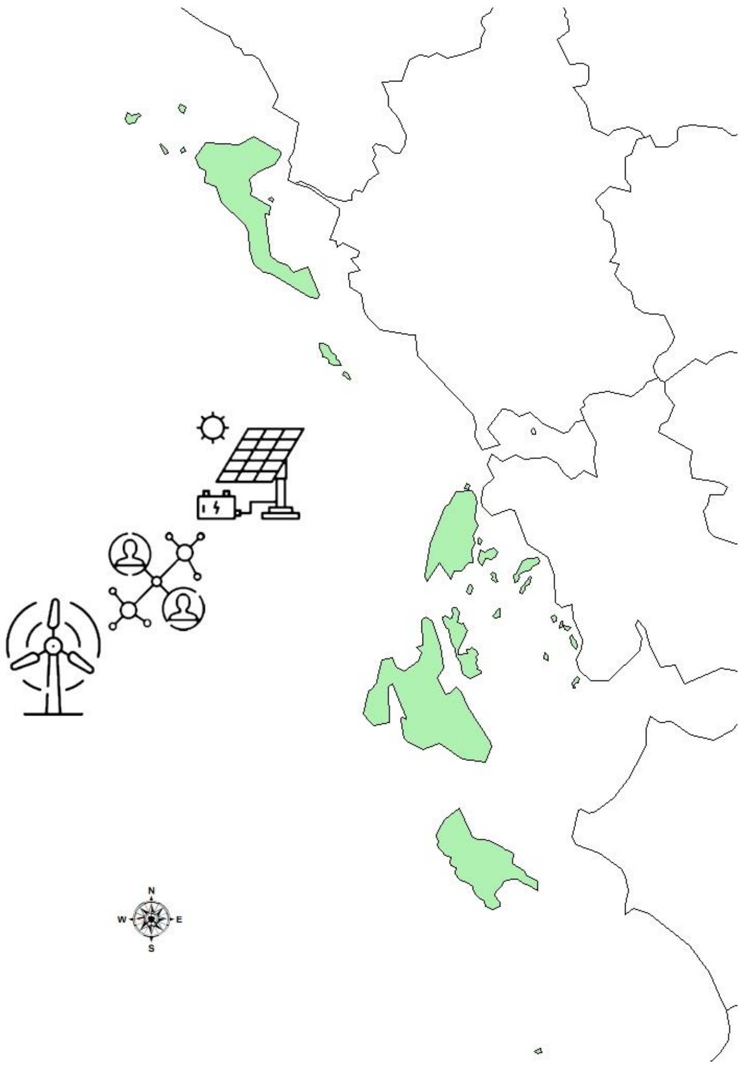
Community Energy Transition in the Ionian Islands

An analysis and scenario roadmap with focus on Corfu and Zakynthos



Disclaimer

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Authors

Foivos Palaiogiannis[1], Athanasios Vasilakis[2], Maria Margosi[3], Giorgos Koukoufikis[4]

[1] Electrical Engineer and researcher, president of Collective Energy Cooperative, Athens, Greece

[2] PhD Candidate, member of the SmartRUE research group, School of Electrical and Computing Engineering, National Technical University of Athens, Greece

[3]PhD Candidate, Department of Economics, National and Kapodistrian University of Athens

[4] European Commission, Joint Research Centre, Petten, The Netherlands

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Introduction

In order to limit the effects of climate change, transition to low carbon and clean energy activities is necessary and a key goal underlined in numerous international climate agreements. The transition to a low carbon energy future and adapting to climate change brings numerous challenges and opportunities for local communities and socio-spatial development (Wilson and Piper, 2010).

Energy transition and its incorporation to integrated socio-spatial planning are thus becoming strongly linked and can lead to more prosperous and empowered communities when favourable transition strategies are in place. This report represents an integrated effort to access possible energy transition scenarios in island communities in Greece and their potential based on extensive use of energy communities.

Greece geomorphologically is characterized by intense spatial fragmentation and discontinuity given a significant amount of island territories, as they approximately occupy 19.1% of the country's land mass and host 14% of its population (Beriatos, 2007). Beyond this particular physical geography, the need to accelerate the energy transition takes place within an ominous socioeconomic environment. The 2008 global economic crisis severely impacted the country up to today. It triggered a long recessional period characterised by negative or low economic growth, persistently high unemployment rates, increasing precariousness in labour markets, widespread spatial and social inequalities among and within the country's cities and regions and further environmental degradation.

In that severe economic context that structurally transformed the society, state and private actors seem to be unable or unwilling to support bold and holistic transition strategies. The transition's rate and path seem to be almost exclusively bound to positive or negative incentives deriving in the forms of subsidies or penalties from the EU's policymaking and legislative agenda.

Today Greece, Europe and the world are in the midst of another severe economic crisis and recessional period triggered by the Covid-19 pandemic. Crises and the context they create are not usually taken into account when economic and political planning takes place. Mega development narratives and blueprints are designed largely within a growth-centric wishful thinking and this goes as well when energy planning takes place in the context of the transition.

Over the past decade, the transformation of the energy system was slower than required to achieve the objectives of the Paris Agreement to combat climate change. As the ongoing COVID-19 pandemic continues to cause economic and social damage, the crisis triggers low energy demand, geopolitical implications due to volatile oil prices, and delayed or stalled sustainable energy investments and projects. According to the International Energy Agency, the world is set to add only 167 gigawatts (GW) of renewable power capacity in 2020 – 13% less than in 2019 (IEA, 2020). This decline reflects delays in construction due to supply chain disruptions, lockdown measures and social distancing guidelines, as well as emerging financing challenges.

Given that in the global interconnected capitalism crises are becoming a more often and intense phenomenon, spatial, economic and energy planning should nevertheless take into account scenarios in which crises occur as well as the behavioural material changes these bring (disrupting access to finance, row materials, jeopardising political/social consensus etc.).

A valuable ally on this transition quest that often proves resilient during crises can be the various collaborative community initiatives. In particular, community energy initiatives are growing around Europe indicating a bottom-up interest for alternative ways of organising and governing energy systems that allow more participative and democratic processes to emerge (Van Der Schoor et al., 2016).

The last years EU and national legislation provided legal frameworks for defining and establishing such communities. The European Commission's Clean Energy Package legally recognised for the first time under EU law, the rights of citizens and communities to engage directly in the energy sector and formally brought forward the term energy communities.[1] In Greece, the Energy Communities Law 4513/2018 that was introduced in 2018 provides the basis for citizens and local governance to participate in and transform the energy sector's landscape.

Energy communities as a new form of social innovative become the medium between micro-level community actions and macro level institutional changes. Their activities could help to a fairer and more democratic energy landscape, create energy security, accelerate the transition, and cultivate energy citizenship among others (Hewitt et al. 2019; Magnani and Osti 2016; Caramizaru and Uihlein, 2020).

Especially for island communities this entity becomes a vehicle that can empower the local population. Traditionally in the Greek islands there was an interest in alternative forms of energy production to reduce energy dependence and promote the use of sustainable energy. So far though the mode of energy development was extractive one where industry and international energy corporations build and operate large scale projects ignoring local communities and their sociocultural setting, downgrading natural reserves while leaving minimal economic benefits to the local system (Argenti and Knight, 2015). Energy communities have the potential to change that setting by shifting the power balance towards local communities that can become owners of their own energy future.

However, to do so, numerous factors need to align that will enable local initiatives to emerge and thrive. The institutional framework beyond the establishment of energy communities (e.g. land use, taxation, legislation concerning production, commerce and distribution of energy), technical capacity (e.g.

How to read the report:

This report offers a complete profile of the study area in every socio-spatial and energy aspect. It does so by providing elements beyond the typical socio economic and technical indicators; as cultural, historical, environmental and other aspects are deemed important both for the understanding of the context on which energy communities will operate and the assessment of their potential.

Across the main storyline, boxes with broader information will be presented while an appendix with further data and information is available at the end highlighting various aspects of human and physical geography.

[1] Energy communities are defined in two separate laws of the Clean Energy Package: The revised Renewable Energy Directive (EU) 2018/2001 and the revised Internal Electricity Market Directive (EU) 2019/944, see (Caramizaru and Uihlein, 2020)

articulation of the energy grid, RES potential, financial support) and numerous other social, political, environmental and cultural factors become important on assessing the potential and the opportunities this type of agency can offer to a given area.

Mainstream methodologies tend to group and socio-spatially decontextualize territorial entities. We follow an analytical tradition that favours the specificities and particularities of the given islands in question. Such a qualitative analysis provides explanatory potential regarding the factors and outcomes of spatial socio-economic development and their theoretical, discursive and political dimensions (Moulaert and Jessop, 2013) and can provide feedback on quantitative scenario-based investigations of energy planning.

So far there are studies exploring the various aspects of sustainable energy potential of the Greek islands (indicative: Kaldellis and Chrysikos, 2018; Stephanides et al., 2018). In this report we focus on two Ionian Islands, Corfu (Kerkira) and Zakynthos. We first take a stock on the socioeconomic, environmental, regulatory and energy realities of the islands followed by a technical assessment of their electric energy status. Based on the above, different scenarios are defined indicating the possible degree of RES penetration and the impacts of an energy communities-based transitional path for the given island communities. Investment and citizens' engagement potential for the islands are estimated based among others on a survey exploring attitudes of the local population in relation to the energy transition and the energy communities. Scenario building and foresight is used to project on possible future community-based RES realities in the local level while recommendations on how to achieve this are offered.

1 Descriptive socioeconomic analysis of the study areas

1.1 The Ionian Islands

The Ionian Islands demarcate the west border of Greece having a crucial geographic position by connecting continental Greece with the Western Europe. They are an island group of seven principal and several smaller islands with their history being an integral part of the Greek world since antiquity. We find relevant references in the epics of Homer, as they were the homeland of Odysseus, the mythical king of Ithaca. Their history has a similar path with the rest of the Greek territory until the early Byzantine years, during which they were part of the Empire. From the 11th century onwards, their trajectory changed as the Ionian Islands experienced several pirates' raids and many different Western sovereigns. During the Crusades, Ionian Islands were separated from Byzantine Empire and were occupied by Franks, an occupation that lasted until the end of the 15th century, when the Venetians conquered them- apart from Lefkada (Choremi-Spetsieri, 2011). After a short Napoleonian era, during the first half of the 19th century, the islands were under British occupation until 1864 when Britain decided to transfer the islands to Greece.

Today, the Ionian Islands (with the exemption of Kythera) form their own administrative region in the subnational administrative setting. During the 20th century, the islands followed an out-migration trend as a result of the primary sector industry decline (fishing and agriculture). The islands managed to achieve an economic stabilization during the last decades with tourism being their major industry. In the following chapters, several trends and indicators of the Ionian region, focusing in particular on the islands under study; Corfu and Zakynthos, will be presented.

Box. 1 Corfu's history in brief

Corfu has a rich history as its location and resources have been making the islands a valuable geopolitical asset over the centuries. Evidence of human presence in Corfu is estimated since the Paleolithic era, yet in some areas we have evidence since the Neolithic era. Since the Homeric era habitats were the famous Faiakes. Corfu from antiquity until the union with Greece in 1864 had many settlers as well as many conquerors. Its strategic position in the crossing road to the mainland coasts and to Adriatic attracted many invaders (Choremi-Spetsieri, 2011).

The first Greek settlers were from Eretria (Evia) and in 734 BC, the Corinthians settled under the leadership of Hersikrates (Jervis, 1852). Corfu was under the Roman rule during the Roman Empire, while in the Byzantine Empire after many invasions by barbarians it was finally conquered by Gyskardos, who had conquered southern Italy and Sicily at that time. After the conquest of Istanbul by the Franks (1204) and the segmentation of Byzantine territory, Corfu was administrated by the Venetians. For some periods Corfu was reconquered by the Greeks, but finally the Andeans conquered the island (1267) until 1386 when the Venetians returned (Jervis, 1852; Miller, 1903).

Despite that the island was dominated by many, the Venetians' domination played the most crucial role in the evolution of local culture, architecture and arts. The Venetian oppression was in fact a western influence and created favorable conditions for the development of Greek art and culture, at a time that the fall of Byzantium brought Greece in a long period of stagnation. In this context, the development of architecture in Corfu, at that time, was unique given also the fact that Venetians were really progressive in that field. The urban development, the architecture of the buildings in the old town and the fortresses created an architectural heritage of great value and a source of knowledge and research until today. A cultural heritage that is characterized for the combination of western styles, like Renaissance and Baroque, with the Greek habitat needs and ideas. This combination created the essential circumstances to a smooth transition of Neoclassicism. Additionally, Corfu was the first Greek town with buildings of more floors, denoting also the evolution of urban residence at that time. This advancement occurred due to the dominant residential type that was characterized by the closed urban form of the fortified city and the limited space (Orfanoudakis and Borri, 2017).

From 1797 to 1799 Corfu passed into the hands of France and later on the Russian empire (Jervis, 1852) which established the Ionian State. From that time on Corfu develops a remarkable activity in the field of typography with the publication of many books, Greek and others, a pioneer in the Greek territory. From 1807 until 1814 the French of Napoleon conquered Corfu. During their presence elements of the French culture affected local culture. With the collapse of Napoleon, the British army occupied Corfu in 1815 and remained until the island was united with Greece along with the other Ionian Islands (Choremi-Spetsieri, 2011; Potts, 2010). At the period of British occupation, the architecture continued to evolve, but this time with a different influence that fit perfectly the environment, creating a homogeneous set of continuity. Around 70% of the existing buildings were reconstructed during that era (Orfanoudakis and Borri, 2017).

Box. 2 Zakynthos's history in brief

Zakynthos has been long populated by humans and during antiquity it was regarded as an Achaian colony. During the late Bronze Age the island was evolved into a notable Mycenaean center and it was also mentioned in the Catalogue of Ships by Homer. The Archaic city was located in the eastern part of the island where today is the Venetian Castle (Souyoudzoglou-Haywood, 1999). Zakynthos, as Corfu, had an important geopolitical position for the maritime routes toward the west, contributing to a flourishing economy with fertile agricultural fields which favored material exports. Zakynthos did not participate in the Persian wars; however, it was an ally of Athens during the Peloponnesian war. It was in 191 BC when Zakynthos was dominated by the Roman Empire for a long period. The mild climate of the island, and its special beauty attracted wealthy Romans who used it for their permanent residence (Bonelou, 2013). In 1485 AC Zakynthos was conquered by the Venetians. The Venetian domination lasted until 1797, and it was under the supreme authority of the eastern Venetian possessions that resided in Corfu. After the Venetians the Republic French and Napoleon, conquered the island.

One of the most interesting historical events of Zakynthos is the first social revolution within Greek territory known as 'the commoner's rebellion' in 1628. The society of Zakynthos was divided into three social classes: the nobles, the bourgeois and the commoners. The commoners rebelled and formed their own administration against the obligatory enlistment of the Venetian. However, the movement was suppressed in 1631 (Choremi-Spetsieri, 2011).

The mixing of the population observed in Zakynthos during the Venetian domination, inevitably influenced the formation of the society until now. However, the common element, regardless of who was dominating the island, was that the economy was based on the agricultural sector. Also sectors like trade and small industries were also growing. The first trade unions had already made their appearance according to Byzantine standards, and were playing an important role in the formation of commercial capital. Raisin was one of the most important export products of the island. With the development of silk weaving, many silk fabrics, veils and headscarves were exported to the West. The trade, although it was small-scaled, was carried out mainly with the cities of Italy, and the coasts of the Peloponnese opposite Zakynthos (Ithakisios, 1988; Choremi-Spetsieri, 2011). On the other hand, since the domination by England in 1809, economic development changed path. British rule led to the development of many projects on the island, such as the development of road networks, the creation of ports, schools, etc. Even that the British dominated the era when the Greeks were fighting for their independence in 1821, the Zakynthians played a decisive role in this struggle, providing money and soldiers. Zakynthos along with the other inhabitants of the Ionian Islands demanded the reunification of Greece as well as constitutional changes, the British at first denied the reunification but finally in 1864 Zakynthos was united with Greece.

In 1953 a strong earthquake of 7.2 on the Richter scale struck the Ionian Islands and almost destroyed the neighboring island of Kefalonia and caused significant damage in Zakynthos. Many nations around the world such as the United States, Britain, France and Norway responded to this tragedy with generous donations of money and medical supplies (Ithakisios, 1988; Choremi-Spetsieri, 2011). Earthquake activity remains frequent and is still considered a high-risk area.

1.2 Demographics

Across the Ionian Islands, the population dynamics, according to the periodical population censuses, do not particularly vary. Corfu and Zakynthos are the most populous islands in the group, representing collectively 70% of the population. As we see in Table 1, Zakynthos presents a constantly growing population while Corfu has fluctuations. In the decade from 1991 to 2001, the population in Ionian Islands grew by 8% in both Corfu and Zakynthos. In the next decade (2001-2011), following the country's trend, the population in the region[2]. More specifically regarding the areas of our interest, during the same period, in Zakynthos, the resident population increased by 1.8% and diminished by 3.6% in Corfu. The Eurostat estimations of the last decade, remaining to be validated by the next census, predict a decrease in population in both islands.

Table 1. Population in the area of research based on census.

	Population		
	census 1991	**census 2001**	**census 2011**
Ionian Islands	193,734	209,608	207,855
Corfu	107,592	111,081	104,371
Zakynthos	32,557	38,883	40,759

Source: Hellenic Statistical Authority- Census 1991, 2001, 2011

In an attempt to investigate the age structure of Ionian Islands, we use the median age of population indicator and the old dependency ratio. Median age is the age that divides a population into two numerically equal-sized groups; half the people are younger than this age and half of them are older. It is a single index that summarizes the age distribution of a population. Moreover, the demographic old dependency ratio is defined as the number of individuals aged 65 and over per 100 people of working age over those aged between 15 and 64 and it is expressed as a percentage.

Zakynthos, once again, differentiates from the region of Ionian Islands and Corfu that seem to have a bigger median age of population than Greece. Zakynthos, given the available years' data, has a bit lower median age of population than Greece (Figure 1).

According to the theory, a low old dependency ratio means that there are sufficient working people who can support the dependent population. Therefore, if the dependency ratio is growing, it means that those of working age face a greater burden in supporting aging population (Blake and Pickles, 2008). Observing the old dependency ratio since 2014, its increase is obvious (Figure 2). In Corfu, it appears higher than Zakynthos and the region of the Ionian Islands. On the contrary, Zakynthos has a ratio even lower than the average of the Ionian region. This is also a result of the overall older population of Corfu and the comparatively younger population of Zakynthos (Figure 3).

[2] See appendix for more data on demographics.

Regarding energy demand, there is evidence suggesting that ageing population is connected with higher energy demand, especially in warmer climates (Estiri and Zagheni, 2019; Deutsch and Timpe, 2013). Countries with a larger percentage of elderly population are also recording lowest energy efficiency scores (Pais-Magalhães, Moutinho, and Robaina, 2020). Combining this knowledge and the increasing ageing in the two islands, energy demand is expected to rise along with energy poverty among elderly population.

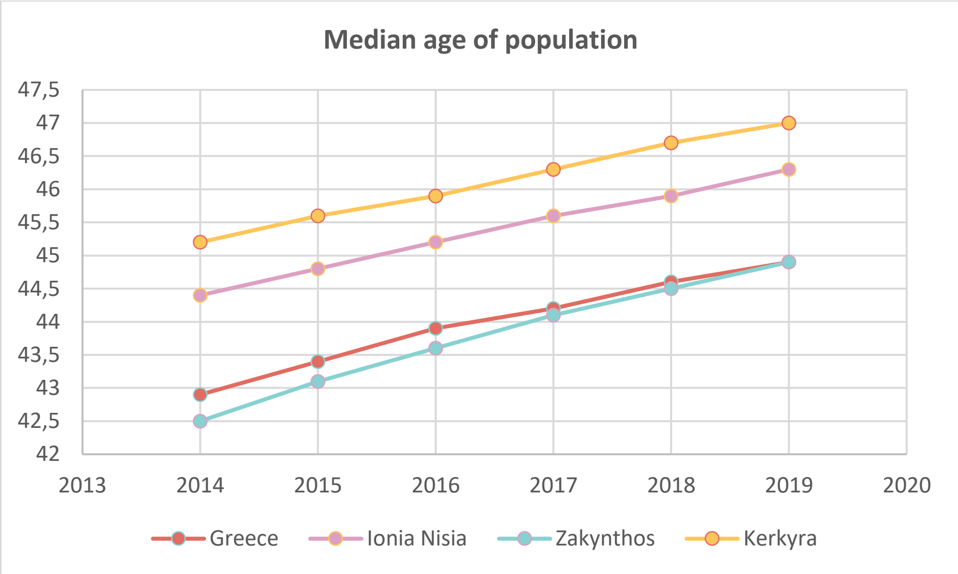

Figure 1. Median age of population dynamics.
Source: Eurostat (demo_r_pjanind3)

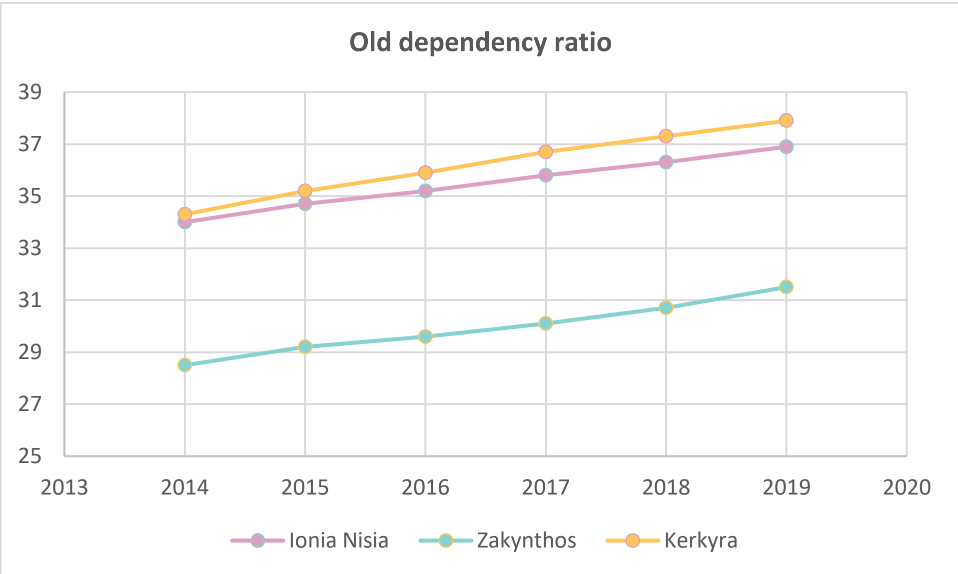

Figure 2. Old dependency ratio.
Source: Eurostat (demo_r_pjanind3)

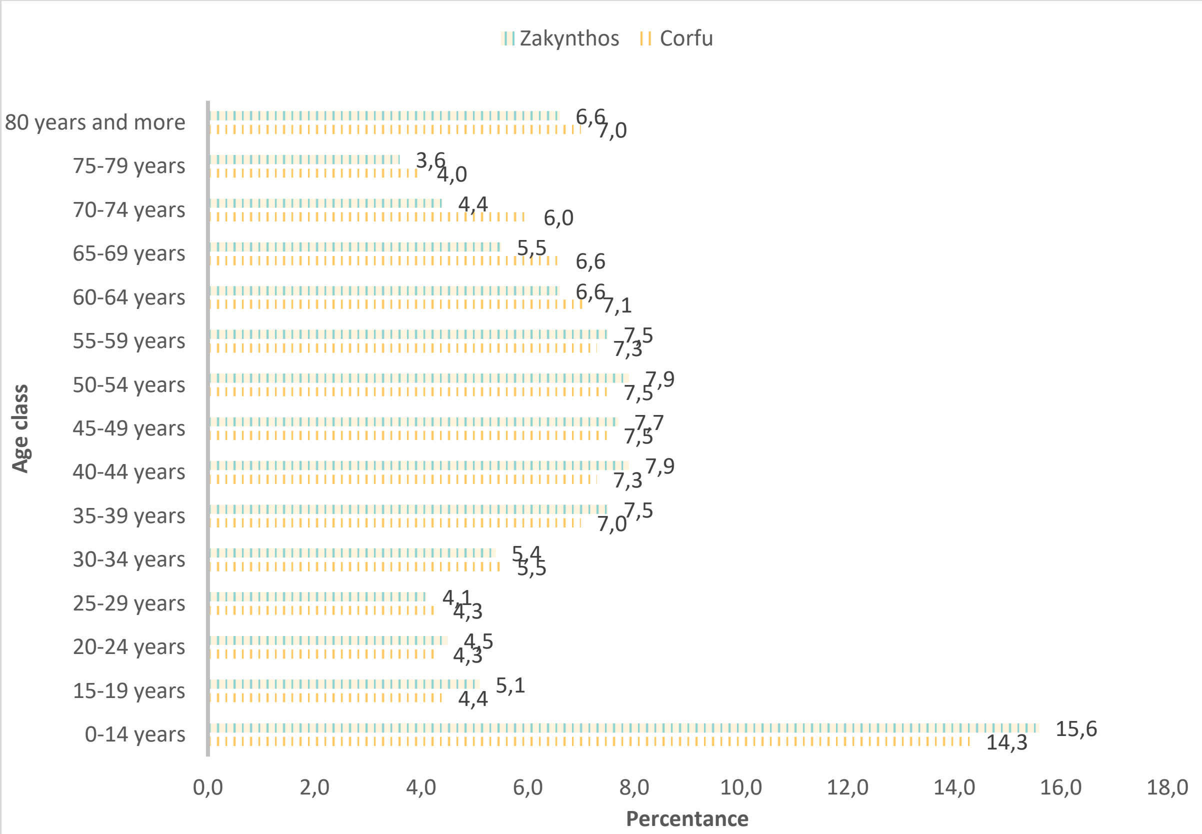

Figure 3. Age structure % by age group.
Source: Eurostat (demo_r_pjanind3)

It is interesting to observe the population density, or in other words, how many persons live per square kilometre. Corfu has one of the highest population density rates in Greece (162.9)[3] and is the third denser province of the country after Athens and Thessaloniki, the most populous cities. There has been an increasing population density trend in Zakynthos as well over the years, as the population is growing. The island has also a high density (98.2) in comparison to other areas of the country, being the sixth denser province out of 51 in total. Thus, both islands have a population density above the country average (82.5) and the Ionian Islands average (89.7).

By observing how this density is translated to the utilization of built environment, we cannot help but notice that in both islands, we meet a high number of available unoccupied dwellings (Table 2). That is probably due to their touristic character, as many buildings are used as second seasonal homes. Thus, in an already dense built environment, we can observe that there is available underutilized building stock, a factor of importance on energy dynamics and potentials.

[3] Population density is calculated as persons per square kilometer, the data are from 2018 – source Eurostat (demo_r_d3dens)

Table 2. Distribution of dwellings to residential and non-residential

	Conventional dwellings	Occupied conventional dwellings	Unoccupied conventional dwellings	% of unoccupied on total
		Non-residential buildings		
Greece	19,380	10,230	9,150	47.21%
Ionian Islands	733	387	346	47.20%
Zakynthos	211	111	100	47.39%
Corfu	159	70	89	55.97%
		Residential buildings		
Greece	6,352,521	4,111,858	2,240,663	35.27%
Ionian Islands	159,373	80,128	79,245	49.72%
Zakynthos	23,887	14,474	9,413	39.41%
Corfu	84,308	40,952	43,356	51.43%
		Total		
Greece	6,371,901	4,122,088	2,249,813	35.31%
Ionian Islands	160,106	80,515	79,591	49.71%
Zakynthos	24,098	14,585	9,513	39.48%
Corfu	84,467	41,022	43,445	51.43%

Source: Eurostat (cens_11dwob_r3)

1.3 Economic activities

The main feature of the region's economy is the high concentration of activities in the tertiary sector (tourism - trade), while the primary and secondary sectors follow a shrinking trend through the years. In order to present a full picture of the economic environment of Corfu and Zakynthos, we used available data from Eurostat. The main macroeconomic variables we used are: Gross Domestic Product (GDP)[4], Gross Value Added (GVA)[5] and Gross Fixed Capital Formation (GFCF)[6].

The impacts of the economic crisis were evident on the Ionian Islands. From 2008 to 2012, the GDP of the Ionian region had a decrease of almost 28%, while the Greek economy as a whole, faced a decrease of almost 21%. Accordingly, Zakynthos faced a decrease of 28% while Corfu encountered an even greater GDP decrease of almost 30% (Figure 4). The GVA decrease for the years of crisis was more or less the same. Generally, GVA of all economics activities follows the trend of GDP through the years, as presented in Figure 5, for Corfu and Zakynthos.

In addition, despite the general acceptance that the recession in Greece was over by 2012-2013, it is obvious that the negative impact of the prior years has not been reverted yet. In GVA, we notice the same trend as GDP; a downward trend until 2012 and from then on, a relatively steady path. However, it is obvious that the negative effects of the economic crisis are still present in real economy. The evidence of this argument is eminent in Figure 6, where the GFCF data is presented. The low levels of GFCF after 2012, with no signs of recovery, shows that the economic uncertainty, caused by the crisis and the economic policies, is still dominant in the investment environment.

According to the last available data of GDP for 2017, Corfu is the dominant economy within the Ionian Islands by producing almost 50% of the region's GDP, while, at the same time, Zakynthos produces approximately 23%. The GDP levels of Corfu and Zakynthos, as well as of Greece and the Ionian Islands, are similar to those of 2003 and by far lower than the ones existing during the years before the crisis breakout.

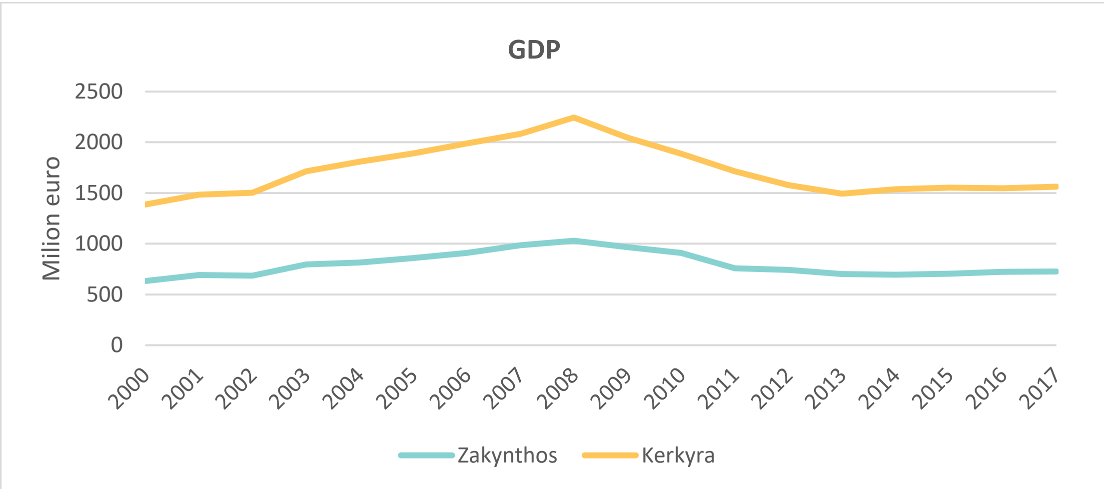

Figure 4. Gross Domestic Product evolution.
Source: Eurostat (nama_10r_3gdp)

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[4] Gross Domestic Product (GDP) is the total value of final goods and services produced within a country in a specific time period.

[5] Gross Value Added (GVA) is a measurement of economic productivity: it provides a monetary value of the amount of goods and services that have been produced in a country or territory minus the costs of all inputs and raw materials that were used for that production.

[6] Gross Fixed Capital Formation (GFCF) consists of resident producers' investments, deducting disposals, in fixed assets during a given period. It is essentially net investment.

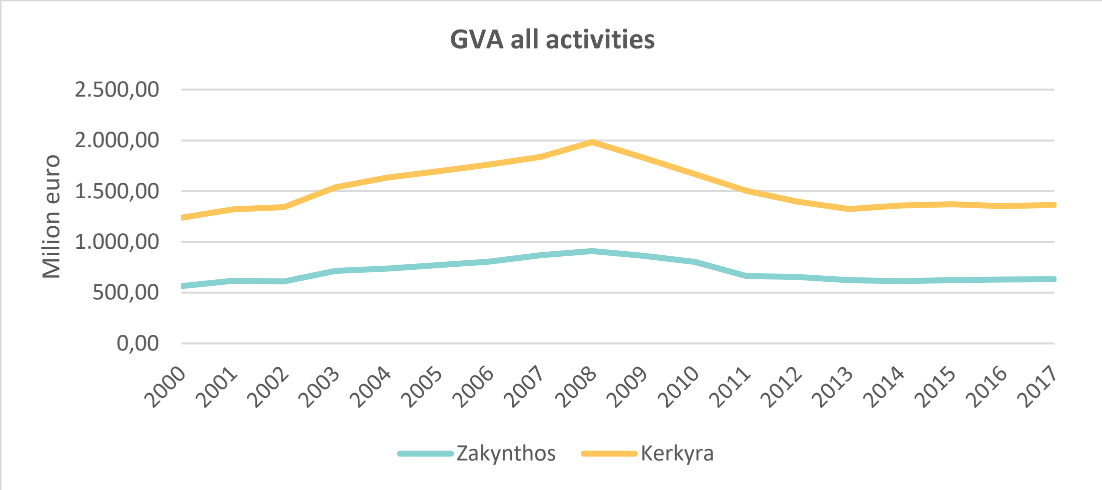


Figure 5. Gross Vales Added evolution.
Source: Eurostat (nama_10r_3gva)

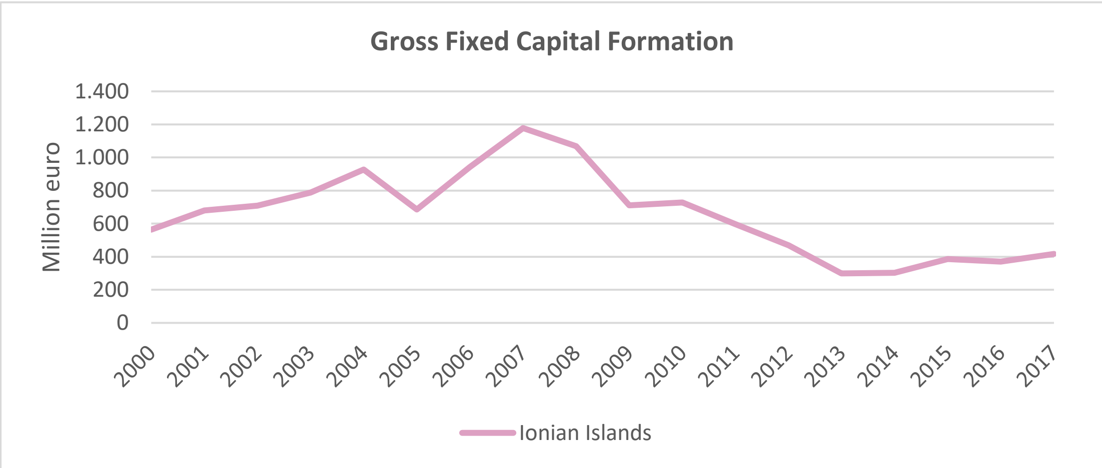


Figure 6. Gross Fixed Capital Formation evolution.
Source: Hellenic Statistical Authority – Regional Accounts

Dynamics by economic sectors

In order to draw evidence for the economic activities, we focus on the GVA data. Starting with the primary sector of the economy -agriculture, fishing and mining-, we notice its downward trend in Figure 7. In Zakynthos, the primary sector seems to have an even more limited role in the local economy and a more descending trend than Corfu. For the year of 2017, the primary sector is only the 2.8% of the total value of primary production in Zakynthos while back in 2000, primary sector was possessing the 8%. At the same time, Corfu's primary sector, being at 4% in 2000, dropped only 1% during the following years and until 2017. Apparently, Ionian Islands follow the overall diminishing trend of the primary sector in the Greek economy.

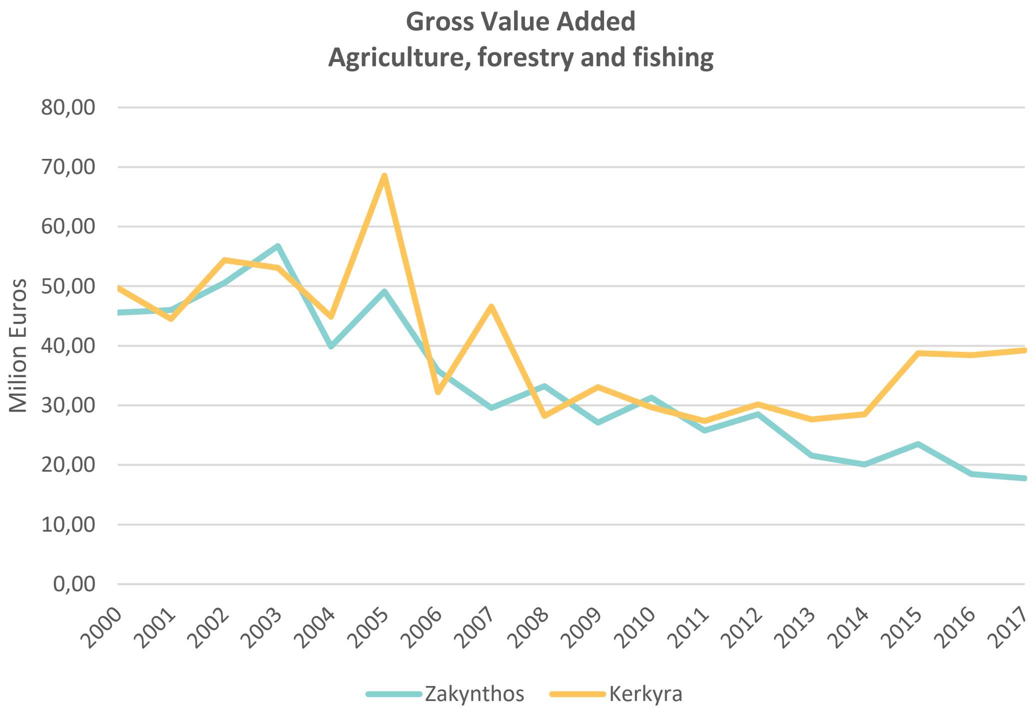


Figure 7. GVA evolution of primary sector in the two islands.
Source: Eurostat (nama_10r_3gva)

Moving forward to the secondary sector of the economy, we observe the indexes on industries; manufacturing and construction. Afresh the impacts of economic crisis were devastating. In both Corfu and Zakynthos (Figure 8), the final production value of the secondary sector faced a decrease of 30% from 2008 to 2012. Corfu experienced the most distressing shrinking of the order of 39% in the construction sector, while Zakynthos appears to have had a decrease of 30% in both manufacturing and construction. The service sector of the economy refers to wholesale and retail trade, transport, accommodation, food service activities, information and communication, financial and insurance activities, real estate, professional, scientific and technical activities and also administrative and support service activities (Figure 9).

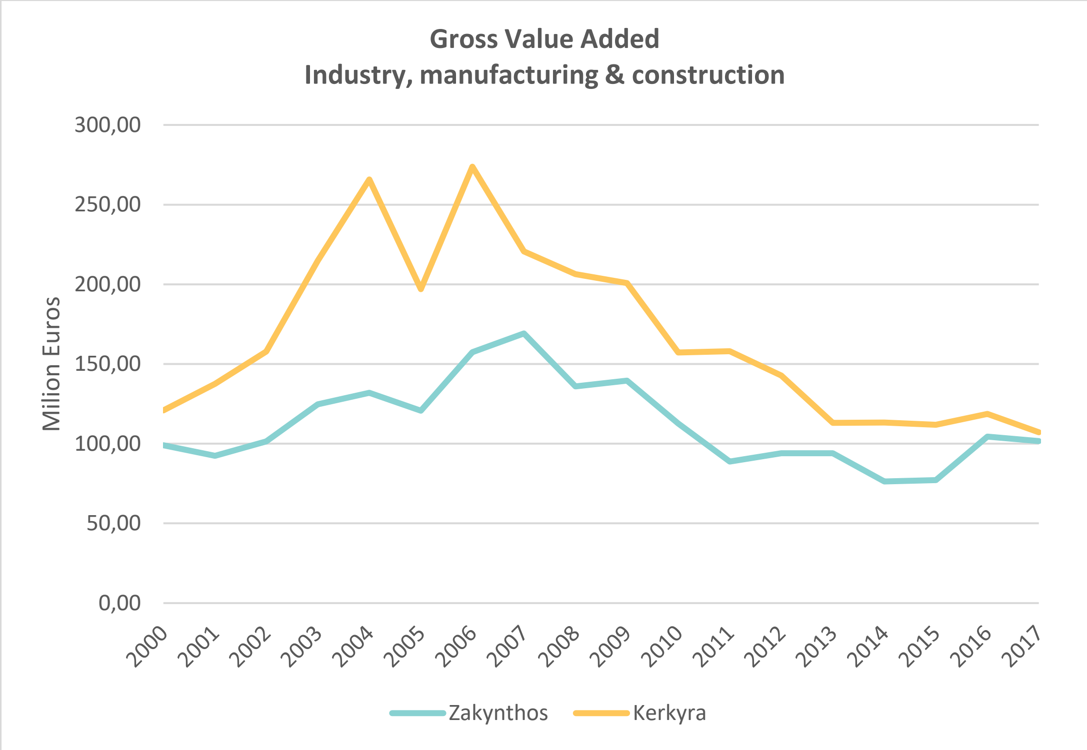


Figure 8. GVA evolution of secondary sector in the two islands.
Source: Eurostat (nama_10r_3gva)

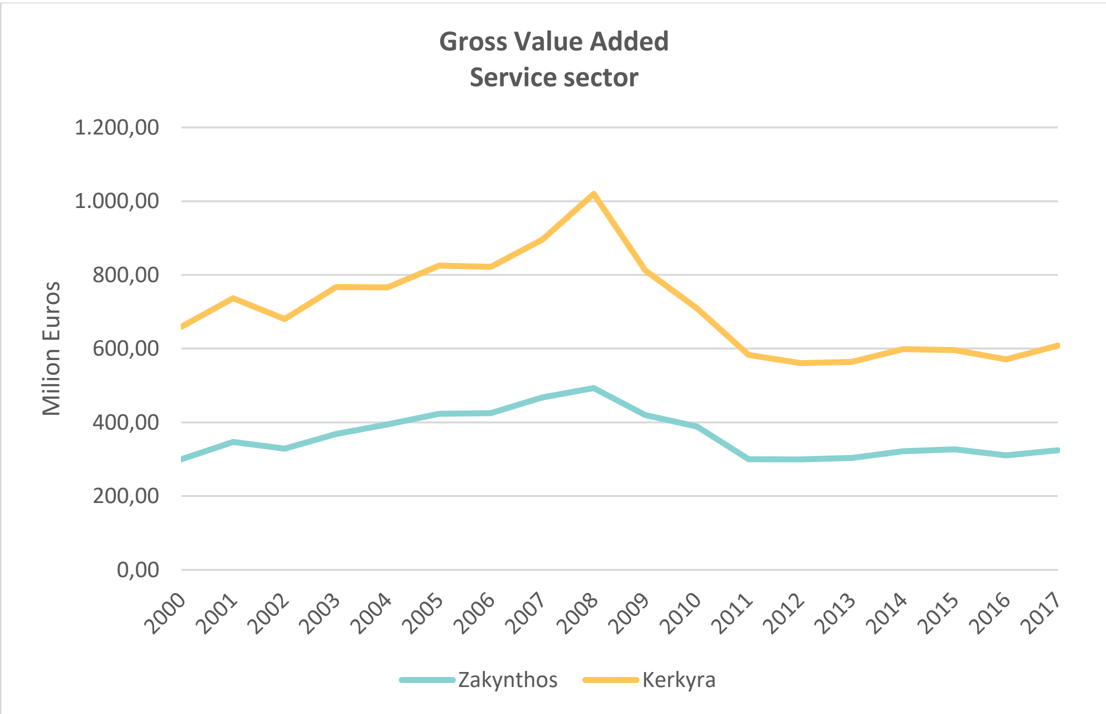


Figure 9. GVA evolution of tertiary sector in the two islands.
Source: Eurostat (nama_10r_3gva)

Tourism

Economic activities related to tourism as part of the tertiary sector also faced the negative effects of economic crisis (2008-2012). In the region of the Ionian Islands the downturn during the years of the crisis was greater (30%) than the average decline of Greece (20%). The total decline, during the reported period, of the sector in Zakynthos was almost 30%, while in Corfu the decline was at a level of 32%. Observing the relevant figures, it is obvious that the effects on the service sector have not been reversed yet, however since 2012 there is no downward trend.

The tertiary sector of the economy includes many services that are tightly connected to tourism. If we turn to more specialized data for tourism the usual downward trend due to economic crisis that we see in the majority of economic data is not confirmed. The number of the establishments - that's for hotels, hostels and other short-stay accommodation, camping grounds, recreational vehicle parks and trailer parks – and the number of the bedplaces in the Ionian Islands increased the years after the crisis breakout. The number of operating hotels in Corfu and Zakynthos have a steady trend through the years with no remarkable fluctuations indicating again the insignificant effect of crisis upon tourism (Figure 10).

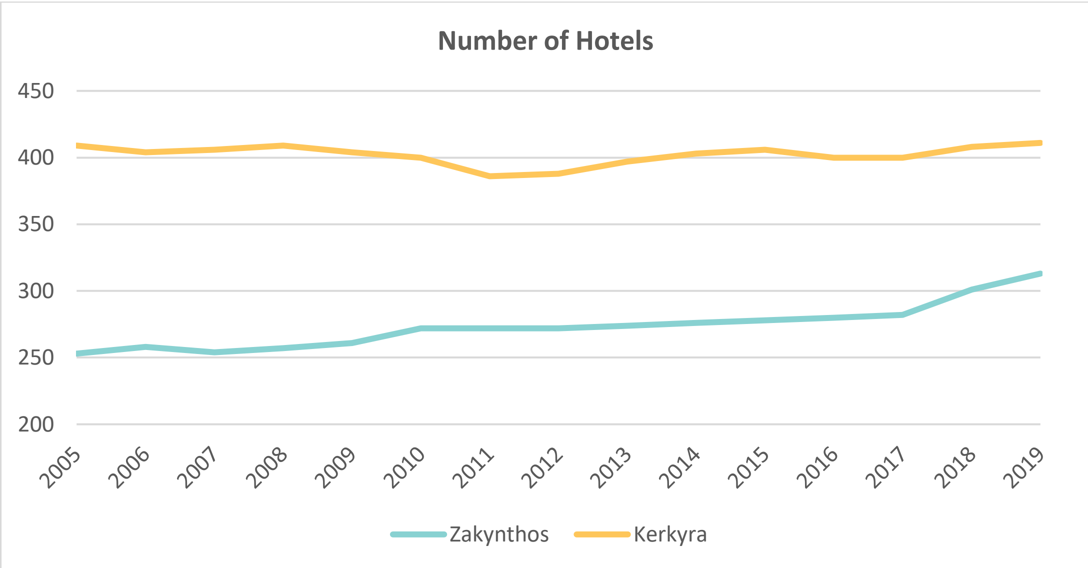


Figure 10. Evolution in the number of hotels in the two islands.
Source: Hellenic Chamber of Hotels

The existing productive structure of the region has led to a large extent, to a dominant model of tourist activity characterized as "mass tourism": tourism may stand out and the Ionian Islands may have gained a prominent position in the Greek tourism market, but some indicators reflect trends of stagnation or even deterioration. Overall, this is a type of "standard" tourism; relatively low value added, strong pressures on the environment and unsatisfactory distribution of benefits. Additionally, concerning the primary sector, although it has enriched the traditional activities and crops with a few local productions, it retains its structural weaknesses, which is reflected in its abandonment.

1.4 People

The main evidence, presented in Figure 11, on the educational structure of the communities in Corfu and Zakynthos come from the last census that took part in 2011. In both regions of interest, the majority of the citizens until 2011 were elementary school graduates. Additionally, we notice that the rates of higher education are low: in Corfu only the 12.08% of the population and in Zakynthos only the 10.23% of the population has a university, master or Phd degree. The majority of the population in both islands are elementary school graduates: 29% for Corfu and 32% for Zakynthos.

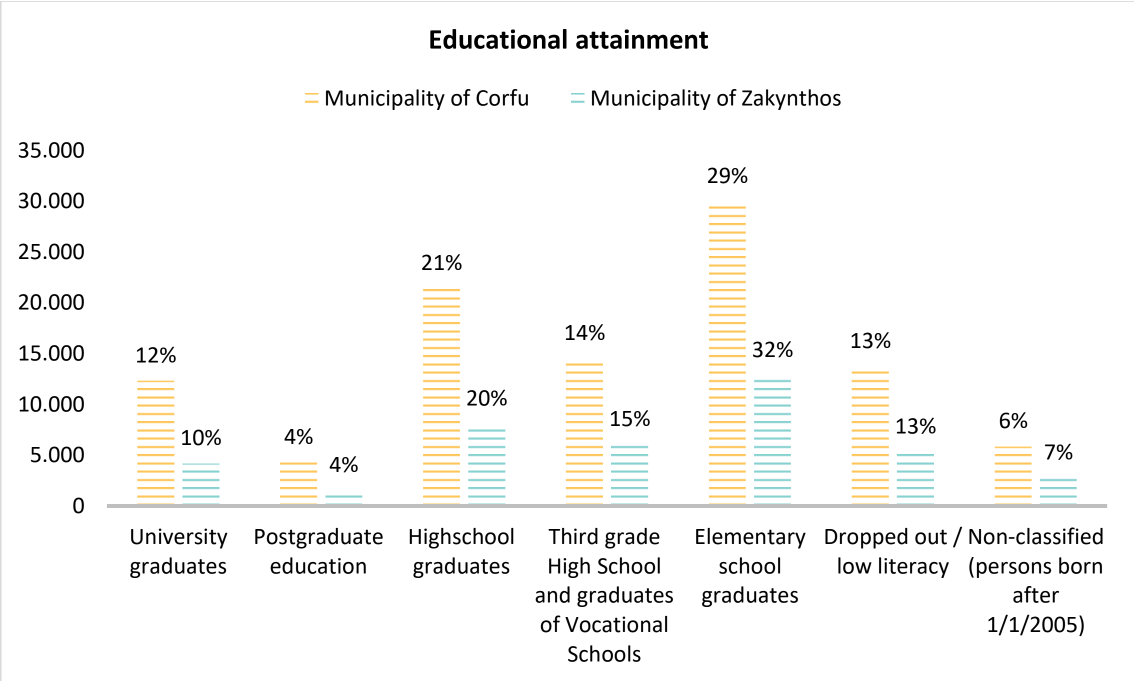


Figure 11. Educational level of islands' population.
Source: Hellenic Statistical Authority- Demographics

In Figure 12 and Figure 13 we see the gender dimension of education level. It is interesting that concerning higher education the percentage of women and men are almost even. In Corfu the 50% of the higher education graduates are men and the 50% are women, while in Zakynthos the 46% are men and the 54% are women, respectively. On the other hand, women have the higher rates of dropping out: in Corfu the 66% of the people that dropped out of elementary school are women while in Zakynthos is the 54% respectively.

Higher levels of education in given areas and engagement in community energy projects are often correlated (Ruggiero et al., 2019). Thus, prosumers behavior it is more difficult to be observed in these islands.

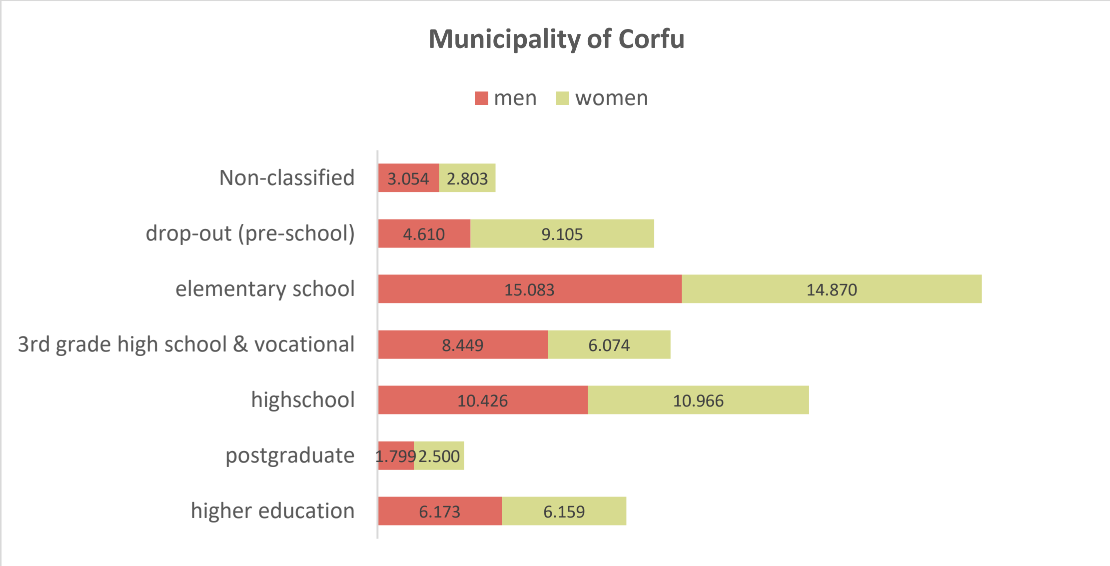


Figure 12. Educational attainment by gender in Corfu.
Source: Hellenic Statistical Authority- Demographics

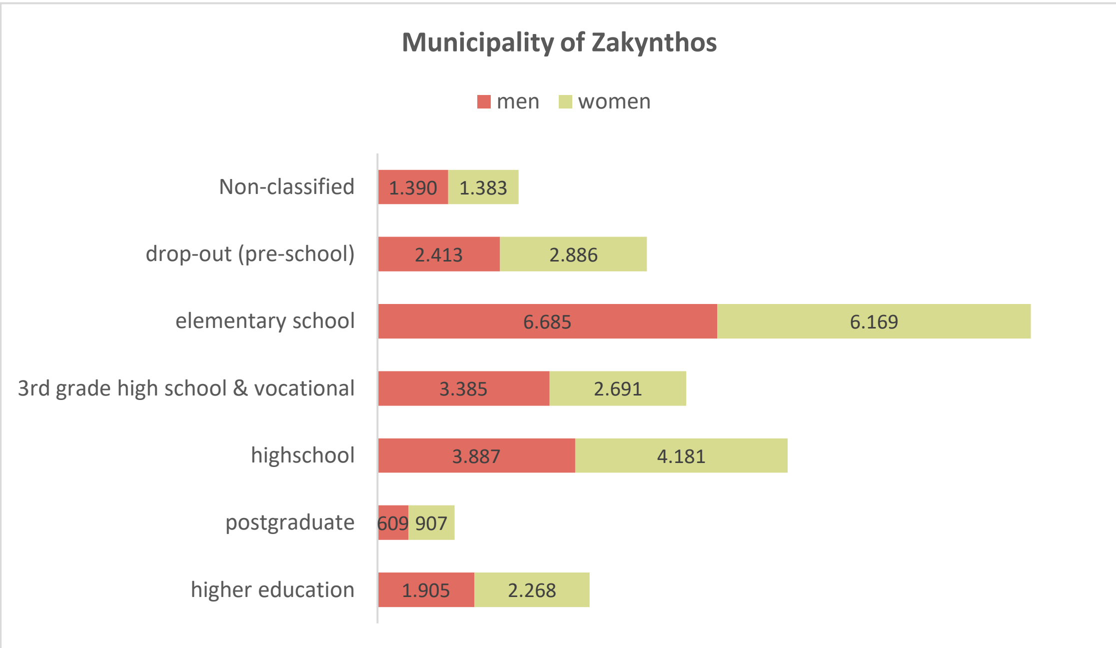


Figure 13. Educational attainment by gender in Zakynthos.
Source: Hellenic Statistical Authority- Demographics

The employment status is divided into two main categories: economically active and economically inactive population. The term economically active refers to the population that is involved in the production and distribution of goods and services, that's to say the labour force, and as well as the unemployed ones. On the other hand, 'economically inactive' term refers to pensioners and as well people that are not looking for a job by choice, or because of a disability or health reason or because they are still studying in school or university.

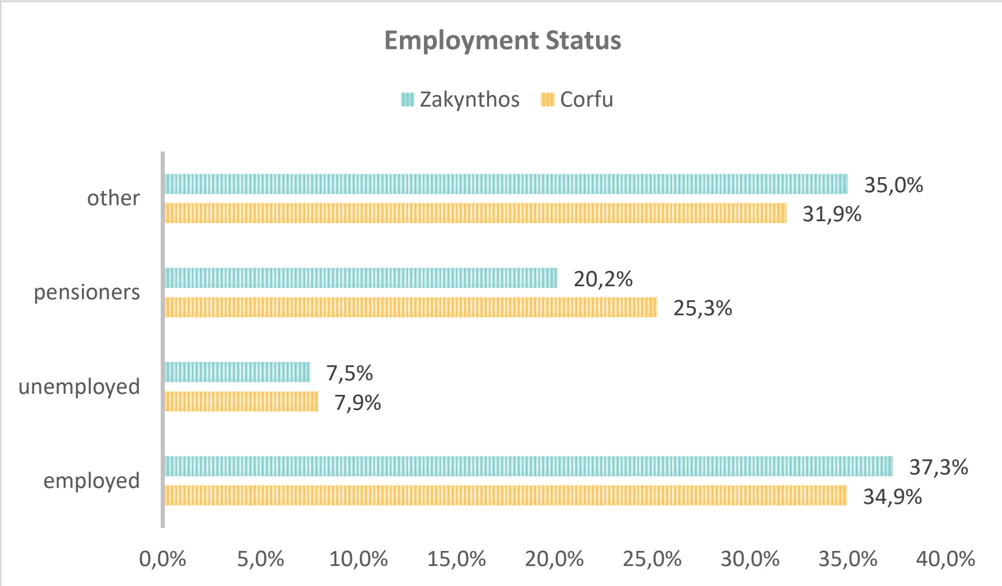


Figure 14. Visualization of employment structure data in the two islands.
Source: Hellenic Statistical Authority - Demographics

The majority of the population in both islands are economically inactive: in Corfu is the 57% of the population while in Zakynthos is the 55%. On the one hand, this may occur because of the aging population of Greece resulting to a large number of pensioners. On the other hand, by observing more carefully the numbers we see that the majority of economically inactive people are classified in the category 'other' where, as it is mentioned before, are people that are still going to school or university etc. Examining each category separately, we see that the larger group is that of the employed, a subcategory of the economically active.

In Figure 15we see the evolution of employment in Corfu and Zakynthos and in Figure 16 and Figure 17 we see the unemployment rate. In Corfu the unemployment rate is increasing with many fluctuations after the crisis breakout. On the contrary, Zakynthos has an unemployment rate with many fluctuations as well, but overall follows a decreasing trend which is more evident in the employment rate which is increasing. The increasing employment rate in Zakynthos occurs maybe because of the growing population of the island and the age structure (see demographics).

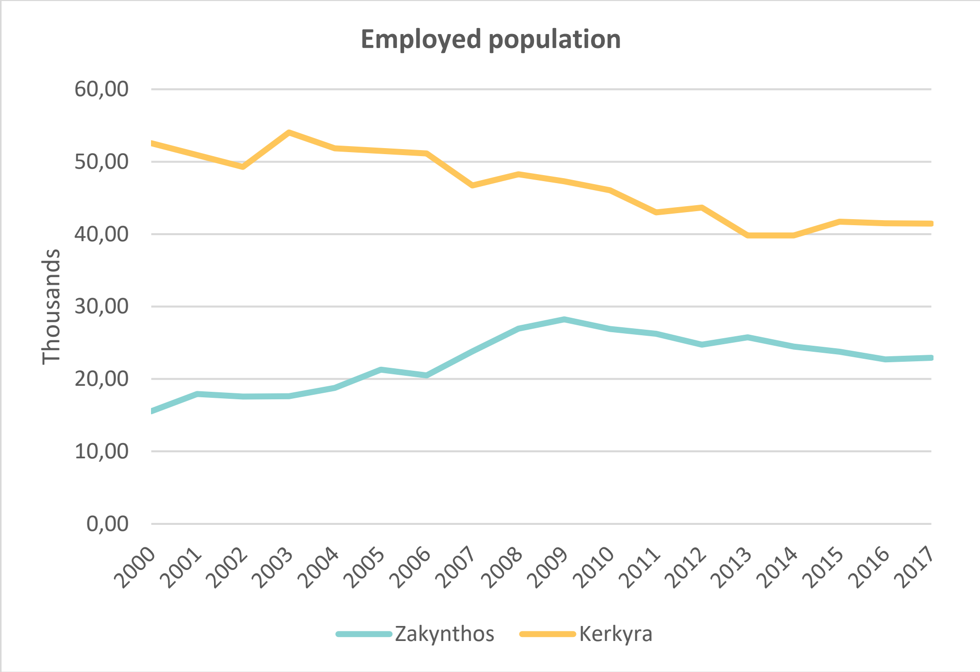


Figure 15. Employment dynamics.
Source: Eurostat (nama_10r_3empers)

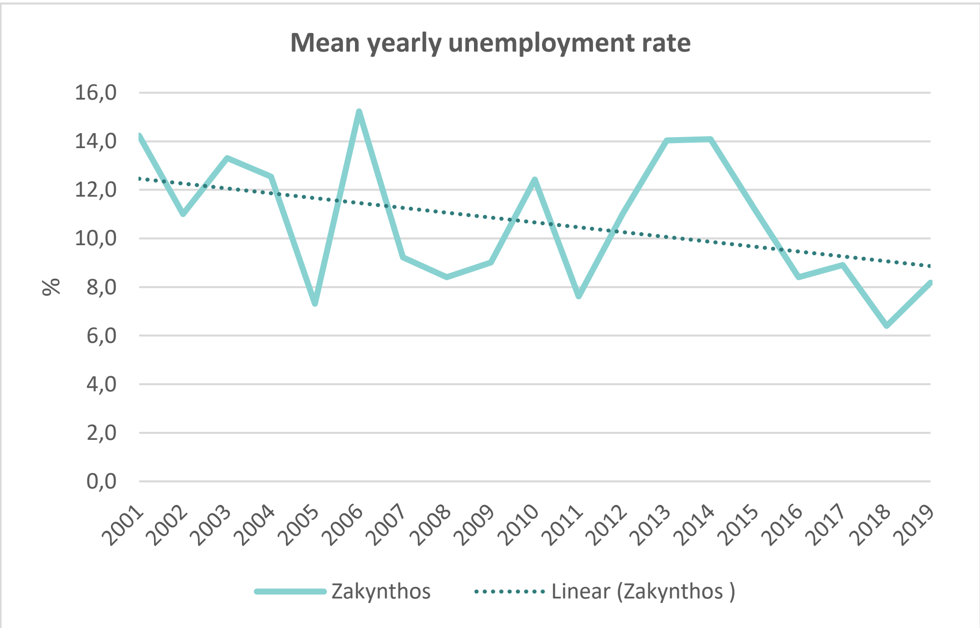


Figure 16. Unemployment rate and trend in Zakynthos.
Source: Hellenic Statistical Authority- Unemployment rate

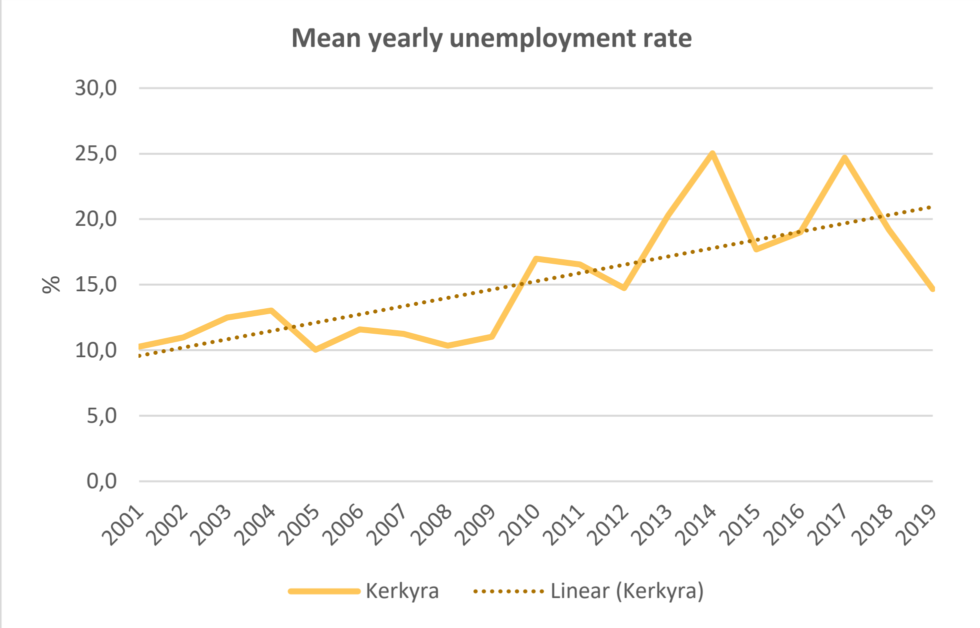


Figure 17. Unemployment rate and trend in Corfu.
Source: Hellenic Statistical Authority- Unemployment rate

Finally, talking about employment and the economic environment it is essential to observe the wages fluctuations (Figure 18) through the years as the most appropriate indicator of income. Unfortunately, data of the compensation of employees (wages) are available only at regional level of Ionian Islands; however, it is a strong indicator for the situation in Corfu and Zakynthos. Based on those data, we see that the wage-dependent working-class families seem to lose significant portion of their purchasing power over the years.

Figure 18. Levels of compensation of employees in Ionian Islands.
Source: Hellenic Statistical Authority- National Accounts

Accepting the general assumption that the economic crisis lasted from 2008 until 2012, we observe a decrease of 16% in wages during those years. However, from 2008 until 2017 wages have fallen by 22.5% and 2015 was the year with the lesser wage compensation. Those evidence demonstrate once again that the effects of the crisis are still present in the real economy of the Ionian Islands.

As a concluding remark we note that the comparative analysis of the main employment and unemployment indicators shows that the Ionian Islands Region is characterized by "participation intensity" of human capital in the production process. The share of the economically active population aged between 15-64 in the total population of the Region is 69.7%, versus 67.9% in Greece and 71.7% in the EU27 (Eurostat, 2012). Women in the Region show significantly lower levels of participation than men.

1.5 Standards of living & supporting infrastructure

Mobility Infrastructure

Remoteness is a key problem that island communities face; thus, mobility infrastructure becomes the key parameter that influences community wellbeing. Mobility infrastructure includes air, land and sea transport infrastructure, as well as public transportation. Each island, Corfu as well as Zakynthos, have an international airport with everyday connections to mainland – Athens and Thessaloniki. Air connections among the Ionian Islands are scheduled about four times a week. Tourist arrivals by air are made both by special international flights (Charter) and by low-cost airlines (e.g. from Italy). In addition, the last years there has been an effort to enhance travel to and from the Ionian Islands by adding new routes / destinations to strengthen the existing ones by Greek airlines.

The most important land transport infrastructures refer to the road networks of the islands and more specifically to the national roads. Zakynthos has a national road (code: 35) that connects the town of Zakynthos with Keri. Corfu has two national roads: the first connects the town of Kerkyra with Palaiokastritsa (code: 24) and the second connects the town of Kerkyra with Gyros Achileiou (code: 25). Of course, both islands have several urban, provincial and local roads that connect settlements.

Moving forward, regarding the maritime transport infrastructure, Zakynthos has one main passenger port, which is located in the town of Zakynthos and connects the island with Kyllini by ferry. The port of Zakynthos also serves the freight traffic of the Island. Corfu on the other hand, has two main passenger ports, the port of Lefkimmi, which provides the connection of South Corfu with mainland Greece via Igoumenitsa, and the port of Kassiopi.

Public transport includes the networks of city, the local and the intercity buses: In Zakynthos the public transport is for long-distance routes, only intercity buses, to Athens, Patras and Thessaloniki and for local destinations to and from the airport. In Corfu public transport is separated to the urban buses and the intercity buses. The Intercity buses have itineraries to Athens, Thessaloniki and Larissa, while the Corfu Urban buses includes itineraries that cover the whole island. In Corfu the public transportation is more expanded than that of Zakynthos.

Finally, the Region introduces the need to develop waterways to improve internal mobility, to minimize the exclusion of small islands from adverse weather conditions and to improve the provided services of tourism. The long-term goal of the Region is to create a connection axis from north to south, by upgrading the port, air and road infrastructure. The port of Corfu is the only port in the Region that belongs to the trans-European maritime network, while the trans-European air transport network includes the airports of Corfu, Kefalonia and Zakynthos[7].

Social Infrastructure

Health

Access to healthcare is difficult for the island communities. The Ionian Islands hold one of the lowest positions in Greece, in terms of the ratio of beds per inhabitant. It seems that all health infrastructure is well located: each island has a hospital; Zakynthos has one health centre and five regional clinics while Corfu has five health centres and twenty-three regional clinics. However, there are several staff shortages, and most hospitals are not sufficiently equipped and specialized to meet all the needs of patients, and as a result there are many cases that the transfers to larger hospitals are necessary (Economou et al, 2017; Ionian Islands Region, April 2019).

Health units like hospitals are considered public infrastructure with high energy demand for heating, cooling, hot water production, ventilation, and lighting given that most operate under heavy duty on a 24-hour basis.

Education

The quality of the provided education, the availability and adequacy of the technical infrastructure and equipment, and the adequacy of the teaching staff composes the aspects of the modern education system.

In the Ionian Islands there are 270 primary schools (with 16,618 students - 2017/2018), 90 secondary schools (with 13,223 students - 2017/2018) and the "new" Ionian University (with 5 Schools and 12 Departments), as well as 4 public units of professional training and 3 Adult Education Centres[8].

In Corfu and Zakynthos the 216 school buildings that operate are an asset for energy transition initiatives, as such public buildings are marked as priority for intervention according to the EU's energy strategy.

In the region of the Ionian Islands, a total of 3,494 teachers of all specialties teach in every level of education: 1,736 in Primary education and 1,758 in Secondary. The ratio[9] of students to teaching staff is lower than or equal to the country's average. However, the region of interest has one of the lowest percentages of co-located schools, while the level of special equipment (laboratories, IT) is constantly improving. Finally, in terms of accessibility to school

[7] Ionian Islands Region, Special Operational Program Management Service for the Ionian Islands Region, April 2019, Regional Plan for Climate Change Adaptation. & Regional Operational Program of the Ionian Islands Region: Strategic Environmental Impact Assessment 2014-2020.

[8] Ionian Islands Region, September 2019, Development Strategy 2021-2027.

[9] Ratio calculated for the school year 2016/2017

units due to geomorphology, the region is ranked 9th in terms of primary and 11th in terms of secondary education. In detail, the 5.7% (15 out of 262) of primary schools and the 13.5% (12 of 89) of secondary schools are difficult to access due to the aforementioned reasons, in relation to 3.5% and 5.5% respectively for the country average (OECD, 2018).

Social Care

The provision of social welfare and inclusion services are carried out with the development and support of accommodation facilities for the elderly, with the services of counselling and therapeutic support to people with disabilities provided by Special Centres, as well as from Recovery Centres - Physical & Social Rehabilitation. In contrary to the country, the Ionian Islands Region in 2007 had only the 1.57% of the total welfare structures, while the program "Help at Home" was only the 1.79% of its total percentage. On the other hand, Ionian Islands have the 10.53% of the total camps and the 4.35% of the nursing homes. The geographical coverage of the needs of the islands is not equal, and the main problem is that subsidized programs are the ones that fund the social care infrastructure[10].

According to the Ionian Islands region report of 2019 several actions were taken to support vulnerable social groups:

- Since 2014, six social structures for the provision of basic goods (Social groceries and meals) in Corfu, Lefkada and Zakynthos were established.
- Community centres were established in 2017 and they are a new structure that helps socially vulnerable groups of citizens, such as homeless, needy, disabled, Roma and immigrants to get informed about the available social programs and services implemented in their area. Corfu and Zakynthos have one Community Center each.
- Three "Social Pharmacies" were established in the Municipalities of Corfu, Lefkada and Zakynthos which provide free provision of medicines, sanitary material and parapharmaceutical products to vulnerable social groups.
- Two structures of "Day Care Centers for Disabled", one in Corfu. Those day centers provide: transportation to and from the centers, accommodation and food, special education operations according to the needs of each individual (occupational therapy, speech therapy, physiotherapy, etc.), individual and group exercise, self-service training and learning daily life activities, creative employment and socialization activities, participation in entertainment, culture and sports programs
- Quality of residential environment

Regarding energy poverty, our research did not manage to identify the specific private or social innovative initiatives that are tacking energy poverty. Energy poverty is a socioeconomic state in which due to inadequate resources or living conditions people are unable to obtain the necessary energy to power their home and meet basic needs (heating, cooling, lighting etc.). Though, experience across Europe indicates that socially innovative activities at the local

[10] Ionian Islands Region, September 2019, Development Strategy 2021-2027.

level can tackle sufficient issues of energy poverty (Mikkonen et al., 2020), so, local organisations and individuals at the Ionian Islands should further explore this opportunity.

1.6 Local governance, competitiveness and collective action movements

Regions, municipalities and other local actors outside the public administration like unions, partnerships, environmental and cultural organizations are key stakeholders that can participate or initiate an energy community. The Region of the Ionian Islands is one of the thirteen administrative regions of Greece and is located along the west coast of Greece. It is divided into the regional units of Corfu, Kefallinia, Lefkada and Zakynthos. It includes most of the islands of the Ionian Islands, except Kythira, Antikythira and Elafonisos. The central office of the Region is located in Corfu. Regarding the administration structure of the islands of our interest the regional unit of Zakynthos consists of only one municipality while in Corfu there are four municipal entities under the regional unit[11]:

- Municipality of Central Corfu and Diapontia Islands, consisting by the municipal units of: Agiou Georgiou, Esperion, Thinaliou and Kassopaion
- Municipality of North Corfu, consisting by the municipal units of: Achillion, Erikoussis, Kerkiraion, Mathrakiou, Othonon, Palaiokastriton, Parelion and Phaiakon
- Municipality of South Corfu, consisting by the municipal units of: Korasion, Leukimaion and Meliteieon
- Municipality of Paxoi

Besides the formal governance bodies in the subnational level there are numerous other stakeholders that can be valuable partners in energy transition projects[12]. The National Center for Social Research provides data of the officially recorded NGOs in the study Islands; according to those data, in Zakynthos there is one NGo and in Corfu six. In the following tables we can see the names and the date of establishment of each NGO as well as the agricultural cooperatives that are operating. In other parts of the country e.g. Agrinio, Karditsa, agricultural cooperatives are developing important initiatives in renewable energy and had established energy communities.

Table 3. Environmental NGOs operating in the islands.

	Name	Date of establishment
Zakynthos	Zakynthian ecological movement	1985
Corfu	Oikokerkyra	2007
	Corfu's Ecology Club	1981

[11] https://www.kallikratis.org/kallikratis-dimi-ana-nomo/

[12] In this section there are presented the officially recorded NGOs, associations etc. located in Corfu and Zakynthos. It is quite certain that they are not the only ones that take actions in the areas, however, we chose to present the official records as the most reliable source.

	Ecologists - alternatives of Corfu	1989
	Corfu Environmental Initiative	2004
	Ionian Environment Foundation	2019
	Corfu Environmental Protection Association	1979
	Port Ilaikos	1991

Source: National Center for Social Research

Table 4. Agricultural Cooperatives operating in the islands

	Name
Corfu	Agricultural cooperative of Paxoi
	Corfu Association of Cooperative Farmers
	Agricultural Cooperative of Olive Producers, and Fruit and Vegetable Producers of Corfu
Zakynthos	Agricultural olive, wine and raisin Cooperative of Zakynthos

Source: National Register of Agricultural Cooperatives and other collective bodies 2019

However, the region lags in terms of competitiveness. According to the European Regional Competitiveness Index (RCI), which measures the major factors of competitiveness over the past ten years for all the NUTS-2 level regions across European Union, Ionian Islands in 2019 rank 256th out of the 262 European Regions. In this context the index also provides information by comparing each region with other European regions with similar characteristics which are named as 'peer regions'[13] The overall assessment, as presented in Table 5 is not very satisfying as in every dimension compared to the peer regions Ionian Islands are underperforming (Annoni and Dijkstra, 2019).

Table 5. Ionian Islands regional competitiveness assessment.

	Score	**Peers comparison**
Basic Dimension	***-1.15***	***Underperforming with respect to its peers***
Institutions	-1.36	Similar to peers
Macroeconomic Stability	-2.02	Underperforming with respect to its peers
Infrastructure	-1.03	Similar to peers
Health	-0.03	Similar to peers

[13] Peer regions of Ionian Islands are: Közép-Dunántúl, Małopolskie, Vest, Extremadura, Severozápad, Vidurio ir vakarų Lietuvos regionas, Southern Scotland, Puglia, Dytiki Makedonia, Campania, Kontinentalna Hrvatska, Łódzkie, Latvija, Sterea Ellada and Stredné Slovensko.

Basic Education	-1.31	Underperforming with respect to its peers
Efficiency Dimension	***-1.42***	***Underperforming with respect to its peers***
Higher Education and lifelong learning	-0.42	Similar to peers
Labor Market Efficiency	-1.67	Similar to peers
Market Size	-2.19	Underperforming with respect to its peers
Innovation Dimension	***-1.4***	***Underperforming with respect to its peers***
Technological Readiness	-1.98	Underperforming with respect to its peers
Business Sophistication	-0.39	Similar to peers
Innovation Dimension	-1.84	Underperforming with respect to its peers

Source: Annoni and Dijkstra, 2019

1.7 Physical and environment profile

Both islands of the study area, Corfu and Zakynthos are located in Western Greece in the region of Ionian Islands. Corfu covers an area of 640 km^2, while Zakynthos covers an area of 405 km^2 (Lorilla, 2018). The climate of the region is Mediterranean so is characterized by dry and warm summers, and mild and wet winters. The natural properties of the islands make them suitable candidates for renewable energy projects mainly solar and wind.

Geomorphology

Given the data of the island areas, the main geomorphological characteristics of the Ionian Islands are the mountainous areas with a significant altitude, while there are also hills, lagoons, as well as mainly coastal, lowland areas. All the islands have rich vegetation and each one has a special natural-geographical identity. The proportions between mountainous, semi-mountainous and lowland areas are about 1/3 of the total area for each category, with Corfu prevailing in lowland areas (SEIA, 2014-2020).

Zakynthos geologically consists of limestones especially along its coasts, sandstones, mudstones and marls are also in some parts of the island, while in the main plain of the island in the eastern part alluvial depositions could be found. Corfu in the other hand, on the north-eastern part of the island, partially consists of limestones, schists and dolomites while the rest is characterized by Neogene formations and quaternary depositions. Zakynthos has an extensive zone of semi-mountainous areas of the order of 55.1%, while Corfu has large parts of lowland areas, approximately the 68.3% of its area. Both islands have high potential in geotopes, geodiversity and ecosystems (SEIA, 2014-2020; Evelpidou, 2012).

Solar potential

Ionian Islands possess a good solar energy potential according to existing long-term measurements. The practical PV potential[14], measured in kWh/kWp/day, for the whole country is presented below.

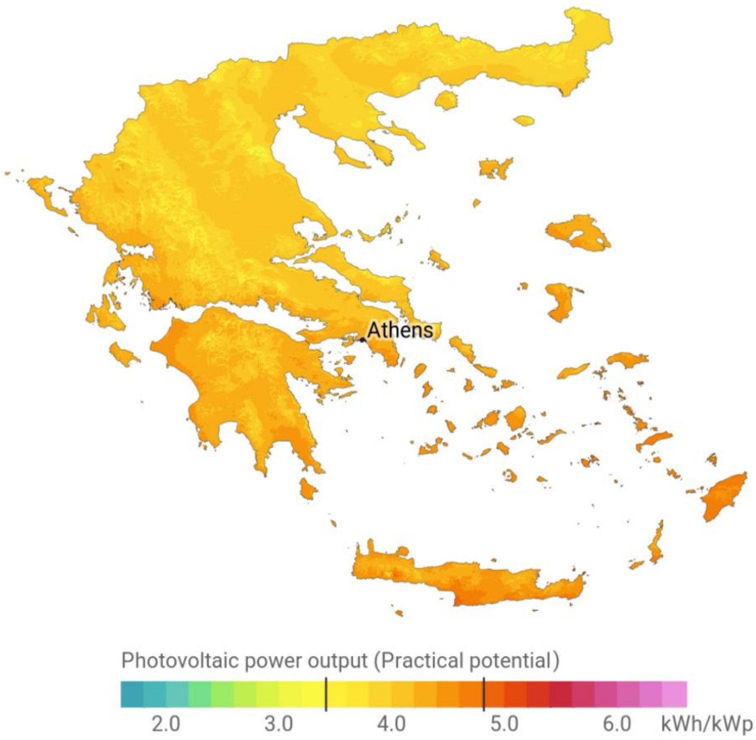


Figure 19. Solar potential of Greece
Source: World Bank - Global Solar Atlas, March 2020

The average daily solar radiation and the average daily clearness at these locations are given in Table 6. The clearness index is indicating the fraction of the solar radiation that makes it through the atmosphere to strike the Earth's surface.

Table 6. Average daily solar radiation in the two islands

City	Latitude N	Longitude E	Daily solar radiation (kWh/m2/day)	Clearness index
Corfu	39° 37'	19° 55'	4.35	0.530
Zakynthos	39° 10'	21° 00'	4.38	0.543

[14] Photovoltaic power output produced by a utility scale installation with fixed-mounted monofacial c-Si modules with optimum tilt.

Source: Centre for Renewable Energy Sources and Saving (CRES)

Wind potential

The wind potential of the two islands is generally low at the biggest part of them, except for a few specific areas, mainly the more mountainous ones. The presented maps are taken from the Regulatory Authority for Energy (RAE) geoportal and the data corresponds to average annual wind speeds (10min measurements). The wind speed measurements were collected at three different heights that is 80m, 100m, 120m from ground surface. From the perspective of energy harvesting, the wind potential is required to be between 6m/s and 7m/s at minimum, to be considered beneficial.

As regards Corfu, the wind potential reaches almost 7m/s at the mountainous regions of the northern (Figure 20) and central part (Figure 21) of the island. For Zakinthos, sufficient wind potential is found at some parts of the mountain range crossing the island from north to south but most importantly at the two southern regions at the sides of Laganas bay (Figure 22). Note, however, that a big part of this region is a protected area.

Wind Potential Color Legend (h80, h100, h120)	
	0.0 < x
	0.0 <= x < 4.0
	4.0 <= x < 5.0
	5.0 <= x < 6.0
	6.0 <= x < 7.0
	7.0 <= x < 8.0
	8.0 <= x < 9.0
	9.0 <= x <10.0
	10.0 <= x < 20.0

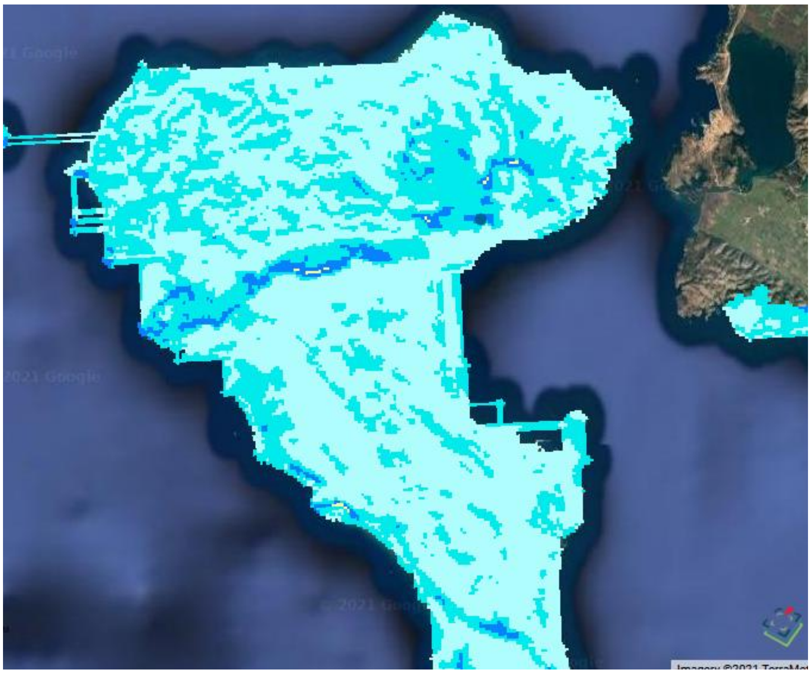


Figure 20. Wind potential of Corfu (north and central part).
Source: https://geo.rae.gr/

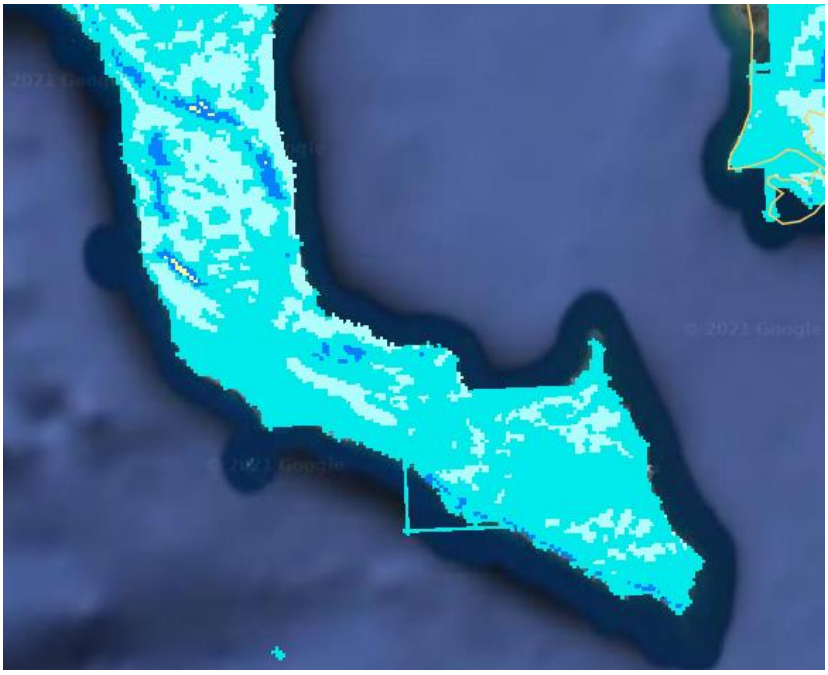


Figure 21. Wind potential of Corfu (central and south part).
Source: https://geo.rae.gr/

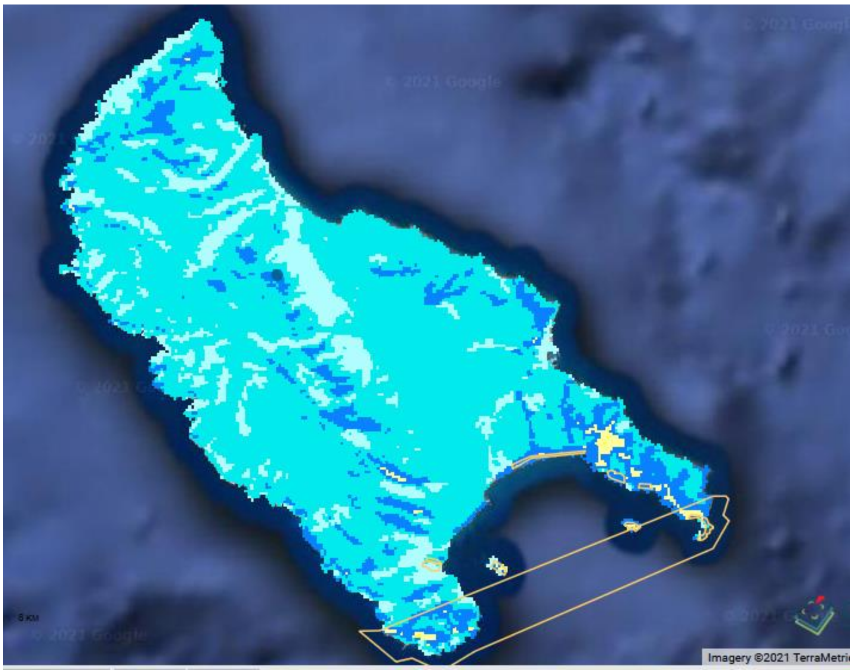


Figure 22. Wind potential of Zakinthos.
Source: https://geo.rae.gr/

1.8 Ecosystems, protected areas and culture

As the transition to renewable sources of energy is ongoing, renewables are taking the lead on electricity generation growth mainly via solar PV, wind, hydropower and bioenergy.

Given that renewable energy can also have impacts on the environment both man-made and natural via e.g. biodiversity due to disturbance and loss of habitat, the generation of noise pollution. Thus, renewable energy projects via project life cycle and environmental impact assessments need to address the associated risks. Sensitive areas containing habitats, species and host ecological capital should be preserved. Moreover, cultural and architectural heritage must be protected and in various buildings or segments of a city energy efficiency retrofitting should respect the architectural constraints. The following section presents the protected and endangered areas in the islands while more data are provided in the appendix.

Corfu

The wider study area, specifically the island of Corfu presents a variety of ecosystems. The variety of ecosystems is the crucial factor that contributes to the existence of great biological diversity on the island. Corfu is generally characterized by rich natural vegetation and agricultural crops. Olive crops are dominating the island and can be found in the coastal as well as on the mainland of the island (Martinis et al., 2015).

Corfu is separated from the opposite mainland coasts by a sea strait which width ranges between 1.5 (north) to 6 miles (south). Both southern Albania and Epirus have important wetlands, so the short distance between the shores allows many species of fauna and especially birds to move and enrich the fauna and birds of Corfu with species that could usually be found in continental natural reserves. Finally, it is worth mentioning that especially in the wetlands there are many different native species of orchids (Georgiev and Ivanova, 2018; Special Business Program Management Service for the Ionian Islands Region, April 2019).

Box. 3 What is Natura 2000?

It is a network of core breeding and resting sites for rare and threatened species, and some rare natural habitat types which are protected in their own right. It stretches across all EU countries, both on land and at sea. The aim of the network is to ensure the long-term survival of Europe's most valuable and threatened species. Natura 2000 is not a system of strict nature reserves from which all human activities are excluded. While it includes strictly protected nature reserves, most of the land remains privately owned. The approach to conservation and sustainable use of the Natura 2000 areas is much wider, largely centered on people working with nature rather than against it. However, Member States must ensure that the sites are managed in a sustainable manner, both ecologically and economically.

According to the European Environmental Agency (EEA) the island of Corfu has 6 ecosystems recognized and protected by the ecological network NATURA 2000 while 3 more exist in the nearby islets (Figure 23).

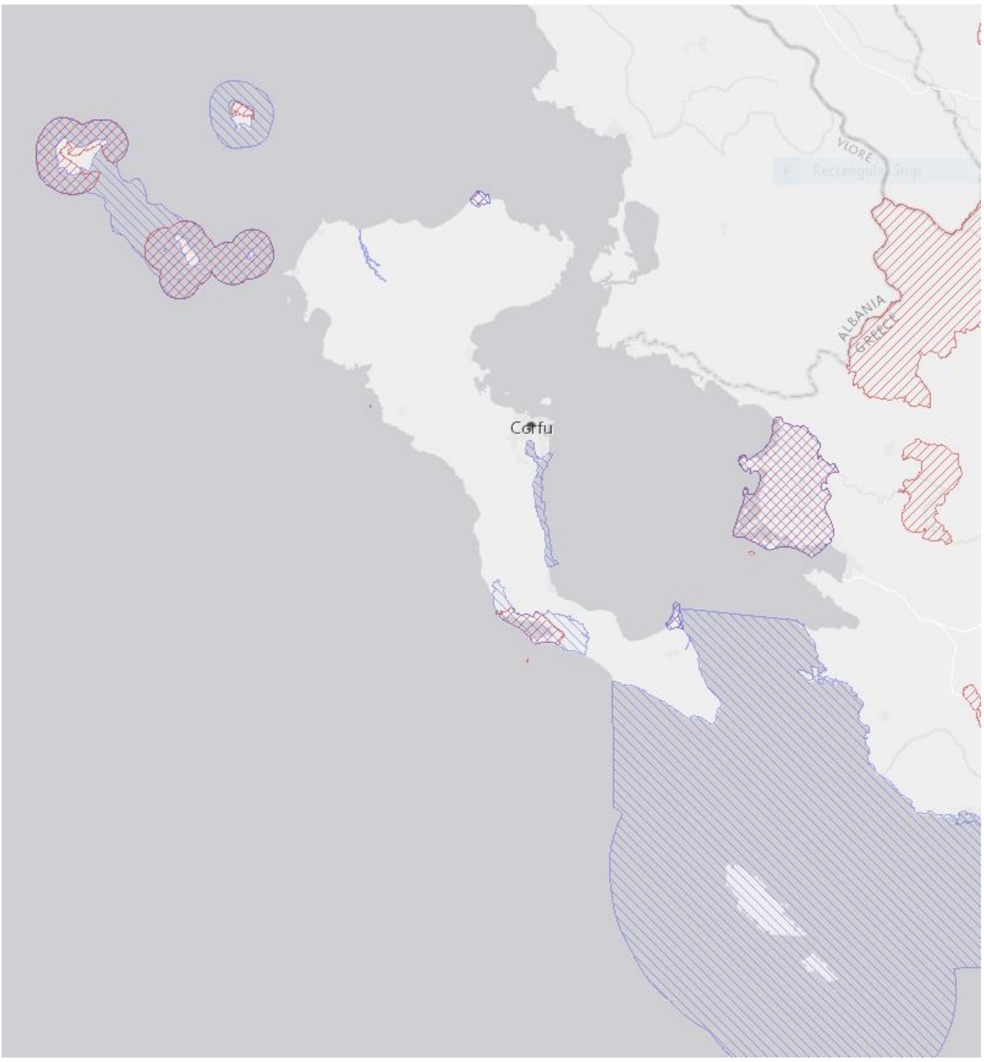


Figure 23. Areas recognized as NATURA 2000 in Corfu.
Source Natura 2000 Network Viewer - European Environment Agency

Landscapes of Particular Natural Beauty

By Landscape of Particular Natural Beauty (LPNB) we refer to places that stand out because of their special aesthetic value and remain natural to a certain level. Often the LPNB include traditional settlements, archeological or historical sites. The selection and evaluation criteria of LPNB are associated with natural and ecological features, such as terrain, vegetation and flora, the presence of fauna, water, meteorological conditions, panoramic views and man-made features, such as the existence of monuments, the traditional character, the land use. Most of the LPNB are threatened with degradation due to intense anthropogenic pressures, such as arbitrary or unsightly construction, road construction, uncontrolled tourism and many other destructive activities that degrade nature (Selman and Swanwick, 2010). Corfu has 30 landscapes of particular natural beauty, which we can see them in the figure below.

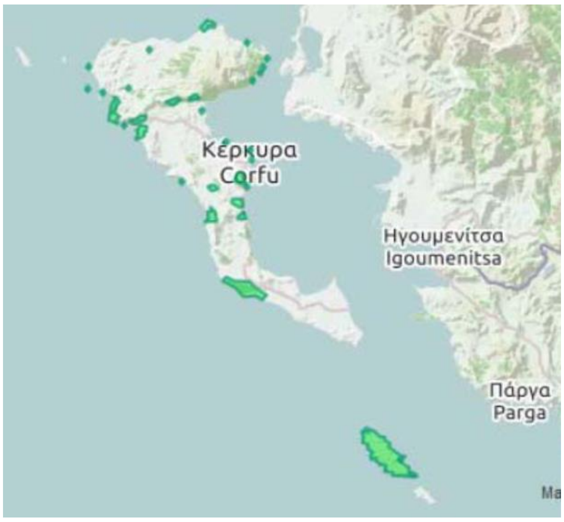


Figure 24. Landscapes of Particular Natural Beauty in Corfu
Source: Filotis Database for the Natural Environment of Greece

Zakynthos

According to the Filotis database for Natural Environment in Greece, in Zakynthos there are no areas characterised as Landscapes of Particular Natural Beauty. On the contrary there are several areas of Zakynthos that have joined the Natura 2000 network. Additionally, in Zakynthos there are Wildlife Refuges and the National Marine Park of Zakynthos. According to EEA Zakynthos has 4 ecosystems recognized and protected by the ecological network NATURA 2000 (Figure 25)

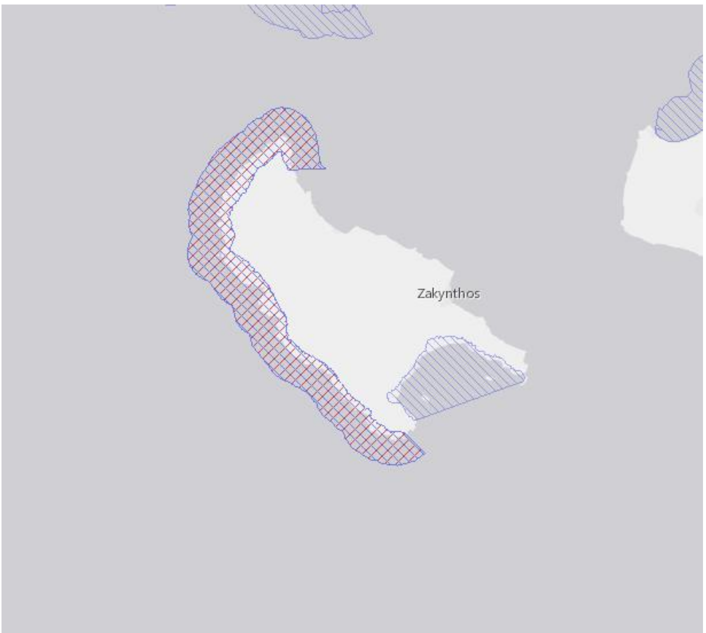


Figure 25. Areas recognized as NATURA 2000 in Zakinthos.
Source Natura 2000 Network Viewer - European Environment Agency

Culture

All the islands have Museums of different subjects of interest, the most important is the Archaeological Museums of Corfu and Paleopolis, the Museum of Kapodistrias, the Museum of Solomos and the Museum of Asian Art also in Corfu, the Museum of Zakynthos and the Museum of Solomos. In Corfu is also the Reading Society, which is the oldest intellectual center in Greece, while in both islands the Historical Archives have unique historical treasures. In Corfu there are two more organized galleries, the Municipal Gallery in the Palace of the city and a branch of the National Gallery in Kastello Bibeli.

Table 7. Number of cultural-touristic points of interest

	Corfu	Zakynthos	Ionian Islands
Archaeological sites	7	1	11
Monuments	21	5	45
Museums	6	2	13

Source: Special Business Program Management Service for the Ionian Islands Region, April 2019

The Old Town of Corfu has been listed to the World Heritage List by UNESCO since 2007. It is estimated that the origins of the three forts of the town are around the 8th century, when they were designed and built by Venetian engineers. Through all these years the fortresses were repaired and rebuilt several times for enhancing the defence of the town. The last known rebuilt was around the 19th century when Corfu was ruled by the British. According to the operational guidelines for the implementation of the World Heritage convention, the old town of Corfu is a protected cultural heritage as it fulfils the 4th criterion, as it is described: "*The urban and port ensemble of Corfu, dominated by its fortresses of Venetian origin, constitutes an architectural example of outstanding universal value in both its authenticity and its* *integrity*". Through those years of protection, restoration and enhancement of the fortifications and of the citadel the result is outstanding, however there are still many works that have to be completed or started (UNESCO, 2013).

1.9 Spatial planning

The lack of land planning and zoning resulting in an anarchic build environment is evident in the Ionian Islands and inherited by the deficiencies of the Greek system[15] (see also 3.2 National policy for RES). The law 4759/2020 (Modernization of Spatial and Urban Planning Legislation and other provisions) presents some opportunities for accelerating the energy transition. Incentives are given for the construction of environmentally friendly buildings, as buildings constructed with high-energy efficiency standards will be entitled to an additional building factor 5-10%. Moreover, specific energy specifications are set for complex tourist accommodation and small-scale mixed tourist accommodation forcing more efficient energy designs to be adopted for the touristic sector.

Land Use

The territorial characteristics of the complex of Ionian Islands is mainly mountainous and semi-mountainous, with a percentage of 64.1%. In the whole region, most of the area is occupied by crops with a percentage of 51.59%, of which the 43.4% is located in the Corfu, followed by the bushes with a percentage of 33.96%. The main crops of the Ionian Islands are olive growing and viticulture. Irrigated holdings at the national level, for 2009, cover 67.8% of the total number of holdings used for agricultural use with the corresponding percentage of the Ionian Islands region being significantly lower and amounting to 54.2%. Internally, Zakynthos has the lowest percentage (41.3%), while Corfu has the highest percentage of farm coverage with 65.1% (SEIA, 2014-2020). In the table below we can see in detail the land use of basic categories.

Table 8. Land uses in the two islands.

	Land Use Categories	**Corfu**	**Zakynthos**
		km2	km2
Agricultural areas	Arable land	28.8	9.6
	Permanent crops	332.4	103.8
	Pastures	30.1	38.2
	Heterogeneous agricultural areas	106.1	96.6
Forests semi-natural areas	Forests	3.2	36.8
	Transitional woodland - Shrubland	6.8	12.7
	Combinations of shrubs and / or grass vegetation	55.3	84.3
	Areas with sparse or no vegetation	38.9	13.3

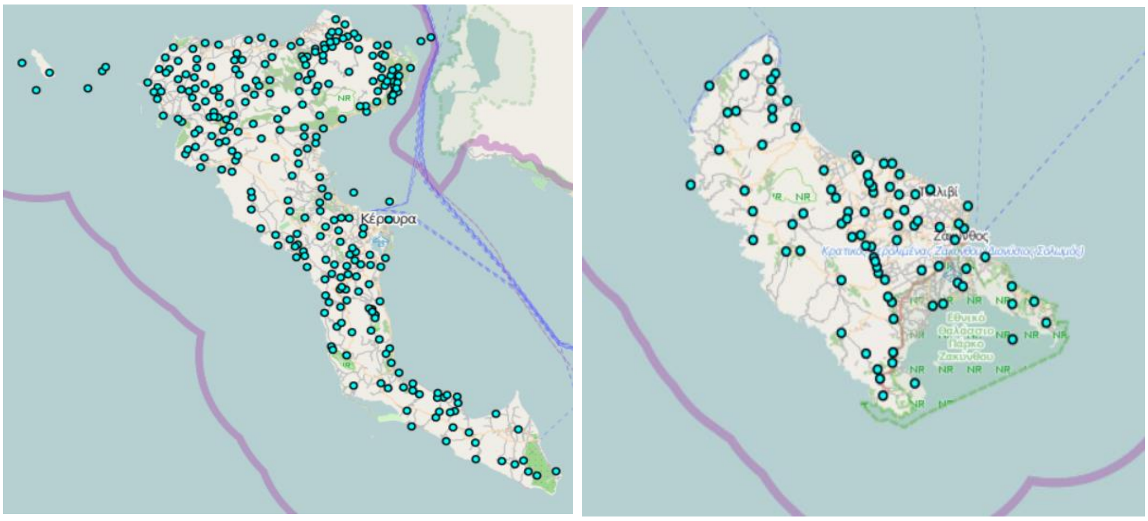
[15] The revision of the spatial planning for RES in a national context is still pending.

Areas covered by water	Land waters	4.1	0
	Internal wetlands	0.2	0
	Coastal wetlands	2.8	0.5
Artificial Areas	Urban construction	28.8	8.9
	Industrial and commercial zones	0.8	0
	Transport networks	0.8	0
	Mines, landfills and construction sites	0.1	0.5
	Artificial, non-agricultural green zones, areas of sports and cultural activities	0.7	0.7

Source: Ionian Islands Region, 2016

The housing potential of Ionian Islands numbers 651 settlements with a total of 207,855 permanent residents (ELSTAT-2011). Based on the wider administrative division into Regional Units, in Corfu there are 309 settlements (104,371 residents), 88 settlements (40,759 residents) in Zakynthos. The Ionian Islands region has in total 87 characterized settlements as traditional, of which 50 are in Corfu. Zakynthos has no such settlements. In the following pictures we can see the distribution of the settlements for each island.

In Corfu there is an approved residential control zone (RCZ) of the Municipality of Argyrades (which is part of the Municipality of Korissia), where is set a partition threshold, land uses, building restrictions and other terms, in 5 different areas. In Zakynthos there is a RCZ in the bay of Laganas, which determines special land uses, partition threshold, building conditions and restrictions as well as special conditions for the protection of the natural environment



depending on the 8 areas into which its entire area is divided[16].

Figure 26. Settlements (cities, villages etc.) in Corfu and Zakinthos

Source: Hellenic Statistical Authority 2011- http://geodata.gov.gr

[16] Ionian Islands Region, Special Operational Program Management Service for the Ionian Islands Region, April 2019, Regional Plan for Climate Change Adaptation. & Ionian Islands Region, September 2019, Development Strategy 2021-2027.

2 Assessment of electrical energy system

In the framework of a clean energy transition plan, along with the socioeconomic analysis of Corfu and Zakynthos, equal focus should be given to the particular energy characteristics. The energy needs of a region are greatly connected to various factors; the type, the size and the structure of the local economic activities, the habits of the people, the climate conditions and the wealth of the region and the country. The required energy is used for transportation, heating and lighting, manufacturing, pumping and other daily activities. In principle, the energy consumed by the end users comes from the energy sources either directly, like the case of the energy used to move a car (using gasoline) or to heat a building (using diesel), or indirectly, by transforming energy from the source into electricity. According to IEA, in 2018 electrical energy covered the 19.2% of global final energy consumption (IEA, 2019) whereas in Greece the usage of electricity covered the 26.6% of the consumed energy, with the biggest part, 52.5%, being covered by petroleum products.[17]

So, the necessity of studying the local energy system is obvious when creating a clean energy transition plan or developing transition roadmaps for a region or island. In this direction, the *Island Transition Handbook (*Clercq S. et al, 2019*)*, the EU guide published under the scope of Clean Energy for EU Islands, considers the investigation of the island's energy system as an important part of exploring and understanding the island dynamics. To gain a comprehensive picture of how energy is produced and consumed on the island, the guide proposes the classification of the energy system description into the following sectors:

- Electricity generation and consumption
- Transport on the island
- Transport to and from the island
- Heating and cooling
- Other

As this study focuses on citizen investments primarily on RES projects at Corfu and Zakynthos, the comprehension of the electric energy system of the two islands is crucial. To achieve this, in the following sections, the electrical infrastructure of the two islands, the local generation, the imported energy and the participation of each sector at the final electrical consumption, are being analysed. Given the report limits, the rest of the sectors that compose the energy systems of the two islands are not studied. However, in order for the reader to form an

[17] See: https://ec.europa.eu/eurostat/cache/infographs/energy/bloc-3a.html

opinion, the petroleum products consumption in Corfu and Zakynthos and some statistics are presented at Box 4.

Box 4. Petroleum products consumption in the two islands

According to Hellenic Statistical Authority the total consumption of petroleum products in Greece for 2019 was 7.281.310 metric tons. From these the 14.9% (1.082.152) was on diesel for heating (showing a decrease of 63% since 2010) while the 68.8% was on fuel for transport (Super, Unleaded, Super Unleaded 98/100, Diesel for Transport) and 8.9% on liquid gas (LPG). At the same year, the total consumption in Corfu and Zakynthos was 68.630 tons (0.94% of the total national consumption) and 33.117 tons (0.45%) respectively. For the two islands there is no available data on the share of the categories that consist the total consumption, therefore the national values can be assumed.

Figure shows the consumption of petroleum products in Greece, in Corfu and in Zakynthos since 2000 using 2019 as a base year. The total consumption in Greece shows steep decrease during the years of recession, but from 2014 and onwards it started to stabilize 50% below the peak of 2007. The consumption of Zakynthos also shows a steep decrease between 2010 and 2013 but since then it has been increasing and in 2019 was only 10% below the peak of 2008. Similar to Zakynthos, consumption in Kerkyra has been increasing since 2014 and in 2019 it reached a value 30% below the peak that occurred in 2008.

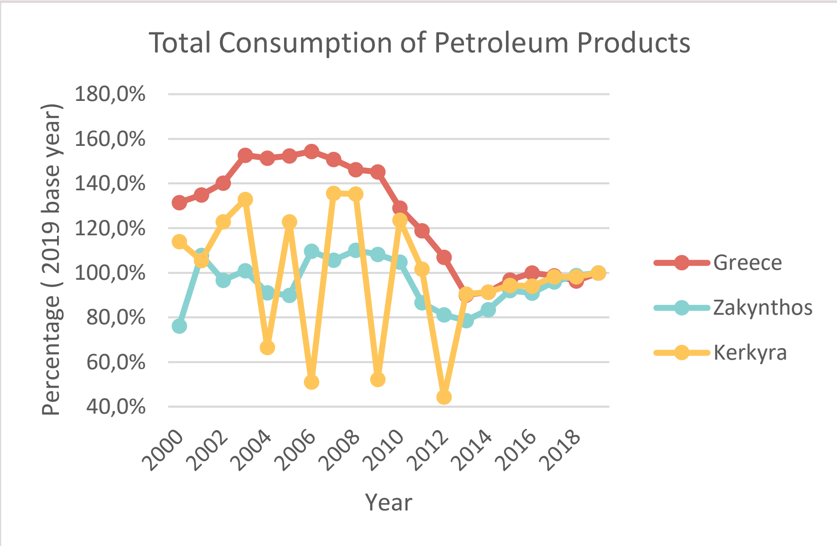


Figure 27 Total consumption of petroleum products.
Source: Author's elaboration on data of Hellenic Statistical Authority

2.1 Electrical Infrastructure of the islands

The Corfu Island, is an interconnected island covering its energy needs via the mainland by using an underwater transmission network. Corfu has 4 electrical substations that change voltage levels between high transmission voltages and lower distribution one – namely Agios Vasilios, Kerkyra I, Kerkyra II and Mesogi - connected to the mainland through two terminal points (of 150kV and 66kV respectively). According to the Network Development Plan (2019 - 2023) submitted by HEDNO (DEDDIE) – the Greek DSO – the substations Kerkyra I and Kerkyra II will be upgraded until 2021. The current rated power of each substation is shown in Table 9.

Similar to Corfu, Zakynthos is also an interconnected island, with two underwater connections (of 150kV) which are coming from Peloponnesus and Kefalonia and are connecting to the single substation of the island. The substation has currently total rated power of 100MVA. According to the Network Development Plan (2019 - 2023) submitted by HEDNO (DEDDIE), an upgrade of 50MVA is planned to be performed. This will raise the total capacity up to 150MVA.

Figure 28. System of electrical infrastructure and interconnections in Corfu.
Source: Ten-year Network Development Plan | IPTO.

Table 9. Rated power of substations in Corfu and Zakynthos.

Installed Power of substations (MVA)	
AG VASILIOS (Corfu)	100
KERKYRA I (Corfu)	50 -> 100
KERKYRA II (Corfu)	50 -> 100
MESOGI (Corfu)	50
Zakynthos	100 -> 150

Source: Five-year network development plan HEDNO.

Figure 29. System of electrical infrastructure and interconnections in Zakynthos.
Source: Ten-year Network Development Plan | IPTO.

2.2 Local generation of electrical energy in the islands

In Corfu local electricity generation is based on Photovoltaic (PV) systems, which were installed mainly during 2012 – 2013, and on a biogas unit, which was activated on November 2018. The latter is located in Akrokefalos Temploniou and it has installed power of 328kW.

Most of the installed PVs are in the north of the island, near the substation Ag Vasilios and in the southern part of the island, near the substation Mesogi.[18]

Similarly, in Zakynthos, local generation is based solely on PV plants, which were mainly installed in 2012 and a few during 2013. Since then and up to now, no other RES are in operation.

Table 10 shows the installed capacity of RES per substation for each island[19] [20],

Table 10. RES installed capacity per substation.

Corfu Substations	Total installed capacity (MWp)	Zakynthos Substations	Total installed capacity (MWp)
AG VASILIOS	8.9	Zakynthos	8.9
KERKYRA I	1.8		
KERKYRA II	0.2		
MESOGI	5.7		
Total	16.6	Total	8.9

Source: Authors' elaboration on available data.

Based on this, it is evident that the installed capacity of RES is small in both islands. As data in Table 11 reveal, the coverage of the total annual electricity demand by local RES generation

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[18] You can find satellite photos of the site on appendix.

[19] Using Res-office to find the installed RES in Corfu: https://www.resoffice.gr/file/reg/query.jsp

[20] HEDNO platform for RES penetration limits: https://apps.deddie.gr/WebAPE/main.html

was estimated at 4.4% in Corfu and at 5.48% in Zakynthos for 2019. For the case of Greece, the coverage of the electricity demand by RES was 23.4% for the same year.

The decreasing tendency of the coverage percentage during the decade is due to a combination of two factors. First, the annual energy consumption in the islands has been increasing in recent years. Second, as no new PVs have been installed since late 2012 (only very few in 2013) in combination with the fact that the existing PVs have suffered an expected deterioration in their energy production.

Note, that in 2019 the contribution of the biogas unit in Corfu would result to a slightly higher percentage than the one calculated, but still not statistically important.

Table 11. Percentage of electricity demand covered by RES generation in the two islands.

Year	Corfu	Zakynthos
2010	0.00%	0.00%
2011	0.00%	0.00%
2012	0.00%	0.00%
2013	4.88%	6.80%
2014	4.89%	6.78%
2015	4.96%	6.79%
2016	4.87%	6.45%
2017	4.66%	6.10%
2018	4.55%	5.83%
2019	4.40%	5.48%

Source: Authors' elaboration on available data.

2.3 Electrical Energy imported from the Transmission System

Based on the available provided by the official site of ADMIE[21], the annual imported electrical energy (from main grid) of Corfu and Zakynthos (Figure 30) and the annual power profile of each island can be visualized (e.g. for 2019 see Figure 31 and Figure 32). In this case, power profile represents the incoming average power (averaged in one hour) with respect to time and shows the power needs of the island during the year.

For the years before 2013, when no PV was installed, the imported energy is almost equal to the actual electrical demand (with a small percent difference attributed to technical losses – see related paragraph). After 2013, the energy produced by PVs makes this difference slightly bigger, especially regarding the peak power values. However, due to the small power penetration of PVs the effect of them on load profile is not substantial, and so it does not affect its attributes.

It is interesting to note that for the case of Corfu, the substation of Agios Vasilios HV/MV takes the biggest share as regards the imported energy and Mesogi the smallest.

[21] See: https://www.admie.gr/agora/statistika-agoras/dedomena?data_type%5B%5D=506&since=&until=&op=%CE%A5%CF%80%CE%BF%CE%B2%CE%BF%CE%BB%CE%AE

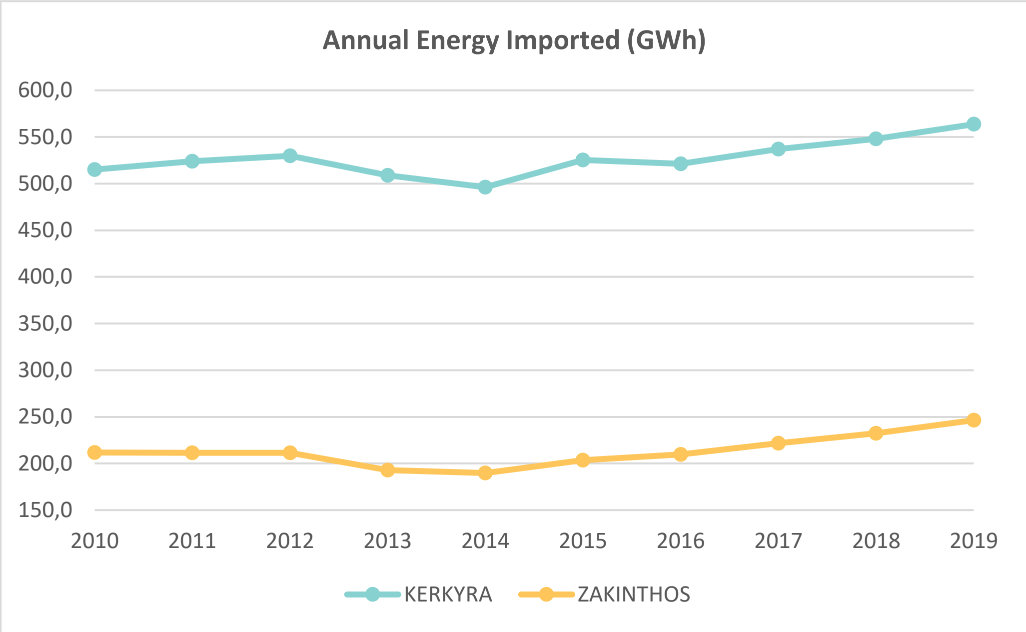

Figure 30. Annual Energy Imported for each Island.
Source: Authors' elaboration on available data.

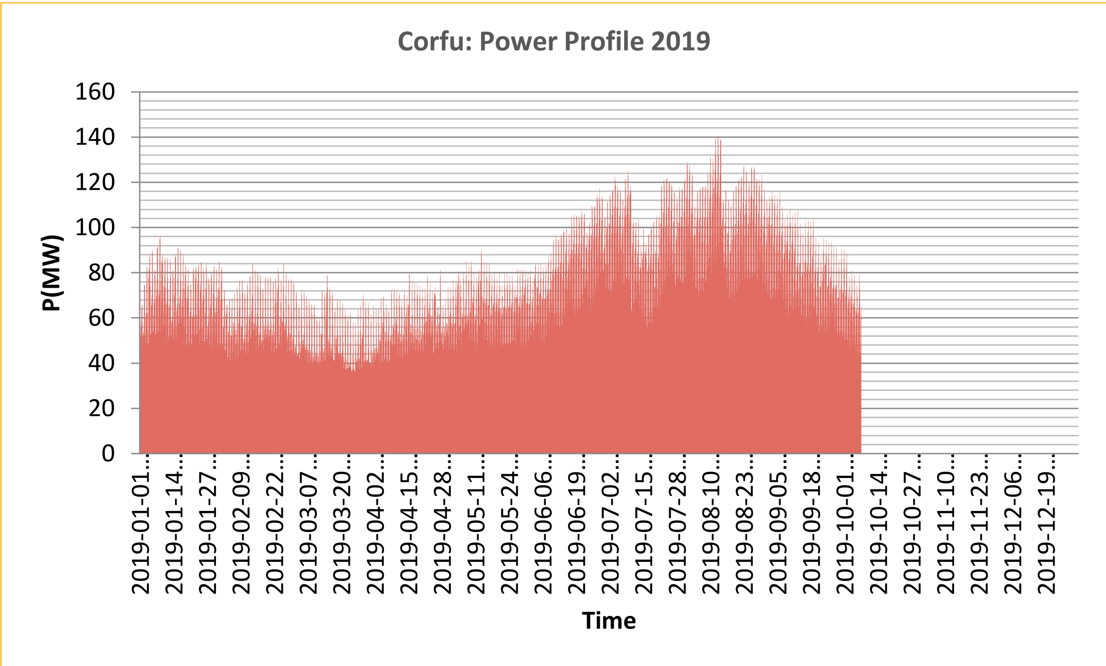

Figure 31. Corfu power profile for 2019.
Source: Authors' elaboration on available data.

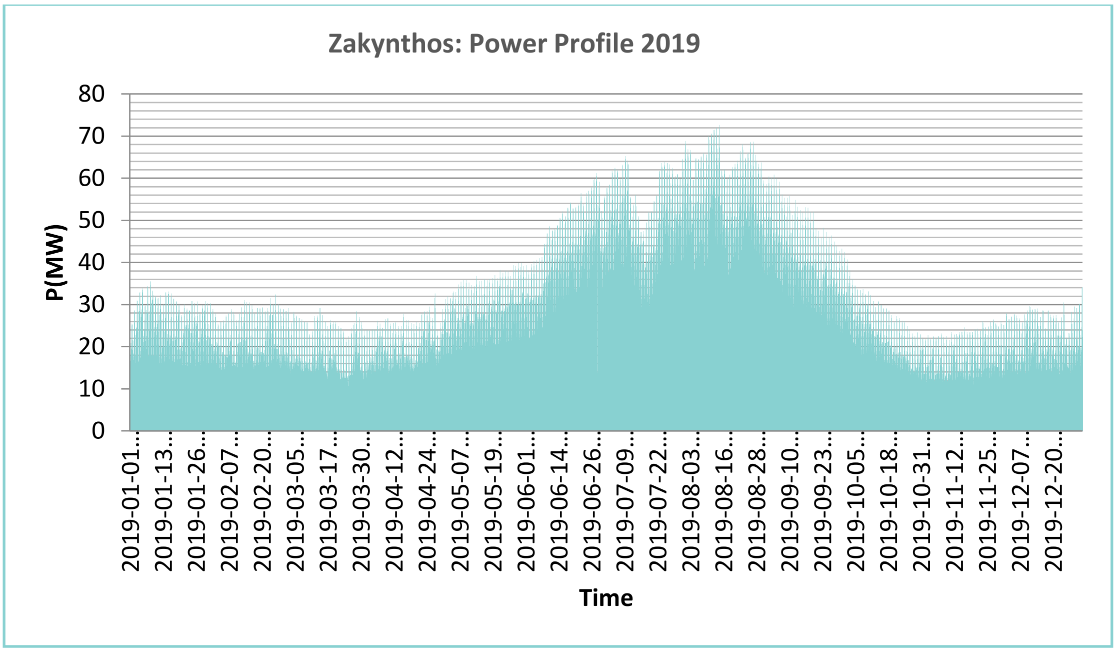

Figure 32. Zakynthos' power profile for 2019.
Source: Authors' elaboration on available data.

As the load profiles indicate, the minimum imported energy occurs around April and around October. From April onwards, the demand has a steady increase until August where the peak occurs. Later, it falls slightly more sharply until November. A second peak, much lower than the summer peak, occurs in winter at the beginning of January.

Those profiles are typical load profiles of islands with high dependence on summer tourism, as during the touristic period the power and energy needs increase substantially. However, weather is also a factor that contributes to the forming of profile loads. In Box 5, it is presented in more detail the relationship between tourism – by using airport arrivals data – and energy consumption for the island of Corfu. Whereas, in Box 6, it is presented the relationship between weather variables and energy consumption for the island of Zakynthos.

Box 5. Tourism and energy demand in Corfu

By investigating the energy consumption profile of Corfu, it is apparent that there is a seasonal increase during months with great tourist activity. The tourism sector is deeply connected to energy consumption and in some cases with environmental burden (Pablo-Romero et al, 2019; Bakhat & Rosselló, 2011; Bianco, 2020). In Corfu there is a growing service and tourism sector the last years. In the figures below, indicate a link between tourist load and energy consumption. There are presented the airports arrivals and the electricity consumption of Corfu from 2017 since 2020. From 2017 since 2019 we observe that as airport arrivals start to rise around May, energy consumption starts to rise as well, in August when there is the maximum energy consumption is also the month with the maximum airport arrivals, while after that from September until November energy consumption and airport arrivals decrease following a parallel path. On the other hand, from November to April, a period of low airport arrivals and tourism, energy consumption does not present any notable variance. During 2020, the COVID-19 impact is evident. Travel restrictions caused a tremendous reduction of arrivals in Corfu. When Greece opened tourism, allowing travelling after the 1st of July the same pattern as the years before is observed. Whenever there is an increase in arrivals there is also an increase in energy consumption.

Figure 33. Airport Arrivals & Power Profile for Corfu.
Source: Authors 'elaboration

Box 6. Relationship between Weather Variables and Electric Power Demand in Zakynthos

Literature has shown that temperature is usually the most significant weather variable influencing electricity consumption (Hernández et al, 2012; Staffell & Pfeningger, 2018). Time series analysis of daily electricity demand for Zakynthos, reviles this relation. A seasonal trend is apparent, influenced by the prevailing weather conditions with peaks and valleys in electricity demand coinciding with respective changes in temperature. Both increases and decreases of temperature, linked to exceeding certain "threshold" temperatures, increase the demand for electricity. This can be seen in the figure below where we can observe positive correlation during the hot months of the year (Apr. – Oct.) and negative one during the cold months (Nov. – Mar).

When the differential between outdoor and indoor temperatures increases, the starting-up of the corresponding heating or cooling equipment immediately raises the demand for electricity. For the Zakynthos case, the largest deviations from the mean in electricity demand occur during the summer, which contravene the expected winter peak (Psiloglou et al, 2009). The implication of tourist load during the summer, amplifies the economic activity and results in this summer time high peak.

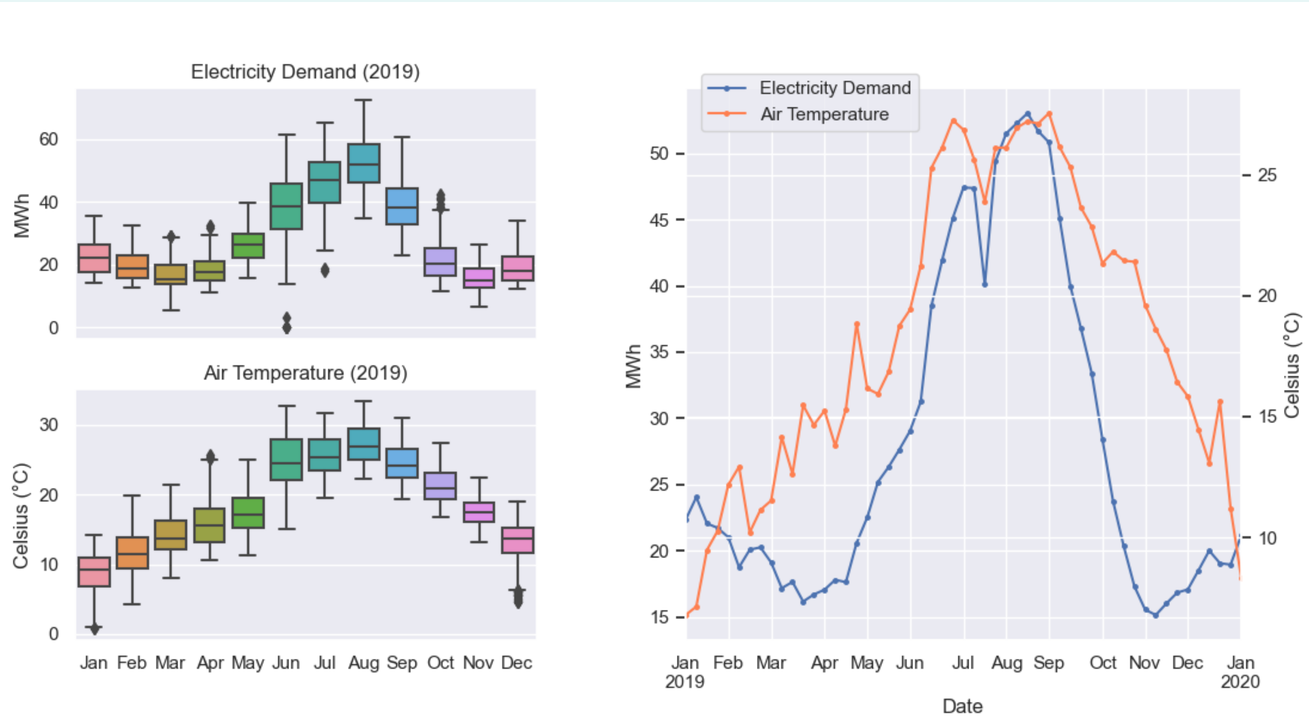

Figure 34. Box-whisker plots for air temperature and total electricity demand.
For Zakynthos (left). Weekly Mean Resamples of temperature and electricity consumption, for Zakynthos during 2019 (right).
Source: Authors 'elaboration

2.4 Electrical Energy Consumers

Based on data from the Hellenic Electricity Distribution Network Operator (HEDNO), the electricity consumers are categorised into a variety of different sectors; residential, industrial, commercial, agricultural, public and others. Each sector group has a similar pattern regarding its profile which is high related to their activity.

Table 12 shows the share of each sector in the total electrical consumption of Corfu from 2015 to 2019. The increasing significance of the commercial sector as a primary consumer is obvious as it is responsible for more than 50% of the demand in 2019 (Figure 35).

Table 12. Share of each sector in the total electrical consumption of Corfu.

Year	Residential	Industrial	Commercial	Agricultural	Other	Public
2015	38,14%	2,91%	50,57%	0,38%	1,90%	6,10%
2016	38,25%	2,32%	52,48%	0,40%	1,88%	4,67%
2017	38,52%	2,13%	52,92%	0,34%	1,78%	4,32%
2018	36,99%	2,21%	54,86%	0,27%	1,64%	4,03%
2019	37,06%	2,03%	55,00%	0,22%	1,56%	4,12%

Source**: Author's elaboration on HEDNO data.**

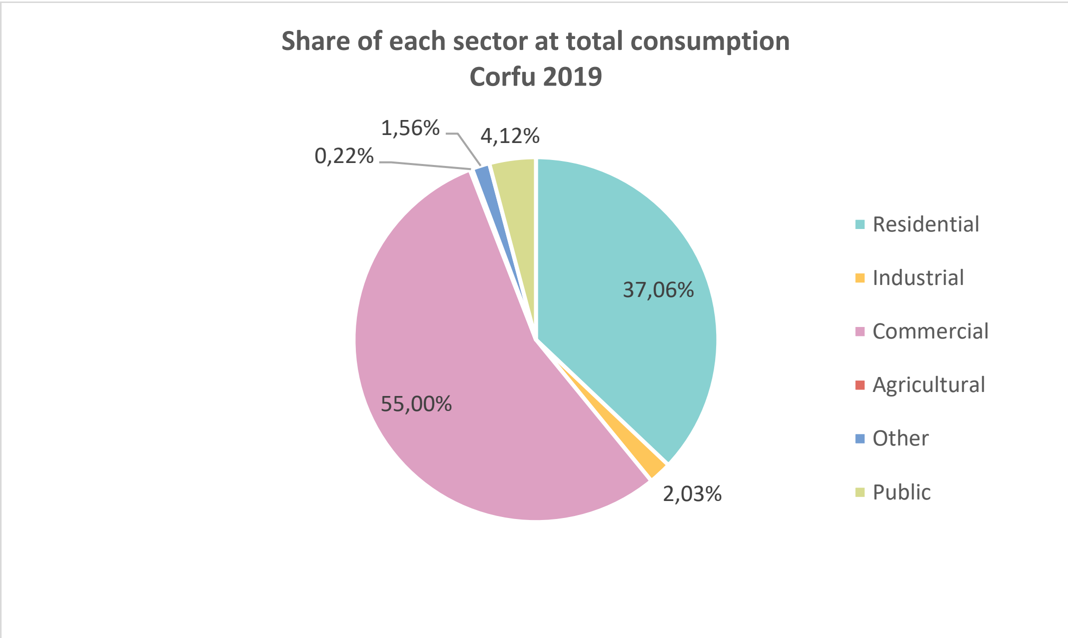

Figure 35. Participation of each sector at total consumption in Corfu.
Source: Authors' elaboration on HEDNO data.

Table 13 shows the participation of each sector in the total consumption of Zakynthos from 2015 to 2019, where, similarly with Corfu, the commercial sector is by far the largest consumer. In 2019, it reaches the five-year peak at 60.25% (Figure 36).

Table 13. Share of each sector in the total electrical consumption of Zakynthos.

Year	Residential	Industrial	Commercial	Agricultural	Other	Public
2015	33,76%	1,90%	54,30%	0,50%	4,36%	5,18%
2016	32,93%	2,12%	54,67%	0,60%	4,40%	5,28%
2017	32,97%	1,29%	56,65%	0,36%	4,39%	4,33%
2018	31,25%	1,59%	59,15%	0,38%	4,34%	3,28%
2019	31,52%	1,17%	60,25%	0,34%	3,80%	2,92%

Source: Authors' elaboration on HEDNO data.

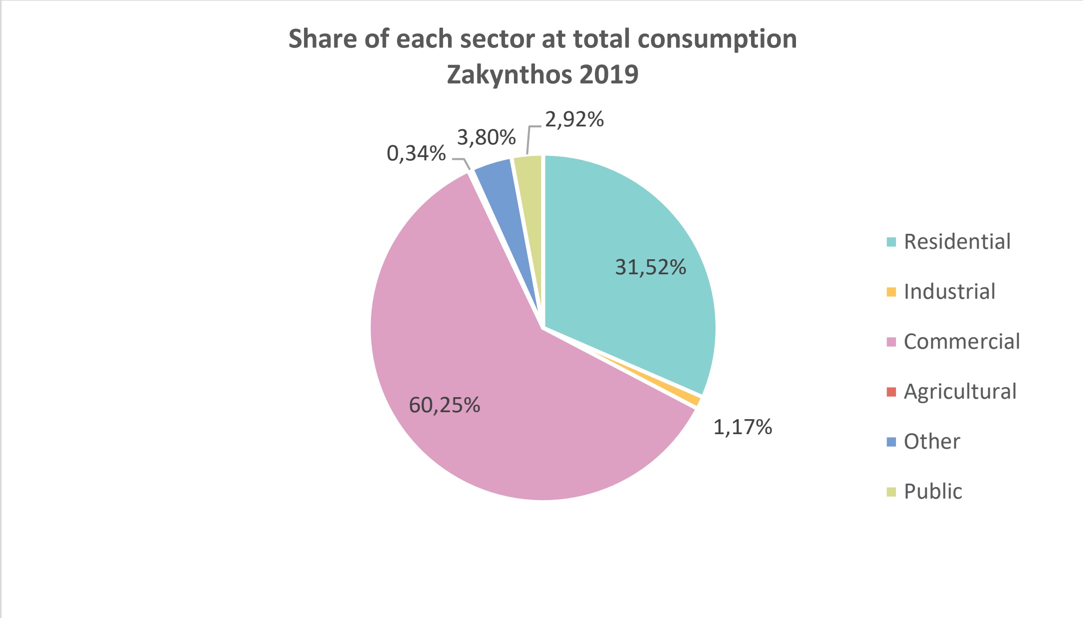

Figure 36. Participation of each sector at total consumption in Zakynthos.
Source: Authors' elaboration on HEDNO data.

The presented data indicate that the long-term economic trends – as presented in section 1.3 - are matching the energy consumption patterns. There is a decrease in agricultural participation in the total load, a decrease in industrial participation and at the same time an increase in commercial participation for both islands. Furthermore, data show that there is a small increase of total consumers per year. It is obvious that the commercial use (which is highly related to tourist industry) is the one that led to the increase of the total energy consumption in both islands.

3 Policy and Regulation

When talking about energy transition plans it is essential to include the related policies and regulations that frame energy community projects, as they are the driving force of every kind of investment. Of course, legislation about energy communities is affected and guided by the directives on RES and climate change.

The world's first legally binding international treaty on climate change, was the Paris Agreement for climate change, in 2016, which was ratified by law 4426/2016 (COP21). It was adopted by 196 Parties and its goal is to limit global warming to well below 2, preferable 1.5 degrees Celsius, compared to pre-industrial levels. The EU has also committed to implement the UN's Sustainable Development Goals (SDGs), adopted in September 2015 as part of the United Nations' Agenda 2030. The SDG 13, Climate Action, is aligned to the goal of the Paris Agreement.

In 2019, the EU with the package "Clean Energy for all Europeans" completed the update of its energy policy framework in order to meet the responsibilities of the European Union (EU) in the framework of the COP21. This legislative package embodies proposals to facilitate a transition to a 'clean-energy economy' and to reshape the electricity market of the European Union. In that package, it was decided to adopt the following objectives for 2030 regarding the energy sector:

- **Renewable energy**: set binding target of 32% for renewable energy sources in the EU's energy mix.
- **Energy efficiency**: set binding targets of at least 32.5% energy efficiency, relative to a 'business as usual' scenario.
- **Greenhouse gas emissions**: reduction of greenhouse gas emissions by 40% compared to 1990.

Launched in December 2020, 'European Green Deal' is the EU's main new growth strategy to transition the EU economy to a 'green' economic model. As part of the European Climate Law, the European council raise the 2030 net greenhouse gas emission reduction target, to at least 55% compared to 1990. The Green Deal framework is expected to produce a wave of legislative procedures in the near future[22] with amendments of existing laws, which were most recently amended as part of the Clean Energy Package and new proposed laws in the following areas:

- implementation of the hydrogen strategy and development of an EU hydrogen industry
- introduction of a border tax adjustment on CO_2
- implementation of a methane strategy to reduce methane emissions.

The National Energy and Climate Plan (NECP), submitted by December 2019, set out a detailed roadmap regarding the attainment of specific energy and climate objectives by 2030. This

[22] New targets and proposal are expected by EU in July 2021.

reflects the goal for increasing the penetration of RES up to 35% by 2030 as well as the goal of reducing the share of lignite in power generation putting a complete end to the use of lignite by 2028. Nevertheless, the new energy landscape shaped by the European goal of reducing emissions by 55% by 2030, is expected to lead to a forced revision of the NECP's target for RES.

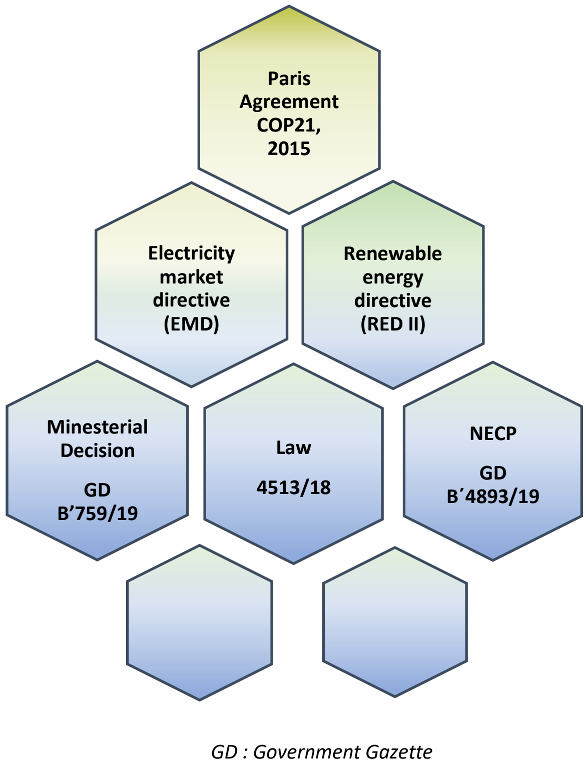

Figure 37. Overview of main frameworks.
Source: Authors' elaboration

3.1 European policy framework and regulation for energy communities

With the 'Clean energy for all Europeans Package' (CEP), the European Union (EU) compose a proposal for the transition to a 'clean-energy economy' that aims to reshape the electricity market of the EU in order to meet the responsibilities derived by the Paris Agreement. Within the new framework the consumers are playing fundamental role into the energy transition, introducing special treatment for energy initiatives. More specifically, the recast renewable energy directive (RED II)[23] and the recast electricity market directive (EMD)[24] introduce a framework for "citizen energy communities" (CEC) and "renewable energy communities"

[23] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources, amending Directive 2009/28/EC.

[24] Directive (EU) 2019/944 of the European Parliament and of the Council on common rules for the internal market in electricity, amending Directive 2012/27/EU.

(REC). These communities, allow citizens to collectively organise their participation in the energy system. The definitions of CEC in the recast EMD and REC in the RED II are similar but have some critical differences.

Table 14. Comparison of Renewable Energy and Citizens Energy Communities definitions.

Renewable Energy Community	Citizens Energy Community
Means a legal entity: a. which, in accordance with the applicable national law, is based on open and voluntary participation, is autonomous, and is effectively controlled by shareholders or members that are located in the proximity of the renewable energy projects that are owned and developed by that legal entity; b. the shareholders or members of which are natural persons, SMEs or local authorities, including municipalities; c. the primary purpose of which is to provide environmental, economic or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits.	Means a legal entity that: a. is based on voluntary and open participation and is effectively controlled by members or shareholders that are natural persons, local authorities, including municipalities, or small enterprises; b. has for its primary purpose to provide environmental, economic or social community benefits to its members or shareholders or to the local areas where it operates rather than to generate financial profits; and c. may engage in generation, including from renewable sources, distribution, supply, consumption, aggregation, energy storage, energy efficiency services or charging services for electric vehicles or provide other energy services to its members or shareholders;

Source: EU Directive 2018/2001 & EU Directive 2019/944.

Both directives allow different forms of organizational structure around specific criteria. They describe a way to 'organise' collective cooperation of an energy related activity around specific ownership, governance and a non-commercial purpose. They must be effectively controlled by their shareholders or members, and their primary objective is to provide environmental, economic and social community benefits rather than financial profits. Finally, participation in CECs and RECs must be open and voluntary.

The differences between the CEC and REC lie in the political directions of the Directives from which they initially emerged. EMD focuses on expanding the market actors and CECs are defined according to these directions. On the other hand, RECs are derived from RED II which main goal is to promote and facilitate the development of energy from renewable sources. The main differences among the two definitions are summarised in the table below.

Table 15. Differences between Citizen and Renewable Energy Communities.

Criteria	Citizen Energy Community	Renewable Energy Community
Membership	Natural persons, local authorities, including municipalities, or small enterprises and microenterprises	Natural persons, local authorities, including municipalities, or small enterprises and microenterprises, provided that for private undertakings their participation does not constitute their primary commercial or professional activity
Geographic limitation	No geographic limitation, MS can choose to allow cross-border Citizen Energy Communities	The shareholders or members must be located in the proximity of the renewable energy projects that are owned and developed by the Renewable Energy Community
Allowed activities	Limited to activities in the electricity sector. Electricity generation, distribution and supply, consumption, aggregation, storage or energy efficiency services, generation of renewable electricity, charging services for electric vehicles or provide other energy services to its shareholders or members	Can be active in all energy sectors. Production, consumption and selling of renewable energy
Technologies	Technology neutral	Limited to renewable energy technologies

Source: Regulatory Aspects of Self Consumption and Energy Communities, CEER Report.

The EU framework for the energy communities has already transpose to various national legal frameworks with significant variations. More specifically, legal frameworks for energy communities have been identified in Belgium, France, Austria, Greece, Germany, Ireland, Luxembourg, the Netherlands, Portugal and Slovenia[25]. The transposition should be seen as an opportunity for Member States to update policy frameworks to support the empowerment of smaller and non-commercial actors in the energy market as well as more decentralised renewable energy production and consumption[26].

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[25] Collective self-consumption and energy communities: Trends and challenges in the transposition of the EU framework, COMPILE Report [online]: https://www.compile-project.eu/wp-content/uploads/Frieden-et-al.-2020-Current-state-of-CSC-and-EnC-1.pdf

[26] REScoop.eu, ' Guidance document for governments & advocates', 2020

3.2 National policy for RES

RES production, in Greece, is regulated by Law 3468/2006 and targeted legislation, such as the RES Licensing Regulation (OJ B 2373/25.10.2011). The RES support system was amended in August 2016 by Law no. 4414/2016 that introduced the Feed in Premium scheme aiming the following:

- Alignment with the EU's Guidelines on State aid for environmental protection and energy 2014-2020 (2014/C 200/01).
- The gradual integration and participation of the RES and CHP plants in the electricity market in the best cost-benefit way for the society and the final consumers.

Subsequently, several Ministerial Decisions and Decisions of the Regulatory Authority for Energy (RAE) were issued for the implementation of the new support system, integrating in to the framework the following elements[27]. Direct operating aid was granted to the RES and CHP power plants in the form of a sliding Feed in Premium, in addition to the price that the plants receive from their participation in the wholesale electricity market to an upper threshold which is the Reference Tariff (RT). The RT was determined by using a typical RES project per technology.

With the Law 4643/2019 (Government Gazette 193 A') the operating framework, enables the RES plants to participate directly in the wholesale electricity market, either independently or through aggregators. The reference prices come from an administratively defined price only for technologies that have received a relevant exemption approval (small hydropower plants, biogas stations, etc.) while for the technologies of PV and Wind stations from the conducting competitive processes.

The licensing steps for RES project is based on law 3468/2006 (as amended by law 4685/2020) and includes the following approvals:

1. Producer Certificates (replace the previous Power Production License),
2. Decision for the Approval of Environmental Terms (AEPO)
3. Installation Permit - Connection and Power Purchase Agreement -Construction Permit
4. Operating License

The 'Special Framework for the Spatial Planning and Sustainable Development' (SFSPSD) for the RES established on 2008[28] identifying, for the first time, criteria and guidelines for the site allocation of RES projects, per RES category and type of geographic area, with emphasis on wind systems. More specifically for wind and PV systems special zones have been defined for areas with high environmental interest (national parks, Natura 2000 & Ramsar Convention areas, etc.), world heritage sites and areas of special uses (high productivity agricultural lands, Tourism Development Areas). Nevertheless, SFSPSD failed to become an integrated

[27] Energy Regulatory Authority (RAE), Report on the results of the competitive procedures for RES for the period 2018-2020.

[28] Government Gazette 2464/2008.

framework that ensures a clear demarcation through the different land uses, especially for those areas that is the most sensitive ones (forest areas, Natura regions, etc). With the latest changes brought by law 4685/2020[29], the simplification of environmental permits (AEPO) in protected areas was held, aimed at accelerating the licensing procedure. However, the new framework raises concerns regarding the introduction of the new mechanism for assessing the potential impact on the environment from the implementation of the RES projects. Moreover, in December 2020 law 4759/2020[30] has put in effect the foundation for the fast-track drafting of local spatial plans, causing further concerns. Local spatial planning seems to be moving away from the vision of a unified and integrated plan that works in harmony with the national level, encouraging the democratic participation of local communities. It promotes the further fragmentation of the legislation and prioritize a development model that is in competition with environmental justice and balance[31]. Up to now the revision of the spatial planning for RES in a national context is still pending.

3.3 National policy on energy communities

In the broader plan to reach the targets for renewables penetration and greenhouse gas reduction the Greek policy makers introduced the law 4513/18 in 2018 which enter the concept of energy communities into the national framework. Energy communities are defined as associations in the form of local and regional cooperatives of exclusive purpose. The legal framework (law 4513/2018) aspired to combine Social and Solidarity Economy and the energy sector in a new type of civil cooperative, the Energy Community. Overall, the purpose of the law is to:

- promoting the social economy,
- promoting innovation in the energy sector,
- addressing energy poverty and promoting energy sustainability,
- production, storage, own consumption, distribution and supply of energy,
- enhancing energy self-sufficiency and security in island municipalities,
- improving energy efficiency at local and regional level

A broad range of activities are allowed that extend to production, distribution and supply of heat and electricity, demand response among others. Moreover, EC can act as an Energy Services Company (ESCO) and provide energy services of all kinds.

The law distinguishes two types of energy communities, non-profit and for-profit cooperatives. Each varies in composition and minimum number of members, and the ability to distribute surpluses. The possible fields of activity, their geographical scope of development, the criterion as well as participation in the cooperative capital, are not differentiated from type to type. The above are summarized in the table below.

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[29] Modernization of environmental legislation, Ch. A - Simplification of environmental licensing.

[30] Modernization of Spatial and Urban Planning Legislation and other provisions.

[31] Bee Green, 2021, Renewable Energy Sources and Spatial Planning, for the Nikos Poulantzas Institute.

Table 16. Energy communities' types in Greece .

<table>
<tr><th></th><th>Minimum Number of Members</th><th>Profit Allocation</th><th>Cooperative Shares</th></tr>
<tr><td>Members</td><td colspan="3">• Natural persons with full legal capacity
• Legal entities under public law or private entities.
• First degree local government of the same region within which the energy community headquarters or their businesses are located.
• Local authority organizations of municipalities (OTAs) of the same region within which the energy community headquarters or their businesses are located within the administrative boundaries of EC's headquarters.</td></tr>
<tr><td>Limitations</td><td colspan="3">• The same region within which the energy community headquarters or their businesses are located within the administrative boundaries of EC's headquarters.
• At least 50%+1 members need to be located in the proximity of the district of the headquarters</td></tr>
<tr><td>Non-Profitable</td><td>• 5 in case the members are natural persons or legal persons governed by public or private law
• 3 in case the members only comprise local authority organizations
• 3 in case the members are natural persons or legal persons governed by public or private law, while at least two of the members are local authority organizations
• 2 in case the members only comprise local authority organizations in an island area</td><td>• Profit allocation among the members is prohibited. Any profits shall be available for the purposes of the energy community
• For islands with a population less than 3100 persons, and in case the community comprises a 1st or 2nd degree local authority organization within the region where the community is registered: part of the profits may be available for actions of general interest linked with the sufficiency and supply of raw materials, fuels and water.</td><td rowspan="2">• Each member can own, except from the obligatory cooperative share, one or more additional cooperative shares.
• The maximum number of cooperative capital of each member is equal to 20%. Local authority organizations are excluded and can participate in the cooperative capital with a maximum limit of 40%.
• Especially for islands with a population less than 3100 persons, the maximum limit for the participation of local authority organizations is set to 50%.</td></tr>
<tr><td>Profitable</td><td>• 15 in case the members are legal persons of public law (with the exception of local authority organizations), or legal persons of private law or natural persons
• 10 in case of a municipality in an island with population less than 3100 persons</td><td>Allocation of profits is allowed among the community's members</td></tr>
<tr><td>Activities</td><td colspan="3">• Mandatory: Production, distribution, RES supply, energy efficiency, supply chain (biomass, etc.), electrification, desalination of water with RES, energy services.
• Optional: information, education, participation in funded projects etc.</td></tr>
</table>

Source: Law 4513/2018

From organizational point of view, EC's operation, is based on voluntary and open participation and are effectively controlled by their members through the general assembly and the board of directors. The principle of 1 member - 1 vote as well as a ceiling on the participation rate of each member in the cooperative capital guarantee the democratic governance. Figure 38 illustrates the organization structure of EC according to the law of urban cooperatives (law 1667/1986) that govern the operation of ECs.

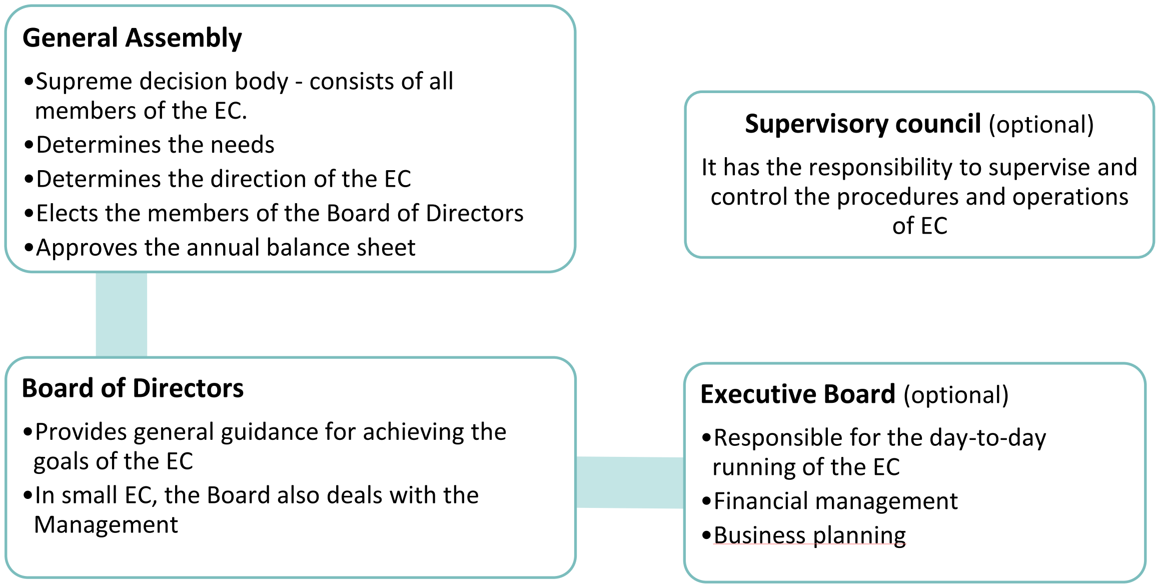


Figure 38 Organization and operation of EC according to the law.
Source: Authors' elaboration based on Law 1667/1986

Many measures have been set in place in order to promote the formation of Energy Communities and also increase the penetration of Renewable Energy Sources (RES) in these communities. Relevant incentives are provided in current legal framework. An overview of such incentives is provided in Table below.

Table 17. Incentives for energy communities' formation

Financial Incentives	Incentives of non-finance nature
• Energy communities can be considered in Law 4399/2016, for the establishment of Private Investment Aid schemes for the regional and economic development of the country • Standard tax rate for five years • When considering the installation of photovoltaics, energy communities can enjoy increased prices for the compensation of the power produced from RES, according to Law 4602/2019 • Exemption from the obligation to pay the annual fee for retaining an electricity production license • In order to issue an electricity generation license to an energy community the cooperative capital shall be equal to 60,000 €, significantly lower than the 600,000 € of corporate capital required for a company to acquire the relevant license. • Exemption from bidding procedures for projects up to 18 MW. An additional compensation of 10% from the weighted average price obtained 3 years before the last bidding procedure for wind farms < 6 MW and for PV installations < 1 MW, based on Ministerial Decision • Reduced guarantee payment of 50% for participation in the auction-based subsidy scheme for renewable energy stations and hybrid stations	• Applications from energy communities for a production license that are submitted to RAE for RES, CHP and Hybrid Stations shall be considered as a priority. • Special conditions may also apply when considering energy communities for the issue of an electricity generation license, when the energy community operates as the actor for the exploitation of charging infrastructure for electric vehicles. • Energy communities may install RES in the oversupplied grid of Peloponnesus and Evia, until exhaustion of certain power limits, as described in Law 4546/2018 • Possibility to install RES, CHP and hybrid stations in ownership of energy communities to cover energy needs of their members and vulnerable consumers or citizens living below the poverty line, within the Region where energy communities' headquarters are located, with application virtual metering, with a maximum installed capacity of 3MW (in case of PVs).

Source: Heinrich Bell Foundation, Building Energy Communities. Energy in the hands of citizens, 2019

The Greek framework for Energy Communities is a good example of transposing and implementing the EU legislation even though it was established before the finalization of the corresponding EU directives. EU Member States must transpose REDII provisions into national legislation by 30 June 2021 and IEMD provisions by 31 December 2020. The current Greek legal framework is expected to be recasted in the near future so as to ensure it is consistent with the new EU legislation. In this direction, REScoop in collaboration with energy communities and other stake holders (Enviromental organizations, etc.) recently published suggestions for facilitating effectively the transposition and propositions for addressing the misfunctions that have been identified in to the framework since its application. For more details, we refer the reader to the original report[32].

[32] Development of energy communities in Greece: Challenges and proposals, Report, 2021

Box 7. Collective Self-Consumption in Greece

Collective self-consumption refers, generally, to the sharing of the generated RES energy among "jointly acting renewables self-consumers"[1]. In other words, it is the generation of renewable energy only for self-consumption among members of a neighborhood, street, municipality or region.

In Greece, this concept, sometimes referred as energy sharing, can be realized using the existing national regulation, specifically the Law 4513/2018, that is the framework that defines the establishment of an Energy Community as a cooperative, and the Ministerial Decision 759B/2019, which defines the net metering and virtual net metering schemes and includes Energy Communities as beneficiaries for the latter.

Currently, virtual net metering is the core of collective self-consumption implementation in Greece. Virtual net metering is the netting between the generated energy from a RES installation and the consumed energy of one or more consumption points, provided that the installation is at a different location from the consumption points and not directly electrically connected with them.

Any Energy Community, established under the Law 4513/2018, is allowed to implement a RES project that complies to virtual net metering scheme. The RES installation has to be located at the same Administrative Region with the consumption points that participate in the project (exceptions are considered for Attiki Region and Non-Interconnected Islands) and they both (RES installation and consumers) need to have the same energy provider. In the scheme various RES technologies can participate (photovoltaics, small wind turbines, small hydro etc.) and for the case of solar projects the maximum installed power is limited to 3 MW (article 162, Law 4759/2020).

An important provision of the framework is that is allows for the participation of vulnerable houses (from the perspective of energy poverty) in the virtual net metering, when implemented by an energy community. These houses are not required to be members of the energy community but they can just participate in the scheme and benefit from the generated energy.

Overall, collective self-consumption or energy sharing, as realized in Greece, allows the members of an Energy Community to share the generated energy from their RES project and see their electricity bills reduced, while supporting, in the same time, vulnerable houses in the region.

It has to be noted here that, according to the European Union, virtual net metering does not fully align to the new target model that defines the operation of the energy markets in member states. For that purpose, EU has proposed the replacement of it with a new framework and, recently, the Greek Ministry of Energy started reconsidering the current regulation defining this scheme.

[1] *Collective self-consumption and energy communities: Overview of emerging regulatory approaches in Europe, COMPILE, Working paper, 2019,*

4 Survey of islands' residents on energy communities and renewable energy

In order to establish a link between local societies' knowledge, needs and aspirations and gain understanding of local dynamics a survey was organized via an online questionnaire. It aimed to record the views of the habitants of the island regarding renewable energy sources and Energy Communities. In this section we provide the key outputs and a brief description.

The questionnaire was titled *"Understanding the views of residents about Energy Communities"* and it consisted of three parts. The first had twelve questions regarding the general purpose and subject of the survey: questions on local environmental problems, environmental awareness, climate change, renewable energy and the energy profile of the respondents. The second part focused on their knowledge and understanding around Energy Communities – as well as their willingness to participate in an energy community project; and the third part had seven questions on demographics.

The survey took place from October of 2020 until February of 2021 and we gathered 173 complete answers: 42 from Zakynthos and 131 from Corfu. The questionnaires distributed online via various channels. We got in touch with several organizations and news media located in Zakynthos and Corfu as well as with the municipalities. In addition, we made several social media posts in local groups and targeted ads. Unfortunately, we did not manage to gather the number of the desired answers despite our great effort.[33] This can be attributed to the pandemic conditions, the online fatigue or to be considered as a more general indication regarding the understanding and interest of the local societies in the topic.

Regarding the main characteristics, our sample is almost equally separated between men (45%) and women (52%), the 40.4% is between ages 35-44 while the majority (50.8%) has a university degree and is employed full time (39.8%). The 68.6% of the respondents has an income lower than 20,000€ - the 27.8% has income lower than 10,000€ and the 40.8% has income between 10-20,000€ while the vast majority 81.5% represent domestic consumers of energy.

Energy communities' survey in the Ionian Islands

A methodological note, a full description of the survey, and all the findings are presented in Annex 1. The template of the questionnaire used in Annex 2. Questionnaire template.

In this section, we provide a brief description and some key outputs that are used to develop the transition

[33] Our target sample size given the population of the two islands was 350 allowing 5% error margin.

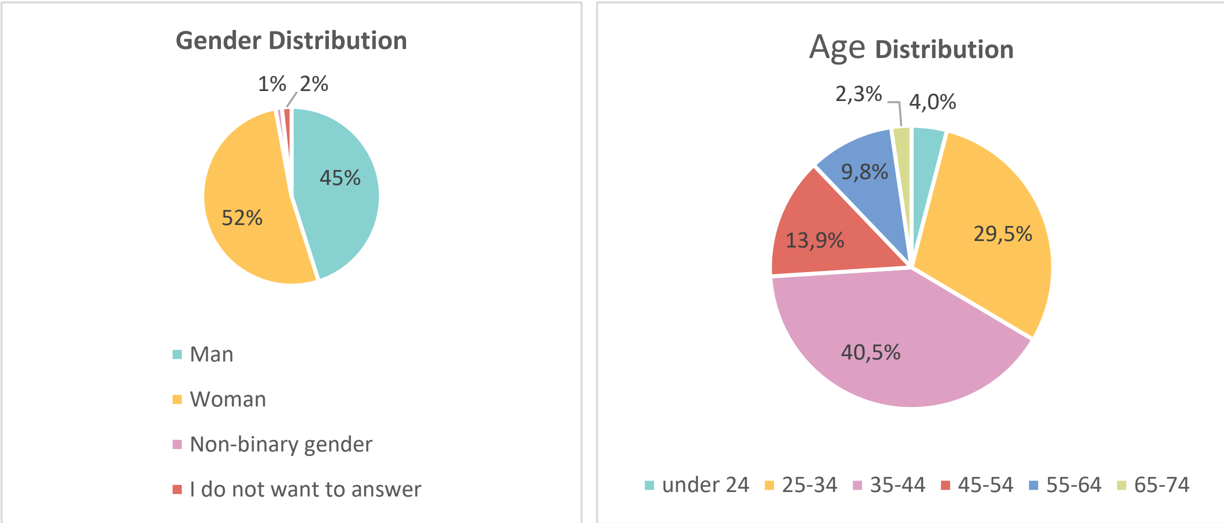
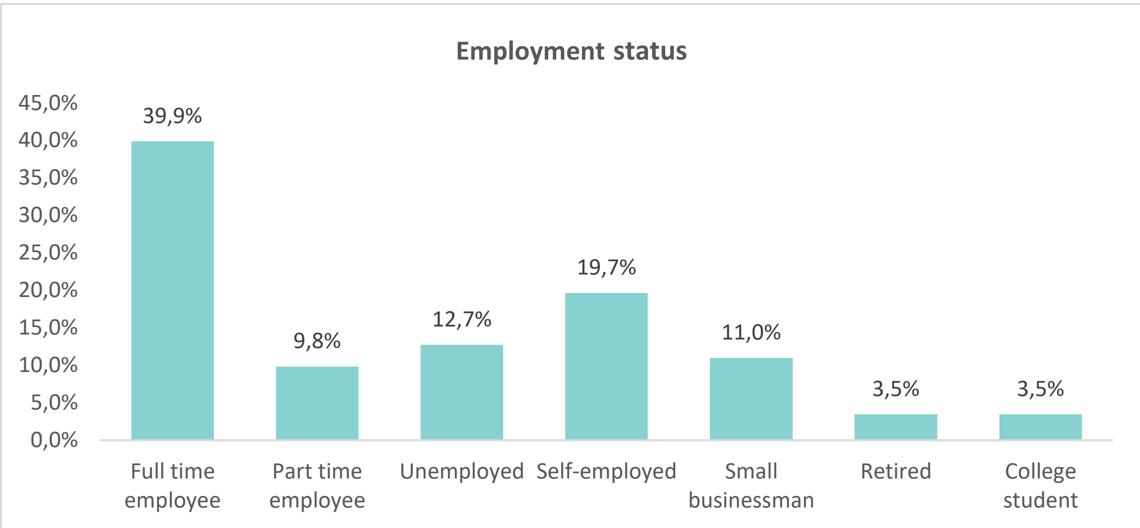


Figure 39. Gender and age distribution of the survey's sample.

Source: Authors' elaboration



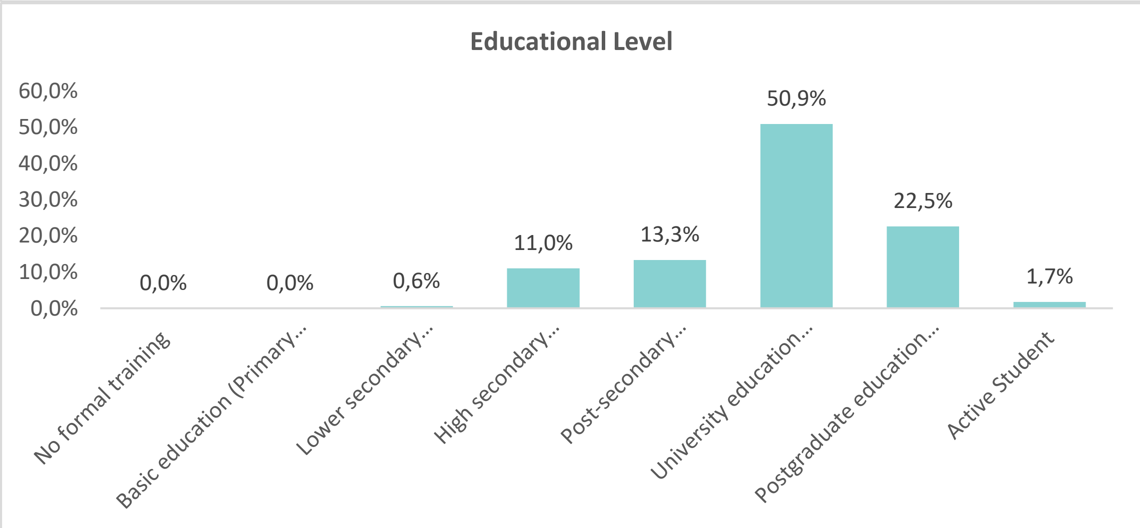


Figure 40. Educational level and employment status of the survey's sample.
Source: Authors' elaboration

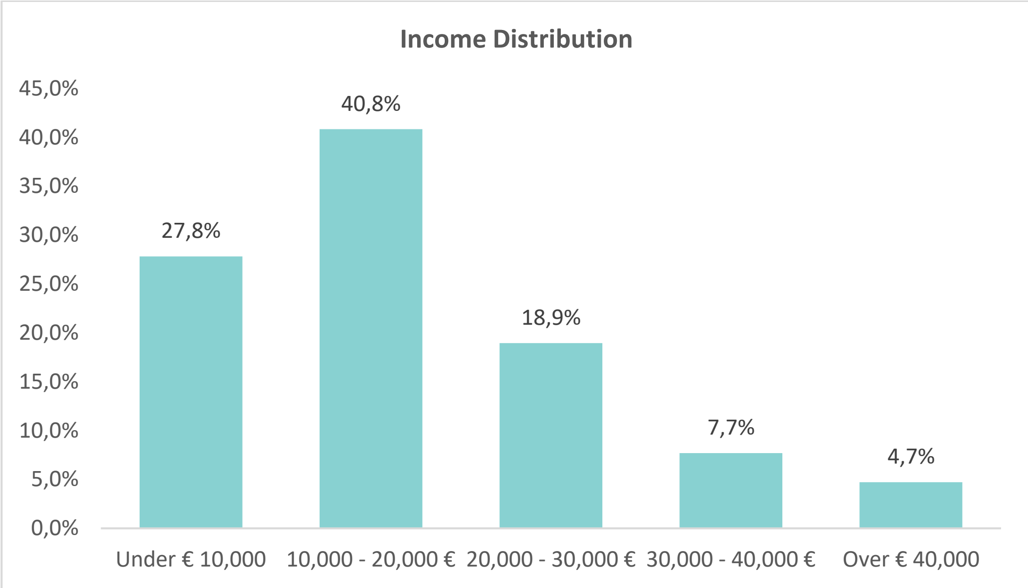


Figure 41. Income groups of survey's sample
Source: Authors' elaboration

The New Ecological Paradigm (NEP) scale is used in order to outline the environmental awareness of every respondent and of our sample and via a series of questions we also tried to capture respondents' perception on renewable energy sources as well as their energy consumption type and in general their energy consumption habits. NEP scale is a survey-based metric, designed by Dunlap and colleagues, which measures the environmental concern of people. It is using a survey instrument constructed of fifteen statements, and respondent asked to indicate the strength of their agreement or disagreement with each statement. Eight of the items, if agreed to by a respondent, are meant to reflect endorsement of the new ecological paradigm, while agreement with the other seven items represents endorsement of the dominant social paradigm (DSP).

In addition, for further analysis the fifteen items separated into five different dimensions: Reality to limits of growth, Anti-anthropocentrism, Fragility of nature's balance, Anti-exceptionalism and Possibility of an eco-crisis. The level of agreement or disagreement in every dimension indicates the respondent's perception in each dimension's subject, and take values from 1 to 5. In each dimension, separately and in total, prevails the score that is closest to 5 (Dunlap et al, 2000; Dunlap, 2008).

The results in the NEP scale gives reveals that in four out of five dimensions our sample is closest to the NEP. Our respondents realize that our relationship with nature should not be anthropocentric; that nature has a fragile balance; that humanity is facing an eco-crisis; that humans are not superior to all other species; but do not realize that there is limit to the resources that earth can provide us.

Climate change and environmental issues are regarded as high political priority themes for the ¾ of the responders and 69.7% prioritize energy transition as high priority. Also, the 86.1%

has a positive (49.1%) or very positive (36.9%) opinion about RES, while, the 70.5% believes that the RES potential of their islands should be exploited.

Nevertheless, the Ionian Islands lag behind in the adoption of energy communities. By mid-2020 throughout Greece more than 400 energy communities (legal entities) have been created since 2018 but none in Ionian Islands was operational. That is reflected also in our survey. Although our sample largely consists of highly educated and environmentally aware citizens 3/4 of them have no prior knowledge or understanding over energy communities. Nevertheless, after introducing the concept to them, 87% of them has positive or curious feelings towards participating in a future energy community project.

This raises the issues of ownership and governance that is central to define future social cohesive strategies for RES development. The large majority of the people seem to prefer RES production and related activities to be managed by local communities and the public sector at large (Figure 43). They favour smaller initiatives or ones that public interest and ownership is evident rather a model of privatisation of profits and management (Figure 47).

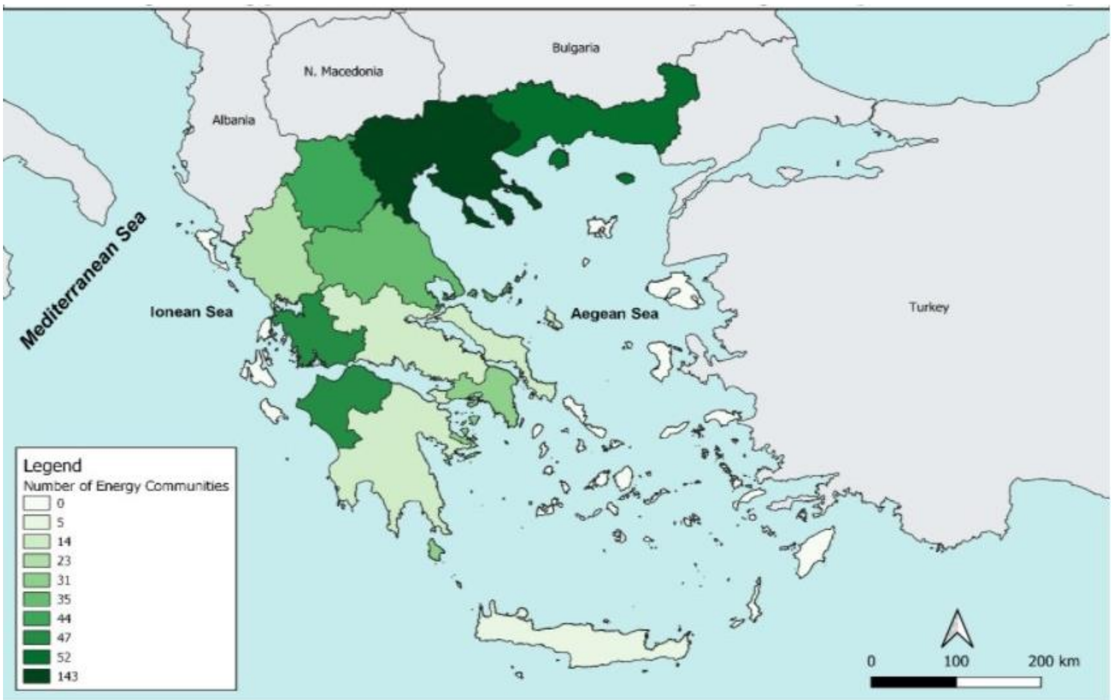


Figure 42. Existing energy communities in Greece (August 2020).
Source: Mapping of energy communities in Greece

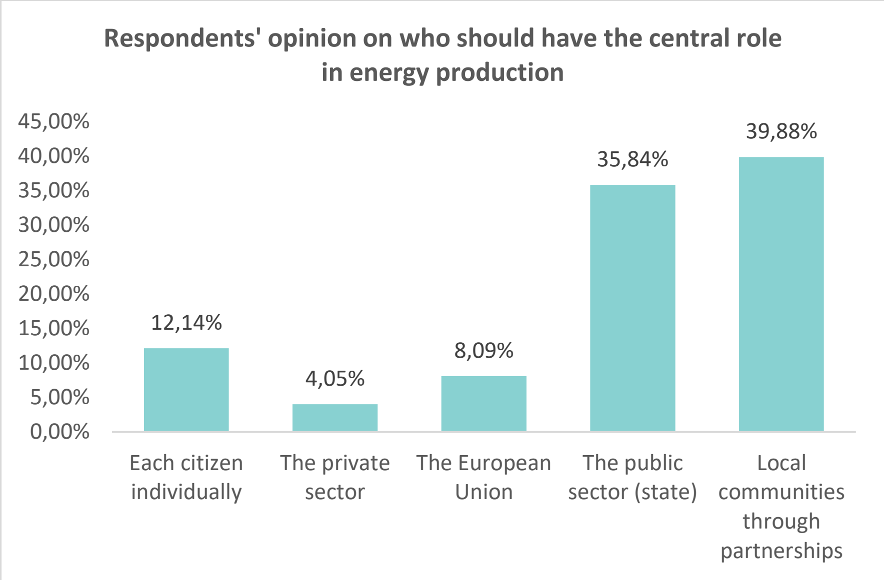


Figure 43. Survey results on energy production ownership.
Source: Authors' elaboration

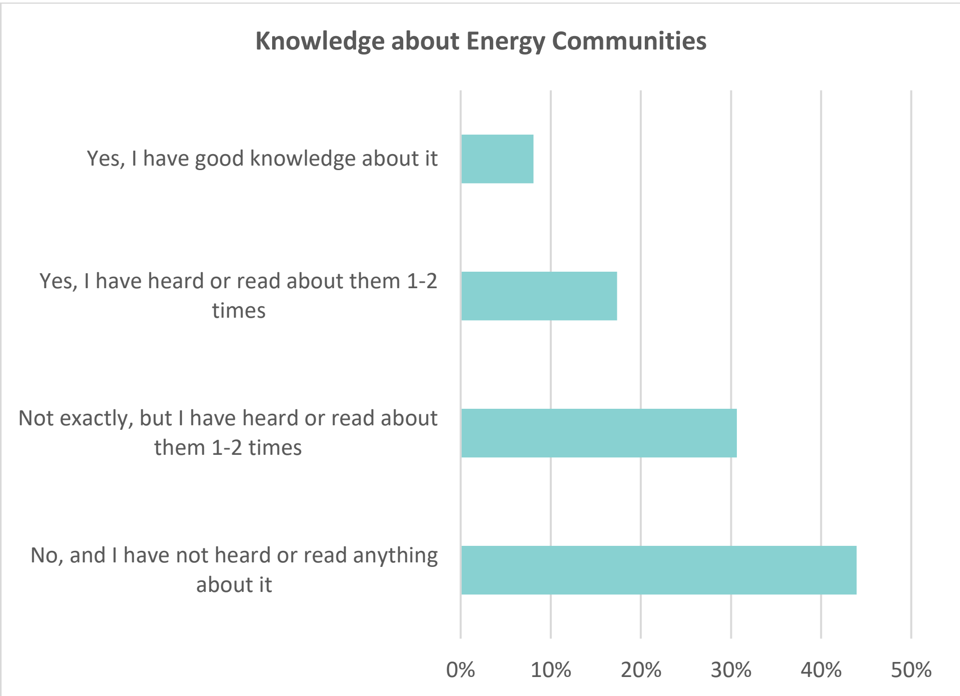


Figure 44. Citizens' knowledge on energy communities.
Source: Authors' elaboration

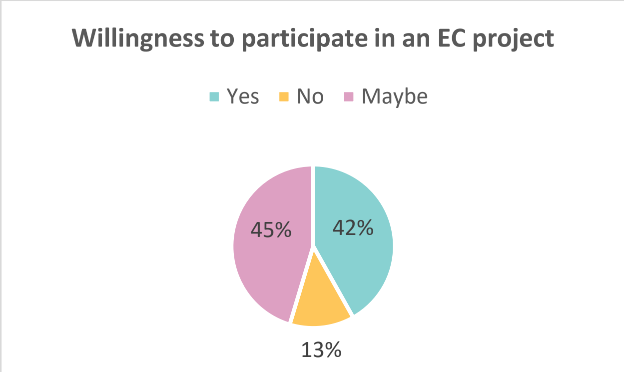


Figure 45. Willingness to participate in an energy community project.
Source: Authors' elaboration

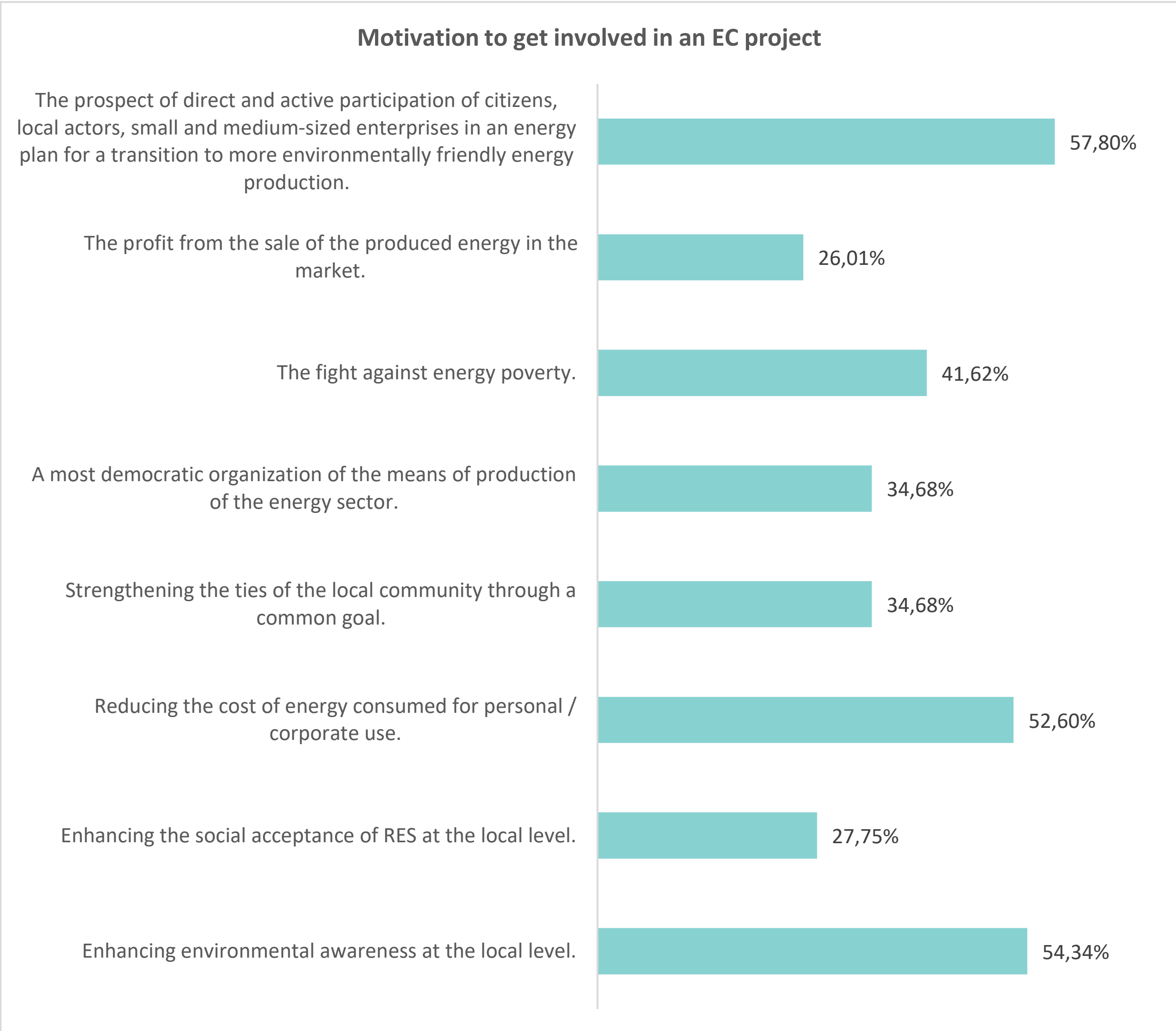


Figure 46. Motivation over potential involvement in an energy community.
Source: Authors' elaboration

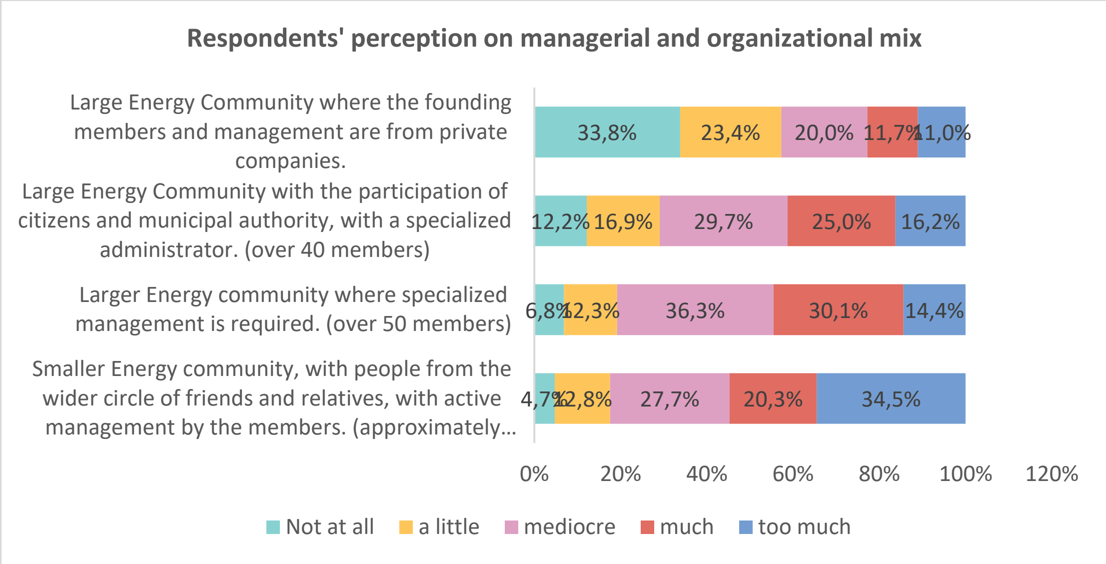


Figure 47. Preferred managerial and organizational mix for energy communities.
Source: Authors' elaboration

As we tried to decode the reasons and motives behind the possible participation of residents on energy communities, we observe the advanced ecological sensitivity but the lack of knowledge around the possibilities of households RES investments and their limited expectations. The prospect of direct and active participation of citizens, local actors, small and medium-sized enterprises in an energy plan for a transition to more environmentally friendly energy production would motivate the most respondents (57.8%). Enhancing the environmental awareness at the local level would also act as a motivation to the majority of our sample (54.3%). As expected, the third motivation appears to be the energy cost reduction (52.2%). Given the income status of the sample this motivation is expected to be strong, as also the reduction of energy poverty, which also is highly selected (41.6%). In general, we could claim that the motivations with the most respondents are more social than personal. This is also obvious by observing that only for the 26% of the sample considered earning profit from the sale of energy in the market as a motive.

Most respondents (39.1%) would be motivated to participate to an EC project with an annual energy cost reduction about 21-40%, and the 27.7% with an annual energy cost reduction about 41-60%. This however is not optimistic enough as contemporary cost- effective solutions could cover easily higher percentages of energy costs up to 100%. Also, the sample seems disconnected from contemporary realities in relation to the return-on-investment period. That is not a local characteristic but a general common cognitive bias when citizens face low carbon decision making over renovation or investments. In our sample, 35.6% preferred repayment period for their investment on 1-2 years and 19.2% in 3-6 this is overly optimistic assumption as in today's setting (e.g. market prices, costs of installation, interest rates) an expecting return would be materialized in 6-9 years.

Social investment capital for RES projects

Going a step further so to generate the basis upon which a scenario for the roadmap for energy communities' development in the Ionians can be modeled we calculated their actual willingness to invest. We got 112 responses from 173 respondents, which is 65% of our sample. The minimum value was 0, the maximum 10,000 and the mean 1,431.30.

To see possible correlations and in order to decide whether we will proceed to a parametric analysis or not, we used the Eta correlation[34], Spearman rho correlation[35] and Kendall's Tau-b[36]. By observing the correlations, we see that willingness to invest has very weak correlations with the rest variables. All the correlations show no significance that would allow us to conduct a meaningful parametric analysis. However, examining all the correlations, we could claim that there is some evidence that education, energy consumer type and percent of income spent to energy bills play a significant role on the willingness to invest. By using the Kaplan-Meier (KM) method for non-parametric analysis we tried to figure out the representative amount to invest in an EC project, as it is resulting from the responses. The analysis resulted that the willingness to invest is 1,043.15€.

Based on this the estimation on the total possible socially invested capital for energy communities' projects for Corfu is between 23,929,907€ to 26,875,768€ and for Zakynthos between 8,562,192€ to 9,615,775€.

Table 18. Potential socially invested capital for RES

	Total households census 2011	Households above poverty	Households willing to invest		Total investment value	
Corfu	41.039	35.293	22.940	25.764	**23.929.907€**	**26.875.768€**
Zakynthos	14.684	12.628	8.208	9.218	**8.562.192€**	**9.615.775€**

Source: Authors'elaboration

We used the KM estimation and we adapted given the socioeconomic status of the Ionian Islands. We assume that the estimated investment is per household, so, the starting point are the total households of Corfu and Zakynthos, as they are recorded in the census of 2011[37]. Next, the total households are reduced for the poverty level of the Ionian Islands[38]. We proceed to this calculation as it is unreal to assume that households living in poverty will have either the amount of money to make an investment on an EC project or the will. Going on, we conduct two different assumptions about the households that will be willing to invest[39]; we

[34] An Eta Coefficient test is a method for determining the strength of association between a categorical variable (e.g., sex, occupation, ethnicity), typically the independent variable and a scale- or interval-level variable (e.g., income, weight, test score), typically the dependent variable. (0=no correlation at all, 1=total correlation)

[35] Spearman correlation is a non-parametric test that is used to measure the degree of association between two variables. The Spearman rank correlation test does not carry any assumptions about the distribution of the data and is the appropriate correlation analysis when the variables are measured on a scale that is at least ordinal. (0=no correlation at all, 1=total correlation)

[36] It is considered an alternative to the nonparametric Spearman correlation coefficient (especially when you have a small sample size with many tied ranks).

[37] Hellenic Statistical Authority

[38] Eurostat dataset 'at-risk-of-poverty' rate by NUTS 2 regions, the at-risk-poverty rate in the Ionian Islands is 14% (https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do)

[39] It is considered an alternative to the nonparametric Spearman correlation coefficient (especially when you have a small sample size with many tied ranks).

account for 65% probability as it results from our survey, and we also account for 73% following the survey of Skordoulis in 2020.

Key takeaways

Despite the difficulties, we encountered in collecting responses and despite the fact that the sample size does not meet exactly our expectations; we can draw some useful insights by this survey:

- Local citizens are ecologically aware and sensitive.
- The majority thinks that energy transition and climate change should be highly prioritized by the policy makers.
- The respondents have a positive view towards RES and believe that the RES capacity of their islands should be exploited and are willing to invest on it.
- They majority feels uninformed and disconnected from local authorities on issues related to RES capabilities and investments.
- The responders have misconceptions of opposite nature regarding the amortization of their investment and the potential energy savings over their consumption.

5 Towards a community energy future for the Ionian Islands

In this section we provide initially a forecast over the status of the electric system up to 2030 for the two islands. Then we develop two scenarios of local RES projects deployment to meet a 64% RE coverage of the expected demand by 2030 along with their projected costs and benefits. This is followed by a reasoning towards the problematiques and a foresight exercise over the possibility of a 100% coverage by 2040. We further develop the vision of how RES investments can occur using community energy schemes rather than the current business as usual model of segregated private investments. Using insights from our survey and the international bibliography we analyse, the barriers and opportunities providing the way forward for an operationalisation of the energy communities model in the Ionian Islands. As part of this, a stakeholders' mapping and a SWOT analysis is also performed.

5.1 Forecasted status of electric system

The evolution of the long-term electrical demand in a region or country depends on a variety of factors and is a complex procedure. Some of the most important factors are:

- The economic status and the growth of the economy, usually expressed with the GDP.
- The changes in the behavioral aspects of the local people (consumption habits, energy use etc.)
- The status of the energy sector (structural changes, electricity costs etc.)
- Demographic changes
- Regulatory initiatives and policies related to energy.

Since such an analysis is out of the scope of this report, for the projection of the electrical demand in the two Ionian islands in 2030 we used the national trend of the electrical demand of Greece, estimated by the Greek transmission system operator, ADMIE, published in the 10-year planning of 2019[40]. It is important to underline that the Covid-19 pandemic has already affected electrical demand, while it is expected to also have long-term consequences, considering the impact on the local and national economies. However, since it is impossible to evaluate so early the size of this impact, in this report we keep the initial projections to perform the analysis.

In the demand forecast, ADMIE, considers two scenarios, the one called "Increased Demand" and the other called "ESEK". The difference between those two scenarios is that the latter takes into consideration the impact of the policies as there are defined by the National Plan for Energy and Climate in the field of energy efficiency. As such, for the period 2020-2030 the "Increased Demand" scenario predicts an increase in the load demand equal to 22.8% while the "ESEK" scenario an increase of 14.15%.

[40] Ten-year Transition System Development Plan, 2019-2028, 4th Revised Plan to RAE, ADMIE

In this report we have considered only the "ESEK" scenario, therefore we assume an increase of the total electrical demand in the two islands equal to 14.15%. This means that in 2030 the demand in the two islands is expected to be as it is shown in the Table 19.

Table 19. Forecast of electrical demand in 2030 for the two islands.

	Electrical Demand in 2030 (ESEK Scenario)
Corfu	633.6 GWh
Zakynthos	279.9 GWh

The total installed capacity of the local generation in the two islands -as presented in Chapter 2- equals 16.6MW for Corfu and 8.9MW for Zakynthos; covering in 2019 the 4.4% and 5.5% of local annual electrical energy demand respectively. In both islands all the PV plants that are now generating, were activated in 2012 and 2013. Since then, no other plant has been activated, except only the 320-kW biogas unit in Corfu, which was activated in 2018. According to the HEDNO data (July 2020), during 2019 only 8 new licensing requests have been submitted, from which 7 at Zakynthos (in total around 700kW) and 1 in Corfu (100kW). For 2020, until July, when HEDNO's report was published, only one request was submitted for licensing; in Zakynthos for a wind farm of 2.4MW. Also, currently, no other investment than the ones already mentioned has been announced or is known to the authors. In conclusion, during the period 2014-2018 there was a complete stagnation with regards to new RES investments in the two islands and only in 2019 this started to change slightly. However, as 2020 data indicate, if the two islands need to achieve the national goals, this change does not seem to be steady or permanent and certainly is not sufficient.

Despite that, the coming decade a set of regulatory measures and incentives are going to be applied as a result of the National Energy and Climate Plan (NECP) which is expected to promote further RES investments. According to the updated NECP that was announced in 2019, by 2030 a 61% - 64% share of RES in the total final electricity consumption is set as a goal. Of course, this percentage refers to the whole Greece and it is not expected that all regions will reach this goal. The special economic, social and geographical characteristics of each region in combination with the type of the measures and the incentives (local and national) will define largely the form of the new RES investments.

Nevertheless, in this analysis we adopt the goal of 64% of NECP for both islands and we assume that all necessary technical requirements to support this level of RES penetration in the grid, both at national and at regional level, will be met by 2030. Considering that, the RES electricity generation for each island is expected to be as following:

Table 20. Goal for RES generation in 2030.

	RES Generation in 2030 (ESEK Scenario)
Corfu	405.5 GWh
Zakinthos	179.1 GWh

5.2 Defining RES projects scenarios to achieve the target

Considering the previous, we assume the presented forecasts for 2030 regarding the demand and generation in the two islands. To achieve the set goal of RES participation in the demand, we have examined only the case of wind and solar generation projects due to their maturity both in terms of technological advancements and economics. This maturity is reflected on the overall costs and benefits of these technologies which have been proven the last years. Of course, other types of economic activities, technologies or business models that could assist in reaching the 2030 target are not rejected or discarded. On the contrary, new and alternative means to reduce the demand and decarbonize the generation are important and need to be studied, if structural changes in the energy system are desired. The scope and limits of this report, however, do not allow to extent the investigation further.

The wind and solar RES projects that need to be realized in the near future are examined considering the total required *installed power per technology*, the *initial investment costs* and the *area required* (only for PV technology) for the installations.

For the calculation of the total required installed power (to achieve the targeted annual energy) we have considered the potentials as presented at Chapter 1 and typical commercial wind and solar project features:

Table 21. Potential solar projects' features.

Solar Project	
Annual yield	1474[41] KWh/kWp
Module efficiency	17,5%
Pmax (PV module) @STC	340W
Module area	1,94m^2

Source: Authors' elaboration on data from commercial photovoltaic panel.

Table 22. Potential wind projects' features.

Wind Project	
Rated power of Wind Turbine	2 MW
Hub height	95m
Annual yield @ 6.5m/s	~7000 MWh
Wind Class	IEC IIIA

Source: Authors' elaboration on data from commercial wind turbine.

The estimation of the total initial investment costs required to materialize the projects is not a straightforward procedure. The installation costs of a technology highly depend on the country where the project is implemented, the size of it (e.g. utility scale, residential,

[41] Statistics on 2019 PV market, HELAPCO, April 2020. This value is an average of all operational PV plants, of all sizes, in Greece in 2019.

commercial etc.), the exact site (for example, if the PV is ground or rooftop) and, of course, the overall prices at the year of implementation (this issue will be discussed later on).

In Greece, there are currently not enough and updated statistics from official reports, neither for solar nor for wind projects, that could allow the estimation of these costs in the country. According to the IRENA (2020) report, the global capacity weighted-average total installed cost of projects commissioned in 2019 was 995 USD/kWp. Similarly, the weighted average for onshore wind projects commissioned in Europe in 2019 was 1800 USD/kW.

Table 23. Assumed installation costs of the RES projects.

Installation Costs (€/Wp)	
Solar Projects	0,825
Wind Projects	1,494

Source: Authors' elaboration

The total area required for the implementation of the solar projects is related to many factors including but not limited to the number and size of different installations, the installation location, the technical characteristics of the components and many more. In this report, we assume a typical PV module (see Table 21) and a Ground Coverage Ratio (GCR)[42] equal to 0.5. Note that the ground coverage ratio is the ratio of module surface area to the area of the ground or roof occupied by the array. A GCR of 0.5 means that when the modules are horizontal, half of the surface below the array is occupied by the array. Typical values range from 0.3 to 0.6.

Finally, as regards the share of the technologies we assume a scenario with only solar projects and a scenario with both solar and wind. In the latter scenario, the wind participation is a percentage of the overall required generation and it was estimated based on the capacity of the two islands to host wind projects and considering the environmental status that was presented in Chapter 1. Note, that this was a high-level estimation. More site-specific and detailed technical and environmental factors that can crucially define the size and viability of the wind projects were not considered due to the limits of this work.

[42] The ground coverage ratio (GCR) is the ratio of module surface area to the area of the ground or roof occupied by the array. A GCR of 0.5 means that when the modules are horizontal, half of the surface below the array is occupied by the array. An array with wider spacing between rows of modules has a lower GCR than one with narrower spacing. Typical values range from 0.3 to 0.6.

Table 24. Scenario 1 for renewable projects in the two islands.

Scenario 1				
	Corfu		Zakynthos	
Demand Forecast	633.600 MWh		279.900 MWh	
RES coverage 64% (2030)	405.504 MWh		179.136 MWh	
	PV: 100%	W: 0%	PV: 100%	W: 0%
Total Installed Power	275 MW		122 MW	
Total Installation Costs	226.875.000 €		100.650.000 €	
Total required area	3.14 km^2		1.39 km^2	

Source: Authors' elaboration

Table 25. Scenario 2 for renewable projects in the two islands

Scenario 2				
	Corfu		Zakynthos	
Demand Forecast	633600 MWh		279900 MWh	
RES coverage 64% (2030)	405504 MWh		179136 MWh	
	PV: 65%	W: 35%	PV: 57%	W: 43%
Total Installed Power	220 MW		91 MW	
Total Installation Costs	208.260.000 €		89.793.000 €	
Total required area *(Refers to solar projects only)*	2.05 km^2		0.79 km^2	

Source: Authors' elaboration

Economic gains for the local system

The above-mentioned upfront investment volume needed to reach the renewable energy target for the two islands surpasses the 300 mill euros mark and might feel demotivational. However, if the 64% locally sourced and owned RES target is met by 2030, tens of millions of euros will be recirculated yearly in the local economy rather than being extracted from the local system. Considering the islands as a system of its own where energy, material, people, information and money flow in and out of them, the political economy of investing in RES becomes evident. We perform a simple thought exercise based solely on the economic benefits for islands communities when investing in RES.

Today the Corfu and Zakynthos largely import their electric energy from the mainland. Using the consumption share per sector (see paragraph 2.4) and the billing prices from Public Power

Corporation energy supplier for each sector[43], we estimate the yearly electric energy costs per sector and in total (presented in table 27) for the two islands. As the islands have limited (around 5%, see paragraph 2.2) and privately owned RES installed capacity and local economic value extracted from the two islands systems every year; this amount largely represents a form of levy the local systems pay to external systems so to import the energy needed.

Local investments in RES will give the opportunity to those systems to not only source locally their energy needs but capture large share of this economic value and maintain it within their local economic system. The word local here is key. Systems thinking also helps to define which type of RES ownership would bring more benefits for the local systems as well. For example, in a business-as-usual scenario large part of RES projects are owned by large corporations at national and international level thus even if the local installed capacity increases the economic value moves out of the local economic system. In the case of local private invested capital, part of the economic value will remain within the island system but the profit will benefit a small number of local investors. Contrary, with energy communities in place a larger amount of this value will be captured and remain in the local economic system. It will be diffused to the local societies and the generated value will cover needs and reinvestment strategies as soon as or in parallel with the projects' repayment plans.

Table 26. Cost of electricity consumption in the two islands (2019 prices).

Cost per Sector (€)	Residential	Industrial	Commercial	Agricultural	Other	Public	Total
Corfu	23.651.635	1.144.657	34.235.376	84.802	1.062.441	2.564.541	62.743.453
Zakynthos	8.707.760	285.581	16.234.314	56.732	1.120.285	786.792	27.191.463

Source: Authors'elaboration

The role of energy storage

The continuously increasing share of variable renewable energy sources in the electricity grid, and specifically that of wind and solar, as a result of the European and national policies and technology advancements, has increased the need of system flexibility in order to cope with the unavoidable intermittency of these sources. To enhance the electricity system ability to integrate effectively and safely the increased number of intermittent renewables various solutions have been proposed including energy storage systems, demand response, dispatchable and flexible power generation and coupling of the industry, heating and mobility sectors with the power sector.

Energy storage systems, and specifically the stationary energy systems for grid-related applications, are promoted as a key candidate solution and have been at the spotlight the last few years. ESSs have an extended range of applications, and for that reason are particularly attractive. The applications currently include[44] ancillary services to the grid, peaking capacity (provisions to meet system maximum demand), energy shifting (provide dispatchabiity), transmission and distribution networks enhancement (to postpone network reinforcement)

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[43] For the billing prices see https://www.dei.gr. Note that in summer 2019 the billing prices were increased. In this estimation we considered the increased prices, which are still in place.

[44] "Energy Storage Grand Challenge: Energy Storage Market Report", U.S. Department of Energy, December 2020.

and increase of rate of self-consumption (for residential, commercial and industrial purposes). A common distinction of the energy storage applications is between front-of-the-meter applications, referring to storage facilities directly connected to transmission or distribution grids, and behind-the-meter applications, referring to storage systems in the residential, commercial and industrial infrastructures.

According to Bloomberg New Energy Finance[45], energy storage deployment for grid related applications is expected to increase 15 times in 2030 compared to 2019, with energy shifting and peaking capacity along with Commercial &Industrial hybrid systems (PV plus storage) being the prevailing applications. Similarly, IEA expects an increase of 20 times between 2019 and 2030 in utility scale battery capacity with US, China and India being the biggest markets[46]. Projections clearly show that storage will have an important role in the upcoming power sector changes, nevertheless, there is a "[…] natural uncertainty about what role BES will play in the least-cost energy transition, given that BES is in its infancy in terms of deployment"[47]. According to IEA's Energy Storage Tracking Report 2020, storage remains an early-stage technology, present in only a few key markets and heavily dependent on policy support[48].

In Greece, a study created by RAE and NTUA estimated that the amount of storage required to achieve the ESEK goals is approximately 1.5 to 1.75 GW, the 500MW of which shall be batteries and the rest pumped hydro energy storage. The report considers only central utility-scale facilities and concludes that currently the feasibility of such projects is not ensured by merely participating in the market and a support scheme is necessary to promote the technology. This, along with the lack of a specific and sufficient regulatory framework for storage, explains partially why, currently, no storage projects are yet implemented in Greece (apart from the already existing pumped hydro storage projects). However, a new regulatory framework is expected to be announced soon, probably as part of the effort to transpose EU directives in the Greek regulation, and an appropriate financial support is currently being considered. Based on the current status and the ongoing public discourse, it seems that in Greece, at least for the upcoming years, central utility-scale storage projects are more likely to emerge unless behind-the-meter applications are strongly supported both financially and legally (e.g by appropriate changes in the net metering framework).

Considering the stage of storage technology deployment in Greece and worldwide, the specific conditions in Greek energy sector with respect to storage projects, and the level of maturity of energy communities in the Ionian Islands of Corfu and Zakinthos, utility scale storage projects are not expected to be among the energy projects of preference of the energy communities in the two islands at least for the upcoming years.

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[45] "2019 Long-Term Energy Storage Outlook" Bloomberg New Energy Finance, New York, 2019

[46] "World Energy Outlook 2020", International Energy Agency, 2020.

[47] "Electricity Storage and Renewables: Costs and Markets to 2030", IRENA, 2017

[48] Energy Storage, Tracking Report, June 2020, Available at: https://www.iea.org/reports/energy-storage

Behind-the-meter storage applications, either at residential or commercial infrastructures, could be more easily considered at the first steps of an energy community, however, currently neither the economics of the technology justify such an investment nor the regulatory framework or any other specific regional reason (e.g enhancement of resiliency or security of supply for the community members due to weak or vulnerable to extreme events grid connections) promote such a solution. In fact, distributed storage among the members of an energy community can be utilized and exploited in various ways provided that regulatory framework, financial incentives and appropriate technology is in place. For example, the community can aggregate and provide as a service the flexibility gained by the storage in combination with the community generation and demand, or even more it can establish a local market in order to trade locally the excess energy. However, since neither of the three conditions is currently existing in the two islands it is difficult to foresee the future of behind-the-meter storage in the energy community projects.

5.3 Towards 100% RES autonomy by 2040?

With fluid socioeconomic trends and constant technological developments, forecasting so to identify trends has become a challenging and sometimes inadequate exercise. By making a data-driven informed projection over the local capacities and scalar dynamics, we developed the 2030 projections and expectations for the Ionian Islands. However, the goal of 64% in 2030 can be regarded as an intermediary step towards the complete decarbonization of the electricity sector by the year of 2040 under socially just terms. In this section, we explore how the decade after might look like, and what can be said now already now instead of a longue durée technical analysis.

Two examples of how modelling in the long term can cause more problems than it creates is the PV and wind RES costs and installation rates. Researchers and institutions expected those to be vastly different during modelling exercises in the beginning of the previous decade. However, the last decade PV systems installation costs decreased dramatically beyond any expectation and modelling efforts of the past (especially during the period 2007-2010 when they reached a peak price). Prices for those systems have fallen by between 44% - 90% due to cost reductions and technology improvements something that was beyond any prediction. Also, in 2013-2017 Europe and other areas of the world experienced a decrease on the rate of new RES installations due to the economic recession among other parameters, also distorting models and predictions of the era. As one cannot accurately predict political economic and technological parameters far in the future, a modelling and scenario exercise actually risks putting the bar lower that it could be. Instead of forecasting, we envision via a foresight exercise the dynamics of the next decade between the 2030 hard target goal of 64% of energy autonomy and towards a 100% vision by 2040.

Approaching 2030

By 2030 the RES revolution will be underway, more citizens, communities and local authorities will be participating, and taking the lead on initiatives related to energy production, distribution and storage. At the same time, the increase in climate awareness will bring forward lifestyle and behavioral changes affecting consumer choices mainstreaming more climate friendly and sustainable lifestyles. Similarly, technological evolution will further reduce the costs of RES while public and private investments will increase support RES projects. Energy Communities in Greece are expected to mature and strengthen substantially. This will allow them to organize much better and their gained momentum will result to enhanced economic and social activity.

Nevertheless, the world might still be far from realizing a 1.5 °C or even 2 °C scenario above pre-industrial levels and related global greenhouse gas emission pathways. The final push for the 100% RES autonomy might prove to be more challenging especially in island territories with fluctuated energy loads and demand. Technical capabilities to support smart grids may not have advanced while the RES systems installed in the past will start to retire during the 2030-2040 decade requiring reinvestments. Pressing socioeconomic realities inherited from the post-Covid global recessionary period will push political agenda towards growth centric monetary policies in a decoupled world. Moreover, rebound effects are expected as cheaper and cleaner energy might boost demand thus eliminating expected gains from new technologies. Thus, an ecological rationalization of lifestyles and economic activity needs to be taken further into account for sustainability assessments and energy strategies of the following decade.

Feasibility of 100% RES autonomy between 2030-2040

The last part of the path to a 100% RES autonomy will be the most difficult. The socioeconomic, political and technical realities will generate barriers and friction that can derail the RES development. However, the goal is reachable if connected with a series of developments in local, national and international level. Given the pressure on planetary [49]

boundaries by the socioeconomic system and demographics, and the increasing socioeconomic disparities, the growth-centric logic on which our socioeconomic system rely will be further questioned. Moreover, dramatic climate-related events might push the political agenda causing more radical planned or forced transition pathways to emerge. This socio-political reality will create forces that will remove the last barriers for achieving a 100% RES transition of our energy systems. The new reality will include among others: Business and consumption patterns pushed towards a circular economy paradigm; Rational use of energy via advanced mechanisms of incentives and counterincentives; Reinforced local value chains covering for the loss of income on interest groups affected by the new reality; Mainstreamed reforms in education and reskilling policies; A new taxation and redistribution system. Under this integrated vision of the global and local post-2030 world where ecological and societal aspirations citizens, economic entities and administration will be aligned, a goal for energy autonomy can be materialised.

5.4 Business as usual vs community energy future

Energy policy is changing the last few decades rapidly because of the devastating effects of climate change. In this context, energy community projects are gaining great attention, as an alternative of the business-as-usual models of energy production and distribution, because of

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their high social involvement character, their decentralized approach to low-carbon energy and the democratization of energy system that they promote. Energy communities though compete in a lucrative energy market where corporate interests are key players trying to gain access to land as well as production and distribution licenses.

The crucial differentiation of the energy communities' projects, compared to a business-as-usual model, is that energy communities include two different conceptualizations of localism; the physical geography and the geography of ownership. The most crucial is the latter, as it refers to the 'geography' of decision-making. Every decision about the establishment, the activation of energy plants, their maintenance, the local accumulation and consumption, is taken by local citizens and not a distant detached, from the local community, manager. Energy communities serve the interests of their members, and their community, in an inherent way; those initiatives include a commitment to place and interest both in processes and outcomes (Smith et al., 2016; Geels et al., 2017). Therefore, with this starting point, energy communities can bring several benefits compared to a business-as-usual models where private investments dominate the RES transition.

Business as usual

In Greece and subsequently the Ionian Islands private investments and corporate interests, dominate the electric energy production. So far, we have two main types of private investors, small-scale PV investments by individual producers, and medium to large scale PV and wind parks operated by corporations. In a business-as-usual scenario for the RES development the next decade, same typologies of investments are expected. This model of RES deployment has a major advantage and several disadvantages. The advantage is that with the technical and legal framework in place the deployment of RES will be accelerated, as market dynamics operate, thus decision making, capital formation and investment tends to be shorter in the case of private/corporate projects. However, this comes with a set of drawbacks for the local communities as the RE potential of their islands will be harvested and privatized with limited gains or even negative consequences for the locality.

Community energy

International experience provides already examples and lessons learned on why community RE projects present advantages for the local community. As we move away from the dominant paradigm of centralized energy production and distribution to decentralized and hybrid ones, energy communities are the best vehicle of local societies to harvest the benefits of this transition. The main ones are listed below:

Energy communities generate economic benefits for their members and increase the local economic value. Energy transition worldwide has positive effects on employment rates; for example, in Europe, in 2015, there were more than 1 million jobs in the renewable energy sector, and it is expected that, by 2035, jobs in renewable energy sector will be up to 3.3 million (Ram et al., 2020). In this context, it is also expected that energy community projects will raise local employment rates. Local employment may increase as demand for local know-how on the energy system is increased; while the installation of a renewable energy technology, such as wind turbines or solar panels, requires external specialists, the maintenance activities can be performed by locals, adding to employment. In 2018, Brummer, by investigating energy communities in UK, Germany and USA, argued that in every study area, energy community projects generated income for the communities near to the energy sites as well as employment opportunities. Apart from employment creation, energy communities benefit local economic systems by direct financial gains generated by energy sale, tax revenues and energy cost reduction. They prevent the extraction of financial resources from the local economic system as energy costs are covered by local producers while diffuse the profits to large segments of the society. Additionally, local resilience is strengthened; with localized production with greater control of energy by citizens, communities are much less vulnerable to price rises in the future.

Tackling energy poverty from the bottom-up. Citizens' active participation in energy communities that will generate and consume energy can play a pivotal role in fighting energy poverty. Energy communities can support vulnerable consumers that are living below the official poverty line in the region where the EC is based even if these citizens are not members of the community. Thus, undoubtedly those projects are a decisive step towards a more democratic and fair energy system; they can act as major supporters of energy democracy (see Box 8) as they create opportunities for destabilizing power relations, reversing social and environmental injustices and replacing monopolized fossil fuel energy systems with renewable structures (Burke and Stephens, 2017).

Community energy projects generate multilevel environmental benefits. Reducing CO_2 emissions by producing clean energy is the first and most apparent benefit, but it's not the only one. EC projects in order to be established and to operate, need from the participants a certain level of commitment and complicit; through this mechanism the participants, directly, and their local communities, indirectly, are getting involved and inevitably are drawing new ecological friendly social norms. Ecological friendly social norms will raise RES acceptance and sustainable consumer behavior.

Increasing social capital and cohesion. The social impact of energy communities can also spread in many other aspects of the local society creating an intrinsic value. Local citizens that join their forces in a unique project will create more and better opportunities for every community activity, by building a stronger sense of 'locality' and 'society'; thus, social capital and social cohesion will be strengthened (van der Horst, 2008; Tricarico, 2017). Social capital is particularly affected by the educational initiatives taken by energy communities, to decrease the barriers to renewable energy adoption. Educational actions such as seminars, workshops and lectures for the public, are, for most energy community projects one of their primary objectives. Along with the education of the public, the interactive, coordinative and synergetic dynamics that are required for an energy community to operate act as vehicles of cooperative education. **Strengthening cooperative thinking, energy democracy and environmental planning.** Community energy, either in the form of a cooperative or in any other local and publicly owned structure, assists towards the democratization of the energy sector both by reclaiming social and public control over the energy sector and by restructuring the latter to better support democratic processes, social justice and environmental sustainability (Bruke, 2017). The concept and emergent social movement of energy democracy supports the shift to a more local or regional based energy system, decentralized technologies and management structures. Furthermore, locally managed energy projects can respect the local socio-environmental particularities. Spatial planning with regards to RES installation will move closer to the hands of citizens that can decide where and what type of projects can be deployed.

Based on the above and besides the technological and governing challenges expected; a pluralistic web of de-centralised energy systems, collective energy consumption and production and bottom-linked energy systems management can arise that will make energy communities a protagonist of RES deployment safeguarding local interests and values. From the point of view of the local community it is clear why energy communities can be preferred as a RES deployment model against the business-as-usual one based on private ownership and investment.

Box 8. Energy Democracy

Energy democracy is a novel concept that emerged within the past decade among renewable energy advocates and social and environmental justice activists. Its main goal is the shift to 100% renewable energy sources in ways that resist the dominant fossil-fuel energy agenda; reclaim social and public control over the energy sector; and restructure the energy sector to better support democratic processes, social justice, inclusion, and environmental sustainability (Burke and Stephens, 2017).

Energy transition is recognized as an opportunity for deep structural political, economic and social changes. However, as noted at the conclusions of the international workshop in Amsterdam in 2016, a transition to zero emissions economy with the existing energy model and orientation will lead to the reproduction of the existing balance of power[1]. For that purpose, energy democracy movements are critical not only to the centralized commodity-based energy system based on fossil fuels and nuclear energy, but also to the *historical inequalities, neoliberal ideologies, alliances with large corporate profit interests, privatization, market-driven and growth-based approaches and concentrations of economic and political power* (Burke and Stephens, 2018) that are apparent in the energy scheme nowadays.

Central to the energy democracy concept is the local community ownership and the control of the energy resources using democratic processes and ensuring inclusiveness and participation. In this context, the citizen in not recognized merely as a passive energy consumer. Furthermore, energy is considered as a public good and, thus, it shall be accessible to everyone. Another fundamental pillar of this concept is that a just energy transition needs to ensure that the "green" jobs provide descent conditions and sufficient organization[2].

Two of the main institutions that have been recognized, under certain circumstances, as vehicles towards energy democracy are the energy cooperatives and the municipalities (Burke and Stephens, 2017). In the working paper "Power to the People, Towards Democratic Control of Electricity Generation"[3] the role of the energy cooperatives and of the municipalities in the promotion of massive, communal, and democratically controlled renewable energy is exhaustively examined.

[1] *"Towards Energy Democracy", Amsterdam Workshop Report, May 2016.*

[2] https://energy-democracy.net/

[3] *"Power to the People, Towards Democratic Control of Electricity Generation", Working paper No. 4, Trade Unions for Energy Democracy*

5.5 How to achieve the target with community paradigm?

Increasing the presentence of community energy on the energy pie is a demanding task that first and foremost require active citizen participation. Given the deep systematic change that needs to take place social innovation will be crucial for the achievement of the transformation of local communities to energy prosumers[50]. Social innovative initiatives in the energy sector can increase the acceptance and adoption of new technologies and practices; accelerate the transition; promote bottom-up innovation, creates a new local relational landscape and act as a catalyst for addressing issues of fairness. For those initiatives, though to commence in a setting with low social innovative engagement like the Ionian Islands where no energy communities operate citizens' participation and engagement becomes the key goal. In order for mobilisation to occur local communities, need to be approached with a set of narratives and tools that will help them to overcome cognitive biases deeply rooted in the individual and collective memory, and push them to move from the energy consumer to prosumer status.

Narratives, biases and support framework

In order to boost citizens' participation a strong energy communities' narrative is needed. Narratives are formal stories constructed and portrayed as real sowing a problem emergence and solution. They are powerful rhetorical tools presenting a vision of reality that can be then internalized by citizens and used to serve energy and climate change tackling purposes (Merchant, 2004; Moezzi et al., 2017). Thus, a narrative in the case of the Ionian Islands has to be crafted so to both increase the awareness and interests of local population to the RES transition and divert it towards energy communities.

There are often material reasons why people may not be able to take part on the energy transition lacking the resources to do so. However, for the ones that have the capacity to do so insights from behavioural sciences need to identify patterns and solutions towards their mobilisation. Behavioural economics, contrary to the classical model of consumers as rational actors claim that although we try to make rational decisions, we apply mental short cuts known as cognitive biases. These biases can be so strong that do may not allow decision making towards our own real interests. In our survey for example the citizens of the two islands had a non-pragmatic perception of the actual level of investment needed and the return on investment over covering their needs with RE via energy communities' schemes.

Behavioural economics described the tendency to stick with the status quo ('default' effect or status quo bias). People tend not move away from the option that is automatically assigned to them. In the context of energy production and consumption patterns, the default might be non-action and non-participation to the RES transition maintaining the traditional status of consumer.

People stick with the default paradigm because of the cognitive effort required in forming new preferences and the actual effort needed to engage in actions. In addition, people stick to the default due to loss aversion. Loss aversion suggests that people emphasise potential losses more than gains when during a decision-making process against the current status. Finally, people stick to the default because it is perceived as recommended to them by default setter. In the case or energy production and prosumerism the default setter or the one that can take this role as new default setter is important.

[50] Social Innovation in the energy transition regards practices and processes that entail social, economic, technological, governance and/or policy innovations capable to satisfy human and societal needs underpinned by energy. It contributes to a low carbon energy transition while in parallel empowering vulnerable social groups and cultivates civic traditions of trust, equity and solidarity within and beyond the spatial context on which they occur (Koukoufikis, 2021).

Innovation diffusion processes are fundamentally social and interpersonal. Early adopters play an important role in spreading information through social networks. These networks can be traditional e.g. word-of-mouth, or contemporary e.g. electronic word of mouth (online communication, social media etc). The networks include social norms, meaning the awareness of what is perceives as normal, common, acceptable and approved, and neighbourhood effects, meaning the real-life observation of activity around influencing our own thinking.

Based on these local and national stakeholders have a critical role to play in steering social innovations for the energy transition and diffusing those. A support framework needs to emerge preparing engagement strategies aiming to increase awareness for RES and climate change, promote a participatory approach in energy production; showcase the benefits, incentives and rewards; generate and highlight community trusted actors; and promote behaviourally informed interventions. Economic, technical, and legal instruments calibrated to fit community needs become part of a diverse landscape of social policy and action.

However, this exercise requires a permanent dialogue between local initiatives, administrative and government bodies and non-state actors at all levels, while entailing the change of social relations and governance dynamics. It requires advanced communication and collaboration capabilities in a multi-stakeholder setting, and includes power sharing and allocation that often is not among the priorities of power holding entities.

The role of stakeholders

There the role of external and internal stakeholders becomes critical in creating or sustaining the frameworks within which energy communities emerge and operate. Stakeholders have different levels of interest, motivations, level of accountability and influence. As in every private endeavor it is essential to effectively identify and manage the, oftentimes, conflicting agendas of project stakeholders early. In the case of a community energy project the targeting is far more specific than a typical business attempt; in this context, we could argue that conflicts may be lesser. Identifying all stakeholders relevant to the energy communities' projects in Corfu and Zakynthos is an important step, as well their separation to local and national stakeholders.

Local Stakeholders

Local governments and municipalities

Cities are going to play a crucial role in the transition and the preservation of the sustainability goals. In Europe, the European Commission has set the grounds for local authorities to create and submit their plans, focusing on "green" actions, with the Covenant of Mayors, a European initiative aiming to engage municipalities into taking action. As of 2020 more than 357 cities in EU have adopted a renewable energy target[51]. Many city governments first have increased the share of renewables in their own operations in order to help build local capacity, demonstrate the business case and raise awareness of the opportunities presented by renewables.

[51] Renewable in Cities 2021 Global Status Report

Up to now, national governments typically are seen as the main bodies responsible for governing energy supply and infrastructure and for driving the transition to a renewables-based energy system. Acknowledging that energy transitions can significantly alter how humans interact with land and water, these planning processes should focus on balancing uses of and impacts to landscapes or seascapes. Local governments are uniquely positioned to curb energy use and related greenhouse gas emissions while respecting the environmental and social boundaries of the local areas.

Although citizen participation is usually based on bottom-up approaches, municipal governments, because of their proximity to citizens, can play a strategic role in facilitating the involvement of citizens. In the process of setting up energy communities, local authorities may assume different roles ranging from enabling the creation of citizen ECs to leading the efforts of establishing such entities. Municipalities may set up the local regulatory framework to foster ECs, incentivize investments in renewables and energy efficiency projects, or even consult and provide administrative support to emerging citizen energy cooperatives. Acting as initiators, municipalities have the potential to engage local actors to plan and act on a wider scale, thus facilitating the achievement of the municipality's energy and climate goals. As a primary entity, municipalities can use their own resources to develop projects that will support and enhance the local energy system.

Box 9. The municipalities as facilitators and as initiators

The municipalities can have various roles at the development of energy communities at a region. In COMPILE[1] the Greek case study was examined and two main roles were identified.

One of them is as a *facilitator*. In this role, regional governance supports citizen initiatives by providing various types of motives, defining appropriate local framework, where applicable, or providing administrative support to the newborn communities. Also, municipalities can support with the networking, with the education -by organizing workshops-, they can look for financing support and they can provide municipal unused and unexploited properties, like rooftops, for local communities to implement a project.

Another role that was identified was that of the *initiator*. In that municipalities develop by themselves energy projects that support and enhance the local energy system. In these activities different municipalities can collaborate, while local businesses, unions and other organisations can also participate. The municipality directly, and the local citizens indirectly benefit from this activity. In addition, local governments through this model can support the vulnerable houses of the community. The techno-economics of such a model are presented at box 9.

[1] *Regulatory frameworks for energy communities in the pilot site countries Croatia, Spain, Greece, Portugal and Slovenia, Deliverable 2.3, COMPILE, October 2020.*

Citizens

Citizens participation has been characterizes as a key aspect for enabling a just transition to a decarbonised energy system that simultaneously considers the needs of impacted communities, addresses energy poverty and delivers on climate mitigation.

Citizen participation can take various forms based on the different ways in which inhabitants are involved in planning, funding, managing, governing and/or executing the development of renewable. Municipal governments have the opportunity to use participatory governance to include citizens in a range of decision making related to energy and climate protection – whether in planning, budgeting or policy development processes.

Engaging citizens at the local level increases public awareness and make participants conscious about their rights and responsibilities adding further to the sense of energy citizenship. Decision-making processes that involve active citizen participation can increase trust in the local community and government. Moreover, citizens can play a central role in providing sites and investment for small-scale distributed projects.

In Greece, citizens can legally become members of energy projects, individually or collectively, by participating on net-metering schemes or investing individually or collectively to RES project (or energy saving projects). Participating in EC, they are entitled to a single vote in the general assembly and can also be members of the community's steering committee. Even if no energy communities are operating in the islands, in our survey we documented the will of local society to do so if the framework to support them is in place.

Local Companies

Local companies are SMEs that in accordance with the individual consumers/prosumers can be members of an energy community. In this context, given the big service sector of the study areas, along with its high energy demand due to the touristic character of the local economies (see section 2.3, box 4), local businesses, especially the purely tourism ones, are stakeholders of high importance. If we focus only in the accommodation infrastructure, we see that Corfu has in total 411 hotels, while Zakynthos 313 (See Section 1.3). Despite the fact that hotel businesses will have great benefits if they participate in an energy community project, by reducing their energy costs, they also have the opportunity to provide to a project space for installations. Apart from the direct economic benefits, when businesses invest in a more sustainable future by investing in clean energy, they also 'invest' in the future of their own business. This happens in a dual way; they built an environmentally friendly profile which is far more attractive for tourists, and at the same time they take a serious step towards achieving the desired targets of the industry.[52]

[52] Hotel Energy Solutions (HES) is a UNWTO-initiated project in collaboration with a team of United Nations and EU leading agencies in Tourism and Energy. The project delivers information, technical support & training to help Small and Medium Enterprises (SMEs) in the tourism and accommodation sector across the EU 27 to increase their energy efficiency and renewable energy usage.

For more information visit: http://www.hes-unwto.org/hes_4/microsite/index.php?LangID=1 and https://www.unwto.org/hotel-energy-solution

Universities/ research institutes

Universities and research institutes can play a significant role in supporting energy communities in their early stages. They have the know-how and experience through research activities and collaborations on European and International level. They can also assist policy makers and take place in public discussions about framework development. Moreover, universities are usually prestigious institutions and can help give credibility and validation to products developed by private corporations for energy communities while engage in their own projects.

In the Ionian Islands is based the Ionian University with department units both in Corfu and Zakynthos. Additionally, in Zakynthos there is a satellite campus of the Technological Educational Institute of the Ionian Islands.

Vulnerable Households

Vulnerable households are defined in the Greek legislation as residential electricity end-users which have trouble dealing with their energy bills. The law N.4513/18 on energy communities provides support for vulnerable households. Each energy community can offer part of their production for such households tackling energy poverty. In order for an energy community project to have a success and to actually fulfill its purposes local citizens should have the central role in organizing, operating and managing a community.

Media

Media have a key role in the promotion of energy communities. Positive promotion can become a key factor for people accepting the new model and become familiar with it. Dissemination of events and best practices, policy making and incentives towards energy communities can create fertile ground for citizen engagement. On the contrary, negative media promotion can form opinions against citizen initiatives. The experience, about the media environment in the study areas, as it arose when distributing the survey, showed a lack of support. However, the special circumstances in the press created by the pandemic does not let us make an estimation about their expected role in the future.

Environmental organizations

Environmental organizations can play important role in the promotion of the institution of the energy communities within the country. Bringing examples from across Europe, they have shown how the new EU renewable energy laws can help remove barriers to community-own renewable energy. Lobbying is another common practice among these organizations to influence policy makers and political networks. Additionally, environmental organisations, through their network, can act as leverage in favour of environmental protection by maintaining and protecting NATURA areas by any kind of exploitation. In this direction the one - officially recorded - environmental organisation of Zakynthos, and the seven of Corfu, could play a central role (see section 1.6).

National Stakeholders

Policy makers

A clear and predictable regulatory framework are key components for the development of energy communities. According to new EU legislation, member states must guarantee the development of this framework. The experience has shown that policy tools promoting renewables such as feed-in-tariffs, tax incentives and grants are considered critical for the rise of prosumers and community ownership schemes. Renewable support schemes have been particularly effective for mobilizing citizens and communities in countries with a strong tradition of local citizen ownership (Curtin, McInerney, and Ó Gallachóir, 2017).

The ministry of Environment and Energy apart from policymaking is also responsible for public funding via the Greek Development Law. Many measures have been set in place in order to promote the formation of energy communities and increase the penetration of Renewable Energy Sources in these communities. Moreover, local and regional authorities can adopt concrete long-term objectives related to energy production, such as a specific target to quantify community owned renewable production capacity, in megawatts or as a percentage, within a certain timeframe.

Distribution System Operators (DSO) and Transmission System Operators (TSO)

The DSO/TSO are responsible for:

- distribution/transmission network planning and development;
- safe and secure operation and management of the distribution /transmission system;
- data management associated with the use of the distribution /transmission system;
- procurement of flexibility services.

In Greece, HENDO (the DSO) contributed in the development of the framework for energy communities. It is keeping up with developments about Citizen Energy Communities on European level and is actively supporting them by prioritizing the review of applications for energy projects network connection to the grid, providing information for grid users and collaborating with retailers for the effective implementation of virtual net metering. Also, HEDNO has announced to be ready to support the microgrids that will be developed by energy communities by providing security and assistance in micro-transactions of energy that will take place amongst prosumers. Nevertheless, there are still omissions in regard to regulatory framework that have not yet been covered by the DSO. For example, the technical specifications for the connection of battery storage systems to the grid and the modes of operation have not yet been defined.

Energy Suppliers

The framework for energy communities when applying Virtual Net Metering, requires the members to have contracts with the same supplier. This is because the energy "netting", meaning the attribution of, e.g., PV electricity share to the participants of the community, is performed by the energy supplier. In order to facilitate the adoption of this new framework the lawmaker decided to remove this task from the competence of DSO. This potentially violates the right of consumers to change energy suppliers. Nevertheless, suppliers have the potential to play a significant role in the development of energy communities since they can financially and technically support community renewable projects. On the other hand, energy communities can potentially compete with suppliers since they share the same market.

Financial institutions and funding organisations

For schemes owned by community co-operatives, a significant challenge is raising sufficient capital. These non-member sources of funds may include for example cooperative or commercial banks that are generally providing loans that are legally secured by collateral (pledged assets of the cooperative). This is one of the main barriers especially for new energy communities where no assets or properties are available to secure the loan. Without existing financial capacity in the local community, innovative approaches are needed (crowdfunding). The requirement for incentives such as grants and soft loans at the feasibility and development stages is a distinguishing feature of projects with citizen involvement, reflecting their greater risk aversion, lack of technical experience and financial capacity, and their inability to balance risk across a portfolio of projects.

Conclusively, energy communities' projects are underscored by a push to give individual citizens more power over the means of energy production and consumption. The factor of locality along with the involvement with energy production, make stakeholders able to reclaim energy sector with more public control and regulatory oversight, to restructure electric power networks to make them more distributed, diverse and inclusive, and to resist energy by fossil fuels. However, energy communities are at risk if they exclusively focus on the financial and policy constrains needed to survive in markets skewed towards massive for-profit utilities. Therefore, the continuous information and training of the stakeholders, and the local community, about evolvements in energy, environment and sustainability is mandatory for the viability of the investment and for contributing to the 'climate action' vision.

Box 9. An example of Collective Self-Consumption in Corfu

In this example, we assume the formation of an Energy Community founded by Corfu municipalities. The members are the local governments and their municipal enterprises. In such a community, members from the commercial/touristic sector could also be assumed. Primary goal of this community is to create RES projects that will eventually reduce the energy costs of its members and participate with various other means in the energy transition of the islands. This means that the described projects will be just part of their extended portfolio. Another, equally important, goal of this community will be to support the vulnerable houses of the region.

The energy community decides to create a number of solar projects that will operate under the virtual net metering scheme and will cover the annual needs of their buildings. The public sector share of energy demand in Corfu in 2019 is 4.12% (probably the municipal needs are less than that but due to lack of information we assume this percentage). Therefore, the aggregated installed power of the projects is approximately 14.8MW.

The cost of such a project would be approximately (depends on various factors) 12.1 million Euros and it would require an aggregated area of around 153.000 m^2. The first year of its operation the PV would generate approximately 22.8 GWh, part of which (we assume 95%) will be shared among its members and the rest (5%) will be donated to vulnerable houses. The donated energy could cover a large part of electricity needs of around 370 vulnerable households.

If we assume commercial pricing of DEI the first year of operation the municipalities would see a total reduction in their electricity bills (having considered operating and maintenance costs) around 2.3 million Euros. The vulnerable houses would see a reduction in their bills proportional to their pricing.

If the project is financed solely from the members (not the vulnerable houses) its payback time would be around 6 years but if a 30% subsidy could be achieved the payback time would be around 5 years.

If we assume the case of 30% subsidy and initiation of the project in 2022, by 2027 the project will have paid back and after that there will be only profits for the municipalities. Part of the profits could be reinvested in new projects, increasing the portfolio of the energy community, strengthening its operation and significantly assisting towards the decarbonisation of the islands' electric system. Another part of the profits could be used to reduce some taxes or to support other initiatives in the region.

We see here that a large amount of money instead of going out of the local economy, remain inside and strengthen it. Note that there is an extra benefit of the local economy here. Part of the operating and maintenance costs, that are estimated to be 266 thousands Euros per year, will be also distributed inside Corfu to technical, and not only, companies or matured energy communities.

Financing the community energy transition

RES deployment requires significant upfront investments. In today's prices for Corfu and Zakynthos to cover the 64% expected demand by locally installed RES and investment of approximate 300 million euros needed (see 5.2). For the emergence of a community energy movement that can accelerate the energy transition in the Ionian Islands a clear understanding over current and future financing possibilities needs to be in place. Generally, there will be four main sources of capital formation that can be used to finance an energy community project. Usually, a mix of those has to be used and its articulation will depend on the risk and capital intensity needed for each project.

Self-financing: The key source for community energy projects is the willingness of the community participants themselves to finance totally or part of the projects. Self-financing accelerates the procedures, empower the participants over decision-making and let them collect all the returns. Given our analysis a locally sourced capital of approximate 35 million euros can be gathered only via direct citizens' contributions to support community energy projects. This covers 11% of the total estimated investment needed to achieve the RES development goal for the two islands transition by 2030. In this calculation, institutional members of energy communities (e.g. municipalities, universities, professional associations) are not included though they could devote a significant amount of capital as well.

Institutional financing: RES investment loans and other green financial products are increasingly provided by private banking or public institutions or non-banking financial institutions (e.g pension funds and insurance companies). Green loans supporting RES investments is the most traditional way for energy communities on acquiring external funding so to start a project. Depending on the source of financing low interest rates can guarantee the survivability of a project. Recently energy communities became the focus of the European Investment Bank as a funding priority as the bank is willing to "support the development of energy communities and microgrids, enabling investment in new types of energy infrastructure, including in small isolated systems".[53] Cooperative financing can also be mobilized. Cooperative banks or cooperative capital accumulated via community energy projects is more often being (re)invested in community energy projects creating a credit chain among initiatives.

Subsidies: Public funding programmes subsidizing energy related investments are expected to proliferate the upcoming years. Especially in the EU where ambitions climate targets where set energy subsidies and the cohesion funds will divert funds are expected to divert funds in community energy projects. Ionian Islands being considered a transition region will have access to a significant number of financial opportunities the next years. This type of financing though creates certain dangers. It is depending heavily on external actors (often non-local) and a local stakeholders' ecosystem that can activate and/or facilitate the access to subsidy programmes. Often projects wait for years to access funding opportunities via subsides resulting in the fatigue of members, the cancellation of projects and the total dependence on the availability of funds.

[53] See: https://energy-cities.eu/5-takeaways-from-the-eibs-new-energy-lending-policy/

Crowdfunding: Socially sourced capital used to develop RES projects no longer has to be local or regional. With online crowdfunding platforms, green investors for all over the world can support the commencement of projects in the Ionian Islands. In Europe, several examples of projects using this financing method exist while in Greece already the first such platform operates (Genervest).[54]

Connecting the dots, a way forward

It is an undoubtedly a tricky exercise to connect all the social, economic, political environmental, legal, and technical parameters a community RES investment planning might need in the scale of a whole island region. In this report we tried to reduce uncertainties and wishful thinking to the minimum, utilize all the contemporary data available, connect existing literature with local realities and engage in thought experiments grounded to the needs and possibilities of the study area.

In order to create a clear picture of the situation in which citizens and other stakeholders in the Ionian Islands operate the following graph is presented. We sup up there the key Strengths, Weaknesses, Opportunities, and Challenges in regards to energy communities' development in the region (Figure 48). This is not exclusive as multiple parameters remain that can influence any plan's deployment.

Looking forward to operationalize the various aspects of a roadmap to community energy transition into concrete actions a dialectic between, citizens, stakeholder and current socio-spatial capabilities needs to take place. In the case of the Ionian Islands, we start with some fundamentals:

1) The given interest of the local community in energy communities and environmental issues and their willingness to invest. The lack though of any active energy community project that can be used as benchmark or role model.

2) The abundant availability of RES potential. Besides the rich cultural and environmental capital that needs to be protected both islands have the land and buildings needed to facilitate RES installations to match their needs.

3) The presence of distinct interest groups that upon proper introduction in the energy communities' ecosystem could be mobilized. The presence of several public institutions (eg. Hospitals, schools, universities, museums), the municipalities, and the professional associations (e.g. Champer of commerce, hotel owners' association) are an important asset. Those entities have the financial resources, economic interest and spatial resources (land/buildings) needed to engage rapidly into energy projects via the creation of energy communities.

The above mix of resources, local interest and stakeholders has to be brought together. Starting this dialogue in the Islands is the first step. Consequently, two parallel processes could start: a) the spontaneous emergence and development of energy communities by the various

[54] Genervest is a crowdfunding platform aiming to facilitate investments ethically and socially and earn market rate returns. The peer-to-peer investment platform operates since 2021 letting investors – big and small – profit while supporting renewable energy projects.

interest groups b) an organized campaign of promoting energy communities while providing ad-hoc support on legal and technical issues for initiatives.

The above processes will create and promote a new local relational landscape acting as a catalyst for further community engagement in energy projects. Demonstration of success along with guidance to easily organize and participate in a community are the two key features needed for the multiplication of initiatives. As we move forward, the first projects will be visible, and the word-of-mouth will allow dispersion of socially innovative practices further.

Figure 48. SWOT on the development of energy communities in the Ionian Islands
Source: Authors' elaboration

6 Discussion and recommendations

In this report we examined a wide set of socioeconomic and technical realities that will allow the gradual decarbonization of Corfu and Zakynthos electric energy systems. The 2030 goal is 64% renewable energy to account for the total energy demand of the two islands. Considering solar and wind technologies solely, to achieve the goal for both islands, total investments equal to 327,5 million euros for Scenario 1 and 298,1 million Euros for Scenario 2 are required and an aggregated installed power of 397MW and 311MW respectively.

We have argued that the community energy pathway for the energy transition will be proved significantly more beneficial for the local communities and we have identified the local stakeholders that could support this endeavor. Unemployment rates, age structure, poverty status, the great development of service sector due to tourism, and land use, create adequate conditions for setting up and operating various forms of energy communities diffusing the benefits widely to the society and environment. As presented in Chapter 3, local citizens, local businesses (or other private legal entities) and the municipalities can participate in energy communities.

Taking into account the survey we conducted, trying to capture the local citizens' views on renewable energy sources and energy communities, we draw several interesting results; citizens seem rather interested in RES issues with high acceptance of RES exploitation and with high environmental awareness. However, despite their low knowledge level about energy communities, after a short description, they expressed high desire to support and participate in such a project. Regarding the models of ownership and management we identified a strong preference in favour of small energy communities and collective investment, while their trust in business-as-usual models was really low. The results of the survey strengthen the position that in the Ionian Islands there is great potential for the energy transition to take place trough energy communities.

We estimated based on the results of the survey and the islands' socioeconomic data that the locally sourced socially invested capital, (capital directly invested from the islands households), of both islands can be between 32,49 million euros and 36,49 million euros representing a fraction of the total required investments ranging between 9.9% and 12.2% depending on the scenario. This indicates the potential investment volume coming from citizens alone, even if they are willing to lead the transition in their islands, locally cover their energy needs and control their energy sources, is practically not feasible. Thus, support and financing of energy communities initiatives should arrive from institutional players.

The technical analysis in Chapter 2, identified the three major contributors in the electrical consumption of Corfu and Zakynthos, the residential, the commercial and the public sector. The commercial sector, that includes the tourist businesses, in both cases is by far the largest consumer (for 2019 it was 55% in Corfu and 60,25% in Zakynthos). On the other hand, the public sector has significantly smaller share (for 2019 it was 4.1% in Corfu and 2.9% in Zakynthos). Since the commercial sector is a major contributor of the islands energy needs, we consider crucial their participation in community energy schemes. Professional associations and SMEs should mobilise their resources and actively get involved in energy communities' projects. These actors have the economic resources needed, higher organisational capabilities and larger benefits to harvest than households.

As regards the public sector, despite their small share in the total energy consumption their role is multiple. Municipalities and other public domain entities (e.g. universities, museums, hospitals) can set up energy communities to cover their energy needs and assist vulnerable consumers. They can also facilitate the development of energy communities in general as the general public seems more interested in participating in energy communities alongside local public entities. The local university and NGOs may play an important role in this process acting as mediator between citizens and institutions. They could analyse the local needs and particularities, educate and inform while provide technical solutions to the initiatives.

In the mid-term given the well-articulated return of investment the financial benefits of the projects will return to the local society. That will allow energy communities to mature and strengthen substantially. They will organize better and their gained momentum will result to enhanced economic and social activity around renewable energy. Technical and regulatory frameworks are expected as well to mature alongside the communities proliferation. Targeting a complete decarbonization of the electricity sector by 2040 requires structural changes of the electrical power system, the adoption of new technologies and business models and appropriate regulatory framework. By the end of this decade these changes are expected to take a more concrete form while energy communities are and can contribute in this reformation.

Recommendations

In line with our study and analysis there are several considerations emerging that we list below. These derive from our knowledge generated via this research and can be used as policy or project guidance by a large spectrum of actors within the two islands and the broader region, or as initiator of follow up steps.

- Local authorities, municipalities and regional administration, need to get strongly involved and support or initiate energy communities' initiatives. As shown, the benefits to the local societies are multiple and the role of local governments is crucial. They access to financial and administrative tools, they can inform, mobilize and coordinate local societies, and act as mediator of funding and knowledge attraction by national and supra national entities.
- Institutional partnership building at the local level needs to be initiated. Municipalities, public institutions (schools, museums, infrastructure operators) local associations, educational and research institutes (e.g. Ionian University), need to collaborate, investigate and initiate community energy projects lifting local barriers and using appropriate technologies and processes for the region. Collaboration also ought to be sought with external institutions for a coordinated research on the subject will provide faster results.
- Initiation of a public discourse over the energy transition creating a collective vision with energy communities in the center is needed. Promoting the idea of local control on energy production and needs using environmental and social conscious decision making is key.

- A communication campaign for RES and energy communities has to take into account behavioral aspects. It needs to include positive messages to encourage the engaged local stakeholders focusing on the mid-long term economic, social and cultural returns of investment rather than the upfront costs and the problematiques.
- The inclusion of the commercial sector and SMSs in energy community initiatives is key for the success of the transition. Information campaigns should also explicitly target that audience.
- A Paradigm shift has to take place aiming on increased responsibility and activation of local communities and local authorities on the general energy planning shifting from a state dominated centralised planning perspective.
- A turn to a regional energy planning is needed and can lead among others to a less intensive but more sustainable touristic activity with diffused benefits for the socioeconomic and environmental system.
- Local RES spatial planning that respects ecological boundaries and cultural heritage is necessary to avoid conflicts. Increased energy self-sufficiency seems to be possible without violating environmental and cultural boundaries and without leading to major land-use issues given the characteristics of the build and natural environment.
- Energy communities should be inclusive and promote the equality among all aspects of their activities. Caution should be taken to avoid the formation of energy communities that involve only middle and upper economic classes as this will not assist on the just transition and might accelerate social disparities.
- Several EU initiatives and funding opportunities are expecting the following years local actors along with energy communities need to take advantage of those.
- A nurturing programme targeting the first initiatives that will provide real life examples and help energy communities to proliferate has also to be established. This can be a citizens ' or institutional driven platform of cooperation and knowledge exchange.
- Beyond community mobilization, the electrical infrastructure needs to be reinforced to support the transition and allow the growth of energy communities and promote the electrification of other energy sectors.
- Our study focused on electric sector and discusses two specific technologies (solar and wind). A detailed and holistic approach that includes heating, cooling and transportation needs of the two islands, that explores a variety of business models and technologies is required as a next step can be considered as a follow up.

List of Abbreviations

AEPO	Approval of Environmental Terms
DSO	Distribution System Operators
EU	European Union
EEA	European Environmental Agency
GCR	Ground Coverage Ratio
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
GVA	Gross Value Added
HEDNO	Hellenic Electricity Distribution Network Operator
IRENA	International Renewable Energy Agency
IPTO	Independent Power Transmission Operator (ADMIE)
LPNB	Landscape of Particular Natural Beauty
LV	Low Voltage
MV	Medium Voltage
NECP	National Energy and Climate Plan
NGOs	Non-Governmental Organisations
RAE	Regulatory Authority for Energy
RE	Renewable Energy
RES	Renewable Energy Sources/Systems
SMEs	Small and Medium Size Enterprises
SDGs	Sustainable Development Goals
TSO	Transmission System Operators

References

Annoni, P. and Dijkstra, L. (2019), The EU Regional Competitiveness Index 2019, Regional and Urban Policy, Luxembourg: Publications Office of the European Union

Bakhat, M., & Rosselló, J. (2011). Estimation of tourism-induced electricity consumption: The case study of Balearics Islands, Spain. Energy Economics, 33(3), 437-444

Bianco, V. (2020). Analysis of electricity consumption in the tourism sector. A decomposition approach. Journal of Cleaner Production, 248, 119286

Blake, D. and Pickles, J. (2008) Apocalyptic Demography? Putting Longevity into Perspective. London: The Pensions Institute, Cass Business School

Burke, M. J., & Stephens, J. C. (2017). Energy democracy: Goals and policy instruments for sociotechnical transitions. *Energy research & social science*, Vol. *33*, pp. 35-48.

Burke, M. J., & Stephens, J. C. (2018). *" Political power and renewable energy futures: A critical review", Energy Research & Social Science, 2017 Energy research & social science*, Vol. *35*, pp. 78-93.

Clercq S., Proka A., Jensen J. and Carrero M. M., 'Islands transition handbook: how to develop your island's clean energy transition agenda', Clean Eenergy for EU islands, October 2019, Available online.

Choremi-Spetsieri, 2011, The Ionian Islands through history, Library of Archeological Company of Athens

Christina Panagiotidou, 2018. Institute of Place Management & Manchester Metropolitan University, Prioritization of issues affecting the tourist development and management of the place in Corfu, conference proceedings of the 5th Corfu Symposium on Managing and Marketing Places, Corfu, Greece

Curtin, J., C. McInerney, and B. Ó Gallachóir, 'Financial Incentives to Mobilise Local Citizens as Investors in Low-Carbon Technologies: A Systematic Literature Review', Renewable and Sustainable Energy Reviews, 2017.

Deutsch, M., Timpe, P. (2013). The effect of age on residential energy demand. ECEEE 2013 Summer Study Proceedings, p. 2177-2188

Dunlap, Riley E. (2008). Th e new environmental paradigm scale: From marginality to worldwide use. *Journal of Environmental Education , 40* (1), 3–18.

Economou C, Kaitelidou D, Karanikolos M, Maresso A. 2017, Greece: Health system review. Health Systems in Transition, World Health Organization 2017, on behalf of the European Observatory on Health Systems and Policies; 19(5):1–192

Estiri, H., and E. Zagheni, 'Age Matters: Ageing and Household Energy Demand in the United States', Energy Research and Social Science, 2019

Evelpidou, N. (2012). Modelling of erosional processes in the Ionian Islands (Greece). *Geomatics, Natural Hazards and Risk*, *3*(4), 293-310

Filotis- Database for the Natural Environment of Greece, Itia, Department of Water Resources and Environmental Engineering, School of Civil Engineering, National Technical University of Athens, view on 10 September 2020, https://filotis.itia.ntua.gr/biotopes

Geels, F.W., B.K. Sovacool, T. Schwanen, and S. Sorrell. (2017). 'The Socio-Technical Dynamics of Low-Carbon Transitions', Joule, Vol. 1, No. 3, pp. 463–479

Georgiev, D., & Ivanova, V. (2018). STUDY ON THE PSOCOPTERA FAUNA OF CORFU (KERKYRA) ISLAND, GREECE. Small, 9, 29-30

Hernández, L., Baladrón, C., Aguiar, J.M., Calavia, L., Carro, B., Sánchez-Esguevillas, A., Cook, D.J., Chinarro, D.; Gómez, J. A Study of the Relationship between Weather Variables and Electric Power Demand inside a Smart Grid/Smart World Framework. Sensors 2012, 12, 11571-11591. https://doi.org/10.3390/s120911571

IEA (2019), World Energy Outlook 2019, IEA, Paris https://www.iea.org/reports/world-energy-outlook-2019

Ionian Islands Region, Special Business Program Management Service for the Ionian Islands Region, April 2019, concessionaire Ioannis Kougianos & collaborators, Regional Plan for Climate Change Adaptation (RePCC)

Ionian Islands Region, Special Business Program Management Service for the Ionian Islands Region, April 2019, concessionaire Ioannis Kougianos & collaborators, Regional Plan for Climate Change Adaptation (RePCC)

Ionian Islands Region, September 2019, Development Strategy 2021-2027

Ionian Islands Region, December 2016, Ionian Islands Regional Waste Management Planning (PESDA) Review Study

Ionian Islands Region, September 2019, Development Strategy 2021-2027

IRENA (2020), Renewable Power Generation Costs in 2019

Jervis, H. J. W. (1852). *History of the Island of Corfú and of the Republic of the Ionian Islands*. Colburn and Company.

Kanakoudis, V., Tsitsifli, S., Papadopoulou, A., Curk, B. C., & Karleusa, B. (2017). Water resources vulnerability assessment in the Adriatic Sea region: the case of Corfu Island. Environmental Science and Pollution Research, 24(25), 20173-20186. JRC122289

Koukoufikis, G, 2021. Social Innovation and the Energy Transition - Towards a Working Definition, European Commission, JRC122277. https://doi.org/10.13140/RG.2.2.19905.58720

López-Santiago, M. A., Meza-Herrera, C. A., & Valdivia-Alcalá, R. (2017). Analysis of methods to estimate the mean and variance of the willingness to pay: parametric and non-parametric case. *Revista Chapingo. Serie Ciencias Forestales y del Ambiente*, *23*(2), 231-242

Lorilla, Roxanne, et al. (2018) "Assessment of the Spatial Dynamics and Interactions among Multiple Ecosystem Services to Promote Effective Policy Making across Mediterranean Island Landscapes." *Sustainability*, vol. 10, no. 9, p. 3285., doi:10.3390/su10093285

Marsden, P.V. and Wright, J.D. (eds.). (2010). Handbook of Survey Research (2nd edition). Bingley: Emerald Group Publishing

Martinis, A., Mazi, S., & Minotou, C. (2015, July). Sustainable development and environmental education in natura 2000 areas. A vision of the mountain of pantokratoras for Corfu and the local community. In 2015 6th International Conference on Information, Intelligence, Systems and Applications (IISA) (pp. 1-6). IEEE

Megalovasilis, P. (2014). A new hydrological balance and water management issues in Zakynthos Island, Greece. International Journal of Hydrology Science and Technology, 4(2), 139-154

Merchant 2004. *Reinventing Eden: The Fate of Nature in Western Culture.* Routledge

Mikkonen, I., Gynther, L., Matschoss, K., Koukoufikis, G., Murauskaite-Bull, I. and Uihlein, A., Social innovations for the energy transition, EUR 30446 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-25283-2 (online), doi:10.2760/555111 (online)

Miller, W. (1903). The Ionian Islands under Venetian Rule. *The English Historical Review*, *18*(70), 209-239

Ministry of development, competitiveness, infrastructure, transport & networks, General Secretariat of Transport, Transport Management Authority, Strategic Transport Investment Framework, May 2014

Moezzi, M., K. B. Janda, & S. Rotmann, 2017. "Using stories, narratives and storytelling in energy & climate change research " *Energy Research & Social Science* 31:1-10

Monemvasioti, K. & Tsoukala, V.K. 2013, A sustainable Management of Zakynthos Marine National Park using Environmental Indicators Analysis, Proceedings of the 13th International Conference on Environmental Science and Technology Athens, Greece, 5-7 September

National Center for Social Research, viewed in 10 September 2020, https://www.ekke.gr/projects/estia/gr_pages/gr_index.htm

National Register of Agricultural Cooperatives and other collective bodies, List of informed Agricultural Cooperatives for the year 2019, http://www.minagric.gr/index.php/el/for-farmer-2/sillogikes-agrotikes-organoseis

OECD (2018),Education for a Bright Future in Greece, Reviews of National Policies for Education, OECDPublishing, Parishttp://dx.doi.org/10.1787/9789264298750-e

Pablo-Romero, M. D. P., Sánchez-Braza, A., & Sánchez-Rivas, J. (2019). Tourism and electricity consumption in 9 European countries: a decomposition analysis approach. Current Issues in Tourism, 1-16

Pais-Magalhães, V., V. Moutinho, and M. Robaina, 'Households' Electricity Consumption Efficiency of an Ageing Population: A DEA Analysis for the EU-28', Electricity Journal, 2020

Potts, J. (2010). *The Ionian Islands and Epirus: A Cultural History*. Oxford University Press on Demand.

Psiloglou B.E., Giannakopoulos C., Majithia S., Petrakis M., Factors affecting electricity demand in Athens, Greece and London, UK: A comparative assessment, Energy, Volume 34, Issue 11, 2009, Pages 1855-1863, https://doi.org/10.1016/j.energy.2009.07.033

Ram, M., Aghahosseini, A., & Breyer, C. (2020). Job creation during the global energy transition towards 100% renewable power system by 2050. *Technological Forecasting and Social Change*, *151*, 119682

Regional Business Program (RBP) of the Ionian Islands Region: Strategic Environmental Impact Assessment (SEIA) 2014-2020

Ruggiero, S., A. Isakovic, H. Busch, K. Auvinen, and F. Faller, 'Developing a Joint Perspective on Community Energy: Best Practices and Challenges in the Baltic Sea Region', No. 2, 2019, p. 33

Selman, P., & Swanwick, C. (2010). On the meaning of natural beauty in landscape legislation. Landscape Research, 35(1), 3-26

Smith, A., T. Hargreaves, S. Hielscher, M. Martiskainen, and G. Seyfang, (2016). 'Making the Most of Community Energies: Three Perspectives on Grassroots Innovation', Environment and Planning A, Vol. 48, No. 2, pp. 407–432

Special Secretariat for Water, Ministry of Environment and Energy, 2017, Management Plan Revision: North Peloponnese Water Basin (EL05)

Staffell I., Pfenninger S., The increasing impact of weather on electricity supply and demand, Energy, Volume 145, 2018, Pages 65-78, https://doi.org/10.1016/j.energy.2017.12.051

Tricarico, L. (2017). Community action: Value or instrument? An ethics and planning critical review, Journal of Architecture and Urbanism, Vol. 41, pp. 214–226

United Nations Educational, Scientific and Cultural Organisation (UNESCO), 2013, Old Town of Corfu, viewed 30 July 2020, https://whc.unesco.org/en/list/978

United Nations, 1997, Glossary of Environment Statistics, Studies in Methods, Series F, No. 67, New York

Van der Horst, D. (2008). Social Enterprise and Renewable Energy: Emerging Initiatives and Communities of Practice, Social Enterpise Journal, Vol. 4, pp. 171–185

7 Appendix

Additional Socioeconomic and technical information

Table 27. Population in the area of research by gender

	Population by gender					
	census 1991		census 2001		census 2011	
	men	women	men	women	men	women
Ionian Islands	95,493	98,241	104,219	105,389	102,400	105,455
Corfu	52,119	55,473	54,264	56,817	50,753	53,618
Zakynthos	16,505	16,052	19,878	19,005	20,274	20,485

Source: Hellenic Statistical Authority- Census 1991, 2001, 2011

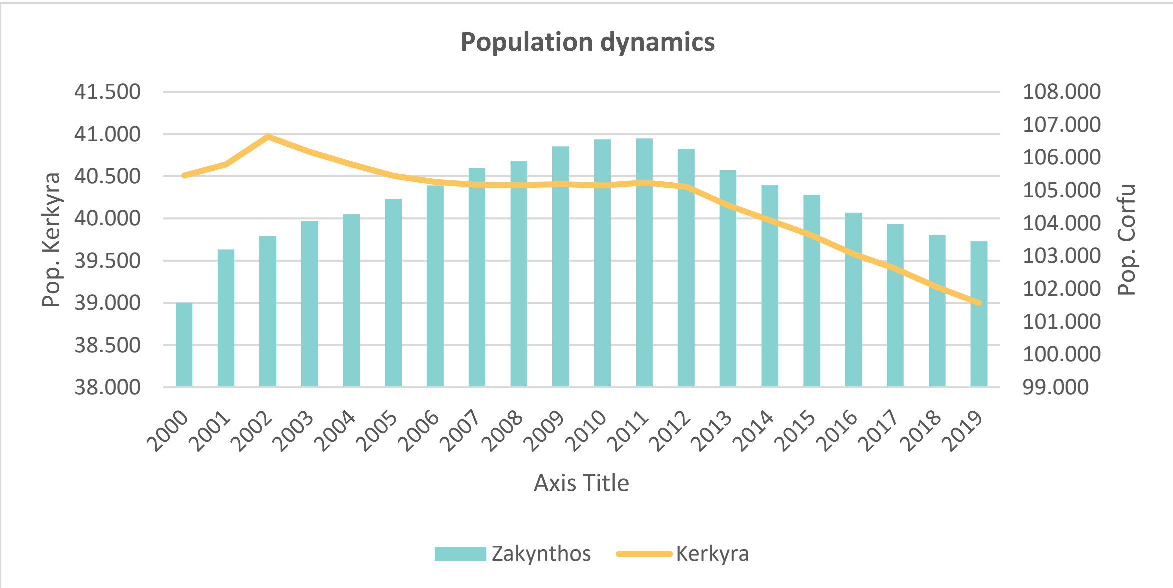


Figure 49.Population dynamics in the two islands (estimations)
Source: Eurostat (demo_r_gind3)

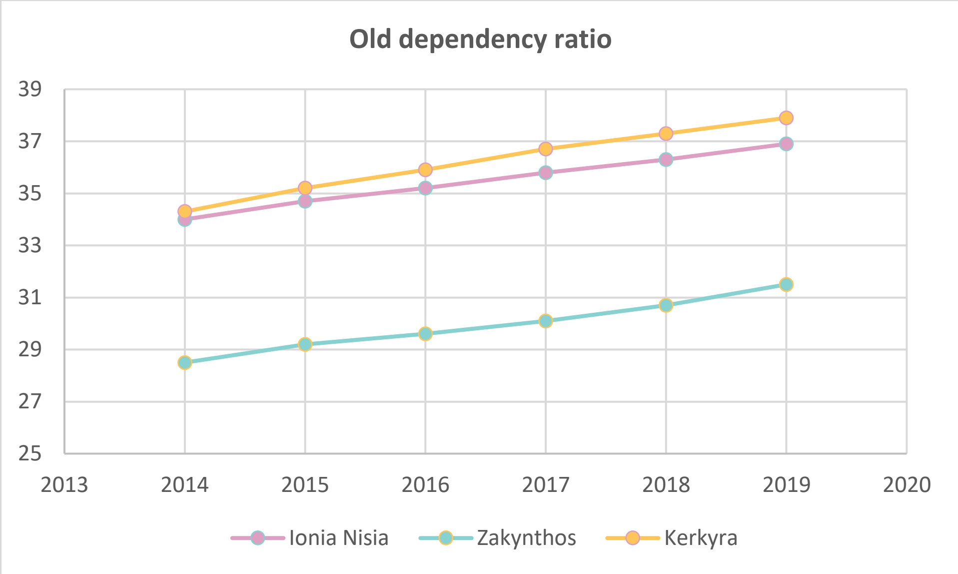


Figure 50. Old dependency ratio
Source: Eurostat (demo_r_pjanind3)

Table 28. Snapshot of employment structure in the two islands based on census data

2011		**Economically active**		**Economically inactive**	
	Total	Employed	unemployed	pensioners	other
Corfu	**104,371**	**36,477**	**8,285**	**26,361**	**33,248**
0-14	14,043	0	0	0	14,043
15-34	23,499	10,710	4,020	0	8,769
35-54	30,460	20,479	3,467	1,112	5,402
55+	36,369	5,288	798	25,249	5,034
Zakynthos	**40,759**	**15,206**	**3,065**	**8,220**	**14,268**
0-14	6,560	0	0	0	6,560
15-34	9,803	4,660	1,636	0	3,507
35-54	12,332	8,408	1,158	356	2,410
55+	12,064	2,138	271	7,864	1,791

Source: Hellenic Statistical Authority- Demographics

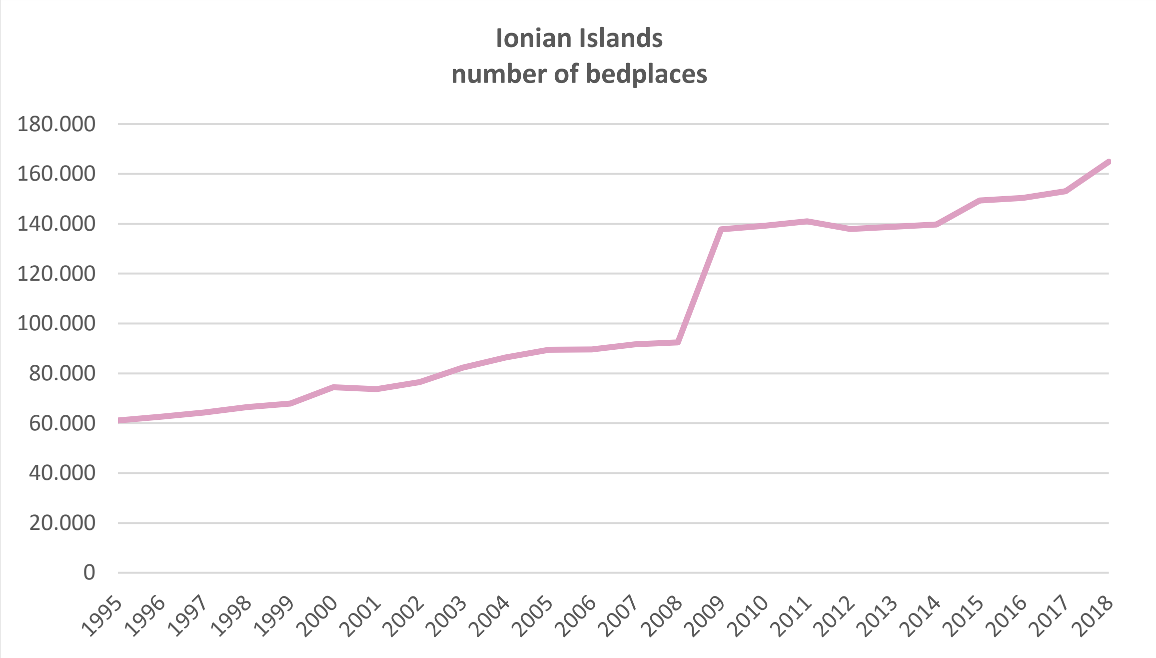


Figure 51. Total number of bed-places in Ionian Islands
Source: Eurostat (tour_cap_nuts2)

Table 29. Number of Students in Primary education

Type of school	Corfu			Zakynthos		
	Male	Female	**Sum**	Male	Female	**Sum**
Kindergarten	698	599	1297	328	307	635
Primary School	3109	2963	6072	1389	1373	2762
Primary School of	19	14	33	22	7	29
Special Education Schools	3826	3576	**7402**	1739	1687	**3426**

Source: Regional Management of Primary and Secondary Education of the Ionian Islands

Table 30. School units in the two islands

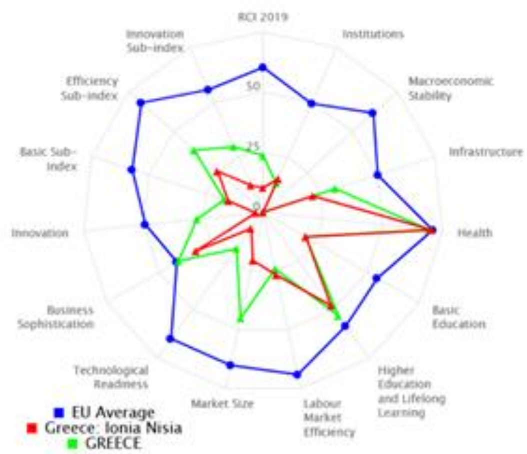
	Number of school units	Number of school sections	Number of teaching rooms
Kindergarten			
Zakynthos	33	49	48
Corfu	60	100	104
Primary schools			
Zakynthos	21		

Corfu	50		
1st stage High school			
Zakynthos	10	87	114
Corfu	22	182	279
2nd stage High school			
Zakynthos	6		54
Corfu	14		119
Total	**216**		

Source: Hellenic Statistical Authority 2017

Regional competitiveness

In the following spider-graphs we can see at a comparison of the Region of Ionian Islands with the European average and with Greece the underperformance competitive-wise.



Source: Annoni & Dijkstra, 2019

Protected areas in Corfu

Table 31. Areas recognized as NATURA 2000 in Corfu

	Natura 2000 code	Designation type	Longitude	Latitude	Size (km²)
1	GR2230001	LAGOON ANTINIOTI (KERKYRA)	19.85056	39.815278	1.8658
2	GR2230002	LAGOON KORISSION (KERKYRA)	19.91806	39.443611	23.1688
3	GR2230003	SALT MARSH LEFKIMMIS (KERKYRA)	20.06861	39.451944	2.1273
4	GR2230005	COASTAL MARITIME ZOME FROM KANONI TO MESONGI (KERKYRA)	19.92056	39.542222	8.6729
5	GR2230007	LAGOON KORISSION (KERKYRA) KAI ISLAND LAGOUDIA	19.90806	39.444444	10.8469
6	GR2230009	LAGOON ANTINIOTI & RIVER FONISSAS (KERKYRA)	19.72663	39.762302	0.8073
7	GR2230010	MARINE AREA DIAPONTION NISON	19.516682	39.794557	153,2727
8	GR2230008	DIAPONTIA NISIA (OTHONOI, EREIKOUSA, MATHRAKI KAI VRACHONISIDES)	20.61667	38.180833	1532727
9	GR2230004	ISLANDS PAXOI & ANTIPAXOI AND SURROUNDING MARINE AREA	20.23613	40.016962	1532727

Source: European Environmental Agency

Lagoon Antinioti: is protected by Birds and Habitat Directive, and it protects 44 species: 35 species of birds, 1 species of invertebrate, 3 mammal species and 5 reptile species. The habitat types being protected are: coastal lagoons, annual vegetation of drift lines, vegetated sea cliffs of the Mediterranean coasts with endemic Limonium spp, Mediterranean salt meadows (Juncetalia maritimi), Mediterranean and thermo-Atlantic halophilous scrubs, embryonic shifting dunes, Southern riparian galleries and thickets, Olea and Ceratonia forests.

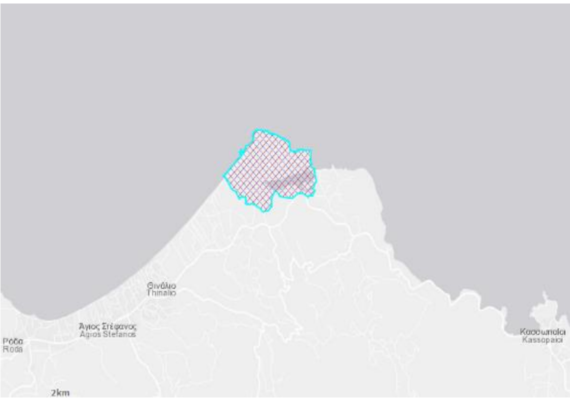


Figure 52. Lagoon Antinioti
Source: European Environmental Agency – EUNIS

Lagoon Korission: is protected by Habitat Directive and it protects 10 species: 2 species of fish, 1 species of invertebrate, 3 species of mammals and 4 species of reptiles. The habitat types protected are the same as in Lagoon Antinioti.

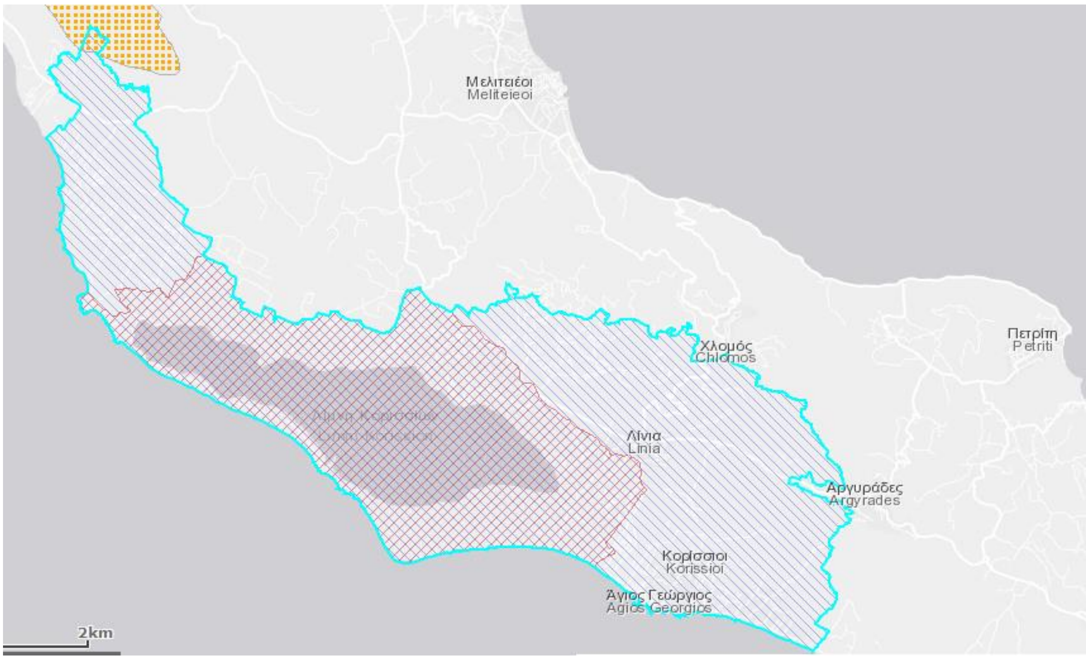


Figure 53.Lagoon Korission
Source: European Environmental Agency - EUNIS

Salt Marsh Lefkimis: is protected by Birds and Habitat Directive, and it protects 39 species: 36 species of birds and 1 species of each: fish, mammal and reptiles. What differentiates the area from the protected areas already mentioned are the protected habitat types that in this area include: Salicornia and other annuals colonizing mud and sand.

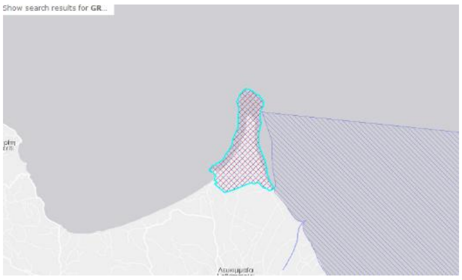


Figure 54. Salt Marsh Lefkimis
Source: European Environmental Agency - EUNIS

Coastal Maritime Zone from Kanoni to Mesongi: is protected by Habitat Directive, and it protects 4 species: 1 species of fish and of reptiles, and 2 species of mammals. The protected habitat types are the well-known Posidonia beds, coastal lagoons and reefs.

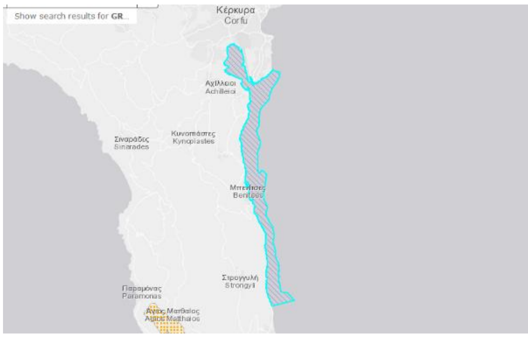


Figure 55.Coastal Maritime Zone from Kanoni to Mesongi
Source: European Environmental Agency - EUNIS

Lagoon of Korission and Island Lagoudia: is protected by Birds Directive, and accommodates about 66 different species of birds.

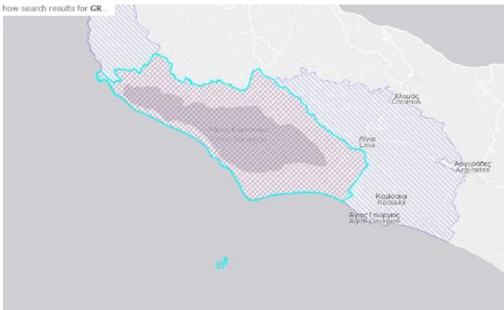


Figure 56.Lagoon of Korission and Island Lagoudia
Source: European Environmental Agency - EUNIS

Lagoon Antinioti & River Fonissas: is protected by Habitat Directive, and it protects 2 species of fish.

Figure 57. Lagoon Antinioti & River Fonissas
Source: European Environmental Agency - EUNIS

Marine area Diapontion Nison: is protected by Habitat Directive. This area is protected because of its posidonia beds, reefs, sandbanks which are slightly covered by sea water all the time and because of the submerged or partially submerged sea caves. Also *Diapondia Nisia (Othonoi, Ereikousa, Mathraki & Vrachonisides)*: it is protected by Birds Directive: 41 species of birds are protected.

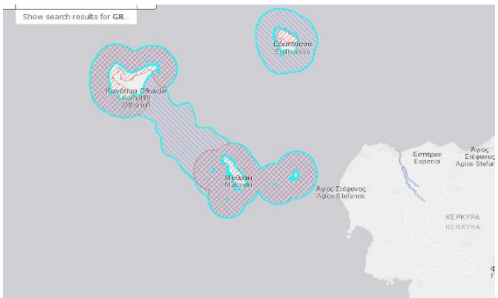
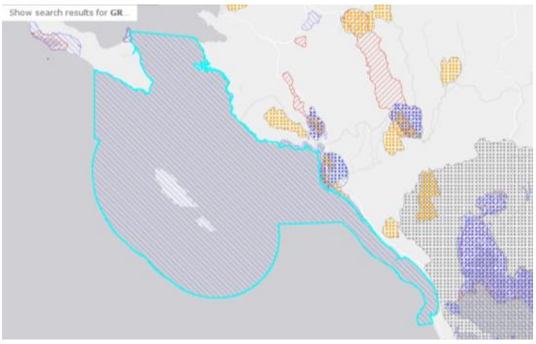


Figure 58. Marine area Diapontion Nison
Source: European Environmental Agency - EUNIS

Islands Paxoi & Antipaxoi and surrounding marine area: Habitat types are protected, some same as in the fore mentioned areas and some unique: Sandbanks which are slightly covered by sea water all the time, posidonia beds ,reefs, vegetated sea cliffs of the Mediterranean coasts, embryonic shifting dunes, arborescent matorral, thermo-Mediterranean and pre-desert scrub, sarcopoterium spinosum phryganas, submerged or partially submerged sea caves, cupressus forests, Olea and Ceratonia forests, Mediterranean pine forests with endemic Mesogean pines.

Figure 59. Islands Paxoi & Antipaxoi



Source: European Environmental Agency - EUNIS

Wildlife refuges are defined as natural areas (terrestrial, aquatic or marine), which are of particular importance for the growth of wild flora or as habitats for the reproduction, feeding, overwintering of wildlife species, or as breeding and ending areas for fish, as important marine habitats. (United Nations, 1997) In Corfu there are 2 areas characterized as Wildlife Refuges: the area "Psilos Pantokrator (Spartilas - Petalias - Nisakiou)" with code K217 and the area "Pantocrator Vigla (St. Matthew)" with code K238. (Special Business Program Management Service for the Ionian Islands Region, April 2019)

Protected areas in Zakinthos

Table 32. Areas recognized as NATURA 2000 in Zakynthos

	Natura 2000 code	Designation type	Longitude	Latitude	Size (km^2)
1	GR2210001	West and north coast of Zakynthos	20.72972	37.7075	214.6492
2	GR2210002	GULF OF LAGANA ZAKYNTHOU (AKR. GERAKI - KERI) KAI ISLETS MARATHONISI KAI PELOUZO	20.90694	37.709167	69.7766
3	GR2210003	ISLANDS STROFADES	21.00944	37.255	5.4826
4	GR2210004	ISLETS STAMFANI KAI ARPYIA (STROFADES) & MARINE ZONE	21.00706	37.606978	116.2283

Source: European Environmental Agency

West and north coast of Zakynthos: is protected by Birds Directive and Habitats directive, since 2006. Along the coast, there are 16 species of birds protected, 1 species of mammals and 4 species of reptiles. Various habitat types also also protected, such as reefs, vegetated sea cliffs of the Mediterranean coasts, arborescent matorral, sarcopoterium spinosum phryganas, endemic phryganas of the Euphorbio-Verbascion, calcareous rocky slopes with chasmophytic vegetation, submerged or partially submerged sea caves, Olea and Ceratonia forests, Mediterranean pine forests with endemic Mesogean pines.

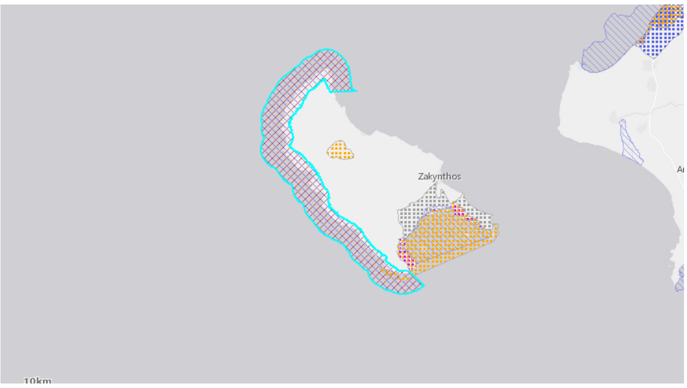


Figure 60. West and North coast of Zakynthos
Source: European Environmental Agency - EUNIS

Gulf of Lagana Zakynthou (akr. Geraki-Keri) & islets Marathonisi and Pelouzo: is protected by Birds directive since 2006. There are 1 species of mammal and 5 species of reptiles under protection in this area.

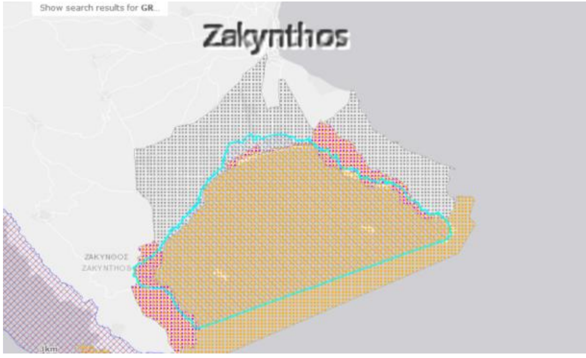


Figure 61. Gulf of Lagana Zakynthou
Source: European Environmental Agency - EUNIS

Islands Strofades: protected under Habitats Derictive. Various habitat types are protected such as vegetated sea cliffs of the Mediterranean coasts, mediterranean temporary ponds, arborescent matorral, sarcopoterium spinosum phryganas, olea and ceratonia forests.

Figure 62. Islands Strofades
Source: European Environmental Agency - EUNIS

Islets Stamfani and Arpya & Marine zone: it is protected by Birds Directive. In this area there are 75 species of birds protected.

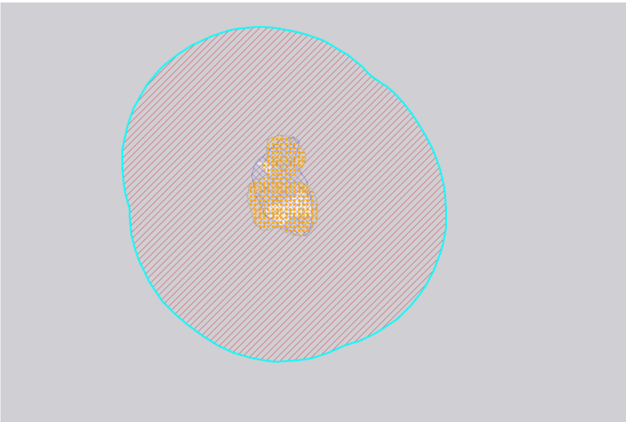


Figure 63. Islets Stamfani and Arpya & Marine zone
Source: European Environmental Agency - EUNIS

In Zakynthos, 1 area is characterized as wildlife refuge: the Vrachionas area with code K425. There is also the National Marine Park of Zakynthos, with code ΕΠ2, which was founded with the aim to protect and conserve the ecological balance of the sea and the coastal area of the bay of Laganas, as well as all the islands of Zakynthos. Within the boundaries of the National Marine Park of Zakynthos, we find one of the most important breeding habitats of the sea turtle Caretta caretta in the Mediterranean as well as habitats of the Mediterranean seal Monachus monachus. It should be noted that the island is the most important spawning habitat of sea turtles in the Mediterranean. Greece is the only European country where Caretta caretta sea turtles lay eggs. Last but not least, migratory bird fauna, endemic flora and also, habitats of European and Mediterranean interest are located and protected in the park. (Special Business Program Management Service for the Ionian Islands Region, April 2019; Monemvasioti & Tsoukala, 2013)

Land use

Additionally, in the figures below, we can see the evolution of the aggregate agricultural area, while in table, we see the evolution of the agricultural area located in the mountain area. No severe changes or fluctuations can be observed based on the available data.

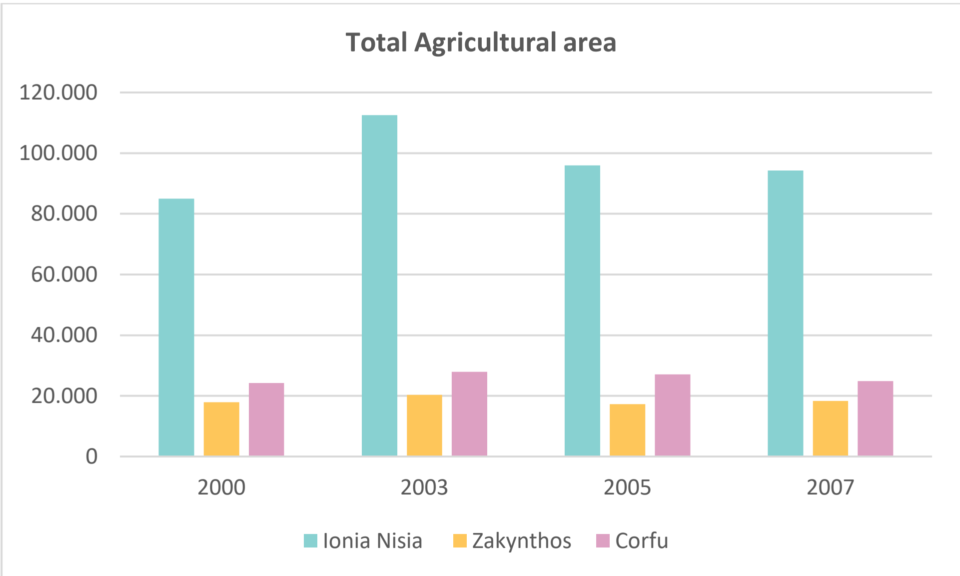


Figure 64. Total agricultural area
Source: Eurostat (ef_r_nuts)

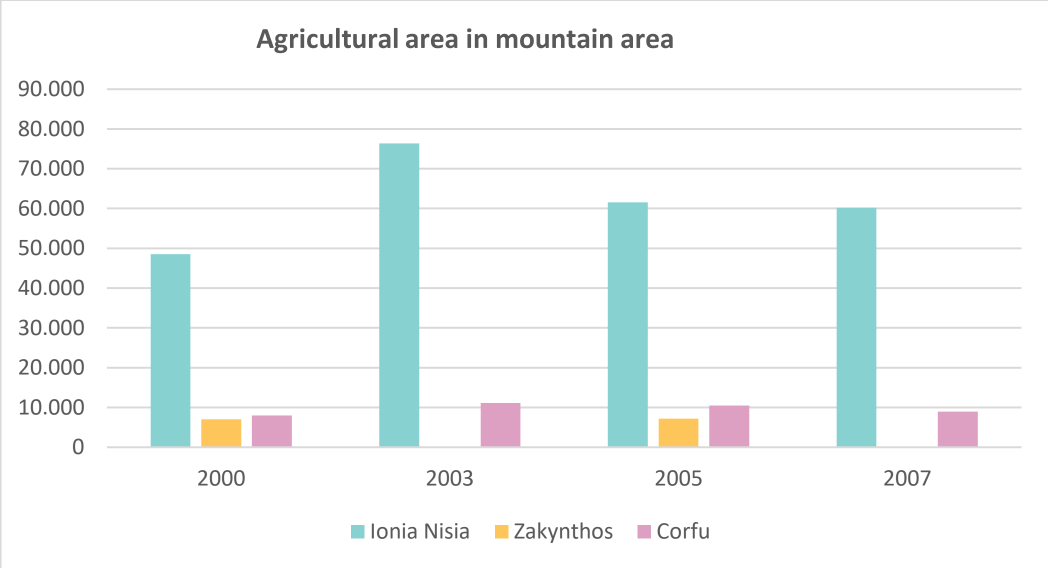


Figure 65. Agricultural area in mountain terain
Source: Eurostat (ef_r_nuts)

Environmental status- Water resources management

Corfu

The islands of Corfu, Othonoi, Ereikousa, Paxos and Antipaxos belong to the Water Department of Epirus (ΥΔ05). The Corfu-Paxos river basin (code: GR34 & 631km^2) does not include any river with a significant flow; nevertheless, the surface water systems are eight in total, the more important of which being the three main rivers of Corfu: Fonisa, with a length of 7km, Mesangis with a length of 7.5km and Potami with a length of 2.1km. Those three river water systems are also natural[55].

The geological formations of the Ionian Zone are located in the river basin of Corfu-Paxoi, where we can identify 5 underground water systems. The main aquifers of groundwater systems are developed in the carbonate formations of the Ionian zone which, due to the presence of evaporites, contain high concentrations of sulfates (Kanakoudis, 2017)[56].

In Corfu island, water uses are distinguished in water supply and tourism, related to drinking water, irrigation, animal husbandry and industry. The water demand for irrigation is higher than the one of drinking water. The demands of industry and livestock are much lower (Kanakoudis, 2017).

In the river basin of Corfu -Paxos, there are no problems of overexploitation of groundwater systems. Extraction from groundwater systems covers generally a small percentage of their average annual natural supply. Locally, in the two main water systems of Corfu, there are local over-pumping that result in local salinities mainly in the coastal zones. An additional issue

[55] Special Secretariat for Water, Ministry of Environment and Energy, 2017, Management Plan Review: Epirus Water Basin (EL05)

[56] Ionian Islands Region, Special Operational Program Management Service for the Ionian Islands Region, April 2019, Regional Plan for Climate Change Adaptation

related to the coverage of the water needs of the island, is the fact that in the karst systems salinization caused by natural causes and not in over-pumping is observed (Kanakoudis, 2017).

Zakynthos

The islands of Kefalonia, Ithaca and Zakynthos belong to the Water Department of the Northern Peloponnese (ΥΔ02). The Kefalonia - Ithaca - Zakynthos water basin (GR45) is located in the Ionian Sea and includes the homonymous islands as well as the Strofades islands. The area range of the river basin is 1,289km^2. The character of the Basin is purely insular without significant rivers and lakes. The average annual rainfall is estimated at 950mm per year.

Zakynthos has only three coastal waster systems that belong to Kefalonia - Ithaca - Zakynthos water basin; one in the west coast, one in the east coast and one in the gulf of Laganas. Zakynthos does not have any important river water systems. In the lowland and hilly area of Zakynthos, we can identify local underground water systems developed in rough materials like cobbles, sands and cobblestones[57].

The quality of the water has deteriorated during the recent years; however, the water services of the island have managed to satisfy the supply which is mainly domestic water demands. The growing population of Zakynthos, as well as the tourism of the summer months, stress the water supplies. Unfortunately, high water losses are reported through the water service network, varying from 30 to 60%. The annual losses cover approximately 45% of the local annual domestic consumption (Megalovasilis, 2014).

Waste management (uncontrolled dump sites, controlled landfill sites, recycling)

The production and uncontrolled disposal of solid waste is one of the main sources of pollution in the Ionian Islands. According to the study of the Regional Waste Management Planning (RWMP, 2016), the estimated production of municipal solid waste (msw) is presented in the following table. Biodegradable materials in the Ionian Islands amount to 54.8% of the total waste generated, while 32.5% of the total municipal solid waste produced are packaging materials. There are four landfills in the Ionian Islands (Zakynthos, Corfu, Kefalonia, Lefkada), one waste transfer station (wts) on the island of Ithaca, as well as two recycling sorting centers (rsc) in Zakynthos and in Corfu (RWMP, 2016; Regional Business Program, 2014-2020).

Table 33. Estimated production of municipal solid waste

	Tonne per year	
	Corfu	**Zakynthos**
2016	65,568	25,606
2017	66,525	25,980
2018	67,497	26,359
2019	68,482	26,744
2020*	69,482	27,134
2021*	70,496	27,530

Source: Ionian Islands Region, December 2016

[57] Special Secretariat for Water, Ministry of Environment and Energy, 2017, Management Plan Review: Epirus Water Basin (EL05)

Until 2019, the Municipalities of Corfu and Paxos are disposing their waste in the Landfill of Central Corfu. The Drainage Treatment Plant of the landfill does not appear to work and the expansion -by adding new cells- project is not yet completed. This is expected to cause an intense problem in the waste management of the Municipalities, as the landfill of South Corfu is not operating yet. The problem is expected to become more intense during the summer, when the amount of waste will increase significantly. A decision was made for the closure of the active landfills in the diapontic islands (Ereikousa, Mathraki and Othonoi). The closure of those landfills was essential as the operation of those units was one of the most important sources of pollution and caused serious environmental problems and risks to the public health of the residents (RWMP, 2016).

In Zakynthos, the landfill continues to be disposed at the existing landfill. The final study for its restoration has been completed and restoration work is in progress. The Recyclable Materials Sorting Center is taking up the content of the network of blue bins that has been developed on the island, and continues to operate smoothly. In addition, the construction and operation of the Integrated Solid Waste Management Unit in the Liva area of the Municipality of Zakynthos has been environmentally approved. Finally, the immediate projects to be implemented are the supply of transhipment equipment and its construction Waste Transfer Stations. In Zakynthos, the landfill as a source of pollution for the surrounding area aside, there are no reported problems or other pressures in the waste management (RWMP, 2016).

Air & noise pollution

As presented by the Strategic Environmental Impact Assessment (SEIA) 2014-2020, the Ionian Islands do not seem to face a particular problem of industrial pollution, as the number of industries with high pollution potential units are limited. The majority of industrial activities in the area of Kefalonia - Ithaca - Zakynthos are related to food production and especially to olive production. Of a total of 214 industries recorded in this area, 80 have been rated as having a significant production line, while half of them produce olive oil. In the area of Corfu and Paxos, there are 121 industrial activities established, three (3) of which are subject to the Directive on large-scale accidents (Seveso Directive[58]), while none is subject to the Directive for Integrated Pollution Control and Prevention (IPPC Directive[59]). The absence of the IPCC Directive indicates that the industrial establishments of the area are not a threat for the environmental quality and no risk of negative environmental impacts and pollution is faced by their operation. In terms of energy consumption and pollutants, the area is generally characterized by low emissions. Nonetheless, relatively high levels of pollution come mainly

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[58] The Directive applies to more than 12 000 industrial establishments in the European Union where dangerous substances are used or stored in large quantities, mainly in the chemical and petrochemical industry, as well as in fuel wholesale and storage. According to the European Commission (2020), Energy prices and costs in Europe Commission Staff working document. European Environmental Agency (UEA) 2019 available at: https://www.eea.europa.eu/

[59] This Directive requires industrial and agricultural activities with a high pollution potential to have a permit. This permit can only be issued if certain environmental conditions are met, so that the companies themselves bear responsibility for preventing and reducing any pollution they may cause. According to the European Commission (2020), Energy prices and costs in Europe Commission Staff working document. European Environmental Agency (UEA), 2019 available at: https://www.eea.europa.eu/

from the built environment, especially in urban centres and the tourist area.

Critical environmental parameters for future planning

Erosion

Neotectonic processes have defined the morphology of the Ionian Islands and it is expected to also affect their morphology in the future. Studies have shown that Corfu and Zakynthos are facing higher erosion risks. In Corfu, the great risk faced results from the vulnerable quaternary and neogene depositions. In Zakynthos, the area considered as high-risk is a zone of the north east - south west direction. The cause of the formation of this vulnerable zone is the different morphology; on the one side there are carbonate rocks while in the other quaternary and neogene depositions (Evelpidou, 2012).

Moving on, we can also see the estimated soil erosion by water separately on agricultural areas and natural grassland being smaller. The available data is hard to show any trends for the islands individually, however, it seems that, in general, erosion in the Ionian Islands is diminishing every year.

Water availability and stress

The availability of water, as well as drinking water quality play a crucial role to shape the quality of life. Ensuring the adequacy and sustainable management of drinking water, as well as managing the pressures on water from human activity, such as the threat of coastal, soil and water pollution, is mandatory.

Despite the fact that in all the Ionian Islands there is a surplus water balance, the water supply faces many difficulties. On the one hand retaining water is difficult due to geomorphology and on the other hand due to the chemical characteristics of the water tables. The water supply of most areas is covered by springs or water drillings. A particular problem is observed mainly in the summer months, due to the increased demand (tourism) as we already mentioned. It is worth noting that in many cases the potential created by increased rainfall has not yet been exploited, while considering underground reserves, a small percentage is exploitable. The annual total water demand is about 2/3 of the water supply needs. Both groundwater and surface water are in environmental stress because of the polluted water flows from agriculture, waste etc., which in combination with over-pumping, create risks of degradation.

The last years have promoted significant interventions in the water supply infrastructure of the islands, while in the current period the combination of regional and sectoral policies encourages the concept of comprehensive environmental management of water resources and reduction of network leaks. The crucial need is to improve quality in conjunction with reducing water network losses, as part of an integrated policy for the management and "saving" of water resources. In addition, priority is the protection and management of water in combination with the continuous monitoring and recording of their status and generally the implementation of good environmental practices. Saving measures also help address the effects of climate change[60].

Finally, the table below presents the available data by water department. There are no significant fluctuations except for the year 2016 when we observe a severe increase in almost every category.

Million cubic metres	Fresh surface water					
	Total gross abstraction		Water abstraction for public water supply		Water abstraction for agriculture - irrigation	
year	Northern Peloponnese	Epirus	Northern Peloponnese	Epirus	Northern Peloponnese	Epirus
2011	360.67	218.5	30	4.3	329.41	214.2
2012	360.67	218.5	30	4.3	329.41	214.2
2013	360.67	218.5	30	4.3	329.41	214.2
2014	360.67	218.5	30	4.3	329.41	214.2
2015	360.67	218.5	30	4.3	329.41	214.2
2016	216.67	331.51	9.43	6.97	207.24	324.54
Million cubic metres	Fresh groundwater					
	Total gross abstraction		Water abstraction for public water supply		Water abstraction for agriculture - irrigation	
year	Northern Peloponnese	Epirus	Northern Peloponnese	Epirus	Northern Peloponnese	Epirus
2011	325.03	166.6	77.17	49.7	241.33	102.9
2012	325.03	166.6	77.17	49.7	241.33	102.9
2013	325.03	166.6	77.17	49.7	241.33	102.9
2014	325.03	166.6	77.17	49.7	241.33	102.9
2015	325.03	166.6	77.17	49.7	241.33	102.9
2016	546.85	193.94	94.08	66.4	436.27	113.04

Figure 66. Water availability
Source: Eurostat (env_watabs_rb)

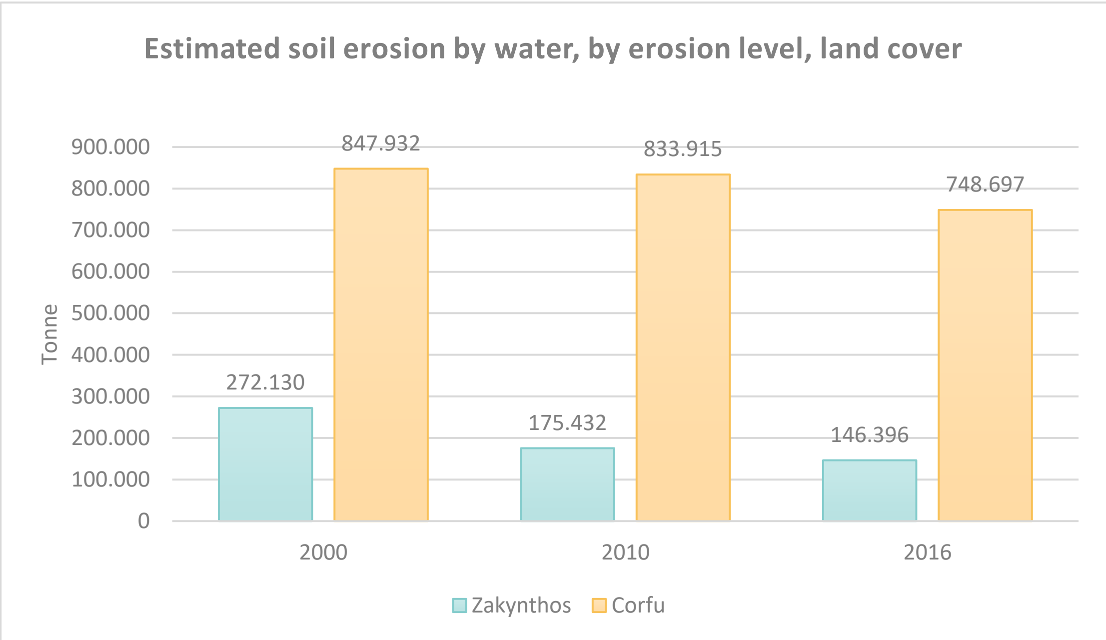


Figure 67. Estimated soil erosion in the two islands
Source: Eurostat (aei_pr_soiler)

60 Special Secretariat for Water, Ministry of Environment and Energy, 2017, Management Plan Review: Epirus Water Basin (EL05) & Ionian Islands Region, Special Operational Program Management Service for the Ionian Islands Region, April 2019, Regional Plan for Climate Change Adaptation

Annex 1. Survey results of Corfu and Zakynthos residents on energy communities and renewable energy

Population and sample composition

The most important element of a survey is sampling. The first stage is to identify the population of interest for research. This depends on the research questions the survey is trying to answer. For this survey, the definition of the population is obvious, as the aim is to collect various data about people in a particular geographic area: the islands of Corfu and Zakynthos. The sampling technique used in this survey, is simple random sampling. In simple random sampling (SRS) the units to be surveyed are randomly selected from the population of interest. This means that each unit (individual, household, etc.) had the same probability of selection. SRS was selected as it serves the purpose of the survey and as it is relatively easy and straightforward to implement (Marsden & Wright, 2010).

Design of the questionnaire

The title of the questionnaire is "*Understanding the views of residents about Energy Communities"* and it consists of three parts. The first part consists of twelve questions regarding the general purpose and subject of the survey: questions on local environmental problems, environmental awareness, climate change, renewable energy and the energy profile of the respondents. The second part is focusing on Energy Communities and it consists of six or ten questions – the number of the questions that a respondent has to fill depends on whether or not he/she is already involved to an EC project – as well as their willingness to participate in an EC project. At last, the third part consists of seven questions on demographics. The types of the questions we used are the following: close-ended questions, rating questions, Likert scale questions, multiple choice questions and matrix questions.

More specifically, the first part can be separated into two subparts. In the first subpart, we pose general questions about the perception of respondents on the severity of environmental issues with a greater focus on climate change. Additionally, in the first subpart we used the New Ecological Paradigm (NEP) scale[61] in order to outline the environmental awareness of

[61] NEP scale is a survey-based metric, designed by Dunlap and colleagues, which measures the environmental concern of people. It is using a survey instrument constructed of fifteen statements, and respondent are asked to indicate the strength of their agreement or disagreement with each statement. Eight of the items, if agreed to by a respondent, are meant to reflect endorsement of the new ecological paradigm, while agreement with the other seven items represents endorsement of the dominant social

every respondent and of our sample. In the second subpart we tried to capture respondents' perception on renewable energy sources as well as their energy consumption type and in general their energy consumption habits.

The second part, as we already mentioned is focusing on EC and it consists of two subparts. The first subpart, is targeting on recording the level of information of respondents about EC. The purpose of the second subpart of the questionnaire is to record if there is interest in investing in EC projects. However, because our sample is random we had to pose a question to differentiate the questions depending on whether or not the respondent is a member of an EC. In the case of not being a member of EC the questions that appear are focusing on outlining the willingness to invest and participate in an EC project and also the incentives around this decision. In this context, we also pose an economic question about the amount of money that they are willing to invest in an EC project. If a respondent states that he/she is not interested at all in EC he/she is automatically transferred to the third part of the questionnaire with no further questions on EC. In the case where the respondent is already a member of EC, the questions that appear are focusing on the incentives that led him/her to this decision.

At last, in the third part we record the demographics: gender, age, place of residence, income, education and professional status.

Implementation of survey

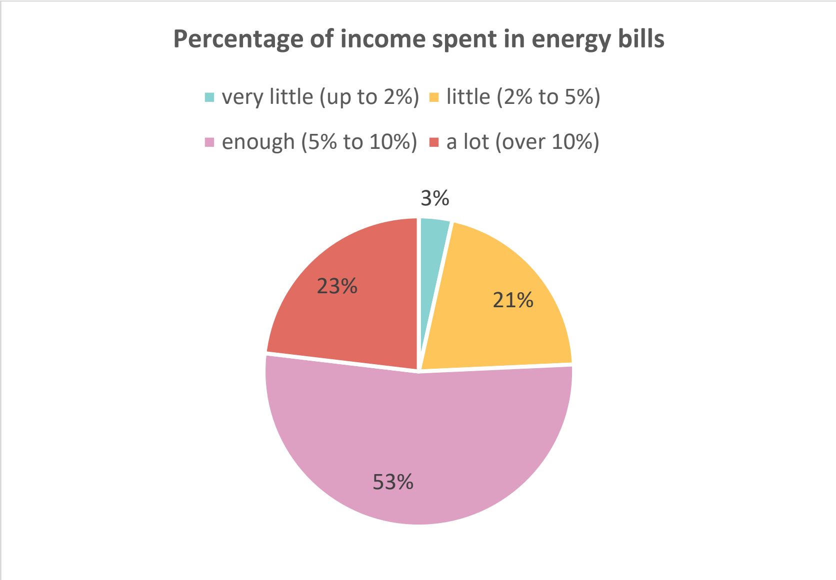
The survey took place from October of 2020 until February of 2021 and we managed to gather 173 answers: 42 from Zakynthos and 131 from Corfu. The questionnaires spread through internet. In order to spread the survey we got in touch with several organizations and news media located in Zakynthos and Corfu as well as with the municipalities. In addition, we made several Facebook posts in local groups. Unfortunately, we did not manage to gather the number of the desired answers despite our great effort. Given our communication with several people in Zakynthos and Corfu, who tried to spread through their networks, we conclude that the pandemic dominated the interest those months not allowing us to move the interest to participate in the survey.

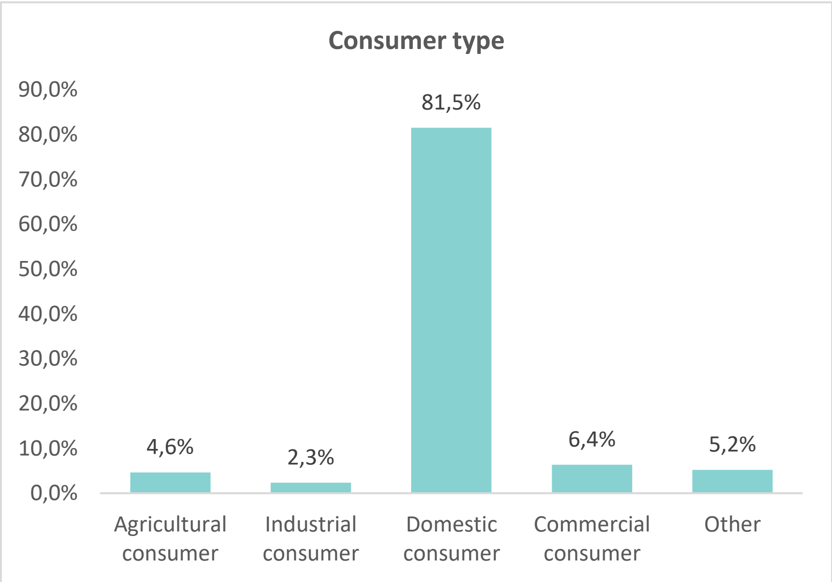
Survey Results

In this section, we will present the results of the survey. For the statistical analysis we used excel and SPSS 26.

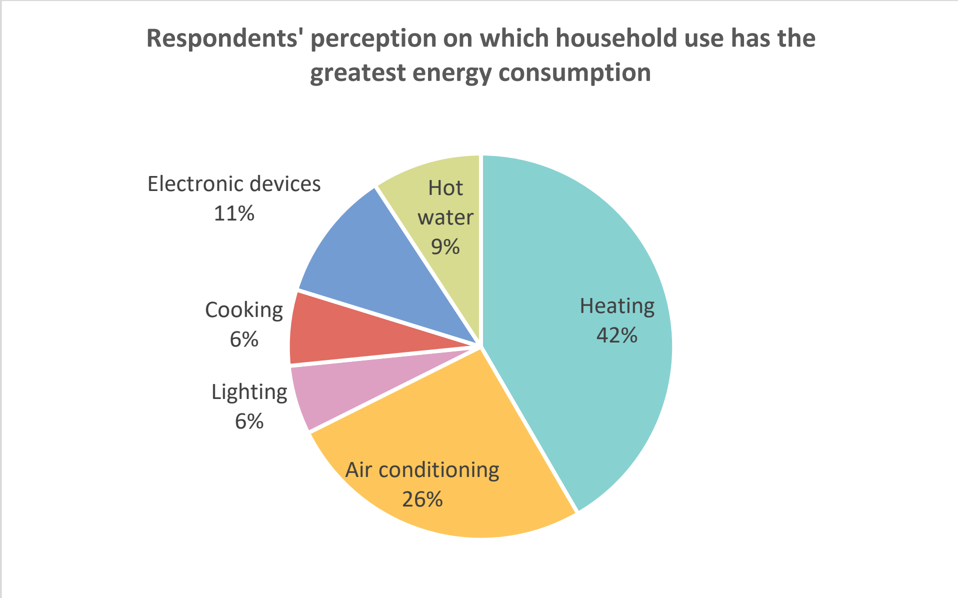
Regarding the main characteristics, our sample is almost equally separated between men (45.09%) and women (52.02%), the 40.46% is between ages 35-44 while the majority (50.87%) has a University degree and is employed full time (39.88%). The 68.64% of the respondents has an income lower than 20000€ - the 27.81% has income lower than 10,000€ and the 40.83% has income between 10-20,000€. The 81.50% is domestic energy consumer, while the 52.60%

paradigm (DSP). In addition, for further analysis the fifteen items are separated into five different dimensions: Reality to limits of growth, Anti-anthropocentrism, Fragility of nature's balance, Anti-exceptionalism and Possibility of an eco-crisis. The level of agreement or disagreement in every dimension indicates the respondent's perception in each dimension's subject, and take values from 1 to 5. In each dimension, separately and in total, prevails the score that is closest to 5. (Dunlap et al, 2000; Dunlap, 2008) believes that the money spent on energy bills is between 5% to 10% of their income. This is almost in accordance with European findings[62].





[62] Central and Eastern Europe spend around 10-15% of their income in energy bills, while this share is around 3-8% in North and Western Europe in 2018. (European Commission, 2020)

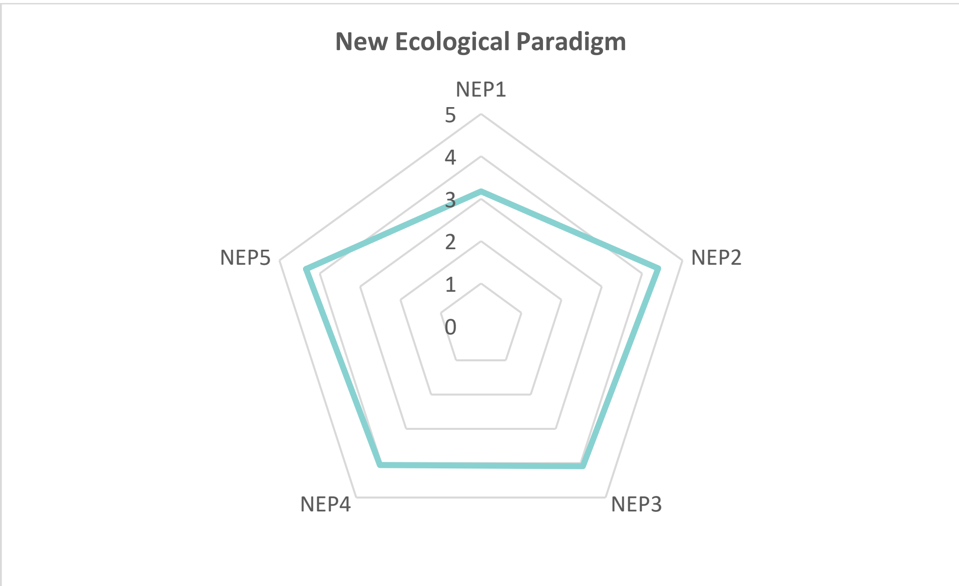


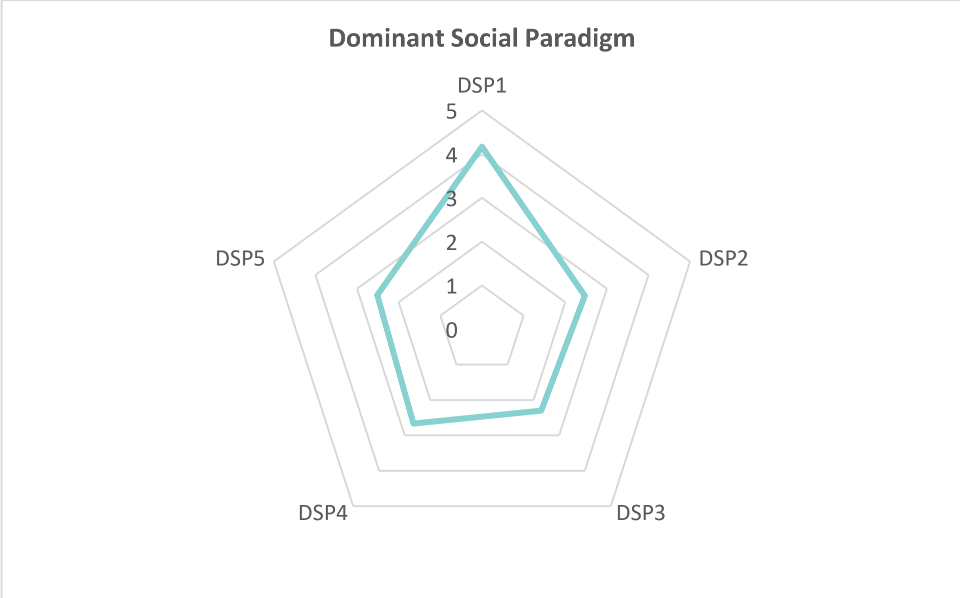
The results of our sample in the NEP scale gives us some really interesting outputs. In table below we see the total results on NEP scale, as well as the results of every dimension. We see that in four out of five dimensions our sample is closest to the NEP. The only dimension that is seems that our model is closest to the DSP is the first one, which refers to limits of growth. So, our respondents realize that our relationship with nature should not be anthropocentric; that nature has a fragile balance; that humanity is facing an eco-crisis; that humans are not superior to all other species; but does not realize that there is limit to the resources that earth can provide us. However, overall the respondents are NEP inspired, meaning that they adopt an ecological worldview. The anti-anthropocentrism character of nature has the highest score amongst the dimensions of NEP, while the possibility of an eco-crisis has the second highest score, revealing that respondents are ecologically sensitive.

NEP Scale's Dimensions		
DIM_1: Reality to limits of growth	NEP1	3.1734
	DSP1	**4.1734**
DIM_2: Anti-anthropocentrism	NEP2	**4.3977**
	DSP2	2.4711
DIM_3: Fragility of nature's balance	NEP3	**4.0867**
	DSP3	2.3064
DIM_4: Anti-exceptionalism	NEP4	**4.0526**
	DSP4	2.6676

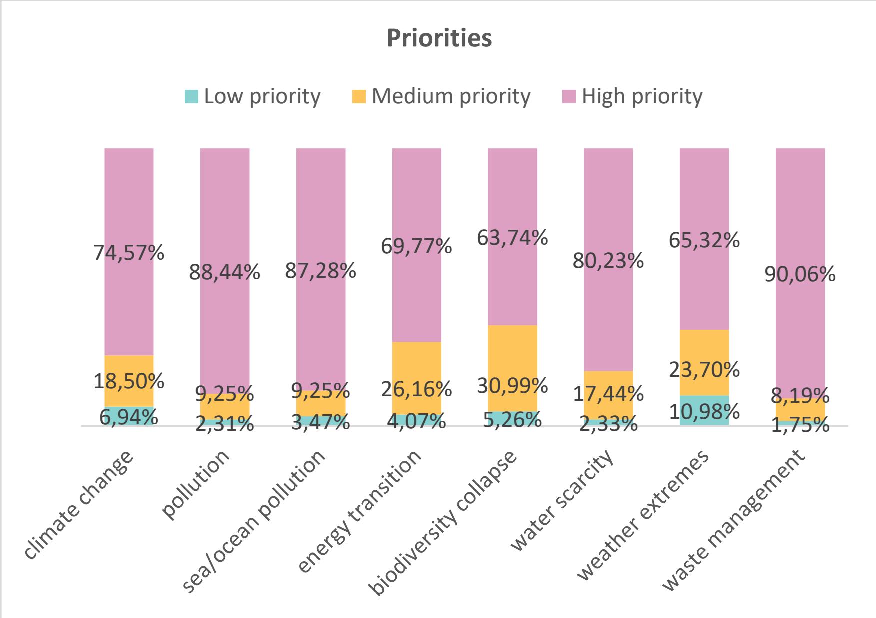
DIM_5: Possibility of an eco-crisis	NEP5	**4.3382**
	DSP5	2.5146
TOTAL	***NEP***	***3.9543***
	DSP	2.7549

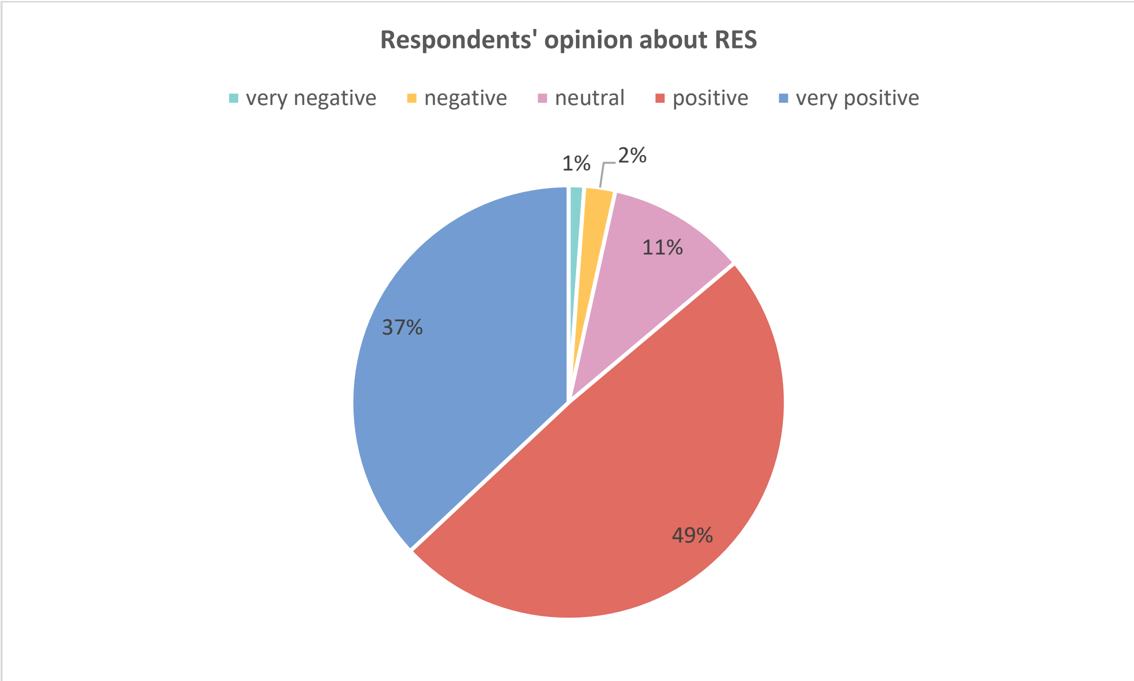
Regarding the degree of political priority that should be addressed about environmental issues, the 74.57% prioritize climate change as a high priority issue, and the 9.24% as medium priority. The 95.05% believes that climate change affects human activity. The 69.77% prioritize energy transition as high priority and the 26.16% as medium priority. In addition, the 86.12% has a positive (49.13%) or very positive (36.99%) opinion about RES. However, only the 21.39% is sure that RES contribute to the reduction of climate change effects. The majority (60.69%) believes that there is a probability that RES help dealing with climate change, but their response - probably (36.99%) and very probably (23.7%) - highlights that the majority of our sample has some doubts regarding this issue. Despite the expressed doubts, the majority (70.52%) believes that the RES potential of their islands should be exploited.

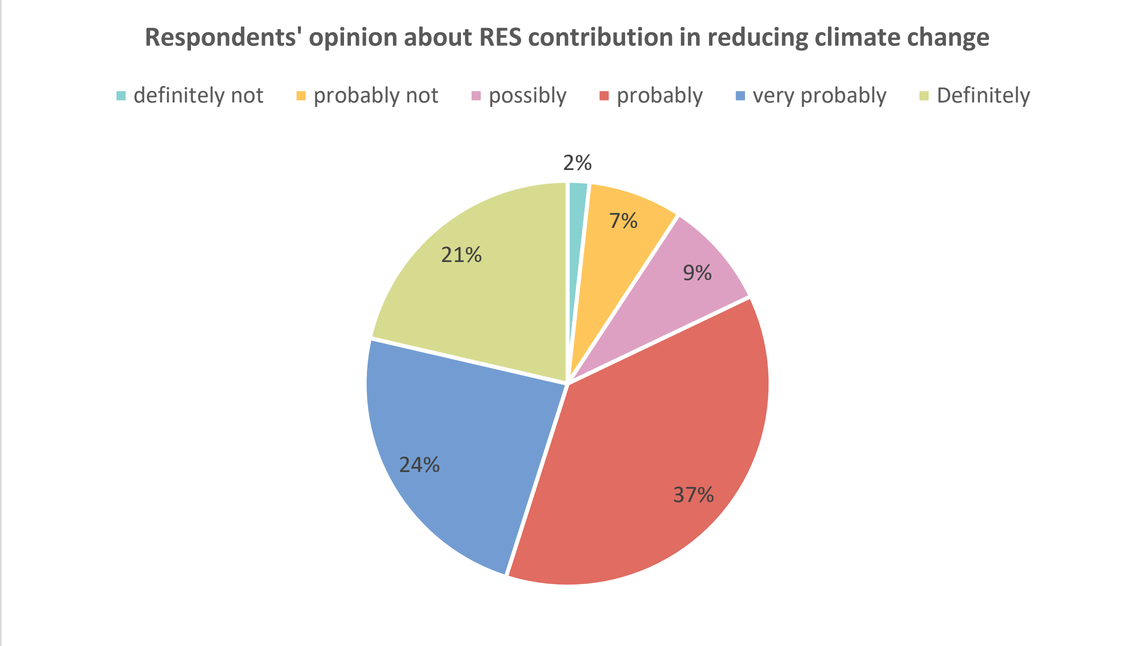


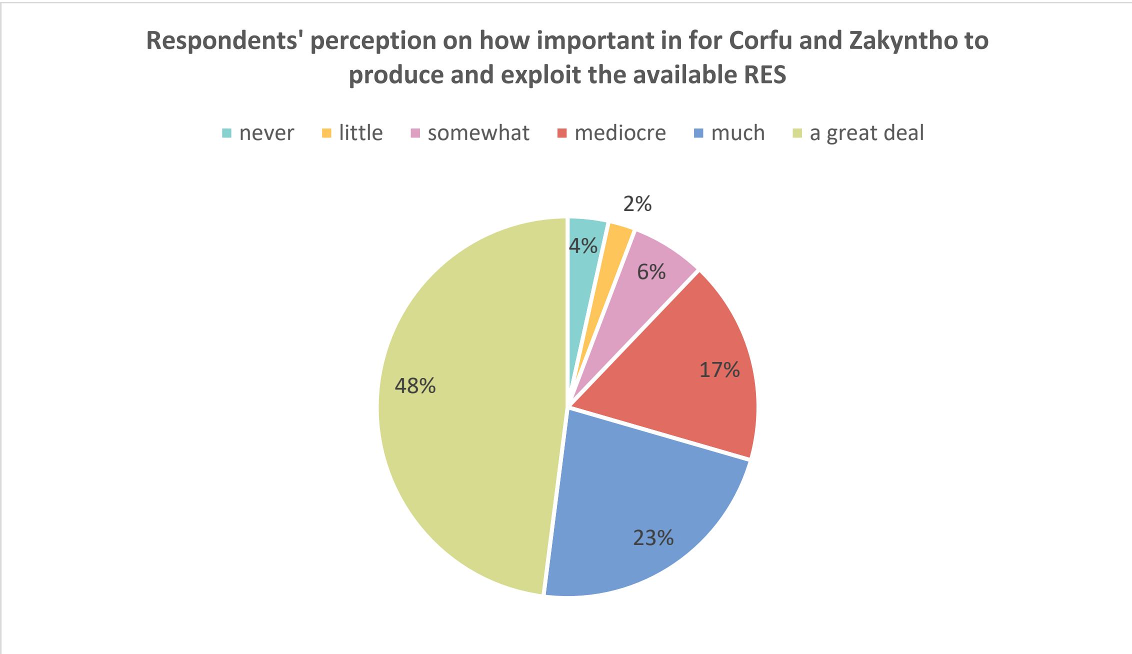


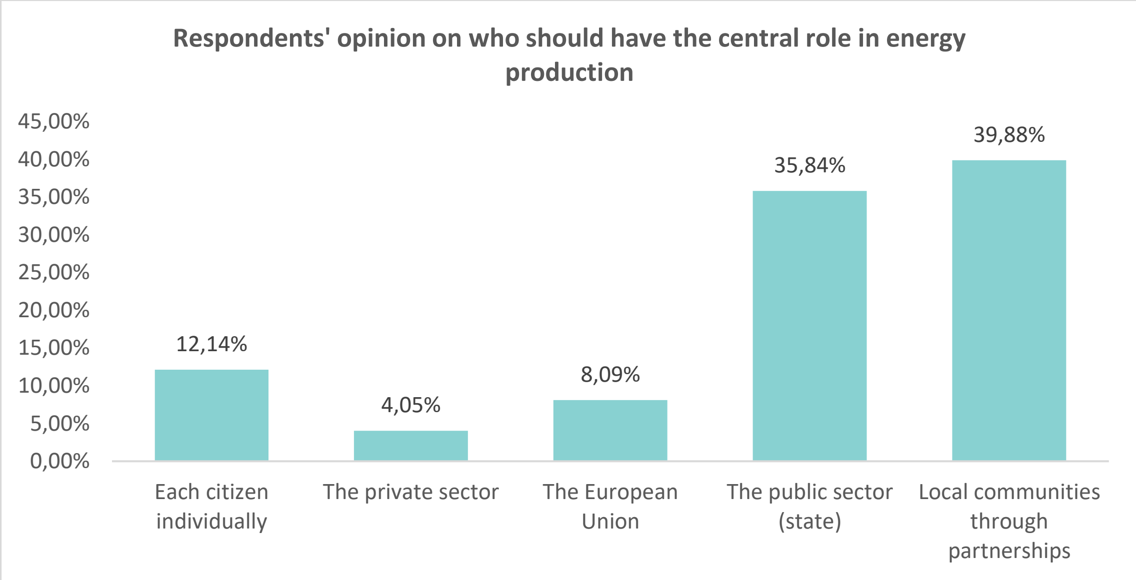
Regarding the organizational mixture of the energy production respondents seem that prefer the public sector (35.85%) to have the central role in production or local communities through partnerships (39.88%). It is really interesting that only the 4.05% believes that the central role in energy production should be undertaken by the private sector. At the same time, it seems that they feel isolated from the decision making of their Municipalities on RES initiatives. The 52.61% thinks that local communities are not involved in decisions while the 26.59% feels that is not able to express an opinion. The negative attitude towards Municipality is also reflected, up to some point, concerning the RES decision-making processes. The 49.71% believes that there is no fair and transparent decision-making processes in RES installations and once again a great percentage of our sample (37.57%) has no opinion on the fairness and transparency of decision-making processes. Thus, it is quite clear when it comes to Municipality issues and its involvement with RES, many residents seem not to be informed so they cannot express their opinion, and the rest seem to be dissatisfied. This lack of information is also apparent when we directly ask the respondents to pick their level of awareness on Municipality's initiatives about RES; the 52.6% has absolutely no information on whether or not there initiatives, while only the 2.31% is fully aware.

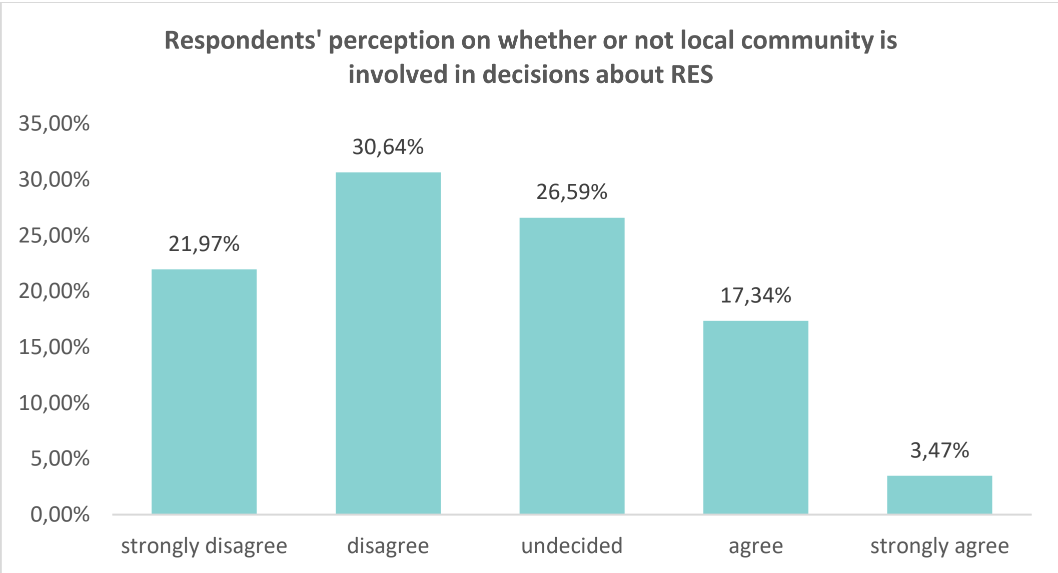

Priorities
Low priority
Medium priority
High priority
74,57%
88,44%
87,28%
69,77%
63,74%
80,23%
65,32%
90,06%
18,50%
9,25%
9,25%
26,16%
30,99%
17,44%
23,70%
8,19%
6,94%
2,31%
3,47%
4,07%
5,26%
2,33%
10,98%
1,75%
climate change
pollution
sea/ocean pollution
energy transition
biodiversity collapse
water scarcity
weather extremes
waste management

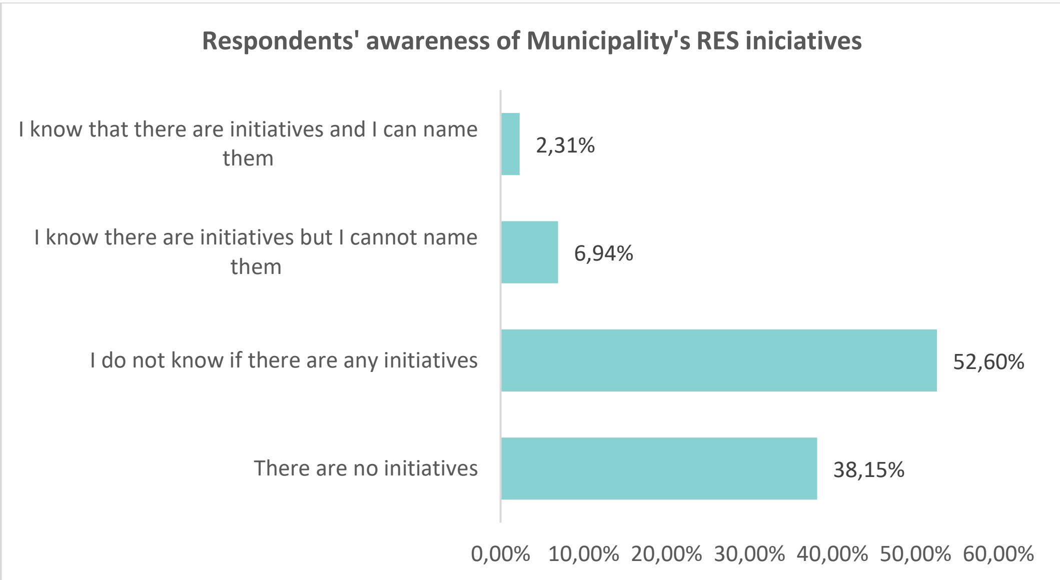

Respondents' opinion about RES
very negative
negative
neutral
positive
very positive
1%
2%
11%
37%
49%


Respondents' opinion about RES contribution in reducing climate change
definitely not
probably not
possibly
probably
very probably
Definitely
2%
7%
9%
37%
24%
21%


Respondents' perception on how important in for Corfu and Zakyntho to produce and exploit the available RES
never
little
somewhat
mediocre
much
a great deal
2%
4%
6%
17%
23%
48%


Respondents' opinion on who should have the central role in energy production
45,00%
40,00%
35,00%
30,00%
25,00%
20,00%
15,00%
10,00%
5,00%
0,00%
12,14%
4,05%
8,09%
35,84%
39,88%
Each citizen individually
The private sector
The European Union
The public sector (state)
Local communities through partnerships

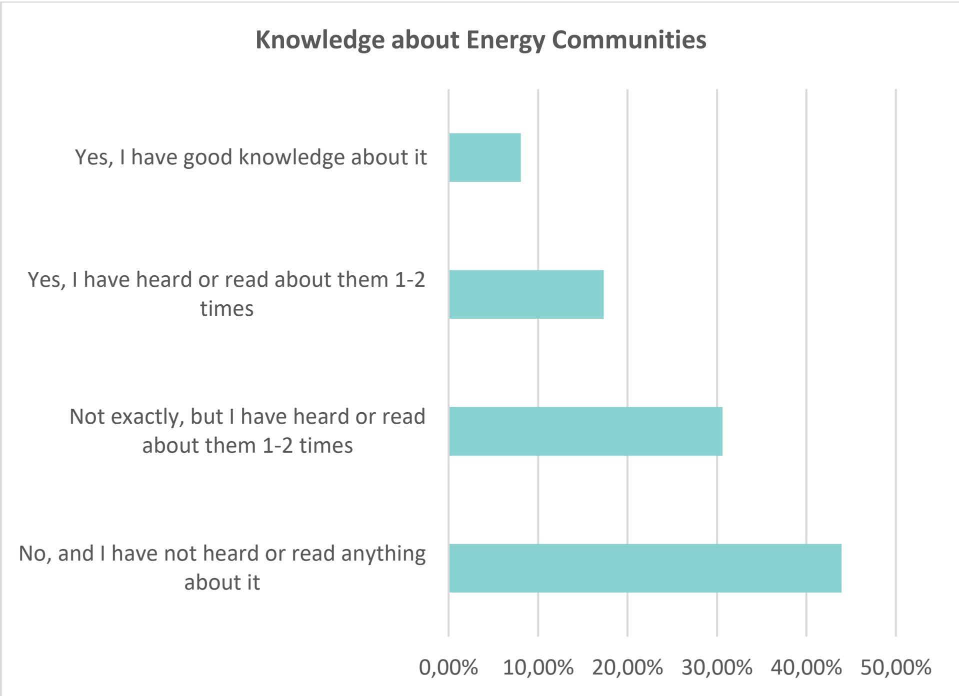

Respondents' perception on whether or not local community is involved in decisions about RES
35,00%
30,00%
25,00%
20,00%
15,00%
10,00%
5,00%
0,00%
21,97%
30,64%
26,59%
17,34%
3,47%
strongly disagree
disagree
undecided
agree
strongly agree

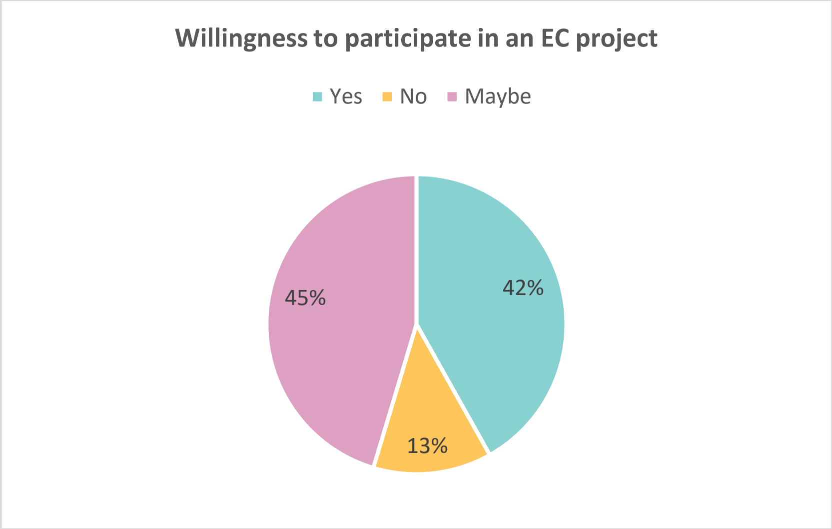

Respondents' awareness of Municipality's RES iniciatives
I know that there are initiatives and I can name them
2,31%
I know there are initiatives but I cannot name them
6,94%
I do not know if there are any initiatives
52,60%
There are no initiatives
38,15%
0,00%
10,00%
20,00%
30,00%
40,00%
50,00%
60,00%

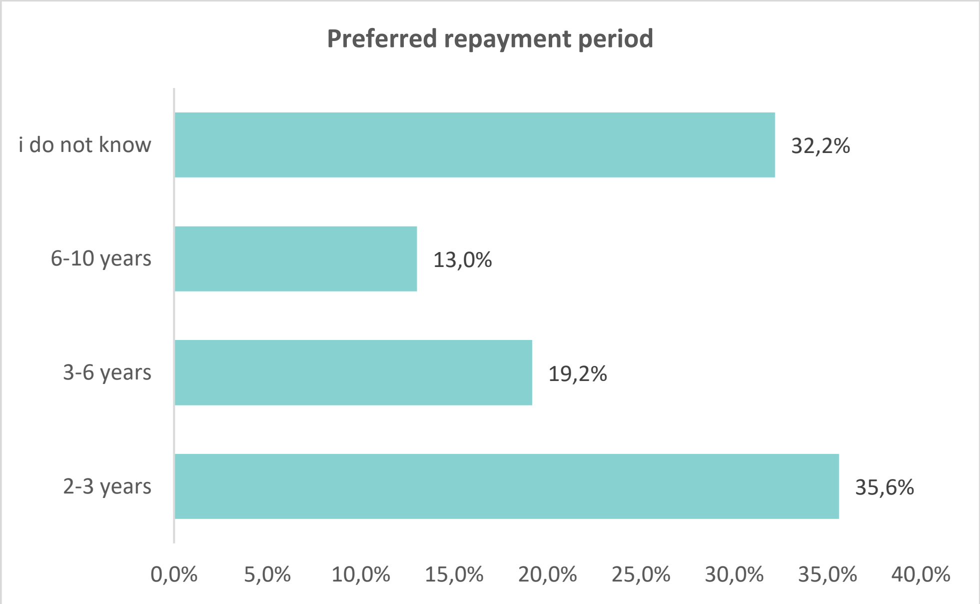
Going on we see that the respondents are not very informed about EC, only the 8.09% knows exactly about the term while the 43.93% is not familiar at all with the term and have not even heard or read about it before. However, after providing to our respondents a short explanation of EC projects, we see that they appear really willing to participate in the future in such a project; the 41.86% respond that they would participate for sure, while the 45.35% respond 'maybe' indicating that they have some doubts. Regarding the expected repayment period, the 35.62% would be satisfied with a repayment period of 2-3 years and the 19.18% with 3-6 years. However, the 32.19%, which is relatively big, does not know.

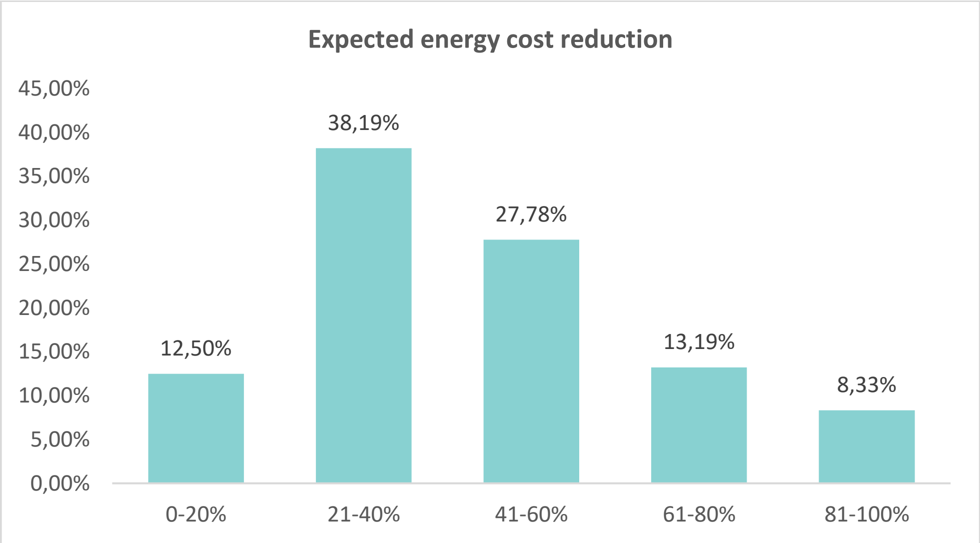
Additionally, it seems that the most respondents (39.19%) would be motivated to participate to an EC project with an annual energy cost reduction about 21-40%, and the 27.78% with an annual energy cost reduction about 41-60%.

So looking closer the responses about repayment and energy cost reduction it seems that people have high expectations from RES projects.




Willingness to participate in an EC project
Yes
No
Maybe
45%
42%
13%


Preferred repayment period
i do not know
6-10 years
3-6 years
2-3 years
32,2%
13,0%
19,2%
35,6%
0,0%
5,0%
10,0%
15,0%
20,0%
25,0%
30,0%
35,0%
40,0%


Expected energy cost reduction
45,00%
40,00%
35,00%
30,00%
25,00%
20,00%
15,00%
10,00%
5,00%
0,00%
12,50%
38,19%
27,78%
13,19%
8,33%
0-20%
21-40%
41-60%
61-80%
81-100%

Regarding the characteristics of the responders that see sure about their participation in an EC project we made a statistical analysis using a Multinomial logistic regression[63] and we found some interesting results. Educational level seems to play the central role in this choice as is the only variable that is significant (P<0,05). Thus, we could argue that we have evidence that as education level increases the willingness to participate to an EC project will eventually increase. The Multinomial logistic regression provides us also with information comparing each participation decision (No, Maybe) against the reference category (Yes). The first set is the comparison between those who are willing to participate (Yes) and those who are not (No). In this comparison education as well as income have significant predictors, and they both have negative coefficients meaning that people with higher education and higher income are less likely to be negative (No) about participating in an EC project. Overall, the model created can predict correctly the outcome (Yes, No, Maybe) 47.5% of the time. [64]

Likelihood Ratio Tests

	Model Fitting Criteria			Likelihood Ratio Tests		
Effect	AIC of Reduced Model	BIC of Reduced Model	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	242.898	267.890	226.898	7.179	2	.028
sex	237.851	262.843	221.851	2.133	2	.344
educ	244.578	269.570	228.578	8.859	2	.012***
income groups	235.965	260.956	219.965	.246	2	.884
ageGroups	240.070	265.062	224.070	4.352	2	.114

Regarding the organizational and managerial mix of a potential energy community project respondents feel more comfortable with a smaller EC, with people from their wider circle of friends and relatives, with active management by the members (34.46%). It is interesting that the business as usual model - large Energy Community where the founding members and management are from private companies – with private sector dominating the project is the option with the less acceptance and makes respondents to feel uncomfortable.

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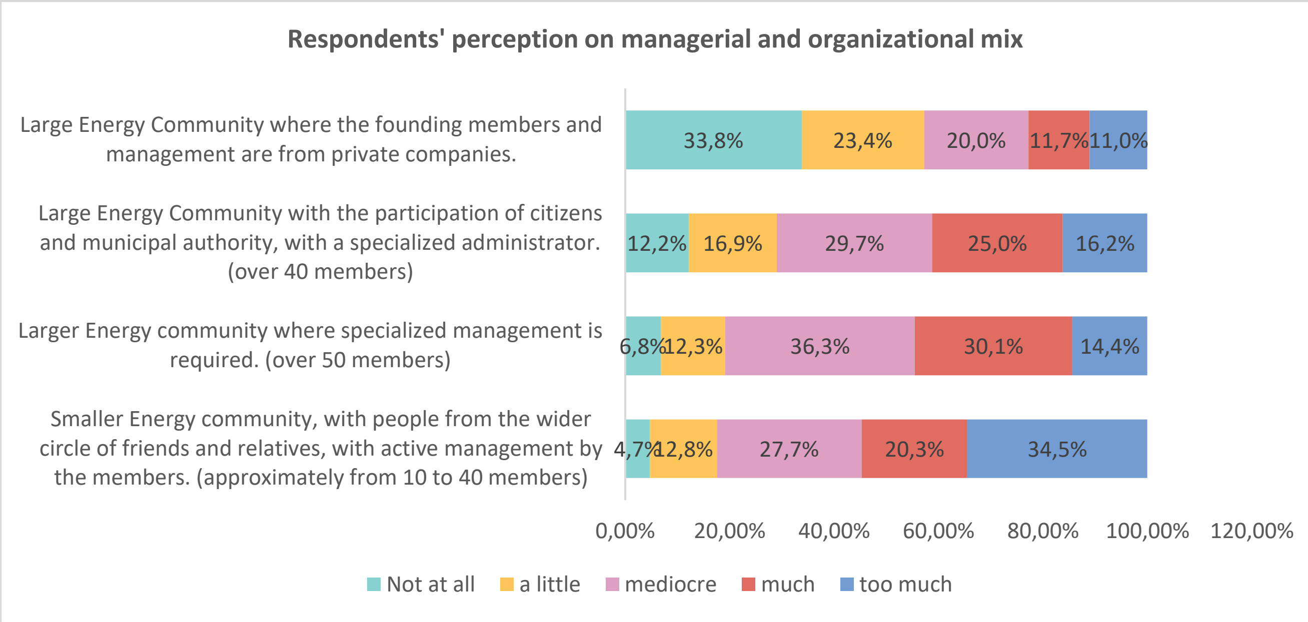
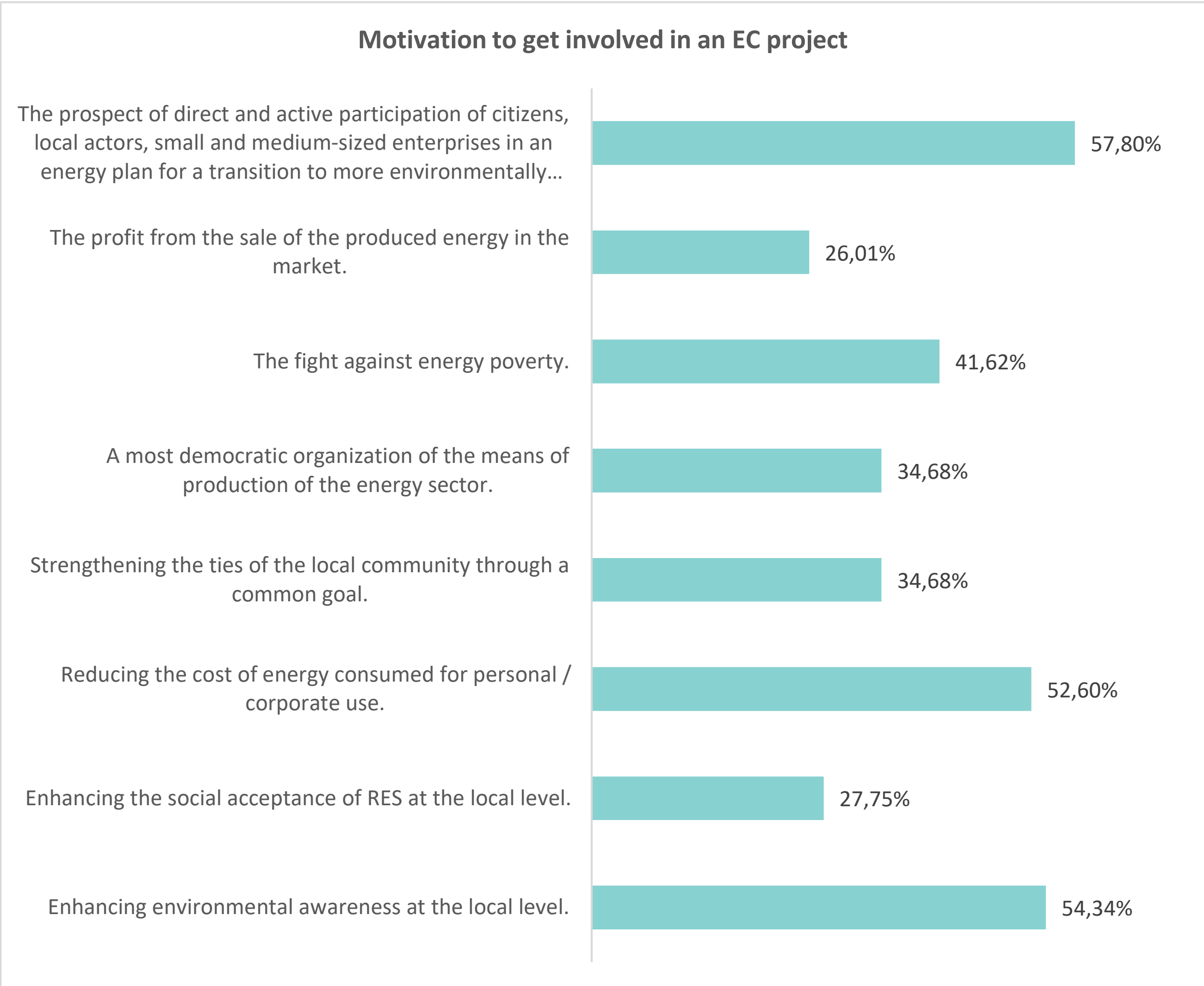
[63] Multinomial logistic regression (often just called 'multinomial regression') is used to predict a nominal dependent variable given one or more independent variables. As with other types of regression, multinomial logistic regression can have nominal and/or continuous independent variables and can have interactions between independent variables to predict the dependent variable.

[64] See Parameter Estimates table, Classification table and regression tests in Appendix ##B


Respondents' perception on managerial and organizational mix
Large Energy Community where the founding members and management are from private companies.
33,8%
23,4%
20,0%
11,7%
11,0%
Large Energy Community with the participation of citizens and municipal authority, with a specialized administrator. (over 40 members)
12,2%
16,9%
29,7%
25,0%
16,2%
Larger Energy community where specialized management is required. (over 50 members)
6,8%
12,3%
36,3%
30,1%
14,4%
Smaller Energy community, with people from the wider circle of friends and relatives, with active management by the members. (approximately from 10 to 40 members)
4,7%
12,8%
27,7%
20,3%
34,5%
0,00%
20,00%
40,00%
60,00%
80,00%
100,00%
120,00%
Not at all
a little
mediocre
much
too much


Motivation to get involved in an EC project
The prospect of direct and active participation of citizens, local actors, small and medium-sized enterprises in an energy plan for a transition to more environmentally...
57,80%
The profit from the sale of the produced energy in the market.
26,01%
The fight against energy poverty.
41,62%
A most democratic organization of the means of production of the energy sector.
34,68%
Strengthening the ties of the local community through a common goal.
34,68%
Reducing the cost of energy consumed for personal / corporate use.
52,60%
Enhancing the social acceptance of RES at the local level.
27,75%
Enhancing environmental awareness at the local level.
54,34%

Of course, it is worth examining the factors that would act as motivation to the public to get involved to an EC project. The results we got are really interesting. Our sample as we have seen so far, is characterized by ecological sensitivity and concern about their local communities; this is also reflected in this part. The prospect of direct and active participation of citizens, local actors, small and medium-sized enterprises in an energy plan for a transition to more environmentally friendly energy production would motivate the most respondents (57.8%). Enhancing the environmental awareness at the local level would also act as a motivation to the majority of our sample (54.3%). As expected, the third motivation appears to be the energy cost reduction (52.2%). Given the income status of the sample this motivation is expected to be strong, as also the reduction of energy poverty which also is highly selected (41.6%). In general, we could claim that the motivations with the most respondents are more social than personal. This is also obvious when we see that only for the 26% it would act as a motive the profit from energy sale in the market.

Willingness to Invest (WTI)

On willingness to invest we got 112 responses from 173 respondents, which is 65% of our sample. The minimum is 0, the maximum is 10.000 and the mean is 1.431,30. To see possible correlations, and in order to decide whether we will proceed to a parametric analysis or not, we used the Eta correlation[65], Spearman rho correlation[66] and Kendall's Tau-b[67]. By observing the correlations we see that WTI has very weak correlations with the rest variables. All the correlations are presented below and there is no significance that would allow us to conduct a meaningful parametric analysis. However, examining all the correlations, we could claim that there is some evidence that education, energy consumer type and percent of income spent to energy bills play a significant role on the WTI. For further observation, we provide the relative scatter graphs. We strongly believe that a bigger sample more normally distributed would have given us more correlations and a better chance for a parametric analysis.

Descriptive Statistics

[65] An Eta Coefficient test is a method for determining the strength of association between a categorical variable (e.g., sex, occupation, ethnicity), typically the independent variable and a scale- or interval-level variable (e.g., income, weight, test score), typically the dependent variable. (0=no correlation at all, 1=total correlation)

[66] Spearman correlation is a non-parametric test that is used to measure the degree of association between two variables. The Spearman rank correlation test does not carry any assumptions about the distribution of the data and is the appropriate correlation analysis when the variables are measured on a scale that is at least ordinal. (0=no correlation at all, 1=total correlation)

[67] It is considered an alternative to the nonparametric Spearman correlation coefficient (especially when you have a small sample size with many tied ranks).

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
WTI	112	10000	0	10000	**1431.30**	205.051	2170.052	4709126.213	2.215	.228	5.145	.453
Valid N (listwise)	112											

Directional Measures

			Value
Nominal by Interval	Eta	RES_Island Dependent	.309
		WTI Dependent	.120

Directional Measures

			Value
Nominal by Interval	Eta	EC_know Dependent	.439
		WTI Dependent	.214

Directional Measures

			Value
Nominal by Interval	Eta	sex Dependent	.428
		WTI Dependent	.311

Directional Measures

			Value
Nominal by Interval	Eta	educ Dependent	.605
		WTI Dependent	.322

Directional Measures

			Value
Nominal by Interval	Eta	profes Dependent	.461
		WTI Dependent	.352

Directional Measures

			Value
Nominal by Interval	Eta	income groups Dependent	.527
		WTI Dependent	.277

Directional Measures

			Value
Nominal by Interval	Eta	ageGroups Dependent	.566
		WTI Dependent	.246

Directional Measures

			Value
Nominal by Interval	Eta	income groups Dependent	.527
		WTI Dependent	.277

Directional Measures

	Value

Nominal by Interval	Eta	WTI Dependent	.150
		inc1 Dependent	.475

Directional Measures

			Value
Nominal by Interval	Eta	WTI Dependent	.008
		inc2 Dependent	.360

Directional Measures

			Value
Nominal by Interval	Eta	WTI Dependent	.063
		inc3 Dependent	.392

Directional Measures

			Value
Nominal by Interval	Eta	WTI Dependent	.022
		inc4 Dependent	.414

Directional Measures

			Value
Nominal by Interval	Eta	WTI Dependent	.009
		inc5 Dependent	.342

Directional Measures

			Value

Nominal by Interval	Eta	WTI Dependent	.004
		inc6 Dependent	.383

Directional Measures

			Value
Nominal by Interval	Eta	WTI Dependent	.146
		inc7 Dependent	.371

Directional Measures

			Value
Nominal by Interval	Eta	WTI Dependent	.037
		inc8 Dependent	.417

Directional Measures

			Value
Nominal by Interval	Eta	WTI Dependent	.058
		Consumer_type Dependent	.533

Directional Measures

			Value
Nominal by Interval	Eta	WTI Dependent	.184
		per_of_income_energy Dependent	.508

Directional Measures

			Value
Nominal by Interval	Eta	WTI Dependent	.122
		OTA_initiatives Dependent	.378

Directional Measures

			Value
Nominal by Interval	Eta	WTI Dependent	.130
		cost_reduction Dependent	.439

			WTI			WTI
Spearman's rho	climate change	Correlation Coefficient	-0.082	RES	Correlation Coefficient	0.085
		Sig. (2-tailed)	0.391		Sig. (2-tailed)	0.374
		N	112		N	112
	pollution	Correlation Coefficient	-0.052	RES_climate	Correlation Coefficient	0.057
		Sig. (2-tailed)	0.587		Sig. (2-tailed)	0.554
		N	112		N	112
	sea/ocean pollution	Correlation Coefficient	-0.128	RES_Island	Correlation Coefficient	0.113
		Sig. (2-tailed)	0.177		Sig. (2-tailed)	0.235
		N	112		N	112
	energy transition	Correlation Coefficient	-0.115	OTA_just	Correlation Coefficient	0.018
		Sig. (2-tailed)	0.228		Sig. (2-tailed)	0.852
		N	112		N	112

	biodiversity collapse	Correlation Coefficient	0.070	LocalCom_involves	Correlation Coefficient	-0.137
		Sig. (2-tailed)	0.465		Sig. (2-tailed)	0.150
		N	111		N	112
	water scarcity	Correlation Coefficient	-0.032	EC_S_10_40	Correlation Coefficient	0.161
		Sig. (2-tailed)	0.741		Sig. (2-tailed)	0.091
		N	111		N	112
	weather extremes	Correlation Coefficient	0.062	EC_M_mng_50	Correlation Coefficient	0.052
		Sig. (2-tailed)	0.518		Sig. (2-tailed)	0.587
		N	112		N	111
	waste management	Correlation Coefficient	-0.100	EC_local_OTA	Correlation Coefficient	0.045
		Sig. (2-tailed)	0.300		Sig. (2-tailed)	0.635
		N	110		N	112
	EC_private	Correlation Coefficient	-0.132			
		Sig. (2-tailed)	0.170			
		N	110			

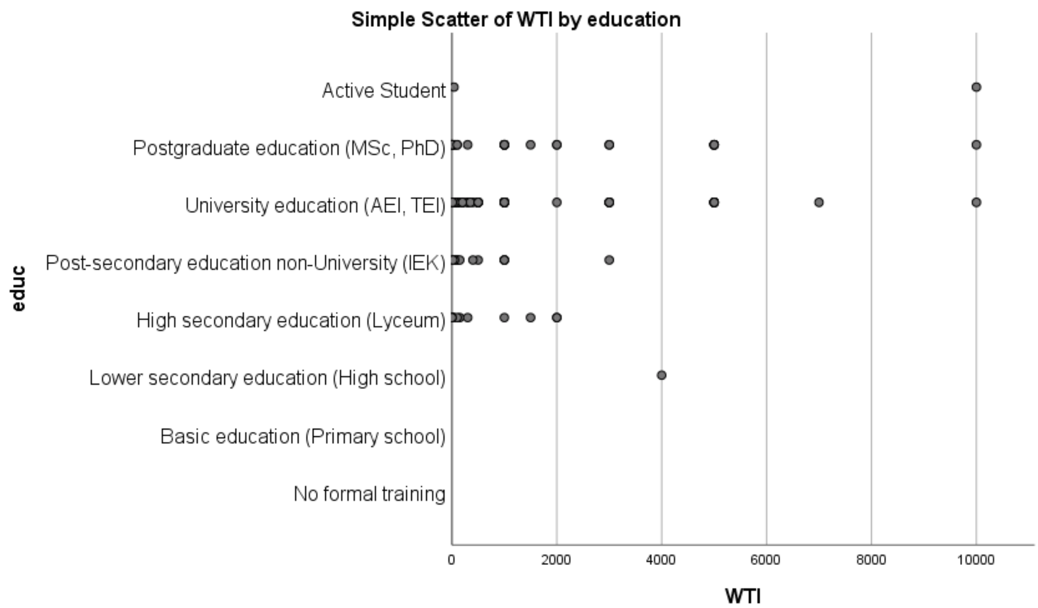
Correlations Kendall's Tau-b

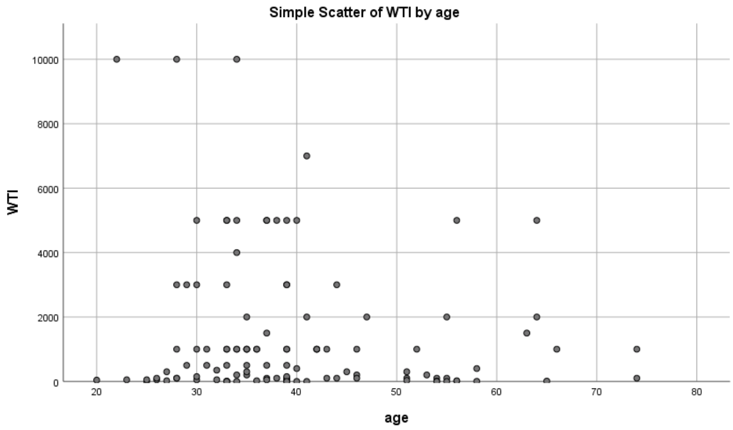
			WTI	income groups	ageGroups	educ	sex
Kendall's tau_b	WTI	Correlation Coefficient	1.000	.193*	-.071	.098	-.115
		Sig. (2-tailed)	.	.010	.337	.193	.149
		N	112	109	112	112	112

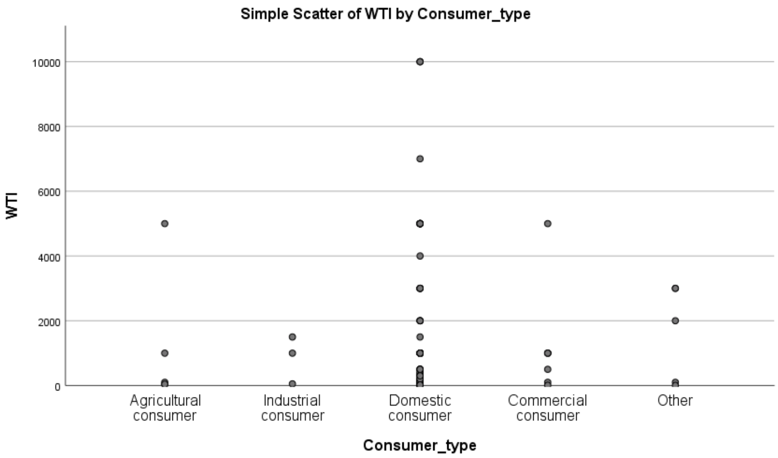
	income groups	Correlation Coefficient	.193*	1.000	.189**	.176**	-.206**
		Sig. (2-tailed)	.010	.	.004	.008	.003
		N	109	169	169	169	169
	ageGroups	Correlation Coefficient	-.071	.189**	1.000	-.132*	.036
		Sig. (2-tailed)	.337	.004	.	.042	.598
		N	112	169	173	173	173
	educ	Correlation Coefficient	.098	.176**	-.132*	1.000	-.123
		Sig. (2-tailed)	.193	.008	.042	.	.078
		N	112	169	173	173	173
	sex	Correlation Coefficient	-.115	-.206**	.036	-.123	1.000
		Sig. (2-tailed)	.149	.003	.598	.078	.
		N	112	169	173	173	173

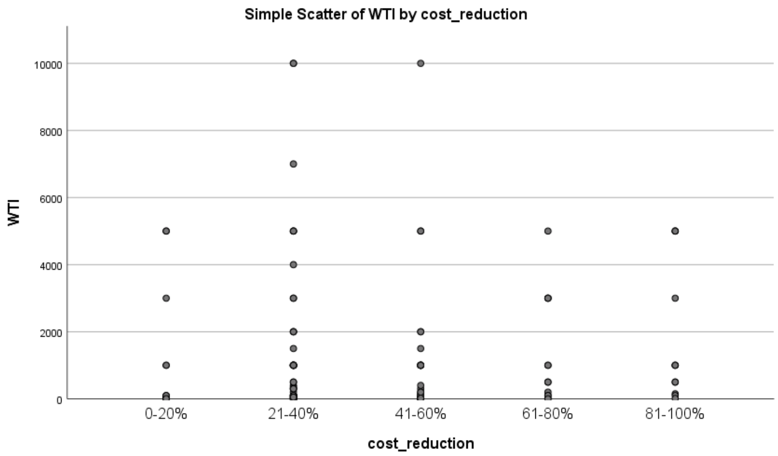
*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).









Kaplan-Meier methodology for non-parametric analysis for WTI

By using the Kaplan-Meier (KM) method for non-parametric analysis we tried to figure out the representative amount to invest in an EC project, as it is resulting from the responses. The analysis resulted that the willingness to invest is 1043.15€.

The KM is a Maximum Likelihood estimator which imposes only a very weak assumption (weak monotonicity) to the data, assumption that is theoretically supported. It is hence very robust to mis-specification errors, which afflict parametric approaches, and this makes it a useful term of comparison for this class of estimates.

Notice that this estimator is not used by interpolating endpoints to the intercept of the axis or between probability estimates. It therefore returns a “step-function” and as such the $\bar{C}$ estimate can be computed.

The KM estimator of mean WTI can be estimated as:

$$\overline{C} = \sum_{j=0}^{J} \hat{S}(C_j) \cdot [C_{j+1} - C_j]$$

In the sample of 173 responses, we have 112 responses on the WTI. In order to calculate the KM estimator, at first, every separate answer (J) of WTI is classified in an ascending order. WTI is now denoted as Cj, were C0 is the zero value and Cj is the highest value recorded. Note that in our case j=23, as we observe 23 different values of WTI.

The total number of responses in a sample with WTI greater than Cj is given by the equation:

$$n_j = \sum_{k=j+1}^{j} h_k$$

As h_k is denoted the number of responses for every C_j.

The empirical estimate for defining the probability of every value is given by the equation:

$$\hat{S}(C_J) = \frac{n_j}{N}$$, for every j=0 to j

More specifically, the final expression of the function of a WTI value is calculated by expressing the number of the largest WTI values from that value as a percentage of the total sample number. If the WTI value is the highest in the sample the function equals zero, which indicates that the probability of having a higher WTI value is zero. The procedures for obtaining the mean C ($\bar{C}$) are presented in the table below.

Kaplan-Meier methodology for non-parametric analysis									
1st step		***2nd step***		***3rd step***		***4th step***		***5th step***	
c0	0	h0	5	n=0	7	S(c0)	0.0625	MC0	0.0625
c1	1	h1	2	n=1	4	S(c1)	0.035714	MC1	0.035714
c2	2	h2	2	n=2	4	S(c2)	0.035714	MC2	0.107143
c3	5	h3	2	n=3	6	S(c3)	0.053571	MC3	0.267857

c4	10	h4	4	n=4	8	S(c4)	0.071429	MC4	0.714286
c5	20	h5	4	n=5	5	S(c5)	0.044643	MC5	0.446429
c6	30	h6	1	n=6	2	S(c6)	0.017857	MC6	0.178571
c7	40	h7	1	n=7	8	S(c7)	0.071429	MC7	0.714286
c8	50	h8	7	n=8	20	S(c8)	0.178571	MC8	8.928571
c9	100	h9	13	n=9	15	S(c9)	0.133929	MC9	6.696429
c10	150	h10	2	n=10	6	S(c10)	0.053571	MC10	2.678571
c11	200	h11	4	n=11	8	S(c11)	0.071429	MC11	7.142857
c12	300	h12	4	n=12	5	S(c12)	0.044643	MC12	2.232143
c13	350	h13	1	n=13	3	S(c13)	0.026786	MC13	1.339286
c14	400	h14	2	n=14	8	S(c14)	0.071429	MC14	7.142857
c15	500	h15	6	n=15	28	S(c15)	0.25	MC15	125
c16	1000	h16	22	n=16	24	S(c16)	0.214286	MC16	107.1429
c17	1500	h17	2	n=17	7	S(c17)	0.0625	MC17	31.25
c18	2000	h18	5	n=18	12	S(c18)	0.107143	MC18	107.1429
c19	3000	h19	7	n=19	8	S(c19)	0.071429	MC19	71.42857
c20	4000	h20	1	n=20	12	S(c20)	0.107143	MC20	107.1429
c21	5000	h21	11	n=21	12	S(c21)	0.107143	MC21	214.2857
c22	7000	h22	1	n=22	4	S(c22)	0.035714	MC22	107.1429
c23	10000	h23	3	n=23	3	S(c23)	0.026786	MC23	133.9286
								Mean C	**1043.152**

So, the estimation on the total investment value for Corfu is between 23.929.907€ to 26.875.768€ and for Zakynthos between 8.562.192 to 9.615.775€. We used the KM estimation and we adapted given the socioeconomic status of the Ionian Islands. We assume that the estimated investment is per household, so, the starting point are the total households of Corfu and Zakynthos, as they are recorded in the census of 2011[68]. Next the total households are reduced for the poverty level of the Ionian Islands[69]. We proceed to this calculation as it is unreal to assume that households living in poverty will have either the amount of money to make an investment on an EC project or the will. Going on, we conduct two different assumptions about the households that will be willing to invest[70]; we account for 65% probability as it results from our survey, and we also account for 73% following the survey of Skordoulis in 2020. Thus we end up with a range of total investment value for both islands.

	Total households census 2011	**Households above poverty**	**Households willing to invest**		**Total investment value**	
Corfu	41.039	35.293	22.940	25.764	**23.929.907€**	**26.875.768€**
Zakynthos	14.684	12.628	8.208	9.218	**8.562.192€**	**9.615.775€**

Conclusions

Despite the difficulties we encountered in collecting responses and despite the fact that the sample size does not meet exactly our expectations, we can draw some useful conclusions. It is quite clear that our sample is ecologically sensitive, as overall the NEP is dominant. The majority of the respondents think that energy transition and climate change should be highly prioritized by the policy makers. They have a positive view towards RES, and they believe that the RES capacity of their islands should be exploited. However, it seems that residents are not well informed by the Municipality about the decision making on RES and the relative initiatives that are taken. As a matter of fact, many also feel that the Municipality proceedings are not transparent and fair. Hence, regarding the high environmental awareness and the lack of information, we could argue that the Municipalities of Corfu and Zakynthos fails to inform and engage their residents into RES initiatives.

[68] Hellenic Statistical Authority

[69] Eurostat dataset 'at-risk-of-poverty' rate by NUTS 2 regions, the at-risk-poverty rate in the Ionian Islands is 14% (https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do)

Despite the fact that they are not familiar with Energy Communities, after a short explanation provided within the questionnaire flow, they are really willing to learn more and even invest to an EC project. Regarding energy production ownership, in general, the prevailing view is in favor of organizational models that bring local communities into the center. This perception is also captured regarding the preferred EC organizational and managerial model; responders feel more comfortable with a smaller EC, with people from the wider circle of friends and relatives, with active management by the members. The rejection of private companies engaging in the energy production scheme and in EC projects is inevitable.

The high level of environmental awareness and ecological sensitivity of our sample, as well as their perception that local communities should engage in energy transition projects, is verified by the results we get regarding which factors would act as a motivation in participating to an EC project; the prospect of direct and active participation of citizens, local actors, small and medium-sized enterprises and enhancing environmental awareness at the local level are the factors that would motivate our sample.

Summing up, the locality in every aspect regarding energy transition and EC is dominating the preferences of the sample. We could claim that the sample is characterized by a public-spirited character, and also, is very concerned about the future of their local communities. At last, we should also mention, regarding the free comments we got for the survey that there is a great interest and apprehension on how RES should be exploited with respect on the local environment.

Descriptive statistics

Descriptive Statistics			
	Mean	Std. Deviation	N
climate change	2.68	.600	173
pollution	2.86	.408	173
sea/ocean pollution	2.84	.454	173
energy transition	2.66	.555	172
biodiversity collapse	2.58	.592	171
water scarcity	2.78	.469	172
weather extremes	2.54	.686	173
waste management	2.88	.373	171
NEP1	3.173	.8803	173
DSP1	4.17	.742	173
NEP2	4.40	.878	171
DSP2	2.471	.8706	173
NEP3	4.087	.7059	173
DSP3	2.31	1.070	173
NEP4	4.05	.870	171
DSP4	2.668	.8765	173
NEP5	4.338	.6536	173

DSP5	2.51	1.205	171
NEP_total	3.954273327828242	.508847717386771	173
DSP_total	2.754885769336635	.590596424027381	173
CC_opinion	2.03	.303	173
RES	4.18	.800	173
RES_climate	4.38	1.226	173
Crole_production	3.87	1.315	173
RES_Island	4.97	1.296	173
Consumer_type	3.05	.693	173
big_energ_consum	2.47	1.730	173
per_of_income_energy	2.95	.761	173
OTA_initiatives	1.73	.689	173
OTA_just	2.48	.956	173
LocalCom_involves	2.50	1.119	173
EC_know	1.90	.965	173
EC_owner	1.99	.076	173
EC_information	1.12	.328	172
EC_participation	2.03	.936	172
repayment	2.42	1.269	146
EC_S_10_40	3.67	1.209	148
EC_M_mng_50	3.33	1.083	146
EC_local_OTA	3.16	1.240	148

EC_private	2.43	1.353	145
cost_reduction	2.67	1.116	144
inc1	1.46	.500	173
inc2	1.72	.449	173
inc3	1.47	.501	173
inc4	1.65	.477	173
inc5	1.65	.477	173
inc6	1.58	.494	173
inc7	1.74	.440	173
inc8	1.42	.495	173
WTI	1431.30	2170.052	112
hrs	7.404	10.6767	109
sex	1.60	.608	173
age	39.91	10.856	173
island	1.24	.430	173
adults	2.30	1.187	173
kids	.67	1.065	172
educ	5.89	.955	173
profes	2.76	1.777	173
income groups	2.21	1.079	169
ageGroups	3.0289	1.09665	173

Statistacal analysis, Dependent variable: EC_Participation

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	151.912	154	.532
Deviance	163.935	154	.277

Pseudo R-Square

Cox and Snell	.081
Nagelkerke	.094
McFadden	.043

Parameter Estimates

EC_participation		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B) Lower Bound	Upper Bound
No	Intercept	3.987	1.961	4.132	1	.042			
	sex	-.046	.473	.010	1	.922	.955	.378	2.410
	educ	-.636	.259	6.051	1	.014	.529	.319	.879

	income groups	-.027	.268	.010	1	.919	.973	.576	1.645
	ageGroups	-.493	.271	3.303	1	.069	.611	.359	1.039
Maybe	Intercept	-1.190	1.456	.668	1	.414			
	sex	.396	.299	1.753	1	.185	1.485	.827	2.667
	educ	.118	.194	.367	1	.545	1.125	.769	1.646
	income groups	-.082	.167	.243	1	.622	.921	.664	1.278
	ageGroups	.033	.160	.041	1	.839	1.033	.754	1.415

Classification

Observed	Predicted Yes	Predicted No	Predicted Maybe	Predicted Percent Correct
Yes	31	3	37	43.7%
No	10	0	12	0.0%
Maybe	25	2	48	64.0%
Overall Percentage	39.3%	3.0%	57.7%	47.0%

Annex 2. Questionnaire template

Understanding the views of residents about Energy Communities

In the context of a research project undertaken by the Laboratory of Electricity Systems of the National Technical University of Athens and Greenpeace Greece, we are conducting a survey that is addressed to the residents of Corfu/Zakynthos. The aim of the questionnaire is to record the views of the habitants of the island regarding renewable energy sources and Energy Communities. The Questionnaire is anonymous and concerns only those who live on the island of Corfu. Your contribution is especially valuable for the success of the research. There are no right or wrong answers. Thank you for your participation!

Part I

1. Which do you think should be the degree of political priority (low, medium or high) to address the following environmental issues?

	Low Priority	Medium Priority	High Priority
* Climate change			
* Environmental pollution & effects on human health			
* Pollution of the seas / oceans			
* Energy Transition and Renewable Energy Sources			
* Biodiversity collapse			
* Water shortage			
* Extreme weather conditions			
* Waste management			

2. Please complete your agreement or disagreement level with the following suggestions:

	Strongly disagree	Disagree	Undecided	Agree	Strongly Agree
* We are approaching a limit on the number of people the earth system can support					
* Humans have the right to modify the natural environment to suit their needs					
* When humans interfere with nature it often produces disastrous consequences					
* Human ingenuity will ensure that we do not make earth unlivable					
* Humans are severely abusing the environment					
* The Earth has plenty of natural resources if we just learn how to use them					
* Plants and animals have as much right as humans to exist					
* The balance of nature is strong enough to cope with the impacts of modern Industrial activities					
* Despite our special abilities, humans are still subject to the laws of nature					

* The so-called "ecological crisis" facing humankind has been greatly exaggerated					
* The Earth is like a spaceship with very limited room and resources					
* Humans were meant to rule over the rest of nature					
* The balance of nature is very delicate and easily upset					
* Humans will eventually learn enough about how nature works to be able to control it					
* If things continue on their present course, we will soon experience a major ecological catastrophe					

1. 3. Which proposal do you agree with most regarding climate change?

- It does not affect human life / activity
- It affects human life / activity
- Not interested
- There is no climate change

4

	Very negative	Negatin e	neutra l	positiv e	very positiv e
* What is your opinion on Renewable Energy Sources (RES)?					

5.

	Definitely Not	Probably Not	Possibly	Probably	Very Probably	Definitely
* Do you believe that RES help in reducing climate change?						

2. 6. In your opinion, who should have the central role in the production of renewable electricity?

- Each citizen individually
- The private sector
- The European Union
- The public sector (state)
- Local communities through partnerships

7.

	Never	Little	Somewhat	Much	A Great Deal
* Do you consider important for your island to produce and exploit the available potential (wind, sun, etc.) of renewable energy?					

3. 8. Among the following types of energy consumers, who best represents you right now? Household consumer

Agricultural consumer - Industrial consumer - Commercial consumer - Other

4. 9. Among the following types of home energy use, which do you think is the one with the highest energy consumption?

Heating and cooling - Air conditioning - Lighting – Cooking - Electronic devices - Hot water

10.

	very little (up to 2%)	a little (2% to 5%)	enough (5% to 10%)	very (over 10%)
* What percentage of your income do you spend (or you think) that you spend annually for your energy needs (heating, electricity, etc.);				

5. 11. Are you aware of recent initiatives by the local government that support a more sustainable energy production and consumption?

- There are no initiatives
- I do not know if there are any initiatives
- I know there are initiatives but I cannot name them
- I know that there are initiatives and I can name them

Please identify the initiatives

12. Please indicate your level of agreement with the following statements regarding the energy policies of your municipality / region.

	Strongly disagree	Disagree	Undecided	Agree	Strongly Agree
* Initiatives by the municipality ensure a fair and transparent decision-making process.					
* The local community is actively involved in the decision-making process in relation to RES in the area.					

Part II

6. 1. Do you know what Energy Communities are? How many times have you heard or read anything about them in the last year?

- No, and I have not heard or read anything about it
- Not exactly, but I have heard or read about them 1-2 times
- Yes, I have heard or read about them 1-2 times
- Yes, I have good knowledge about it

Energy communities are local proprietorships through which citizens (whether as natural or legal entities) as well as legal entities governed by public law (eg municipalities) can operate in the energy sector, using clean energy sources. The new institutional framework ensures favorable conditions for the establishment and operation of energy communities, with the aim of strengthening not only individual / family incomes, but also local entrepreneurship, the solidarity economy and the promotion of energy democracy. (source: Greenpeace)

7. 2. Are you involved in an Energy Community (EC)?

   Yes - No

8. Given the brief description of the Energy Communities, would you be interested in learning more about the Energy Communities?

   Yes - No

9. Would you be interested in participating in an Energy Community project?
   Yes - No - Maybe

10. If you invest in an EC to reduce the amount you spend on electricity, how much should the repayment period be in order to be satisfied?

- 2-3 years
- 3-6 years
- 6-10 years
- I do not know

How comfortable would you feel from 1 (not at all) to 5 (too much) with your participation in one of the following forms of Energy Communities?

	1	2	3	4	5

* Smaller Energy community, with people from the wider circle of friends and relatives, with active management by the members. (approximately from 10 to 40 members)					
* Larger Energy community where specialized management is required. (over 50 members)					
* Large Energy Community with the participation of citizens and municipal authority, with a specialized administrator. (over 40 members)					
* Large Energy Community where the founding members and management are from private companies.					

11. What would be the percentage reduction in annual energy costs that would motivate you to join an EC?

- 0-20%
- 21-40%
- 41-60%
- 61-80%
- 81-100%

12. Which of the following would motivate you to get involved in an EC project?

- Enhancing environmental awareness at the local level.
- Enhancing the social acceptance of RES at the local level.
- Reducing the cost of energy consumed for personal / corporate use. Strengthening the ties of the local community through a common goal.
- A most democratic organization of the means of production of the energy sector. The fight against energy poverty.
- The profit from the sale of the produced energy in the market.
- The prospect of direct and active participation of citizens, local actors, small and medium-sized enterprises in an energy plan for a transition to more environmentally friendly energy production.

13. Implementing an Energy Community project requires financial resources from the participants. It would be especially helpful to know how much money you will be willing to spend to invest in an EC. For your answer you should take into account the current income and expenses of your household as well as other possible needs that you would like to cover with your income.

Please fill in the amount in money (only number)

14. Aside from investing, how much time could you volunteer to help to the management and the operation of the energy community per week?

Fill in number of hours

15. How long have you been involved in the EC project?

- <6 months
- about 1 year
- >1 year

16. Which of the following was an incentive for your involvement in the EC project?

- Enhancing environmental awareness at the local level.
- Enhancing the social acceptance of RES at the local level.
- Reducing the cost of energy consumed for personal / corporate use. Strengthening the ties of the local community through a common goal.
- A most democratic organization of the means of production of the energy sector. The fight against energy poverty.
- The profit from the sale of the produced energy in the market.
- The prospect of direct and active participation of citizens, local actors, small and medium-sized enterprises in an energy plan for a transition to more environmentally friendly energy production.

Please answer:

	Very dissatisfied	Dissatisfied	Neither Satisfied nor Dissatisfied	Satisfied	Very satisfied
* How do you evaluate your experience from your participation in the Energy Community to date?					

17. Can you describe any problems that arise in the Energy Community you are participating in

Part III

18. 1. You are identified as:

- Man
- Woman
- Non-binary gender
- I do not want to answer

19. 2. Please, fill in your age:

3. Place of permanent residence (Municipal unit)

..

4.

	How many adult and minor members (along with you) does your household consist of?
* Adult members	
* Minor members	

20. 5. What is the highest level of education you have completed?

- No formal training
- Basic education (Primary school)
- Lower secondary education (High school) High secondary education (Lyceum)
- Post-secondary education non-University (IEK) University education (AEI, TEI)
- Postgraduate education (MSc, PhD) Active Student

1. What is your current professional status?

Full time employee - Part time employee - Unemployed - Self employed - Small businessman - Retired

- College student – Other Please specify:

2. Which of the following categories does your household belong to, based on the total net income received by all its adult members in the past year?

- Under € 10,000
- 10,000 - 20,000 €
- 20,000 - 30,000 €
- 30,000 - 40,000 €
- Over € 40,000

Thank you very much for your participation! If you have any comments please fill in the field below: