occupy 196 m^2.
Moss Maritime Floating Solar Park [10]	Offshore-grade steel-framed platform supported with box-type floaters. Solar panels are installed at 3 m from the sea surface. Intended to be deployed at remote islands and oil and gas installations.
Heliofloat Solar Platform [11]	The flexible open cylinder produces air cushioning to cope with marine movement. The lightweight and cost-effective platform is for water body deployment, including offshore marine applications. Made up of semi-transparent material, allowing sunlight to pass through.
Solarduck Floating Solar Platform [12]	Triangular-structured elevated platform connected with 10° tilt PV panels. Lightweight ocean-grade aluminum with a service life of more than 30 years. Easy integration with oil and gas platforms.

Table 2. The key findings of the earlier research conducted.

Factors	Findings
Cooling Effect	In a field experiment, the heat loss coefficients were compared between ground and floating panel arrangements [8]. It was evident from the experimental demonstration that the heat loss factor for the offshore environment would be in the higher range, particularly when the installation type is free-standing. Accordingly, the related 'Heat Loss Factor' in the PVsyst 7.2.21 tool would be adjusted for the floating PV system type [5].
PV Panel Geometry	Based on the review of four patented design schemes concerning their panel geometry types, it is appreciated that the geometry types, which are modular and customized to fit different system sizes, should be a potential design scheme to be considered for floating applications [9–12].
Structural Stability	The existing literature research reveals that highly durable material and adaptability to scale up the capacity determine the technical and economic feasibility [5].

Based on the conducted literature review, the following considerations are applied in this study:

- The floating panel's temperature shall correspond to the seawater surface temperature and not just only with the temperature coefficient and the temperature difference between standard operating conditions and the ambient temperature. The empirical equations that factor in sea water surface temperature, incident solar irradiation, and other aforementioned factors have been considered in this study.
- The PVsyst 7.2.21 software tool does not predict the performance based on the module temperature in relation to the seawater surface temperature. Instead, the heat loss factor, which improves air transmission, has to be adjusted to adapt to the offshore environment. Hence, a suitable validation methodology that factors in the drop in panel temperature using the MATLAB Simulink R2022b has been performed to compare the results.
- Different geometries of panel arrays were reported in the literature. In this study, the most practical arrangements that optimize the energy yield in the holistic context of economics, mooring systems, and maintenance have been evaluated.

3. Materials and Methods

In this section, the details of the selected case study are described, followed by the design and selection of floating PV system components, simulation, and validation. PVsyst was used in the design process for adapting the offshore condition and selecting appropriate system components, including PV panels, inverters, and battery banks. The validation of solar energy generation was performed using MATLAB Simulink R2022b.

3.1. Case Study: Overview and Demand Assessment

An offshore jack-up platform, 'QMS Al Bahia', in Abu Dhabi, as shown in Figure 2, was chosen for this case study [13,14]. The platform is located at 24°42′42.9″ N Latitude and 53°36′57.0″ E Longitude. The case study location was selected with due consideration and the advantages are

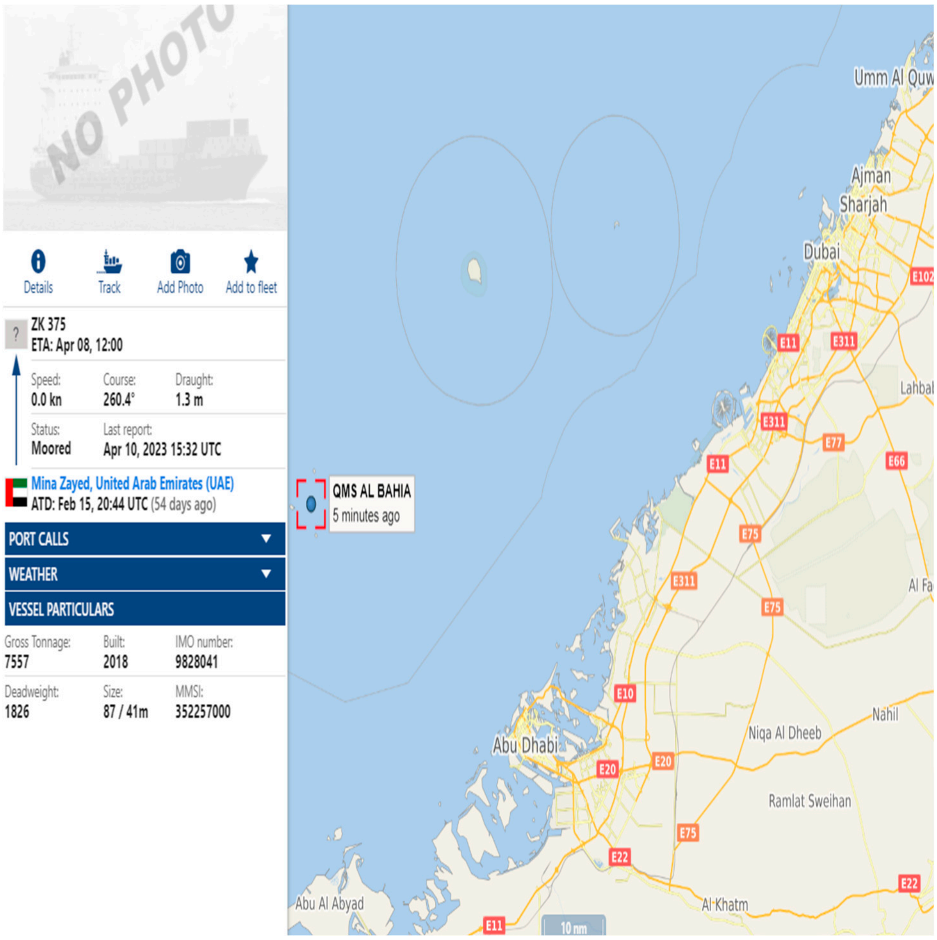


Figure 2. Case study location—QMS Al Bahia, Abu Dhabi [14].

- Despite other renewable energy technologies that exist in oceans such as waves and the tide, solar PV technology is seen as a prospective technology to be commercialized in regions like the Persian Arabian Gulf, where wind resource potential is weak and annual solar radiation potential is very strong [2].
- The QMS Al Bahia facility includes supplemental loads that require electric power all through the year.
- All requested data sources were available for this facility. Also, regional-specific research findings were available for this study [13].
- UAE as a country sets decarbonization goals for the oil sector; accordingly, this research study could attract researchers in the UAE and the wider region [15].

The total energy requirement for the platform is 6.85 MW, and diesel is used as an energy source [13]. The predominant energy use is for the production platform with relatively constant loads. The supplemental loads that vary throughout the day are for the accommodation facilities. Based on the available data, energy demand for different seasons has been worked out using the PVsyst 7.2.21 demand profiling. The average daily demand of the accommodation facility is 2398 kWh/day, and the daily profiling is depicted in Figure 3 [13].

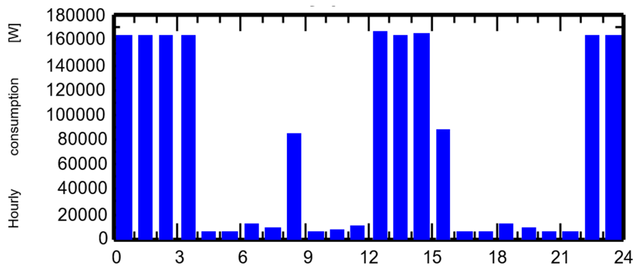


Figure 3. Annual average daily load profile of accommodation facility [13].

3.2. System Design

Given that the selected location is not connected with a grid, the proposed system includes PV panels, a battery bank, inverters, and a backup diesel generator. PVsyst simulation software has been utilized to design the system components for the identified energy demand. For the energy demand of 2398 kWh/day with one-day autonomy, the estimated PV panel capacity was 530 kW. The specifications of PV panels, battery banks, and inverters are presented in Table 3, Table 4, and Table 5, respectively.

Table 3. PV panel specification at Standard Testing Conditions (STCs)—Irradiance: 1000 W/M^2; Cell Temperature: 25 °C; Atmospheric Mass: 1.5.

Module Power	540 W
Maximum Power Voltage (Vmp) and Current (Imp)	41.65 V/12.97 A
Open Circuit Voltage (Voc)	49.50 V
Short-Circuit Current (Isc)	13.85 A

Table 4. Battery Bank Specifications.

Nominal Capacity	120 Ah
Voltage	48 V
Nominal Capacity	120 Ah

Table 5. Inverter Specifications.

Max. PV input power	13,300 W
MPP voltage range for nominal power	280–850 V
Short-circuit current of PV input	48 A
Max. PV input current	37.5 A

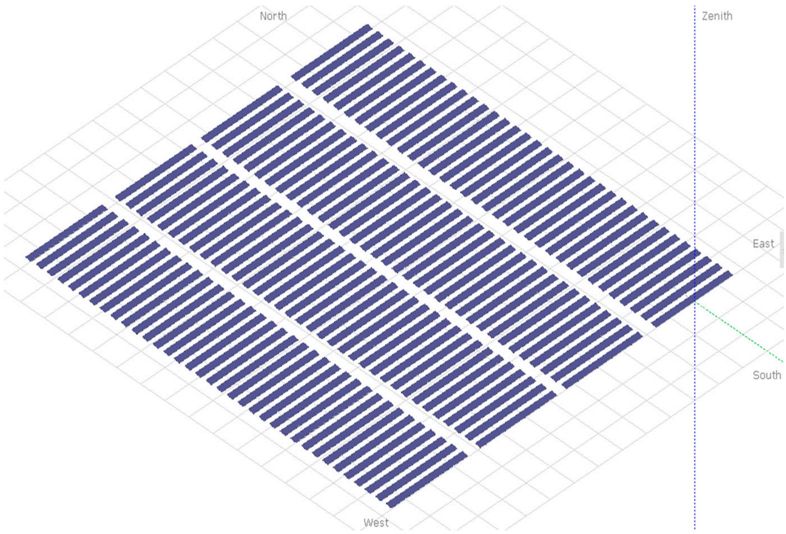
As highlighted in the literature review, the feasibility of a floating PV system in an offshore environment depends on the floating system's design scheme and its durability and scalability. Thus, this study evaluated the implementation of two potential floating systems. Both floating systems' PV panel layouts have been modelled using PVsyst as shown in Figure 4.

3.3. System Performance

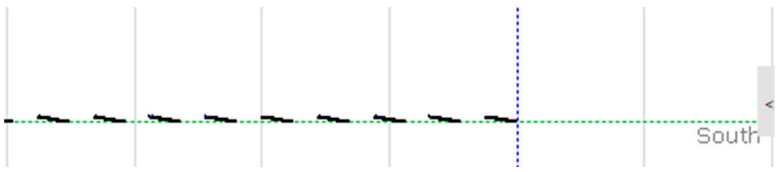
The performance of the floating PV system for the 530 kWp design capacity has been simulated using the PVsyst 7.2.21 tool. Since the PVsyst 7.2.21 tool does not have the option to model the floating PV systems, the tool has been adjusted to adapt the floating characteristics. The key considerations of the water surface on the system performance are the temperature of the modules and the reflectivity. The default heat loss factor in the PVsyst 7.2.21 tool has been adjusted in line with the cooling effect due to the water surface. Also, the albedo of the water surface was revised to be 0.1. Other modelling parameters include the shading profile, which was duly considered based on the pitch, tilt, and azimuth angles. The model for Scenario 1 has single orientation tilted at 10°, facing true south, i.e., 0° azimuth and with the pitch of 2.2 m. However, the Scenario 2 model has two orientations, one with 0° azimuth and another orientation is 180° azimuth, and both are tilted at 10°. The performance of the modelled system was simulated using the PVsyst 7.2.21 tool by considering losses due to the soiling factor, changes in the irradiance level, temperature variations, module efficiency and mismatch, and inverter efficiency to understand the useful energy supply to the demand. The key output results include the monthly energy generation, energy lost due to the battery being full, missing energy, and performance ratio.

Design Scenario 1

PV panel arrangement—Isometric view



PV panel—Sectional view



Design Scenario 2

PV panel arrangement—Isometric view

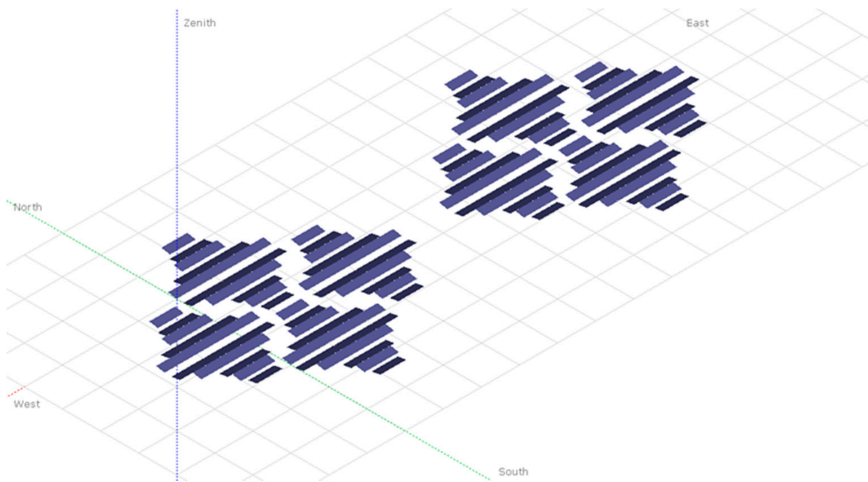


Figure 4. *Cont.*

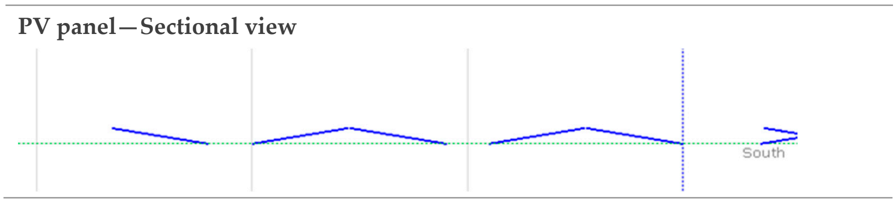


Figure 4. Floating PV panel layout configurations.

The results obtained from the PVsyst 7.2.21 tool have been validated using the mathematical modelling tool MATLAB Simulink R2022b.

A simple PV module with a project capacity (530 kW) has been modeled using MATLAB Simulink R2022b as shown in Figure 5. Then, the PV output results for different irradiation and cell temperatures were computed using the MPPT algorithm [16]. The irradiation and ambient temperature values for each hour (average monthly data) have been obtained from the PVsyst 7.2.21 meteorological database. The average module temperature for each month has been calculated using Equation (2) [17].

$$T_{FPV} = 1.8081 + 0.9282T_a + 0.0215G - 1.221WS_w + 0.0246T_w \quad (2)$$

where T_{FPV} is the PV module temperature, T_a is ambient temperature (°C), G is the incident solar irradiation (W/m^2), WS_w is the wind speed (m/s), T_w is the seawater surface temperature (°C).

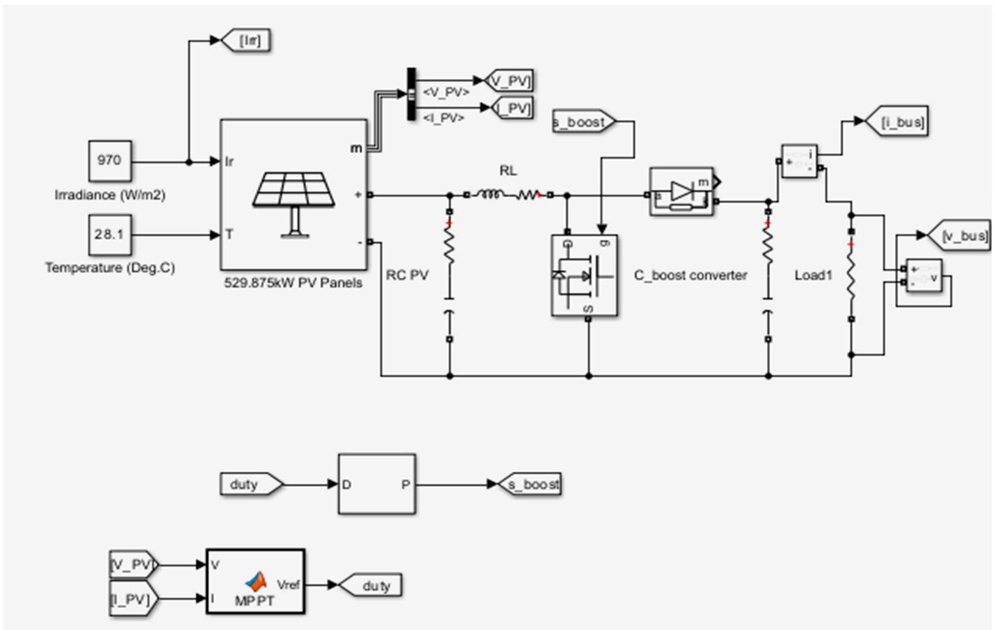


Figure 5. Solar PV array model using MATLAB Simulink R2022b.

4. Results and Discussion

The developed methodology was executed for the offshore oil platform 'QMS Al Bahia' in Abu Dhabi and the climatic conditions of the Persian Gulf. The first part of this section presents the results of the system performance and its design optimizations using PVsyst 7.2.21, followed by the critical discussions of floating PV system structures adapting to the offshore marine environment. The third part focuses on an economic feasibility analysis. The last part discusses the validation of results from PVsyst 7.2.21 and MATLAB Simulink R2022b.

4.1. Performance Evaluation

The performance evaluation of any floating-type photovoltaic system starts with the analysis of the uplift in the power output due to the temperature effect of the PV panels. As depicted in Figure 6, the effect of PV cell working temperature on an offshore environment does impact the efficiency with the maximum difference of 4.1 °C in the month of November as compared to the ambient temperature [18]. Considering the PV panel efficiency of 21.17% at STC and temperature coefficient of 0.34%/°C, the offshore environmental conditions exceed the standard condition efficiency for November to March.

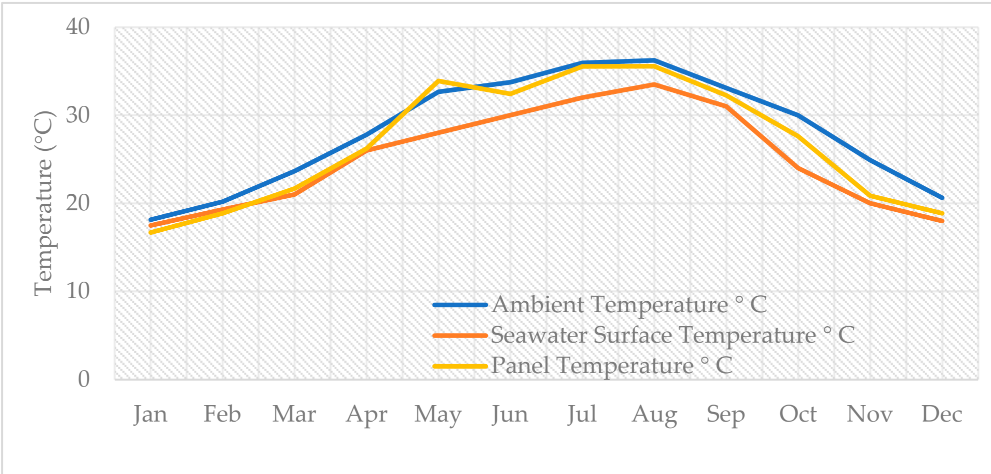


Figure 6. Effect of panel temperature corresponds to the seawater surface and ambient temperature.

In comparison with the ground installations as depicted in Figure 7, the increase in annual energy yield is 2.31%. As stated in the methodology section, besides the panel temperature, an additional factor that affects the floating PV system yield is the reflectivity of the water surface. It was examined that the yield decreased with a lower albedo compared to with ground installations. The combined effect of panel temperature and reflectivity has been simulated using the PVsyst, assuming that the same installation is adapted to the ground conditions. Further, analyzing the monofacial panel's performance with the bifacial panel, the performance of the fixed-tilt PV panel does not outperform, and thus the bifacial panel is not an economical option in the offshore environment. Despite the efficiency gain, the bifacial technology deployment would be more economically viable where energy density is crucial like in an urban environment and not for the offshore installations.

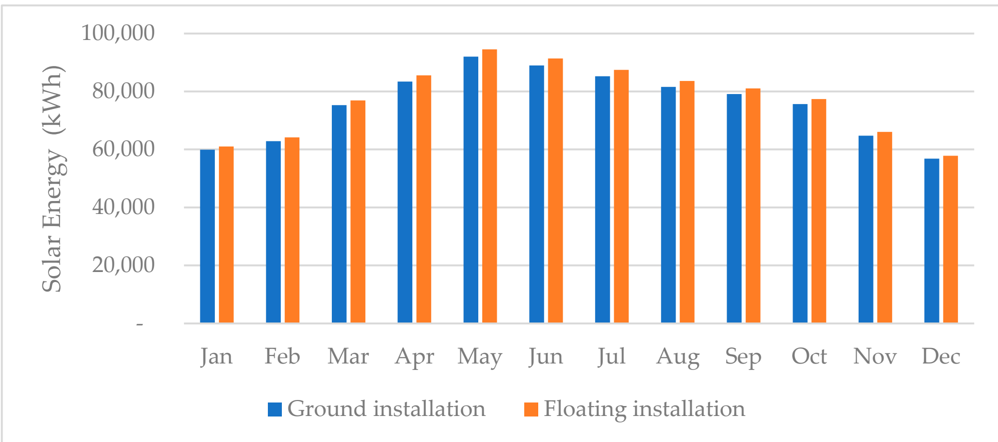


Figure 7. Illustration of the solar energy yield of 530 kWp floating PV system in comparison with the ground installation.

4.2. Floating PV System Design Optimization

Results on the design optimizations were utilized for feasibility assessment of the proposed floating PV system at the case study site. Design concepts evaluated include

- Design Scenario 1: A rectangular array having 10° tilt oriented at 0° azimuth with the 2.2 m pitch.
- Design Scenario 2: A triangular array having 10° tilt, oriented at 0° and 180° azimuth.

The PV panel layout in this study incorporated a total of 980 panels with 540 Wp; each module capacity consists of 7 series strings and 140 parallel strings. Table 6 illustrates the key performance indicators of the design scheme for the same capacity. Iterations were carried out for 22° tilt (zero loss on annual radiation) to align with the Latitude of the location and 10° tilt (0% loss with respect to optimum orientation in summer) to enable self-cleaning, and based on the evaluation, 10° is considered an optimal tilt from a shading and space utilization perspective. For the same capacity, considering that the Scenario 1 scheme has a single orientation, the area required for installation is 5107 m^2, while with the two orientations, the Scenario 2 scheme requires only 3600 m^2. The drop in yield on the Scenario 2 scheme is due to the increased loss with respect to the optimum orientation, particularly in winter. Also, it was comprehended that the Scenario 2 system outperforms in the summer months (May, June, and July) due to the increased incident solar irradiation, as shown in Table 7 [18].

Table 6. Illustration of Simulated Performance Data for Scenario 1 and Scenario 2 Design Scheme.

	Scenario 1 Scheme	**Scenario 2 Scheme**
Tilt Angle (°)	10°	10°
Azimuth (°)	0°	0° (Orientation #1) 180° (Orientation #2)
Energy Production (MWh/yr)	905	896
Specific Yield (kWh/kWp)	1708	1690
Capacity Factor	19.50%	19.30%

Table 7. Results for Annual Incident Solar Radiation and Output for Proposed Design Scenarios.

Month	**Scenario 1 Scheme**		**Scenario 2 Scheme**	
	Incident Irradiation kWh/m²	**Energy kWh**	**Incident Irradiation kWh/m²**	**Energy kWh**
January	132.9	59,916	115.5	53,880
February	140.0	62,874	126.6	58,900
March	171.3	75,257	161.5	74,190
April	193.9	83,423	188.5	85,020
May	218.4	91,988	218.7	96,330
June	211.8	88,953	214.7	94,270
July	204.8	85,259	206.3	90,100
August	196.3	81,569	193.2	84,330
September	187.6	79,087	178.2	78,690
October	176.8	75,616	160.8	71,860
November	146.6	64,733	127.6	58,070
December	127.3	56,804	109.2	50,310
Year	2107.7	905,479	2000.8	895,950

In addition to increasing the performance of the system with various design interventions to boost yield and reduce losses, it is acknowledged that a good operation and maintenance strategy is developed to ensure the soiling and module availability loss is kept at the minimum rate [19].

4.3. Floating PV System Structure

Noting that the structural integrity evaluation is beyond the scope of this study, the design schemes considered for feasibility have been critically reviewed on their adaptability for the offshore environment. Based on the available information in the literature, five key aspects are critically reviewed and presented in Table 8. From an overall perspective, both designs intend to cope with the offshore conditions by addressing the dynamic marine environment. From an economic point of view, the service life and maintenance costs play a significant role in the implementation of offshore floating PV systems.

Table 8. Floating PV system structure review.

Aspects	Design Scenario 1 [11]	Design Scenario 2 [12]
Buoyancy	Lightweight flexible cylindrical material dampens wave energy rather than absorbing as with other floating system designs.	Rigid triangular flexible structure with lightweight material utilizes the benefit of multidirectional waves for self-balancing.
Material	Semi-transparent material. No information is available on the service life of the material.	The aluminum used to frame the floating platform is ocean-grade with 30 years of service life.
Mooring	The system utilizes the conventional mooring system, and as such, no specific information is available.	The triangular floating structure reduces the number of mooring lines and mooring forces.
Maintenance	The platform is elevated to avoid any wave-related maintenance activities.	The elevated platforms allow lower salt deposition. Smaller floating area reduces the marine growth on the structure.
Environmental	Semi-transparent material allows penetration of sunlight.	The elevated open system enables better air and sunlight transmission to ensure safety of marine life.

4.4. Economics and Environment

An economic analysis was carried out to analyze the cost-effectiveness of the proposed floating PV system. The economic indicators selected for the study are

- Levelized Cost of Electricity (LCOE);
- Net Present Value (NPV);
- Discounted Payback Period (DPP).

The first step in an economic analysis is estimating capital investment and operational expenses for the service life. For the solar PV-based project, a 25-year project lifespan is considered [20]. The cost of solar PV system components was taken from reliable sources such as the International Renewable Energy Agency (IRENA), International Energy Agency (IEA), National Renewable Energy Laboratory (NREL), and other research journals. The entire cost of the floating PV system was determined to be USD 2,559,774 after considering the cost of the floating system, soft costs, and operational expenses. Cost estimation is provided in Table 9.

Table 9. Cost estimation of the proposed floating PV system.

Capital Costs	
Solar PV Panel and Inverters [21]	USD 467,990
Battery Bank [20]	USD 1,535,475
Floating System [22]	USD 111,300
Anchoring and Mooring [22]	USD 145,750
Cables and Accessories	USD 16,686
Soft Costs (Engineering, Project Management, Approvals)	USD 13,624
Total Cost	USD 2,290,825
Maintenance and Decommissioning Costs	
Maintenance Cost [23]	USD 7950/year
Decommissioning Costs [24]	USD 70,199

Table 9. *Cont.*

Capital Costs	
Total Cost	USD 268,949
Overall Cost	
Total Cost during a Lifetime of 25 Years	USD 2,559,774

4.4.1. Levelized Cost of Electricity (LCOE)

The cost of electricity production from the proposed floating solar PV system was estimated with the costs associated with the initial and operational components. The sensitivity analysis was carried out to comprehend how the LCOE varies with discount rates for Scenario 1 and Scenario 2 systems. In line with the IEA guidelines, to account for the risk and uncertainty, discount rates of 3%, 7%, and 10% have been considered in the LCOE calculations. Further, the annual PV efficiency loss was assumed to be 0.5% for the first 10 years and 1% for the remaining 15 years. The slight variation in LCOE values is dependent on the energy production with both systems. Although Scenario 1's LCOE is slightly lower than Scenario 2, the optimal anchoring system could reduce costs. However, in this study, the cost components for both Scenario 1 and Scenario 2 were assumed to be constant in the absence of specific information, particularly for the floating, anchoring, and mooring system where the cost estimation was based on [21], which stipulates specific cost in USD/kWp [21]. It was noted that the battery storage costs constitute 67% of total capital costs, and further, they add to the operational costs. The analysis showed that the LCOE of the battery-integrated floating PV system is at the level of 261–349 USD/MWh, which is aligned with the case study conducted for off-grid solar PV in Indonesia with the LCOE range from 290 to 310 USD/MWh [25].

4.4.2. Net Present Value (NPV) and Discounted Payback Period (DPP)

Net Present Value accounts for the cash inflows and outflows over the project life and with a positive NPV, the project is considered to be economically successful. The NPVs of the Scenario 1 and Scenario 2 floating PV system for the discount rate of 3% are USD 46,764,051 and USD 46,164,267, respectively. The DPP is the span of time when a project's NPV value equals zero. For both the scenarios, the DPP is less than 10 yrs.

4.4.3. Environmental Considerations

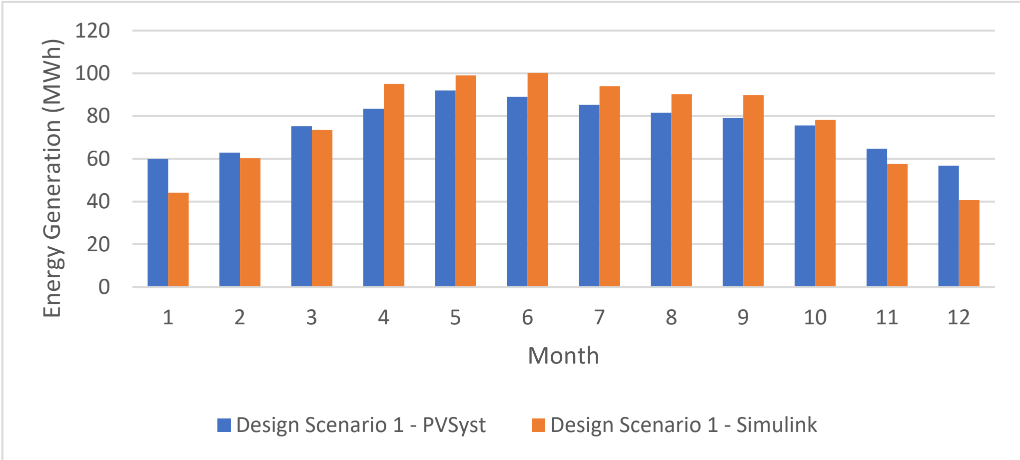
The estimated carbon dioxide (CO_2) emission reduction with the implementation of the floating PV system design is 18,286 tons for the 25-year lifetime with the specific CO_2 emission reduction potential of 34.5 tons/kWp. The system proposed has the solar energy contribution of 96.2% and the remaining 3.8% missing energy would be fed using the diesel generator [18]. The elevated platform scheme is considered a better option for protecting marine life by not having a structure that blocks sunlight and air transmission and limiting the contact of material on the water's surface.

4.5. Validation of Solar Energy Generation

As described in performance evaluation and system optimization sections, the PVsyst 7.2.21 tool was used to estimate the monthly solar energy production from the floating PV system of a capacity of 530 kWp. The obtained results from PVsyst 7.2.21 have been validated with the mathematical tool 'MATLAB Simulink R2022b' and are presented in Table 10. The results from the Simulink model were based on the Maximum Power Point Tracking (MPPT) algorithm and offshore factors such as reduced panel temperature and incident solar irradiation. The developed PVsyst 7.2.21 model was validated by comparing the output from the MATLAB Simulink R2022b model. The results from MATLAB Simulink R2022b are a good match with PVsyst 7.2.21 results, with an annual deviation of 1.85 and 1.88% for the Scenario 1 and the Scenario 2 systems as illustrated in Figure 8.

Table 10. Comparison of results from PVsyst 7.2.21 and MATLAB Simulink R2022b.

	Design Scenario 1	Design Scenario 2
Results from PVsyst 7.2.21 Software		
Energy Production (MWh/yr)	905	896
Specific Yield (kWh/kWp)	1708	1690
Capacity Factor	19.50%	19.30%
Results from MATLAB Simulink R2022b Model		
Energy Production (MWh/yr)	923	911
Specific Yield (kWh/kWp)	1741	1719
Capacity Factor	19.87%	19.63%
Deviation from PVsyst 7.2.21	1.85%	1.68%



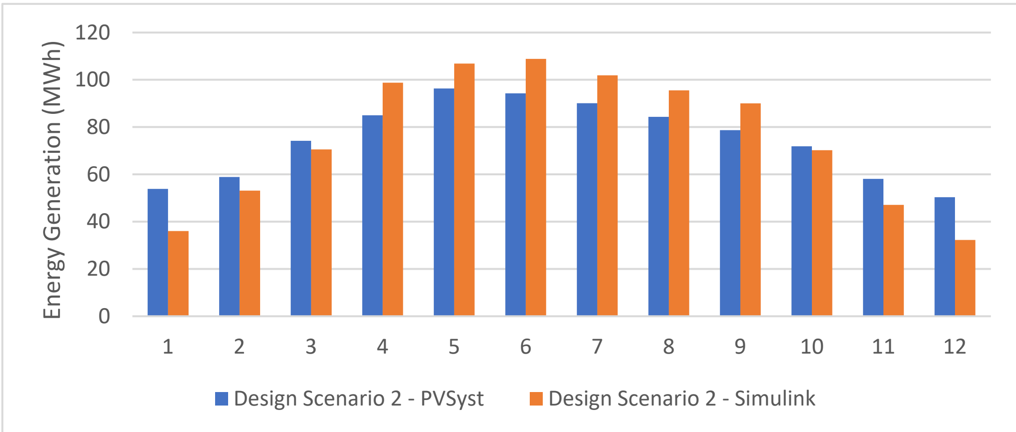


Figure 8. Comparison of energy generation output for design scenarios from PVsyst 7.2.21 and MATLAB Simulink R2022b.

5. Conclusions

This paper provided an approach to evaluate the performance of floating PV systems, which are applicable to the marine environment within offshore oil platforms. The influencing parameters such as the panel temperature, heat loss factor, incident irradiation, and albedo pertaining to the performance of floating PV systems were investigated. The main findings of the techno-economic analysis of 530 kWp battery-integrated floating PV for an offshore oil platform are

- Floating PV configuration has an additional energy yield of 2.3% compared to ground installations.

- The capacity factor of the simulated design options is in the range of 19.3% to 19.5%, which is aligned with the typical capacity factor for solar PV systems worldwide.
- The available patented floating PV designs were intended to cope with the dynamic offshore conditions; however, in the economic sense, the material service life and maintenance costs do play a significant role in the implementation of offshore floating PV systems.
- The studied floating PV system could reduce CO_2 emissions by 731 tons per year.
- The optimized solution achieved the Levelized Cost of Electricity (LCOE) of 261 USD/MWh with a Discounted Payback Period of 9.5 years. Although the LCOEs of the designed battery-integrated system were found to be higher than a typical on-grid solar PV system commonly installed over lakes or dams to support a national energy portfolio, an offshore environment essentially requires an energy storage solution. Also, the calculated NPVs favor the implementation as battery technology increases the LCOE and lowers the payback.
- The results obtained from PVsyst simulation were found to be aligned with the mathematical model with a maximum deviation of 1.89%.

The elevated floating platform with an optimized panel layout and anchoring/mooring system determines the success for offshore implementation. Moreover, patented designs provided by maritime experts could pave the path to successful implementation. International design standard development could potentially further ease the penetration and acceptance of investors. The proposed floating solar PV projects ideally fit the United Arab Emirates (U.A.E) due to its high yearly solar intensity and less windy/stormy climate, which might result in a potentially revolutionary green energy architecture. Making the most polluting oil rigs in the world more environmentally friendly would be a positive move. Additional research studies based on the real-time measurements from offshore demonstration projects would provide insights into the efficiency improvements and the energy losses due to the environmental conditions.

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