ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΙΡΑΙΩΣ
UNIVERSITY OF PIRAEUS

Thesis topic: Renewable energy sources in Greece : Potential opportunities and challenges

By: Fenia Panagopoulou

Professor-Supervisor: Spyros Roukanas

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Abstract

The renewable energy sources sector constitute a very important subject nowadays on a global level and many nations are trying to direct some investments in this field. After the pandemic strike and the conflict between Russia and Ukraine a problem that appeared was the energy crisis. Energy prices has gone up and energy poverty has risen in many countries. As an answer many countries have started trying to be energy independent, something that can happen through renewable energy sources.

So, in this thesis we examine the renewable energy sources sector in the context of energy economics and the latest developments. There are many types of RES such as solar and wind energy, with a lot of room for improvement in order to tackle energy poverty. The EU Green Deal launched in 2020 has some useful instructions to offer in order to make European countries energy independent as much as possible. In this context there are also many opportunities for Greece, a country with a lot of renewable sources due to its geographic position. From the examination of some RES stations in Greece it is clear that the country should facilitate investments in this direction, because there can be many benefits from renewable energy.

Key Words

Energy crisis, Energy economics, Renewable energy sources, SWOT Analysis, Case study, Wind energy, Photovoltaic stations

Chapter 1. Introduction to thesis subject

1.1 The aim

The global energy landscape is undergoing a significant transformation driven by concerns about climate change, energy security, and the need for sustainable development. In this context, renewable energy sources have gained prominence as a viable alternative to traditional fossil fuels, offering the potential to mitigate greenhouse gas emissions, enhance energy security, and foster economic growth. Among the countries embracing this transition, Greece stands out as a nation with abundant renewable energy potential. This chapter introduces the research focus and provides an overview of the background and context that underscore the significance of the study.

The primary aim of this thesis is to analyze the potential opportunities and challenges associated with the integration and utilization of renewable energy sources in Greece. By assessing the various renewable energy technologies available and considering the country's geographical, economic, and regulatory contexts, this research seeks to provide insights into how Greece can effectively harness its renewable energy potential. In addition, based on the proposed topic, another aim is to explore the field of Renewable Energy Sources (RES) in Greece, during the last years, in order to clarify the opportunities, challenges and perspectives of the specific sector. This sector will be examined during the impact of negative externalities on the economy such as the Covid-19 pandemic crisis and the conflict between Russia and Ukraine. This will contribute to present the steps that have been taken in Greece for a green transition, especially since it has given a direction through the Green Deal targets for 2050. Also, we can spot if the global pandemic of Covid-19 had an impact on renewable energy sources in Greece.

1.2 The methodology

The research design is a mixed-method approach, incorporating both qualitative and quantitative research methods to provide a comprehensive analysis of renewable energy sources in Greece. At first there is a bibliographic overview about RES, in order to understand how this sector developed in Greece. Through the presentation of previous research results and conclusions, a better understanding of the subject will be achieved, before proceeding to an analysis of the current situation based on data. The data will concern the percentage of RES in the energy mix of Greece, but also the sectors with the greatest contribution (e.g. wind energy, solar panels). Through the data, a SWOT analysis can be created regarding the opportunities, threats, strengths and weaknesses of RES in Greece. Finally, a case study could be cited, such as the wind farm on the island of Agios Georgios and how energy production contributes to the country's economy. These case studies will offer insights into project implementation, technology choices, and outcomes.

1.3 The structure

The structure will include indicatively 6 chapters. The first chapter is an introductive one to the thesis. It includes the sections of the main aims of the thesis, the methodology that followed in order to conclude in correct results, the structure and the contribution of the thesis. Besides it is very important to clarify the significance of the subject, which concerns a contemporary branch of economic science.

The following two chapters are the theoretical ones, based on the bibliographic review. It is very important to present all the theoretical terms concerning the sector of energy economics as well as the renewable energy sources. In that way the research that will follow will be supported in the right theoretical background and the data used will concern only the main terms of this thesis. Through the theoretical background of energy economics, we will clarify terms such as energy poverty, energy pricing and allowances for energy bills, keeping in mind the recent events of the covid-19 pandemic

and the Russian – Ukrainian conflict, that affected a lot the energy field. In the third chapter where we present the multiple theories surrounding renewable energy sources field. The affection of recent events will also be spotted in addition with the European instructions concerning the Green Deal and the Greek legal framework for RES. It also records the high significance that RES have on the economic science.

The fourth chapter will concern the Green Deal in Greece and the drawing conclusions based on it. There are many challenges and opportunities arising from the Greek Green Deal, especially when we are referring to a country with lot of potential in the field of RES. Based on the theoretical background and the data a SWOT Analysis has been presented where it is clear what are the strengths and the opportunities in the RES field in Greece and on the other hand the weaknesses and the threats. In the fifth chapter, a SWOT analysis for RES in Greece will be presented. The fifth chapter reflects the examination of some case studies of the operation of RES in Greece and their contribution to the domestic economy. Our research in this chapter is based on wind and photovoltaic parcs in Greece. Through that we have all the necessary data concerning the economic and energy field under the scope of RES in the country. Thus, we have a complete picture of the RES field in Greece.

All the above contents will eventually lead us to the conclusions about the potential opportunities of renewable energy sources in Greece as well as the challenges this sector can face in the sixth chapter of the thesis. Apart from the conclusions, another topic that concerns us and rises from the theoretical review and the research is the suggestions for future research. Based on the final results on the energy field and the RES in Greece, future researchers can examine this subject on a larger scale.

1.4 The contribution of the thesis

In the context of the global energy crisis and the growing emphasis on sustainable energy solutions, this thesis delves into a comprehensive exploration of renewable energy sources in Greece, focusing on the potential opportunities they offer and the challenges that need to be addressed. The overarching goal of this research is to shed light on the intricate interplay between renewable energy, energy economics, and the

local environment. This chapter outlines the key contributions and insights provided by this thesis in addressing these critical issues.

The thesis will contribute to the examination of a field, RES, which until about a decade ago did not gather significant interest. However, today, due to climate change and other externalities, it has attracted significant interest from many states in the world, while the E.U. has issued a series of directives concerning him. Examining this issue at the national level after the pandemic crisis and the conflict between Russia and Ukraine, is something that has not been studied in depth based on the existing literature.

One of the core contributions of this thesis is the detailed exploration of Greece's renewable energy potential. By conducting an in-depth analysis of wind energy and photovoltaic stations, this research provides a nuanced understanding of the country's capacity to harness these resources. The identification of key geographical locations and the assessment of energy production capabilities offer valuable insights for policymakers, investors, and stakeholders interested in leveraging Greece's renewable energy potential. The incorporation of a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis within this thesis adds another layer of contribution. By evaluating the internal and external factors influencing the implementation of renewable energy projects in Greece, this research presents a holistic view of the country's readiness to embrace sustainable energy solutions. The SWOT analysis serves as a roadmap for devising effective strategies to maximize strengths and overcome challenges.

Overall, by analyzing Greece's renewable energy potential, conducting a SWOT analysis, and presenting some case studies, this research empowers policymakers, investors, and stakeholders with valuable insights to drive the country's transition towards a greener and more sustainable energy future. Through its multifaceted approach, this thesis fosters a holistic understanding of the complexities involved in integrating renewable energy sources into Greece's energy landscape.

Chapter 2. Theoretical terms in the field of energy economics

2.1 Introduction

Energy serves as the lifeblood of industrialization, economic growth, and human well-being. Energy and its different sources are a crucial one factor for economic development and in general is a vital element for the development of mankind. The storage of energy contributes in building societies through the years. More energy and more efficient consumption of it gave the possibility to provide greater amounts of heat, electricity developing other sectors such as that of transport (Fouquet 2008). Nowadays, economies are driven by increasingly specialized techniques in the collection, storage and utilization of energy resources. The development of economies is closely related to the availability, export, distribution and use of energy. So, energy economics is the interdisciplinary study that unites the realms of economics and energy. It encapsulates the intricate relationship between energy resources, production, distribution, consumption, and their economic implications. In essence, energy economics investigates the ways in which societies allocate, utilize, and manage energy resources to satisfy their needs and aspirations. It encompasses a myriad of topics, from energy markets, pricing mechanisms, and policy formulation to environmental sustainability, technological innovation, and geopolitical influences.

Energy economics is a trend that has taken shape over the past half century or so. Thus, energy economics is a scientific field that includes issues related to the supply and use of energy in individual socioeconomic systems. It also highlights energy sources, resources and energy products, which are directly linked to energy demand. After all, the use of energy stems from the (economic) structures of demand and supply (Ntanos et al., 2018).

Having all these in mind, it this section we present all the theoretical approaches concerning a newly created branch of economics, energy economics. It is important to notice how it was formed and its impact in the science of economics. Apart from that

there are some useful terms such as energy pricing, the energy markets structure and energy policies. The examination of these terms can lead us in understanding energy economics and how they operate in the everyday life of any society. Above all economics is a social science, due to the fact that the human factor is vital for this science. Moreover, we examine how the energy poverty of the last years was formed and what strategies have been used so far in order to tackle its negative effects. All these sections of this chapter will eventually lead us to some conclusions concerning energy economics, policies, markets and recent facts such as energy poverty. In that way we will be able to explain how energy demand and supply contribute in negative energy facts, such as poverty.

2.2 The field of energy economics

Energy at a national level is one of the most important goods that make it independent or dependent respectively on other countries and shape its power in an international, complicated, dynamic and highly competitive environment. But, apart from these, energy could also play an important role in the overall development of the economy by strengthening its macroeconomic indicators, in a positive direction both in the short and long term without being affected in case of negative fiscal measures of any country (Sklias et al., 2017).

In the 1860s, the initial large-scale exploitation of oil wells took place in Pennsylvania, located in the northeastern region of the United States. By the 1880s, a single company known as Standard Oil emerged as the primary producer and distributor of petroleum products. This company effectively controlled both the quality and pricing of these products, which brought stability to customers seeking lighting oil in a volatile market (Fouquet, 2009). With the advent of the internal combustion engine in the early twentieth century, the usage of petroleum products expanded significantly, especially in the transportation sector. During the period between the two World Wars, a considerable drop in car prices triggered a substantial surge in gasoline demand. As a response to antitrust legislation, more suppliers entered the oil market, resulting in a gradual decline in oil prices from the 1930s until the early 1970s.

Following World War II, global oil production and consumption experienced a rapid surge. This was driven by a soaring demand for private transportation and the broadening utilization of oil for various purposes, including heating and even electricity generation. However, starting from the early 1970s, the United States, despite being the world's largest oil producer, found itself consuming more oil than it could produce for the first time. This shift meant that American companies lost the ability to regulate oil prices through production cuts, ceding this power to Saudi Arabia, a key member of OPEC. In response to policies in the Middle East initiated by North American and European nations, Saudi Arabia curtailed oil supply and raised prices, triggering the oil crisis of 1973. This crisis was followed by additional concerns about oil supply in the Middle East in 1979 and 1980, precipitated by the Iranian Revolution and the Iraq-Iran War, both of which had significant impacts on oil prices, allowing them to rise considerably (Black, 2000). Moving into the mid-1980s and 1990s, a surplus of oil emerged as many countries ramped up production. Despite low prices, consumption surged, especially due to the rapid growth of developing economies in Asia. The early 21st century marked a return to rising oil prices due to heightened global demand and political instability in the Middle East. However, by the end of the first decade of the 21st century, as the world economy entered a recession, oil prices once again declined, enabling energy companies to expand their reserves and infrastructure. During the 1960s and 1970s, concerns about energy supply security prompted various responses from oil-importing governments (Smil, 2018). Some nations sought to establish strong diplomatic ties with oil-rich countries, while others explored domestic oil exploration. Several countries also began to invest in alternative energy sources such as natural gas, which originally had been used for lighting in the mid-19th century.

Concerns regarding the security of oil supply had prompted consumers to adopt natural gas for heating, and producers began spreading their production across expanding demand sources as a risk mitigation strategy. Following the oil crises of the 1970s, the natural gas market expanded swiftly, constituting 21% of the global energy market by 2000. Prior to the 1960s, coal was the primary source for electricity generation. However, the share of electricity generated from oil increased until the oil crises in the 1970s, prompting many economies to explore the advantages of hydropower. In the aftermath of World War II, the quest for affordable electricity led many governments to support nuclear power programs. While nuclear power contributed significantly to

the electricity supply of certain countries, concerns over anticipated costs and safety issues hindered the advancement of nuclear energy in other regions (Black, 2000).

Coming to the 21st century, shifts in energy supply and demand within an economy have global repercussions. The global economy increasingly operates as a unified and interconnected energy consumer. Consequently, it's valuable to examine worldwide patterns in energy consumption. As previously mentioned, the gradual transition from firewood to coal commenced in the latter half of the 19th century (Fouquet, 2009). In 1900, firewood was still believed to cater to nearly 40% of the world's energy requirements. By 1950, fossil fuels were estimated to constitute 75% of the total, and by 2000, this estimate had risen to 78%. Remarkably, biomass fuels have exhibited remarkable resilience, continuing to fulfill approximately 10% of the world's energy demands.

Energy is usually defined as the means or ability to do work or produce heat (normally heat could come from burning a fuel - i.e. a substance containing internal energy which on burning produces heat, or by other means - such as capturing the sun's rays or from rocks below the earth's surface and therefore can be produced in a variety of ways. The first categorization can be made into primary and secondary. In primary the particular form of energy has not undergone change or conversion, except for separation and purification (e.g. solar energy coal reserves, crude oil, natural gas, nuclear power, etc.) while in secondary a process of transformation or conversion is used (petroleum products or electricity). A second separation concerns renewable and non-renewable energy sources: primary energy comes from a finite resource stock (coal or crude oil) On the other hand, if there is primary energy obtained from a continuously available flow of energy, the energy is known as renewable energy sources (solar energy, wind energy, are renewable energy sources) (Edenhofer, 2013). Finally, there is a third division into conventional and non-conventional. Conventional sources of energy are those which are usually obtained through known technologies while non-conventional sources of energy are those which are obtained using new, innovative technologies or sources. At this point, however, we should emphasize the important role of information that makes decision-making more efficient for several policy makers. Information in the field of energy should be reflected in energy use by various economic activities, energy production, transformation and distribution to users, the technical and

production characteristics of the different factories, the financial characteristics as well as other cost elements and finally various macroeconomic data (Bhattacharyya, 2019).

In the context of energy economics, it is important to present two important factors. These are the energy demand and the energy supply. Energy demand usually refers to the type and quantity (necessary) of energy that satisfies the needs of each of us for some amounts of energy (e.g. cooking, heating, transportation). So energy can correspond either to the necessary amount of energy for a country (primary energy demand) or to the amount provided to consumers (final energy demand) and it is necessary to distinguish between these terms. Energy supply pertains to the availability of energy resources to meet the demand. These resources encompass both fossil fuels (like coal, oil, and natural gas) and renewable sources (such as solar, wind, hydro, and geothermal). Energy economists assess the potential of these resources, taking into serious account factors like reserves, extraction costs, technological advancements, and environmental impacts (Jenniches, 2018).

Having all these in mind energy economics have a great degree of complexity that stems first from the differences in the trading area (e.g. pollution, technological status, human resources), from international influences (existence of organizations such as the World Bank, the IMF, etc.) as well as from other influences (e.g. competition, partnerships) (Percebois & Hansen, 2022). Energy economics constitutes a division of practical economics that employs economic concepts and methodologies to pose appropriate inquiries and to methodically analyze them, thereby cultivating a comprehensively informed comprehension of the subjects at hand (Bradford, 2021). Through energy economics we can examine the economic impact of energy field.

2.3 Energy Pricing, Market Structures, and Policies

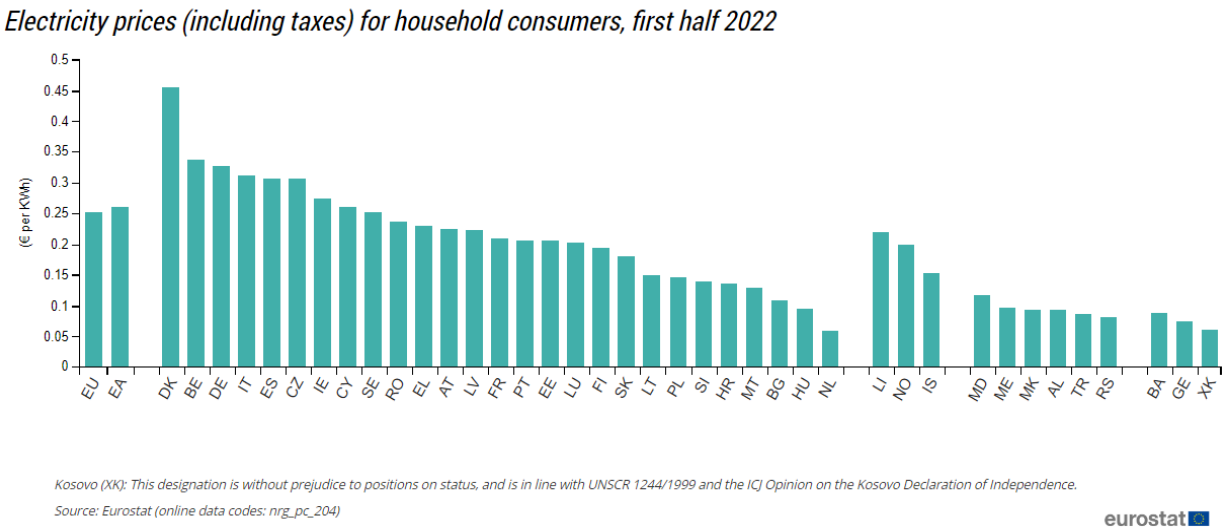
An important factor of energy economics is energy pricing which refers to the determination of the cost at which energy, such as electricity, natural gas, oil, or even energy coming from renewable sources is sold to consumers, enterprises, industries and countries. It involves setting a monetary value on energy resources to cover the expenses of producing, distributing, and delivering energy to end-users, no matter if the

user is a household or a whole country. Energy pricing plays a crucial role in shaping energy consumption patterns, influencing investment decisions, and balancing economic considerations with environmental sustainability goals (Bradford, 2021). In addition, energy pricing constitutes a significant tool within the comprehensive energy strategy of any nation and is employed to fulfill a range of often conflicting objectives. Furthermore, domestic energy prices are partially shaped by the interactions and influences of global energy markets, alongside the sociopolitical landscape of the country. Given that energy serves both as an intermediary input and a final output, pricing necessitates differentiation between producers and consumers. Additional factors such as resource depletion, capital intensity, and non-storability must also be considered where relevant (Al-Mulali & Ozturk, 2016). Hence, establishing price structures for energy commodities is an intricate and challenging endeavor. To comprehend and address the inherent intricacies of energy pricing, a proposed two-phase strategy emerged from existing literature. The initial phase involves evaluating prices solely from an economic standpoint. Subsequently, these economic prices undergo modifications in the second phase to align with additional objectives, thereby providing insights into the deviations from the fundamental economic price framework (Bhattacharyya, 2019).

The first concept is the one of average cost pricing. It employs the production costs of a representative firm that strikes a balance, avoiding excessive losses or significant gains. This approach takes into account both capital and operational expenses, dividing them by the output. The method's broad appeal stems from its inherent simplicity. From a theoretical standpoint, in a competitive market operating under standard assumptions of constant economies of scale, unchanging technologies, and perfect divisibility of capital, the optimal level of production aligns average cost with marginal cost in the long run. This implies that the firm's expansion trajectory is defined by the long-run average cost curve, and average cost pricing functions effectively when numerous firms compete in the market, producing uniform goods. However, economically speaking, average cost carries certain drawbacks. First of all this method lacks incentives for performance enhancement, allowing weaker firms to coexist with stronger counterparts (Pandey, 2002). In addition, it relies on historical costs and neglects the expenses associated with new capacity additions, which could significantly differ from historical costs. Last it fails to offer sufficient signals to investors.

The second concept is the marginal cost approach. The basis of this approach derives from the competitive market model, where prices are determined by the marginal costs set by the last supplier (Barrage, 2020). This framework arises under the conditions of pure and complete competition, leading to a price that curbs inefficient consumption and production of goods. Moreover, this ensures Pareto optimality, aligning with the principles of neoclassical economics. However, it was highlighted that due to the distinctive attributes of the energy market, the application of marginal cost-based pricing might not be suitable. The challenge stemming from the indivisibility of capital illustrated that adhering strictly to marginal cost-based principles could result in price instability. Nevertheless, strategies to manage the price volatility arising from this approach require attention. Existing literature proposes an alternative: long-run marginal cost-based pricing, which charges consumers for future investments in capacity expansion each time they purchase a commodity. Additionally, the discussion touched upon monopoly and natural monopoly market structures in the energy sector. These adjustments tend to bring pricing more in line with average prices, diverging from the concept of marginal cost (Bhattacharyya, 2019).

Figure 1. Energy prices as formed for the first six months of 2022.



Source: Eurostat (2022).

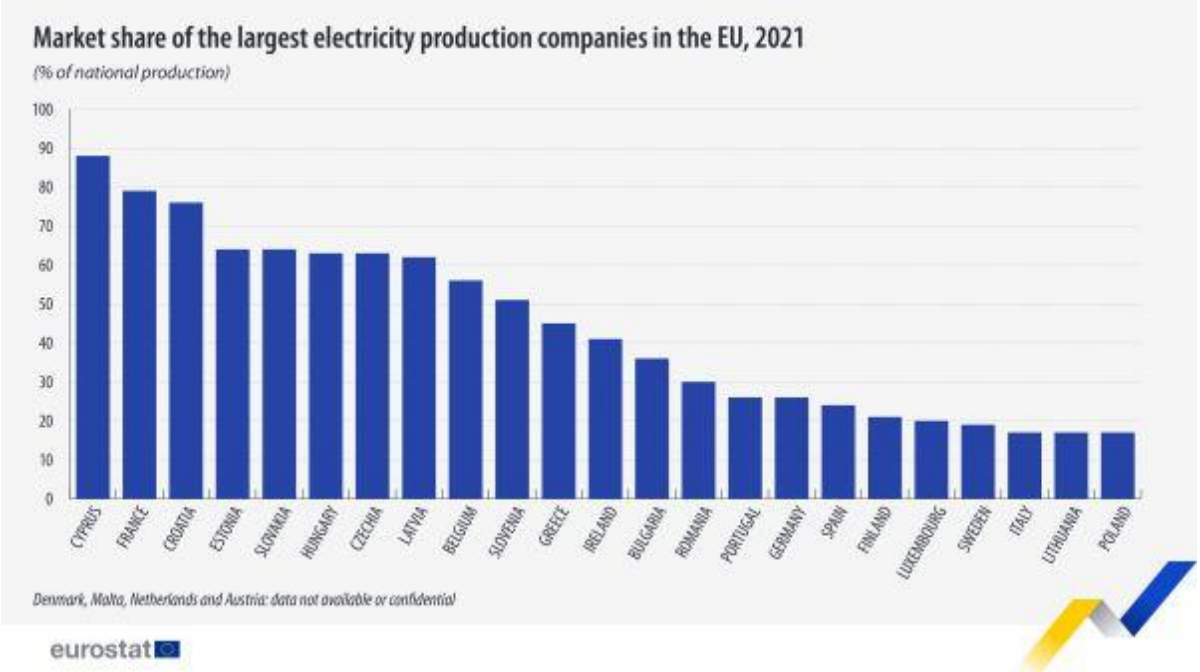
As we can see from figure 1, in order to have a complete picture of what happened lately in the energy pricing field there are many differences between the energy prices among the countries of the figure. These prices concern households which are the

biggest energy consumers. The highest price was recorded in Denmark just above 0,45 euro per KWh, almost the double price of EUs mean. Then we notice that also in Belgium and Germany the electricity prices were very high. On the other hand, Netherlands, Hungary ang Bulgaria have the lowest prices among the countries members of EU. As for countries that are not members of EU, Liechtenstein and Norway record the highest prices, while the lowest can be found in Kosovo and Serbia. So from that diagram we can include that energy pricing is very different among countries and even for EU members there are significant differences in that field.

The market structure in the energy field is characterized by its complexity due to the diverse nature of energy sources, regulatory frameworks, and technological advancements. Energy markets can be broadly categorized into several types of market structures, each with its own dynamics and implications. Maybe the more efficient structure is the perfect competition. In economic science it is referred as an idealized market structure where there are many buyers and sellers of a homogeneous product. In the energy sector, this may apply to some wholesale electricity markets. In perfect competition, no individual firm has the power to influence the market price, and resources are allocated efficiently (Gui & MacGill, 2018). Another market structure is monopoly. In a monopoly, there is a single seller of a product with no close substitutes. In the energy field, this could refer to situations where a single company dominates the market, potentially leading to market power and the need for regulatory intervention to prevent exploitation. Oligopoly is another market structure characterized by a small number of firms dominating the market. This structure is common in the energy sector, especially in the oil and gas industry, where a few major players control a significant portion of the market share. Oligopolistic markets can lead to strategic interactions between firms, impacting pricing and competition. Monopolistic competition is another market structure that features many firms selling differentiated products. In the context of energy, this could relate to retail markets for electricity or natural gas, where consumers can choose among various providers. Product differentiation can involve factors like renewable energy sources or pricing strategies (Babiker, 2005). Finally, especially in the field of energy, there is also the natural monopoly. Certain segments of the energy industry, such as electricity transmission and distribution networks, exhibit natural monopoly characteristics (Hvelplund & Djørup, 2019). It is economically efficient for a single firm to provide these services due to high fixed costs

and limited scope for competition. Regulation is often needed to ensure fair pricing and access to these essential services.

Figure 2. The market share of the biggest electricity production companies in Europe for the year 2021



Source: Eurostat (2022).

As we can see from figure 2, it presents the market share of the largest electricity production companies between the member countries of the European Union. We can spot that the highest percentage of electricity market share owned by one company is recorded in Cyprus. The percentage is almost 90% of the total market. Also, France and Croatia are facing a similar situation with their percentages waiving just a bit lower than 80% of the total market. So, we can assume that in these countries the market structure is monopolistic or a natural monopoly. This comes in contrast to countries such as Poland, Lithuania and Sweeden which have the lowest market percentages owned by one company. There is a high possibility that in these countries monopoly doesn't apply. So, they have an energy market structure closer to perfect competition. As for Greece it can be spotted in the middle of the diagram, so its energy market has a degree of openness.

Energy policies can be described as comprehensive plans and strategies formulated by governments or other relevant authorities to guide and manage the production, distribution, consumption, and protection of energy resources within a country or region. These policies have a critical role in shaping the energy landscape, ensuring energy security, promoting sustainability, and addressing various economic, environmental, and social challenges. Some key aspects of energy policies include first of all energy security, which refers to the aim of ensuring a stable and reliable energy supply to meet the needs of a country's economy and population (energy demand). Policies may include diversifying energy sources, promoting domestic production, and establishing contingency plans for energy disruptions (Li et al., 2021). Another aspect is sustainability and environmental concerns. Many energy policies focus on promoting environmentally sustainable practices to mitigate the impacts of energy production and consumption on climate change, air quality, and natural resources. This often involves increasing the share of renewable energy sources, improving energy efficiency, and reducing greenhouse gas emissions. In recent years a new aspect of energy policies concerns renewable energy promotion. In this case governments often adopt policies to encourage the use of renewable energy sources such as solar, wind, hydroelectric, and geothermal power. These policies can include incentives such as subsidies, tax credits, feed-in tariffs, and mandates for renewable energy adoption (Eleftheriadis & Anagnostopoulou, 2015). In addition, policies that encourage energy efficiency measures can help reduce overall energy consumption while maintaining or improving the quality of services. Energy efficiency policies may include standards for appliances, buildings, and industrial processes, as well as public awareness campaigns. Energy policies may also support research and development efforts to advance new technologies, enhance energy production methods, and improve energy storage and distribution systems. Moreover, energy policies may involve collaborations with neighboring countries or international organizations to ensure energy security, promote cross-border energy trade, and address common energy challenges (Solomon & Krishna, 2011). Finally, policies that concern the energy field can address issues of energy poverty by ensuring that all segments of society have access to affordable and reliable energy services.

2.4 The raise of energy poverty

Energy poverty refers to a situation where a household is not able to meet its energy needs. Energy poverty goes beyond a simple lack of access to modern energy sources. It involves a complex interplay of factors that affect a person's quality of life, health, and overall well-being (Bhattacharyya, 2019). It arises when a household's energy costs are disproportionate to their income, leading to difficult trade-offs between energy consumption and other essential needs, like food, education, and healthcare It cannot be described as a newly formatted situation, but due to inflation pressure for the last two years it has started to affect all countries worldwide (Streimikiene & Kyriakopoulos, 2023). Moreover, the increase in the prices of raw materials for energy production (e.g. oil prices). After the tackle of covid-19 pandemic in the fall of 2021, due to vaccination, markets started operating without any negative externalities such as lockdowns. The lockdowns that took place between 2020 and 2021 in many countries had a result of decreased trade between them and in order to be protected there where measures such as quantitative easing in Europe and helicopter money in USA. Quantitative easing is a monetary policy tool used by central banks to stimulate the economy. It involves the central bank purchasing financial assets, typically government bonds, from the open market to increase the money supply and lower long-term interest rates. This injection of money aims to encourage borrowing and spending by businesses and consumers, thereby promoting economic growth and preventing deflation (Rebucci et al., 2021). On the other hand, helicopter money refers to a theoretical unconventional monetary policy where a central bank directly distributes money to households or individuals as a way to stimulate economic activity and boost demand (Reis & Tenreyro, 2022). So, these measures had an important role in the rise of inflation which immediately affected energy prices. In addition, the quick turn of many countries in renewable energy sources to produce energy without having the required infrastructure to support this green transition, also contributed to the raise of energy prices.

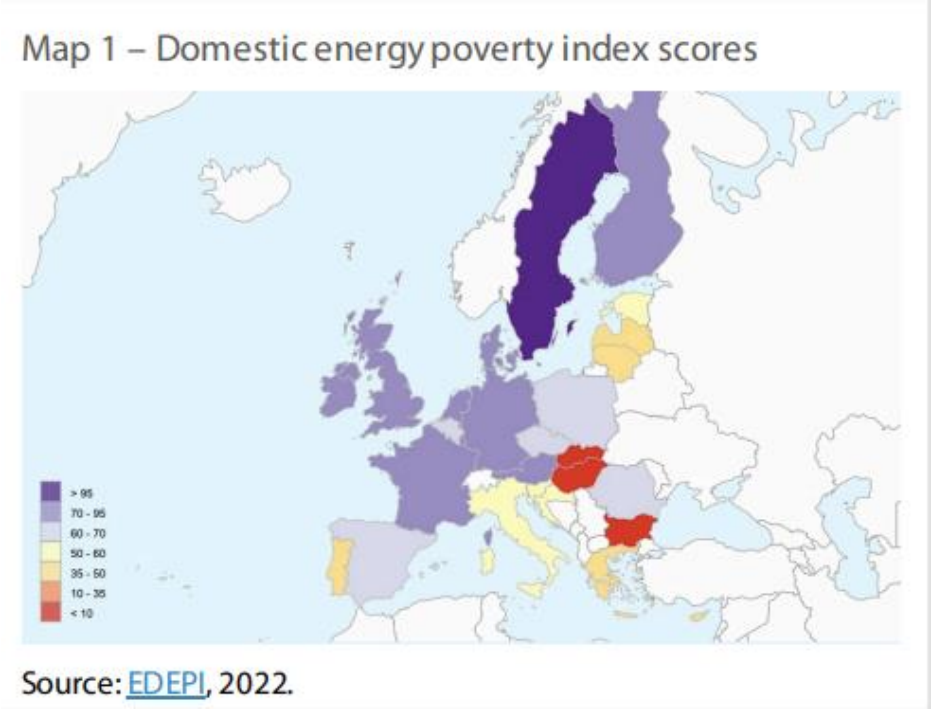
The COVID-19 pandemic has triggered a cascading series of economic shocks and disruptions, disproportionately affecting vulnerable populations. Lockdown measures, business closures, and job losses have led to reduced incomes and heightened uncertainty, making energy affordability an even greater concern for millions of households. As people spend more time at home due to remote work and restrictions,

the demand for energy services has surged, straining already limited resources. The digital divide has also become more pronounced, with those lacking access to digital technologies at a disadvantage in managing their energy consumption (Hesselman, et al., 2021). As mentioned before, the measures to tackle lockdown negative effects increased money supply in market that was not fully operational at that time.

In the beginning of 2022, another fact contributed to the boost of energy prices. That was the Russian - Ukrainian conflict. Moreover, in February of 2022 Russia invade in Ukraine. Till that time Russia was Europe's largest supplier of natural gas while Ukraine exported wheat, iron and steel to European countries. So, the two main energy raw materials export countries to Europe were involved in a war. As result of the invasion European countries banned Russian products and reduced immediately their dependence in the Russian natural gas. This geopolitical tension led Europe to find more expensive suppliers, mostly due to transportation costs. The incursion of Russia into Ukraine has worsened the energy dilemma in Europe, causing a rapid escalation in energy costs within a short span (Siksnelyte-Butkiene, 2022) . In general, the shock of the conflict has led to price fluctuations and supply uncertainties, further affecting energy affordability for countries dependent on these imports. Additionally, energy infrastructure disruptions in conflict zones have left communities without access to essential services, exacerbating energy poverty in regions already grappling with security challenges (Hasheminasab et al., 2023). Till that time energy poverty was mostly a problem of developing and undeveloped countries, but after the pandemic and the conflict this situation started rising in developed countries.

The negative effects of the pandemic contributed to the formation of energy poverty, while the energy shortages after the Russian – Ukrainian conflict boost that situation (Streimikiene & Kyriakopoulos, 2023). Energy poverty was severe for households with low income. Although both facts made governments take measures like energy reduction that affected even households with higher income. So, energy poverty nowadays has another dimension which is the limitation of energy consumption, in order to prevent energy shortages that can lead to blackouts. The raise of energy poverty had also a significant effect slowing down the green transition for all European countries.

Figure 3. Energy poverty index map among countries members of EU.



Source: EDEPI (2023).

As we can see from the map in figure 3 the energy poverty index in Europe gives us a recent image of what happened in the energy field lately. This index is a measurement tool used to assess and quantify the extent of energy poverty within a given population or region. From the map above we can see that Bulgaria, Hungary and Slovakia are facing more severe energy poverty problems. Also, Greece, Portugal, Lithuania and Latvia have to be alert about the energy poverty situations. On the other hand, Sweeden and Finland are far from facing the energy poverty problem. So their citizens are more secured against an energy crisis.

2.5 Conclusions

Energy, as a fundamental driving force behind industrialization, economic development, and human well-being, has occupied a central role in shaping societies and economies throughout history. The intricate relationship between energy resources, production, distribution, consumption, and their economic ramifications underscores the significance of energy economics. This field unites economic principles with energy-related complexities, uncovering the ways in which societies allocate, manage, and employ energy resources to meet their diverse needs.

The diverse landscape of energy sources, regulatory frameworks, and technological advancements forms the foundation of energy markets, which exhibit varying structures such as perfect competition, monopoly, oligopoly, monopolistic competition, and natural monopoly. Each structure carries its own dynamics, shaping pricing strategies, competition, and market power. Energy pricing, a critical determinant of energy consumption patterns, investment choices, and the balance between economic and environmental objectives, presents a complex challenge. The concepts of average cost pricing and marginal cost-based pricing illuminate different strategies to set energy prices while addressing efficiency, equity, and incentivizing improvements in the energy sector.

Energy policies play a pivotal role in guiding a nation's energy landscape. These policies encompass a broad spectrum of goals, including energy security, environmental sustainability, renewable energy promotion, energy efficiency enhancement, and international collaboration. By shaping regulatory frameworks, incentives, and investments, energy policies endeavor to align economic progress with ecological consciousness.

The emergence and exacerbation of energy poverty due to the COVID-19 pandemic and the Russian-Ukrainian conflict have introduced new dimensions to the energy landscape. Energy poverty, characterized by the inability of households to meet their energy needs, has been propelled by factors such as reduced incomes, increased energy consumption, supply chain disruptions, and geopolitical tensions. These events underscore the vulnerability of societies to energy-related shocks and emphasize the

importance of addressing energy poverty as an essential aspect of energy policies. To sum up, these two recent facts had significantly increased energy poverty worldwide.

Chapter 3. Theoretical terms in the field of renewable energy sources

3.1 Introduction

When discussing the Renewable Energy Sources (RES) sector, we are essentially addressing a dynamic and rapidly expanding industry that has become a fundamental cornerstone of the global economy. It's noteworthy to highlight that this field garners significant and consistently growing business attention. This is primarily due to its direct connection and integration with technological advancements, creating favorable conditions and expectations for profitable investments. The global significance of this sector became evident as early as the 1990s, with the emergence of the "Kyoto Protocol," which aimed to curtail emissions of environmentally detrimental gases (including carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, fully fluorinated hydrocarbons, and sulfur hexafluoride) (Gupta, 2016). Renewable energy sources offer substantial exploitable potential, encompassing forms such as wind, hydroelectric, solar energy, and biomass. This underscores the necessity of transitioning towards these specific energy forms. In contrast, conventional energy sources like lignite, natural gas, and oil are considered "finite," with their extraction carrying adverse environmental repercussions. This brings forth a crucial question about the "efficient management/distribution" of energy resources, where those derived from RES hold an advantage. More broadly, the ecological, economic, and societal benefits of RES have catalyzed a shift not only within the business realm but also among entire nations, towards harnessing their own renewable energy sources.

Renewable energy sources are now an important chapter of economic science. The economics of RES and in general environmental economics are gaining more and more

interest from researchers and economists around the world. In this chapter, we highlight the RES sector along with the multiple and different types of them. We also focus on the advantages and challenges that arise from renewable energy sources field. After all it is very important to present the appropriate infrastructure in order for a country or a company to implement properly a renewable energy station. In this way we will understand the economic impact of RES. In order to make an introduction to the Green Deal in Greece, in the final chapters we describe the EU Green Deal and the Greek legal frame concerning RES.

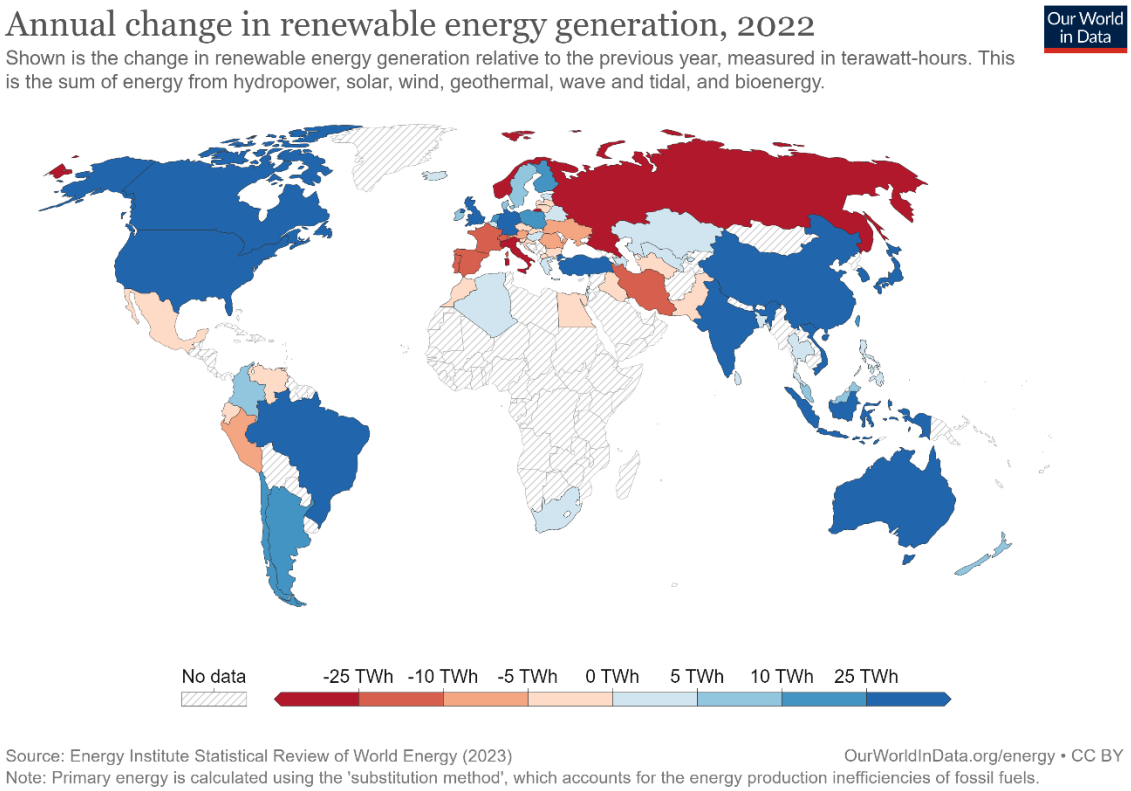
3.2 The renewable energy sources sector

Renewable energy sources forms (RES) encompass energy sources with such a rapid rate of energy regeneration that they are practically inexhaustible. Directive 2009/28/EC from the European Parliament classifies renewable non-fossil energy sources as wind, solar, geothermal, hydroelectric, tidal, biomass, ocean energy, sewage treatment gases, and landfill gas. Consequently, RES serve as a foundational approach to addressing global ecological and energy challenges (Ntanos et al., 2018). The interest in tapping into mild and renewable energy sources emerged in the 1970s due to successive energy crises and escalating environmental concerns. Initial attempts were experimental and expensive, but advancing technology gradually lowered energy application costs, rendering their adoption advantageous. Thirty years ago, the notion of homes producing electricity from rooftop photovoltaics or electric cars on streets would have seemed improbable (Twidell, 2021). Given the above, RES are considered the most ideal solution regarding the depletion of fossil fuel reserves as well as one of the most important indicators of success for the protection of the environment and the entire ecosystem. Today, the pressing need for further RES utilization within the European Union, particularly in Greece, is compounded by geopolitical and economic maneuvers by mineral-exporting countries like Russia and Saudi Arabia (Delagrammatikas & Roukanas, 2023). Energy conservation, achieved through bioclimatic building designs and low electricity consumption practices, is another facet of the energy challenge.

During the early 1980s, there were the first but particularly ambitious attempts at technological exploitation of both wind and solar energy. The first major "technological experiment" was the installation of approximately 16,000 wind turbines in the state of California, and then the use of water potential in hydroelectric plants (Aslani & Wong, 2014). At the same time, the first electricity generation and geothermal applications began, as well as in the utilization of biomass. Finally, in the early 1980s, no other marine energy harnessing applications (e.g. wave energy, ocean thermal energy, etc.) were officially recorded, while solar harnessing with the help of photovoltaic panels was essentially in trial stage. These technological experiments contributed to the establishment of a new energy model based on renewable energy sources, with the aim of creating a sustainable model at a global level. The development of RES has attracted great interest and is expected to show even more in the coming years since their course shows a continuous increase in the last decades (Gui & MacGill, 2018).

Generally speaking, renewable energy sources are natural resources that have the remarkable ability to replenish themselves over relatively short periods of time, making them practically inexhaustible on human timescales. Unlike fossil fuels, which are finite and contribute to environmental degradation, renewable energy sources provide a sustainable and cleaner alternative for meeting our energy needs (Eleftheriadis & Anagnostopoulou, 2015). These sources harness the power of natural processes and phenomena, converting them into usable energy forms.

Figure 4. The change in renewable energy generation power for the year 2022 compared to 2021.



Source: Our world in data (2023).

As we can see from figure 4, many countries in Asia, Oceania, North and South America have focused their attention on producing power from renewable energy sources. Coming to European countries there is some contrast between the countries, in the use of renewable energy. For example, Germany, Finland, Poland, Netherlands and Denmark have increased the use of renewable energy, while on the other hand countries like Italy, Norway, France, Portugal and Spain had decreased their renewable energy use percentage. Although it is important to highlight that this situation may change in the next year. In addition, the Russian – Ukrainian conflict that triggered a significant change in raw materials of energy took place in 2022 had an immediate impact on European countries. As a final conclusion we notice that the renewable energy sources field is of high importance for most developed and developing countries.

3.2.1 Types of RES

In this chapter, it is considered appropriate to present some of the forms of RES, with the aim of the reader's complete understanding of their function and necessity. Through the years since the 1970's many forms of RES were developed, based on environmental respect and sustainable development.

The first form of RES that we are going to present is solar energy. This term refers to the totality of the various types of energy that come from the sun itself. Both sunlight and radiated heat are absorbed by various compounds and elements and then modified into other forms of energy. Today's technology has the ability to use a small percentage of the solar energy that reaches the earth through three different systems. Solar energy is a mild, clean and renewable source of energy, used for thermal applications such as water heaters and furnaces, while at the same time its use through photovoltaic systems for the production of electricity is increasing (Percebois & Hansen, 2022). The advantages of this type of energy are that solar energy as a "resource" cannot be controlled by anyone, it is abundant in our country and in fact it is the main source of energy, it does not run out and provides independence and security in terms of energy supply (Guangul & Chala, 2019). There are three ways, as mentioned, of utilizing the energy that comes from the sun. Thermal solar systems or active solar systems, which use the sun for cooling or heating and hot water using mechanical means, passive solar systems, which take advantage of the sun's radiation but do not use any mechanical means to transfer heat and a third are photovoltaic systems. The difference between these three ways is that in the first two, the heat produced by the radiation is collected and used, while contrary to the PV system, the solar radiation is converted through the photovoltaic effect into an electric current.

Another form of RES is wind energy. It is a renewable source of power generated by harnessing the kinetic energy of moving air, typically through the use of wind turbines. These turbines convert the wind's energy into mechanical power, which can then be used to generate electricity. The first wind park that was fully operational took place in 1988 in the state of Ohio in, USA Wind energy is considered one of the most mature and widely used forms of renewable energy, contributing significantly to global efforts to reduce carbon emissions and combat climate change (Aslani & Wong, 2014). Wind energy is clean and renewable, producing no direct greenhouse gas emissions or air

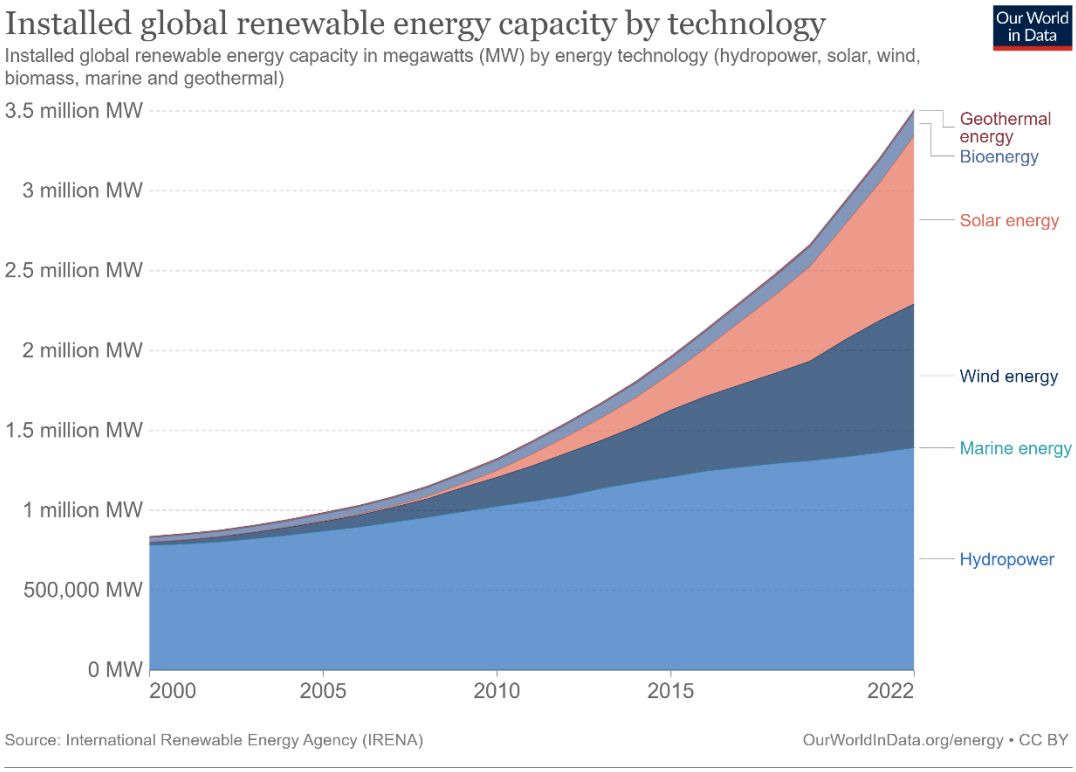
pollutants during operation. It also helps reduce the reliance on fossil fuels and contributes to energy security by diversifying the energy mix. From an economic point of view, wind energy creates jobs in manufacturing, installation, operation, and maintenance. It is also an environmentally friendly form of energy with significant contribution in the field of sustainable development (Kumar et al., 2016). In addition, the energy produced from wind is less expensive for consumers compared to other forms of RES.

Geothermal energy is the energy that comes from the bowels of the earth in the form of water, steam, gases or as energy from rocks. It is a natural energy of the earth that travels through the warm interior of its core towards the surface. The internal heat of the earth is so great that it can be considered a practically inexhaustible form of energy and by extension it also belongs to the field of RES (Fouquet, 2008). The technological infrastructure required to extract this type of energy is differentiated into shallow geothermal, which is used at relatively low temperatures, and deep geothermal, which is suitable at higher temperatures. In addition, geothermal energy is considered to be linked to volcanism but also to the more specific geological and geotectonic conditions of the region in which it is located. Geothermal sources are perceived by the steam that appears in the fissures of the earth's crust or also by the existence of various hot springs. This practically shows that in order for hot water to be available there must also be an underground storage tank. Geothermal energy is a reliable and consistent source of power that operates all year long without pausing, regardless of weather conditions. It has a relatively small environmental footprint compared to fossil fuels and can help reduce greenhouse gas emissions. It also provides energy security, as it is not subject to fuel price fluctuations (Sklias et al., 2017).

Bioenergy refers to the energy derived from organic materials, collectively known as biomass, that come from living or recently living organisms. This renewable energy source has been used by humans for various purposes throughout history, such as heating, cooking, and lighting. In modern times, bioenergy is harnessed through advanced technologies for electricity generation, transportation fuels, and other applications. Bioenergy contributes to reducing greenhouse gas emissions, promoting sustainable waste management, and enhancing energy security (Mandley et al., 2020). Bioenergy is considered a renewable energy source because biomass can be replenished through natural processes or sustainable practices. It can help reduce greenhouse gas

emissions by displacing fossil fuels and providing an alternative to landfills for organic waste disposal. Additionally, it can contribute to rural development by creating jobs in agriculture, forestry, and related industries (Percebois & Hansen, 2022). An important fact about bioenergy is that includes liquid biofuels like ethanol, biodiesel, and renewable diesel, and all of them can be used as substitutes for conventional transportation fuels. Ethanol is mainly derived from crops like corn and sugarcane, while biodiesel can be produced from vegetable oils, animal fats, and used cooking oils.

Figure 5. The global energy capacity based on different types of RES.



Source: Our world in data (2023).

As we can see from figure 5, geothermal energy has the highest capacity among the RES. Also, this diagram shows that bioenergy along with solar energy have high capacity. On the other hand, hydropower has the lowest capacity. This refers to a global level of different types of RES, covering a time period from 2000 to 2022.

3.2.2 Advantages and challenges in the renewable energy field

After recording the various types of RES, it is important to highlight the advantages that have been noticed about them. Moreover, renewable energy sources have plenty of advantages and that is why the attention of nations is growing on them. One advantage that has been recorded most in the literature is that some of the RES will never run out (e.g. solar, wind, hydro). At the same time some others are renewed at a faster rate than their consumption rate. In addition, there has not been notified that they have a negative environmental footprint. All types of RES are environmentally friendly and this is why they contribute and enhance sustainable development, because they can be available for future generations. Renewable energy have a minor environmental impact compared to fossil fuels. Renewable sources produce little to no greenhouse gas emissions, reducing air pollution and mitigating climate change.

The utilization facility of RES is relatively simple to implement and maintain and has a long life. If we combine this advantage with the fact that they can cover the energy needs at a local level and that way avoid the transfer of energy over long distances, we can conclude that RES can have lower costs for consumers and at the same time low cost considering the necessary facilities. Another benefit is that renewable energy sources reduce the import of electricity and the necessary mineral resources for its production (Kowalski M., 2011). This means that until now all RES have a supporting role in the electricity system in existing conventional power plants in order to increase the amounts of electricity. The consequence of this is the immediate reduction of energy produced from fossil fuels that would otherwise be consumed in a conventional production unit. Another important advantage from the use of RES is the strengthening of economic development both in the energy sector and other related activities related to it. RES have a great multiplier effect in all countries that have a developed industrial zone for the production of energy-related machinery and equipment based on technological innovations, especially in their export sector (Kowalski M., 2011). Innovation can promote technical and technological changes according to a new market and in that way improve business activities and investments. So renewable energy sources can lead to economic development. In this case they require specialized employes, something that can enhance employment. This can lead to lower unemployment percentages and strengthen the economy of a place or a country.

Simultaneously it also improves the human capital of a country, because some people will get further education. So new jobs can be created.

On an energy security level relying on local renewable resources can enhance energy security by reducing dependence on foreign fossil fuel imports, which can be subject to supply disruptions and price fluctuations. Lastly, there is also the advantage of reduced water usage. Unlike conventional power plants that require large amounts of water for cooling, many renewable energy technologies consume little to no water during operation, thus conserving water resources.

Apart from the advantages there are also some challenges in the renewable energy field. As mentioned, before it is a newly created field, so challenges are rising, especially when external facts can affect their evolution. The first challenge concerns the lack and variability of them. Some renewable sources, like solar and wind, are intermittent and variable in some areas and that causes problems in their energy production, making it challenging to ensure a consistent and reliable energy supply. There is also the problem of energy storage. To address intermittency, effective energy storage solutions are needed to store excess energy generated during peak production for use during periods of low production. It is very important because it ensures that there will not be any energy lack, which can lead to blackout situations, where people can use only a small amount of energy. Another challenge is the high initial costs. The upfront costs of installing renewable energy systems can be higher for some types of them compared to conventional fossil fuel systems. However, these costs are often offset by long-term savings on fuel and maintenance. Integrating renewable energy into existing energy grids may require upgrades to infrastructure and smart grid technologies to manage fluctuations and ensure stable energy supply.

An important challenge is technological limitation. Some renewable energy technologies are still under development and face technical challenges, limiting their widespread adoption and scalability. This challenge applies mostly for developing and underdeveloped countries. A challenge that is usually expressed as an environmental impact is the land and the resource use. Large-scale renewable energy projects, such as solar and wind farms, can require significant land and resources, potentially conflicting with other land uses, like agriculture or conservation. Apart from this there is the not in my backyard problem. It is a problem that arise when communities resist the installation

of renewable energy projects near their homes due to concerns about aesthetics, noise, or other local impacts. Lastly there is also the challenge of energy transition. Transitioning from a fossil fuel-based energy system to a renewable-based one requires policy support, regulatory changes, and coordinated efforts among stakeholders, which can be complex and challenging.

3.3 Economic contribution of RES

The growing global concern over environmental degradation, climate change, and the depletion of finite fossil fuel resources has prompted a significant shift towards renewable energy sources as a sustainable and economically viable alternative. So, in the last about fifty the new sector of economic since, energy economics form a new economic field, that attracts the attention of researchers. Economic activity is based on the utilization of natural resources for energy (coal, oil, etc.), material goods (furniture, cars, etc.), food (fish, etc.) and medicines (main chemical compounds, herbs, etc.). The economic contribution of RES has been recognized through many studies and especially during the last three years, that energy insecurity is continuously growing. The economic impact of RES can be spotted in everyday life since it can boost economic activity in many ways. RES have also significant impact on creating a sustainable economic system (Müller-Steinhagen & Nitsch, 2005).

First of all, renewable energy sources have emerged as a key driver of economic growth in both developed and developing nations. The deployment of RES projects stimulates economic activity through various channels. Firstly, the establishment and maintenance of renewable energy infrastructure create direct employment opportunities, from manufacturing components to project installation and maintenance. Secondly, the supply chain for renewable technologies generates demand for goods and services, fostering local and national industries (Li et al., 2021). Moreover, increased spending on RES projects often results in a multiplier effect, stimulating related sectors such as transportation, construction, and logistics. Studies have consistently demonstrated that investments in renewable energy yield higher employment and economic output per unit of energy generated compared to fossil fuel-based systems. Renewable energy

industries have proven to be significant sources of employment, contributing to reductions in unemployment rates and poverty alleviation. The labor-intensive nature of renewable energy installation, operation, and maintenance fosters a broad range of job opportunities, from skilled engineering positions (e.g. mechanical engineers) to unskilled labor (e.g. production workers without specialization). The diversity of roles accommodates a wide spectrum of skill levels and educational backgrounds, enhancing inclusivity in the job market. Furthermore, many renewable energy projects are localized, creating jobs in rural and remote areas that may have previously faced economic challenges (Timmons et al., 2014). Nowadays there are also remote working opportunities in the renewable energy sector, which can help people that live very far from the working space of the company to find a job without moving away from their residency.

One other critical benefit of renewable energy sources in an economic level is the enhancement of energy security (Delagrammatikas & Roukanas, 2023). Unlike fossil fuels, which are often imported and subject to price volatility due to geopolitical factors, renewable energy resources are abundant domestically. This mitigates the risks associated with energy supply disruptions and the economic uncertainties arising from fluctuating fuel prices. As a result, a greater reliance on renewables provides stability to energy markets and shields economies from the impacts of sudden price shocks (Mahmood et al., 2019). In addition, some countries can evolve into renewable energy exporters, which means that they can export the energy surplus, especially in nearby countries. In this way they can add extra profit to their balances and if this profit is high, they can lower their taxation. So, their citizens will have more money to spend in order to strengthen the national economy.

The deployment of renewable energy technologies has spurred substantial technological innovation across various sectors of the economy. Investments in research and development to improve efficiency, storage capabilities, and grid integration have resulted in technological advancements that transcend the energy industry. Innovations in battery storage systems, for example, have found applications in electric vehicles and grid management. This cross-sectoral innovation enhances competitiveness, promotes the growth of knowledge-based economies, and creates opportunities for export and international collaboration. In this way research and development (R & D) departments can attract more investments at a local, national or

global level (Bourcet, 2020). There are many studies that have proven that renewable energy projects attract foreign direct investment and foster international trade relationships. Countries that invest in and develop their renewable energy sectors often become exporters of renewable energy technologies, components, and expertise. This not only contributes to their economic growth but also enhances their global standing as leaders in sustainability (Afonso et al., 2017). Renewable energy projects can also incentivize international collaboration and partnerships for technology transfer and capacity building. The contribution of RES in international trade can lead to economic growth, economies of scale, foreign exchange earnings and technological transfer. In general, energy is now an important factor in international trade.

3.4 The EU Green Deal

In order to understand the importance of renewable energy sources, we have to examine a package of policy initiatives that aim to make EU countries complete a green transition in order to reach climate neutrality in 2050. This action plan also aims to enhance a sustainable economy by 2050. It encompasses a wide range of policies and initiatives to address the pressing challenges of climate change, environmental degradation, and social inequality. The ultimate goal is to ensure economic growth and well-being while respecting planetary boundaries (Siddi, 2020). This plan was presented in 2019 by the European Union and approved at the beginning of 2020.

As mentioned before the central objective of the Green Deal is to achieve net-zero greenhouse gas emissions across the EU by 2050. This means balancing the amount of emissions produced with the amount removed from the atmosphere through measures like afforestation and carbon capture. Energy transition is a very important aim for this initiative (Leonard et al., 2021). The Green Deal emphasizes a transition to a clean energy system by boosting renewable energy sources, improving energy efficiency, and supporting the development of innovative technologies. In this way environmental pollution will be tackled. Generally speaking, renewable energy sources are an important parameter for the success of the Green Deal.

Moreover, the EU aims to transition towards a circular economy where resources are used more efficiently, waste is minimized, and products are designed for longevity and

reusability. Another important aim of the Green Deal is to commit in reversing the loss of biodiversity and restoring ecosystems by protecting and rehabilitating natural habitats. There is also the Farm to Fork Strategy. It is an initiative that seeks to create a more sustainable and resilient food system, reducing the environmental impact of agriculture, promoting healthier diets, and ensuring food security. This strategy plan incorporates objectives like attaining 25% organic farming by 2030, cutting down pesticide utilization by 50% and fertilizer usage by 20% by 2030, and implementing labeling systems that indicate the level of sustainability of products (Krämer, 2020). Through this action plan there is also the aim to improve the energy efficiency of buildings across Europe, reducing energy consumption and contributing to emissions reduction. So, we are referring to a renovation wave for many buildings. The construction industry heavily relies on nonrenewable resources and offers significant potential for enhancing energy efficiency. European buildings account for 40% of the total energy consumption on the continent. As of the drafting of the Green Deal, the Commission projected that the annual rate of building renovations should increase from 0.4% to a minimum of 1.2% compared to 2018 statistics. It is also important to highlight the aim of sustainable mobility. The EU plans to promote clean and sustainable transportation by supporting electric vehicles, improving public transportation, and reducing emissions from the aviation and shipping sectors. To curb mobility emissions, the initiative suggests transitioning the 75% of transported goods currently conveyed by road in Europe to rail and water transport. In terms of personal commuting, the Green Deal advocates for robust measures to promote emission-free modes of propulsion, primarily electric vehicles, by expanding charging infrastructure and encouraging light transport options and shared mobility solutions (Tutak et al., 2021).

The Green Deal is such an important initiative for the EU that it has been supported by additional strategies. First in 2020, a recovery strategy called Next Generation EU was collectively established by the European Commission, the European Parliament, and EU leaders to revitalize the European economy, which had faced a slowdown due to COVID-19. This financial instrument of €806.9 billion was designated to be utilized by 2025, aiming to stimulate a "sustainable, even, inclusive, and fair recovery." Notably, a significant portion of this investment was allocated towards clean energy, industrial sustainability, new modes of mobility, and the redevelopment of buildings (Biancone et al., 2021). The Next Generation funds served as a means for numerous countries to

initiate the Green Deal, while also serving as a safeguard against the potential risk of the economic crisis derailing climate objectives. Secondly in 2022, the European Union responded to the energy market crisis triggered by the conflict in Ukraine through the REPowerEU plan, which brings adjustments to the Green Deal. This plan sought alternative sources of gas, oil, and coal in the short term to address supply disruptions. Simultaneously, the plan raised the targets for renewable energy sources. REPowerEU, for which the European Parliament and the Council achieved a substantial political consensus in December 2022, establishes a higher benchmark for the share of energy to be generated from renewables by 2030, setting it at 45% instead of the previous 40% outlined in the Fit for 55 frameworks (Deng et al., 2022).

The EU Green Deal involves a complex and ambitious agenda that requires strong commitment from member states, businesses, civil society, and citizens. It also involves significant financial investment to support the transition to a sustainable economy. However, challenges include balancing economic growth with environmental protection, addressing social inequalities that may arise during the transition, and ensuring that policies are effective and feasible (Siddi, 2020). Overall, the EU Green Deal is a comprehensive and groundbreaking initiative that demonstrates the EU's commitment to addressing urgent environmental challenges while fostering economic growth and social progress. It reflects the EU's vision of a sustainable and climate-neutral future for the region and beyond.

3.5 Greek legal frame of RES

After examining all the shapes of renewable energy sources field and present all the useful details of the Green Deal, it is important to examine this subject particularly for Greece. In the next chapters of this thesis research about RES in Greece will take place. So, the first step in order to understand how this field operates in Greece so far and also why there are challenges and opportunities is the legal framework. By that we mean all the laws concerning the RES field. Besides it is commonly admitted that when an investment is about to take place abroad the legal framework of the host country of the investment is above the very first things that businesses examine (Bradford, 2021).

In the year 2016, a new regulatory framework was instituted with the aim of supporting RES (Law 4414/2016, Official Gazette 149 A') and their full harmonization with the "Guidelines for state aid in the environment and energy sectors (2014-2020). In addition, this regulatory framework is also related to the integration and with an increasing participation of RAE (Public Electrical Company Renewable Energy Sources) and SHITHYA (High Efficiency Cogeneration of Electricity and Heat) (Pegkas, 2020). In the electricity market in the best possible way at a cost-benefit level for the final consumer and, by extension, society. With Law 4414/2016, the new data incorporated in the domestic RES market concern:

‣Support that was established on the basis of Operational Support under the type of Differential Surcharge in addition to the costs received by RES due to their participation in the Market up to an upper threshold which is the Reference Price.

‣The use of a typical project per RES technology regarding the operating cost and construction cost as well as its productivity (Capacity Factor) determined the reference price per category based on a reasonable return on the invested funds. According to the specific (Greek) law, additional capital support is carried out within the framework of National Development Investment Programs will be taken into account using a specific impairment methodology to avoid excessive compensation of the projects. Finally, existing stations will be able to voluntarily change their infrastructure to the new operating support and market participation regime.

‣According to the law "Guidelines for state aid in the environment and energy sectors (2014-2020)" from 01.01.2017 the reference price for the mature technologies of wind and photovoltaic plants is determined through a competitive process, with the aim of reducing the costs for consumers and now only those businesses or plans that will be successful in this process will receive the operational support (Angelopoulos et al., 2017).

‣Finally, it should be noted that for the first time the obligation of RES participants producers who receive a differential surcharge in the market mechanisms was established either voluntarily or through Collective Representation Bodies (FoSE), while DAPEEP S.A. (Administrator of RES & Guarantees of Origin S.A.) was appointed as a cumulative representation body. Furthermore, according to the law 4643/2019 (Government Gazette 193 A') the framework for the operation of RES

stations established by law 4414/2016 was completed, enabling RES stations to participate directly in the wholesale electricity market and to be paid by the power mechanisms without receiving functional reinforcement (Pegkas, 2020).

Based on the existing decision, the Regulation is implemented for the granting, modification, extension of time, renewal, transfer, merger, division, revocation and automatic termination of validity of the Electricity Producer Certificate from RAE and SITHYA (Certificate), as well as the Electricity Producer Certificate Energy Special Projects by RAE and SITHYA (Certificate of Special Projects) and the Production License. The applications for the granting of a electricity producer certificate or the one concerning special projects, as well as any other application referred to in the Regulation, are submitted through an electronic platform of electricity production from RAE and SITHYA (electronic register). So regarding the submission of an application for the granting of a certificate, the interest party must have either natural or legal persons who have legal status and are based in a member state of the EU, the European Economic Area or in one of the countries of the Energy Community or in third countries, in the event that the right has arisen from a bilateral agreement that the country has concluded with Greece or the European Union or they have legally established a branch in Greece (Nikas et al., 2020). To sum up, we have to indicate that the Greek framework has started to follow the European one in the field of renewable energy and it is expected to be renewed in this direction in the near future.

3.6 Conclusions

In this chapter we discussed the significance and the renewable energy sources sector, through the presentation of their theoretical terms, their types, advantages and challenges. In order to understand the importance of them in a national level the presentation of the Green Deal concluded to point out that RES are an important factor in a global level. In addition, the Greek legal frame of RES showed that the Green Deal directions can contribute in the framework concerning the RES sector of a European country.

RES, which include wind, solar, geothermal, hydroelectric, tidal, biomass, ocean energy, sewage treatment gases, and landfill gas, offer a solution to global ecological and energy challenges. Emerging in response to energy crises and environmental concerns, RES adoption has become more viable due to advancing technology. They provide a sustainable alternative to finite fossil fuels, contribute to energy conservation, and have a minimal environmental impact. They offer numerous advantages that are driving global attention towards their adoption. The environmentally friendly nature of RES, their sustainability, and their capacity to mitigate climate change make them a crucial element in promoting sustainable development and securing a cleaner energy future for generations to come. Their minimal environmental impact, characterized by reduced greenhouse gas emissions and lowered air pollution, positions them as key players in combating environmental degradation. Moreover, the simplicity of implementing and maintaining RES, combined with their potential to provide localized energy solutions and reduce long-distance energy transmission, results in lower costs for consumers. These advantages also extend to economic development, as RES contribute to job creation, enhanced industrial innovation, and human capital growth. Energy security is further bolstered by relying on local renewable resources, reducing dependence on foreign fossil fuel imports and their associated supply disruptions. Additionally, RES offer the advantage of reduced water usage compared to conventional power plants. However, despite these numerous benefits, challenges in the renewable energy field persist. Issues such as intermittency, energy storage, high initial costs, technological limitations, land and resource conflicts, public resistance, and the complexity of energy transition highlight the need for continued research, innovation, and policy support to ensure the successful integration and widespread adoption of renewable energy sources.

Over the past five decades, energy economics has evolved into a distinct field, attracting extensive research attention due to its critical economic implications. The economic contribution of renewable energy sources has been increasingly recognized, particularly in the context of growing energy insecurity. This contribution is manifested in manifold ways, profoundly impacting economic vitality. RES have emerged as potent catalysts of economic growth, fostering direct employment opportunities through infrastructure development, manufacturing, and maintenance. Additionally, their influence extends through supply chains, stimulating local and national industries. Furthermore,

investments in renewable energy projects yield significant multiplier effects, invigorating related sectors and ultimately promoting economic expansion. These investments effectively generate higher employment and economic output per unit of energy compared to conventional fossil fuel systems. The diverse spectrum of job opportunities provided by renewable energy, from highly skilled engineering roles to remote working arrangements, enhances inclusivity in the workforce. Additionally, the development of renewable energy sources contributes substantially to energy security by mitigating dependence on unpredictable global fuel markets. This shift shields economies from the impacts of fuel price volatility and supply disruptions, while potentially transforming some nations into energy exporters, amplifying economic growth. Moreover, the deployment of renewable energy technologies has catalyzed widespread technological innovation, permeating diverse sectors and fostering cross-sectoral advancements. Such innovations, like breakthroughs in battery storage, have far-reaching applications in electric vehicles and grid management, bolstering competitiveness and knowledge-based economies. Consequently, investments in renewable energy research and development spur not only local growth but also facilitate international trade, technology transfer, and collaborative partnerships, solidifying the pivotal role of renewable energy sources in shaping robust and resilient economies on a global scale.

the EU's Green Deal stands as a monumental response to the escalating imperatives of our time, uniting policy initiatives geared toward steering member states toward a sustainable and climate-neutral future by 2050. Rooted in the ambition of combatting climate change, environmental degradation, and social disparities, this multifaceted action plan underscores the EU's resolve to strike a harmonious balance between economic growth and ecological preservation. By nurturing a green transition, the Green Deal seeks to usher in a circular economy, rejuvenate ecosystems, and foster resilient food systems, all while bolstering the role of renewable energy sources as fundamental drivers of change. This intricate framework extends to revitalizing building efficiency, promoting sustainable mobility, and reimagining various industries, all underpinned by substantial financial investment, most notably through the Next Generation EU strategy. Amid its comprehensive scope, the Green Deal acknowledges the complexities of the path forward, acknowledging the challenge of harmonizing economic prosperity with environmental stewardship, addressing

potential inequalities, and fine-tuning the efficacy of policies. Despite these hurdles, the EU Green Deal signifies a resolute commitment to steering the region toward a sustainable, equitable, and prosperous future, exemplifying the EU's leadership in embracing transformative change on a global stage. In Greece the legal framework about RES has been renewed for last time in 2016, in the direction of giving producers of renewable energy support and motivation, aiming not to go back in the use of fossil fuels for energy. The Greek public electricity company has turned its attention to renewable means of energy production. There is a high chance that the next changes in the legal framework for RES will adapt more of the Green Deal instructions.

Chapter 4. The Green Deal Greece

4.1 Introduction

By recording the instructions of the Green Deal in the previous chapter, it is clear that this plan is very important for the boost of the renewable sector in Europe. But the instructions is not only used on a European level but also on a national level. Many countries have started investing in the renewable energy sector in order to produce energy from sustainable resources. Besides in this way, nations can be energy suppliers and increase their profits. Due to the fact that in the next chapter we will present renewable energy infrastructures of Greece, we will concentrate on this specific country.

Greece, a nation known for its rich history and stunning landscapes, is embracing a transformative journey toward a sustainable and environmentally responsible future as an active participant in the European Union's ambitious Green Deal initiative. This comprehensive and groundbreaking program, unveiled by the European Union, seeks to position the continent as a global leader in combating climate change, fostering economic growth, and ensuring the well-being of its citizens. At its core, the Green Deal represents a resolute commitment to achieving climate neutrality by 2050, effectively balancing economic prosperity with environmental stewardship. Greece, with its unique geographical advantages and considerable potential in renewable

energy, is poised to play a pivotal role in this paradigm shift, contributing to a greener, more resilient, and prosperous future for its citizens and the broader European community. This introduction delves into Greece's role within the European Green Deal, exploring its commitments, aspirations, and the transformative pathways that hold the promise of a sustainable future for the country and the planet.

There are many challenges as well as opportunities for the renewable energy sector in Greece to be recorded. The instructions of the Green Deal can help in boosting the RES field in Greece. In addition, the implementation of Green Deal on a Greek level offers a variety of aims for the renewable sector of our country. Moreover, the instructions of the Green Deal will also affect the new legal frame of Greece about RES, in order to make to motivate the investments in that sector. A SWOT analysis will reveal the advantages and disadvantages of Greece about the RES sector. So, we will be able to record the weaknesses where the Green Deal can contribute to boost RES development in Greece.

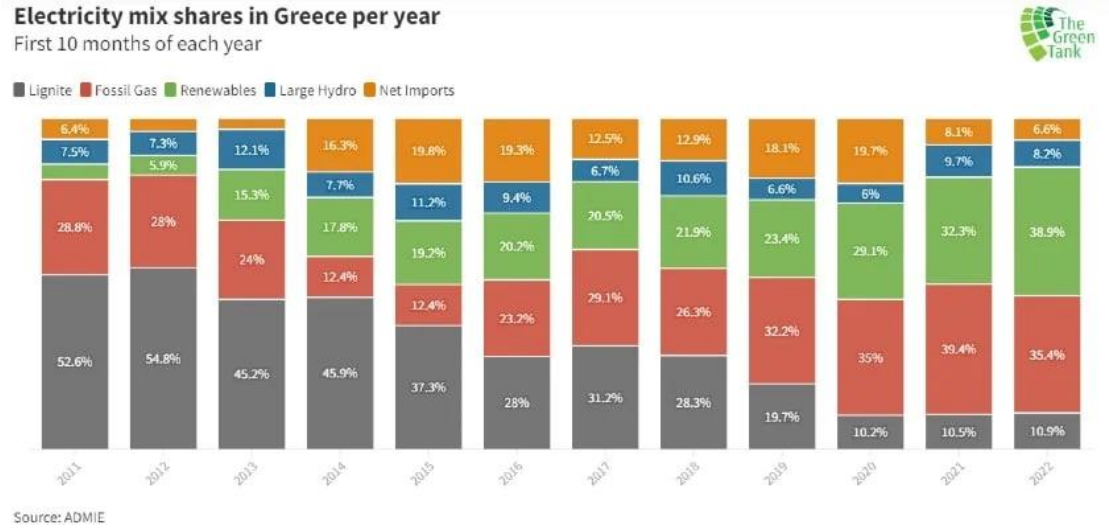
4.2 Challenges and opportunities of the RES sector in Greece

The electricity market in Greece till now shows an oligopolistic form. The dominant position is held by the public electricity company (DEI). But in recent years, with the liberalization of the electricity market, more and more private companies are active in the production and marketing of electricity. Companies like Protergia and Elpedison now have a significant share of the market, and it is possible that this will increase in the near future. Some of the private electricity generation companies use traditional fuels for electricity production (natural gas and oil). However, the sector of particular interest is that of renewable energy sources (RES), which is showing great growth. Greece gathers significant advantages in relation to RES (Pegkas, 2020). Moreover, Greece has significant renewable energy potential and abundant natural resources (large number of sunny days, water, sea, wind). It has been estimated that by 2050, 87% of electricity generation could be covered by RES.

In the period 2004 – 2012 based on Eurostat data, the participation of RES in Greece for the production of electricity more than doubled. This means that during this period very important investments were made in the renewable energy production field. The percentage of RES in electricity production at the end of 2012 was 15% while the European average was 14%.

Nowadays, due to the war in Ukraine and the great dependence of Europe and Greece in particular on the oil and natural gas of the warring countries, the necessity for our country to become energetically self-sufficient, through the exploitation of RES, becomes imperative. In general, in Greece, there has been a very large increase in investments in wind energy, which are considered by banking institutions to be particularly efficient and thus relatively easy to finance (Delagrammatikas & Roukanas, 2023). In many regions of our country, there are wind farms and new ones are constantly being created, despite the reactions of critics of this technology who cite environmental reasons (Apostolopoulos et al., 2020). The installed capacity today, through wind farms, is 4,338 MW.

Figure 6. The electricity energy mix in Greece between 2011 and 2022.



Source: Balkan Green Energy News (2023).

As we can see in figure 6, the RES sector in Greece can offer important opportunities for any interested part to invest. First of all, in the last ten years the electricity that comes from renewable sources has increased by 33%. This means that the country's

attention to renewable energy has given some optimistic results, especially for the future of the renewable energy sector. On the other hand, the electricity coming from the use of lignite has decreased significantly by 43,9%. To be more specific this percentage was at its higher point in 2012 at 54,8%, but in 2022 the lignite percentage is only 10,9%. During the initial nine months of the year, fossil fuels maintained their lead. However, a shift occurred due to factors like a rise in renewable energy generation, a notable decrease in electricity demand, elevated gas prices, and various economic indicators. Consequently, there was a reversal in the pattern, with power generation from fossil gas and lignite witnessing a decline of 58% and 23%, respectively, compared to October 2021. It is also notable that the share of net imports was only 6,6% in 2022, the lowest point since 2013. Another renewable source the hydropower reached a percentage of 8,2% in 2022. This percentage might seem low, but if we added on the renewable energy sources, the total amount of them in Greece for 2022, was 47,1% of the total energy mix. To sum up, the green transition of Greece has been started and offers opportunities in the RES sector, especially when the use of lignite to generate energy has been quickly decreasing.

Greece has made significant strides in embracing renewable energy sources (RES) as a means to transition towards a sustainable and green energy future and that was clear in the figure 6. However, this transition is not without its challenges. Even though there have been made some steps ahead of green transition, there are still some key obstacles and hurdles that Greece faces in its pursuit of a robust renewable energy sector. First of all, there is a changing policy landscape. Greece's renewable energy sector has been marked by a changing policy landscape. Frequent changes in regulations and support mechanisms can create uncertainty for investors. The most recent laws concerning RES were formed in 2016, but the adaptation of EU Green Deal from 2020 means that this legal frame has to be renewed. To maintain a stable and attractive investment climate, Greece must establish consistent, long-term policies that encourage RES development, according to Green Deal policies (Wolf et al., 2021).

Another obstacle that is often highlighted in many sectors in Greece is the administrative burden or bureaucracy. Navigating the bureaucratic processes for permitting and licensing can be cumbersome and time-consuming. Simplifying administrative procedures and streamlining regulations could significantly improve the

speed and efficiency of RES project development (Moustakas et al., 2020). This is a challenge for the upcoming legal framework for RES.

A very important challenge in Greece renewable energy field is the grid integration. Moreover, we are referring to grid capacity and flexibility. Integrating intermittent renewable sources, such as wind and solar, into the national grid is a challenge. Greece has to invest in grid infrastructure to accommodate a higher share of renewables and ensure grid stability. In addition, variability in renewable energy production requires advanced grid management and energy storage solutions (Apostolopoulos et al., 2020). Developing energy storage infrastructure, demand response programs, and grid-scale batteries is essential to match supply with demand.

In the field of financing and investment there are also some challenges. Access to financing for RES projects can be a challenge. Greece must attract both domestic and foreign investments to fund the development of renewable energy projects. Establishing favorable financing mechanisms, such as feed-in tariffs and green bonds, can encourage investment. In this direction also a new legal framework with less bureaucracy can contribute, especially when it gives motives for investments in start up companies that act in the renewable energy sector (Hafner & Raimondi, 2020).

Lastly, we have to refer to the challenge of NIMBYism. It is a problem that have been recorded in Greece more and more recently. There is a recent example in order to understand this challenge. First in Kalavryta town where wind generators were about to be placed close to a monastery. The nuns following the legal path managed to make the company installing these generators to move them to another spot further from the monastery. So this decision cost money and time in the installation of a renewable energy infrastructure in a not so crowded area.

4.3 Aims, observations and conclusions about the Green Deal of Greece

In September 2021, Greece was actively participating in the European Union's ambitious Green Deal initiative, which aims to make the EU climate-neutral by 2050.

That time it was the first initiative that Greece took, since the launch of the Green Deal in 2020. The European Green Deal, as referred in a previous chapter, encompasses a wide range of policies and initiatives to address climate change, promote sustainability, and foster economic growth. Greece involvement in this initiative has many aspects. It is of high importance for Greece to achieve its targets towards the green transmission, especially when the EU has allocated significant funding to support member states to achieve these goals. Like other member states, Greece would have access to these funds to invest in renewable energy projects, energy efficiency upgrades, and other green initiatives (Pegkas, 2020).

First of all, there is the National Energy and Climate Plan (NECP). Like all EU member states, Greece was required to develop a National Energy and Climate Plan. These plans outline how each member state intends to contribute to the EU's overall climate and energy goals. Greece's NECP would have detailed its targets for reducing greenhouse gas emissions, increasing the share of renewable energy, improving energy efficiency, and more. Greece's NECP is aligned with the EU's overall targets for 2030. These include reducing greenhouse gas emissions by at least 40% compared to 1990 levels, achieving a 32% share of renewables in the final energy consumption, and improving energy efficiency by 32.5%.

An important aspect of the Green Deal that Greece is trying to implement is the renewable energy expansion. Moreover, Greece's NECP places a significant emphasis on the expansion of renewable energy sources. It aims to increase the share of renewables in its gross final energy consumption to 35% by 2030. This includes the development of wind, solar, hydro, and biomass energy sources. Besides, Greece has significant potential for renewable energy, particularly solar and wind power. As part of the Green Deal, Greece was expected to increase its use of renewable energy sources. This might involve the construction of new wind farms, solar installations, and other renewable energy projects (Marinelli et al., 2021). In the field of energy efficiency Greece has set specific targets for its national action plan. These targets are designed to contribute to the EU's goal of improving energy efficiency and reducing greenhouse gas emissions. Greece aims to significantly enhance the energy efficiency of its building stock. The goal is to renovate at least 3% of public buildings annually to meet higher energy performance standards, with a focus on energy efficiency and the use of renewable energy sources. An important factor in this field is the energy efficiency in

transport. Our country aims to promote energy-efficient and sustainable modes of transport. This includes increasing the use of electric vehicles (EVs), improving the energy efficiency of conventional vehicles, and enhancing public transportation systems. In this way an improvement in public transportation will take place and the reduction of emissions from transportation means will improve the quality of people's life.

Most recently in 2022, the EU cohesion policy decided to transit a funding of 1,63 billion euros to Greece for a just climate and energy transition. This will happen through the Just Transition Fund (JTF). The JTF, provides support to regions most impacted by the shift towards a climate-neutral economy. The identification of these regions is outlined in Territorial Just Transition Plans (TJTPs), which are developed through discussions with the Commission during the negotiations of the 2021-2027 Partnership Agreements and associated programs. These TJTPs, crafted in close collaboration with local stakeholders, delineate the challenges, development needs, and objectives for each region by 2030. They also define the proposed operations and governance mechanisms (Kyriazi & Miró, 2023). Approval of these TJTPs opens avenues for dedicated funding under the other two components of the Just Transition Mechanism (JTM): a just transition scheme under InvestEU and a Public Sector Loan Facility for Just Transition, combining Commission grants with European Investment Bank loans. The JTM is a crucial tool to ensure an equitable transition to a climate-neutral economy, ensuring that no one is left behind. It offers targeted support to mobilize approximately €55 billion between 2021 and 2027 in the most affected regions to mitigate the socio-economic impacts of the transition.

In July 2021, Greece achieved a significant milestone by becoming the first of the 27 EU Member States to secure approval for its Partnership Agreement with the Commission. This agreement involves substantial investments, with 30% of the European Regional Development Fund and 55% of the Cohesion Fund dedicated to initiatives focused on energy efficiency and the reduction of greenhouse gas emissions. In addition to the JTF Programme, two other Cohesion Policy programs linked to the Partnership Agreement have received approval: the 'Competitiveness Programme' and the 'Civil Protection Programme.' Responding to a request from Greek Authorities, the Commission provided tailored technical expertise to assist in the preparation of the TJTP, with a specific focus on building capacity for effective implementation and

designing governance systems. This support was channeled through the Technical Support Instrument under DG REFORM. The Greek plan is slated to receive €1.38 billion in grants from the Just Transition Fund. This program will support decarbonization initiatives in regions most impacted by the energy and climate transition, such as Western Macedonia, Megalopolis, neighboring municipalities, and the phase-out of fossil fuel power stations in the islands of North-South Aegean and Crete. These efforts aim to drive economic diversification and modernization, including the creation of jobs and the development of skills for individuals affected by the transition. A significant portion of the funds will be directed toward entrepreneurship, including the financing of both existing and new enterprises, improvements in business infrastructure, and the strengthening of connections between companies and research and innovation (comprising just over half of the funds). Another substantial allocation (20.4% of the total) will be dedicated to enhancing human resources and workforce skills in affected areas, with a focus on promoting employment. The JTF support will also address the energy transition, adaptation of land use, and the circular economy, encompassing activities such as energy enhancements, the promotion of self-production through energy communities, the utilization of renewable energy sources, the advancement of e-mobility, and the development of energy storage systems (Kyriazi & Miró, 2023).

To sum up, the program includes two strategically significant operations:

‣The 'Innovation Zone' in Western Macedonia, designed as a central entity for infrastructure development and initiatives in innovative entrepreneurship.

‣The investment called ‘Bioeconomy 360° Hub' in the Municipalities of Megalopolis, Gortynia, Oichalia, and Tripoli, aimed at transforming business activity across the bioeconomy value chain, including agri-food, circular, and digital economy aspects.

There are also some challenges for Greece in order to implement successfully the instructions of the Green Deal. Like other EU countries, would face challenges in achieving the Green Deal's objectives. These challenges might include the need for significant investments, potential job transitions in sectors affected by decarbonization, and ensuring that the transition is socially and economically fair. One of the biggest challenges is how the foundation coming from NSRF (National Strategic Reference Framework) will be utilized at a national level, especially by small and regional energy

production companies or producers (Kyriakarakos et al., 2022). Another challenge is the utilization of the foundation coming from the JTF and the EU cohesion policy. So, there should be supervision over the use of this money and the investments that will be made in this context. Another challenge refers to the economic constrain of Greece. Moreover, Greece has been dealing with economic challenges for years, including high public debt and unemployment. Financing the transition to a green economy and meeting the Green Deal targets requires significant investments. Balancing these financial commitments with the need for economic recovery and stability will be challenging (Wolf et al., 2021). There has also been noticed the challenge of biodiversity conservation. Part of the Green Deal involves conserving biodiversity and protecting natural habitats. Greece is known for its rich biodiversity, and achieving these goals may require changes in land use and farming practices, which can be met with resistance from some stakeholders (Kougioumoutzis et al., 2021). Lastly it has been noticed that there are some regional disparities. Greece is a country that includes a lot of islands, that have significant differences comparing to mainland. The transition efforts of the country will need to address regional disparities in economic development and ensure that the benefits of the Green Deal are spread across the country, including in less-developed regions (Biresselioglu et al., 2021).

4.4 SWOT Analysis of RES sector in Greece

A SWOT analysis serves as a strategic planning instrument employed by individuals, businesses, and organizations for the purpose of appraising their internal strengths and weaknesses, alongside external opportunities and threats. Besides the name of this analysis, comes from these four words. This method offers a structured framework to gain insights into the present circumstances and the external landscape within which a specific venture or enterprise functions. Strengths and weaknesses encompass intrinsic factors such as resources, competencies, and constraints, while opportunities and threats concern external elements like market dynamics, competition, and regulatory shifts (Armstrong & Kotler, 2015). By methodically scrutinizing these four dimensions, a SWOT analysis aids in making well-informed choices, devising strategies, and pinpointing areas for enhancement or potential expansion. It proves to be a valuable

instrument for elevating planning, addressing challenges, and enhancing decision-making processes across a diverse array of scenarios.

Having all these in mind, a SWOT analysis of renewable energy sector in Greece can reveal every aspect of this landscape. Moreover, we can spot what goes well and what goes wrong and also make some future predictions. In this way, we will be able to understand the changes that happened and can take place in this field in Greece.

So, starting from the strengths in the RES sector in Greece, we notice that this specific country has abundant of renewable sources, due to its position and geomorphology. Moreover, Greece enjoys ample sunlight and wind, making it suitable for solar and wind energy production. Its geographical location provides significant potential for harnessing renewable energy. The days when the sun is shining has been calculated at 250 per year. This means that at least 68% of the year solar parks can have more than enough sources to produce energy. So, there are 3,000 sunny hours a year in Greece. Another strong point in the renewable sector for Greece that came up lately is the government support, especially after the 2016 law frame. The Greek government has shown a commitment to renewable energy with various incentives, feed-in tariffs, and regulatory frameworks to promote its development. In addition, some of the Green Deal instructions has already been implemented in Greece and in this context new incentives have already been carried out (Siddi, 2020). Some of these incentives include reduced taxation for investments in the RES field and motives for households to use renewable energy. The energy independence can also be referred as a strength for Greece. Increased reliance on renewables sources reduces Greece's dependence on fossil fuel imports, enhancing energy security and reducing exposure to energy price fluctuations. Besides Greece has been entered a post-lignite era and there are plans for the conversion of lignite energy production factories into renewable energy production ones (Marinakis et al., 2020).

Passing on to the weaknesses of Greece in the renewable energy field, maybe the biggest one is the bureaucratic procedures. There is still a lot of paperwork that investors have to do in order to get permission for implementing infrastructures for renewable energy and through this procedure they waste a lot of time, something that can discourage new investments. There are also other investment barriers. Securing financing for renewable projects can be challenging due to the economic climate,

perceived risks, and credit availability. Another weakness is the need for a renewed legal framework according to the Green Deal instructions. The existing legal framework has been implemented four years before EU Green Deal, so some laws have to be reconsidered and align with these instructions (Biresselioglu et al., 2021). Lastly another drawback is that there are no rate-based incentives. Rate-based incentives, often referred to as feed-in tariffs (FiTs), are a mechanism used in many countries to promote the development of renewable energy sources (Zhao et al., 2021). However, some regions, including Greece, have opted for alternative approaches that do not rely on rate-based incentives like the German model.

In the field of opportunities for RES sector in Greece we can refer firstly to the EU funding. As seen in a previous chapter there are some subsidies coming from the European Union in order to boost RES field in Greece. This foundation can lead the country into a renewable energy producer and into an energy export. In the future Greece can potentially export surplus renewable energy to neighboring countries, leading to economic benefits (Kyriakarakos et al., 2021). Another opportunity is the liberalization of energy market in Greece. During the last decade more and more companies have been entering the Greek energy market, meaning that there are not so many barriers for new entrants and the market is not oligopolistic now. Lastly there is the new EU Directive for energy efficiency in buildings. Moreover, there are subsidies for households in order to make their residences more energy efficient.

As for the threats of RES field in Greece there is the bureaucratic problem as referred before, that can be even more severe if a new law framework will not be implemented soon (Tsagkari, 2021). Another threat is the resistance to change. A lot of people don’t want RES infrastructure close to their houses. So there has been spotted some local reactions to some RES projects, especially in rural areas. Another threat is the lack of effective cooperation and streamlined administrative procedures between energy and environment agencies in Greece. This raises several challenges to the development and management of renewable energy projects.

Out of this analysis we can create a table including the strong and weak points of the RES sector in Greece as well as the opportunities and threats. So, the table is as follows.

Figure 7. A SWOT Analysis table about RES field in Greece.

Strengths	***Weaknesses***
‣A country abundant of renewable sources. ‣About 250 shinny days per year. ‣Implementation of Green Deal instructions.	‣Timewasting bureaucratic procedures. ‣The need for an update law framework for RES. ‣Lack of rate-based incentives.
Opportunities	***Threats***
‣EU funding for all types of RES. ‣Liberalization of Greek energy market. ‣Subsidies for households.	‣Delays in the launch of a new legal framework. ‣Resistance to change. ‣Lack of cooperation between energy and environment agencies.

Source: The author (2023).

4.5 Conclusions

Greece's journey into embracing renewable energy sources (RES) is promising, as evidenced by the significant growth in this sector over the past decade. The country's commitment to transitioning to a sustainable energy future, coupled with abundant natural resources and increased RES generation, paints an optimistic picture. The reduction in lignite use and the rise of RES in the energy mix are particularly encouraging. However, this transition is not without its challenges. One significant challenge is the ever-changing policy landscape. Frequent alterations in regulations and

support mechanisms can create uncertainty for investors. To maintain a stable and attractive investment climate, Greece must establish consistent, long-term policies in line with Green Deal objectives. Administrative burdens and bureaucracy also hinder the RES sector. Simplifying permitting and licensing procedures is essential to expedite RES project development and adapt to the evolving legal framework. Grid integration, including capacity and flexibility, poses another obstacle. To accommodate a higher share of renewables and ensure grid stability, Greece must invest in grid infrastructure and advanced grid management, along with energy storage solutions. Access to financing for RES projects remains a challenge. Greece needs to attract both domestic and foreign investments, with favorable financing mechanisms such as feed-in tariffs and green bonds playing a crucial role. Finally, the challenge of NIMBYism (Not In My Backyard) is emerging in Greece, where local opposition to renewable projects can cause delays and relocations. Addressing these challenges while capitalizing on its renewable energy potential is essential for Greece to continue its green transition successfully.

Greece's active participation in the European Union's ambitious Green Deal initiative, with a focus on becoming climate-neutral by 2050, marks a significant step towards a sustainable and green energy future. The country has outlined its goals and strategies through its National Energy and Climate Plan (NECP), which aligns with the EU's targets for reducing greenhouse gas emissions, increasing the share of renewables, and improving energy efficiency. Greece is well-positioned to capitalize on its abundant renewable energy potential, particularly in solar and wind power. Moreover, the country has received substantial funding support from the EU, primarily through the Just Transition Fund (JTF), to facilitate a fair and just transition to a climate-neutral economy, with a particular focus on regions most affected by the shift. However, Greece faces challenges, including navigating evolving policy landscapes, addressing administrative complexities, integrating renewables into the grid, securing financing, managing NIMBYism, and ensuring regional equity. Overcoming these challenges will be crucial for Greece to successfully implement the Green Deal's objectives while fostering economic growth and environmental sustainability.

The SWOT analysis of the renewable energy sector in Greece provides a comprehensive overview of its current status and future prospects. Greece possesses numerous strengths, including its abundant renewable energy sources, government

support, and increasing energy independence, all of which position it favorably for renewable energy development. However, several weaknesses exist, such as bureaucratic hurdles, financing challenges, and the need for an updated legal framework to align with Green Deal instructions. Opportunities for the sector are significant, including access to EU funding, a liberalized energy market, and the potential for energy export. Nonetheless, threats include bureaucratic inefficiencies, resistance to change from local communities, and the lack of effective cooperation between energy and environment agencies. Overcoming these challenges while capitalizing on opportunities will be pivotal for Greece to achieve a robust and sustainable renewable energy sector in line with the Green Deal's objectives.

Chapter 5. RES stations in Greece: A case study

5.1 Introduction

In this chapter we will make some more extensive research on the field of renewable energy stations in Greece. Moreover, this will take place through the examination of some case studies about RES parks. A case study is a research method that involves an in-depth and detailed examination of a particular subject, event, group, or phenomenon within its real-world context. Typically utilized in various fields such as business, psychology, and social sciences, a case study aims to provide a comprehensive understanding of the subject by collecting and analyzing multiple sources of data, including interviews, observations, documents, and quantitative information. It often involves a holistic exploration, offering insights into the complexities, nuances, and unique characteristics of the subject under investigation. Case studies are valuable for their ability to illuminate specific situations, facilitate problem-solving, and generate rich, contextually grounded insights.

Greece boasts abundant sunshine, making it an ideal location for solar power generation. Solar farms and photovoltaic (PV) installations are common throughout the country. They harness solar energy to produce electricity, contributing significantly to Greece's renewable energy capacity. In addition, Greece's coastal regions and islands

experience strong and consistent winds, making them suitable for wind energy production. Wind farms, equipped with wind turbines, are prevalent, particularly in these areas. They generate clean electricity by harnessing wind power.

The first case study we will present concerns the sector of solar energy. It is about the photovoltaic park of Kourtesi which is located in the Western side of Peloponnese and there through solar panels the energy coming from the sun turns into electricity. The next case study concerns another type of renewable energy, wind energy. The wind installation on the island of Agios Georgios, which is in the north section of the Aegean Sea, was a big investment from a private company. Also, it is a non-inhabitant island. Last, we examine the wind park of Panachaiko mountain in the north part of Peloponnese, which operates since 2006.

5.2 The photovoltaic park of Kourtesi

An important RES installation in Greece concerning the solar energy is located in the village Kourtesi. In February 2011, the 4.99 MW photovoltaic park in Kourtesi, in the region of Ilia started operating. The electricity production of this park is 7.72 GWh per year. This mean that it can supply with electricity around 1700 households per year, the size of a typical Greek village. One of the biggest achievements of this installation is that through its electricity production more than 7600 tons of CO2 emissions have been avoided. So, it has a strong ecological impact not only for the area which is located but also for the whole country. Besides according to the website capital.gr, this photovoltaic park aimed, since it was built, among other to produce clean energy, not to have a negative environmental impact and at the same time reduce the greenhouse effect.

It was built by the Italian multinational company Enel Green Power. Enel operates renewable energy parks in more than 30 countries worldwide. For the completion of the solar park in Kourtesi this company cooperated with Greek companies in order to build the infrastructure for the panels, such as metal bases and panels. This shows the international investment interest in the RES field in Greece, especially in an era when electricity production from renewable resources was not so popular in our country.

It is worth mentioning that in 2021 a new way of RES started. Moreover, in the solar park of Kourtesi, trial cultivation of medicinal herbs for the manufacture of animal feed have been carried out. The promotion of renewable energy sources will be boosted in this way, while at the same time the company is ensuring the sustainability and protection of the biodiversity of the areas in which the solar park is operating. In 2022, according to energypress.gr, Enel was awarded for its agrovoltaic success in Greece, in the World Conference on Photovoltaic Energy Conversion - WCPEC-8, which took place in Italy. In this way the company proved that renewable energy production and agricultural sustainability can coexist and result in success. In general, combining the theoretical background of RES and the installation of solar energy in Kourtesi we can conclude that sustainability and renewable energy are two terms with strong connection (Güney, 2019).

Picture 1. The photovoltaic park of Kourtesi from above.

Source: Enel Green Power (2022)

5.3 The wind energy park of the island Agios Georgios

Coming to the next case study which concerns aa wind energy park in Greece it is important first to explain some things about this renewable source. Wind energy is a renewable energy source harnessed from the kinetic energy of moving air masses. It is generated using wind turbines, which convert the kinetic energy of wind into electrical power through the rotation of turbine blades connected to a generator. Wind power is a clean and sustainable energy option, emitting no greenhouse gases or air pollutants during operation (Delagrammatikas & Roukanas, 2023).

In the middle of the Aegean Sea, between the Saronic Gulf and the Western Cyclades, the uninhabited islet of 4,300 acres of Agios Georgios, located 12 miles from cape Sounio and 20 from the island of Hydra, was to be the point where a landmark project for the energy transformation and development of Greece was being carried out. It is important to mention that this island belongs to Attica region. The wind energy park of Agios Georgios island is an autonomous power generation unit, which is connected to the National Energy Transmission Grid through a submarine cable to the mainland. In this island also operates a closed type of GIS substation of Medium to High Voltage elevation. The installation on the island started building in 2014 and two years later in 2016 the wind park was fully operational. Today it includes 23 wind turbines. The location of the island was characterized as ideal because its distance from the coast is 20 km, it enjoys favorable winds averaging 8.4 m/s and it is located in close proximity to the port of Lavrio near Athens. It was built by the Greek multinational company Terna S.A. This investment wasn't easy to complete because Greece was still under the affection of the economic crisis back in 2014. Today this wind park reflects a successful investment. Some key information about its production and management of wind energy, according to the website of Terna, are the following:

- The total power of the park is 73.2 MW.
- The total investment amounted to 150 million euros.
- It is one of the largest realized investments in the field of electricity generation from renewable sources in Greece.

‣It is an innovative investment incorporating an undersea link between islands and continental system.

‣It produces electrical energy that corresponds to covering the above energy needs of more than 40,000 households per year (the size of more cities in Greece).

‣It contributes to the avoidance of more than 180,000 tons of emissions pollutants and the avoidance of more than 60,000 tons of oil.

‣ It is the first wind park on a non-inhabited island.

Picture 2 . The wind park of Agios Georgios island from above.

Source: Terna S.A. (2023).

5.4 The wind energy park of Panachaiko mountain

Another important facility in the field of renewable energy and especially the one coming from wind is the wind energy park of Panachaiko mountain. It is located in the north Peloponnese in Achaia region. This facility can be found at an altitude of 1800 meters, where there are strong winds. In general, this park benefits from the region's strong and consistent winds, making it an ideal location for harnessing wind energy. So, this location was not randomly chosen, but after careful consideration and research. The park was built by the Spanish multinational company Acciona. The wind park of Panachaiko consists of two separate wind farms named "Panachaiko I" and "Panachaiko II". The wind farm "Panachaiko I" has a power of 34.85 MW and "Panachaiko II" has a power of 13.6 MW (Kádár, 2016). Both wind parks extend in an area of 20 km from the north part of Panacahiko peak to the south.

This project was financed by an operational program called "Competitiveness" and gives considerable remunerative benefits to the municipalities of Patras and Rio. The wind park "Panachaiko I" started operating in 2006 and now consists of 41 triple wind turbines, model Vestas V52, with a total capacity of 850 kW each (Zoumprouli, 2011). The original wind farm "Panachaiko I" is considered the largest wind farm in Greece. The "Panachaiko II" wind park started operating in 2009. "Panachaiko I" and "Panachaiko II" have now in total 57 wind turbines with a total power of 48.5 MW. The wind turbine types that have been operating in both parks are Vestas and Siemens-Gamesa. "Panachaiko I" is estimated to provide 90,000 MWh each year, which the public electrical company of Greece uses to cover the needs of approximately 25,000 houses in the Patras area (about 5-7% of the city's households electricity needs).

To sum up, wind parks like the one in Panachaiko play a crucial role in Greece's efforts to transition to cleaner and more sustainable energy sources. They contribute significantly to the country's renewable energy production and help reduce greenhouse gas emissions. Besides wind energy is considered environmentally friendly because it produces electricity without emitting greenhouse gases or air pollutants during operation.

Picture 3. View of Panachaiko wind park.

Source: Energypress (2023).

5.5 Conclusions

After examining the case of three renewable energy installations in Greece it is important to mention that the country had made some important steps into green energy transformation. All three projects was built and started operating before the launch of the Green Deal by EU. This means that both the country and investments (national or foreigners) had recognized the importance of a blooming sector in Greece. The RES industry in Greece offers a variety of investment opportunities because of the country's position and natural resources. It is worth mentioning that there are plenty of renewable energy types such as solar or wind, that can be fully operational in Greece.

The photovoltaic park of Kourtesi in Western Peloponnese showed that a country such as Greece that has more than 250 sunny days per year can strengthen its energy mix and in some years be an energy exporter. If this case succeed the country could have more sources of income that will contribute to the boost of public economics. We have to keep in mind that the country faced a lot of problems during the previous decade due to a severe economic crisis.

The wind parks of Agios Georgios island and Panachaiko mountain show that wind energy is a renewable resource that Greece has abundance of. Wind parks can operate everywhere in the country. From the above case studies, we can refer that there is no geographical restriction. Both wind parks can supply with energy a whole city for a year. To sum up, besides the sustainable and ecological footprint that all RES installations have, they can also boost the economy by offering job vacancies and profits from the sale of their energy production.

Chapter 6. Conclusions and suggestions for future research

6.1 Main conclusions

Through the exploration of the renewable energy sector not only on a theoretical basis but also on a practical level in Greece there have been recorded a lot of conclusions. Besides the subject of RES, is very important not only from an economic aspect but also from a social. Nowadays, more and more nations have been started investing in the direction of RES, because of the uncertainty coming from the pandemic footprint and the Russian – Ukrainian conflict, two facts that will have significant impact in the future. The impact can be recorded in every aspect of everyday life and especially in the economic field. By specializing this to the energy economics field there has been revealed a fruitful sector for research. Besides, energy economics is a branch of economic science that started drawing attention after the oil crisis in the middle of 1970.

Energy economics is a complex field influenced by various factors, including market structure, pricing mechanisms, and policy initiatives. Market structures range from perfect competition to monopoly, with each type having its implications for pricing and competition. Energy policies, on the other hand, encompass energy security, sustainability, renewable energy promotion, energy efficiency, and international collaboration, addressing a wide range of economic, environmental, and social challenges. Understanding and effectively managing energy economics and policies are

vital for nations in the 21st century as the global economy becomes increasingly integrated and energy consumption patterns continue to evolve.

Energy poverty has arisen nowadays, and it involves households struggling to meet their energy needs while making difficult trade-offs with other essential requirements like food, education, and healthcare. As the pandemic forced people to stay at home and rely more on energy services for work and daily life, the demand for energy surged. However, disruptions in energy supply chains and the rapid rise in energy prices, partly driven by increased money supply due to economic stimulus measures, made energy affordability a critical issue for many households. The conflict in Ukraine further compounded these challenges, leading to energy price fluctuations and supply uncertainties, particularly in Europe, which had been heavily dependent on Russian natural gas. This geopolitical tension not only affected energy costs but also disrupted energy infrastructure, leaving some regions without essential services. As a result, energy poverty, once primarily associated with developing countries, has become a pressing concern even in developed nations. Governments have been compelled to take measures like energy reduction to mitigate shortages and prevent blackouts. This multifaceted crisis has also slowed down the green transition in some European countries. The Energy Poverty Index indicates that Bulgaria, Hungary, Slovakia, Greece, Portugal, Lithuania, and Latvia are particularly vulnerable to energy poverty, highlighting the need for urgent attention and policy action in these regions to address this pressing issue. Conversely, Sweden and Finland appear better insulated against energy poverty, providing their citizens with greater energy security.

In summary, renewable energy sources offer a practical and sustainable solution to address global ecological and energy challenges. These sources, including solar, wind, geothermal, hydroelectric, and biomass, are practically inexhaustible and have the potential to provide a reliable, clean, and long-term energy supply. Their adoption gained momentum in response to energy crises and environmental concerns, evolving from experimental and costly technologies to mainstream energy sources. RES are critical for mitigating the depletion of fossil fuel reserves and minimizing environmental impact. However, their increased utilization is now urgent due to geopolitical and economic factors, such as mineral-exporting countries' maneuvers. These energy sources also offer numerous advantages, including sustainability, low environmental impact, simplicity of implementation, job creation, and economic

development. They reduce greenhouse gas emissions, enhance energy security, and require minimal water usage. Nonetheless, challenges exist, including energy storage, high initial costs, technological limitations, resource conflicts, resistance from local communities, and the complexity of transitioning from fossil fuels to renewables. Overall, RES represent a pivotal component of the global energy landscape, offering a cleaner and more sustainable future.

RES have emerged as a powerful catalyst for economic growth and sustainability worldwide. Their deployment fosters economic activity through multiple channels, including the creation of direct employment opportunities, stimulation of supply chains, and generation of a multiplier effect across various sectors. Moreover, RES projects have proven to be significant sources of employment, contributing to reductions in unemployment rates and poverty alleviation, while offering diverse job opportunities that enhance inclusivity. So, the importance of renewable energy can be reflected in the EU Green Deal. The European Union's Green Deal is a multifaceted and ambitious initiative designed to address pressing challenges such as climate change, environmental degradation, and social inequality while fostering economic growth and well-being. This comprehensive plan encompasses various strategies and policies aimed at achieving net-zero greenhouse gas emissions by 2050, transitioning towards a circular economy, reversing biodiversity loss, promoting sustainable agriculture, improving energy efficiency in buildings, and fostering sustainable mobility. The EU Green Deal is supported by significant financial investments, including the Next Generation EU recovery plan, to ensure its successful implementation. However, it also faces challenges related to balancing economic growth with environmental protection, addressing social inequalities, and ensuring policy effectiveness. In this context Greece had made some significant steps ahead of the green transition, but there are still a lot that needs to be done especially concerning Greek laws about RES.

The main challenge in the context of EU Green Deal for Greece is the decarbonization because of the lignite still using in the energy production process. On the other hand, there are plenty of investing opportunities in RES stations such as photovoltaic or wind ones. The foundation from the EU in the renewable energy sector can be a strong motivation for new investors. The SWOT Analysis of RES sector in Greece revealed that due to the country position there is abundant of renewable sources and in combination with the implementation of the EU Green Deal instructions can make the

country an energy supplier in the future. On the other hand, the time-wasting bureaucratic process along with the delays in the implementation of a new legal framework should be tackled immediately.

Through the examination of some case studies of RES stations across Greece the main conclusion is that the country has now the knowledge to manage and support more of these investments in the future. We have to notice that these kinds of investments can take place on an island or in the mainland successfully.

6.2 Future research suggestions

After completing the main conclusions of this thesis, we are now in a position to make some important suggestions for future researchers in order to examine this subject more thoroughly. It is very important to continue the research on RES sector in Greece, because it is a matter that will have the country's attention in the future. Besides if Greece made all the way to be an energy supplier in the future, this means increased profits for the country. So, some suggestions for future research are the following:

‣ The RES field in Greece should be investigated through the use of data from reliable resources like Eurostat or Our World in Data, in order to notice the evolvement of this sector in a more practical level. Through this there can be data analysis in many fields of renewable energy like solar or wind one.

‣ In this thesis we used a SWOT Analysis about RES sector in Greece. So, another suggestion for future research is a PEST Analysis for the same sector. PEST stands for Political, Economic, Social, and Technological factors. This analysis will help the country to understand the broader context in which the RES sector operates and also the legal gaps formed in order to implement the Green Deal instructions.

‣ There can also be research about the cooperation on an energy level between Greece and other countries, especially in Europe. An example can be the new Burgas-Alexandroupoli pipeline, which will transfer energy from Greece to Bulgaria.

‣ Lastly there can be extensive research on many more RES energy stations in Greece that couldn't be included in this thesis, because of the limitation of time. Some

examples are the photovoltaic complex of Ptolemaida or solar power plant in the Megalopolis area in Central Peloponnese.

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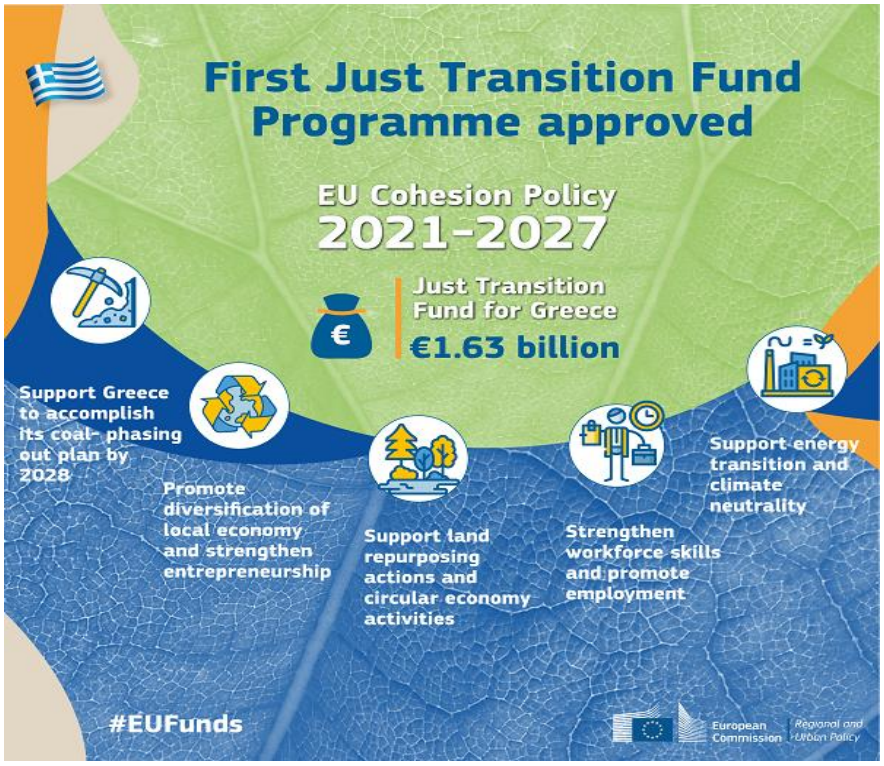
Appendix



Picture 1. Information about EU cohesion policy for Greece. Source: European Commission