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Use of Renewable Energy Sources for Water Desalination in Crete, Greece: A PESTEL analysis

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Abstract
The increasing water scarcity in many countries requires the development of new sources for water production. Water desalination with reverse osmosis consists of a method producing potable water with increasing applications in many countries. Although it is energy intensive technology the current advances in membranes' technology have decreased the energy consumption and the production cost of the desalinated water. Although fossil fuels are the main fuels used in water desalination plants the use of solar and wind electricity is a challenging option particularly in areas with high solar and wind energy potential. The island of Crete, Greece is foreseen to face water shortages in the future for several reasons while it has abundant solar and wind energy resources. Sea water desalination using membranes technology powered by solar and wind electricity is an attractive option for Crete to cope with water scarcity in the future. Although there are several challenges a PESTEL analysis indicates that the external environment favors the development of water desalination plants in Crete powered by solar and wind electricity. Our results could be useful to policy makers, to municipalities, to water management authorities and to agricultural unions in the island which depend on water resources.

Keywords: Crete-Greece, PESTEL Analysis, Renewable Energies, Reverse Osmosis, Water Desalination

1. Introduction
Water shortages are common in Mediterranean islands which are exacerbated by climate change. The island of Crete, Greece is self-sufficient in water resources under normal meteorological conditions [1, 2]. However, the inadequate management of the existing water resources, the growing water demand in the expanding tourism industry and the decrease of annual precipitation due to climate change result in water deficit in the island. Sea water desalination consists of a potable water production method which isenergy intensive [3, 4, 5, 6]. Water desalination plants using reverse osmosis technology can be powered with renewable energies such as solar and wind energy which are abundant in Crete [7, 8, 9, 10]. PESTLE analysis is a methodological tool which explores the external environment of an organization facilitating the decision making process [11, 12, 13].
The aim of the current work is toconduct a PESTEL analysis regarding the use of renewable energies for water desalination in Crete, Greece.
The text is structured as follows: After the literature survey the water resources in Crete are mentioned followed by a section regarding the water desalination technologies. In the next sections the development of renewable energies in Crete is stated followed be description of the PESTEL methodology and the implementation of a PESTEL analysis regarding the use of renewable energies for water desalination in Crete. 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 limited studies so far regarding the use of renewable energies in water desalination in Crete while it fills a gap regarding a PESTEL analysis on this topic. The results could be useful to policy makers, to water management authorities and to local oranizations and cooperatives which depend on this essential resource.

2. Literature survey
The sustainable management of water resources in Crete has been studied [1]. The authors stated that Crete with annual precipitation at 967 mm is water sufficient. They also stated that agriculture is the main water user (78% of total water use)

followed by domestic use (21%). The management of water resources in Crete has been studied [2]. The authors stated that the island of Crete has limited water resources and growing water demand. They also mentioned that the lack of cooperation among Crete's several water authorities does not facilitate the effective management of the water resources in the island. The reverse osmosis desalination has been examined [3]. The authors stated that novel high-permeability membranes reduce the energy consumption in reverse osmosis desalination while large-scale reverse osmosis desalination plants are economically feasible. They also mentioned that the use of renewable energies in reverse osmosis desalination plants reduce the GHG emissions by 90%. The seawater desalination with reverse osmosis has been analyzed [4]. The author stated that seawater desalination with reverse osmosis is one of the most important technologies in water desalination. He also mentioned that large scale reverse osmosis desalination plants are operating nowadays while the price of desalinated water is affordable. The water desalination technologies have been reviewed [5]. The authors stated the commercial water desalination processes such as reverse osmosis, multi-stages flash desalination and multi-effect distillation. They also mentioned the current research regarding the use of renewable energies in water desalination plants. The energy consumption the GHG emissions and the cost of sea water desalination in China have been investigated [6]. The authors stated that reverse osmosis is the major process used for sea water desalination in China. They also mentioned that the unit cost of the desalinated sea water is higher than other water supply alternatives while the cost of desalinated water with reverse osmosis is estimated at 0.96 $\$/M^3$. The seawater desalination in Crete using reverse osmosis powered by wind energy systems has been studied [7]. The author stated that producing 20% of the potable water demand in Crete requires 114.84 GWh/year which correspond at 3.83% of the annual electricity consumption in the island. The reverse osmosis water desalination driven by wind and solar-PV energy has been studied [8]. The authors stated that renewable energies have not been used to drive large desalination plants except with grid connection. They mentioned that direct coupling of the reverse osmosis plants with renewable energies requires variable-speed operation or/and modular operation to match the load to the variable power. The seawater desalination in Crete using reverse osmosis powered by solar-PV electricity has been examined [9]. The author estimated that powering reverse osmosis desalination plants to meet 20% of Crete's annual potable water demand would require solar photovoltaic systems with nominal power at 76.56 MW_p. The water desalination systems integrated with renewable energies have been reviewed [10]. The authors stated that desalination seems to be one of the most promising solutions to water scarcity. They also mentioned that the integration of renewable energies into water desalination systems has become increasingly attractive due to growing demand of water and energy and the low-carbon footprint of these systems. A PESTLE analysis to compare desalination technologies using renewable energies in Saudi Arabia has been conducted [11]. The authors stated that desalination with reverse osmosis using renewable energies has many benefits in terms of human health, ecosystems quality and low GHG emissions. The PESTLE methodology has been explored [12]. The authors examined all the parameters used in PESTLE analysis stating that the external macro environment is equally important as the micro environment. The PESTEL framework has been analyzed [13]. The author stated that despite its popularity the PESTEL framework faces criticism as a simplified method lacking analytical depth. This methodology is adopted in domains such as energy and sustainability policy while it is often combined with SWOT analysis and multi-criteria decision making. The water desalination powered be renewable energies in islandic communities in Greece has been studied [14]. The authors stated that water and energy security are top priorities in Greece. They also mentioned that water supply in Greek islands in the future is expected to be provided by water desalination plants powered by solar and wind energy systems. The desalination potential in Greek islands using renewable energies has been reviewed [15]. The author stated that the current cost of transporting water to Greek islands with water deficit is high. He mentioned that sea water desalination using the rich solar and wind energy potential of the Greek islands is a challenging prospect. A report regarding the water desalination using renewable energies has been published [16]. It is stated that only 1% of the total desalinated water is based on renewable energies. It is also mentioned that desalination is an energy intensive process while there are two broad categories of desalination technologies including thermal desalination and membranes' desalination. The use of renewable energies in a sea water desalination plant using reverse osmosis has been assessed [17]. The authors estimated that 15% of the energy consumption in a large water desalination plant with reverse osmosis can be covered with renewable energies**.** The integration of wind energy with desalination systems has been reviewed [18]. The authors stated that wind energy can satisfy the high energy consumption of desalination plants reducing their cost and their carbon emissions. However, the mismatch between the intermittent availability of the wind energy and the power demand in the desalination plants makes the integration of these two technologies difficult. The trends in wind-power desalination for water supply have been studied [19]. The authors stated that there is an increasing number of patents combining wind power with reverse osmosis desalination while China is the leading country in this field. The wind-powered desalination on islands has been reviewed [20]. The authors stated that an increasing number of papers each year are dealing with wind-powered desalination systems. The use of solar and wind energy in water desalination systems in Egypt has been studied [21]. The authors stated that the cost of desalinated water using a solar-PV system is at 0.08 $\$/M^3$ while its cost using a wind power system is at 0.19 $\$/M^3$. The use of hybrid renewable energy systems in water desalination has been examined [22]. The authors stated that in some cases concentrated solar power can be used for thermal desalination and solar-PV electricity for membranes' desalination. However, they mentioned the most important problem in using renewable energies in water desalination systems is their unsteady nature. The PEST methodology has been analyzed [23]. The author stated that PEST analysis is useful in practice exploring the external environment facing an organization. He mentioned that the successful implementation of a PEST analysis requires the consideration of its systemic aspects. The use of water desalination to reduce water scarcity in developing countries has been explored [24]. The authors stated that current studies indicate that by 2050 2 billion people will likely suffer from water scarcity of which 95% may live in developing countries. They mentioned that membrane-based desalination technology is expected to supply water in most of the water-scarce countries.

3. The water resources in Crete

Crete, the largest island of Greece, faces a complex water economy shaped by its Mediterranean climate, geography, and socioeconomic development. The island experiences long, dry summers and mild, wet winters, with rainfall distributed unevenly across regions. Western Crete receives significantly more precipitation than the eastern part, creating disparities in water availability. Seasonal and spatial variability, combined with rising temperatures and reduced rainfall linked to climate change, have intensified concerns about water security.Agriculture is the dominant consumer of water on the island. Crete is a leading producer of olives, citrus, grapes, and vegetables, much of which is destined for export. This agricultural dependence has encouraged intensive irrigation practices, often leading to over-extraction of groundwater resources. In coastal areas, this has resulted in seawater intrusion into aquifers, reducing water quality and threatening long-term sustainability.

Tourism, a cornerstone of Crete's economy, adds another dimension to the water challenge. Millions of visitors arrive annually, particularly in the dry season, placing additional demand on already stressed supplies. Hotels, resorts, and recreational facilities require significant volumes of water, often in direct competition with agricultural needs.To address these pressures, local authorities and researchers have promoted water-saving technologies and policies. These include the expansion of modern irrigation systems, the reduction of water losses in urban water distribution systems, investment in desalination plants, and the reuse of treated wastewater. Efforts are also being made to improve water governance through integrated management strategies that balance agricultural, urban, and environmental needs.Despite these initiatives, the water economy of Crete remains under strain. Sustainable solutions require continued investment, public awareness, and adaptation to climate variability. Balancing the competing demands of agriculture, tourism and local communities will be central to ensuring the island's long-term water resilience.

Table 1: Use of water resources in Crete

Sector	Annual water consumption (%)	Annual water consumption (mil. M^3)	Annual water consumption per capita (M^3 per capita)
Agriculture	78.3	478.4	753.5
Domestic uses	20.9	127.6	201.0
Others	0.8	4.9	7.7
Total	100	610.9	962.2

Source: [1]

4. Water desalination technologies and the role of reverse osmosis

Water desalination has become a vital solution to global water scarcity, particularly in arid regions where natural freshwater sources are limited. The process involves removing salts and impurities from seawater or brackish water to produce potable water. Over the years, several desalination technologies have been developed, each with its own advantages, limitations and applications. Among these, reverse osmosis (RO) has emerged as the most widely adopted method due to its efficiency and cost-effectiveness. Desalination technologies can broadly be categorized into thermal processes and membrane processes. Thermal methods, such as multi-stage flash (MSF) and multi-effect distillation (MED), rely on heating seawater to produce vapor that condenses into freshwater. These methods are robust and capable of handling high salinity levels but are energy-intensive, often powered by fossil fuels and thus less sustainable. In contrast, membrane-based methods, particularly RO, depend on filtration through semi-permeable membranes, requiring significantly less thermal energy and offering greater flexibility in plant size and location. Reverse osmosis technology works by applying high pressure to saline water, forcing it through a semi-permeable membrane that blocks dissolved salts and other impurities while allowing pure water molecules to pass through. The result is high-quality freshwater suitable for domestic, agricultural and industrial uses. RO systems are highly efficient, producing up to 45–50% freshwater recovery in seawater applications and even higher recovery rates with brackish water. The advantages of RO include lower energy consumption compared to thermal processes, modular scalability and continuously improving membrane technology, which enhances efficiency and reduces costs. Additionally, RO plants can be integrated with renewable energy sources, such as solar and wind energy, to further minimize their environmental footprint. However, challenges remain, including membrane fouling, the need for pre-treatment of feed water and the disposal of concentrated brine, which can negatively impact marine ecosystems. Today, RO accounts for more than 60% of global desalination capacity, underscoring its dominance in the sector. Continuous research focuses on improving membrane durability, reducing operational costs and developing environmentally friendly brine management solutions. Therefore, while multiple desalination technologies exist, reverse osmosis stands out as the leading approach for sustainable freshwater production. Its combination of efficiency, adaptability and compatibility with renewable energies makes it a cornerstone of future water security strategies worldwide.

Table 2: The main water desalination technologies

S. No	Technology	Energy use in water desalination
1	Reverse osmosis	Electricity
2	Multi-Stage Flash Distillation	Heat
3	Multi-Effect Distillation	Heat
4	Electro dialysis	Electricity
5	Vapor Compression Distillation	Heat or electricity

Source: Own estimations

Table 3: Advantages and drawbacks of reverse osmosis water desalination technology

Advantages	Drawbacks
Only electricity is required	Lower water quality
Low investments	High cost for membranes and chemicals
Can be combined with renewable energies	Subject to biofouling
Modular structure of the plant	

Source: [5]

Table 4: Share of renewable energies in desalination systems powered by renewable energies worldwide

Renewable energy source	Share of renewable energy in desalination systems powered by renewable energies worldwide (%)
Solar electricity	43
Solar thermal energy	27
Wind electricity	20
Other	10
Total	100

Source: [10]

5. The growth of renewable energies in Crete

Crete, the largest Greek island, has become a focal point for renewable energy development due to its unique geographic and climatic conditions. With abundant sunshine, strong winds, and significant geothermal potential, the island possesses natural advantages that make it well-suited for sustainable energy production. In recent decades, Crete has invested in renewable technologies to reduce dependence on imported fossil fuels, lower greenhouse gas emissions, and strengthen its energy security. Solar energy is one of the most prominent resources. Crete enjoys over 300 days of sunshine annually, enabling extensive use of photovoltaic panels and solar thermal systems. These installations supply both households and businesses, significantly contributing to the island's energy mix. Wind power is also well developed, as Crete's mountainous terrain and coastal areas provide consistent wind flows. Wind farms have been established across the island, with capacity steadily increasing over the past two decades. Geothermal and biomass energy remain less exploited but hold promising potential for future expansion. Pilot projects in geothermal energy are under study, particularly in eastern Crete, while biomass initiatives support local agriculture and waste management. Despite these advances, challenges remain. Crete's isolated grid limits the full utilization of renewable energy resources, sometimes leading to curtailment of excess energy. To address this, Greece is developing interconnection projects linking Crete to the mainland, which will enhance stability and allow for greater renewable energies integration. Overall, the development of renewable energies in Crete reflects both opportunity and challenge. The island has made substantial progress in harnessing its natural resources, positioning itself as a leader in sustainable energy development within the Mediterranean. Continued investments, grid modernization, and supportive policies will be crucial for realizing Crete's full renewable energy potential and contributing to Greece's broader energy transition.

Table 5: Electricity generation from wind farms and solar photovoltaics in Crete (2018)

Parameter	Value	%
Annual electricity generation	3,043 GWh	100%
Total installed power of wind farms	200.3 MW	
Total installed power of solar-PV systems	95.5 MW	
Total installed power of hydroelectric plants	0.6 MW	
Annual electricity generation from thermo-electric plants	2,398 GWh	78.80%
Annual electricity generation from renewable energy systems	645 GWh	21.20%
Total installed power in Crete	1,121 MW	

Source: Own estimations

6. PESTEL analysis: A strategic framework in decision making

PESTEL analysis is a widely used strategic tool that helps organizations evaluate external factors influencing their operations and long-term decision-making. The acronym stands for Political, Economic, Social, Technological, Environmental, and Legal dimensions, each representing a crucial aspect of the macro-environment that shapes organizations' performance. The political dimension refers to government stability, trade policies, taxation, and regulations that can affect organizations' operations. Political decisions influence market entry, investment opportunities, and the cost of compliance. The economic factor considers issues such as inflation, interest rates, exchange rates and overall economic growth, all of which directly impact demand, profitability, and investment strategies. The social element examines demographics, cultural norms, education levels and consumer lifestyles. These factors shape market trends, consumer preferences and workforce dynamics. The technological dimension focuses on innovation, automation, digitalization and research advancements that can either provide competitive advantages or disrupt existing industries. The environmental component has gained importance in recent years, covering sustainability, climate change and resource management. Organizations must adapt to growing pressures for eco-friendly practices. Finally, the legal factor addresses laws regarding labor, competition, health, safety and intellectual property. Legal compliance is essential for avoiding disputes and maintaining reputation. PESTEL analysis is valuable because it provides a holistic perspective on external opportunities and threats. It allows organizations to anticipate changes, adapt strategies and remain competitive in dynamic environments. Therefore, PESTEL analysis is an essential tool for strategic planning. By systematically examining macro-environmental forces, organizations can make informed decisions, manage risks effectively and align their strategies with long-term sustainability and growth.

7. PESTEL analysis regarding the use of renewable energies in water desalination by reverse osmosis in Crete

Renewable-energy-powered reverse osmosis desalination offers a sustainable solution, but its complexity requires careful strategic assessment. A PESTEL framework helps assess its feasibility. Applying a PESTEL analysis provides significant benefits by examining political, economic, social, technological, environmental, and legal dimensions comprehensively. The main benefit of applying PESTEL to renewable-energy-powered desalination in Crete is its ability to provide a holistic, forward-looking assessment. By capturing opportunities and anticipating challenges across multiple dimensions, PESTEL supports better-informed, resilient, and sustainable investment decisions. PESTEL analysis is a useful tool for understanding external factors that influence strategic decisions but it also has notable limitations.

7.1 Political Impacts

Public policies play a decisive role in shaping the adoption of renewable energies in seawater desalination. Because desalination is energy-intensive, traditionally powered by fossil fuels, policy frameworks are essential in steering the sector toward more sustainable and climate-friendly practices. One major impact of policy is the creation of financial incentives. Subsidies, tax reductions, and favorable tariffs lower the costs of installing renewable energy systems, making solar- or wind-powered desalination more economically viable. Governments also use renewable energy targets and water pricing regulations to provide long-term certainty, which encourages investment from both public and private sectors. Policy support for research and development has also been crucial. By funding innovation in energy-efficient membranes, hybrid systems and energy storage, governments help reduce technical barriers that often hinder renewable-powered desalination. Furthermore, infrastructure policies, such as grid integration and transmission planning, enhance the reliability of renewable energy supply for continuous desalination operations. However, inconsistent policies and fossil fuel subsidies remain obstacles, as they make renewable energies integration less competitive. To achieve sustainable progress, policies must align water security objectives with renewable energy strategies, creating a coherent approach to both energy and resource management. Ultimately, effective policy frameworks accelerate the transition to cleaner desalination, ensuring reliable water supplies with reduced environmental impact.

7.2 Economic Impacts

The adoption of renewable energies in seawater desalination has significant economic implications, both in the short and long term. Traditionally, desalination plants have relied on fossil fuels, exposing operations to volatile energy prices and high carbon costs. By integrating renewable sources such as solar and wind power, desalination can achieve greater economic stability and resilience. One of the most notable economic benefits is the reduction of operational costs over time. Although the initial investment in renewable-powered desalination infrastructure is often higher, the absence of fuel expenses and the decreasing costs of renewable energy technologies make the long-term cost per cubic meter of water more competitive. This is particularly relevant in regions with abundant renewable resources like Crete, where localized energy generation reduces dependency on imported fuels. Moreover, renewable energies powered-desalination projects stimulate job creation in both the energy and water sectors. Investments in construction, operation, and maintenance generate employment, while technological innovation can foster new industries and export opportunities. However, challenges remain: high upfront capital requirements, financing barriers and the need for energy storage to manage intermittency may limit immediate large-scale adoption. Overall, renewable energies-powered desalination represents a pathway toward cost-effective, sustainable water supply while enhancing economic security and reducing vulnerability to fossil fuel markets.

7.3 Social Impacts

The integration of renewable energies into seawater desalination systems carries important social impacts that extend beyond technical and economic considerations. Access to clean, affordable, and sustainable water directly improves public health, food security, and overall quality of life. By lowering dependence on fossil fuels, renewable energies-powered desalination also reduces local air pollution, contributing to healthier communities. Social equity is another critical dimension. Traditional desalination, driven by costly fossil energy, often leads to high water prices that disproportionately affect low-income households. Renewable energies integration has the potential to lower long-term water costs, making safe water more accessible and reducing inequalities in resource distribution. Furthermore, decentralized renewable energy systems, such as solar-powered desalination units, can bring clean water to remote communities that are not connected to centralized grids. The transition also creates new social opportunities through education, training, and employment in renewable energy and water management sectors. These jobs can empower local populations and promote community resilience. However, challenges such as land use conflicts, public acceptance of new technologies, and the need for skilled labor must be carefully addressed. Ultimately, renewable energies-based desalination strengthens social well-being by ensuring sustainable water access while fostering inclusivity, health, and resilience.

7.4 Technological Impacts

The integration of renewable energies into seawater desalination has significant technological impacts, driving innovation in both energy and water sectors. Traditional desalination methods, such as reverse osmosis and multi-stage flash distillation, are highly energy-intensive and dependent on fossil fuels. By coupling these processes with renewable energy sources like solar, wind, or geothermal energy, new technological pathways are being developed to enhance efficiency and sustainability. One key impact is the advancement of hybrid systems. For example, solar thermal energy can be directly used for distillation, while photovoltaic panels can power reverse osmosis plants. Such innovations reduce carbon footprints and create opportunities for decentralized, small-scale desalination technologies suitable for rural and off-grid communities. The reliance on intermittent renewable energy sources also drives progress in energy storage and smart-grid technologies, ensuring stable and continuous desalination operations. Additionally, the push for renewable energies integration has accelerated research in improving membrane materials, energy recovery devices, and system automation, all of which reduce costs and enhance performance. Nevertheless, challenges persist. Integrating variable renewable energy supply with continuous water demand requires technological optimization and resilience. Despite these hurdles, renewable energies-powered desalination is transforming the technological landscape, promoting cleaner, smarter, and more adaptive water solutions for the future.

7.5 Environmental Impacts

Seawater desalination provides a critical solution to global water scarcity, yet conventional plants powered by fossil fuels raise serious environmental concerns, including high carbon emissions and air pollution. The integration of renewable energies into desalination processes offers a pathway to reduce these impacts while supporting sustainable water production. The most immediate benefit is the reduction of greenhouse gas emissions. By replacing fossil fuel-based electricity with solar, wind or geothermal electricity, desalination plants can significantly lower their carbon footprint, contributing to climate change mitigation. Renewable energies integration also enables the development of decentralized desalination units, which can serve small communities without large-scale infrastructure, thereby reducing land disturbance and transmission losses. However, environmental challenges remain. Large-scale deployment of solar and wind energy facilities may create land-use conflicts and affect ecosystems. Furthermore, while renewable energies address energy-related impacts, desalination itself still produces brine discharges that threaten marine habitats, requiring advanced disposal or treatment technologies. Overall, coupling renewable energies with desalination plants represents a crucial step toward reducing environmental harm. It offers cleaner, more sustainable water production, though complementary measures are essential to address brine management and ecosystem protection.

7.6 Legal Impacts

The use of renewable energies in seawater desalination carries important legal implications, shaping how projects are developed, regulated and sustained. Laws and regulations influence not only the environmental and economic dimensions of desalination but also determine how renewable energies integration is incentivized, monitored and enforced. At the national level, renewable energy laws, feed-in tariffs and clean energy mandates create a legal framework that encourages investment in sustainable desalination projects. For instance, binding renewable energy targets often push utilities and private investors to integrate solar or wind power into desalination systems. Similarly, water governance laws may require utilities to align with national climate policies, ensuring that desalination expansion supports broader sustainability goals. Environmental legislation also plays a crucial role. Regulations on carbon emissions, marine protection and land use directly impact how renewable energies-powered desalination plants are designed and operated. Legal mechanisms can enforce stricter brine disposal standards, ensuring that environmental benefits from renewable energies integration are not offset by ecological harm. On an international scale, legal commitments under climate agreements encourage countries to adopt renewable energies desalination as part of their low-carbon strategies. However, inconsistencies in regulations, permitting delays and overlapping jurisdictions can create barriers. Clear, harmonized legal frameworks are therefore essential to accelerate renewable energies-powered water desalination.

8. Discussion

A PESTEL analysis regarding the use of renewable energies in water desalination in Crete has been conducted. The political, economic, social, technological, environmental and legal parameters which affect the use of renewable energies in water desalination systems have been analyzed. Reverse osmosis is an energy intensive method while the rich solar and wind energy in Crete can provide the required electricity in reverse osmosis desalination plants. The current work implies that the development of water desalination plants using reverse osmosis technology in Crete should be combined with the development of solar-PV and wind power systems which will provide the required electricity in these plants instead of using grid electricity.

PESTEL analysis is inherently descriptive rather than predictive. It outlines potential influences but does not quantify their impact or indicate how they interact, making it difficult to prioritize factors effectively. PESTEL methodology also relies heavily on the quality and timeliness of data. Rapid changes in political, technological, or environmental conditions may render an analysis outdated quickly. For example, sudden policy shifts or technological breakthroughs may not be fully captured. Additionally, PESTEL methodology does not account for organizational capabilities or internal dynamics, meaning it cannot alone determine feasibility or competitive advantage. It also tends to assume that all factors are equally relevant, when in reality, their importance may vary greatly by context. Finally, PESTEL analysis is prone to subjectivity, as the selection and interpretation of factors depend on analysts' perspectives. Without rigorous validation, conclusions may be biased or incomplete.

Future research should be focused on the implementation of a case study regarding the preliminary design of a water desalination plant with reverse osmosis in Crete using solar-PV and wind power systems for generating the required electricity in the desalination process.

9. Conclusions

The use of renewable energies for water desalination in Crete, Greece has been analyzed with PESTEL methodology. The political, economic, social, technological, environmental and legal parameters which affect water desalination powered by renewable energies in Crete have been examined. It has been indicated that:

1. The expected water shortages in the future in Crete can be mitigated with the development of water desalination plants.
2. Reverse osmosis is the preferable method for sea water desalination. However, it is energy intensive while the cost of desalinated water is affordable.
3. The rich solar and wind energy resources in Crete can be used in reverse osmosis desalination plants providing the required electricity. Their use will decrease the carbon footprint of the desalinated water. The problem of the unstable nature of solar and wind energy does not facilitate their direct use in desalination plants.
4. The external environment favors the use of renewable energies in water desalination in Crete. However, there are several barriers hindering the development of desalination plants powered by renewable energies in Crete.

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