ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΙΡΑΙΩΣ

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Master of Science in 'ENERGY: Strategy, Law & Economics'

Thesis in the course of studies:

Clean Energy for EU islands- Greek energy islands/ Gr-eco islands turning into models of green and sustainable development

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Table of Contents

Abstract:

Greece is in the process of implementing a strategic plan to upgrade everyday life through the expansion of the use of renewable energy sources, considering both national and European legislation. It is worth noting that the national legislative process is improving and laws are being passed to support the use of renewable energy. The country's stance towards renewable sources makes her a leader in the energy transition in the Mediterranean zone. Autonomous and resilient energy systems are designed to minimize dependence on the mainland grid and on fossil fuels. The abovementioned energy systems integrate renewable sources—mostly solar, wind, and hydropower—with innovative storage technologies, in order to create self-sufficient and environmentally responsible infrastructures.

Main goal is to transform islands into models of sustainability and enclose several interconnected initiatives, such as the expansion of renewable energy production, the immersion of digital and energy-efficient infrastructures, sustainable management of natural resources. It is important to expand and promote the idea of e-mobility, primarily by providing economic motives, trying to turn into green philosophy great pillars such as agriculture and tourism, main economic pillars of the country. These actions should be aligned with targeted interventions by the Ministry of Environment and Energy in cooperation with other governmental bodies, under the broader framework of Greece's current energy policy.

Greece comprises more than 6,000 islands, of which 227 are inhabited, accounting for approximately 15% of the national population. While many islands are now interconnected to the mainland grid, others operate as autonomous systems. According to the Integrated National Energy and Climate Plan (2021–2030), Greece aims to achieve a 35% share of renewables in gross final energy consumption by 2030, with targets of 60% for electricity, 42.5% for heating and cooling, and 19% for transport.

Keywords: *Greek islands, energy framework, renewable energy, energy sufficient islands, energy consumption, energy independence, eco-friendly practices, energy storage, green technologies, sustainable policies, Greek government policies, energy goals, implementation challenges.*

Introduction of thesis subject

The purpose of this thesis is to highlight Greece's energy transition based on environmentally friendly practices and the principles of sustainability, focusing on its potential role as a model of environmental management and responsibility. Furthermore, it is appropriate to highlight the renewable energy innovatives that has developed in the use of renewable sources and the development of sustainability aspirations in the territory. Main purpose also remains, to highlight the transition of regions into “green” beacons. Lastly, we will analyze the contribution of this transition in national and European level.

Structure

The thesis is organized into thirteen chapters, each of which introduces an aspect of the chosen topic. It begins with the introduction and structure, followed by the second chapter, which presents the institutional framework of energy policy in the European Union and in Greece as a member state. The principles of green energy and sustainability are then analyzed, focusing on their importance and benefits, the sustainable policies followed by the EU, as well as the difficulties of their implementation.

The following chapters analyze the importance of adopting and producing clean energy, presenting the actions of Greek and worldwide islands that use clean energy. The focus then becomes the development of green technologies around the world, the advantages and difficulties of adopting clean energy principles, while follows an analysis of the positions and actions of the Greek government in achieving clean energy goals and the challenges it faces.

Concluding, the thesis evaluates the results of the adoption of clean energy principles and energy transition in the Greek islands and evaluates the actions taken so far.

1.1. Methodology

The methodological approach adopted for the preparation of this thesis is essentially theoretical and consequently qualitative. It is based on an extensive bibliography and academic texts, studies by political scientists and official publications of both the European Union and the Greek government, while being complemented by data and analysis from scholarly journals and institutional studies. Through this method of analysis, this thesis aims to evaluate existing practices for the utilization of renewable energy sources, to find new and successful environmental strategies, and to assess the challenges related to the energy transition and sustainability in the island country. This thesis also includes parallels between Greek initiatives and similar projects implemented internationally, to provide a broader understanding of effective sustainability transitions in insular contexts.

1.2. Aim

The aim of this thesis lies primarily in the importance and dynamics created by the transformation of the Greek islands into energy-autonomous and sustainability hubs, energy autonomous communities that act as energy transition examples for global energy efforts. This thesis highlights the significant importance of contribution of the existing energy islands that are already acting influentially and positively towards the global goal of sustainability, while their further development demonstrates that an environmentally friendly lifestyle can coexist with the use of renewable sources in modern life.

1.3. Contribution

The purpose of thesis is based on presenting the Greek islands as working models of sustainability transition, demonstrating that the use of renewables can improve the quality of life and not burden it. Combining environmentally friendly practices with economic and social progress Greek energy islands can function as sustainability laboratories while at the same time they contribute useful information for the formulation of sustainability policies in various parts of the world. In conclusion, this thesis aspires to highlight the importance of implementing sustainability policies and reinforce the notion that local and community driven initiatives can lead into global environmental change.

2. Energy policy framework in EU and Greece

2.1. Introduction

The European Union has issued a series of directives and regulations with the main focus on promoting the institution of renewable energy sources, energy efficiency, but mainly the reduction of greenhouse gas emissions. The aforementioned European guidelines constitute cross-temporal binding policies that all member states must adopt by 2050 within the framework of climate neutrality. This ensure a coordinate effort toward greener future. Greece is a leader in the energy transition primarily through the adoption of environmentally friendly practices and by implementing directives and regulations that lead to a greener future. Greece is in full compliance with European requirements regarding sustainability and is even expanding its institutional framework in this direction through a national initiative.

The issued ministerial decisions that stem from the country's institutional framework advocate for an energy transition and development of the institution of sustainability, in accordance with European policy. This position that the country holds not only aligns with EU climate objectives but also power up energy security, stimulates investment in clean technologies, and it is fundamental for a sustainable energy future.

It is obvious that Greece holds a positive attitude towards energy issues so far, and has developed a system that supports renewable sources, both institutionally and practically, all by implementing European directions and practices that enhance renewables, energy efficiency and greenhouse gas reduction.The country has institutionalized practices that promote sustainability towards a cleaner future with the ultimate goal of improving the quality of life.

2.2. EU’s Legal Framework

EU Renewable Energy Directive (RED II):

In 2023, the European Union amended a directive on renewable energy sources called RED II. RED II had a horizon of 2021-2030 and aimed to harmonize climate goals with the European energy market, with a view to minimizing impacts. Essentially, the goal is to integrate RES more fully into the markets, by simplifying and accelerating licensing procedures, removing regulatory obstacles, integrating them into market mechanisms and expanding their contribution in many sectors.
The RED and its revisions define the regulatory framework and provide guidelines for the development of renewable energy sources in the electricity, heating and cooling and transport sectors in the EU, as well as to self-consumers and self-producers of energy from RES and energy communities, in the Member States of the European Union. It also sets binding targets for production from RES and includes measures to ensure economic efficiency. It is noteworthy that the EU Council on December 19 reached an agreement on targeted amendments to the RES Directive, which are proposed under the REPowerEU plan.

Member States will identify specific priority areas for renewable energy sources with shortened and simplified permitting procedures, in areas of lower environmental risk. The Council confirmed the objective of a share of energy from renewable sources of at least 40% of the Union's gross final consumption in 2030, as set out in its general approach on the revision of the Renewable Energy Directive, which was adopted in June 2022. The Commission's proposal in the REPowerEU plan set the target at least at 45% for 2030. The current target in the 2018 Renewable Energy Directive is 32.5% for 2030.

In particular, the RED II defines a series of sustainability and GHG emission criteria that bioliquids used in transport must comply with to be counted towards the overall 14% target and to be eligible for financial support by public authorities. On the other hand, RED II is about sustainability for forestry feedstocks as well as GHG criteria for solid and gaseous biomass fuels. Greece has adopted this target and is working towards achieving it.

EU Green Deal & Climate Law:

The European Green Deal which launched in 2019, has as main goal climate neutrality for Europe by 2050. By ‘climate neutrality’ term we mean, zero greenhouse gas emissions by 2050 for all EU member states emissions. This policy will be succeeded by cutting emissions, promoting and investing in green technologies and of course protecting the natural environment. This law aims EU member states to achieve climate neutrality, through all affected sectors, economic, environmental and social. Of course, this policy aligns with Greece's commitment to reducing greenhouse gas emissions and promote renewable energy.

EU Emission Trading System (ETS):

In 2005 emission trading system is launched and it’s the world’s first carbon market and one of the biggest globally. It is mandatory for polluters to pay for their greenhouse gas (GHG) emissions while at the same time it is binding for them to keep emissions down. It generates revenues to finance and enhance the processes of the much-needed green transition.

This EU system concerns emissions that come from electricity and heat generation to industrial manufacturing and aviation sectors - which account for roughly 40% of total GHG emissions in the EU. It is also expanded in order to cover emissions from maritime transport in 2024.

EU ETS is based on a cap and trade system. The cap refers to the limit set on the total amount of GHG that can be emitted by installations and operators covered under the scope of the system. It is reduced per year aligning with the EU’s climate target, making sure that overall EU emissions decrease over time. By 2023, the EU ETS has helped reducing emissions from European power and industry plants by approximately 47%, compared to 2005 levels. As the cap decreases, so does the supply of allowances to the EU carbon market. It is of a great matter to mention that with this system, companies and industries are obliged to monitor their emissions annually and then make

report with their results. Greece is part of the EU's carbon market, so this contribute to the reduction of carbon emissions because it is making polluting more expensive.

Clean Energy for all Europeans Package:

The Clean Energy for all Europeans package, also mentioned as the *Clean Energy Package (CEP)*, is a set of eight legislative acts on the energy performance of buildings, renewable energy, energy efficiency, governance and electricity market plan. European Commission published its initial proposal for the package in November 2016 and because of the time that it was published, was nicknamed as the '*Winter Package'* at that time.

The package was completed by the publication of its final texts in the Official Journal of the European Union in June 2019, after a trialogue between the European Commission, Council and Parliament. The CEP is the fourth package of its kind. Unlike the other energy packages, this one does not include specific legislation for the gas sector. The package elevates energy policy framework set by the Third Energy Package and makes easier the green transition, excluding fossil fuels and leads to a carbon-neutral economy. More specifically, the CEP updates the following EU targets for 2030 and includes among others a 40% cut in greenhouse gas (GHG) emissions compared to 1990 levels, 32% for renewable energy sources (RES) in the EU's energy mix and 32.5% energy efficiency target, relative to a baseline scenario established in 2007. It is important to pinpoint that as a part of the EU Green Deal, the European Commission made an announcement to revise the GHG emission target. The European Commission released in the summer of 2020 a comprehensive plan, with reachable targets in order to increase the EU's current 2030 target of at least -40% GHG emission reductions to at least -50% and towards -55%, compared to 1990 emission levels.

2.3. Directives and Regulations

Concerning the regulation part, the Clean Energy Package contains four Directives and four Regulations:

(a) *Energy Performance in Buildings Directive (EU) 2018/844*: The Directive sets specific targets for stable and more energy–efficient buildings. It updates and amends many provisions from the Directive 2010/31/EU.

(b) *Renewable Energy Directive (EU) 2018/2001*: The Directive sets a binding target of 32% for renewable energy sources (RES) in the EU's energy plan by 2030, with an ambitious upcoming review for an increase in 2023. It also includes provisions for mainstreaming RES in the transport, heating and cooling sectors.

(c) *Energy Efficiency Directive (EU) 2018/2002*: The Directive sets a goal of 32.5% of energy efficiency for 2030, compared to a reference point in 2007, with a possible upward revision in 2023. It also includes practices to extend energy savings obligation and heat meters remote reading.

(d) *Governance of the Energy Union Regulation (EU) 2018/1999*: The Regulation establishes a new governance plan for the Energy Union. Each Member State have to set an integrated 10-year National Energy and Climate Plan (NECP) for 2021 to 2030,

with a long-term view to 2050. The main goal is to figure out how the Member State will achieve its respective targets.

(e) *Electricity Regulation 2019/943,*which includes principles for the internal EU electricity market. It concerns mainly to the wholesale market as well as network operation. With that point of view, the Regulation consists provisions that affect certain articles in the electricity network codes and guidelines. It regulates, for example, a new bidding zone review process and establishes regional coordination centers, replacing regional security coordinators and complementing the roles of transmission system operators at regional level.

(f) *Electricity Directive (EU) 2019/944*; which sets goals for the generation, transmission, distribution, supply and storage of electricity power. It also includes consumer empowerment and protection aspects.

(g) *Risk Preparedness Regulation (EU) 2019/941*: This Regulation makes mandatory for the Member States the preparation in order to confront a potential future electricity crisis. It suggests to use common ways and methods and identify potent electricity crisis scenarios, at both national and regional levels.

(h) *ACER Regulation (EU) 2019/942*: which updates the role and functioning of the European Union Agency for the Cooperation of Energy Regulators (ACER). At this point it is worth to mention that the Clean Energy Package also expands the capacity of the ACER in cross-border cooperation. Moreover, it adapts the ACER's tasks to the new regulatory framework established by the Clean Energy Package, such as, for instance, the decision on the system operation regions and the monitoring of regional coordination centers.

Generally, Greece is adopting and implementing the EU's "Clean Energy for All Europeans" legislative package. Under this light, Greece's National Renewable Energy Action Plan, pinpoints the country's roadmap to reach the EU renewable energy targets with main goal being the renewable energy share in electricity, heating, and transportation sectors. More specific, the National Energy and Climate Plan (NECP) concerns the period from 2021 to 2030 and sets Greece's national energy and climate targets, including a renewable energy share of 35% in final energy consumption by 2030, and a decrease of greenhouse gas emissions by 55% compared to 1990 levels. At the same time, to become stronger on sustainable policies and green energy, Greece adopts several national energy laws and regulatory authorities.

2.4. Greek Legislation

A primary role in the Greek institutional framework concerning energy is played by **Law 4342/2015 (Energy Law**), which defines energy issues such as energy security, sustainability and energy competitiveness. The main thing that is institutionalized by this law is the establishment of Hellenic Regulatory Authority for Energy (RAE), which is an independent authority responsible for energy-related issues, such as issuing licenses for energy projects, managing tariffs, and supervising the operation of energy markets. RAE is also responsible for the natural gas and electricity markets in Greece.

Subsequently, **Law 4643/2019** was issued, which reshapes the current operation of energy projects, facilitating the licensing process and presenting incentives for businesses and private consumers to invest in renewables. In this context, the country intends to strengthen the use of green energy, taking into account that supporting mechanisms, both economic and regulatory, have been developed, such as Feed-in Tariffs (FiTs) and Feed-in Premiums (FiPs). These schemes provide guaranteed payments for renewable energy producers, making investments in renewable energy more attractive.

Since 2018, Greece has been using competitive auctions to allocate power purchase agreements (PPAs) to renewable energy producers. This seems to be efficient and cost-effective in supporting renewable energy development. Also, in small-scale renewable energy projects, Greece provide incentives such as net metering, allowing consumers to produce their own electricity (usually solar) and offset their consumption. The Greek government, along with the EU, offers subsidies, grants, and financing programs for the development of renewable energy, including projects for wind, solar, and biomass.

Additionally, Greece has adopted several financial and regulatory mechanisms in order to support renewable energy projects to enhance the green energy route. Starting with "Feed in Tariffs (Fits) and also Feed in Premiums (FiPs)" policy that secure a guaranteed price to all energy producers for the electricity that they generate, making investments in energy much more attractive, helping the energy market growth by enhancing providers security and confidence for as long as this long- term contracts guarantee a fixed price.

2.5. Greek government' s green actions

Greece, promotes self- consumption, allowing consumers to produce their own energy by their own generated energy system, most common ways is with solar panels and net-metering by which the energy that the solar panels produce beyond the real-time needs, is sent to the public electricity grid. This has an outcome the energy independence. As long as consumers produce direct energy from their own generated system, their electricity bills become lower and it is feasible to store produced energy with batteries, enhancing energy sufficiency.

The Greek government prepares to launch several investment incentives to promote private investment in clean energy projects. These are, green tax incentives, special tax benefits that are available for renewable energy producers, such as exemptions or reductions in VAT for renewable energy projects, special funds and financing, which they give access to all interested parties to various EU funds, such as the European Structural and Investment Funds (ESIF) and the Just Transition fund. It will finance green energy projects, mostly in regions that rely heavily on fossil fuels. Greece, also, has been exploring the issuance of green bonds to fund renewable energy projects, in line with EU sustainable finance goals.

In the green energy spirit spreading concept, there is a national strategy for sustainable mobility. The promotion of the drafting of SUMPs came from the European ELTIS initiative of the European Secretariat DG MOVE. The European ELTIS Guidelines are always the reference point for the drafting of SUMPs at both European and national

level. Both the previous and recent ELTIS guidelines define specific thematic areas. Specifically, the recent guidelines that countries are called upon to implement aim to study: land use, transport, energy, electromobility, environment, bioclimatic design, thematic fields in which the Ministry of Environment and Energy contributes with its responsibilities, its General Secretariats and its thematic Directorates.

The SUMPs aim to formulate an integrated strategy for sustainable urban mobility where all the above sectors work together harmoniously and in a balanced manner. In addition, their success relies on collaborations at various levels and fields of governance to address any risk of discontinuity and inconsistency between planning approaches with the aim of clear and specific results as well as the synergy between land use policies, property values, accessibility for disabled users and infrastructure development.

The use of the bicycle as a means of daily transportation for citizens and a means of transporting products has been taken very seriously in the last 20 years in the planning of cities and the countryside. The integration of the bicycle into transportation achieves multiple goals such as reducing energy consumption, reducing urban noise and pollutants, improving the urban microclimate in particular, and increasing road safety, the protection of public health and the promotion of the urban and suburban environment in terms of sustainability. For the above reasons, a large number of European and non-European countries have already established and implemented national cycling strategies, which promote actions and objectives at the national level, and guide regional and local authorities as well as institutions and businesses on the required actions and actions they must implement to achieve these strategies. From the entry into force of Law 4710/2020 "Promotion of electromobility and other provisions" (A'142) (ref. 1), and until 31.3. 2021, the municipalities of metropolitan centers, the large and medium-sized mainland municipalities, the municipalities of capital regional units, as well as large and medium-sized island municipalities, in accordance with article 2A of Law 3852/2010, are required to prepare an Electric Vehicle Charging Plan (EVCP), in which they plan the placement of a sufficient number of regular or high-power publicly accessible EV recharging points and EV parking spaces within their administrative boundaries.

2.6. Conclusion

In conclusion, it is noteworthy that Greece has made very important steps in adopting green strategies in line with European standards. There is a commitment to reducing greenhouse gas emissions and promoting the use of renewable energy. All of the above are included within the updated institutional framework and continuous legislative improvements towards green development. This process encounters challenges such as delays in obtaining permits for energy projects and constant bureaucracy, which create problems but they don’t alter the stable energy trajectory on which the country is headed.

3. Analyzing the principles of sustainability and green energy:

3.1. Introduction

Sustainability is the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs. The term is associated with the balance between three pillars: environmental, economic and social, and means preserving ecological balance and natural resources, promoting social justice and supporting long-term economic prosperity while green energy has more practical aspect as she in some way, apply the main principles that forms sustainability. Renewables, biomass and the goal of greenhouse gas emissions are on the spotlight.

3.2. Introducing Green energy:

Green energy is actually derived from natural resources and also powered from them. Natural resources, such as sun, air, water, biomass, and geothermal energy, precisely because of their nature, are inherently renewable and, unlike fossil fuels, are environmentally friendly and contribute to improving living conditions.

It is logical to create conceptual confusion regarding the terms “renewable energy”, “green energy”, “clean energy”, however, there are small real differences that separate them as each concept has a different connotation. In particular, the term “renewable energy” sources refer to their ability to be naturally renewed, as is evident from their very definition, “clean energy” refers mainly to the zero emission of any type of harmful gas into the atmosphere, while “green energy” refers to the use of renewable sources, zero greenhouse gas emissions and air pollution. It is obvious that green energy encompasses the inherent nature of the other two terms with sustainability being the point.

As mentioned above, green energy has several pillars. In addition to sustainability, which is the main goal, the central idea of green energy is renewable sources. Renewable sources are theoretically inexhaustible because they come from nature and do not depend on factors other than nature itself. Solar energy, for example, is inexhaustible as long as the sun shines. The same applies to wind, the sea, etc. This is precisely where the big difference between renewable energy sources and fossil fuels lies, which on the one hand have a limited supply time, and on the other hand, take several years to form. The biggest difference, however, between renewable energy sources and fossil fuels is that the former constitutes a reliable pillar of the energy transition since they are inexhaustible.

One of the most important bets in achieving the energy transition is the reduction of environmental impacts, which is intended to be achieved through the use of energy technologies that will not be harmful to the environment. This possibility will be provided through energy. Of course, this equation cannot exist without the energy efficiency that is required. Energy efficiency is achieved through the energy

technologies that have been developed, such as photovoltaics in buildings, or small-scale turbines that minimize energy consumption.

The green energy transition has many advantages. Among others, the creation of decentralized energy systems by local communities helps meet daily needs, produce, manage and store electrical energy. At this point, energy efficiency is crucial issue, as it enhances energy security to communities and reduce long distance energy transmission and dependence fossil fuels.

Furthermore, clean energy must be affordable and accessible to all so that everyone can enjoy its positive impact. In particular, geographically inaccessible local communities should benefit from clean energy as well as low-income ones. Financial instruments, microgrids operated by local communities help reduce the cost of households and provide access to renewable energy. Battery storage, pv panels smart grids, even electrical vehicles help create resilience, reliability and energy efficiency.

The technologies being developed to support renewable energy sources are a very important step towards to energy efficiency and reliability of renewables. For example, batteries can store excess solar or wind energy for use during periods of low production, helping balance supply and demand. Floating solar panels, offshore wind farms are crucial developed technologies as their use reduce land use and environmental disruption.

3.3. Introducing Sustainability:

In a broad sense, sustainability refers to the ability to maintain or support a process continuously over time. In business and political contexts, sustainability seeks to prevent the depletion of natural or natural resources, so that they remain available for the long term. Sustainable policies emphasize the future impact of any given policy or business practice on humans, ecosystems, and the broader economy. The idea often corresponds to the belief that without significant changes in the way the planet functions, it will suffer irreparable damage. As concerns about anthropogenic climate change, biodiversity loss, and pollution have become more widespread, the world has shifted towards adopting sustainable practices and policies, primarily through the implementation of sustainable business practices and increased investment in green technology.

3.4. The EU Green policies

Already from the institutional framework of the European Union there is a clear direction towards sustainability practices. More specifically, such policies constitute the European Green Deal and the 8th Environmental Action Programme (8EAP) with the ultimate goal of achieving a balance between the greenhouse gas emissions produced and those removed from the atmosphere, so that the net result is zero. Climate neutrality and resource efficient Europe by 2050 is the ultimate goal.

The 8th EAP entered in force, in May 2022, and cconstitutes the European agenda for environmental policy until 2030. The ultimate environmental goal of 2050 is the one towards which all environmental actions are related to living well in a healthy

ecosystem move. It includes all actions related to 2030. It is based on the European Green Deal, the core of which is climate neutrality, the reduction of gas emissions, the energy transition and in general the development of green energy techniques that will lead to social prosperity and well-being. The 8th EAP requires convergence and integration of all stakeholders at all levels of governance to ensure that all legal regulations are effectively implemented by all Member States. In essence, it co-shapes the 2030 Agenda and sets the goals for sustainable development.

The adoption of green energy practices by societies that apply the principles of sustainability certainly leads to climate neutrality. The above-mentioned constitute a foundation for a cleaner, more resilient and environmentally friendly green future while at the same time we are safeguarding the planet.

3.5. Conclusion

It is undoubted that sustainability principles are vital for the environmental future so as for the prosperity of societies. Sustainability provides the framework for energy policies, innovative technological solutions while green energy seems to implement these ideas of sustainability by helping the reduction of gas emissions, supporting energy efficiency and providing long-term environmental, economic and societal benefits. It is crucial these principles to be embodied into national framework as they constitute not only European legal framework but European sustainability practices in order to achieve as soon as possible climate resilient and energy safe future, ameliorating the vital conditions of societies.

4. Relative EU sustainable policies:

4.1. Introduction

It is undoubted that EU along with her member states have embodied legal framework that promote the most, climate neutrality, all by a series of actions and measures that are taken into consideration in order to succeed the spread of green actions. The reduction of greenhouse gas emissions and the appliance of renewable energy are the means for a vital and prosper future. Key strategies that help and are the leader towards climate neutrality. By applying these key strategies, EU can shape the way energy markets work in order them to be more efficient, set environmental standards and create investment incentives. In this spirit, EU has set a reference point for sustainability, not only by forming policies and legal framework, but setting in them in action, having taken into account environmental, social, and economic aspects.

4.2. European Green Deal

The European Green Deal in one of these abovementioned key strategies set in order to achieve climate neutrality. The European Green Deal is the EU's growth strategy, a set of initiatives and policymaking launched in 2019, that sets EU political part and it's not just the EU's position in the Paris Agreement, which was ratified by the EU and all its countries and set the goal of limiting global warming to a maximum of +1.5°C compared to pre-industrial levels. The Green Deal supports the transformation of the EU into a fair and prosperous society with a modern and competitive economy. It underlines the need for all policy areas to contribute to the fight against climate change. Under the Green Deal, the Council — together with the European Parliament as co-

legislator — adopted legislative acts that translated the vision of the strategy into laws and rules applicable in all EU Member States.

4.3. Fit for 55 Package

Another key strategy applied for a greener future, is the Fit for 55 Package. Fit for 55 consists of legislation aimed at reducing EU greenhouse gas emissions by at least 55% by 2030 and putting the EU on track to achieve climate neutrality by 2050. The package eensures socially equitable transition, maintains and strengthens the innovation and competitiveness of EU industry, while ensuring a level playing field with economic operators from third countries, consolidates the EU's position as a global leader in the fight against climate change

4.4. Circular Economy Action Plan

The Circular Economy Action Plan is an initiative of the European Commission, and a key part of the European Green Deal, which aims to transition the EU to a sustainable and competitive economy, reducing waste, keeping products and materials in use for as long as possible, and decoupling economic growth from resource consumption, through the reuse, repair, recycling and redesign of products. Main goals for this plan is reduction of waists, product lifecycle management and enhancement of economic markets by creating competitive incentives.

4.5. Farm to Fork Strategy

In May 2020, the Commission presented the Farm to Fork Strategy, one of the key actions under the European Green Deal. By contributing to achieving climate neutrality by 2050, the strategy aims to shift the current EU food system towards a sustainable model. Farm to fork strategy first and foremost has to ensure food safety and food security. The transition into an ecofriendly food system has as target to create new business opportunities with positive impact into the incomes of agricultural businesses. In October 2020, is was decided that economic and healthy food will be accessible to all people while their production ways should be in harmony with climate neutrality measures. Fair income and great support in all ways to all the producers and making the EU agriculture competitive at a global level is the key aspect of this strategy.

4.6. Climate Adaptation Strategy

The Climate Adaptation Strategy includes a series of measures to prevent situations that could potentially lead the ecosystem and, consequently, people to a difficult position. In particular, a preventive measure is the restoration of wetlands and the creation of green urban spaces, to enhance resilience against extreme weather events. The above, in conjunction with the measures taken by the EU to disseminate the importance of utilizing renewable energy sources, the creation of smart grids and energy storage, constitute energy stability measures with a long-term character once their implementation. In addition, the ETS, as the largest carbon market in the world, within this framework of prevention, integrates the cost of emissions and provides incentives for cleaner production practices in all sectors.

The EU's main goal is political neutrality, which should be achieved by 2050. The holistic approach that the EU has adopted to achieve this goal includes technological change and innovation that will help maintain healthy ecosystems but also promotes the participation of local communities in this direction. By spreading the use of renewable energy sources, implementing circular economy practices and biodiversity conservation, strengthening the interconnection of even the most isolated places and island regions, the EU is trying through these interventions to maintain healthy ecosystems and healthy citizens, reduce harmful gas emissions and create a more resilient environment. All of the above indicates that achieving sustainability, which is one of the ultimate goals, is a multidimensional phenomenon to the evolution of which social, economic, and energy ties contribute.

The holistic approach required to achieve sustainability is also required to create a change-resistant environment and therefore a better and more resilient future. All the interrelated sectors, society, politics, energy, should be brought together. After all, there are many examples of successful resilience of ecological islands, from Denmark to Greece, which clearly demonstrate that when all the stakeholders involved act collectively and for the common good, the result is always positive. The use of renewable energy sources is key to a greener future in all areas of life.

The key strategies mentioned above, and implemented by the EU, from the Green Deal to the Fit for 55 Package, are examples that the desired change comes through collective effort and the participation of even the most remote parties. Through this effort, a resilient future can be achieved and the energy transition is carried out in order to achieve protection of ecosystems and improve living standards.

The only thing certain is that the term sustainability is multidimensional and multifaceted. Supporting political frameworks that will help achieve sustainability, such as the use of renewables, the circular economy, citizen awareness, but also the fair management of resources are the key to greener and more resilient future.

4.7. Conclusion

In light of the above, it becomes clear that sustainability is achievable and certainly accessible. By spreading green practices and ecological means but also with the help of local communities, a resilient, sustainable future is possible. Strategies such as the circular economy, waste reduction and the adoption of clean energy can create environments that are resilient to climate change and improve the quality of life of citizens and future generations.

EU's legal framework and applied policies concerning climate neutrality, circular economy practices, protecting biodiversity, enhancing energy security and energy efficiency serve as the backbone of Europe's strategy for climate and energy, while at the same time the above mentioned are main targets, in need to be succeeded, from all member states. Balance will come in many areas of everyday life, economic, societal, environmental.

Greece is embodying a series of EU initiatives and directives which constitute a lighting pathway towards sustainability, fostering green practices and meeting climate targets.

Following these practices shows how coordinated actions can meet all targets for climate, and energy change for the better, while at the same time adopting all these methods from society, demonstrates that when we are united and committed to one target, everything is achievable.

5. Clean Energy:

5.1. Introduction

Clean energy refers to energy derived from renewable, low-emission sources that have the least environmental impact unlike to fossil fuels. Applying clean energy methods, can help reduce greenhouse gas emissions, mitigate climate change, and reassure a more sustainable future. For all the above, it is important, a transition to be succeeded, that includes technologies, solar, wind, hydro, and biomass, as well as energy efficiency measures and smart grid systems.

For Greece and the EU as a unity, clean energy is not only a tool for environmental protection but also a strategic lever for economic growth, energy independence, and technological innovation. Taking these principles under consideration, positive outcomes and challenges may come up, but clean energy is crucial for shaping future energy policies and investment strategies.

5.2. Clean energy adaptation

By incorporating the use of clean energy into our lives, we primarily help the environment. This is because the use of clean energy reduces the burdensome impacts on the environment since it helps reduce emissions of pollutants and greenhouse gases, while the energy sources it includes are many, natural, and have benefits both for the ecosystem, since it mitigates climate change by creating a more sustainable environment for humans since they live on a cleaner and safer planet.

Regarding the benefits offered by the use of clean energy, a reduction in greenhouse gas emissions, a reduction in global warming, mitigation of the phenomenon of sea level rise, and also the loss of biodiversity have been observed. Clean energy is the key to the integration into our lives and the daily use of renewable energy sources, which in turn reduce dependence on polluting fuels in the production process, as a result, the atmosphere is not polluted, while the use of renewable energy sources ensures energy security and self-sufficiency. Clean energy starts and emanates from renewable energy sources, a key characteristic of which is sustainability. The sun, the wind, the sea, hydroelectric energy are inexhaustible resources, thus ensuring long-term availability, while at the same time the use of clean energy has not only environmental benefits but also social and economic ones. The major thing, however, is the non-further pollution of the atmosphere, water, and air.

Undoubtedly, the transition to the era of clean energy is not an easy process. Issues arise at various stages with varying results. The use of renewable energy sources, although inexhaustible in a sense, is not continuous and this is because there is not always sun or wind. Due to the inexhaustible but intermittent nature of renewable sources, the need to find ways to store, create smart networks and develop transmission networks for this

produced energy that is imperative. And of course, although the cost of developing these technological methods has decreased significantly, the investment itself is what makes things difficult from the beginning since the cost and the land value are significant obstacles to starting such investments and therefore the adoption of such practices. It is a fact that the existing networks are saturated, resulting in the need for significant upgrades in the transmission, distribution and storage infrastructure for new energy to be supported at every stage of the production process by the existing networks.

5.3. Clean energy and Green energy

At this point, a clarification of the terms clean energy and green energy should be made. They seem to have a lot in common as concepts but are by no means identical concepts. Green energy as a term includes forms of energy that come from the environment itself and are friendly to it. They are solar, wind, hydroelectric. On the other hand, clean energy basically concerns the way of producing energy with a zero-polluting footprint for the environment, that has no production of greenhouse gases or in the worst case, with minimal environmental impacts. A typical example of the above described, is biomass, which is a renewable energy product but is not completely green as due to its combustion, it emits polluting gases.

The mixture of these two forms of energy is the best combination for a resilient ecosystem. Due to the increased energy needs, no single form of energy is sufficient to meet the ever-increasing needs of the planet, especially in remote places where access to these forms of energy is even more difficult. By combining these two forms of energy, citizens can look forward to sustainability while significantly reducing environmental damage.

In this context, the Greek islands are such a shining example. They benefit from solar, wind and hydroelectric energy and have become world pioneers in the use of renewable energy sources. The fact that they are also a magnet for tourists from every corner of the earth, confirms to the maximum the argument that sustainability can be combined with economic development and robustness while the uniqueness of the Greek islands will remain intact.

5.4. Advantages of clean energy methods

It is crucial to adopt the use of clean energy. It is the means to achieve a sustainable direction and a more resilient ecosystem. The ultimate goal is to wean societies from the use of fossil fuels that immediately pollute the environment and to integrate into our lives regular and promotional actions for the use of renewable energy sources and technologies that will enhance clean energy. Through them it is possible to achieve economic prosperity and energy security.

It remains a challenge for the EU but also for Greece, the adoption of the principles of clean energy since beyond the environmental goal of sustainability, with the development of innovative technologies for managing generated energy, the economy, technological development and job creation are strengthened. This energy transition is

product of the work of many. Politics and society must be at the forefront of achieving environmental goals in order to ultimately enjoy the benefits of implementing these practices.

It is undeniable that the adoption of clean energy is a maximum goal for sustainable development and combating the climate crisis. Countries that adopt clean practices, including Greece, ensure energy sufficiency and security, reduce their environmental footprint, while emerging challenges, such as the intermittent nature of renewable energy sources, the non-completion of investment plans and networks, do not affect them to the fullest, however, they strengthen the idea that the partnership between the public and private sectors can be the basis for achieving sustainability and the means for the energy transition in any case.

5.5. Conclusion

It is very important to understand that sustainable development will be achieved, among other things, through the integration into our lives and the use of clean energy forms. Renewable energy sources are the pillar of this approach. The sun, the wind, hydroelectric power and all their derivatives, through technological innovations, can create a sustainable and safe standard of living, a clean environment and certainly an environmentalist attitude and conscience, especially if it is understood that it will not change for the worse or that difficulties will not be created by the adoption of clean energy in everyday life. It is crucial for both Greece and the EU to draw up strategies for both the approach of the term "clean energy" by society and the adoption of its use, since the benefits are many and multifaceted. Beyond the ultimate goal of sustainability, economic resilience is promoted since energy security is largely ensured mainly with the help of technological methods, e.g. batteries, storage networks for produced energy, while at the same time achieving energy independence, the country becomes more competitive in the energy sector.

Taking practical initiatives to promote clean energy, through renewable energy sources, at the local level and even more so in less remote places, promotes the ultimate multi-level goals mentioned above. A typical example is the Greek islands, some of which have fully adopted the model of using renewable energy sources and the results are wonderful. However, it is certain, that achieving energy security, independence and sustainability will have multiple issues-difficulties that will arise in the process of energy transition. Just as achieving the energy goal of sustainability has multiple and multi-level benefits, so do the difficulties that arise from this process, are many and cover many areas.
Bureaucratic issues in the implementation of procedures create chronic delays, finding funds for these purposes is difficult. The socialization of the idea of using clean energy and the integration of these practices into society is a key goal to be achieved with also emerging difficulties, while issues also arise in the infrastructure to support energy practices. With a sustainable future as the main guideline, the difficulties, with strategy, plan and practical applications, can be significantly reduced.

6. Greek energy islands:

6.1. Introduction

Pioneers in the energy transition and in achieving sustainability are the Greek energy islands. This is a success in energy issues if one considers that the Greek islands were basically dependent on fossil fuels and diesel generators. However, these islands are on a transitional energy trajectory and are increasingly utilizing renewable energy sources such as solar, wind, hydroelectric and using hybrid systems. Achieving the energy transition, especially for the Greek islands, is of great importance since it will strengthen their independence, their energy security, reduce the cost of energy, and reduce pollutants from fossil fuels.

Another reason why the Greek islands are unique candidates to pioneer the energy transition is that due to their geographical location, many are isolated, making them excellent candidates for the implementation of technological innovations in the energy sector such as smart grids. The results from the practical application of renewable energy sources as well as the technological methods constitute an example for the wider adoption of such an energy model in other remote places.

The energy transition aimed at energy independence and sustainability provides advantages in all sectors, economic, environmental, social. From an economic point of view, it is a fact that the strategy of adopting the principles of renewable energy certainly reduces dependence on imported fuels since the energy produced from renewable sources covers the needs traditionally covered by fossil fuels. In this way, the local economies of the islands are protected in a more general unstable environment in terms of energy prices. The use of green energy also has advantages for society since the maintenance of these technologies that support energy projects creates jobs in these supporting mechanisms and strengthens the labor market, especially in smaller places that have fewer job opportunities. In addition, with green energy, alternative forms of tourism are promoted, such as ecotourism, giving a new dimension to this level and showing how much can be achieved from green development.

The advantages of this model extend across environmental, economic, and social dimensions. Environmentally, replacing diesel or oil-based generation with solar and wind reduces greenhouse gas emissions, air pollution, and noise, directly contributing to climate mitigation targets. Economically, local renewable projects decrease reliance on imported fuel, lowering energy costs and insulating island economies from global energy price volatility. Job creation in installation, maintenance, and energy management fosters skill development and strengthens local labor markets. Moreover, the visible implementation of green technologies promotes eco-tourism, generating additional revenue and incentivizing further investment in sustainability.

It is worth noting that the Greek energy islands, thanks to the advanced technologies that have been developed to promote renewable energy sources, combine advanced methods from energy production to consumption and storage.

The Greek energy islands, have as their main backbone and at the same time their driving force, the use of advanced technological innovations that have been developed to integrate green energy into the lives of all of us. They operate by combining methods

of storing the energy produced while also using technological methods of distributing it. A key axis of energy adequacy and, therefore, security, is the storage of the energy produced, an act that becomes extremely important if one takes into account the intermittent nature of renewable energy sources such as solar or wind. In addition, they have developed microgrids through which they essentially control both the production and consumption of energy and the quantity of energy produced, giving them the ability to know the real needs at any given time. These technological methods are utilized on large islands such as Crete and are combined with green actions such as the use of electric vehicles (EV) in industries that until recently used entirely fossil fuels for energy transportation.

These actions prove that energy islands and the use of green energy are, on the one hand, complex and multidimensional shapes that positively and directly affect the social fabric, on the other hand, they are reality and have not remained in the announcements since their use is becoming widespread day by day.

However, the use of green energy in Greek energy islands has multiple implications on many levels. They demonstrate that the achievement of the environmental goals that have been set is possible, while simultaneously affecting the economy, ensuring energy sufficiency and actively involving society in the maintenance of this network through their application in everyday things. Even in the most remote places, even the smallest-scale energy projects can have a catalytic effect on the energy development of a region, while helping to achieve the goals of sustainability and the EU's energy strategies. The Greek energy islands continue to be energy models, while the data collected for their energy progress could be utilized even by the most remote and small places, either in mainland and island Greece, or worldwide, to expand the use of renewable energy sources.

Nevertheless, the process of transitioning to green energy and sustainability has many obstacles, but not insurmountable ones. The implementation of policies and energy strategies is delayed in practice, the investment costs in energy projects are quite high, the technological development is complex and complicated to be fully effective. Furthermore, issues of storing the energy produced limit the energy sufficiency and independence of islands, but with the right guidance these problems are not insurmountable.

6.2. Introducing Greek energy islands

Starting with Tilos, which could easily be called a "pioneer" in the use of green energy since it initially adapted quite quickly to the idea of the exclusive use of renewable energy sources and in the process completely adopted this approach. Tilos has ensured energy security and sufficiency since it operates on a small scale. It exploits technologies such as solar photovoltaics and has developed a system for storing the generated energy with batteries while also exploiting the generated wind energy with the help of wind turbines, making it energy autonomous from the mainland grid. The fact that it has developed the ability to store the generated energy ensures its energy sufficiency and from any interruptions that are possible due to the intermittent nature of renewable energy sources. The operating model that the island has developed makes

it energy-resilient, ensures local energy demand and covers the needs that arise, while at the same time its mode of operation constitutes a standard reproductive model, especially for the smallest and most remote places.

Continuing, the Cyclades islands also have a special place in the energy landscape with a holistic approach to the field since they utilize renewable energy sources such as solar and wind through the technologies that have been developed to produce energy of each type but also store hydrogen. However, unlike Tilos which is self-sufficient and does not depend on the mainland grid, the Cyclades islands use submarine cables and are connected to each other, -inter-island interconnection-, through smart networks and in this way, they ensure energy sufficiency, exchange energy and shield the system in case of need. Since these islands constitute a complex, the process of energy autonomy is complicated. There are many interdependent networks due to the complex of islands, resulting in the need for larger-scale networks, the management and maintenance of which requires continuous monitoring to prevent errors and coordinate actions. It is important to note that the energy model implemented in the Cyclades islands is perfectly combined with tourism. It covers and serves the ever-increasing energy needs due to the volume of tourists that these islands receive, especially in the summer months, while at the same time combining new innovations such as rental electric cars.

Next and strong, comes Crete. It is the largest island that makes use of renewable energy sources on a large scale. The demand for energy is considerably higher due to the population needs, which also includes the large tourist flow that the island has almost all year round, therefore the supply must meet these needs. It follows a more complex system, of an industrial approach and of a larger scale due to the population, also considering the needs of the tourist season. It mainly uses the energy produced by photovoltaic and wind farms, stores the energy produced in batteries, has created smart utility networks, while the use of electric vehicles has spread beyond permanent residents to tourists who rent during their vacation period. It is certain that the energy scheme followed by Crete, compared to that of the Cyclades or even Tilos, is considerably more complex due to the greater energy consumption because of the population density and the needs arising from daily activity. The implementation of green strategies on the islands and in this case in Crete for the energy future, since they demonstrate in the most powerful way that even the most remote places from the mainland can be energy independent and autonomous, following the national strategy for renewable energy sources without compromising the result.

Also noteworthy is the energy effort of a small island but with a pioneering attitude in the integration of the principles of green energy and the achievement of energy independence. Agios Efstratios, utilizes the energy produced by solar parks and wind turbines while at the same time storing the excess energy in batteries and has developed a small-scale network with multiple benefits. The small network ensures the energy needs of the island while ensuring energy adequacy and self-sufficiency. However, what is particularly remarkable about the case of this island is the social dimensions of the 'green energy' project, since the participation of society is essential. The residents have fully embraced the principles of green energy and live under this perspective. In this way, a healthy and clean environment is ensured for the island's residents and visitors to enjoy. Energy independence also helps the island's economy, which proves that a small island that follows the national strategy for the implementation of

renewable energy sources makes a difference both locally and nationally and, by extension, globally.

6.3. Strategic advantages of Greek energy islands

It is undeniable that the adoption of green energy principles and the systematic use of renewable energy sources bring many advantages in all areas of daily life, socially, economically, environmentally. With the expansion of the use of renewable energy sources, the widespread use of oil and fossil fuels is automatically reduced while at the same time there is a reduction in greenhouse gases emitted into the atmosphere. Instead, the energy produced by solar and wind farms is utilized. In this way, the quality of the air we breathe is greatly improved, the environment is not burdened by pollutants, while by incorporating these practices daily in our lives, we ensure a healthier future. Therefore, the environmental benefits are multiple and interconnected with the social and economic ones.

The use of renewable energy sources automatically reduces the import and therefore the use of fuels, therefore reducing costs. The energy produced, and especially its storage, helps to keep electricity prices stable while the maintenance of renewable energy production systems creates jobs, mainly stimulating local communities in remote areas from the mainland. A typical example is Crete and the Cyclades, which, due to their energy sufficiency and the large reach of networks, attract investments that yield significant profits and benefits locally and nationally, while smaller islands such as Tilos and Agios Efstratios benefit from the jobs created in the infrastructure and maintenance projects of renewable energy sources.

Islands that use renewable energy sources achieve energy sufficiency and security, while microgrids and smart grid technologies enable them to be energy secure in cases of intermittent energy flow or emergency situations. The most important thing in these is that society actively participates and integrates energy practices into everyday life, enjoying the benefits generated.

It is certain that beyond the multiple benefits, implementation issues arise. Due to the fact that energy policy and the formulation of national strategies do not measure very many years and although several islands in Greece apply the principles of green energy, it does not mean that the investment cost of renewable energy technologies does not remain high as beyond the installation of solar or wind farms, energy storage systems and network infrastructures have equally high costs. Subsequently, there is also technical complexity in these projects since a combination of energies and sophisticated means are required for the energy production line of each island to operate effectively, especially the larger ones whose systems are more complex due to their size. It is necessary to harmonize energy goals with national strategies and EU requirements in order to achieve the ultimate goal of sustainability.

6.4. Conclusion

The Greek energy islands implement the energy policies set out by the EU based on the European Green Deal. The main axes are the use of renewable energy sources, the reduction of polluting gases and greenhouse gases in the atmosphere, as well as the development of technological applications that will help ensure energy sufficiency. The

Greek islands, therefore, because they combine all the above, are a global example of integrating energy policies and achieving energy goals. They could also be considered useful laboratories that extract useful information and become application models for other islands worldwide. Innovative actions such as the production of green hydrogen and the use of smart grids strengthen the pioneering position of the islands. Furthermore, the Greek islands serve as experimental laboratories for innovations in green hydrogen, smart grids and community energy participation, constituting replicable models for other European islands and remote areas worldwide.

Tilos, Crete, Agios Efstratios and the Cyclades have a holistic approach to the term of renewable energy sources, combining new energy practices, innovation and socio-economic benefits. They have managed to achieve energy security and adequacy by adapting RES to their needs and define the rules of energy supply and demand. Thus, they set an example that such actions are feasible for everyone and can be specialized in each circumstance depending on the local and national needs.

With the use of renewable energy sources, the advantages are many and energy resilience, regardless of conditions, is achieved. Due to the complex nature of energy practices, challenges are not lacking in their implementation since high investment costs, innovations in storage and uninterrupted operation increase the difficulty. Continuous support, social and political, is needed. Sustainability encompasses all aspects, social, economic, environmental, human, and the goal remains one, a healthy environment.

7. Clean energy islands around the World

7.1.Introduction

In the same context of energy transition that the Greek energy islands have entered, other energy islands worldwide are following. The adoption of clean energy principles also makes these islands bright examples in the green transition. They develop technologies for the use of renewable energy sources in remote and small places, use small-scale and smart grids, biomass, store the energy produced, as a result of which they achieve energy independence while covering their needs while at the same time eliminating any old means of energy, such as fossil fuels, diesel generators, or imported fuels. The way these islands operate is a laboratory for operating and managing energy practices that will lead to a cleaner and more sustainable environment.

We must not forget the goals set by the EU. Zero greenhouse gases by 2050, Fit for 55 laying the foundations and charting the energy path for the Member States. The adoption of clean energy principles and the achievement of sustainability have as their purpose the improvement of the quality of life of the inhabitants, a healthier environment and the longevity of the planet. Both the Greek islands and the islands worldwide have turned to this energy approach and the reason why special mention is made to them is because of their bold initiative for clean energy even, though one could say, that they have, compared to the mainland, disadvantages of distance and size. On the contrary, they are pioneers in the energy transition and examples to be emulated for their excellent results.

Because they make use of renewable energy sources, solar wind farms, biomass, smart grids, storage of produced energy, promote environmentally friendly actions, such as electric cars, bicycles, recycle and compost with reciprocal benefits, they need more support in this effort, both from the political system with the provision of incentives and from the local community with promotional actions but also the provision of financial incentives. When the issue of implementing clean energy's practices leaves policymaking and society is called upon to implement, if done holistically and with the aim of sustainability, then it is certain that the longevity of the planet and the health of citizens will be achieved.

7.2.Energy islands around the world

To achieve sustainability, energy islands have developed a network of coordinated actions in every field involved in the energy transition in order for it to be smooth on the one hand and to be achieved on the other. In this process, it is understood that the difficulties are many, however, with coordinated action, the obstacles to sustainable development can be overcome. Citizens become the driving force and the lever of support for the selected actions. Educational programs, information days are carried out, financial incentives are given, jobs are created. The islands become a living organism of energy transition. In addition, strategies that encourage electromobility, such as electric cars, electric bicycles, investments in robust energy networks with the aim of protecting the environment, help these communities to actively participate in the energy transition while maintaining their unique, environmental identity.

Islands worldwide are pioneers of clean energy, starting with Samos in Denmark, which, like Tilos, fully secures its energy from renewable energy sources, solar, wind, biomass and is energy autonomous. In fact, there is intense social action regarding energy issues since the residents invest in renewable energy sources, since they are shareholders in wind turbines, participate in the construction of photovoltaic panels. This island is a worldwide model of energy self-sufficiency and social participation in the sustainable transition.

Then Gotland in Sweden, has managed to eliminate emissions of polluting gases into the atmosphere thanks to the extensive use of renewable energy sources. They promote sustainable practices in everyday life and include society in actions to spread green development. They greatly promote sustainable agriculture and promote the consumption of local food systems.

Also, Isla del Coco, Costa Rica, which has been declared a UNESCO World Heritage Site with a significant geophysical footprint since it has one of the largest protected national parks and despite being a tourist destination, it tries to reduce tourism to keep the island's terrestrial and aquatic environment clean.

Harbour Island, Bahamas, is another island that is powered by renewable energy sources and has given special importance to the protection of the aquatic environment since it tries to limit tourism to coral reefs in order to protect them.

Next is El Hierro, Canary Islands in Spain which, similarly to the above mentioned, is powered almost exclusively by solar and wind energy as well as hydroelectricity while at the same time it has developed studies to support energy networks to limit development policies to the extent that they do not burden the environment.

A great example of a significant environmental footprint is Iceland which is powered by geothermal and hydroelectric energy and has developed alternative forms of tourism centered on sustainability such as ecotourism. They have also developed actions in the industrial sector since they use electric cars to reduce carbon emissions.

Actions that combine tourism and sustainability are implemented by both the Maldives, a popular tourist destination that utilizes solar energy produced by photovoltaic panels in tourist resorts in ecosystems burdened by tourism, recycles food and material goods while trying to reduce waste, and Panglao Island in the Philippines, which promotes alternative forms of tourism such as ecotourism, promotes recycling, utilizes green energy in tourist resorts while not allowing the use of single-use plastics.

The Nusa Islands in Bali (Nusa Lembongan, Nusa Penida) share the same philosophy of combining tourism and renewable energy sources, where they have built accommodations based on solar energy to meet their energy needs, have taken protective measures and promote actions to protect coral reefs from tourism and climate change, while the most important social achievement is that they operate the "Green School" in which children are educated about the use and value of renewable energy sources while also learning about good environmental practices that they can develop by cultivating their ecological awareness.

Waiheke Island, New Zealand, is also following suit, promoting environmentally friendly practices such as organic farming and sustainable vineyards, while with the help of the community they have created eco-resorts based on energy produced from RES.

Also worth mentioning are the islands of Efate, Vanuatu, which focuses on initiatives related to the reduction of air pollutants and the use of plastics, especially single-use. It utilizes renewable energy sources and the energy produced, all with the active participation of the community, while Lamu Island in Kenya, with minimal means, contributes to a positive environmental footprint since they do not use cars and do not emit carbon into the atmosphere, but mainly use walking as a means of transportation, as well as, animals, such as donkeys.

It is clear from the list of energy islands on a global scale that even with minimal technology, if there is a will, the goals of sustainable development can be achieved with the simplest means, and a healthier environment can be created. The key to all the above is the cultivation of environmental awareness through actions that will improve the quality of life and protect the environment at the same time.

It is worth noting that with the adoption of the principles of clean energy and the use of renewable energy sources, the character of these islands will not be altered in any way, nor will they lose their cultural identity due to the energy transition. On the contrary, the ideal is to combine the new technologies in the energy field but also the preservation

of the rich urban heritage that these unique places have. A key part is the sustainability and the preservation of their natural characteristics without alterations from extreme environmental phenomenon, atmospheric pollution and erosion of natural and cultural beauty. Promoting ecological awareness, applying circular economy terms and practices, reducing harmful waste in combination with the use of renewable energy sources, the green transition and sustainability is the natural consequence of these actions.

7.3.Advantages of green energy islands

It is clear from the presentation of tangible examples, of energy islands both in Greece and worldwide that sustainability is achievable even from the most remote places with the smallest operating networks. In fact, the results of the use of renewable energy sources are only positive and have an impact on every sphere, social, environmental, economic. The strategies that are drawn up to promote renewable energy sources are achievable and are a motivation due to the findings that yield a resilient environment and a healthy person as a main axis.

The means to achieve the ultimate environmental goal of sustainability is clean energy. To do this, greenhouse gas emissions and the dependence of large industries on fossil fuels, the use of which burdens the atmosphere, must be significantly reduced. The use of renewable energy sources is a tool for combating these harmful pollutants and not only. The use of these technologies, in addition to their significant environmental footprint, stimulates local economies since jobs are created for their maintenance and, in general, for monitoring their operation. In order to achieve the environmental goals set by the policies that the EU has outlined and have been largely incorporated into domestic law by the member states, the action of a few is not enough, but a holistic approach by the whole of society for the transition to green energy and the creation of a resilient environment is necessary. Incentives to achieve these goals must be provided accordingly. Investment incentives, financing opportunities, access to new technologies are just some of the things that could be useful. Of course, this effort is not without challenges and obstacles to practical implementation, but with proper management and political planning, the trajectory towards green development and a sustainable future is unquestionable.

The use of renewable energy sources must be accompanied by actions that will enhance their importance. The excess energy produced by solar or wind farms should be stored and not lost. Batteries and storage stations are solutions for storage. Furthermore, the creation of smart grids could, in combination with the above, ensure energy security and adequacy in society. The most important thing for all of this to happen, is the will of local communities to become participants in these actions and to integrate green energy as a way of life. Of course, there are economic benefits, since the development of renewable energy technologies creates a new economic field in every society that adopts them. Renewable energy sources, biomass, solar and wind farms, small and smart grids, storage systems, are some of the things that energy islands use and achieve environmental goals and therefore constitute a global example of environmental management.

As a result, their mode of operation with the use of renewable energy sources draws conclusions and demonstrates implementation methods, elements that could be utilized by other places that would like to follow green energy practices, having the example of energy islands as a springboard. Through their efforts, it is confirmed how important it is for society to participate in these actions as a whole, to draw up political lines for implementation and achievement of goals and ultimately to achieve sustainability.

Besides, from these examples, regardless of the way they have decided to integrate clean energy practices, the result is one and that is the adoption of these principles. This is due to a combination of things, social acceptance and integration, political line and strategy formulation, economic and educational incentives. All of this together makes these islands successful examples to be emulated by the rest of the world.

7.4.Conclusion

Clean energy islands are an inspiration for both Greece and EU member states. Due to the practices they implement, their results provide important information for achieving sustainability, energy security and set goals of climate neutrality. The environmental, social and economic benefits of clean energy islands are many. The only thing certain is that achieving clean energy goals through the implementation of green policies is not only possible but also challenging due to the practical difficulties, however, clean energy islands are the trigger for a healthier, sustainable and climate change-resistant future.

8. Green technologies in green energy islands:

8.1.Introduction

A key factor in achieving sustainability as an ultimate environmental goal is the use of innovative technologies with the help of renewable energy sources. The technological solutions that have been explored exclusively for the energy sector are a breakthrough in the evolution of energy issues in general. They have helped remote places through the development of technologies to be energy secure, so that the constant search for financing for each stage of the evolutionary energy process is not the greatest obstacle. The same applies to unstable levels of energy demand. Pioneering technologies are solar and wind systems, energy storage stations, smart grids, hybrid grids, energy software, batteries. With the help of these technological systems, even the smallest and most remote places from the mainland, such as islands, can ensure their energy needs and ensure their energy security while also gaining stability mainly through the storage of generated energy, for any moment of instability. In this way, they reduce dependence on polluting fuels and contribute to environmental balance.
Countries with numerous islands such as Greece are a technological hub in the development and dissemination of green practices, because all technological developments aim to help remote places to the maximum with energy security issues. The development of energy practices with innovative means has exactly this purpose. To provide energy security and sufficiency to their users. Islands that adopt "green practices" with the help of renewable energy sources are energy hubs and an example to be followed by other remote places. The Greek green islands are laboratories for

learning and disseminating energy practices since, using innovative technologies, they have managed to be energy autonomous and safe.

8.2.Forms of green technologies

Technological development goes hand in hand with renewable energy sources since the production of energy from natural resources starts, among other things, through the advanced technologies that have been created to produce energy. In particular, the Greek green islands have developed innovations such as solar panels due to the abundant solar radiation that prevails almost all year round, while there is the possibility of converting solar radiation into solar thermal systems. The heat produced by them is consumed either for domestic use or at an industrial level. On the other hand, there is the energy produced by wind turbines, again produced primarily on islands, since especially in the Cyclades, there is strong wind, almost all year round. While onshore wind turbines are common, offshore and floating wind turbines are emerging as cost-effective ways of exploiting wind potential in deeper waters.

Another technological innovation is the use of a tidal current generator that operates on the momentum of waves, which it converts into energy. Continuous energy production is ensured by studies of ocean movement and the potential energy produced is estimated. It is also worth mentioning the energy produced from biomass. It is produced from forest or agricultural material, plants and especially from residues or waste and is mainly found in places with more developed agricultural and farming activity, while because of this, it has a more local scope compared to other forms of energy.

However, the key to achieving sustainability is not only in the production of energy from natural resources but also in the subsequent management of this energy. The storage of the energy produced is important. The use of batteries is a way of storing the produced energy. The most common example is the storing of electrical energy in batteries and its widespread use is found in night lights with a flashlight. In such a storage system, (BESS) both solar and wind energy are stored and create energy security and adequacy in periods with non-continuous energy flow from natural resources since renewable energy sources have this element of non-continuous flow as an inherent feature. Pioneer technologies, including solid-state batteries, provide higher energy density, longer life and safety compared to common lithium-ion batteries.

In addition, another form of innovation in energy development is pumped storage projects, widely used in remote places such as islands. Hydroelectric power pumping stations store the energy produced since they dynamically release water after it has been lifted and from the force of the descent, electricity is generated. This action helps stabilize the network while ensuring excess energy production.

Another form of green energy is the production of green hydrogen, which is achieved using renewable energy sources, solar, wind, hydroelectric, water electrolysis. The production of green hydrogen is free from any environmental burden since no pollutants are emitted, while its storage can be utilized in many sectors, such as industry, transportation in the form of electricity.

In addition, compressed air energy storage (CAE), which is usually used in the form of electricity, is a technological innovation since it compresses air and releases it dynamically through a turbine, producing energy, and offers an opportunity to balance supply and demand, especially in island environments with suitable geological formations.

In the list of forms of green energy, there are also microgrids which are widespread mainly in smaller places and are used at a local level. Practically they are local electricity networks that operate in conjunction with the solar and wind energy produced and biomass together with storage systems, such as batteries. They operate either connected to the central grid, or are autonomous, thus ensuring energy adequacy and security, efficiency and resilience to any energy changes since there is stored energy produced. Microgrids have a central controller that distributes and manages energy while maintaining production with consumption.

Not only is energy production sufficient, but its proper management is also needed to make the most of the advantages it offers. Systems have been developed that record energy demand rates in order to adjust consumption accordingly. Another innovation is the use of energy management software which, through the action of the system, can predict supply and demand and in this way, ensure the continuous supply of energy that meets the emerging needs and achieve stability. It is very important to develop ways of providing and controlling the energy produced from natural resources, especially for the smallest and most isolated places because the investments due to these two characteristics, in these places are less, than the natural wealth (sun, wind, etc.)

Another technological innovation is the use of electric vehicles (EV). This action proves that the convergence of technology and green transition can have wonderful results in the industry sector. These vehicles operate exclusively with the help of natural resources, renewable forms of energy, since they operate with the energy produced by photovoltaics and wind turbines. In this way, the emission of harmful gases into the atmosphere is reduced, while grid-to-grid (V2G) energy transfer technologies enable electric vehicle batteries to function as temporary storage, supplying the grid with electricity. Green hydrogen works in the same way, it functions as electricity and the stored energy is utilized in all areas of daily life, electric vehicles, industry, shipping, making it clear that sustainability is not only a matter of strategy formulation and policymaking, but is achievable with the partnership of nature, technology and human will.

In this climate of technological development and "green" evolution, it is necessary to mention the major issue of water scarcity that has been observed in many places and is a global phenomenon. In Greece, there is a serious issue, and it is observed mainly on the islands in summer due to tourism. It is becoming imperative to find water saving solutions but also the water supply itself. The desalination method has emerged mainly as a solution. With the use of solar or wind energy, fresh water is produced through reverse osmosis. With advanced technological means, waste is balanced after water needs are recorded and supplies are adjusted. Technological systems such as floating wind farms, tidal energy systems and general energy activities in deep sea waters are technological innovations that require further study, with their results being spectacular,

while at the same time adding another note of progress to the energy map of green development.

8.3.Conclusion

The Greek green islands, as pioneers in the field of energy policy, confirm this innovation and technological development to achieve and cover energy needs. The sequence between energy production, consumption and storage demonstrates the complex nature of these actions and the achievement of the energy goal of sustainability. Using renewable energy sources, as well as the storage of the produced energy and the development of smart networks, they acquire energy sufficiency. The progress made in the development of green technologies serves the goal of sustainability, especially in remote areas such as islands, helping to reduce environmental pollutants while at the same time being examples to study the energy transition worldwide.

9. Greek government ’s contributions and actions to reach clean energy goals in more islands

9.1.Introduction

Greece, as a member state of the EU, actively participates in the planning of the development of energy policy. However, it has drawn its own lines regarding the adoption of the principles of clean energy, while providing many types of incentives in order to integrate clean energy into everyday lives of citizens. Through the provision of economic incentives, investment opportunities, rewarding actions, technological innovations that are integrated, educational programs and actions to disseminate the concepts of green development and clean energy, Greece aims to achieve sustainability and reduce carbon emissions and dependence on fossil fuels through the development and use of renewable energy sources. These actions are in line not only with European energy policy but also with global ones.

Ideal candidates for the implementation of green energy strategies are the most remote and smaller places since they traditionally present issues related to energy adequacy and face most issues with the national central grid. The development of new renewable energy technologies on the Greek islands, for example, is an ideal solution due to their location and the natural advantages they have, such as abundant sunlight and air, especially on the Cyclades islands, while at the same time due to the extensive livestock farming, in addition to tourism, energy other than solar or wind, such as biomass, is also produced. The goal is for the islands to no longer depend on fossil fuels. Greece follows both the principles of the Green Deal and Fit for 55 package to reduce greenhouse gas emissions by 2050, utilizing all the natural wealth it has. By following this policy, it is certain that it will cover the energy needs not only of the island regions but also of the wider mainland.

9.2. Clean energy strategy

The implementation of the principles of clean energy has as a final and immediate result, the achievement of energy independence and sufficiency. By producing energy through solar, wind, biomass and innovative technologies such as green hydrogen, islands can reduce their dependence on fossil fuels and imports and achieve cost reduction and sufficient energy production. It is important to understand that energy produced and consumed from RES creates independence and, most importantly, covers both domestic and industrial needs.

The development of an energy strategy is reflected in the actions that the Greek islands are already developing. As it is abovementioned, Greek islands, are brilliant examples, such as Tilos, which has created a microgrid system that fully serves energy needs. It has developed solar photovoltaic panels, wind farms and stores the energy produced, making it fully self-sufficient in energy. Crete has also developed larger-scale projects, solar farms, wind turbines, a hydroelectric network, while promoting clean energy actions in tourism, with the creation of tourist resorts that also operate with renewable energy sources to cover a percentage of energy in this way, it uses electric cars in rental cars, promoting the policy of reducing pollutants. The Cyclades islands follow, which cover energy needs from solar and wind energy but also from biomass. While the effort of Agios Efstratios remains remarkable, which although small and quite remote has managed to eliminate dependence on fossil fuels, and to store enough energy produced from renewable sources. The examples provided by the Greek islands for the progress of global energy policy are tangible and very important, while reminding us that all that is needed to achieve sustainability is the will.

The technology that has been developed and is worth mentioning is that of the microgrid. In practice, it is a network that combines all forms of energy with storage methods and operates either fully autonomously or connected to the central grid, ensuring in each case the energy required for each area that creates a microgrid. The innovative thing is that it has a control center and determines where and when energy is needed, thus controlling the flow. It helps in the continuous flow of energy, not depending on the central grid and enhances the action of renewable energy sources since it operates with them. Equally important is the use of green hydrogen that is produced through electrolysis using renewable energy sources, which is produced without emitting carbon dioxide, making it clean for use in industries and transport.

9.3.Regulatory and financial measures

Beyond the political direction and practical implementation of the principles for the energy transition, the Greek government has instituted a series of measures to support this action. It has provided a series of financial incentives in order to increase investments in the energy sector and in infrastructure for renewable energy sources. It has proceeded with a series of tax breaks in the economic sector concerning investments in energy, while at the same time it is establishing a system for the installation of renewable energy sources on agricultural land that will favor crops and save costs and energy for each farmer who will implement this measure while at the same time, for the

installation of pv panel, it is financed to a certain extent, in order for the incentive to be greater and more tempting since the agricultural sector in the country is an important part of the GDP. In addition, the private-public partnership (PPP) creates the ground for more investments and technical expertise.
All these initiatives are extremely important, especially for places that are more remote and smaller in size and therefore less flexible in approaching private capital for investment due to higher costs. A typical example of the benefit from these actions are the Greek islands, that with the energy produced from renewable energy sources ensure their energy needs and can supply the mainland through stored energy and vice versa when necessary, through interconnection with smart grids and submarine cables.

This "interoperability" remains critical both in terms of optimization and in terms of the fact that it creates, as it succeeds a balance between supply and demand and creates the basis for energy independence. Of course, the country's energy policy and the projects it implements are in full compliance with the principles of the European Union and in fact, support is reflected in practice - financially, since there are financing, technical support and patent mechanisms, such as the European Investment Bank (EIB), the "Horizon Europe" program and the Green Deal initiatives. Financial and technological assistance also create a field on the horizon of research related to the energy sector, with the discovery of new methods of exploiting Greece's rich natural resources but also of better exploiting the already existing ones through renewable energy infrastructure.

If one focuses on the areas where the country has developed pro-environmental action and has developed renewable energy production infrastructure, one will see in practice that it has managed to dramatically reduce the cost of imported fuels intended for both domestic needs and industry, while simultaneously reducing costs, consequently reducing emissions into the atmosphere, creating jobs supporting renewable energy infrastructure, achieving economic resilience. Perhaps most importantly, it has achieved to build the foundation of sustainable future and has cultivated it socially, while making the Greek islands pioneers on the global energy scene.

9.4. Conclusion

The way in which Greece manages and implements the strategy set by the EU and its own internal policy, creates the right conditions and paves the way for achieving sustainability, setting an example of energy independence and sufficiency worldwide. It makes the most of its natural resources while making the most of new technologies to achieve the desired energy result. The mix of technology, the adoption of clean energy principles and the active action of both local authorities and society have created the right ground for the transition to a healthier and cleaner environment while at the same time creating a model for the reproduction of energy management.

10. Implementation challenges and policy recommendations

10.1. Introduction

Greece's transition in clean energy and sustainability, is undoubted, even though the transition to a fully green energy strategy, in Greek islands may be challenging, the ultimate goal remains stable. The obstacles that come up, differ, there is a wide range of issues that come up from technical and financial aspects to regulatory and social. In order to face these challenges and overcome them, there are measures needed to be taken and requires a combination of policy interventions, technological innovation, and active stakeholder engagement. It is important to take into consideration the implementation challenges and proposes recommendations to overcome them, ensuring the success of Greece's green energy goals.

It is a critical necessity and not just a wishful thinking, the shift towards a clean energy future and the demand is stronger than ever, taking into consideration the energy issues, the sustainability that is more needed than ever and generally the creation of better, healthier environment. Clean energy sources such as solar, wind, hydroelectric, and geothermal power offer substantial environmental and economic advantages over fossil fuels. However, despite their potential, the large-scale implementation of clean energy, challenges occur. Overcoming these obstacles requires coordinated and innovative policy responses and last but not least, social unity over these subjects in order a smooth and equitable transition to be ensured.

10.2. Clean energy adoption actions

It is undoubted that among all obstacles that clean energy transitions faces, one of the greatest one with economic character, is investment required for infrastructure development. Technologies such as solar panels, wind turbines, and battery storage systems often demand substantial capital, which can be prohibitive for individuals, small businesses, or governments with limited budgets. Although operating costs are typically lower in the long term, the initial expenditure remains a deterrent, especially in developing countries where access to financing is limited and this is a typical case of high initial capital costs that are occurring.

Furthermore, most current electricity grids were built to distribute energy from large, centralized fossil fuel power plants. It is most common for clean energy to be produced locally, that is, closer to the point of consumption and not so close to the central grid (decentralized energy), making interconnection with the central grid more difficult, while at the same time this difficulty is a challenge that must be resolved in order to integrate energy into the central grid. However, decentralized energy provides more favorable results since production and consumption are closer to the consumer without losses during its transmission, local networks are utilized to the maximum and there is complete independence and energy sufficiency for consumers of local consumption. Of course, these networks, due to their continuous operation, need upgrades in order to prevent energy loss at any destination they serve.

Another issue is the fact of the intermittent nature of renewable energy sources that is inherent. Solar and wind energy are not always available since they depend mostly on favorable conditions for each case, sun and wind respectively. To address this intermittent nature of renewable sources, solutions must be found to deal with periods when energy is not sufficient. The solution to this is the storage of excess energy produced or the utilization of backup power systems. By storing the energy produced, the supply and demand of energy are regulated, resulting in the effective management of energy reserves.

In the integration of the use of clean energy, stable policymaking also plays a very important role. It is clear that a well-designed and studied development plan for the use of RES will help, on the one hand, in understanding the benefits offered by their use, and on the other hand, will help in their better integration and operation by society. On the contrary, the changing environments and conditions in the drawing of the energy line only bring confusion and distance from the goal of sustainable development.

10.3. Clean energy's implementation issues

Starting from the supply chain sector, there is an issue regarding the adequacy of resources and the limitations that this creates in turn. Typical examples are the suppliers of clean energy such as lithium, cobalt, nickel, whose availability is limited. This stems from the fact that they come from specific countries while creating this dependent relationship with the countries of origin in terms of supply and what this entails. It is worth noting that even these materials need management in terms of their processing in order not to burden the environment but also the society.

The complications in the adoption of clean energy principles and the energy transition are diverse issues with an impact on a wide range of factors. Issues of infrastructure projects often raise local reaction and are disapproved despite the fact that the transition to clean energy is a politically supported action. Issues arise at the level of land use, environmental disturbance, noise pollution and change of the previously existing environmental use, such as the movement and relocation of agricultural activities, or of the indigenous people of the area, resulting in reactions and tensions that make it difficult to implement RES projects.

In addition, bureaucratic issues create additional obstacles and delays in the process of developing RES infrastructure. There is a delay in the licensing process due to overlapping responsibilities, property ownership issues and raised ownership issues of the Greek State on various lands that are requested for the installation of RES, and the collection of opinions on the requested land from each involved authority of the decentralized administration is also time-consuming. These are just some of the issues that arise during the process of transition to clean energy. Issues are also raised in areas that have increased tourist activity as permanent residents maintain reservations regarding the quality of services that will be offered, noise pollution and the alteration of many areas. It is imperative to take measures for all the above. It is needed to strengthen the institution of RES, and to ensure the maintenance of balance with local communities.

Feed-in tariffs and long-term energy supply agreements (FITs and PPAs) are tools that can be used by investors to make renewable energy investments more attractive. In the same context, carbon pricing - through carbon taxes or cap-and-trade systems - can reduce the environmental impacts of coal and fossil fuel, using and creating equal opportunities for competition in the energy market for all.

To be integrated into the central energy grid, decentralized networks that use renewable energy sources require continuous work and network upgrades to ensure their smooth operation. In fact, in order to increase the dynamics of the central grid, new technologies for RES should be expanded, such as smart and small grids, energy storage systems, which will help increase society's trust in the use of RES while at the same time mitigating their intermittent nature.

Beyond financial incentives, actions should certainly be taken regarding education and research and the development of new technologies for consumers to benefit to the maximum from the use of RES. A significant contribution to this will be the partnership of private and public bodies to promote actions and innovations in the field of energy and its alternative forms. Real government support for pilot projects and demonstration programs will certainly help in the development of new technologies and the provision of incentives.

It goes without saying that all the above are important because they have been institutionalized as incentives for RES. Such strategic frameworks are necessary in order to spread the use of alternative forms of energy and even more to make more investments in this sector to promote sustainable development. A clear regulatory framework and the development of applicable strategies will help to create more interest in investments in the RES sector, while at the same time measures should be taken by the government to reduce bureaucracy and administrative obstacles.

The transition to clean energy is not an easy task, but it is an urgent need given today's environmental conditions. The state is the first link in the chain that should give the impetus for this transition by establishing the critical elements and establishing procedures, always having society as a guide, which is called on to implement and support the creation of new technologies. Therefore, the energy transition must first and foremost be fair and benefit citizens, through the provision of economic incentives, jobs, education. It is very important that local communities participate in the creation of these projects, in the environment they live in, to benefit to the maximum but also to become part of clean energy.

Governments should ensure the continuous supply and flow of energy, to reduce the use of imported fossil fuels in order to preserve critical minerals with mining and recycling capabilities based on the principles of the circular economy and with a significant reduction in negative impacts on the environment.

10.4. Clean energy transition

It is clear that, the transition to clean energy is a complex task, with several challenges, however the obstacles are not insurmountable, as long as there is a firm political and social will. Politicians, economists, social actors, institutions, education, technology

and science should collaborate for the desired result for the transition to be as smooth and effective as possible. All the advantages of using clean energy should be put forward and of course the necessary incentives should be given to society for the integration of clean energy actions and infrastructure development. Considering all of the above and always with a healthy and resilient environment in mind, sustainable development is achievable.

10.5. Conclusion

Greece has all the qualifications to lead the energy transition at a global level, since its geomorphology makes it an ideal candidate for the development of renewable energy technologies and actions. The green transition in the country has already started. The Greek islands can become a pillar of clean energy in the Mediterranean with the development of smart grids, RES infrastructure, storage systems, and incentives for energy upgrading. The key to this upgrade remains the local initiative to take environmental actions and adopt the principles of green energy. The transition to clean energy is also an absolute priority of the Greek government.

11. The impact of the adaptation of these principles on Greek islands

11.1. Introduction

In a country like Greece, which relies almost exclusively on fossil fuels for energy and even imports a large part of them to cover the energy needs of both households and industries, the adoption of clean energy and its integration into the daily life of the country is a very important step. Nevertheless, the path to achieving climate neutrality and sustainability is not an easy one.
In any case, it is necessary to lay the foundations to pave the way to sustainability and to overcome any issues that have arisen since the transition to clean energy has become an absolute priority both in the policies outlined by the EU and in domestic law. Climate change is here; it is obvious and is affecting the lives of societies to the maximum. For Greece, the energy transition to a sustainable future is a very important step, especially for its islands, which due to their geographical location face energy challenges. Most islands depend on fossil fuels and diesel generators, resulting in increased costs and despite the high cost, due to tourism, even this is not enough to fully cover their needs. This of course also has an impact on their ecosystem since the environment is degraded by polluting gases. Covering energy needs from renewable energy sources has multiple, positive impacts in many sectors while creating energy autonomy and economic resilience, without being affected by economic energy policies. After all, many of the Greek islands have entered this new era of energy transformation with spectacular results.

11.2. Environmental Impact

The first sector that is deeply affected by climate change is the environment. The adoption of clean energy principles is what will make the difference. In particular, in

the parts of Greece that depend to a large extent on fossil fuels and diesel generators to meet energy needs, such as the islands, the environmental burden is great from pollutant emissions and the worst thing is that the coverage of energy needs, especially in the summer months, due to over tourism, is not achieved one hundred percent. However, the energy shift that the Greek islands have made is changing the environmental data so far. The installation of renewable energy infrastructure and the collection of solar and wind energy, the creation of smart networks, the utilization of biomass, geothermal and hydroelectric energy is an immediate and important solution to the energy issue of the Greek islands. Of course, the production and utilization of this energy, in cases where microgrids are connected to the mainland, also facilitate the energy needs of the central Greek area. Of course, the infrastructure supporting renewable energy sources also contributes to this - accompanying projects, such as energy storage stations, batteries, etc. All of this contributes beyond reducing emissions of harmful gases into the atmosphere and ensuring energy adequacy and self-sufficiency, economic stability and social well-being. Let us also not forget that in addition to air pollution from the combustion of polluting gases, oil spills also pollute the sea, which has a serious impact on the islands, and by extension on tourism and therefore on the country's economy.

The Greek islands have rich flora and fauna, and the sea is home to many species of fish and other rare marine species and their protection starts from the shift to sustainable development and the integration of the principles of clean energy. The practices followed by the country in relation to energy policy are fully harmonized with the European environmental policy, since they are in line with the "Green Deal" and the "Fit for 55" strategy for the reduction of greenhouse gases in the atmosphere and climate neutrality. Islands are classified as sensitive ecosystems and their protection is necessary for this very reason, even the installation of renewable energy infrastructure should be done with absolute respect to the environment and local ecosystems so as not to alter the landscape, create noise pollution, or generally disrupt the local habitat, in order to protect the uniqueness of these places and not affect their main economic tool, which is tourism. Sustainability, which is the ultimate ecological goal, is achievable.

11.3. Economic Impact

The benefits of adopting the use of renewable energy sources naturally extend to the economic field. In fact, the use and production of energy from renewable energy sources so far shows that it is a profitable process. Direct economic benefit results from the reduction in the import of fossil fuels, which was done abundantly until now to meet the needs mainly of the islands. In addition, cost reduction also results in electricity since renewable energy sources cover these needs and due to the storage of the energy produced, while for the same reason the consumption and transport of diesel oil is reduced, which as a process is quite complicated and expensive due to the cost of transportation and the inaccessibility of the areas. One of the most direct benefits is the reduction in the cost of electricity, while at the same time with the reduction in the associated demand, market prices fluctuate less. It has been observed that the installation of RES results in low operating costs and stable market prices. In addition to the infrastructure that has been created for renewable energy sources, new jobs have been created at the same time, both for the technical and practical part of monitoring and operating the infrastructure and for the scientific part of finding new technological

practices and developing new ones. Furthermore, the energy transition has also created new forms of tourism, such as ecotourism where all activities take place in the environment, RES projects are combined with popular tourist resorts. Besides, the adoption of the principles of clean energy results in clean islands, which equates to more profits for both local businesses and the country as a whole. It has also been observed that islands that use renewable energy sources are more attractive as green tourist destinations since most tourists prioritize sustainability. Therefore, islands that demonstrate a commitment to clean energy may see longer tourist seasons, higher visitor numbers and improved revenues for local businesses. It is worth mentioning that it is quite common that, if the surplus energy is sufficient and stored, it is ultimately sold to an area or business that needs it most (net billing), thus generating an immediate financial benefit. Many individuals construct properties and install infrastructure to cover the energy needs of the building or business, such as solar panels, which are the most common, resulting in a higher cost if an opportunity arises to sell, but also in the case of renting, due to its energy independence from the central energy supply network. Something similar happens in agricultural products where their production and development is based to a certain extent on RES installations, such as greenhouses with solar panels, farms with RES installations that allow cultivation. These environmentally friendly actions increase the cost of both the property itself, and the product produced therefore. Places that develop environmentally friendly practices and adopt clean energy increase their profits and their visitor numbers.

11.4. Social Impact

The adoption of clean energy principles has equally important implications. The import of fuels, the stability of electricity and in general the high demand for energy, especially in the summer months, has both physical and social impacts, since it creates difficulties in daily practices such as planned or unplanned power outages. All social services, from catering to health, are affected in this way. The use of renewable energy sources, and specifically the storage of excess energy produced, solves these issues and is provided uninterruptedly. In addition, energy from renewable sources offers a more stable price, making it more accessible to everyone, providing more people with the opportunity to use it. This reduces the cost and consequently energy poverty. In addition, collective actions to promote green practices of educational and practical content strengthen the feeling of social participation in the energy transition. While the development of microgrids in local communities makes citizens partakers of energy security and adequacy, participants in technological projects of public benefit and better informed, since they enjoy the benefits of continuous and uninterrupted clean energy.

In addition, RES models increase jobs and stimulate local communities economically and socially since people work in new positions of technological practice and development of these systems, adding to the social hierarchy, a new professional group, with significant social benefits, beyond technological development.

It is worth mentioning that according to studies, it has been observed that the use of renewable energy sources reduces the impacts of climate change and extreme weather events since the ecosystem is not burdened as much by practices such as the use of fossil fuels and the release of harmful gases into the atmosphere. The use of electric

vehicles, which are subsidized to a certain extent and with state funds, is increasing, thus strengthening their social appeal and facilitating their purchase by citizens.

The major thing, however, is the fair distribution and equal access of citizens to clean energy and sustainability therefore, which is efficient and extremely economical in relation to the energy supply so far. The goal is to make all citizens participants in the energy transition.

11.5. Conclusion

The Greek government is implementing a dual approach to the energy transition, which is derived from the strategies outlined in the energy sector. More specifically, it aims, among other things, to achieve energy autonomy and sufficiency for the smallest and most isolated parts of the island country and the transition to sustainability. The development of microgrids and smart grids, but mainly the ability to store energy produced by RES, is the key to energy upgrading, since even the most remote parts gain energy security and provide the ability to interconnect with the mainland, even using submarine cables, in order to provide backup energy in case of need. In this way, energy supply and demand are balanced, while energy resilience is achieved.

We must bear in mind that the implementation of new RES technologies on the Greek islands, as well as the development of new technologies such as green hydrogen, biomass, etc., in addition to the multiple and multi-level benefits to the environment, society and the economy, provide important data for the energy transition and the procedural issues of achievement and certainly for its benefits. Moreover, these data can constitute important examples and a source of inspiration for actions to be taken by other local communities, to achieve the long-awaited sustainable development overall.

12. Conclusion

12.1. Introduction

It must be understood at every level and stage that the transition to clean energy and the achievement of sustainability is not simply a strategy or a political announcement to raise awareness of a social group, but is a necessity, environmental, social, economic. The increase in the world population also increases energy needs, resulting in an increasing burden on the environment. It has been proven that the current energy sources such as coal and fossil fuels, oil, degrade the environment and consequently the quality of life. On the contrary, the use of renewable energy sources has only a multi-level, positive effect with brilliant results.

12.2. Adopting clean energy

On an environmental level, the adoption of clean energy implies the protection of the environment. The use of fossil fuels, due to the release of carbon dioxide, greatly burdens the atmosphere and air quality. Other burdens for the environment are water pollution from oil spills, the rise in sea levels and, respectively, the melting of ice due

to global warming, leading to a change in the environmental balance and bringing about unusual climatic phenomena, in many cases extreme, which have a direct social impact. In contrast to all this, the use of clean energy and green technologies reduces, if not eliminates, these environmental impacts, while it has been observed that the benefits are much greater and more tangible in densely populated areas where harmful gas emissions are correspondingly increased. The atmosphere is quite polluted and living conditions are unhealthier with long-term environmental impacts.

In contrast to fossil fuels, energy produced from renewable energy sources, with proper management, is the safest choice, even though their intermittent nature can create concerns regarding adequacy, proper management of the energy produced and its reserves, excludes any malfunction. To this must be added the benefit to the environment, society and the economy since it has been proven that the energy resources used are absolutely harmful to the environment (coal, oil), their import is necessary and this burdens the national economy due to the increased cost while the environmental impacts concern first and foremost society. The cultivation of environmental awareness and local actions to disseminate the benefits of clean energy in combination with the development of new RES technologies, lead to the ultimate environmental goal, which is sustainability.

12.3. Energy security

It is certain that countries that use mainly fossil fuels that they import to meet their energy needs are largely exposed to energy instability and high economic costs, as well as to emerging supply difficulties. This process, as is understandable, makes the energy transition difficult. Because of these, the shift to the use of clean energy is an imperative and this will be achieved through renewable energy infrastructure and the development of new technologies in the energy sector. With the use of energy produced from renewable sources, dependence on imported fuels is reduced and global instability in the energy market does not have the same impact on the country's internal energy policy, which, due to RES, acquires self-sufficiency and adequacy in the energy needed to meet daily needs. These findings are even more evident in smaller and more remote places such as islands, which faced difficulties in connecting with the mainland anyway.

12.4. Economic Benefits

As we have already mentioned many times, the use of fossil fuels to meet the necessary energy needs has several disadvantages and multiple levels. It also has major impacts on the economic sector since the import requires increased costs which increase in cases of global energy instability while costs also arise during their transportation. However, in the case of the use of renewable energy sources, things change because the production of energy and mainly the storage of the surplus, creates the conditions for energy sufficiency and security, offsetting the costs of purchasing and importing new energy while the potential global energy instability does not affect the national economy. In addition, the development of technological energy innovations and in particular the use of RES creates jobs at all stages of the production operation, resulting in stimulating the local society and market. In fact, renewable energy, in various economic and technical measurements, appears to have a significantly lower cost than

conventional energy from fossil fuels, being increasingly chosen by households, businesses and industry as the cheapest and most sustainable option.

12.5. Environmental Benefits

The first sector that is completely affected by the use of fossil fuels is public health since the environment is burdened with harmful gases such as sulfur dioxide, nitrogen oxides and other harmful microparticles which are inextricably linked to cardiovascular diseases and respiratory problems. These data can of course be changed and improved with the use of clean energy. Public health and quality of life have also improved through the adoption of clean energy. There is also noise pollution from fuel use units and water pollution from oil spills. These can of course be reduced and eventually eliminated by the use of renewable energy sources and the energy transition through the improvement of living conditions.

The energy produced from renewable energy sources reduces the environmental risk but also the risk to public health. In addition, these energy systems create conditions of reliability and stability in the energy market. In fact, in the event of energy disasters, these systems, local, smart networks, maintain the production and flow of energy stable, without long-term interruptions, improving the vulnerability of these systems. A significant contribution to the continuous and uninterrupted flow is the storage of the produced energy, which is extremely critical in periods of energy instability, offering reliability to RES systems and energy sufficiency.

12.6. Social Benefits

Energy from renewable energy sources addresses a wide network with footprints on the environment, the economy, and of course, society. Initially, the locally produced energy creates the basis for equal and direct access to meeting the energy needs of a local community, a good that sounds obvious but in reality, is not since the connection to the continental grid is particularly difficult, especially for small and remote places. In addition, the development of RES infrastructure creates jobs in the development, technology and maintenance of these projects, utilizing the knowledge of the citizens of local communities and stimulating them economically. In short, energy poverty is reduced while local communities are stimulated, in terms of energy, labor and finances and participate in more actions to disseminate clean energy technologies and promote the ideas of sustainability. Fertile ground is being created for finding sustainable solutions in every sector related to social life, transportation, heating, and industry.

12.7. Conclusion

The sum of what has been stated above is condensed into one sentence. Greece is moving rapidly but steadily towards sustainable development. It has integrated clean energy into all sectors of social life with every innovative technological means, from households and businesses to industries and the agricultural sector. It provides the resources to anyone interested in developing ecological awareness and action in order to secure their energy needs but also to contribute to sustainable development with the main milestone being the purification of the environment. From the strategic outline,

the adoption of a political position to the implementation and finding the means for the universal use of green energy, the time is long, but the beginning has been made and it is strong. Of course, the challenges and obstacles to the energy transition are many and multifaceted, but stable policies along with the will of local communities make the goal of sustainability achievable. The use of clean energy lays the foundation for an environment free of polluting gases, a healthier planet and certainly a safer future for future generations. Environmental well-being is ensured using renewable energy sources which in turn leads to the well-being of the planet's inhabitants.

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