

Floating solar photovoltaics in Greece. A SWOT analysis

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ABSTRACT: Floating solar photovoltaics is an emerging solar energy technology which allows the installation of solar photovoltaic systems on the surface of water bodies. It has several advantages and drawbacks compared to ground-mounted solar photovoltaics. There are many applications worldwide while the majority of them are located in Asia. Greece has abundant solar energy resources while many solar photovoltaic systems are installed on the ground and on rooftop of buildings. However, there are not currently installations of floating solar photovoltaics in the country. SWOT analysis is a strategic management tool which helps organizations to assess their internal capabilities and the external environment for making rational decisions for the future. The current study investigates the possibility of developing floating solar photovoltaic systems in Greece using SWOT analysis. The strengths, weaknesses, opportunities and threats in developing these innovative solar energy systems in Greece have been identified. Our results could facilitate the promotion of this emerging benign energy technology in Greece removing the existing barriers which hinder their deployment. The findings could be used from policy makers, local authorities and renewable energy companies which are involved in the development of renewable energy systems generating green electricity in the country.

KEYWORDS: electricity, floating solar photovoltaics, Greece, SWOT analysis

1. INTRODUCTION

The use of solar photovoltaic (Solar-PV) technology can assist the decarbonization of the global economy in the next decades. Apart from their installation on the ground and on rooftop of buildings they can be installed on the surface of water bodies avoiding the use of valuable land resources. Several studies have analyzed the advantages and drawbacks of the floating photovoltaic systems (FPV) systems compared with the corresponding ground-mounted systems [1], [2], [3]. Several FPV systems have been already installed worldwide while the majority of them operate in Asia countries [4], [5], [6]. Commercial FPV systems have not been reported in Greece so far although there are several water bodies which could be used for their installation [7], [8]. Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis is a strategic planning methodology which assists organizations and businesses to assess their internal capabilities and the external environment for the development of successful strategies for their future [9], [10], [11]. This methodology has been already used for the assessment of FPV systems [12], [13], [14]. SWOT analysis is currently used, combined with other similar tools, in many cases from businesses, countries and organizations [15], [16].

The aim of the current study is to investigate the development of floating solar photovoltaic systems in Greece using SWOT analysis.

The text is structured as follows: After the literature survey the floating solar photovoltaic technology is described and the SWOT methodology is analyzed. Next, the strengths, weaknesses, opportunities and threats of installing FPV systems in Greece are identified. The text ends with discussion of the findings, the conclusions drawn and the citation of the references used.

The text is innovative since there are no other studies related with SWOT analysis of installing FPV systems in Greece while it covers an existing gap regarding the deployment of FPV systems in the country. The results could be useful to policy makers, to local authorities, to water management organizations and to energy companies developing solar-PV systems.

2. LITERATURE SURVEY

The best practice guidelines of floating solar-PV systems have been reported (1). The study stated the sustainability aspects of FPVs and presented various applications of them. Several best practice examples in Europe are mentioned as well as the global perspectives of FPV systems. A literature review of FPV systems has been conducted (2). It is stated that global installations of FPV systems are projected to reach 10 GW by 2030 potentially generating 13.5 TWh of solar electricity annually. It is also mentioned that the levelized cost of electricity (LCOE) of FPV systems varies in the range of 0.05 to 0.07 \$/kWh making FPV systems increasingly competitive. A review of FPV plants has been published (3). It was stated that the global cumulative installed capacity was at 7.7 GW in 2023 while almost 90% of the installed FPV capacity is in Asia. It is mentioned that they face challenges



like regulatory barriers, cost competitiveness and uncertainties about environmental impacts and system reliability. The strategies for developing FPV systems in South Korea have been explored (4). It is stated that FPV systems have not reached a mature technological and institutional stage. It is also mentioned that the government should increase the support in FPV systems. The potential, the advantages and the challenges of FPV systems have been studied (5). It was stated that a capacity at 404 GW_p might be attained by using FPV systems covering only 1% of the world's water reservoirs. It is also mentioned that their effect on water quality and in aquatic ecosystems is not well known. The technical potential of FPV systems in USA using a novel geospatial method has been studied (6). It is stated that the potential FPV capacity is in the range 861 GW to 1,042 GW representing approximately half of the future USA solar generated electricity needed for a decarbonized grid. An assessment of the potential of installing FPV systems in existing water reservoirs in Greece has been conducted (7). It is stated that the nominal power of FPV systems installed in the existing 128 water reservoirs in Greece covering 10% to 30% of their surface varies between 4.77 GW_p to 14.31 GW_p while the annual generated electricity varies at 6,435.2 GWh to 19,305.6 GWh. The integration of FPV systems with hydropower plants in Greece has been studied (8). It is stated that the nominal power of FPV systems which can be installed in hydropower water dams covering 10% of their surface is at 3,861 MW_p generating 5,212.35 GWh annually. The SWOT analysis as a strategy to enhance competitiveness in organizations has been studied (9). The authors followed quantitative approach using interviews and literature survey. They stated that SWOT analysis should be re-evaluated using data from within and outside organizations. The role of SWOT analysis in enhancing business growth and sustainability has been explored (10). The authors stated that by examining every aspect of the four dimensions in SWOT analysis organizations will be provided with the necessary tools to evaluate their internal capabilities to adapt to the external world. The importance and performance of SWOT analysis have been examined (11). The authors stated that SWOT analysis has been criticized that it is likely to hold subjective views of the individuals who participate in brainstorming sessions. It is also mentioned that SWOT factors are not prioritized by their significance. The sustainability of FPV systems has been studied using SWOT-PESTEL analysis (12). The authors stated that FPV systems present a transformative approach to renewable energy generation. They mentioned that targeted policy support, technological innovation and environmental management are crucial for successful deployment of FPV systems. A SWOT analysis of FPV systems has been realized (13). The authors analyzed the current status and future directions of the technology using SWOT analysis. They stated that the technology is maturing while it has a high potential to meet global power demand. However, there are several challenges hindering its rapid development. A SWOT analysis of FPV plants has been implemented (14). It is stated that the future of FPV systems seems bright while the technology is technically feasible and economically viable. It is also mentioned that in the near future the surface of the water bodies associated with hydroelectric dams, pumped-hydro storage installations and cooling ponds of electric power plants will be totally covered with FPV systems. The organization of water resources management in Zakynthos Island, Greece using SWOT analysis has been studied (15). The authors stated that Zakynthos Island is solely depended on groundwater resources for its water supply. They proposed various measures in order to restore the negative water balance, to provide adequate water to consumers and to improve the water quality in the island. The bioenergy development in Kentucky, USA has been studied using SWOT analysis (16). The study was realized with the support of forest policy experts. The authors stated that the negative factors associated with bioenergy development in Kentucky were more important than the positive aspects. A review of economic feasibility of FPV systems has been published (17). It was stated that the LCOE of FPV systems varies considerably ranging from 28.47 €/MWh to 1,737 €/MWh depending on several parameters. A review of FPV systems has been conducted (18). It was stated that these systems have many advantages related with minimum land use, their modular design and the reduction in water evaporation. It was mentioned that the advances in their technology and the growing environmental awareness are going to promote their future development. A market research study regarding floating solar photovoltaics has been published (19). It is stated that the technical challenges associated with the long-term durability and sustainability of these systems are not yet fully understood. It is also mentioned that there are no official standards for FPV systems in the USA. A review of FPV systems has been implemented (20). It is stated that FPV systems can resolve issues related to land availability and lower environmental impacts. It is mentioned that there is huge untapped market potential of FPV systems in comparison with ground-mounted solar-PVs. The decarbonization potential of FPV systems on lakes has been studied (21). It is stated that with increasing land-use pressures water surfaces are exploited for the installation of FPV systems. It is mentioned that with a 10% surface water coverage FPV systems could produce sufficient energy to contribute a considerable fraction of the electricity demand in several countries. The current status of SWOT analysis has been explored (22). The authors stated that SWOT analysis is an appropriate tool for strategic planning

used not only from companies but from countries and industries as well. They mentioned the need for quantification since SWOT analysis does not indicate the weighting, ranking and prioritizing of variables. A literature review regarding the applications of SWOT analysis has been conducted (23). It is stated that SWOT analysis is an effective strategic tool that can be used efficiently to assess the strengths, weaknesses, opportunities and threats of businesses. It is also mentioned that the use of SWOT analysis in some fields is more common than in others.

3. FLOATING SOLAR PHOTOVOLTAICS: A SUSTAINABLE SOLUTION FOR CLEAN ENERGY GENERATION

Floating Solar Photovoltaics are solar power systems installed on floating structures that rest on water bodies such as reservoirs, lakes, ponds, and even coastal areas. As the global demand for renewable energy continues to rise, FPV technology has emerged as an innovative solution that addresses land scarcity while contributing to sustainable electricity generation. Over the past decade, floating solar installations have gained significant attention due to their environmental, economic, and technical advantages.

One of the primary benefits of floating solar systems is their efficient use of space. Conventional solar farms require large areas of land, which may compete with agriculture, urban development, or natural ecosystems. By utilizing the surface of existing water bodies, FPV systems eliminate the need for additional land acquisition and make productive use of otherwise underutilized areas. This feature is particularly valuable in densely populated regions where available land is limited and expensive. Another important advantage of FPV technology is its enhanced energy performance. Solar panels generally operate more efficiently at lower temperatures. The cooling effect provided by the surrounding water helps reduce the operating temperature of the photovoltaic modules, leading to higher electricity output compared to similar land-based installations. Studies have shown that floating solar systems can achieve energy gains of several percentage points due to this natural cooling mechanism. Floating solar installations also contribute positively to water resource management. The panels provide shade over the water surface, which reduces evaporation rates, especially in arid and semi-arid regions where water conservation is crucial. Additionally, the reduced sunlight penetration can limit the growth of algae and aquatic weeds, helping maintain water quality in reservoirs and other water storage facilities. Despite these benefits, FPV systems face several challenges. The initial installation costs are generally higher than those of conventional ground-mounted solar plants because of the specialized floating platforms, anchoring systems, and corrosion-resistant materials required. Moreover, the systems must withstand harsh environmental conditions such as strong winds, waves, and fluctuating water levels. Maintenance activities may also be more complex and require specialized equipment and expertise. Environmental considerations are another important aspect of floating solar development. While FPV systems can reduce evaporation and algae growth, excessive coverage of water surfaces may affect aquatic ecosystems by altering light penetration, oxygen levels, and habitat conditions. Therefore, careful planning, environmental impact assessments, and sustainable design practices are essential to ensure that floating solar projects do not negatively affect local biodiversity. Many countries, including China, India, Japan, South Korea, and several European nations, have invested heavily in floating solar projects. As technology advances and installation costs continue to decrease, FPV systems are expected to play an increasingly important role in the global transition toward clean and renewable energy sources.

Therefore, Floating Solar Photovoltaics represent a promising innovation in renewable energy technology. By generating electricity without consuming valuable land resources, improving solar panel efficiency, and supporting water conservation efforts, FPV systems offer multiple benefits for sustainable development. Although technical and environmental challenges remain, ongoing research and technological improvements are likely to make floating solar power a key component of future energy systems worldwide.

4. SWOT ANALYSIS: A STRATEGIC PLANNING TOOL

SWOT Analysis is a widely used strategic planning technique that helps organizations, businesses, projects, and even individuals evaluate their current position and make informed decisions for the future. The acronym SWOT stands for Strengths, Weaknesses, Opportunities, and Threats. By systematically examining these four elements, organizations can better understand their internal capabilities and external environment, enabling them to develop effective strategies for growth and success. The concept of SWOT analysis emerged in the 1960s and has since become one of the most popular management tools. It provides a simple yet powerful framework for assessing factors that can influence the achievement of objectives. The analysis is typically divided into two categories: internal factors, which include strengths and weaknesses, and external factors, which include opportunities and threats.

Strengths refer to the positive attributes and resources that give an organization a competitive advantage. These may include a strong brand reputation, skilled employees, advanced technology, financial stability, efficient operations, or a loyal customer base. Identifying strengths helps organizations understand what they do well and how they can leverage these advantages to achieve their goals.

Weaknesses are internal limitations or areas where improvement is needed. Examples include outdated technology, insufficient financial resources, lack of expertise, poor management practices, or low market recognition. Recognizing weaknesses is essential because it allows organizations to address shortcomings and reduce their negative impact on performance and competitiveness.

Opportunities are external factors that can contribute to growth and development. These may arise from market expansion, technological advancements, favorable government policies, changing consumer preferences, or emerging industry trends. Organizations that effectively identify and capitalize on opportunities can improve their market position and gain a competitive edge.

Threats are external challenges that may hinder success or create risks. These can include increasing competition, economic downturns, regulatory changes, technological disruptions, supply chain issues, or shifts in customer behavior. Understanding potential threats enables organizations to prepare contingency plans and minimize risks before they become significant problems.

One of the major advantages of SWOT analysis is its simplicity and versatility. It can be applied to businesses of all sizes, non-profit organizations, government agencies, academic institutions, and personal career planning. The framework encourages critical thinking and promotes a comprehensive understanding of both internal and external factors affecting performance. Additionally, SWOT analysis facilitates communication among stakeholders by providing a structured approach to discussing strategic issues. However, SWOT analysis also has certain limitations. The quality of the analysis depends heavily on the accuracy of the information collected and the objectivity of the participants involved. Oversimplification of complex issues can lead to incomplete conclusions, while subjective judgments may result in biased assessments. Therefore, SWOT analysis is often most effective when combined with other strategic planning tools and supported by reliable data. By evaluating strengths, weaknesses, opportunities, and threats, organizations can gain valuable insights into their current situation and identify pathways for future success. Although it has some limitations, its simplicity, flexibility, and effectiveness make it one of the most widely used frameworks in business and management. When conducted thoughtfully and supported by accurate information, SWOT analysis can significantly enhance strategic planning and improve long-term performance.

5. THE STRENGTHS OF INSTALLING FLOATING SOLAR PHOTOVOLTAICS IN GREECE

As countries around the world seek sustainable solutions to meet growing energy demands and combat climate change, renewable energy technologies have become increasingly important. Among these technologies, Floating Solar Photovoltaics have emerged as an innovative method of generating clean electricity. Greece, with its abundant solar radiation, numerous reservoirs, lakes, and water bodies, is particularly well positioned to benefit from the installation of floating solar photovoltaic systems.

One of the main strengths of FPV systems in Greece is their ability to maximize the country's exceptional solar potential. Greece enjoys more than 250 sunny days per year, making it one of the sunniest countries in Europe. By placing solar panels on water surfaces, the country can generate significant amounts of renewable electricity without requiring additional land resources. This is especially valuable in regions where land is needed for agriculture, tourism, or urban development. Another major advantage is the efficient use of underutilized water surfaces. Greece possesses numerous artificial reservoirs associated with hydroelectric dams, irrigation systems, and water supply infrastructure. Installing floating solar panels on these reservoirs allows energy production without disrupting existing land uses. This dual use of infrastructure increases the overall productivity of public assets and reduces potential conflicts over land allocation. FPV systems also offer higher energy efficiency compared to conventional ground-mounted installations. The cooling effect of water helps reduce the operating temperature of photovoltaic panels. Since solar panels perform better at lower temperatures, FPV installations can achieve higher electricity yields. This increased efficiency is particularly important in Greece, where summer temperatures can become very high and negatively affect the performance of traditional solar systems. In addition, FPV installations contribute to water conservation. The panels partially cover the water surface, reducing evaporation rates. This benefit is particularly relevant for Greece, which frequently experiences drought conditions and water scarcity, especially on islands and in southern regions. By decreasing water loss from reservoirs, FPV systems can support more sustainable water management practices while simultaneously producing clean energy. FPV projects can also complement Greece's



existing renewable energy infrastructure. Many reservoirs are already connected to the electrical grid through hydroelectric facilities. As a result, FPV systems can often utilize existing transmission infrastructure, reducing installation costs and simplifying grid integration. Furthermore, combining hydropower and floating solar generation can improve energy reliability and provide a more stable electricity supply. From an environmental perspective, FPV systems help reduce greenhouse gas emissions and support Greece's transition toward a low-carbon economy. By replacing fossil-fuel-based electricity generation, FPV systems contribute to national and European climate targets. They can also strengthen the country's energy security by reducing dependence on imported fuels and enhancing domestic renewable energy production.

Therefore, floating solar photovoltaics offer numerous advantages for Greece. Their ability to utilize abundant solar resources, conserve land and water, improve energy efficiency, integrate with existing infrastructure, and support environmental goals makes them a highly attractive renewable energy solution. As Greece continues its transition toward a sustainable energy future, the deployment of FPV systems could play a significant role in achieving long-term economic, environmental, and energy security benefits. The strengths in installing floating solar photovoltaic systems in Greece are presented in Table 1.

Table 1. Strengths in installing floating solar photovoltaic systems in Greece

1	FPV systems in Greece can maximize the country's high solar potential.
2	FPV systems promote the use of underutilized water surfaces.
3	FPV systems offer higher energy efficiency compared to conventional ground-mounted installations.
4	FPV installations contribute to water conservation.
5	FPV systems can complement Greece's existing renewable energy infrastructure.
6	FPV systems help reduce greenhouse gas emissions and support Greece's transition toward a low-carbon economy.
7	FPV systems can often utilize existing transmission infrastructure when installed in hydropower dams.

Source: own estimations

6. THE WEAKNESSES OF INSTALLING FLOATING SOLAR PHOTOVOLTAICS IN GREECE

Floating Solar Photovoltaic systems have attracted considerable attention as an innovative renewable energy technology capable of generating electricity while utilizing water surfaces. Although Greece possesses favorable climatic conditions and abundant solar energy resources, the large-scale deployment of floating solar photovoltaics is not without challenges. Several technical, economic, environmental, and regulatory weaknesses must be carefully considered before widespread implementation can occur.

One of the primary weaknesses of FPV installations in Greece is their relatively high initial investment cost. Compared to conventional ground-mounted solar photovoltaic systems, FPV projects require specialized floating structures, anchoring systems, corrosion-resistant materials, and additional engineering studies. These components increase both installation and maintenance expenses. For a country that continues to face financial constraints and seeks cost-effective energy solutions, the higher capital requirements may limit the attractiveness of FPV projects for investors and public authorities. Another significant challenge is the harsh marine and climatic environment found in many parts of Greece. The country has an extensive coastline and thousands of islands that experience strong winds, waves, saltwater exposure, and occasional extreme weather events. Saltwater corrosion can damage metal components and electrical equipment, reducing system lifespan and increasing water pollution and maintenance costs. Although FPV systems can be installed on freshwater reservoirs, suitable sites may be limited in some regions, restricting deployment opportunities. Environmental concerns also represent an important weakness. While FPV systems are generally considered environmentally friendly, they may affect aquatic ecosystems if not properly designed and managed. Large-scale coverage of water surfaces can reduce sunlight penetration, potentially impacting aquatic plants, algae, and fish populations. Changes in water temperature and oxygen levels may alter ecosystem dynamics. Given Greece's rich biodiversity and the ecological importance of many lakes and reservoirs, environmental assessments are necessary to prevent unintended ecological consequences. Land availability, often cited as a major advantage of FPV technology, may be less critical in Greece than in densely populated countries. Many regions of Greece still possess suitable land areas for conventional solar farms, particularly in rural locations. Ground-mounted photovoltaic systems are generally less complex, more mature, and less expensive than floating alternatives. As a result, FPV systems may not always provide sufficient additional benefits to justify its higher costs. Regulatory and administrative



barriers also present obstacles. Floating solar technology is relatively new, and Greece's legal and permitting framework is still evolving to accommodate such projects. Developers may face uncertainty regarding licensing procedures, environmental approvals, water-use rights, and responsibilities among different governmental agencies. These administrative complexities can delay project implementation and discourage investment. Furthermore, maintenance and operational challenges must be considered. Accessing floating installations for inspection, cleaning, and repair is often more difficult than servicing land-based systems. Specialized equipment and trained personnel may be required, increasing operational costs over time. In remote island regions, these logistical difficulties may become even more pronounced.

Therefore, although floating solar photovoltaics offer promising opportunities for renewable energy generation in Greece, several weaknesses must be addressed. Higher installation costs, exposure to challenging environmental conditions, potential ecological impacts, regulatory uncertainties, and maintenance complexities may limit their widespread adoption. Consequently, careful planning, thorough environmental assessments, supportive policies, and technological improvements will be essential to ensure that FPV systems contribute effectively and sustainably to Greece's renewable energy transition. The weaknesses in installing floating solar photovoltaic systems in Greece are presented in Table 2.

Table 2. Weaknesses in installing floating solar photovoltaic systems in Greece

1	FPV systems have relatively high initial investment cost.
2	Although FPV systems can be installed on freshwater reservoirs, suitable sites may be limited in some regions, restricting deployment opportunities.
3	Offshore FPV systems face harsh marine and climatic environment.
4	FPV systems may affect aquatic ecosystems and water quality if not properly designed and managed.
5	Land availability, may be less critical in Greece than in densely populated countries. As a result, FPV systems may not always provide sufficient additional benefits to justify its higher costs.
6	Developers may face uncertainty regarding licensing procedures, environmental approvals, water-use rights, and responsibilities among different governmental agencies.
7	Accessing FPV installations for inspection, cleaning, and repair is often more difficult than servicing land-based systems.

Source: own estimations

7. THE OPPORTUNITIES OF INSTALLING FLOATING SOLAR PHOTOVOLTAICS IN GREECE

The transition to renewable energy has become a central objective for countries seeking to reduce greenhouse gas emissions, strengthen energy security, and achieve sustainable economic growth. Among the emerging renewable energy technologies, FPV systems have gained significant attention due to their ability to generate clean electricity while utilizing water surfaces. For Greece, a country with abundant sunshine and numerous reservoirs, lakes, and water infrastructure facilities, FPV systems present a wide range of opportunities that can contribute to both national development and environmental sustainability.

One of the most significant opportunities offered by floating solar photovoltaics is the expansion of renewable energy capacity without competing for valuable land resources. Greece has experienced increasing demand for land to support agriculture, tourism, urban development, and conventional solar farms. By utilizing reservoirs and other water bodies, FPV installations can generate substantial amounts of electricity while preserving land for other productive activities. This creates new possibilities for renewable energy expansion without causing conflicts over land use. Another important opportunity is the enhancement of Greece's energy security. The country has historically relied on imported fossil fuels to meet part of its energy needs, making it vulnerable to fluctuations in international energy prices and geopolitical uncertainties. FPV systems can increase domestic electricity production from renewable energy sources, reducing dependence on energy imports and strengthening national energy independence. This is particularly important as Europe continues to pursue energy diversification and resilience. FPV technology also creates opportunities for the modernization of existing water and energy infrastructure. Many Greek reservoirs are already associated with hydroelectric power plants and grid connections. Installing floating solar panels on these reservoirs allows the development of hybrid renewable energy systems that combine solar and hydropower generation. Such systems can improve energy reliability, optimize grid utilization, and support more stable electricity production throughout the year. Water conservation represents another valuable



opportunity. Greece frequently faces periods of drought and water scarcity, especially in southern regions and on islands. Floating solar panels reduce the amount of direct sunlight reaching the water surface, thereby decreasing evaporation rates. This can help preserve water resources used for drinking water, irrigation, and hydropower generation. The simultaneous production of clean energy and conservation of water resources provides a unique environmental benefit that is particularly relevant to Greece's climatic conditions. The growth of FPV projects can also stimulate economic development and job creation. The planning, design, installation, operation, and maintenance of floating solar facilities require skilled engineers, technicians, environmental specialists, and construction workers. As the industry develops, new employment opportunities may emerge, supporting local economies and fostering technological expertise within Greece. Furthermore, successful FPV projects could position Greece as a regional leader in innovative renewable energy technologies within the Mediterranean region. In addition, floating solar photovoltaics can support Greece's commitments to international climate and sustainability goals. Increased renewable energy generation contributes to reducing carbon emissions and helps the country meet European Union targets for clean energy deployment. Access to European funding mechanisms and green investment programs may further accelerate FPV development and reduce financial barriers to implementation.

Therefore, the installation of floating solar photovoltaics in Greece presents numerous opportunities. These include expanding renewable energy capacity without using additional land, enhancing energy security, conserving water resources, modernizing infrastructure, creating jobs, and supporting climate objectives. By capitalizing on its abundant solar energy resources and available water surfaces, Greece has the potential to become a pioneer in FPV technology and strengthen its transition toward a more sustainable and resilient energy future. The opportunities in installing floating solar photovoltaic systems in Greece are presented in Table 3.

Table 3. Opportunities in installing floating solar photovoltaic systems in Greece

1	FPV systems expand renewable energy capacity without competing for valuable land resources.
2	FPV systems enhance Greece's energy security.
3	FPV systems modernize the existing water and energy infrastructure.
4	Floating solar panels reduce the amount of direct sunlight reaching the water surface, thereby decreasing evaporation rates.
5	FPV projects can stimulate economic development and job creation.
6	FPV systems can support Greece's commitments to international climate and sustainability goals.

Source: own estimations

8. THE THREATS OF INSTALLING FLOATING SOLAR PHOTOVOLTAIC SYSTEMS IN GREECE

Floating Solar Photovoltaic technology is increasingly recognized as a promising solution for expanding renewable energy generation while minimizing land use. Despite its potential benefits, the successful deployment of FPV systems in Greece faces several external threats that could hinder their development, economic viability, and long-term sustainability. These threats arise from environmental, economic, regulatory, technological, and social factors that may affect the future growth of FPV projects across the country.

One of the most significant threats is the increasing impact of climate change and extreme weather events. Although FPV systems are designed to withstand varying environmental conditions, Greece has experienced more frequent heatwaves, storms, floods, and strong winds in recent years. Severe weather can damage floating structures, anchoring systems, and electrical equipment, leading to costly repairs and interruptions in electricity production. In coastal and islandic areas, strong winds and rough water conditions may pose additional risks to the structural integrity of floating solar installations. Another important threat is regulatory and policy uncertainty. Renewable energy projects often depend on stable government policies, licensing procedures, and financial incentives. Changes in energy regulations, delays in permitting processes, or reductions in public support programs could discourage investment in FPV technology. Since FPV systems is still a relatively new sector in Greece, the absence of a fully developed legal framework may create uncertainty for developers and financial institutions considering long-term investments. Economic and financial risks also represent a considerable threat. FPV projects generally require higher initial investments than conventional ground-mounted solar systems. Rising interest rates, inflation, fluctuations in material prices, and supply chain disruptions could increase project



costs and reduce profitability. Furthermore, competition from other renewable energy technologies, such as onshore wind farms and traditional photovoltaic parks, may limit investor interest in floating solar projects if alternative technologies offer lower costs and faster returns. Environmental opposition and public resistance constitute another potential threat. Although FPV systems contribute to clean energy production, concerns may arise regarding their impact on aquatic ecosystems, water quality, fisheries, biodiversity, and landscape aesthetics. Local communities, environmental organizations, or tourism stakeholders may oppose projects if they believe water bodies will be negatively affected. Given the importance of tourism and environmental conservation to the Greek economy, public acceptance will be a critical factor in the success of future FPV developments. Technological dependence presents an additional challenge. Greece currently relies heavily on imported solar panels, floating platforms, and specialized equipment from international suppliers. Global supply chain disruptions, geopolitical tensions, or trade restrictions could increase costs and delay project implementation. Dependence on foreign technology may also limit the growth of a domestic FPV manufacturing sector and reduce the economic benefits retained within the country. Finally, competition for water resources may become increasingly important in the future. Reservoirs and lakes serve multiple functions, including water supply, irrigation, recreation, and hydropower generation. As climate change intensifies water scarcity in many regions of Greece, conflicts may emerge among different users regarding the allocation and management of water bodies. Such conflicts could restrict the availability of suitable locations for floating solar installations.

Therefore, while floating solar photovoltaics offer considerable promise for Greece's renewable energy transition, several external threats could affect their development. Extreme weather events, policy uncertainty, financial risks, environmental concerns, technological dependence, and competing demands for water resources all represent significant challenges. Addressing these threats through careful planning, supportive regulations, technological innovation, and stakeholder engagement will be essential for ensuring the long-term success of floating solar energy projects in Greece. The threats in installing floating solar photovoltaic systems in Greece are presented in Table 4.

Table 4. Threats in installing floating solar photovoltaic systems in Greece

1	Climate change and extreme weather events can damage floating structures, anchoring systems, and electrical equipment.
2	The absence of a fully developed legal framework may create uncertainty for developers and financial institutions considering long-term investments.
3	FPV projects generally require higher initial investments than conventional ground-mounted solar-PV systems.
4	Environmental opposition and public resistance may delay FPV projects. Public acceptance will be a critical factor in the success of future FPV developments.
5	Technological dependence presents an additional challenge. Global supply chain disruptions, geopolitical tensions, or trade restrictions could increase costs and delay project implementation.
6	Competition for water resources may become increasingly important in the future. Conflicts may emerge among different users regarding the allocation and management of water bodies.

Source: own estimations

9. DISCUSSION

A SWOT analysis regarding the development of FPV systems in Greece has been conducted. Greece is a country with abundant solar energy resources and many on-shore water bodies which could be used for installation of FPV systems. At the same time climate change is expected to reduce the availability of water resources in the future in the country. The strengths, weaknesses, opportunities and threats related with their development have been indicated and analyzed. The higher installation and maintenance cost compared to ground-mounted solar-PV systems, the lack of appropriate legal framework regarding their use, the unknown impacts on water quality and on aquatic organisms, the acceptance of these projects by local communities and the uncertainty regarding water use rights are important obstacles hindering their development in Greece. The exploitation of underutilized water surfaces, the maximization of the high solar potential in the country, the enhancement of Greece's energy security, the saving of valuable land resources and the stimulation of local development are the main advantages related to the growth of FPV systems in



Greece. The limitations of our study are related with the subjective view of the results, the lack of quantitative assessment and the absence of prioritizing the factors that affect the deployment of FPV systems in Greece. It is recommended that future work should be focused in the realization of a PESTEL analysis regarding the deployment of FPV systems in the country.

10. CONCLUSIONS

The possibility of developing floating solar photovoltaics in Greece using SWOT analysis has been explored. The findings can be summarized as follows.

- a) The main strengths are related with the fact that FPV systems offer higher energy efficiency compared to conventional ground-mounted installations while they promote the use of underutilized water surfaces and contribute to water conservation.
- b) The main weaknesses are related with the fact that FPV systems have relatively high initial investment and maintenance cost while they may face uncertainty regarding licensing procedures, environmental approvals, water-use rights, and responsibilities among different governmental agencies.
- c) The main opportunities are related with the fact that FPV systems expand renewable energy capacity without competing for valuable land resources while they enhance Greece's energy security and stimulate economic development and job creation.
- d) The main threats are related with the fact that FPV projects generally require higher initial investments compared to conventional ground-mounted solar-PV systems and with absence of a fully developed legal framework which may create uncertainty for developers and financial institutions considering long-term investments.

The main take away of the current study is the fact that FPV systems is an emerging renewable energy technology which can support in the near future Greece's commitments to international climate and sustainability goals.

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