24th International Conference on Renewable Energies and Power Quality (ICREPQ'26)
Santander (Spain), 10th to 12th June 2026
ISBN-13: : 978-84-09-82044-3

Economic feasibility analysis of a SeaVolt offshore solar farm in the Canary Islands

C. Fernández-Blanco[1], D. Cordal-Iglesias[2], D. Fernández-Mira[3], A. Filgueira-Vizoso[4], L. Castro-Santos[5]

[1] Universidade da Coruña, Centro de Investigacións en Tecnoloxías Navais e Industriais (CITENI), Campus Industrial de Ferrol, Departamento de Enxeñaría Naval e Industrial, Escola Politécnica de Enxeñaría de Ferrol, Esteiro, 15471, Ferrol, Spain. carla.fblanco@udc.es

[2] Universidade da Coruña, Centro de Investigacións en Tecnoloxías Navais e Industriais (CITENI), Campus Industrial de Ferrol, Escola Politécnica de Enxeñaría de Ferrol, Esteiro, 15471, Ferrol, Spain. david.cordal@udc.es

[3] Universidade da Coruña, Centro de Investigacións en Tecnoloxías Navais e Industriais (CITENI), Campus Industrial de Ferrol, Escola Politécnica de Enxeñaría de Ferrol, Esteiro, 15471, Ferrol, Spain. daniel.fernandez.mira@udc.es

[4] Universidade da Coruña, Centro de Investigacións en Tecnoloxías Navais e Industriais (CITENI), Campus Industrial de Ferrol, Departamento de Química, Escola Politécnica de Enxeñaría de Ferrol, Esteiro, 15471, Ferrol, Spain. almudena.filgueira.vizoso@udc.es

[5] Universidade da Coruña, Centro de Investigacións en Tecnoloxías Navais e Industriais (CITENI), Campus Industrial de Ferrol, Departamento de Enxeñaría Naval e Industrial, Escola Politécnica de Enxeñaría de Ferrol, Esteiro, 15471, Ferrol, Spain. laura.castro.santos@udc.es

Abstract. This study evaluates the economic feasibility of a 13.1 MW offshore solar farm based on SeaVolt platforms in the Canary Islands. While Levelized Cost of Energy (LCOE) results are promising, Net Present Value (NPV) and Internal Rate of Return (IRR) remain negative, indicating limited economic viability under current assumptions. Nevertheless, offshore solar represents a highly promising technology, particularly as a complementary solution to offshore wind farms, enhancing energy output and supporting a sustainable energy transition. The study provides insights for stakeholders and highlights the importance of cost optimization, site selection, and supportive policies to improve future financial feasibility.

Key words. LCOE, CAPEX; Photovoltaic; Solar; Offshore; Energy

1. Introduction

The growing scarcity of fossil resources to meet current global energy demand highlights the urgent need to transition towards cleaner and more sustainable energy systems. In this context, marine renewable energies offer several advantages compared to their land-based counterparts, including greater space availability and reduced land use conflicts. In the case of offshore solar energy, additional benefits arise from the cooling and self cleaning effects of seawater on photovoltaic modules [1,2]. Offshore wind energy, on the other hand, benefits from stronger and more stable wind resources, which significantly enhance energy production and capacity factors.

Among marine renewable technologies, offshore wind energy is currently the most mature, with extensive deployment worldwide and a large body of research dedicated to its optimization, cost reduction, and environmental integration [3–6]. Offshore solar energy, in contrast, remains an emerging but highly promising technology. Beyond the advantages already mentioned, offshore solar installations may contribute to reduced algae growth beneath the platforms due to lower light penetration, exhibit compatibility with existing offshore electrical infrastructure, and avoid the need for land preparation [2]. These characteristics make offshore solar particularly attractive in regions with limited available land or high population density.

Despite its potential, offshore solar energy faces several technical and environmental challenges [2]. Installation and maintenance operations are considerably more complex than those of land-based systems and may require specialized vessels and underwater interventions. Potential impacts on the marine environment must be carefully assessed, including interactions with marine ecosystems and competition with other maritime activities such as navigation, fishing, and tourism. Additional safety requirements are also necessary to ensure the integrity of the equipment under harsh offshore conditions. Furthermore, photovoltaic modules are exposed to specific degradation mechanisms, including corrosion due to the

saline environment and soiling caused by birds, which may negatively affect long term performance.
From an economic perspective, offshore solar energy is currently less competitive than conventional land-based photovoltaic systems [7]. This is mainly due to the higher costs associated with submarine power cables, electrical protection systems, mooring and anchoring structures, as well as more complex installation procedures. At a global level, China currently leads the offshore solar market, with large scale pilot and commercial projects, and significant activity is also observed in other Asian countries such as Japan, India, South Korea, and Indonesia. In Europe, several countries have developed pilot offshore or nearshore floating solar projects, including the Netherlands, Norway, Belgium, Germany, France and Austria [7,8].
Previous studies have shown that, under favorable assumptions, the LCOE of offshore solar installations can approach that of land based photovoltaic systems. For instance, estimates from 2019 suggested that a 50 MWp offshore photovoltaic plant could achieve an LCOE in the range of approximately 46.8 to 49.0 €/MWh, while land based installations in arid or desert climates could reach values around 45.2 €/MWh, assuming a weighted average cost of capital of 6% [7].
In this study, an economic feasibility analysis of an offshore solar platform, SeaVolt, assuming its location in the Canary Islands is presented. Key economic indicators, including capital expenditures, operational expenditures, levelized cost of energy, net present value, and internal rate of return, are evaluated to assess the viability of the proposed system under local environmental and economic conditions.

2. Methodology

A. Energy calculations

Solar radiation over the Canary Islands was estimated using data for the maritime region corresponding to the variable “shortwave solar radiation at the surface” expressed in J/m², obtained from the Copernicus ERA5 reanalysis dataset [9]. The datasets were retrieved in NetCDF4 format and spatially processed using QGIS. The mean annual solar irradiation, expressed in kWh/m² per year, was subsequently derived through post processing using a Python based script:

$$E_{kW\ /m^2/year} = \frac{\left(\frac{1}{N}\sum_{h=1}^{N} E_h\right) \times N}{3.6 \times 10^6} = \frac{\sum_{h=1}^{N} E_h}{3.6 \times 10^6} \quad (1)$$

Where E_h is the hourly solar radiation in J/m² and N is the total number of hours in the year, the annual solar radiation in kWh/m²/year.

Finally, the total energy output of the solar farm was estimated by accounting for both the number of photovoltaic modules installed on each platform and the overall number of platforms deployed. The expression used to compute the total energy production is presented below.

$$E_{farm} = E_{solar} \times \eta \times (1 - P_{loss}) \times (1 + G_{gain}) \times A_{panel} \times N_{panel} \times N_{platform} \quad (2)$$

Being:

- E_{solar}: Available solar energy per unit area (kWh/m²/year).
- η: Solar panel efficiency (%).
- P_{loss}: Sum of relative losses.
- G_{gain}: Sum of relative gains due to offshore conditions.
- A_{panel}: Area of a single solar panel (m²).
- N_{panel}: Number of panels per platform.
- $N_{platform}$: Total number of platforms in the solar farm.

The system loss factor was estimated using an online calculator provided by NREL [10], while an efficiency gain of 10.2% associated with offshore operating conditions was assumed based on values reported in the literature [11].

B. CAPEX and OPEX calculations

The definitions of CAPEX and OPEX are presented [12]:

$$\text{CAPEX} = f(C_1, C_2, C_3, C_4, C_6) \quad (3)$$

$$\text{OPEX} = f(C_5) \quad (4)$$

Being:

- C_1: conception and definition cost.
- C_2: design and development cost.
- C_3: manufacturing cost.
- C_4: installation cost.
- C_5: operation and maintenance cost (OPEX).
- C_6: decommissioning cost.

For the estimation of operational expenditures, a value of $77 per kW (€72.4 per kW) was adopted based on reported offshore wind OPEX costs for 2023 [13], assuming a project lifetime of 20 years, which was adopted based on the Spanish Tax Agency’s depreciation schedule for facilities, furniture, equipment, and other tangible fixed assets [14]. Additionally, component C_6 was assumed to correspond to 10% of cost component C_4.

C. LCOE, IRR and NPV calculations

The equation utilized to estimate the LCOE was:

$$LCOE = \frac{\sum_{n=0}^{N_{farm}} \frac{CAPEX_n + OPEX_n}{(1+r)^n}}{\sum_{n=0}^{N_{farm}} \frac{E_n}{(1+r)^n}} \quad (5)$$

Being:

- Capital Expenditure in year n ($CAPEX_n$), in €/year. It is the cost of conception and design of

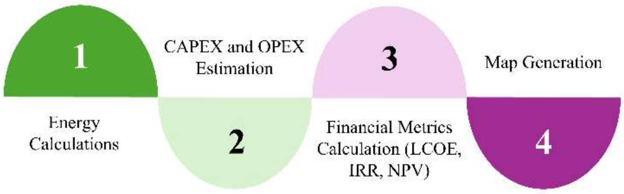

Fig. 1. Flowchart of the methodology followed.

- the farm, manufacturing, installing and decommissioning.
- Operational Expenditure in year n ($OPEX_n$), in €/year. It is the cost of operating and maintaining.
- WACC or Weighted Average Cost of Capital (r), in %.
- Life-cycle (N_{farm}), in years.
- Energy generated by the floating offshore solar farm yearly ($\boldsymbol{E_n}$), in MWh/year.

The equation for determining IRR is obtained by setting NPV equal to 0, as shown:

$$NPV = -I_0 + \sum_{n=1}^{N_{farm}} \frac{CF_n}{(1+r)^n} \quad (6)$$

Being:
- Initial investment (I_0), in €.
- Cash flow in year n (CF_n), in €/year.
- Life-cycle (N_{farm}), in years.

Besides, the NPV was calculated using the following formula:

$$0 = -I_0 + \sum_{n=1}^{N_{farm}} \frac{CF_n}{(1+IRR)^n} \quad (7)$$

Being:
- Initial investment (I_0), in €.
- Cash flow in year n (CF_n), in €/year.
- Life-cycle (N_{farm}), in years.
- WACC or Weighted Average Cost of Capital (r), in %.

The methodology used in this study is summarized in the diagram shown in Figure 1.

3. Case of study

Seavolt consists of a semisubmersible offshore solar platform concept (Figure 2) that is currently under development by a Belgian company bearing the same name [2]. The project is still at an early stage, as the first fabricated prototype [3] was deployed in September 2023 at the Blue Accelerator test site.

Although empirical data and peer reviewed studies remain limited, the proposed design of the final system exhibits several promising features. Notable advantages include a structural configuration specifically engineered to withstand harsh offshore environmental conditions, as well as the elevated positioning of the photovoltaic modules, which enhances protection and enables the use of conventional commercial solar panels.
Thus, the economic viability of a 13.1 MW Seavolt offshore solar farm in the Canary Islands was studied with two electricity tariffs, corresponding to two Iberdrola plans in July 2025: €0.1199/kWh and €0.187375/kWh. For the calculations, a distance to the coast of 12 km and a water depth of 50 meters were considered.

4. Results

Table I summarizes the results of the estimation of the cost components associated with the deployment of an offshore solar farm based on SeaVolt platforms with a total installed capacity of 13.1 MW. The results indicate that cost component C_3, corresponding to manufacturing expenses, represents the largest share of the total project cost. This is mainly attributed to the high manufacturing costs of the steel platform structure, mooring and anchoring systems, as well as the electrical equipment and cabling required for offshore operation.
The second most significant cost component is operational expenditure (OPEX), reflecting the complexity of maintenance and inspection activities in offshore environments. Installation costs constitute the third largest contribution to the overall project budget, further highlighting the economic challenges associated with offshore solar deployments compared to land based photovoltaic systems.
Similarly, Table II presents the main financial indicators, including the LCOE, IRR and NPV, for the two electricity tariff scenarios analyzed.

Fig. 2. SeaVolt - Own elaboration.

Table I. Breakdown of costs for the 13.1 MW offshore solar farm with the SeaVolt platform.

Nomenclature	Total Cost	Total Cost per Installed MW
	€	M€/MW
C_1	4,708,228	0.358
C_2	496,800	0.038
C_3	32,138,799	2.446
C_4	11,686,177	0.889
C_5 (OPEX)	21,527,234	1.638
C_6	1,168,618	0.089
CAPEX	50,198,622 €	

Table II. LCOE, IRR and NPV values for a 13.1 MW offshore SeaVolt solar farm with two different electric tariffs (Canary Islands).

	LCOE (€/MWh)	IRR (%)	NPV (€)
Electric tariff 1: €0.1199/kWh	296.12	-8.11	-34,095,163.36
Electric tariff 2: €0.187375/kWh	290.61	-0.70	-19,546,423.02

The results indicate that the lowest and therefore most favorable LCOE values are observed under the higher electricity tariff scenario, which is consistent with expectations, as higher revenue per unit of energy naturally improves economic performance. However, in this particular case, the difference in LCOE between the two tariff levels is relatively modest.

Analysis of the financial indicators further reveals that both the IRR and the NPV are negative in both scenarios, indicating that, under the conditions considered, the offshore solar farm would not be economically viable. Despite this, the NPV is considerably less negative under the higher tariff scenario, highlighting the strong influence of electricity pricing on overall project economics. This suggests that revenue assumptions play a critical role in determining project feasibility and that optimization strategies, such as securing power purchase agreements at favorable rates or integrating additional revenue streams, could significantly improve the financial outlook.

Floating solar power in offshore environments is still in the early stages of development, although significant progress has been made in recent years in research aimed at assessing its technical and economic viability. In terms of costs, its LCOE remains high compared to other renewable technologies, with estimates around €354/MWh in recent periods, although a gradual decline to values close to €50/MWh is projected by 2030 [15], in line with technological maturation and the sector's expansion. By comparison, offshore wind energy is already more competitive, with average LCOE values close to

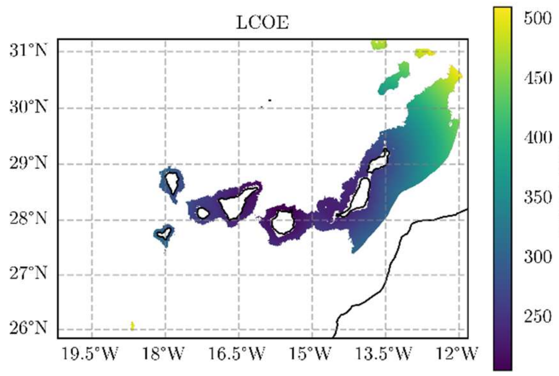

Fig 3. LCOE map for the Canary Islands for a 13.1 MW SeaVolt offshore wind farm.

€100/MWh in 2020 and projections of a reduction to approximately €30–40/MWh over the same time horizon [16]. However, floating wind power still has higher costs, exceeding $200/MWh compared to significantly lower figures for bottom-fixed installations [17], reflecting the nascent nature of these technologies and the current limitations in scale and supply chain development.

Although the estimated LCOE values may be considered in line with current technologies, the financial indicators obtained in this study (i.e., negative NPV and low IRR) indicate that the project is not economically viable under the assumptions considered. This apparent discrepancy is explained by the fact that the LCOE reflects only the unit cost of electricity generation, whereas NPV and IRR depend on additional factors such as the market price of electricity, revenue structure, financing terms, and initial investment. Consequently, a relatively low LCOE does not necessarily imply strong financial performance.

Moreover, these results emphasize the sensitivity of offshore solar projects to both capital and operational costs, as well as to policy or market incentives. While the base case assumptions result in unprofitable outcomes, targeted cost reductions in manufacturing, installation, or maintenance, coupled with strategic location selection to maximize solar irradiation, could potentially shift the project towards economic feasibility. Consequently, careful techno-economic planning remains essential for emerging offshore solar technologies, where high upfront expenditures must be balanced against expected energy production and market conditions.

Finally, Figure 3 presents an economic map of the LCOE across the Canary Islands. The mapped area takes into account the constraints established by the Spanish Maritime Spatial Planning (POEM/MSP), including factors such as fishing grounds, power and telecommunications cables, marine protected areas, the Natura 2000 network, biosphere reserves, as well as priority areas for biodiversity conservation and national defence. The blue areas on the map correspond to the lowest LCOE values, while the more yellowish regions indicate areas with higher LCOE values. The map clearly shows that LCOE tends to increase with distance from the coastline, which is consistent with the additional costs associated with mooring systems, submarine cabling, and other offshore infrastructure requirements. Nevertheless, areas close to the coast exhibit relatively low LCOE values, below 300 €/MWh, showing promising potential for an emerging technology such as offshore solar energy.

These results highlight the importance of site selection in optimizing the economic performance of marine photovoltaic systems. Proximity to shore reduces installation and operational expenditures, thereby improving the financial feasibility of the project. While costs are still higher than those of conventional land-based solar farms, the relatively low nearshore LCOE values demonstrate the potential of offshore solar as a competitive renewable energy option in the Canary Islands. This also suggests that early deployment could focus on nearshore locations to balance technical feasibility, economic efficiency and environmental considerations, serving as a stepping stone for future, larger scale offshore installations further from the coast.

On the other hand, the use of a 20-year useful life, in line with the reference values listed in the Tax Agency's table, represents a conservative approach compared to the longer time horizons typically assumed in photovoltaic projects. In economic terms, the project's duration directly influences financial indicators: a shorter operational period reduces cumulative cash flows, which tends to lower the NPV and IRR, while increasing the LCOE as the initial investment costs are spread over fewer years of generation. Also, the use of OPEX figures from offshore wind farms as a benchmark for offshore photovoltaic systems should be interpreted with caution, as the two technologies differ in their operation and maintenance requirements. While offshore wind power includes moving mechanical components that require more complex periodic maintenance, photovoltaic systems have fewer moving parts but are exposed to issues specific to the marine environment, such as corrosion, biofouling and the degradation of electrical and structural systems. In this context, the use of OPEX data from offshore wind is considered a preliminary approximation in the absence of specific data for offshore solar, introducing uncertainty into the results, and therefore, it should be understood as a conservative estimate.

5. Conclusions

In this study, the economic feasibility of an offshore solar farm based on SeaVolt platforms with a total capacity of 13.1 MW was evaluated. The results indicate that, while the LCOE values are consistent with those reported in the literature and suggest a competitive level of energy production costs, the NPV and IRR remain negative, indicating that the project is not yet economically viable under the current assumptions.

Despite these economic limitations, offshore solar energy emerges as a highly promising technology, particularly when considered as a complementary solution to offshore wind farms. Its integration could enhance the overall energy output and contribute to a cleaner, more sustainable energy transition.

The findings of this study provide valuable insights for stakeholders, policymakers, and investors interested in emerging marine renewable energy technologies. They highlight the importance of optimizing system design, reducing manufacturing and installation costs, and exploring supportive policy mechanisms or favorable electricity tariffs to improve economic feasibility. Future work should focus on cost reduction strategies, hybridization with other offshore energy systems, and site selection optimization to maximize both technical performance and financial viability. Overall, the study reinforces the potential of offshore solar as a key component of a diversified and sustainable renewable energy portfolio.

Acknowledgement

This research was partially funded by Project PID2024-161677OB-I00 "Tool for the strategic planning of energy storage from offshore renewable energy sources in Spain (SEAPLAN)", financed by Ministerio de Ciencia, Innovación y Universidades, Agencia Estatal de Investigación and Fondo Europeo de Desarrollo Regional (Proyecto PID2024-161677OB-I00 financiado por MICIU /AEI /10.13039/501100011033 / FEDER, UE).

This research was partially funded by Project 101181231 "Multi-disciplinary risk management for stable, safe, and sustainable offshore wind-powered hydrogen production" (WINDHY), financed by the European Commission under the Marie Skłodowska-Curie (MSCA) Staff Exchanges Actions of the Horizon Europe.

This study contributes to the international project 3E-Partnership (proposal number 101128576) funded with support from the European Commission under the Action ERASMUS-LS and the Topic ERASMUS-EDU-2023-CBHE-STRAND-2.

References

[1] Ramanan CJ, Lim KH, Kurnia JC, Roy S, Bora BJ, Medhi BJ. Towards sustainable power generation: Recent advancements in floating photovoltaic technologies. Renewable and Sustainable Energy Reviews 2024;194. https://doi.org/10.1016/j.rser.2024.114322.

[2] SolarPower Europe. Floating PV Best Practice Guidelines. 2023.

[3] Gao Q, Bechlenberg A, Jayawardhana B, Ertugrul N, Vakis AI, Ding B. Techno-economic assessment of offshore wind and hybrid wind–wave farms with energy storage systems. Renewable and Sustainable Energy Reviews 2024;192. https://doi.org/10.1016/j.rser.2023.114263.

[4] Castro-Santos L, Diaz-Casas V. Sensitivity analysis of floating offshore wind farms. Energy Convers Manag 2015;101:271–7. https://doi.org/10.1016/j.enconman.2015.05.032.

[5] Satymov R, Bogdanov D, Breyer C. Techno-economics of offshore wind power in global resolution. Appl Energy 2025;393. https://doi.org/10.1016/j.apenergy.2025.125980.

[6] Horwath S, Hassrick J, Grismala R, Diller E. Comparison of Environmental Effects from

Different Offshore Wind Turbine Foundations. 2020.
[7] Group WB, Program ESMA, Singapore SERI of. Where Sun Meets Water. Where Sun Meets Water 2019. https://doi.org/10.1596/32804.
[8] World Bank Group. Floating Solar Market Report. Where Sun Meets Water. 2019.
[9] Copernicus. ERA5 monthly averaged data on single levels from 1940 to present 2024.
[10] NREL. NREL's PVWatts® Calculator n.d. https://pvwatts.nrel.gov/ (accessed July 14, 2025).
[11] Goswami A, Sadhu P, Goswami U, Sadhu PK. Floating solar power plant for sustainable development: A techno-economic analysis. Environ Prog Sustain Energy 2019;38:e13268. https://doi.org/10.1002/ep.13268.
[12] Ioannou A, Angus A, Brennan F. Parametric CAPEX, OPEX, and LCOE expressions for offshore wind farms based on global deployment parameters. Energy Sources, Part B: Economics, Planning and Policy 2018;13:281–90. https://doi.org/10.1080/15567249.2018.1461150.
[13] IRENA. Renewable power generation costs in 2023. Abu Dhabi: 2024.
[14] Agencia Tributaria. Manual de actividades económicas. Obligaciones fiscales de empresarios y profesionales residentes en territorio español 2026. https://sede.agenciatributaria.gob.es/Sede/ayuda/manuales-videos-folletos/manuales-practicos/folleto-actividades-economicas/3-impuesto-sobre-renta-personas-fisicas/3_5-estimacion-directa-simplificada/3_5_4-tabla-amortizacion-simplificada.html (accessed April 8, 2026).
[15] Bellini E. Offshore floating PV may reach maturity in 2030. Pv Magazine 2020.
[16] Ministerio para la Transición Ecológica y el Reto Demográfico. Hoja de ruta eólica marina y energías del mar en España. 2021.
[17] International Renewable Energy Agency. Floating Offshore Wind Outlook. 2024.