Re-vitalising Energy Transition in Touristic Islands

Road-mapping needs, typology, Island specific recipes

Deliverable 4.1 - Public

Lead Beneficiary: USE (Univer-Cities, Use Efficiency Associations)

Disclaimer:

"Co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them."

Co-funded by the European Union

History of Changes

Version	Date	Authors
V0.1	22.09.2023	The first contribution from all partners. USE elaborates the first definition of typologies.
V0.2	12.12.2023	Second contribution from all partners. Elaboration of typologies and analysis of the islands' dynamics in the pilot cases carried out by USE.
V0.3	08.01.2023	USE The first draft of the deliverable
V0.4	25.01.2023	USE The final draft of the deliverable
V0.5	30.10.2023	UPV and READ Comments and suggestions
V1	31.10.2023	USE Final version

List of Acronyms

Acronym	Meaning
CETA	Clean Energy Transition Agenda
CBA	Cost-Benefit Analysis
ET	Energy Transition
EU	European Union
GA	Grant Agreement
MCDM	Multiple Criteria Decision Making
MEI	Monitoring Emission Inventory MEI
RES	Renewable Energy Sources
SDG	Sustainable Development Goals
SECAP	Sustainable Energy and Climate Action Plan
SMART	Specific, Measurable, Achievable, Realistic, and Time-bound
SWOT	Strengths-Weaknesses-Opportunities-Threats
WP	Work Package

Executive Summary

This document has been developed as part of **LIFE21-CET-LOCAL-GENERA** project, funded by European Climate, Infrastructure and Environment Executive Agency - LIFE Project Grants, under **Grant Agreement No. 101077073**.

It corresponds to the activities implemented during the first year of the project within Work-Package 4 (WP4) – *Sustainable Energy Road-mapping* and to Deliverable D4.1 – *Road-mapping needs, typology, Island-specific recipes.*

This document follows the previous reports delivered within the GENERA project, specifically the *Comprehensive report on Island Dynamics* (deliverable D2.1) and the *Co-creation methodology and tools* (deliverable D6.1).

At the same time, the work here presented must be understood as parallel to implementing the Energy Transition Monitoring tools that will be validated in the GENERA pilots and the other activities related to the WP 3 of the project.

The activities aim to analyse in greater detail, compared to the research carried out in the first months of the project, the dynamics present in the case studies, grouping them into typologies to allow the extension of the results obtained to all the islands of southern Europe.

The final objective is to provide recipes and guidelines, tailored to types of islands and stages of decarbonisation process, to help the islands and the municipalities present on the islands themselves in the transition towards the use of clean energy.

List of Contents

List of Tables

List of Figures

1. Introduction

1.1 Purpose and Scope

The first objective of this deliverable is to define typologies of islands based on their size, climate, geographic location, tourism level and, overall, their specific needs related to their stage in the transition towards the production and use of clean energy.
Subsequently, the report aims to draw up a list of recipes to encourage and support the transition of the various types of touristic islands.
This deliverable reports the outcomes of task 4.1- islands typology and available best practices and task 4.2 Recipes for fast island-tailored roadmap production, concerning the island typology and specific needs of the diverse local authorities in the different stages of the energy transition process and the development of island-specific roadmap and SECAPS.

1.2 Structure of the Deliverable

- **Chapter 2 – Characterization of islands located in the EU.**

This chapter contains data and its analysis that explains the context of the Southern European Islands on the regional island. Data used in this chapter covers demography, economy, tourism, energy, and climate to understand the islands further.

- **Chapter 3 – Definition of island typologies.**

The concept of island typologies was built upon data from the previous chapter and experience working with the islands. This chapter details the conclusions drawn from the data, assumptions, and generalisations made to define an appropriate list of islands typologies.

- **Chapter 4 – Island typology decision tree, best practices and tailored recipes for clean energy transition.**

Islands can use this "decision tree" to group themselves into types that would lead them to relevant recipes and best practices to help them advance in their energy transition journey.

- **Chapter 5 – Guidebook for fast roadmap production.**

The document concludes with a collection of the manuals, guidelines, regulations and tools currently available. This section is organised following the various stages of the process of elaborating a transition strategy towards a net-zero energy model, up to the identification of specific actions and their subsequent implementation.

2. Characterization of islands located in the EU

Due to the opportunities offered by islands, the EU is focusing on islands specifically for modern energy planning, both in terms of potential for energy efficiency, renewables and innovative solutions and in terms of creating a broad and robust community-driven transition process. A feature of the EU is that it has a wide variety of islands characterised by disparity in terms of electricity grids, geographical specificities, local population, tourism and other aspects, all of which affect the stability of the energy grid and create energy planning challenges.

Analysing different southern European islands in an energy transition context requires examining data at various regional, island, and municipal scales. This multi-level approach is crucial for understanding these islands' diverse energy landscapes and challenges, enabling tailored solutions and strategies for each level.

At the regional level, we assess population, employment and energy production, tourism variation, climate, etc. This regional context is essential for identifying common challenges and opportunities across the islands, fostering collaboration and knowledge sharing.
Furthermore, in almost all the islands, the regions (autonomous communities in Spain) corresponding to NUTS 2 are the administrative level at which the energy-territorial legislation is concretised in applying the national energy and climate plans (NECPs).

The island-level analysis delves into the unique energy dynamics of each island, considering factors such as geography, composition of different population groups, economic activities and infrastructure. This level of granularity is crucial for developing island-specific energy strategies that address local needs and constraints.

Municipal-level data provides insights into patterns and challenges faced by individual towns and villages. This level of detail is essential for identifying areas to start on the ground action and engaging people in the process.

By examining data across these multiple levels, a comprehensive understanding of energy transition in southern European islands can be achieved, leading to effective and sustainable energy policies and strategies tailored to the specific needs of each island and municipality.

In this section, a first characterisation of the island regions located in Spain (Balearic and Canary Islands), France (Corsica) and Italy (Sicily and Sardinia), Greece (North and South Aegean) is presented. These regions have been selected because they have islands with similar characteristics (size of the island, tourism, different energy sources, etc.) and most notably, all these regions stand out in that despite having access to renewable energy sources such as wind and wave power, many of them rely on costly imports of fossil fuels for their energy supply. Nevertheless, the Canary Islands are not explicitly located in the

Mediterranean Sea, but they are tourist islands with peculiar features due to their remoteness from the mainland. Comparing them with the Mediterranean islands may provide added value in terms of climate influence, among other factors.

2.1 Regional-level analysis

2.1.1 DEMOGRAPHY

Islands have a growing demographic decline linked with young people leaving to find better opportunities on the mainland. This is especially true for smaller islands, as we see for North and South Aegean regions composed of islands with quite a low population and population density.

However, despite having population density, Corsica has the highest employment rate (see Figure2).

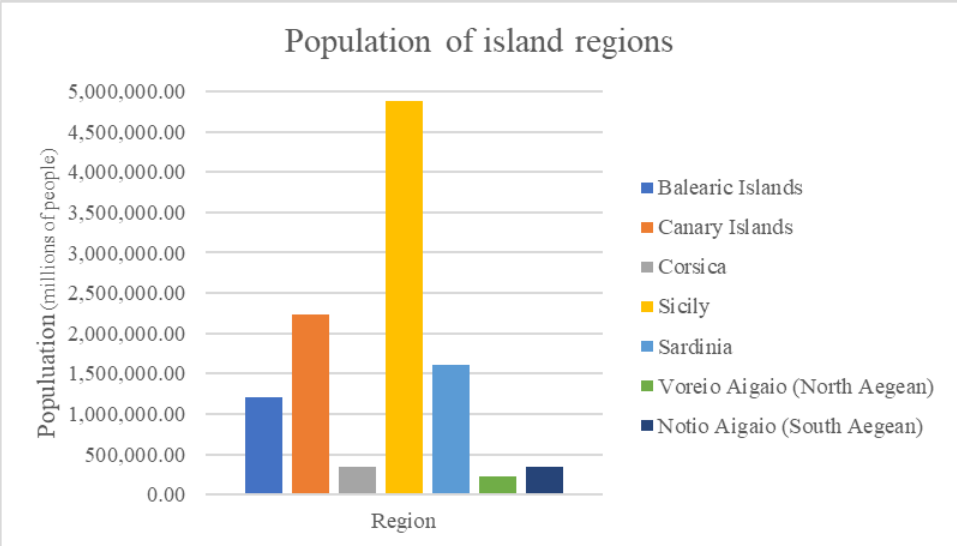

Figure 1. Population per study island region (1)

Sicily is the most populated island out of the selection, with a reported 4,875,290 inhabitants (see Figure 2) and a relatively large area (around 25,711 km2), making it third by density (see Figure 3), which may be linked with its employment data.

Sardinia, the largest island, has quite a low density, standing at 67.9 people per square kilometre, which, although not the lowest, is considerably lower than the Italian average of 195.5 people per kilometre.

Canary and Balearic Island regions have medium-sized islands and are the most densely populated ones at 299.4 and 241.2, respectively. They are, in fact, way above the Spanish national average of 94.11 inh/km2.

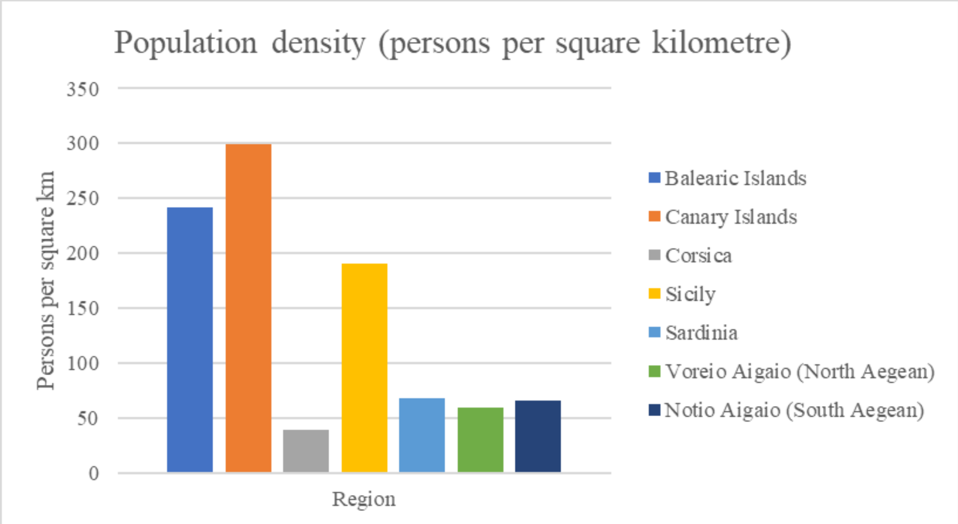

Figure 2. Population Density per study island region (1)

2.1.2 ECONOMIC

In terms of economic development, islands face many challenges that put them at a disadvantage compared to the mainland, such as high transportation costs, the absence of large urban centres, etc. These, among many other reasons, led them to develop insular economies, which lean heavily into tourism on the southern island.

In the figure below, it is possible to evaluate the employment rate among the pean regions where most of the islands fall in under 66 per cent employment with a few notable exceptions being Corsica; however, it performs below average in mainland France and island countries like Malta and Cyprus.
Corsica has the highest employment rate of 74% while 3rd lowest in population and the lowest in density. Sicily, on the other hand, has the lowest one at just 45% (which is below country average of 68.5%).

It is important to note the Greece and Italy have the lowest employment rates in Europe (2) which may in part affect the islands.

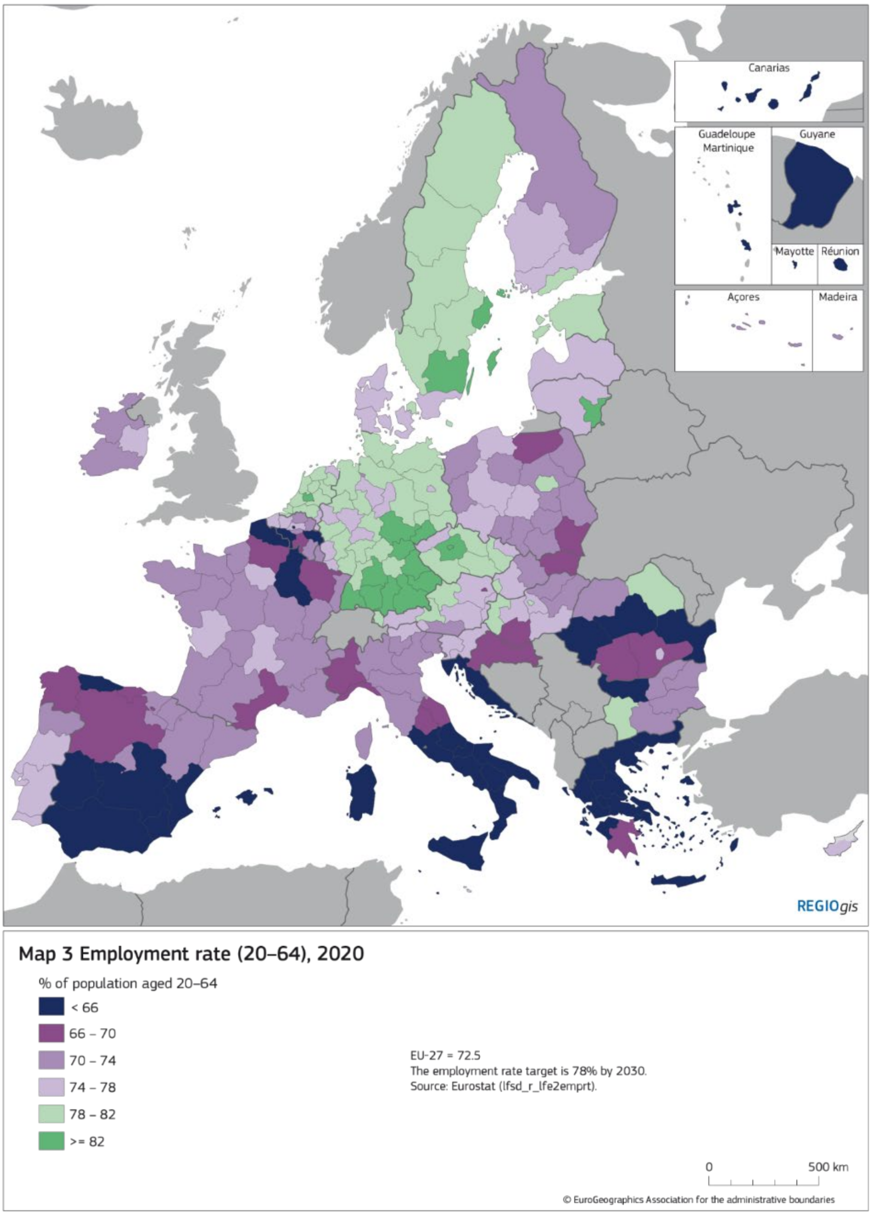

Figure 3. Employment rate (20-64 y. old.) 2020 by region (3)

However, as noted by “Report on Economic, Social and Territorial Cohesion” (3), islands’ economic activity significantly declines during the low season, leading to the closure of many seasonal businesses and causing widespread unemployment.

Fisheries and agriculture face stagnation due to depleted fishing stocks and unprofitable land exploitation.

The challenges are compounded by the small size or fragile economies of certain islands, making it difficult to retain human capital and lacking expertise in emerging fields like ICT. Additionally, access to lifelong learning opportunities for professional diversification is not readily available for island populations. (4)

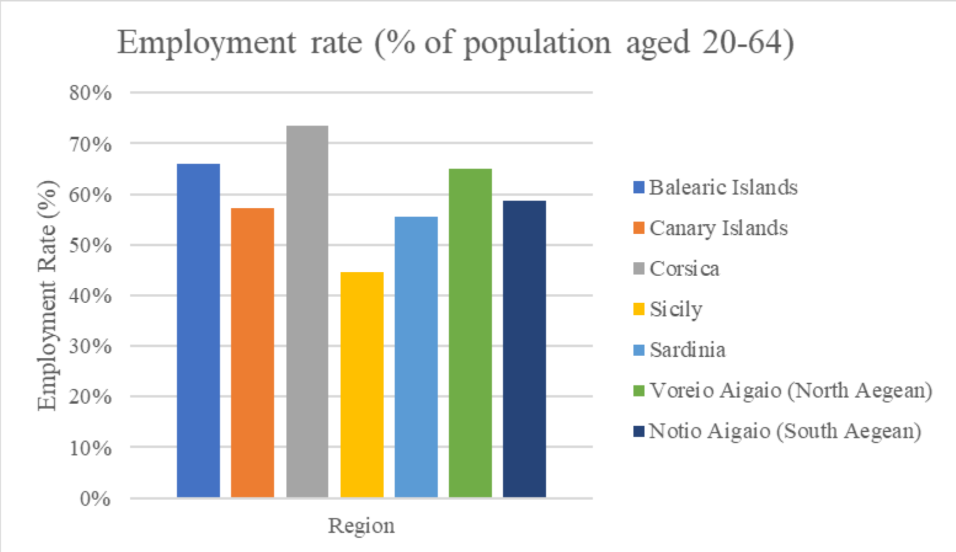

Figure 4. Employment rate in the study island regions (1)

2.1.3 TOURISM

The figure below represents the hotel occupancy rate of the region, indicating the economic development of the region due to tourism.

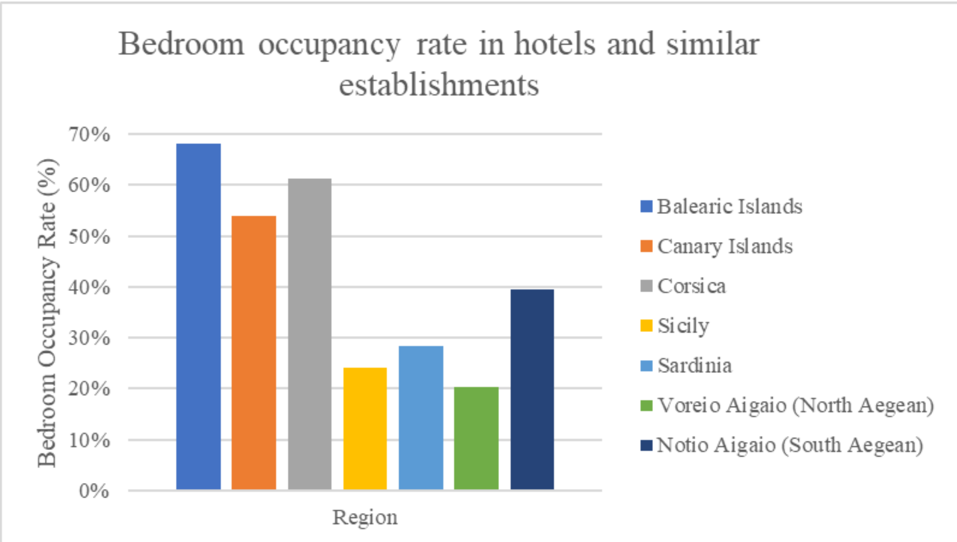

Figure 5. Bedroom occupancy rate in hotels in the study insular region (1)

The regions benefiting most from hotel business are the Balearic Islands (68%) and Corsica (62%), followed by the Canary Islands (54%).

In contrast, Sicily is the island least dependent on tourism (24%), followed by Sardinia (29%). Lower hotel occupancy rates in Sicily that are likely related to the employability rate, as they therefore have lower economic income from tourism.

North Aegean despite having low occupancy rate and has high employment which is likely to low population and density.

This figure may be partially linked to accessibility of these islands for tourist. Seen in the figure below, we see the access to passenger flights data for NUTS 3 regions. It is an important metric to consider for islands especially the touristic ones.

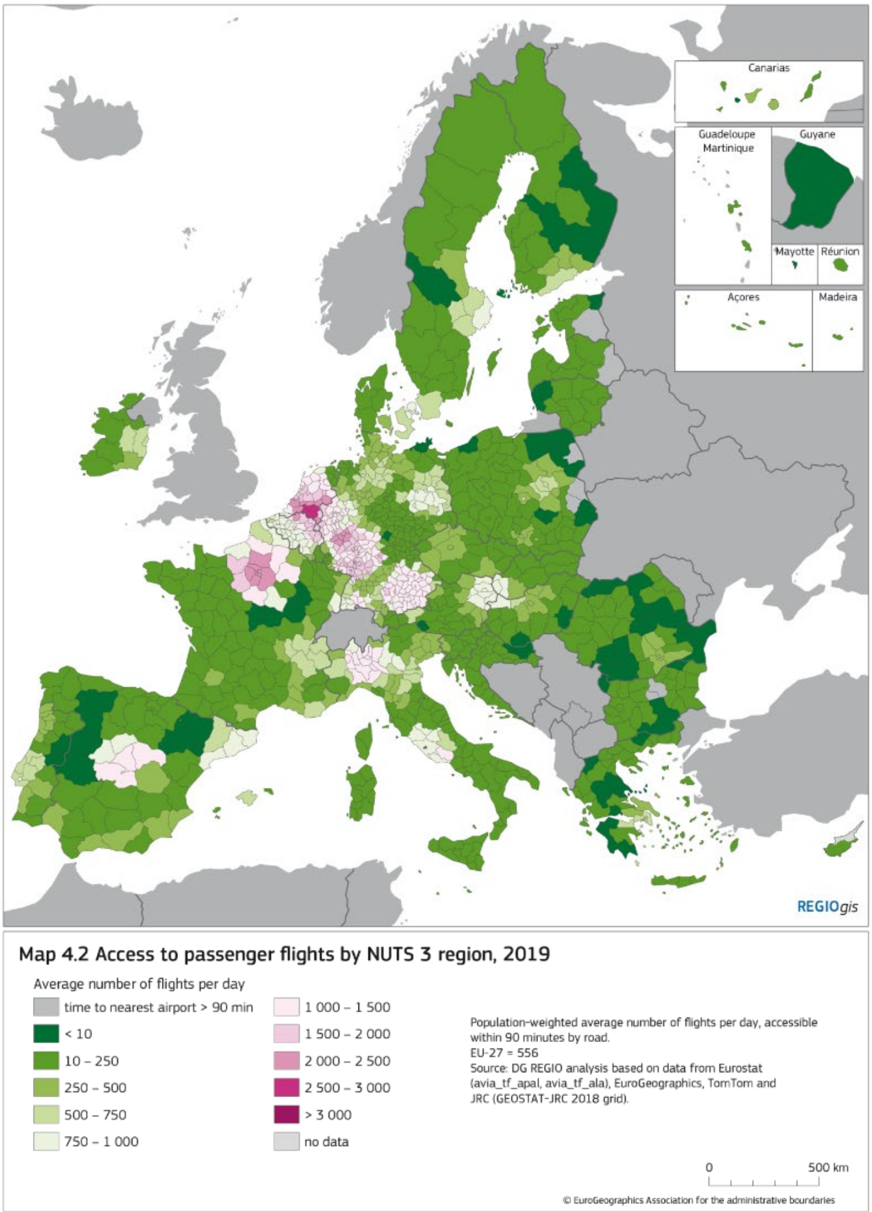

Figure 6. Access to passenger flights by NUTS 3 region, 2019 (3)

2.1.4 ENERGY

European Mediterranean islands diverge from mainland territories due to their unique geographical constraints, promoting a shift towards innovative and sustainable solutions to meet the islands' distinct energy needs.

The energy systems on European Mediterranean islands exhibit distinctive characteristics compared to mainland territories, primarily due to the islands' geographical and environmental constraints. These unique features necessitate innovative solutions to address energy production, distribution, and sustainability.

Islands often face challenges in accessing traditional energy sources, leading to a greater reliance on imported fossil fuels. To counteract this, many Mediterranean islands are increasingly adopting renewable energy sources such as solar, wind, and hydropower. The abundance of sunlight and consistent winds in the region provides an opportunity for islands to harness clean energy, reducing dependency on external resources.

The limited land availability on islands also influences energy infrastructure. Compact spaces demand efficient technologies and decentralized systems, encouraging the implementation of microgrids and localized renewable energy installations. Energy storage solutions, such as batteries, become crucial to balance the intermittent nature of renewable sources and ensure a stable and reliable power supply.

Moreover, the tourism-driven economies of many Mediterranean islands necessitate flexible energy systems capable of accommodating fluctuating demand. Smart grid technologies, demand-side management, and energy-efficient practices play pivotal roles in optimizing energy consumption while minimizing environmental impact.
However, each one of the islands we look closer at in our study has their own unique energy demands that are formed due to various factors such as size, economy composition etc.
Below we can see examples of a monthly energy production for Spain as a country that has overall uniform production with various sources of energy, with biggest variation in use of natural gas and the expected variation in solar energy output.

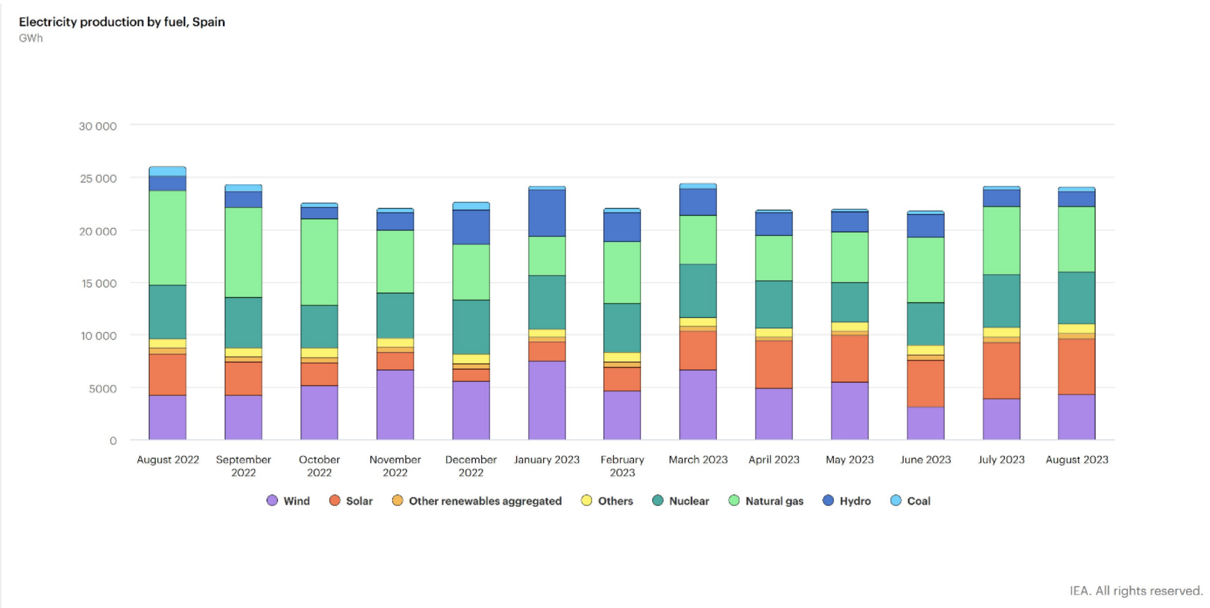

Figure 7. Electricity production by fuel, Spain (5)

However, looking at the data from the islands we see greater variability with expected upticks for during higher touristic seasons. From the data we see that demand in Tenerife is much less variable then in Ibiza.

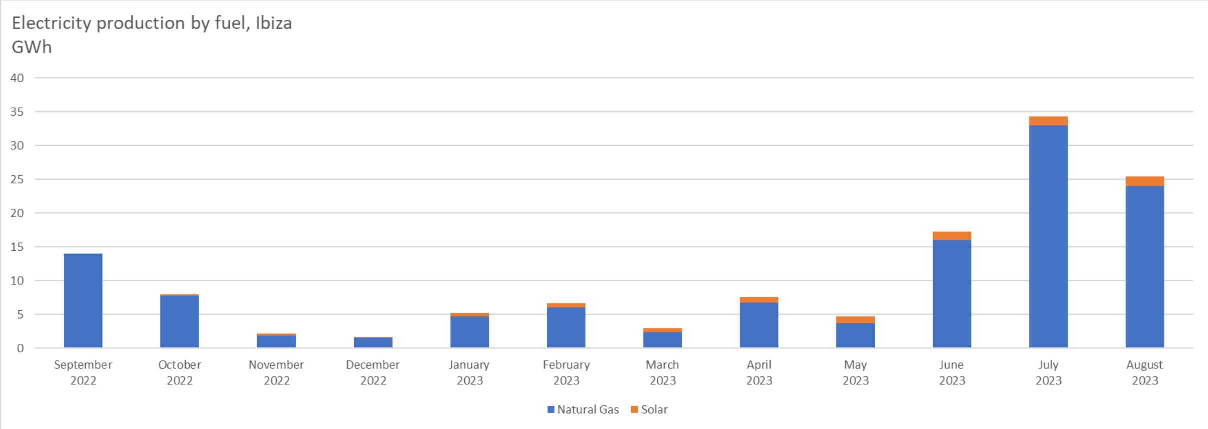

Figure 8. Electricity production by fuel, Ibiza (6)

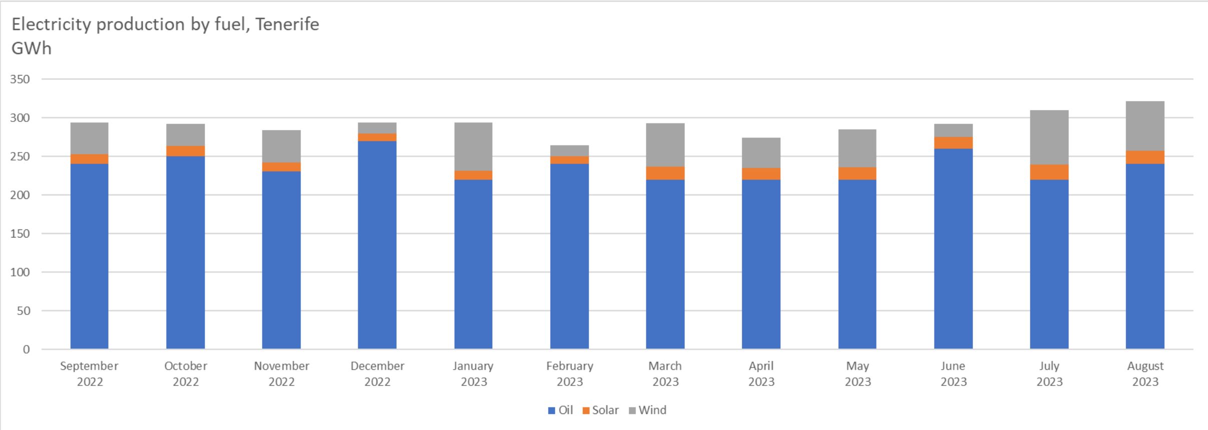

Figure 9. Electricity production by fuel, Tenerife (6)

For Italy we see similar trend with various sources and expected but not dramatic variation in production. Sardinia to large extend follows this trend in large due to being the location to major power plants that are also linked to the mainland grid, so we don't see change in the production data.

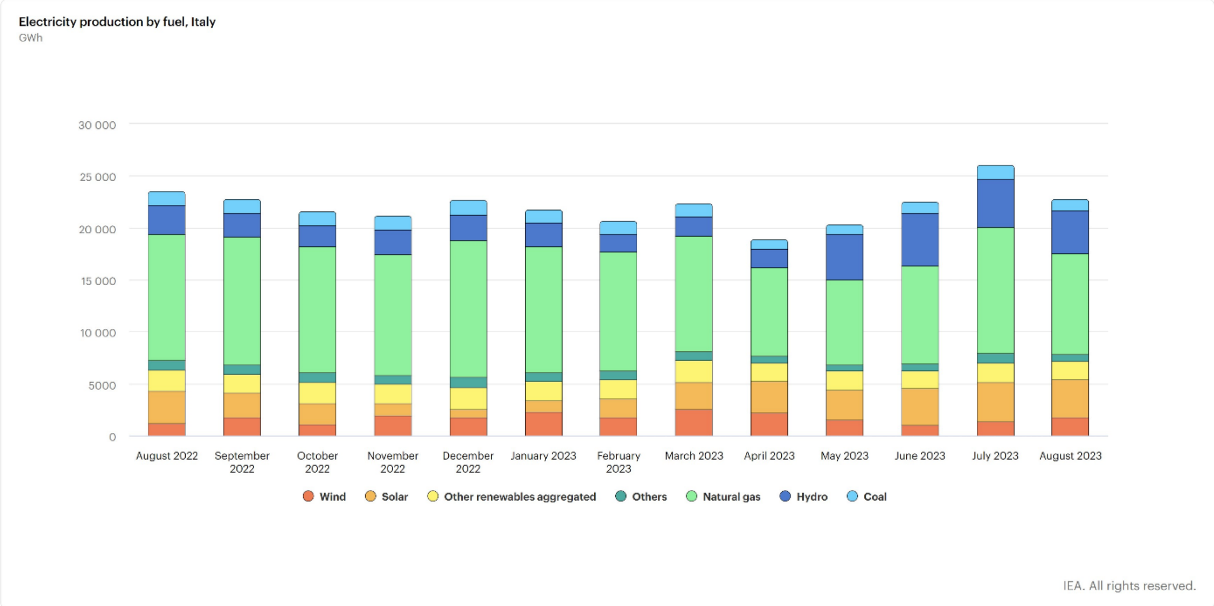

Figure 10. Electricity production by fuel, Italy (5)

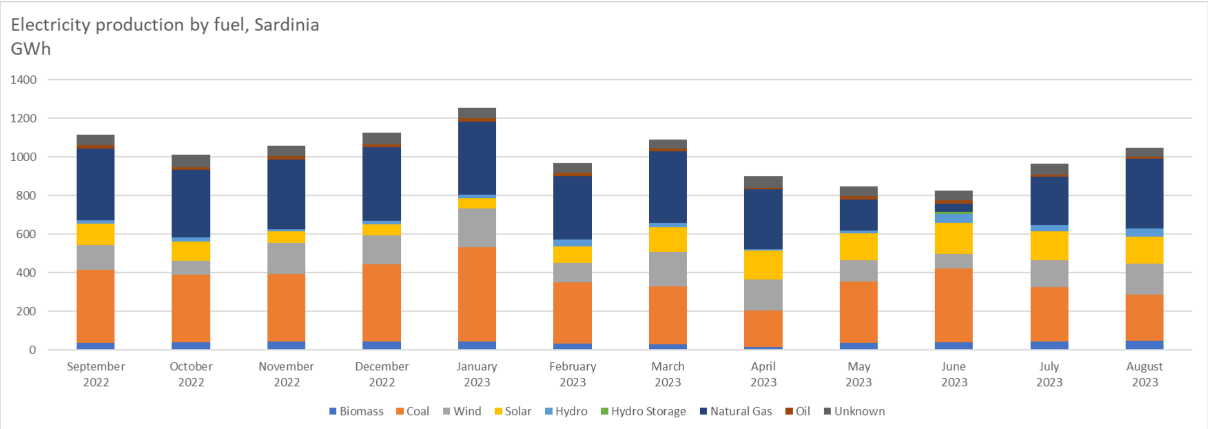

Figure 11. Electricity production by fuel, Sardinia (6)

France is notably a big producer of nuclear and hydro energy that comes with limitations on where it can be produced. Comparatively, we see only a small part of their energy supply being taken up by renewable sources.

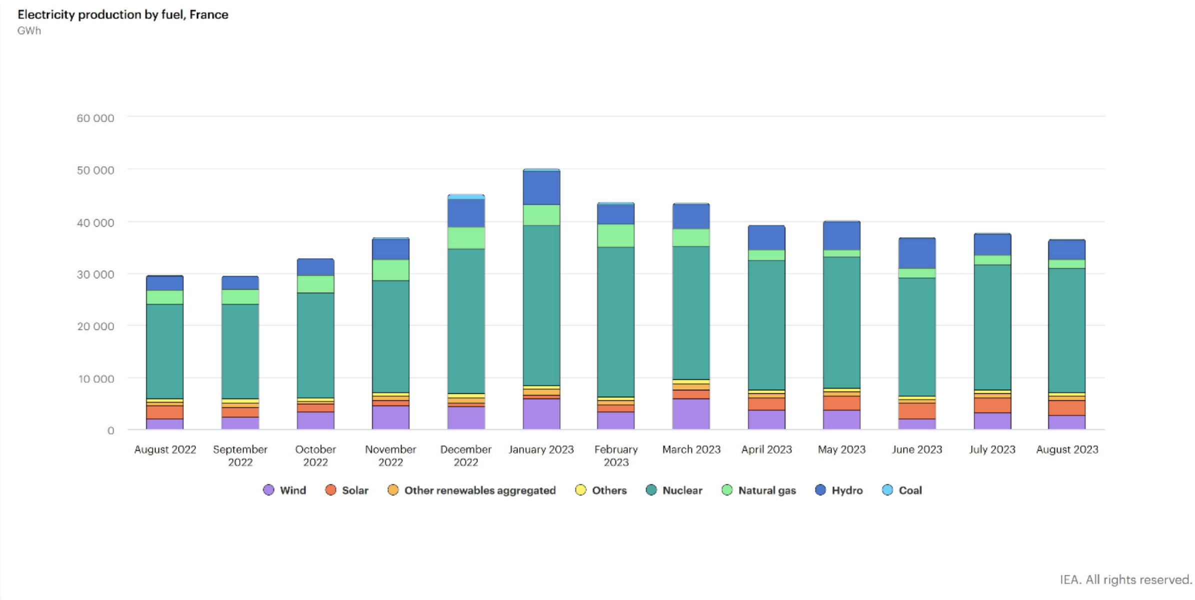

Figure 12. Electricity production by fuel, France (5)

Comparted to other countries analysed Greece has the biggest proportion of it's energy production being taken up by renewables as we see from the graph below. However, we also see a greater deal of coal use.
Unfortunately, data for Greek islands is not available to us at the moment, but seeing the big uptick in energy production from sources like gas and coal during the touristic summer month we can expect this trend to be passed on to the islands. However, due to lack of data no concert conclusions can be made.

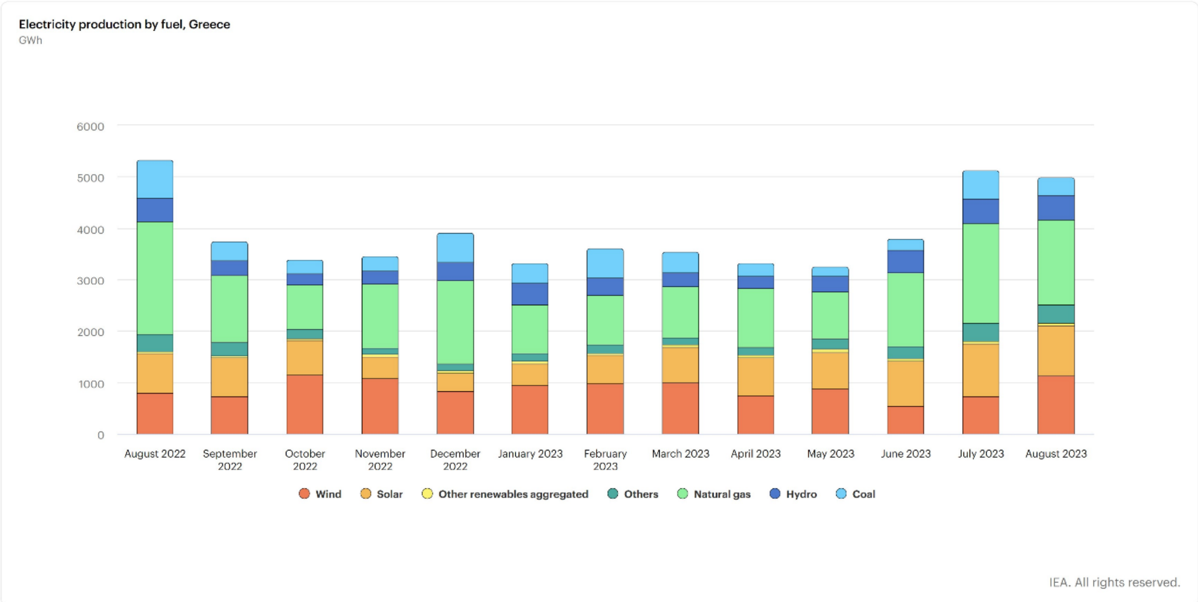

Figure 13. Electricity production by fuel, Greece (5)

After studying the different key aspects that characterise the islands of the Mediterranean, it may be stated that:

- The island of Sicily is characterised by a large population which contrasts with a low population density (larger territory). Its employability ratio is low, and its economy is less dependent on tourism than in other Mediterranean regions.

- In contrast, the Spanish archipelagos of the Balearic and Canary Islands have a high population density but are also characterised by a fair rate of employment, and are heavily dependent on tourism, especially the Balearic Islands.

- The island of Sardinia is characterised by a low population and population density, resulting in a good employment ratio, however, it is not strongly dependent on tourism.

- Corsica is considered an island with a low population but strongly linked to tourism, which means a high employment ratio (the highest of all the islands).

Following the characterisation of the study regions, a method of energy transition analysis for islands is proposed in the next section. This method will be applied in the study regions and the results obtained will be analysed.

2.2 Island-level analysis of the Genera Case studies

2.2.1 Balearic Islands – Ibiza

General Information

General information	
Country	Spain
Region	Balearic Islands
Island name	Ibiza
Area (km2)	571.6 km2

Permanent population	
Population (Number of inhabitants)	154,210 (2022)
Nationalities %	18.87% inhabitants are from a different nationality (2022): Bulgaria, 0.23%, France, 1.32%, Italy, 3.90%, Netherlands, 0.79%, Poland, 0.20%, UK, 2.74%, Germany, 1.55%, Romania, 2.43%, Morocco, 2.78%, Senegal, 0.33%, Cuba, 0.15%, Argentina, 0.98%, Bolivia, 0.09%, Brazil, 0.64%,

	Colombia, 1.21%, Ecuador, 1.02%, Paraguay, 1.33%, Uruguay, 0.36%, Venezuela, 0.25%, China, 0.29%, India, 0.05%	
Languages spoken	Native languages: Spanish and Catalan. Others: English, German, French, Italian and Arabic.	
	Female	*Male*
>18 years old	*13,702*	*14,344*
18 - 30 years old	*8,377*	*8,626*
30 – 45 years old	*22,575*	*21,449*
45 – 65 years old	*17,000*	*23,516*
Over 65 years old	*10,952*	*9,463*

Climate

Climate
The months of low season are the coldest in Ibiza, with temperatures that can reach 8 degrees. January is the coldest month overall. This season is the cheapest to travel to Ibiza, since in these months the island is no longer a beach destination. However, it is the time of the year with less daylight hours. On the other hand, the months before and after summer also enjoy warm temperatures (around 20 degrees), so they can be a great option to visit Ibiza without large crowds and with much more affordable prices in high season. In the summer months, the highest temperatures of the year are concentrated, with highs of more than 30 degrees in August. June and September are milder months in terms of temperatures, but there are also very hot days (26-27 degrees). This is the time of the year when the most hours of sunshine per day can be enjoyed. Prices are much higher than the rest of the year and most tourist establishments (hotels, bars, car, motorcycle or boat rentals...) are crowded. The month with the wettest days in Ibiza is November, with an average of 7.5 days with at least 1 millimetre of precipitation. The month with the fewest wet days in Ibiza is July, with an average of 0.9 days with at least 1 millimetre of precipitation.

Touristic Season					
January	February	March	April	May	June
L	L	L	M	M	H
July	August	September	October	November	December
H	H	H	M	M	L

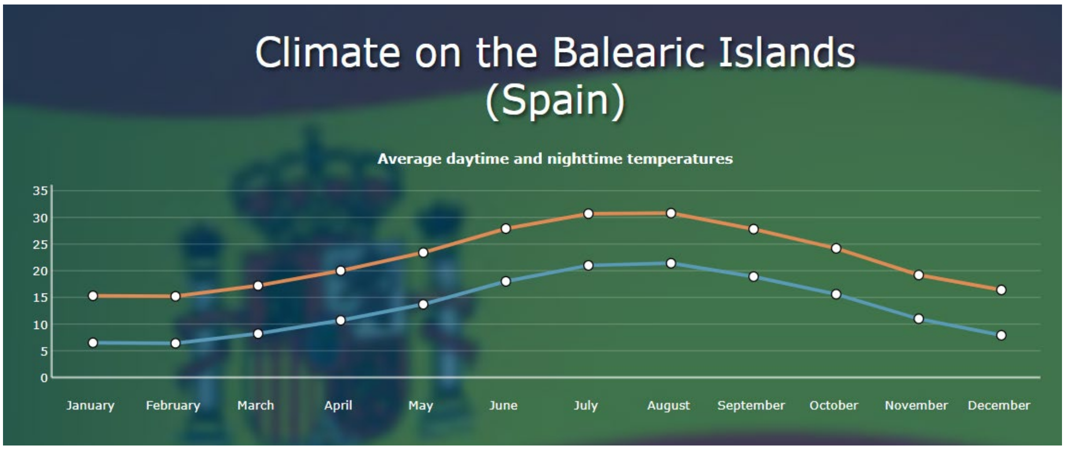

Figure 14.Climate on Balearic Islands (Spain) average daytime and nighttime temperatures (7)

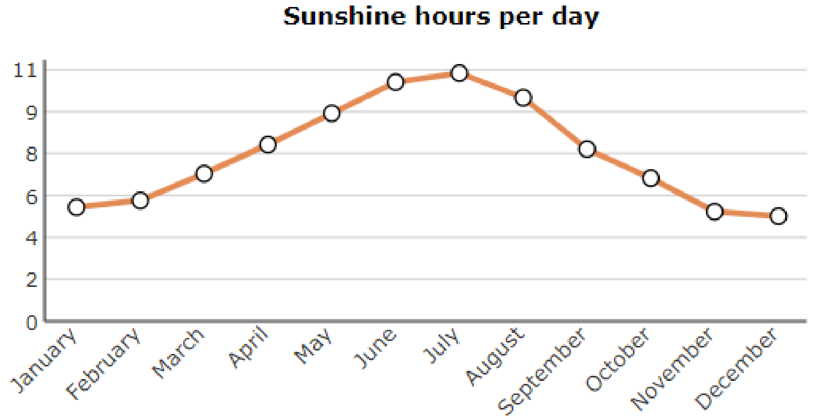

Figure 15.Sunshine hours per day Balearic Islands (Spain) (7)

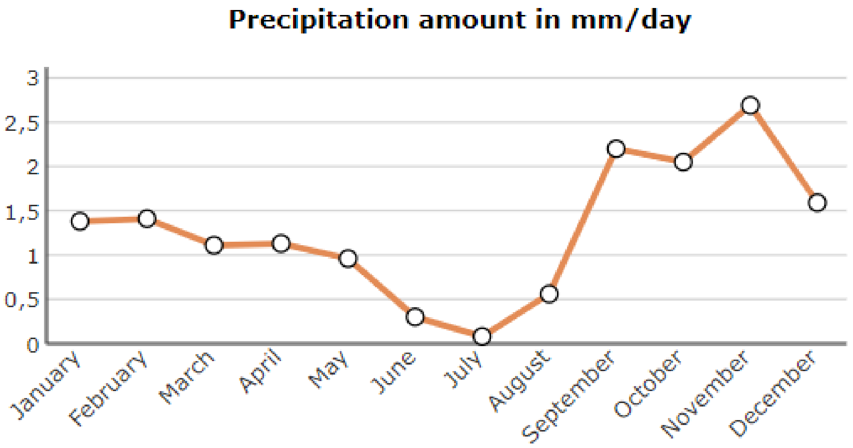

Figure 16.Precipitation amount Balearic Islands (Spain) (7)

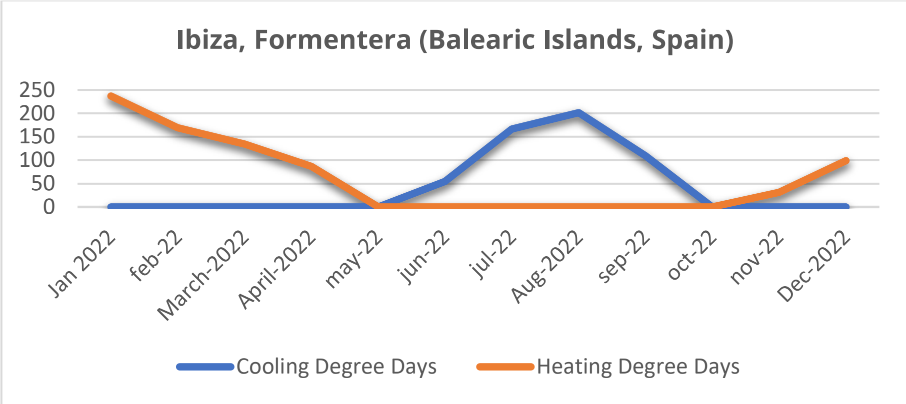

Figure 17.Heating and Cooling Degree days Balearic Islands (Spain) (7)

Connection to the mainland

Relation with the mainland	
Distance to the mainland	150 km
Legislative connection to the mainland	Part of Balearic Islands autonomous community
Infrastructures	
Physical connections for people/goods' transport	It is possible to travel to Ibiza both by ferry and by plane, either from other islands such as Mallorca or from the mainland.
Number of harbours	Ibiza Town (Eivissa), San Antonio and Santa Eulalia are the main (and so far the only) harbours on the island of Ibiza. There are currently around 3,000 moorings in Ibiza's harbours (1. Puerto Deportivo Santa Eulalia, 2. Club Nàutic Sant Antoni de Portmany, 3. Puerto Deportivo Marina Botafoch, 4. Comercial harbour- Marina Ibiza, 5. Club Náutico de Ibiza, 6. Port de Sant Antoni de Portmany, 7. Puerto Ibiza Magna, 8. Puerto Deportivo Coral Mar), with capacity for motor and sailing boats of almost any size.
Number of airports	Ibiza Airport (IBZ)
Main means of transport used by the residents to reach the island	Transport reached a peak in the months of July and August in flights, with a maximum number of passengers of 698,446, while in the case of ferries a peak was reached in August with 262,829 passengers.
Main means of transport used by the tourists to reach the island	In the case of tourists, according to the above data it is easier to reach the island of Ibiza by plane, so it is understood that most tourists travel by plane, although there will also be cases of travel by ferry.
Main means of transport used for the import/export of goods	There are international maritime or air freight transport service companies operating between all the islands of the Balearic archipelago and, more specifically, Ibiza.
Connections for energy supplies (Connection of the islands grid to the mainland one)	Electrical cables for electrical energy Gas pipeline that carries gas from the Alicante town of Denia to Mallorca via the island of Ibiza. Oil pipeline with the harbour of Palma

Local Government

Administrative structure	
Level of government of the island	One of the four constituencies represented in the Parliament of the Balearic Islands, the regional legislature of the Autonomous Community of the Balearic Islands.
Number of municipalities on the islands	5
Number of the municipality/ies involved in the project	5
Responsible organizations overseeing energy	Consorci de l'Energia de les Illes Balears (CIB) The CIB is the public company that manages the energy sector in the Balearic Islands. It is responsible for the production, distribution, and sale of electricity, as well as the development of renewable energy sources. Regulació de Serveis Energètics de les Illes Balears (ERSEB) The ERSEB is the regulatory authority for the energy sector in the Balearic Islands. It is responsible for ensuring that the energy market is competitive and efficient, and that consumers are protected. Autoritat de Competència de les Illes Balears (AICB) The AICB is the competition authority for the Balearic Islands. It is responsible for investigating and taking action against anti-competitive behavior in the energy sector. Consells Insulars d'Energies Renovables (CONIRE) The CONIREs are the island councils for renewable energies. They are responsible for promoting and developing renewable energy projects in their respective islands. Aigües de Ibiza, S.A. (AIIB) The AIIB is the water utility company for Ibiza. It is responsible for supplying water to the island's residents and businesses. Energia Elèctrica d'Ibiza, S.A. (EEI) The EEI is the electricity distribution company for Ibiza. It is responsible for delivering electricity to the island's homes and businesses.

Economic activities

Island GDP		
Industry	GDP %	Workforce involved/ people employed

Industry and Energy	6.43	7.53
Agriculture	*0.79*	*1.57*
Construction	8.86	10.27
Services	83.91	74.96

Energy Consumptions

Annual energy consumption by sector	[MWh]
Residential	402,683.097
Primary sector	23,041.296
Industries	1,592.703
Tertiary sector	376,073.821
Transport	1,561.068

Annual energy consumption for heating and cooling	[MWh]
Electricity	97,200.516
Light fuels (oil and natural gas derivatives)	95,842.83
Natural Gas	38,634.86
Biomass	8,687.61
GLP	143,060.6

Electricity Production and carbon intensity in the last 12 months

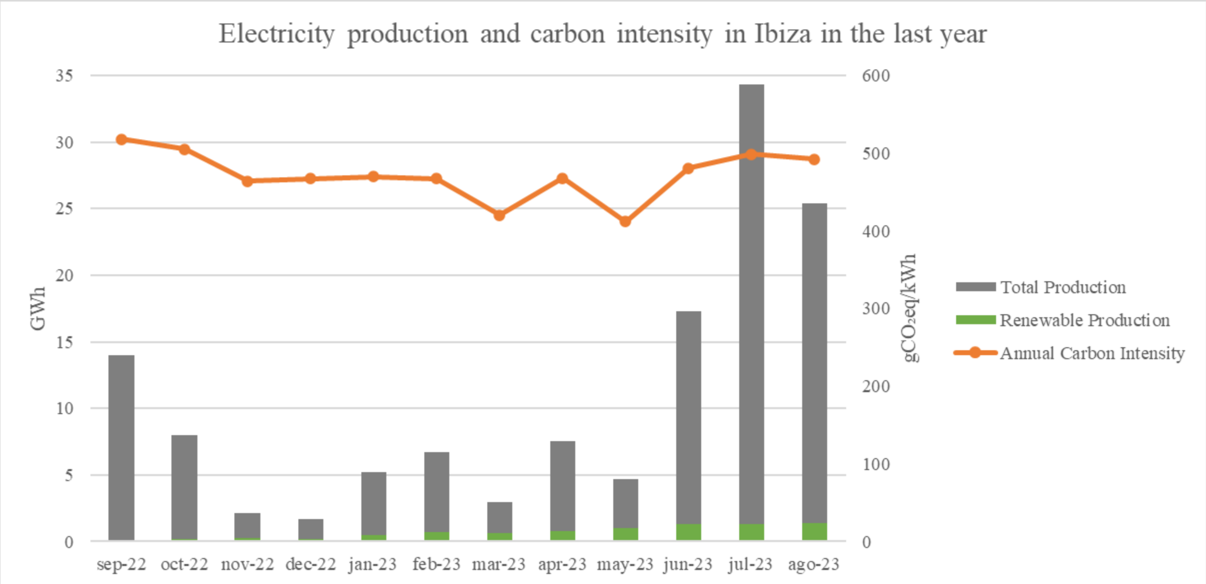

Figure 18.Electric production and carbon intensity in Ibiza Sep.2022-Aug.2023 (8)

Data Sources for Ibiza

List of data sources	
Red Electrica de España - Mallorca - Ibiza electricity connection	https://www.ree.es/sites/default/files/01_ACTIVIDADES/Documentos/Romulo2_es.pdf
Balearic Harbour Authority	https://www.portsdebalears.com/es/eivissa
Harbours of Ibiza and Formentera	https://goacatamaran.com/es/puertos-ibiza-y-formentera/
Ibiza Airport	https://www.aena.es/es/ibiza.html
Sustainable urban mobility plan (PMUS) of Eivissa	https://www.eivissa.es/portal/images/stories/pdf/220218PMUS.pdf
Fuel and liquid fuel logistics services	https://exolum.com/sobre-exolum/que-hacemos/
Redexis Gas - Expands its distribution network in Eivissa	https://www.redexis.es/es/b/redexis-gas-amplia-la-red-de-distribucion-en-eivissa
Labour Market Report Balearic Islands Data 2021 - State Public Employment Service	https://sepe.es/SiteSepe/contenidos/que_es_el_sepe/publicaciones/pdf/pdf_mercado_trabajo/2022/mercado-de-trabajo-provincial-2022/MT-Illes-Balears-Datos-2021.pdf
Institute of Statistics of the Balearic Islands	https://ibestat.caib.es/ibestat/estadistiques/8b419725-bb6e-4710-a94f-34f08a4ad5ba/6e87e8c1-4755-4fe7-bb7c-5daed471c35e/es/u204004_0002.px
Clean Energy for EU Islands	https://transparencia.conselldeivissa.es/public/docs/F_ES_1693469376.pdf

2.2.2 Canary Islands – Tenerife

General Information

General information	
Country	*Spain*
Region	Canary Islands
Island name	Tenerife
Area (km²)	2034.38 km²

Permanent population	
Population (Number of inhabitants)	*1,048,306*
Nationalities %	85.8% Spanish; 14.2% Foreign; Rest of Europe 8.8%; Germany 1%; Austria 0.1%; Belgium 0.3%; Finland 0.1%; France 0.4%; Italy 2.9%; Netherlands 0.1%; Portugal 0.3%; United Kingdom; Sweden; 2004 Expansion; Bulgaria; Romania; Other European Union Countries; Norway; Switzerland; Other European Countries; Africa; Morocco; Mauritania; Senegal; Others from Africa; Americas; Cuba; Dominican Republic; Argentina; Colombia; Chile; Ecuador; Uruguay;

	Venezuela; Other American Countries; Asia; China; Philippines; India; Republic of South Korea; Other Asian Countries; Oceania; Stateless	
Languages spoken	*Spanish, English, German, Russian,*	
Population pyramid		
	Female	*Male*
>19 years old	73,125	77,682
20 - 29 years old	49,104	48,847
30 – 45 years old	95,427	94,281
45 – 65 years old	141,202	137,756
Over 65 years old	87,639	68,559

Climate

Climate
Tenerife enjoys a subtropical climate, making it a year-round destination for tourists. The winters in Tenerife (December to February) are mild and pleasant. Daytime temperatures typically range from 18°C to 24°C, making it a popular destination for those looking to escape colder climates. The summers (June to August) are warm and sunny. Daytime temperatures can range from 26°C to 32°C. Nonetheless Tenerife's landscape includes mountains and coastal areas, leading to diverse microclimates. The north is generally greener and cooler, while the south is drier and sunnier, which means you can go from 0 to 28ºC in one day depending on where you are on the island. Another important characteristic is the Alisio. These northeast trade winds can influence the weather, leading to some variation in temperature and humidity across the island. These winds can bring cloud cover to the north, which contrasts with the sunny skies in the south.

Touristic Season					
January	February	March	April	May	June
H	H	H	H	H	M/L
July	August	September	October	November	December
H	H	M/L	M/L	M/L	H

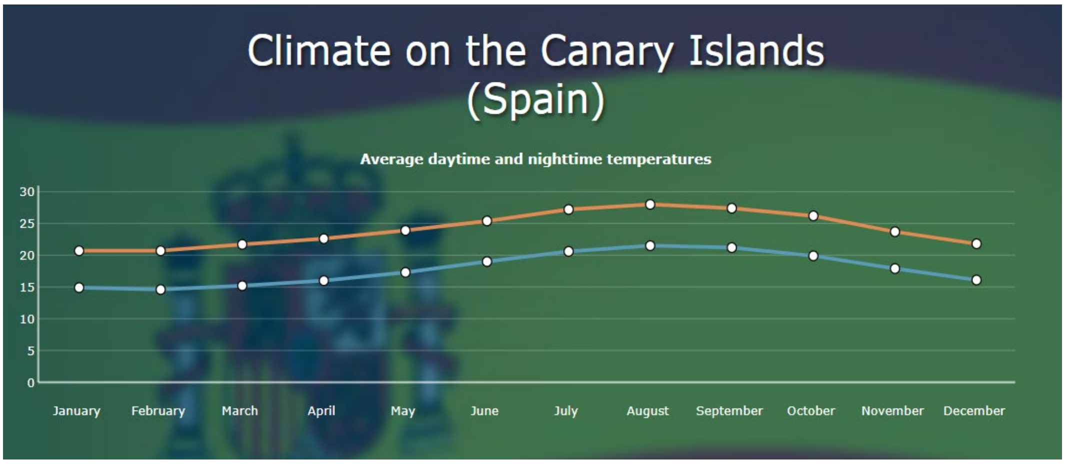

Figure 19.Climate on Canary Islands (Spain) average daytime and nighttime temperatures (7)

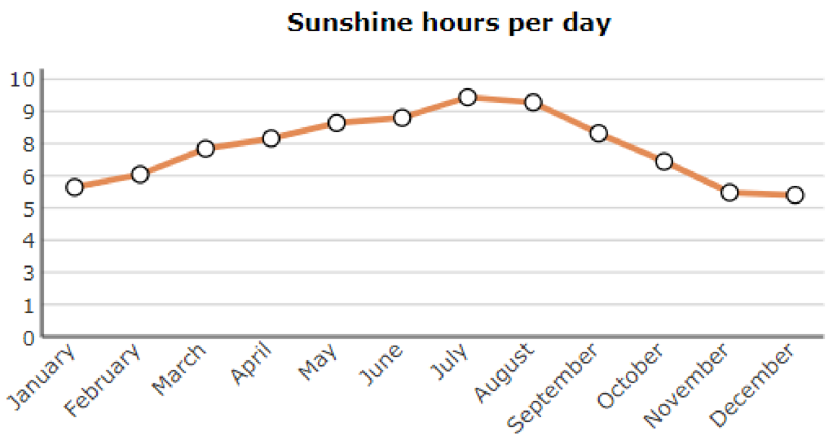

Figure 20.Sunshine hours per day Canary Islands (Spain) (7)

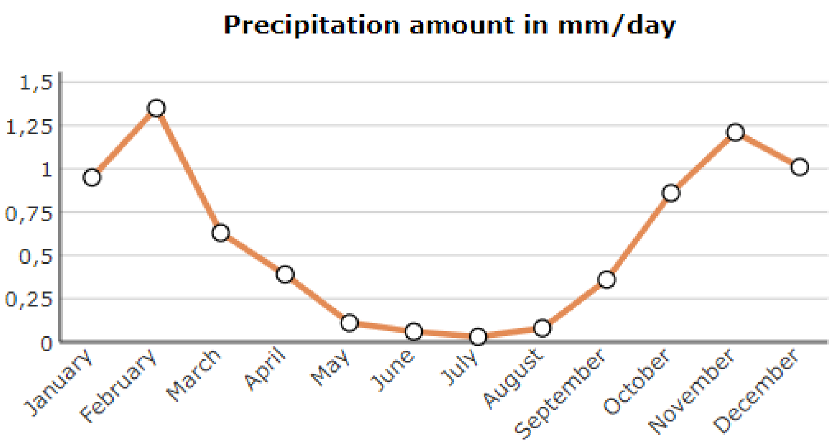

Figure 21.Precipitation amount Canary Islands (Spain) (7)

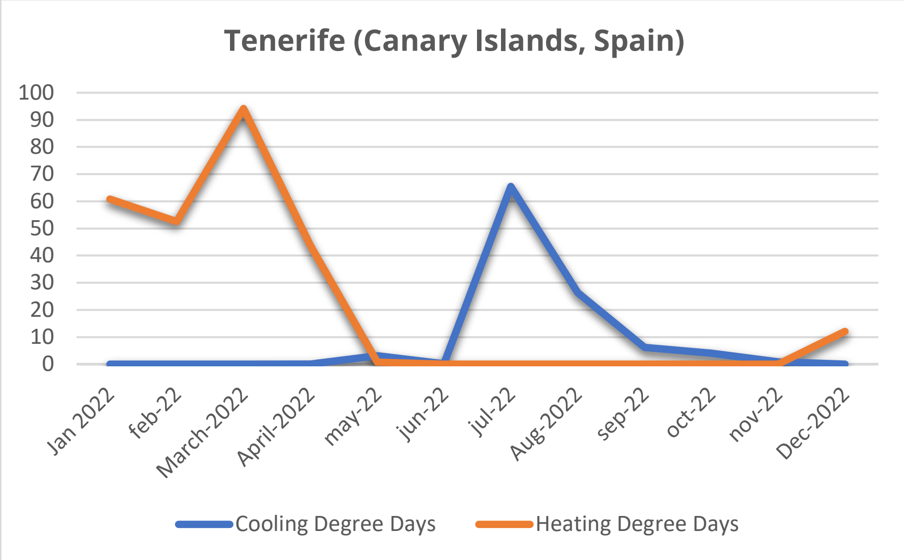

Figure 22.Heating and Cooling Degree days Canary Islands (Spain) (7)

Connection to the mainland

Relation with the mainland	
Distance to the mainland	Approximately 1,150 km
Legislative connection to the mainland	The Autonomous Community of the Canary Islands has its own Parliament and President. The Canary Islands are regarded as outermost regions. The islands have 14 seats in the Spanish Senate. The autonomous island status and their own tax system are both mentioned in the Spanish Constitution. Furthermore, there is special legislation set up for the autonomous regions. The island, itself is part of a Spanish province named Santa Cruz de Tenerife, which is divided administratively into 31 municipalities. Tenerife is one of the 4 islands that make up one of the two provinces that make up the Canary Islands Autonomous Community.
Infrastructures	
Physical connections for people/goods' transport	Ferrys connect Tenerife with the nearby islands: Gran Canaria, La Pama and La Gomera. Tenerife is also connected with Cádiz, and Huelva in the south of Spain. There are no bridges or similar physical structures that connect the island with the rest.
Number of harbours	Tenerife has two principal maritime ports: the Port of Santa Cruz de Tenerife (Puerto de Santa Cruz), which is the main entrance of services and passengers to the island (both commercial and touristic), and the Port of Los Cristianos (Puerto de Los Cristianos), which is mainly used for passenger transport - touristic harbour.
Number of airports	The island has two international airports, Tenerife Sur Airport (TFS) and Tenerife Norte Airport (TFN)
Main means of transport used by the residents to reach the island	Majority of residents use plane and small number uses ferries

Main means of transport used by the tourists to reach the island	The tourists arrive by plane. During their visit, they use rental cars, plane, ferry, bike, bus etc.
Main means of transport used for the import/export of goods	Goods are imported mostly by boat, using the Harbour of Gran Canaria, one of the most important harbours in Spain as main entrance, which then distributes to the rest of the islands, including Tenerife.
Connections for energy supplies (Connection of the islands grid to the mainland one)	The Canary Islands are not electrically interconnected to the mainland. There is an interconnection between Fuerteventura and Lanzarote, two Canary Islands. Tenerife has and isolated electrical subsystem, as most of the islands in the Archipelago. Given its isolated position and small size, Insular and Extra-peninsular Electricity Systems present their own limitations and constraints affecting the electricity supply, resulting in higher investment and operating costs than a typical interconnected mainland grid system. In the same way, the electricity generation in these territories is not regulated according to the mainland model of a wholesale market. The wholesale market model would not be able to respond to the aim of guaranteeing the electrical power supply by meeting demand efficiently, in cost terms. Today's generation in Insular and Extra-peninsular Electricity Systems is through fuel-oil, or combined cycle generators, and, to a lesser extent, by wind, PV, and cogeneration facilities.

Local Government

Administrative structure	
Level of government of the island	Tenerife is a part of the Canary Islands, which is an autonomous community of Spain. Therefore, the level of government overseeing Tenerife would be the regional government of the Canary Islands. Additionally, there are municipal governments that oversee specific areas within the island, providing services and managing local affairs.
Number of municipalities on the islands	31
Number of the municipality/ies involved in the project	Granadilla de Abona is the Municipality where ITER is located.
Responsible organizations overseeing energy	**Regional Government:** The Canary Islands government, particularly the regional Ministry of Economy, Industry, Trade, and Knowledge, plays a significant role in energy policies, regulations, and initiatives within Tenerife. **Councils and Municipalities**: Local governments, such as the Tenerife Island Council (Cabildo de Tenerife), and municipal councils within Tenerife, often have departments or bodies

	responsible for managing and promoting energy-related projects and sustainability initiatives at a local level. **Energy Regulatory Authority:** Spain has a national energy regulator, the National Commission of Markets and Competition (Comisión Nacional de los Mercados y la Competencia, CNMC), which oversees the electricity and gas markets, including regulations, tariffs, and competition. **Utility Companies**: Several energy companies operate in Tenerife, providing electricity, gas, and renewable energy services. These companies comply with regulations set by national and regional authorities while offering services to residents and businesses.

Economic activities

Island GDP		
Industry	GDP %	Workforce involved/ people employed
Agriculture, livestock, forestry and fishing	2.19	-
Industry	6.68	-
Construction	6.22	-
Services sector (Tourism)	**84.92**	-

Energy Consumptions

Annual energy consumption by sector	**[MWh]**
Residential	1,120,705.4
Primary sector	61,245.58
Industries	154,604.68
Tertiary sector	1,705,871.99
Transport	16,241.09

Annual energy consumption for heating and cooling	**[MWh]**
Electricity	
Light fuels (oil and natural gas derivatives)	
Natural Gas	
Biomass	
GLP	
Note: *Heating and cooling are rarely used in the island. Cooling is more often but is mostly restricted to the touristic sector. Could not find information about it*	

Electricity Production and carbon intensity in the last 12 months

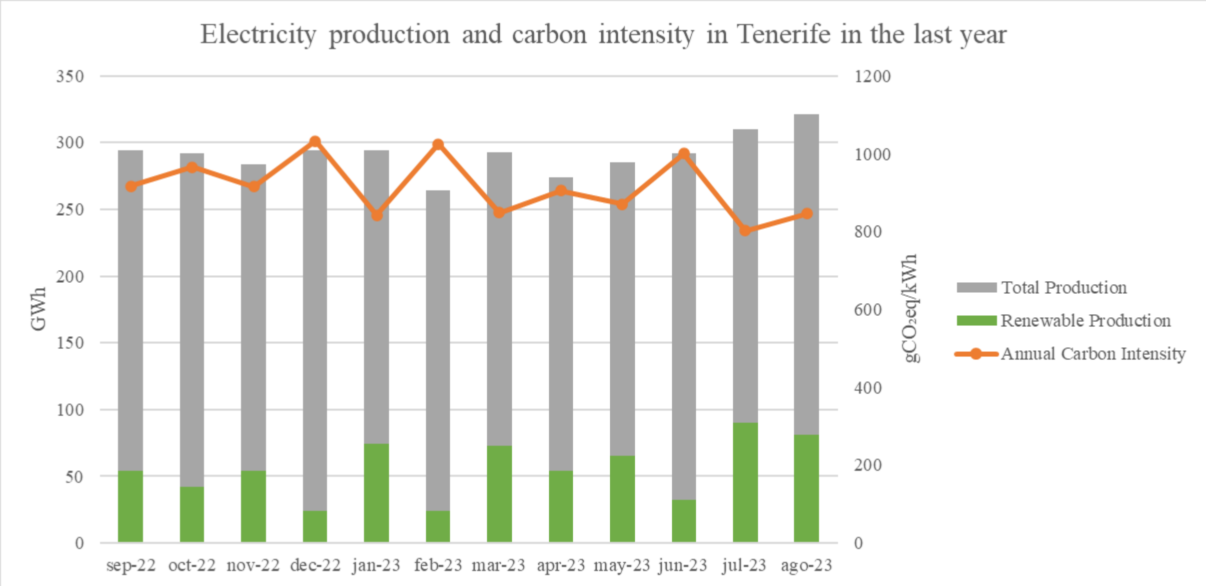

Figure 23.Electric production and carbon intensity in Tenerife Sep.2022-Aug.2023 (8)

Data Sources for Tenerife

List of data sources	
WEB Tenerife	*https://www.webtenerife.com/investigacion/*
Instituto Canario de Estadística	*https://www.gobiernodecanarias.org/istac/*
Anuario estadístico de Canarias 2021	*https://www3.gobiernodecanarias.org/ceic/energia/oecan/files/AnuarioEnergeticoCanarias_2021_v2.pdf*
Cabildo de TENERIFE	https://www.tenerife.es/portalcabtfe/es/descubre-tenerife/sobre-la-isla-de-tenerife/economia-y-demografia
Annual energy consumption by sector : Consumo final de energía eléctrica y número de clientes según principales sectores. Islas de Canarias por años . ISTAC.	*https://www3.gobiernodecanarias.org/istac/statistical-visualizer/visualizer/data.html?permalink=1qcsuodvgkdtnttc18qpjtc15c*
Elaboration of the carbon footprint carbon footprint of the municipalities of canary islands	https://www.idecanarias.es/resources/_TE_CC/HC/Elaboracion_Huella_Carbono_Canarias_conFichas.pdf)
Population by sex, municipalty and age., INE.	https://www.ine.es/jaxiT3/Datos.htm?t=33902#!tabs-tabla
Households by municipality and size. INE)	https://www.ine.es/up/BAr2pcxL
Graph of Population pyramid .STAC | Explotación Estadística del Padrón Municipal	http://www.gobiernodecanarias.org/istac/estadisticas/demografia/poblacion/cifraspadronales/E30260A.html
Households by size according to household structure	https://www.ine.es/up/hYX0gJ1Y

2.2.3 Italian Islands - Sardinia

General Information

General information	
Country	Italy
Region	Sardinia
Island name	Sardinia
Area (km^2)	24,100

Permanent population		
Population (Number of inhabitants)	1,575,028	
Nationalities %	3.2 % of residents are from a different nationality (2023): 22.5% Romania, 8.5% Senegal, 7.9% Morocco, People's Republic of China 6.48%, Ukraine 5.75%, Philippines 3.92%, Nigeria 3.57%, Bangladesh 2.80%, Germany 2.42%, Pakistan 2.09%, Poland 2.07%, Kyrgyzstan 1.88%, Russian Federation 1.57%, France 1.52%, Albania 1.52%, United Kingdom 1.41%, Brazil 1.40%, Tunisia 1.29%, Argentina1.20%, Bosnia and Herzegovina1.09%, Spain 1.06%, India1.08%, Others less than 1%	
Languages spoken	Native languages: Italian Others: Sardinian, Catalan English, Spanish, French	
Population pyramid		
	Female	*Male*
>18 years old	*112,766*	*105,199*
18 - 30 years old	*88,530*	*81,547*
30 – 45 years old	*142,890*	*137,619*
45 – 65 years old	*255,039*	*260,393*
Over 65 years old	*173,353*	*21,7692*

Climate

Climate
Sardinia's climate is typically Mediterranean, i.e. the temperatures have a summer maximum and a winter minimum, while rainfall follows an exactly opposite trend, concentrated in two peak periods in late autumn and spring, separated by a moderately rainy period. As far as temperature analysis is concerned, the annual average maximum temperature for Sardinia is 20.4°C; the hottest month is usually July (average maximum 30.5°C). The annual minimum temperatures average 10.5°C, the coldest month January (average minimum temperature of the month 4.9°C). Significant differences can be recorded in microclimatic regions of the island: the Campidano and Sulcis areas reach higher average temperatures than the rest of Sardinia, with maximum temperatures in August almost never below 34°C.

Rainfall patterns vary considerably in different micro-regions of Sardinia: the rainiest areas are Limbara, the Campeda plateau, the Gennargentu massif and Ogliastra. The driest areas are the southwest regions of the island, the Nurra and Campidano, and other spot areas along the coastal strip. The lowest values are usually recorded in the south-western part of the island, where the annual accumulations do not exceed 380-400 mm; the rainiest region is the Gennargentu where the annual accumulation almost always exceeds 1200 mm.

An important characteristic of Sardinia's climate is the frequency of winds. Windless days are rare. The mistral and the west are the strong winds that blow most frequently and in all seasons. In summer, the frequency of winds from the southern quadrants increases.

Touristic Season					
January	February	March	April	May	June
L	L	L	M	M	H
July	August	September	October	November	December
H	H	M	M	L	L

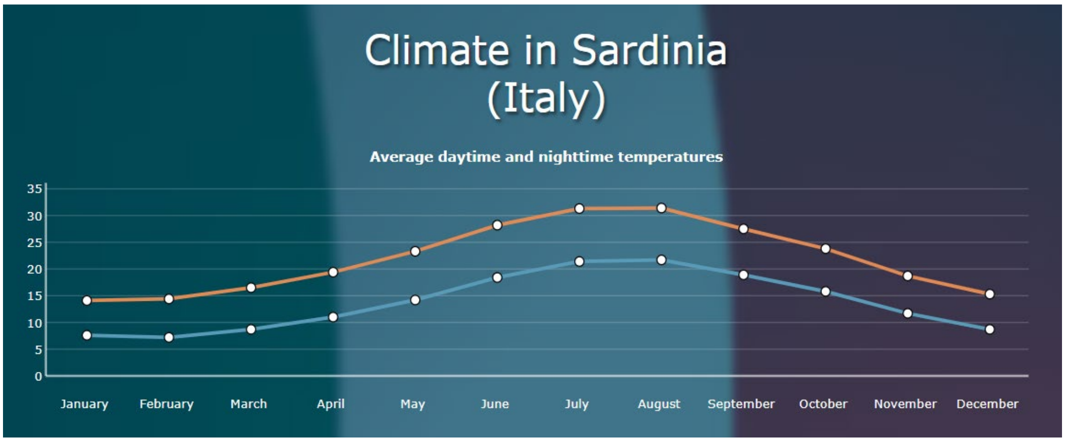

Figure 24.Climate on Sardinia (Italy) average daytime and nighttime temperatures (7)

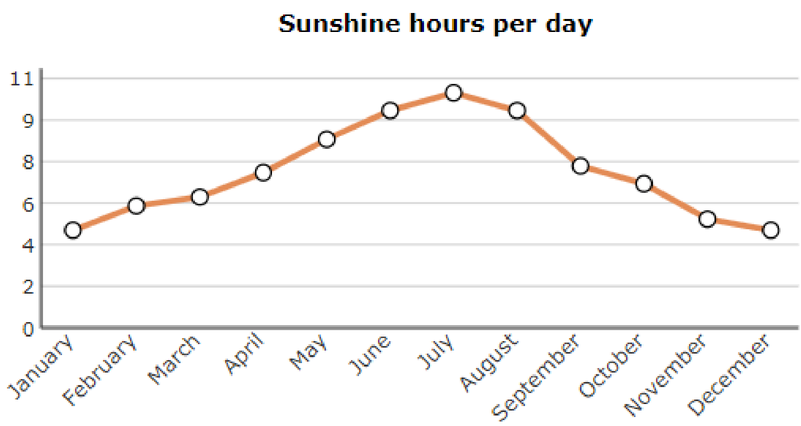

Figure 25.Sunshine hours per day Sardinia (Italy) (7)

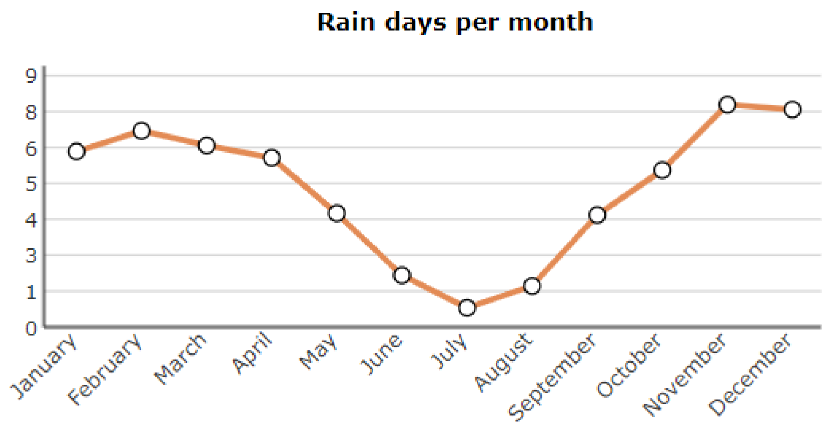

Figure 26.Rain days per month Sardinia (Italy) (7)

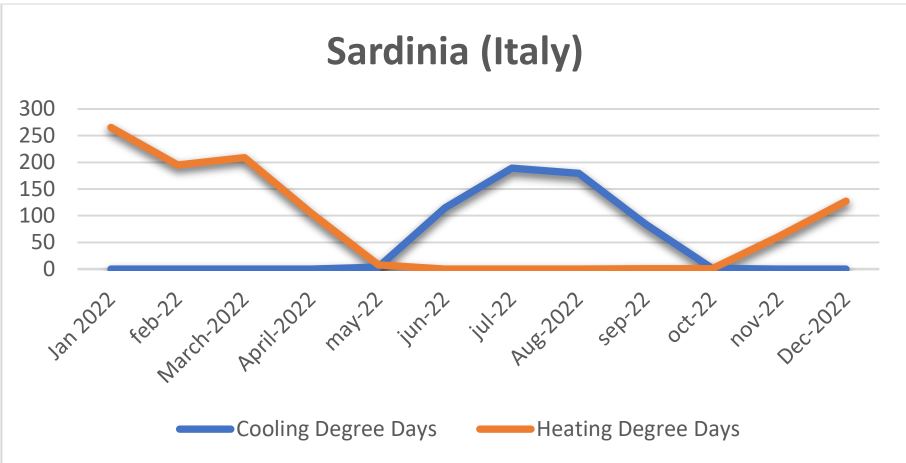

Figure 27.Heating and Cooling Degree days Sardinia (Italy) (7)

Connection to the mainland

Relation with the mainland	
Distance to the mainland	188 km
Legislative connection to the mainland	The “Independent Region of Sardinia” is one of the five Italian regions with a special statute that is, it is a region that enjoys particular forms and conditions of autonomy with respect to the others.
Infrastructures	
Physical connections for people/goods' transport	ferry routes, flights,
Number of harbours	4 touristic and commercial, 1 commercial
Number of airports	4 touristic and commercial, 1 military, 1 private traffic. The current available capacity makes it possible to meet a traffic of around 10 million passengers. The 83.3% of traffic operated from the airports of Sardinia it is National character

Main means of transport used by the residents to reach the island	Residents use plane and ferries.
Main means of transport used by the tourists to reach the island	ferry routes and flights
Main means of transport used for the import/export of goods	Freight transport is mainly carried out by sea. Cargo traffic at Sardinia's airports is marginal compared to sea freight
Connections for energy supplies (Connection of the islands grid to the mainland one)	The interconnection with the national electricity grid for bidirectional energy flows is guaranteed by two submarine cables, the Sa.Co.I. (Sardinia-Corsica-Italy), the and the most recent and high-performance Sa.Pe.i. (Sardinia-Italian Peninsula). A third submarine cable (Sar.Co.) manages energy flows between Sardinia and Corsica.

Local Government

Administrative structure	
Level of government of the island	Region with special statute. The functions attributed by the Statute to the Region can be traced back to three: legislative function, administrative function, political function and are exercised by the following bodies: President-elect, government junta and regional council, i.e. the parliament of the region. The territory is then divided into 6 provinces that have territorial competences and finally there are local authorities, municipalities.
Number of municipalities on the islands	377
Number of the municipality/ies involved in the project	Stintino as Consortium Partners, around 90 municipality involved indirectly
Responsible organizations overseeing energy	National and Regional Government Councils and Municipalities ARERA- Italian Regulatory Authority for Electricity gas and water system GSE - Manager of energy services in Italy Several energy (electricity and gas) distributors (companies operating in all provinces)

Economic activities

Island GDP		
Industry	GDP % (year 2021)	Workforce involved/ people employed (year 2022)
Trade	24.1	25
Agriculture, forestry and fishing	4.1	24

Services	57,8	30
Construction	5.3	14
industry	8.7	7

Energy Consumptions of the Municipality of Stintino

Annual energy consumption by sector	[MWh] (year 2005)	
Residential	22%	7,319
Primary sector		
Industries	3%	821
Tertiary sector + public	21%	6,482 + 439
Transport	54%	17,910

Annual energy consumption for heating and cooling	[MWh]
Electricity	39% (32971 MWh total)
Oil	0
Natural Gas	0
Biomass	0
GPL	61% (32971 MWh total)

Energy Consumptions of the Sardinia Region/island

Annual energy consumption by sector	[MWh]
Residential	1,012,300.00 electrical + 5,152,090.00 thermal
Primary sector	106,000.00 el. + 34,890.00 therm.
Industries	1,457,500.00 el. + 3,523,890.00 therm.
Tertiary sector	1,017,600.00 el. + 546,610.00 therm.
Transport	42,400.00 electrical
Others	360,530.00 thermal

Annual energy consumption for heating and cooling	[MWh] (only heating)
Electricity	965,290.00
Oil	616,390.00
Natural Gas	
Biomass	1,256,040.00
GPL	628,020.00
others	127,930.00

Electricity Production and carbon intensity in the last 12 months

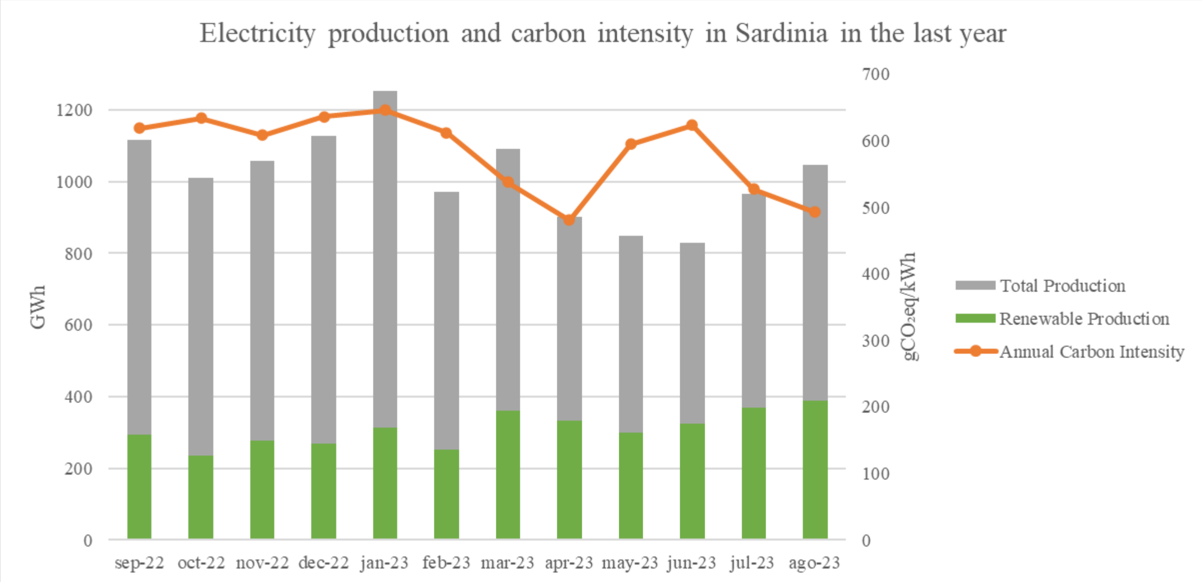

Figure 28.Electric production and carbon intensity in Sardinia Sep.2022-Aug.2023 (8)

Data Sources for Sardinia

List of data sources	
SECAP of Stintino	Stintino Piano transizione energetica (eumayors.eu)
Energy Environmental Plan of Sardinia (PEARS)	PEARS (regione.sardegna.it)
Monitoring reports of the PEARS	Esiti monitoraggio - SardegnaEnergia (regione.sardegna.it)
Italian Civil Aviation Authority (ENAC) report on State of the National Airport System	Vol3_ParteII_CAP_10_SARDEGNA.pdf (enac.gov.it)
TERNA SPA_Electricity and natural gas demand scenarios for the sardinia region	Scenari - Terna spa
Energy System Research (RSE) - RSE study on the development of energy infrastructure in sardinia	Rapporto_RSE_Sardegna_FASE_2_revMD_FL_CLEAN.docx (arera.it)
Region of Sardinia - strategic guidelines for updating the regional environmental energy plan of sardinia	delibere.regione.sardegna.it/protected/53388/0/def/ref/DBR53299/
Centre for north south economic research - report on the economy of Sardinia 2022	Versione integrale del 29° Rapporto sull'Economia della Sardegna.pdf (unica.it)
Italian National Institute of Statistics	Istat.it english
Bank of Italy – Annual report on the Economy of Sardinia 2023	2320-sardegna.pdf (bancaditalia.it)

2.2.4 South Aegean Islands – Rhodes, Chalki, Tilos

Climate of South Aegean region

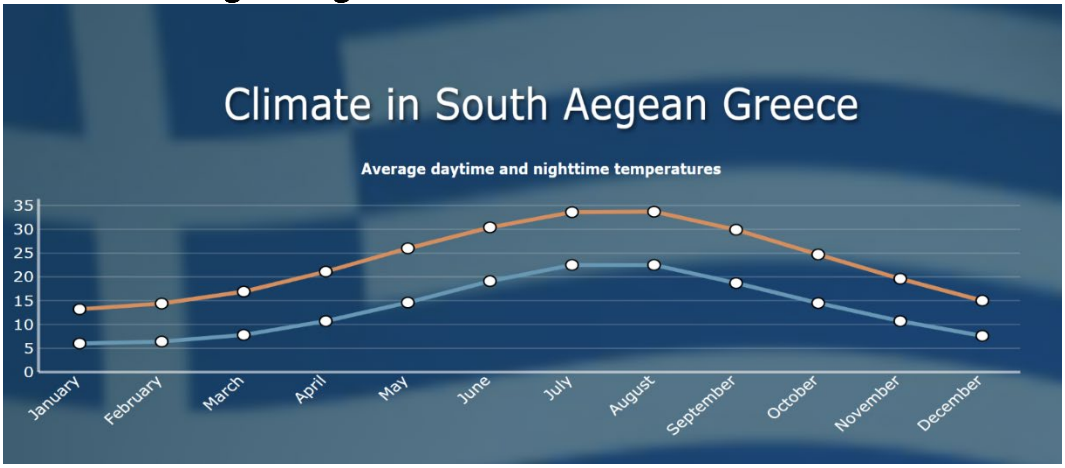

Figure 29.Climate on South Aegean (Greece) average daytime and nighttime temperatures (7)

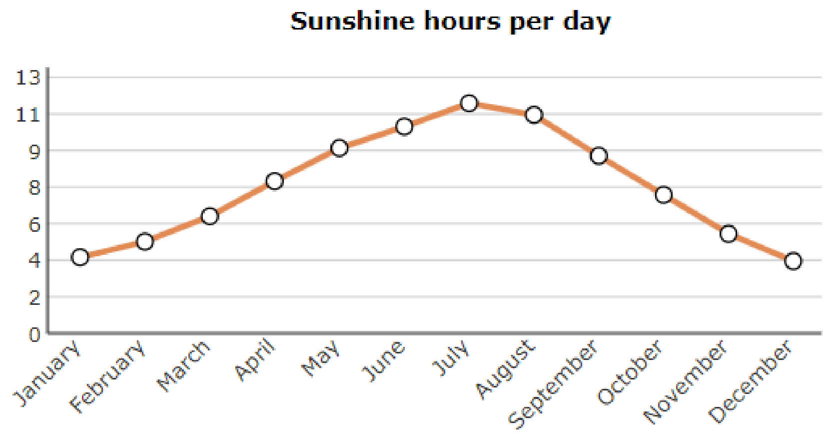

Figure 30.Sunshine hours per day South Aegean (Greece) (7)

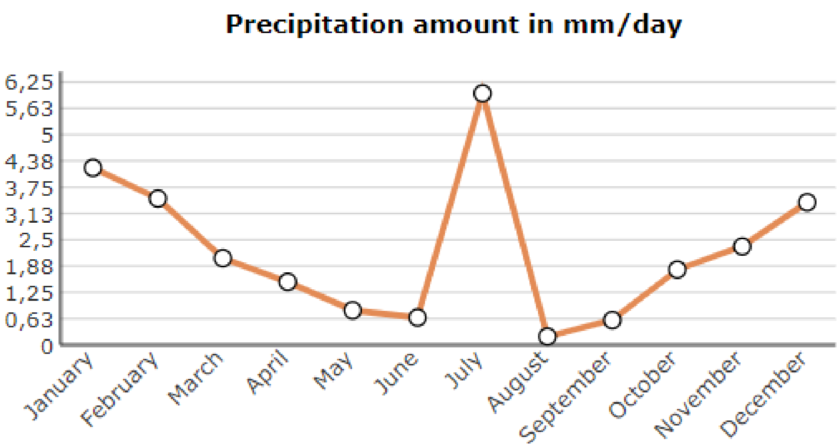

Figure 31.Rain days per month South Aegean (Greece) (7)

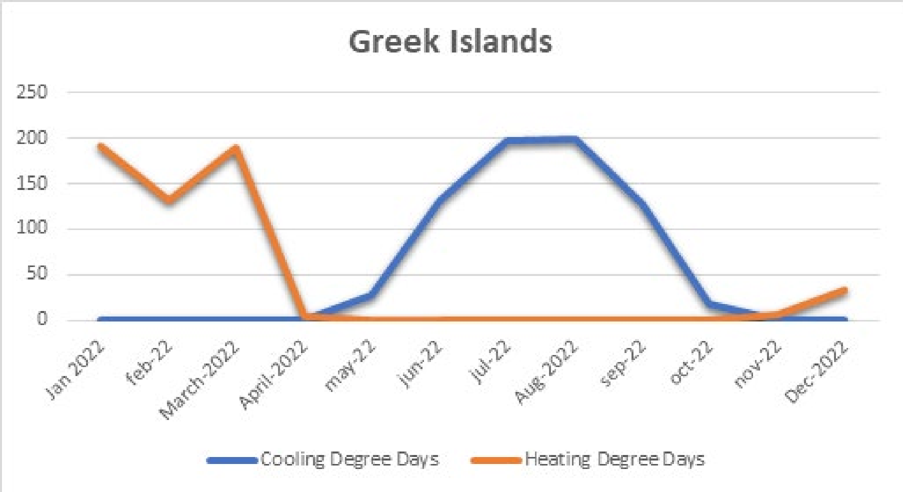

Figure 32.Heating and Cooling Degree days Greek islands (7)

Rhodes

General Information

General information	
Country	Greece
Region	South Aegean
Island name	Rhodes
Area (km^2)	1,401 km^2

Permanent population			
Population (Number of inhabitants)	115,500		
Nationalities %	Greek 98.7%, Turkish, Albanian, British, Russian and German 1.3%		
Languages spoken	*Greek, English, Turkish*		
Population pyramid			
	total	*Female*	*Male*
>18 years old	*23,500*	-	-
18-30 years old	*19,000*	-	-
30–45 years old	*28,800*	-	-
45–65 years old	*28,000*	-	-
<65 years old	*16,200*	-	-

Climate

Climate
Rhodes island has a Mediterranean climate, with mild, rainy winters and hot, sunny summers. The average temperature in January is 12°C (54°F), and the average temperature in August is

27°C (81°F). The island receives an average of 500 millimetres (20 inches) of rain per year, most of which falls in the winter months. The climate on Rhodes is ideal for tourism, with warm weather and plenty of sunshine throughout the year. The following is a short narrative description of the climate on Rhodes Island: Winter: The winters on Rhodes are mild and rainy, with average temperatures ranging from 10 to 15°C (50 to 61°F). There are occasional cold snaps, but the temperature rarely drops below freezing. Rainfall is common in the winter, but it is usually light and scattered. Spring: The spring on Rhodes is a beautiful time of year, with warm weather and blooming flowers. The average temperature in the spring is 15 to 20°C (59 to 68°F). Rainfall is less common in the spring than in the winter, but it can still occur. Summer: The summers on Rhodes are hot and sunny, with average temperatures ranging from 25 to 30°C (77 to 86°F). There is little rainfall in the summer, and the skies are usually clear. Fall: The fall on Rhodes is a mild and sunny time of year, with average temperatures ranging from 20 to 25°C (68 to 77°F). Rainfall is more common in the fall than in the summer, but it is usually light and scattered.

Touristic Season					
January	February	March	April	May	June
Low	*Low*	*Low*	*Medium*	*Medium*	*High*
July	August	September	October	November	December
High	*High*	*High*	*Medium*	*Low*	*Low*

Connection to the mainland

Relation with the mainland	
Distance to the mainland	The distance from Rhodes to the port of Piraeus, the main port of Athens, is approximately 363 kilometres (226 miles).
Legislative connection to the mainland	Rhodes is part of the South Aegean region, which is governed by a regional council that is elected by the people of the South Aegean region. The regional council is responsible for a range of services, such as education, healthcare, and economic development. The South Aegean region is also represented in the Greek Parliament, which is the national legislature of Greece. The parliament is responsible for making laws for the whole of Greece, including Rhodes. In addition, the Greek government has established a number of organizations that are responsible for developing and implementing policies for the Greek islands. These organizations include the Greek Ministry of Insular Policy and the General Secretariat for the Aegean and Island Policy.

Infrastructures	
Physical connections for people/goods' transport	• **Sea:** Rhodes is connected to the mainland of Greece and other Greek islands by ferry. There are regular ferry services from Rhodes to Piraeus, the main port of Athens, as well as to other islands such as Crete, Kos and Samos. • **Air:** Rhodes is connected to the mainland of Greece and other European cities by air. There is an international airport on Rhodes Island, which is served by a number of airlines. • **Road:** Rhodes has a well-developed network of roads, which connect all of the major towns and villages on the island. There are also a number of bus routes that operate on Rhodes, which connect the island's major towns and villages.
Number of harbours	• **Mandraki Harbour:** This is the main harbour of Rhodes island, and is located in the heart of the Old Town. • **Akandia Harbour:** This is the commercial harbour of Rhodes island, and is located just outside of the Old Town. It is a busy port, with ferries and cargo ships arriving and departing daily. • **Kolona Harbour:** This is a small harbour located just opposite the Mandraki Harbour. It is a popular spot for yachts and small boats. • **Kamiros Harbour:** This is a small harbour located in the village of Kamiros, on the south coast of Rhodes island. It is a popular spot for fishing boats and small yachts.
Number of airports	There is **one** airport in Rhodes, Greece, called Diagoras International Airport (RHO). Diagoras International Airport is located on the west side of the island, approximately 16 kilometers (10 miles) from the city of Rhodes.
Main means of transport used by the residents to reach the island	The main means of transport used by residents to reach the island of Rhodes is by **ferry**. There are frequent ferries to Rhodes from the Greek mainland, as well as from other nearby Greek islands. The journey from Piraeus, the main port of Athens, to Rhodes takes around 12 hours. Some residents of Rhodes also travel to the island by **plane**. There is an international airport on Rhodes, with direct flights from many European cities. Once on the island of Rhodes, residents can get around by **car**, **bus**, **taxi**, or **moped**. The island has a good public bus network, but many locals prefer to drive their own cars, especially if they live in rural areas. Taxis are also readily available.
Main means of transport used by the tourists to reach the island	• **Plane:** Rhodes International Airport (RHO) is located about 16 kilometers from the capital city of Rhodes Town. It is the fourth busiest airport in Greece, with direct flights from many European cities. • **Ferry:** There are frequent ferries to Rhodes from the Greek mainland, as well as from other nearby Greek

	islands. The journey from Piraeus, the main port of Athens, to Rhodes takes around 12 hours. • **Package tour:** Many tourists also choose to travel to Rhodes on a package tour, which typically includes flights, accommodation, and transfers to and from the airport and hotel.
Main means of transport used for the import/export of goods	The main means of transport used for the import/export of goods in Rhodes is **shipping**. The island has a large commercial port, which is located in Rhodes Town. The port is connected to major ports all over the world, and it handles a wide variety of goods, including agricultural products, manufactured goods, and construction materials. Some goods are also imported/exported by **air**. Rhodes International Airport has a cargo terminal, which is used by a number of freight airlines. However, air transport is generally more expensive than shipping, so it is only used for high-value or time-sensitive goods.
Connections for energy supplies (Connection of the islands grid to the mainland one)	Rhodes is connected to the mainland Greek electricity grid through a subsea high-voltage alternating current (HVAC) cable. The cable is 152 kilometers long and has a capacity of 200 megawatts (MW). It was installed in 2018 and is operated by the Greek Independent Power Transmission Operator (IPTO). The connection to the mainland grid allows Rhodes to import electricity from the mainland, which is important for ensuring the reliability of the island's electricity supply. It also allows Rhodes to export renewable energy generated on the island to the mainland. In addition to the connection to the mainland grid, Rhodes also has a number of power plants of its own, including thermal power plants, renewable energy power plants, and battery storage systems. The island is also developing a number of new renewable energy projects, such as solar and wind farms. The goal of the Greek government is to connect all of the country's islands to the mainland grid by 2030. This will help to reduce the reliance of the islands on imported fossil fuels and make the country's energy system more sustainable.

Local Government

Administrative structure	
Level of government of the island	The island of Rhodes belongs to the Dodecanese Prefecture, which, along with the Cyclades Prefecture, forms the Region of South Aegean. The Municipality of Rhodes covers the entire island of Rhodes and belongs to the "Regional Unit of Rhodes", where the headquarters of the Regional Unit of Kos is located, which administratively includes the island of Tilos, Chalki, Symi and Megisti. The island of Rhodes is governed at the following levels: • **Local government:** Rhodes is a municipality, which is the lowest level of government in Greece.

	• **Regional government:** Rhodes is part of the South Aegean region, which is one of the 13 administrative regions of Greece.
Number of municipalities on the islands	There is only **one municipality** on the island of Rhodes. It was formed in 2011 by the merger of the former municipalities of Rhodes, Ialysos, and Kallithea. The capital of the municipality of Rhodes is Rhodes Town, which is also the largest city on the island.
Name of the municipality/ies involved in the project	Rhodes
Responsible organizations overseeing energy	The following are the key organizations responsible for overseeing energy in Rhodes: • **Rhodes - HEDNO S.A.** (Hellenic Electricity Distribution Network Operator S.A. – Department of Rhodes) • **Ministry of Environment and Energy:** The Ministry of Environment and Energy is responsible for developing and implementing national energy policy in Greece, including policy for Rhodes. • **Greek Independent Power Transmission Operator (IPTO):** IPTO is the independent power transmission operator in Greece. It is responsible for the operation and maintenance of the high-voltage electricity transmission grid in Greece, including the subsea HVAC cable that connects Rhodes to the mainland grid. • **Public Power Corporation (PPC):** PPC is the state-owned electricity company in Greece. It is responsible for the generation, distribution, and supply of electricity to Rhodes and the rest of Greece. • **Municipality of Rhodes:** The Municipality of Rhodes is responsible for a range of local services, including energy planning and efficiency. In addition to these organizations, there are a number of other organizations that play a role in overseeing energy in Rhodes, such as the: • **Rhodes Chamber of Commerce:** The Rhodes Chamber of Commerce is a non-profit organization that represents the interests of businesses in Rhodes. It plays an important role in promoting renewable energy and energy efficiency on the island. • **Rhodes Tourism Board:** The Rhodes Tourism Board is a non-profit organization responsible for promoting tourism on Rhodes. It also plays an important role in promoting sustainable tourism and renewable energy on the island. • **Rhodes University:** Rhodes University is a public university located on Rhodes. It conducts research on a

	range of energy-related topics, such as renewable energy, energy efficiency, and energy storage. These organizations work together to develop and implement energy policy on Rhodes, promote renewable energy and energy efficiency, and oversee the operation of the island's energy system. Overall, the energy sector on Rhodes is overseen by a number of different organizations at the national, regional, and local levels. These organizations work together to ensure that the island has a reliable, sustainable, and affordable energy supply.

Economic activities

Island GDP		
Industry	GDP %	Workforce involved/ people employed
Tourism	75%	60%
Agriculture	*15%*	*20%*
Other activities (Trade and transport, Manufacturing)	10%	20%
Note: The economy of Rhodes is also seasonal, with tourism activity peaking in the summer months and declining in the winter.		

Energy Consumptions

Annual energy consumption by sector	**[MWh]**
Residential	340,000
Primary sector	207,000
Industries	59,000
Tertiary sector	620,500
Transport	350,000*
*estimate	

Annual energy consumption for heating and cooling	**[MWh]**
Electricity	84,064
Oil	34,042
Natural Gas	0
Biomass	6,808
.... *(other)*	

Chalki

General Information

General information	
Country	Greece
Region	Southern Aegean
Island name	Chalki
Area (km2)	28 km²

Permanent population			
Population (Number of inhabitants)	478 (as per 2011)		
Nationalities %	99.9 % greek; 0.1% others -		
Languages spoken	-90% greek; around 10% english.		
Population pyramid			
	total	*Female*	*Male*
0-14 years old	*145*	-	-
15-24 years old	*144*	-	-
25-64 years old	*726*	-	-
Over 65 years old	*243*	-	-

Connection to the mainland

Relation with the mainland	
Distance to the mainland	The port of Chalki is located 343.93 kilometers (213.71 miles) away from the port of Athens
Legislative connection to a municipality/region on the mainland	There is no road connection between the island of Chalkis and the mainland, it is only through sea. Chalki has only one port, this one in Emporio and is the barren island line. In terms of transport, Chalki is connected by a ferry of the racing lines with the Piraeus and Kos twice a week. Also with Cyclades and Crete three times week. It connects with Rhodes five times a week from the main port and from at Kamiro Skala four times a week in winter, while in summer they take place daily itineraries with a 3-day ferry
Infrastructures	
Physical connections for people/goods' transport	• **Sea:** Chalki is connected to the mainland of Greece and other Greek islands by ferry. There are regular ferry services from Chalki to Piraeus, the main port of Athens, as well as to other islands such as Crete, Kos and Samos. • **Air:** Chalki is connected to the mainland of Greece and other European cities by helipad
Number of harbours	One central habour
Number of airports	Helipad

Main means of transport used by the residents to reach the island	Daily ships connected to Rhodes daily or other islands every 2-3 days
Main means of transport used by the tourists to reach the island	Daily ships connected to Rhodes daily or other islands every 2-3 days
Main means of transport used for the import/export of goods	Daily ships connected to Rhodes daily or other islands every 2-3 days
Connections for energy supplies (Connection of the islands grid to the mainland one)	Chalki is connected to Rhodes with submarine electrical cable

Local Government

Administrative structure	
Level of government of the island	Administratively belongs to: • In the Regional Unit of Rhodes • In the Prefecture of Dodecanese • In the South Aegean Region • In the Decentralized Administration of the Aegean
Number of municipalities on the islands	1
Name of the municipality/ies involved in the project	Chalki Municipality
Responsible organizations overseeing energy	Chalki
	Chalki - HEDNO S.A. (Hellenic Electricity Distribution Network Operator S.A. – Department of Rhodes)

Economic activities

Island GDP		
Industry	GDP %	Workforce involved/ people employed
Agriculture	-	31
Industry	-	*25*
Services	-	63

Energy Consumptions

Annual energy consumption by sector	[MWh]
Residential	928.83 [853.18 (households - electricity) + 21.92 (biomass) + 53.73 (solar energy for hot water)]

Primary sector	113.29 [1.71 (electricity) + 111.22 (2.54+108.68) (diesel) + 0.36 (gasoline)] [2012 – source: SECAP of Chalki]
Industries	TOTAL: 325.07 = 309.10 [32.83 (services) + 15.66 (schools) + 24 (watering infrastructures) + 236.61 (desalination infrastructures)] + 15.98 MWh (municipal lighting) [2012 – source: SECAP of Chalki]
Tertiary sector	1,601.98 (electricity) [2012 – source: SECAP of Chalki]
Transport	TOTAL: 355.96 = (304.25 gasoline + 51.71 diesel) Municipal fleet (waste trucks etc.): 38.27 (13.18 gasoline + 25.09 diesel) + Private and Commercial: 317,7 (291.08 gasoline + 26.62 diesel)

Annual energy consumption for heating and cooling	**[MWh]**
Electricity	
Oil	
Natural Gas	
Biomass	21.92
.... *(other)*	

Tilos

General Information

General information	
Country	Greece
Region	South Aegean
Island name	Tilos
Area (km^2)	61,49 km^2

Permanent population			
Population (Number of inhabitants)	780 (429 men - 351 women)		
Nationalities %	Greek 80%, European nationals (Germany, France, United Kingdom, Italy) 20%		
Languages spoken	*Greek, English, Italian, French and German*		
Population pyramid			
	total	*Female*	*Male*
>18 years old	*150*	-	-
18-30 years old	*155*	-	-
30–45 years old	*145*	-	-
45–65 years old	*130*	-	-
<65 years old	*110*	-	-

Climate

Climate					
Tilos has a Mediterranean climate with hot, dry summers and mild, wet winters. The average temperature in July is around 28°C (82°F), while the average temperature in January is around 12°C (54°F). The island receives an average of 600mm of rainfall per year, with most of the rain falling in the winter months. Here is a more detailed breakdown of the climate of Tilos: Summer (June-August): Hot and sunny weather: The average temperature is around 28°C (82°F), with highs of up to 35°C (95°F). Low humidity: The humidity is low, making the heat feel more bearable. Little rain: There is very little rain in the summer months. Ideal for sunbathing, swimming, and water sports: The clear blue waters and warm temperatures make the summer months perfect for enjoying the beaches and water sports. Autumn (September-November): Warm and sunny days, cool evenings: The average temperature is around 25°C (77°F), with highs of up to 30°C (86°F). Pleasant temperatures for hiking and exploring the island: The weather is still warm enough for outdoor activities, but the crowds have started to thin out. Ideal for exploring the island's historical sites and visiting the local villages: The mild weather makes it comfortable to walk around and explore the island's many attractions. Winter (December-March): Mild and sunny days, cooler evenings: The average temperature is around 12°C (54°F), with highs of up to 18°C (64°F). Rainfall increases: The Island receives an average of 100mm of rain per month during the winter months. Ideal for hiking and exploring the island's natural beauty: The mild weather and fewer crowds make it a great time to enjoy the island's natural beauty. Some businesses may close during the winter months: It is important to check opening hours before planning a winter trip to Tilos.					
Touristic Season					
January	February	March	April	May	June
L	L	L	M	M	H
July	August	September	October	November	December
H	H	H	M	L	L

Connection to the mainland

Relation with the mainland	
Distance to the mainland	The distance from Tilos to the port of Piraeus, the main port of Athens, is approximately 372 kilometres (231 miles).
Legislative connection to the mainland	Tilos is part of the South Aegean region, which is governed by a regional council that is elected by the people of the South Aegean region. The regional council is responsible for a range of services, such as education, healthcare, and economic development. The South Aegean region is also represented in the Greek Parliament, which is the national legislature of Greece. The

	parliament is responsible for making laws for the whole of Greece, including Rhodes. In addition, the Greek government has established a number of organizations that are responsible for developing and implementing policies for the Greek islands. These organizations include the Greek Ministry of Insular Policy and the General Secretariat for the Aegean and Island Policy.
Infrastructures	
Physical connections for people/goods' transport	The main physical connections for people and goods transport in Tilos are as follows: Sea: Tilos is primarily connected to other islands and mainland Greece by ferry. The main port of Tilos is Livadia, located in the northwest of the island. There are regular ferry services to Rhodes, Kos, Symi, and other islands in the Dodecanese. There are also a few ferries a week to the port of Piraeus in Athens. The journey by ferry from Tilos to Piraeus takes approximately 5 hours and 30 minutes. Air: There is no airport on Tilos, so the only way to reach the island by air is to fly to one of the nearby islands and then take a ferry to Tilos. The nearest airports are on Rhodes and Kos. Road: There are a total of 100 kilometres (62 miles) of paved roads on Tilos. The main road runs from Livadia to Megalo Horio, the capital of the island. There are also a few smaller roads that connect the villages and beaches. However, most of the island is best explored on foot or by bicycle.
Number of harbours	Port of Livadia: The main port of Tilos, located in the northwest of the island, and the gateway for ferry and hydrofoil services to the other Dodecanese islands, Rhodes, and Kos, as well as to mainland Greece from Piraeus. There are also smaller harbors located around the island, primarily used for fishing boats.
Number of airports	There is no airport in Tilos.
Main means of transport used by the residents to reach the island	The main means of transport used by the residents of Tilos to reach the island are as follows: Ferry: Ferries are the most common and convenient way for residents of Tilos to travel to and from the island. The main port of Tilos, Livadia, is served by regular ferries from other Dodecanese islands, such as Rhodes and Kos, as well as from mainland Greece from Piraeus. The ferry journey from Tilos to Piraeus takes approximately 5 hours and 30 minutes. Private boat: Some residents of Tilos own private boats, which they use to travel between Tilos and other islands in the Dodecanese. This is a more flexible option than taking a ferry, as it allows residents to travel at their own pace and schedule. Driving to the port: For residents who live in the vicinity of the port of Livadia, driving to the port is a convenient option. There are a few parking spaces available at the port, and the journey from the nearest villages takes only a few minutes.

Main means of transport used by the tourists to reach the island	Ferry boats remain the most popular mode of transport for tourists traveling to Tilos from the mainland of Greece or other Greek islands. Several ferry companies operate regular services from major Greek ports like Piraeus, Rhodes, and Heraklion, connecting Tilos to the wider Greek transportation network. The ferry journey from Piraeus to Tilos takes approximately 12-14 hours, while from Rhodes, it takes around 2-3 hours. Ferries offer a scenic and affordable way to reach Tilos, providing access to both the island's port town of Livadia and the smaller port of Megalo Horio.
Main means of transport used for the import/export of goods	The primary modes of transportation used for the import and export of goods in Tilos are as follows: Ferry: Ferries are the primary mode of transport for importing and exporting goods to and from Tilos. The main port of Tilos, Livadia, is connected to other Dodecanese islands, mainland Greece, and occasionally international destinations via regular ferry routes. This allows for the efficient movement of goods, including food, construction materials, and other essential supplies. Trucks: Trucks are occasionally used to transport goods to and from Tilos, particularly for larger or heavier items that cannot be accommodated on ferries. Trucks are typically utilized to transport goods from the port to local distribution centres or directly to businesses and residents.
Connections for energy supplies (Connection of the islands grid to the mainland one)	As of 2023, Tilos is not directly connected to the mainland Greek electricity grid and relies on its own local power generation and storage systems. This is due to several factors, including the island's remote location and the challenges of laying submarine cables. Current Energy Sources: The island's electricity supply is primarily generated from a combination of diesel generators and renewable energy sources, including solar and wind power. A few small hydroelectric plants are also in operation. Alternative Energy Solutions: Given the challenges of grid connection, Tilos is focusing on developing alternative energy solutions to ensure a reliable and sustainable electricity supply. These include: Expanding Renewable Energy Capacity: The island is expanding its solar and wind power generation capacity, with the goal of generating as much of its own electricity as possible. Energy Storage Solutions: Tilos is investing in energy storage solutions, such as batteries, to store excess renewable energy and provide power during periods of low renewable energy production. Demand-Side Management: The Island is implementing demand-side management programs to encourage energy conservation and reduce peak demand for electricity. These efforts are helping Tilos to achieve its goal of becoming a self-sufficient and sustainable island with a reliable and clean energy supply.

Local Government

Administrative structure	
Level of government of the island	The island of Tilos is part of the South Aegean Region, which is one of the 13 regions of Greece. The region is governed by a regional council, which is elected by the people of the region. The regional council is responsible for regional planning, infrastructure development, and the provision of regional services. The municipality of Tilos is the main administrative unit of the island. It is responsible for providing municipal services, such as garbage collection, water management, and public transportation. The municipality of Tilos is governed by a municipal council, which is elected by the people of the municipality.
Number of municipalities on the islands	There is only one municipality on the island of Tilos. There are two islets belonging to the municipality of Tilos: Antitilos and Gaidaros. Antitilos is a small uninhabited island located to the west of Tilos. Gaidaros is a smaller, more remote islet located to the east of Tilos, also uninhabited.
Name of the municipality/ies involved in the project	Tilos
Responsible organizations overseeing energy	Several organizations are responsible for overseeing energy in Tilos, working at various levels of governance and with different areas of expertise. Here's a breakdown of the key organizations involved: Greek Ministry of Environment and Energy: This ministry oversees the overall energy policy and strategy for Greece, including setting targets for renewable energy deployment, issuing permits for energy projects, and regulating the energy market. South Aegean Regional Authority: As the governing body for the South Aegean Region, which includes Tilos, the Regional Authority plays a role in supporting energy initiatives and projects on the island. It collaborates with the municipality of Tilos and other stakeholders to promote sustainable energy solutions. Municipality of Tilos: The local municipality has direct responsibility for managing the island's energy infrastructure and services within its jurisdiction. This includes maintaining power grids, managing solar and wind power installations, and implementing energy efficiency measures within municipal buildings and facilities. Tilos Renewable Energy Association (TREA): This non-profit organization was established to promote the development and utilization of renewable energy sources on Tilos. TREA works closely with the municipality, local businesses, and community groups to raise awareness about renewable energy, provide

	technical support, and facilitate the implementation of renewable energy projects. European Union (EU): As a member state of the EU, Greece and Tilos are subject to various EU directives and regulations related to energy, including those promoting renewable energy deployment, energy efficiency, and sustainable energy practices. International Renewable Energy Agency (IRENA): IRENA provides technical assistance, capacity building, and knowledge sharing to support the transition to renewable energy in Tilos and other countries worldwide. IRENA's expertise is valuable in helping Tilos to optimize its renewable energy resources and develop sustainable energy strategies. These organizations work together to ensure that Tilos has a reliable, sustainable, and environmentally friendly energy supply. They collaborate on planning, implementation, monitoring, and evaluation of energy projects, ensuring that Tilos continues to advance towards its goal of becoming a net-zero energy island.

Economic activities

Island GDP		
Industry	GDP %	Workforce involved/ people employed
Tourism	70	40%
Agriculture	*20*	*10%*
Fishing	10	5%
The remaining 45% of Tilos's workforce is employed in a variety of sectors, including public administration, retail, construction, education, and healthcare.		

Energy Consumptions

Annual energy consumption by sector	[MWh]
Residential	95.53
Primary sector	792.90
Industries	3.72
Tertiary sector	1,649.33
Transport	

Data Sources for South Aegean

List of data sources	
CLEAN ENERGY TRANSITION PLAN of Chalki	https://clean-energy-islands.ec.europa.eu/countries/greece/Chalki
SECAP of CHALKI	https://diavgeia.gov.gr/doc/9%CE%9A%CE%A7%CE%9C%CE%A9%CE%97%CE%A3-6%CE%98%CE%91

SECAP of Rhodes	https://www.adaptivegreece.gr/Portals/0/LIFE-IP%20AdaptInGR/0.4_Deliverables/LIFE-IP%20AdaptInGR_A.3_D.2_TR_1.0_SECAP%20Rhodes.pdf?ver=wXQ1fOQc9UCuYfPrZR2uTQ%3d%3d
The official website of the Municipality of Rhodes	https://www.rhodes.gr/en/
The official website of Aegean University	https://www.aegean.edu/campus-life/rhodes/
The official website of the South Aegean region	https://www.pnai.gov.gr/
The official website of the Greek Ministry of Environment and Energy	https://ypen.gov.gr/
The official website of the Greek Independent Power Transmission Operator (IPTO)	https://www.admie.gr/en
The official website of the Public Power Corporation (PPC)	https://www.dei.gr/en/
The official website of the Rhodes Chamber of Commerce	https://www.ebed.gr/Page/display_page_en/5745
The official website of the Rhodes Tourism Board	https://rhodeswelcome.gr/
The official website of the Greek Statistical Office	https://www.statistics.gr/ https://www.statistics.gr/el/statistics/-/publication/SAM05/2011
The official site of Rhodes International Airport	https://www.rho-airport.gr/en
The official site of Greek National Tourism Organization	https://gnto.gov.gr/
The official site of the Operator of the Hellenic Electricity Distribution Network	https://deddie.gr/en/
The official site of the Hellenic Electricity Distribution Network Operator (HEDNO)	https://deddie.gr/en/deddie/i-etaireia/profil/
The official site of Ministry of Labor and Social Affairs	https://ypergasias.gov.gr/en/

3. Definition of Island typologies

There is big variety among islands in Europe, from climate and geography to economy and administration. However, to promote green energy transition, it is important to derive commonalities islands can use to create synergy in their efforts by sorting island by typologies.

In context of GENERA project, we are focusing on Mediterranean European islands.

It is important part of island typologies as northern and southern islands have large differences in aspects that need to be taken in account and their order of preference.

The climate divergence between the two regions plays a crucial role in shaping the islands' energy requirements. North European islands, due to their colder climates, often have a greater demand for heating solutions, while those in the South may focus more on cooling technologies, given the warmer temperatures. These climatic distinctions influence the energy consumption patterns and the types of energy infrastructure needed on the islands.

Economically, North European islands are often associated with fishing, maritime industries, and, in some cases, abundant geothermal energy resources. For instance, Iceland utilizes its geothermal potential for heating and electricity generation. On the other hand, South European islands frequently rely on tourism, agriculture, and solar energy. The economic structures of these islands are shaped by their geographical features and climatic conditions, leading to different sectors driving their economies.

The economic disparities are mirrored in the energy systems adopted by North and South European islands. In the North, there is a tendency to harness renewable resources such as geothermal and wind power. Iceland, for example, not only benefits from geothermal energy but has also invested significantly in harnessing wind power. In contrast, South European islands often prioritize solar energy due to the ample sunlight available in the Mediterranean region. The differences in available natural resources drive the islands to develop specific energy infrastructures aligned with their environmental conditions.

These variations in geography, climate, economy, and energy systems significantly impact the islands' approach to energy transition. In the North, the focus may be on developing advanced geothermal technologies, expanding wind farms, and optimizing energy efficiency in heating systems. Meanwhile, in the South, efforts may concentrate on enhancing solar infrastructure, implementing energy storage solutions, and promoting sustainable tourism practices. These region-specific strategies are essential for achieving successful energy transition on the islands.

Context of European Mediterranean islands is an important aspect that makes it easier to have them sorted into typologies. This context is seen both on energy demand and supply side.

On the supply side, islands uniquely blend threats and opportunities. Depending on their location and proximity to the mainland, islands may be connected or not connected to the mainland energy grid and other islands.

The Mediterranean islands within the European Union represent a unique blend of cultural richness, natural beauty, and environmental diversity. As these islands navigate the complex landscape of energy transition, several factors come into play, including seasonal variability in population structures, a dynamic interplay between seasonal, tourist, and permanent populations, and current reliance on fossil fuels. Understanding the vulnerabilities of island energy systems when not connected to the mainland grid is crucial for formulating sustainable energy strategies. Moreover, exploring the vast possibilities for green energy production becomes essential in shaping the future of these Mediterranean islands.

The Mediterranean islands experience significant fluctuations in population throughout the year, driven by seasonal changes and tourism patterns. During peak tourist seasons, islands witness a substantial influx of visitors, leading to a surge in energy demand. This creates a unique challenge for energy planners, who must ensure the infrastructure can accommodate these peaks without compromising sustainability goals. The seasonal variability in population structures further complicates energy planning, as energy demand and supply must be balanced to meet the needs of both residents and visitors.

The islands are home to a blend of seasonal, tourist, and permanent populations. Seasonal residents, often drawn by favourable weather conditions, contribute to increased energy demands during specific times of the year. Tourist populations, which can multiply the islands' resident numbers many times during the peak season, exert immense pressure on existing energy infrastructure. On the other hand, permanent residents maintain a consistent but relatively lower demand throughout the year. Managing this intricate web of population dynamics is crucial for developing resilient and sustainable energy solutions.

Many Mediterranean islands rely heavily on fossil fuels to meet their energy demands. This dependence poses environmental concerns and makes the energy systems vulnerable. When these islands are not connected to the mainland grid, disruptions in the supply chain, geopolitical uncertainties, or natural disasters can have severe implications for energy security. The reliance on imported fossil fuels also exposes the islands to volatile global energy markets, making them susceptible to price fluctuations and supply disruptions.

Despite many challenges, Mediterranean islands possess immense potential for green energy. Solar energy, with abundant sunlight throughout the year, stands out as a promising avenue. Photovoltaic installations can harness the sun's energy to generate electricity, creating a more sustainable and resilient energy mix. Wind power is another viable option, particularly in locations with consistent and robust wind patterns. Additionally, the islands can explore the potential of geothermal energy, tapping into the natural heat beneath the Earth's surface and other sources.

On the demand side, islands like the ones that are part of GENERA projects can be part of a complex energy network that requires them to consider their energy needs and other islands and sometimes the mainland in case the island is set as a net energy producer.
In addition, islands experience significant fluctuations in population throughout the year, driven by seasonal changes and tourism patterns. During peak tourist seasons, islands witness a substantial influx of visitors, leading to a surge in energy demand. This pattern creates a unique challenge for energy planners, who must ensure the infrastructure can accommodate these peaks without compromising sustainability goals.
Building on this understanding, data provided by the islands as well as island experience within the project so far, we have developed key determining factors that help us to develop typologies based on island characteristics and needs.

3.1 Relative size

Categorizing Southern European islands based solely on their geographical area for the purpose of energy transition planning overlooks critical socio-demographic factors that significantly influence the efficacy of such initiatives. Islands, with their unique characteristics, present a diverse landscape that extends beyond mere geographical boundaries. Relying solely on area measurements can lead to misleading categorizations, as it neglects crucial elements like population distribution, urbanization levels, and the balance between rural and urban land.
Take, for example, the islands of Malta and Kos. Both fall under the Southern European umbrella, yet they differ drastically in terms of size, population density, and urbanization. Malta, with its small landmass, accommodates a relatively high population density, while Kos, being larger in size, has a lower population density. Categorizing them based on area alone fails to capture these disparities, hindering the development of targeted and effective energy transition strategies. The energy needs of densely populated urban areas vary significantly from those of sparsely populated rural regions, and a one-size-fits-all approach may result in inefficiencies and misallocation of resources.

Furthermore, the oversimplification of categorization like in case of using population density can lead to the grouping of islands with starkly different profiles. Consider the islands of Cavallo and Formentera. Cavallo might be a small island with quite a number of people leaving together, while Formentera could be a bustling tourist destination with a much higher population density. Placing them in the same category based solely on density neglects the nuanced differences in energy consumption patterns, infrastructure needs, and environmental considerations.
Recognizing the need for a simplified yet nuanced approach to categorize Southern European islands for energy transition, a strategic solution involves considering the island's area relative to the administrative region it falls under (NUT2). The Nomenclature of Territorial Units for Statistics (NUTS) system, developed over decades for administrative and financial purposes, provides a practical framework for this categorization.
By incorporating the island's area relative to the NUT2 region, we gain a more comprehensive understanding of the local context. This approach recognizes that islands

are not standalone entities but integral parts of larger administrative regions. The ratio of an island's area to the overall administrative region provides a valuable metric that captures both the island's size and its significance within the broader territorial context.
This method allows for a simplified yet insightful classification, offering a scalable solution that can be easily adopted for widespread use. It takes into account the established administrative divisions that have already been refined and utilized over the years. The relative area approach offers a quick and effective means to gauge the challenges an island might face during the energy transition process, providing a basis for targeted interventions.
In essence, sorting Southern European islands based on their area relative to the NUT2 administrative region aligns with the existing administrative framework, offering a pragmatic solution that balances simplicity with nuance. This approach ensures that the unique energy transition challenges of each island are considered within the broader regional context, facilitating efficient decision-making and resource allocation for a sustainable and effective energy transition.

Country	Region/ NUT2	Area	Island	Area	% of region
Italy	**Sardinia**	**24,106**	**Sardinia**	**24,090**	**99.93**
	Sicily	25,833	Sicily	25,711	99.53
	Sicily	25,833	Pantelleria	85	0.33
	Sicily	25,833	Lampedusa	20	0.08
Malta	Malta	316	Malta	246	77.85
Spain	**Balearic Islands**	**4,990**	**Ibiza**	**571**	**11.44**
		4,990	Formentera	83	1.66
		4,990	Mallorca	3,640	72.95
	Canary Islands	**7,447**	**Tenerife**	**2,034**	**27.31**
		7,447	La Palma	708	9.51
		7,447	Gran Canaria	1,560	20.95
Greece	**Southern Aegean**	**5,311**	**Rhodes**	**1,401**	**26.38**
		5,311	Kos	295	5.55
		5,311	**Chalki**	**28**	**0.53**
		5,311	**Tilos**	**62**	**1.16**
	North Aegean	3,848	Lesbos	1,632	42.41
	Crete	8,346	Crete	8,312	99.59
France	Corsica	8,726	Corsica	8,722	99.95
		8,726	Cavallo	1	0.01

Table 1. Relative size of islands

We have noticed in our analysis that the big and small islands that usually form their regions have uniquely their own set of opportunities and obstacles and need to operate

on a different level of complexity. For these reasons, when considering typologies, we separate islands that makeup 100-75% of their own region as these islands operate a regional level and need coordination on national level to make substantial changes to their energy system. This big region-forming islands included **Sardinia**, Sicily, Malta, Crete, Corsica.
On the other hand, we have seen that in the lower bracket of >25% On the other hand, we have noticed that in the lower bracket of >25%, there is a much greater emphasis on the municipal level. This is especially true in small one municipality islands (this island usually makes up >5% of it's region) like **Chalki or Tilos.** However, at this level there is greater distinctions for island as a whole in weather or not island is or is not connected to the other island. For example, La Palma that is not connected to rest of the Balearic Islands would only have to consider its energy system and dependency on fossil fuels much in the same way. This example comes in contrast to Ibiza or Chalki, which, although they have dramatic size differences, would both require interisland cooperation for successful energy detransition.

3.2 Connection to the Mainland

Islands although physically detached from the mainland are in some cases connected to its energy system through underwater cables etc. This is important factor that has its profound impact on the process of energy detransition.
Key advantages to the connection to the mainland greed is One of the primary benefits is the potential for a more stable and reliable energy supply. Islands often grapple with energy volatility due to factors such as weather conditions affecting renewable sources. Integration with the mainland grid enables islands to tap into a diverse mix of energy sources, including those with higher reliability, such as conventional power plants.
Furthermore, the interconnection allows for the sharing of excess energy between the mainland and the island. During periods of surplus renewable energy generation on the island, excess electricity can be transmitted to the mainland grid, contributing to overall energy sustainability and reducing waste.

3.2.1 Receiver vs Producer

In some cases, large islands can supply energy to the mainland; for example, Sardinia has large fossil fuel plants that produce energy that passes through the grid into mainland Italy. In this case energy transition has to be heavily coordinated with the mainland which requires more involvement from national energy agencies.
We operate under assumption that only larger islands produce such an extensive energy surplus that makes them play a role substantial role in energy grid of the country.

3.3 Connection to the other islands

Islands that are close to each other are often united in a single grid to improve energy stability and efficiency of the system. Although, big islands can also be connected to the other islands, it rarely is a determining factor for them.

On the other hand, for medium and small islands interconnectivity between islands is often an important consideration as with smaller amount of energy producers. On the other hand, for medium and small islands, interconnectivity between islands is often an important consideration as with smaller amounts of energy producers, it is crucial for each one in preventing power outages growth.

3.3.1 Receiver vs Producer

When an island is connected to the other islands in the system, one significant difficulty lies in coordinating and optimising energy flow within the interconnected island system. Balancing the surplus and deficit of energy among islands requires sophisticated grid management and control mechanisms. The variability in energy demand and production across different islands further complicates this task, necessitating adaptive and responsive technologies to maintain a stable energy network. This is true even when the system operates with fossil fuels and creates additional consideration when the system ates with variability of some types of green energy.

These issues are especially true when an island is a net energy producer, but the investment required for establishing and maintaining inter-island connections and renewable energy infrastructure can be substantial. Islands must navigate the economic challenges associated with initial capital expenditures and ongoing operational costs, often exacerbated by their relatively more minor economies and populations.

Due to these considerations, interconnected islands that are net producers are separated into different typologies.

3.4 Demand Fluctuation

Many European southern islands are highly attractive for tourism and large portion of their economy in turn relays on it. This leads to some islands seeing large jumps in population in peak seasons. One of the primary issues arising from seasonal fluctuations is the imbalance between energy production and demand. During peak tourist seasons, these islands witness a surge in energy consumption, stressing the existing energy infrastructure and often necessitating reliance on non-renewable energy sources to meet the heightened demand. This imbalance undermines the core objective of transitioning to green energy, as the increased reliance on conventional power during peak periods hinders progress toward carbon neutrality and sustainability goals.

The dependence on tourism as a major economic driver exacerbates the challenge. Tourist arrivals, which typically surge during the summer months, bring with them a spike in energy needs for accommodations, transportation, and various recreational activities. The existing energy infrastructure may struggle to accommodate these sudden and substantial increases, leading to a higher carbon footprint as fossil fuels are often deployed to bridge the energy gap. This compromises the islands' commitment to reducing greenhouse gas emissions and transitioning to cleaner, renewable energy sources.

Furthermore, the intermittent nature of renewable energy exacerbates the mismatch between supply and demand during seasonal peaks. Solar and wind, two primary green

energy sources, are subject to variability based on weather conditions. The sunny summer months might witness abundant solar power, but the winter season could bring reduced sunlight, impacting solar energy production. Similarly, the variability of wind patterns contributes to the challenge, as periods of low wind coincide with heightened energy demand during peak seasons. This intermittency complicates efforts to maintain a stable and consistent energy supply, necessitating effective energy storage solutions or alternative sources to mitigate the impact of seasonal fluctuations.
The economic implications of these challenges are profound. The costs associated with expanding and upgrading energy infrastructure to accommodate peak demand can be substantial, and the return on investment may be challenging to achieve during off-peak periods. This has to be accounted for in every step of the energy detransition process.

4. Island typology decision tree, best practices and tailored recipes for clean energy transition.

To help island authorities to have a better start with their energy transition process we have developed specific decision trees.
Through a series of simple questions authorities would be able to understand their priorities and access the most relevant best practices, starting by just assessing their relative size:

a) large – island area is composed more than 75% of the region;
b) medium - island is composed 75-25 % of the region;
c) small - island is composed less than 25% of the region.

4.1 Large islands

There are few large southern islands in the EU, but all possess unique characteristics through their geography or history. They possess enough area and are, at times, at the level of development where matters concerning them go beyond regional and straight to the national level of importance.
For example, Malta is the largest of the three islands, comprising the state of Malta, which hosts a lot of energy production capacity for the country. This makes its energy de-transition a matter of national importance in the same way Sardinia's process needs to account for the country's energy needs.
Bigger islands have areas for land energy production and generally have more established economies and energy production.
This gives them more room to invest in green technology and requires them to consider a bigger context.

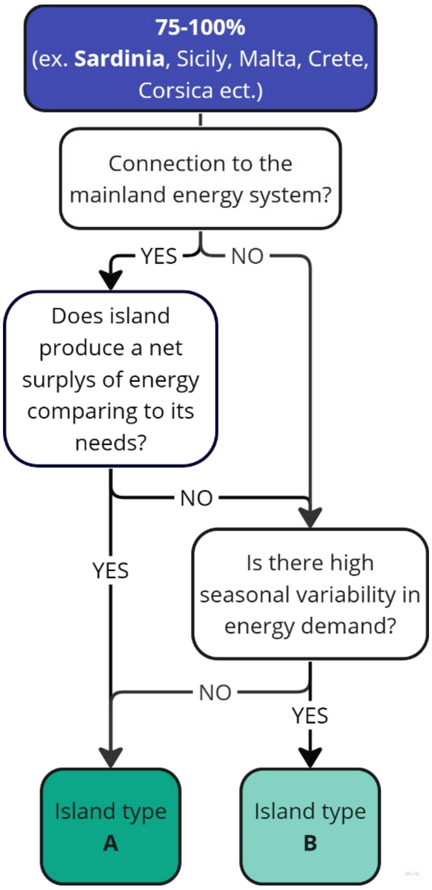

Figure 33.Decision tree for large type of island

Type A

It's a large island assumed to have high energy stability as it is either connected to the mainland by grid or has stable energy demands and access to sufficient energy to cover its needs.

This island type has high freedom in pursuing green energy production without stabilising the demand and making significant investments in energy storage.

Type B

This island has a large area and a high seasonal demand variability. This island should start by analysing its demand and exploring how it can be controlled/adjusted to work with the specificity of green energy sources. This can be done entirely on the island level before going deeper into energy production, which would require a higher level of coordination.

4.2 Medium islands

We have grouped most of the islands into the medium size. For this reason, it represents a diverse group of islands: economic and energy demand side, energy production capabilities, etc.

However, medium islands exist in many configurations: some have densely populated urban areas or large areas dedicated to natural reserves; some benefit from sharing energy from nearby islands or are connected to the mainland, and others are on their own.
For this group, there is a heavy focus on understanding whether their system is connected to a mainland grid or other islands or exists on its own.

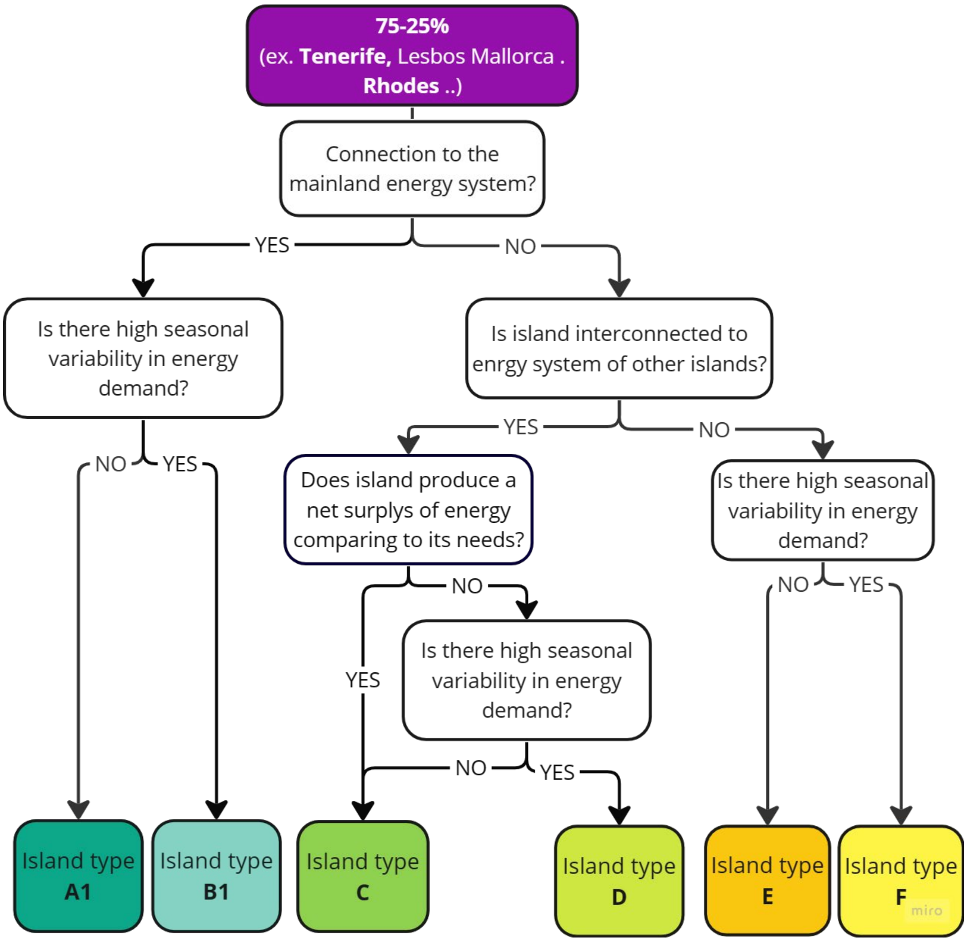

Figure 34.Decision tree for medium type of island

Typology A1

It's an island connected directly to the mainland energy system; therefore, it can rely on the energy stability of the mainland. This typology assumes that medium-sized islands don't contribute substantially to the energy system like some bigger islands do.
In this case, investment in energy production is relatively easy as surplus and underproduction can be covered by energy from the mainland grid.

Typology B1

This type is connected to the mainland system and has high energy security. However, this island type is characterised by high demand spikes, which must be accounted for first.

In the meantime, as for the type A1, the energy supply from the mainland guarantees a secure support in the early stages of development of a local infrastructure based on RES.

Typology C

This type of island has an energy system linked to other islands but not to the mainland. It also has a stable energy production and is an exporter of energy to the other islands in the grid. Interconnection with other islands enhances energy security and improves overall efficiency as any surpluses can be shared.

These characteristics allow this type of island to focus its efforts on decarbonising its energy production system. However, this system must prioritise inter-island coordination efforts to ensure a seamless transition.

Typology D

For this island typology, the interconnectivity to the other islands provides a certain level of energy security. Still, the island has high demand variability that calls for careful consideration of green energy strategies, including smart grids, energy storage and inter-island collaboration to avoid power shortages.

Typology E

It's an island that is fully self-dependent for its energy needs. This created a situation where the island is entirely dependent on fossil fuel imports, making green energy production a high-priority task. Despite the challenges, this transition fosters environmental stewardship, reduces reliance on imported fuels, and positions the island as a model for sustainable energy practices.

Typology F

The closed energy system of this type of island is paired with seasonal variability, creating a situation where the demand variability needs to be managed to accommodate the limitations of green energy production to avoid over or under-production and capacity creation.

4.3 Small islands

Small islands share common aspects that shape their distinct socio-economic and environmental characteristics. Often isolated, these islands face limited land availability, fostering close-knit communities and emphasizing resource sustainability. Economic reliance on specific sectors, such as tourism or fisheries, is a common trait, contributing to vulnerability during external shocks. Challenges include limited infrastructure, heightened sensitivity to climate change impacts like sea-level rise, and susceptibility to extreme weather events.

With small islands, due to the limited space, we operate under the assumption that they wouldn't produce a surplus of energy.

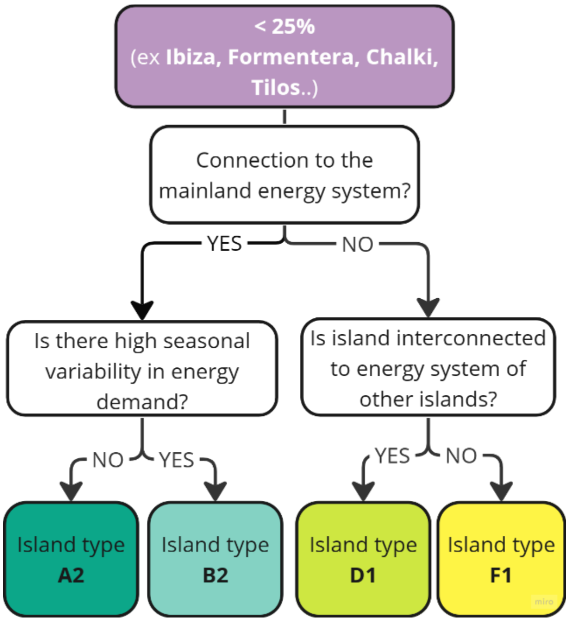

Figure 35.Decision tree for small type of island

Typology A2

Small island connected to the mainland by the grid has the security of having its energy needs met with the security that the mainland grid provides. This typology may not have any energy production within the island, so the green transition starts with a clean slate for them.

Typology B2

There is a stable energy supply to the island due to the interconnection with the mainland. However, high seasonal variability in energy demand patterns must be addressed before a full energy transition can be achieved.

Typology D1

This island typology is interconnected with other islands but not with the mainland grids. This means that in cases of higher demand, it can benefit from other islands' surplus. This also leads to higher flexibility in production as if there is a surplus of energy, the energy could be passed on, and the island would avoid the need to invest in energy storage.

Typology F1

This is a perfectly detached island that isn’t connected by its energy system to mainland or other islands. In this case we operate under assumption that island is able to satisfy its needs on its own and can start building a green energy system by phasing out its existing one.

4.4 Islands' needs, best practices and case studies analysis.

Following the analyses and considerations developed in the previous section, the following table summarises, for each type of island previously identified, the main needs related to the energy transition process, and their level of priority.

NEEDS	Improve Local Clean Energy Production	Curbing of the energy demand	Collaboration with other islands
Type ↓	**RES**	**EE**	**Cooperate**
A	high	low	low
A1	high	low	low
A2	high	medium	low
B	low	high	low
B1	medium	high	low
B2	medium	high	low
C	high	low	medium
D	medium	high	high
D1	medium	high	high
E	high	medium	medium
F	high	high	medium
F1	high	high	medium

Table 2. Priority level of specific needs of each island typology

The needs have been aggregated into three main categories with the intention of providing as simple, clear and easily accessible tool as possible to support island local authorities facing the decarbonisation journey.
These categories are the following:

RES (Renewable Energy Sources):
Invest on improvement of RES infrastructure to cover the energy demand with clean energy self-produced. This means allow the decarbonisation of the island and in meantime the energy independence from the mainland, if grid connected, or from not sustainable import of fossil fuels.
The first step in responding to this need is to understand which renewable source, or much more frequently the mix of them, is most cost-effective and feasible for the island. To understand this, the development of different scenarios is a primary concern. The factors to be taken into account are not only related to the physical characteristics of the territory (such as the natural availability of certain sources or the usability of land to be allocated to the specific infrastructures needed) but must also include local regulations,

the existence of specific heritage and/or landscape limits, the perception and willingness of the population, the characteristics of existing energy grids and their ability to manage unstable energy flows and the possibility of storing surplus energy to ensure security even in deferred use.

Once you have chosen the mix of RES on which to base your transition, following a careful feasibility study, it is necessary to find sources of funding and set up the team that will be responsible for building the new energy system. It is therefore essential that the people involved have the appropriate technical skills.

EE (Energy Efficiency):

Energy savings and efficiency are a crucial aspect in any kind of clean energy transition process. Containing energy demand is essential in a strategy that involves the use of RES which, by definition, have a variable supply in terms of power and time.

In some cases, such as the typologies that identify islands that experience great variability in demand (in most cases due to tourist seasonality), focusing one's strategy on improving the efficiency of the largest energy consumers is the priority, rather than investing in energy production plants.

Acting in these terms is impossible without a detailed mapping of the energy consumption of the island (or municipality). The higher the level of detail and accuracy of the measurements, the more effective the resulting efficiency strategy will be.

If economically and technically feasible, it is always preferable to choose to carry out a few interventions but with the greatest savings achievable. In other words, acting on large energy consumers and producer of pollutants and climate-changing emissions. To do this, however, they must first be identified.

Often, however, it is preferred to act with small interventions distributed throughout the territory that overall still achieve excellent results in terms of cutting energy demand.

This is due to the lower technical and managerial skills required by this type of intervention, as well as often to the accessibility of funding and incentives for this type of action.

Cooperate:

As explained in the previous chapter, most of the islands in Southern Europe that could be clustered in the typologies 'medium' and 'small', have been part of archipelagos.

Furthermore, although they are territorially and geographically independent, they often lack the necessary administrative level to be able to independently implement political and legislative changes in the energy supply system. The same dependence on existing administrative superstructures and inter-dependence with other islands belonging to the same archipelago (which very often coincides with the region to which they belong - nut 2), is a factor that affects the ability to access forms of financing and resources.

Possible collaboration with other islands, whether they are connected through infrastructure (networks) or not, could ensure that they gain more political and financial clout, as well as being able to share resources such as space (land on which to install plants), renewable sources, and technical and managerial capacities in a network.

These indications are deliberately very general as it is impossible to define univocal recipes for all the islands. While making the effort to organize them into types, each reality will inevitably trace a specific transition path dictated by the interweaving of the natural, anthropic, energy, legislative and economic characteristics that define it.

For this reason, it is considered essential to provide examples of best practices that can best help an island to outline its own path. After all, the European Commission itself, as well as the Covenant of Mayors and the EU Secretariat for clean energy in island, promotes the sharing of experiences, encouraging activities on pilot cases and presenting real examples in its manuals and guidelines.

The following is a non-exhaustive compendium of best practices developed in southern European islands, including the cases analysed within the GENERA project.

Type	South-Europe Island examples
A	**Sardinia**; Sicily; Corsica
A1	Euboea
A2	**/**
B	Crete
B1	**Rhodes**; Mallorca
B2	**Ibiza**
C	/
D	/
D1	Menorca; **Chalki; Tillos;** Favignana, Levanzo & Marettimo
E	Tenerife
F	Lesbos
F1	La Palma, Egadi archipelago, Aeolian archipelago, Pantelleria

Table 3. Best Practices and Case studies clustered by island typology.

4.4.1 Type A - Sardinia, Sicily, Corsica

Large islands connected to the mainland have multiple advantages regarding the energy transition, primarily the area that can be used for energy production.
According to studies, Sardinia has some of Europe's highest renewable energy production capabilities. They can also sell excess of their grid production and cover the needs of the peak demands with relative ease.
However, even though they can allocate a bigger budget to their energy transition, this advantage is often diminished, as in the case of Corsica, due to an outdated grid system or legislative and political issues.
There are many initiatives being developed in Corsica and Sardinia. For example, the Corsican Pluriannual Planning for Energy (PPE), jointly formulated by regional authorities and state representatives, was released in 2015. The primary goals include augmenting

electricity production from renewable sources, enhancing energy security, and improving overall efficiency. Specific targets involve a 38% increase in electricity production from renewable energy sources. However, there are little island-wide green energy practices that are operating at the moment.

Genera Case Studies: Stintino and Sardinia
Level of action: Regional Level (island of Sardinia) and municipality level (Stintino)
CETA: Sardina is not officially committed to the Clean energy for EU islands secretariat.
SECAP: 295/377 (9)
In Sardina 295 municipalities have so far made some degree of commitment to participate in the Covenant of Mayors.
Other Energy Transition plans: Energy Environmental Plan of Sardinia (PEARS) (10), Sardinia Regional Strategy2030 (11)

The case of Stintino, a partner of the GENERA Consortium, is very special. As a pilot case, it is completely different from the others in that it is a small municipality within one of the largest islands in the Mediterranean. This forces the case to be analysed on two levels, that of the island of Sardinia and that of the municipality of Stintino.
For an island like Sardinia, whose territory geographically and administratively coincides with the regional one, a possible CETA cannot but start from the national plan and cannot but slavishly follow the regional energy plan, when present.
This is because an island of this size, in terms of population and territory, has considerable weight in the national energy strategy. In the specific case of Sardinia and Type A, being connected to the national energy grid and home to important power plants, the island plays a central role in the energy transition of the entire country.
European and Italian policy objectives envisage a complete decarbonisation of the energy system by 2050. Sardinia represents a particular context in the national decarbonisation path: geographically isolated, with interesting renewable potential, it did not have access to a gas grid until a few years ago and will be subject to coal phase-out in 2025.
In recent years, the construction of the methane gas network has begun, but it is unlikely to cover the entire territory of the island before 2025. The regional energy plan envisages a massive use of renewables alongside the methane network and, in the long term, the development of hydrogen as an energy storage technology.

	Positive	Negative
	STRENGTHS	**WEAKNESSES**
Internal	High renewable energy production capabilities. High Level of energy security – export of the 24% of electrical energy.	Spatial planning and stringent and generic restrictions Outdated energy grid system
	OPPORTUNITIES	**THREATS**
External	Interconnection to mainland and other islands Large area and low population density	Risk of mismanagement of the carbon phase-out (closure and/or transformation of two big electricity plants). Lack of attention for the local level within national strategic energy planning. Complex and lengthy permitting procedures.

Table 4. SWOT analysis for Sardinia

As for the city of Stintino, the SECAP was submitted in the year 2013. At present, no action has been implemented, in defiance of the official deadlines set by the covenant of mayors. In fact, the administration intends to update its SECAP within the GENERA project.

	Positive	Negative
	STRENGTHS	**WEAKNESSES**
Internal	Compact urban morphology and well-preserved building heritage. Extensive system of arable and grazing land. The 54% of CO2 emissions are attributable to electricity (residential and tertiary sectors). They are therefore more easily convertible to greater use of RES.	Strong seasonality of tourist flows and therefore of the variation in energy consumptions. Intense vehicular traffic during the summer period along the inland roads. Insufficient public transport services between beaches and centre. Highly constrained area in terms of nature and landscape.
	OPPORTUNITIES	**THREATS**
External	Municipality Urban Plan provides for special projects for the redevelopment of the historic core. Policies aimed at the conversion of activities that are not consistent with environmental protection.	Difficulty in finding figures with sufficient technical and managerial skills. Non-compliance with plans and targets due to the change of council. Lack of coordination with higher level administrations (Province-Region)

Table 5. SWOT analysis for Stintino Municipality

Suggested sources	
Description	**Link**
Corsica	The electrical energy situation of French islands and focus on the Corsican situation - ScienceDirect
Isolated islands in Europe: A policy review	Renewable energy projects on isolated islands in Europe : a policy review (zbw.eu)

Sardinia	The uncertain games of energy transition in the island of Sardinia (Italy) - ScienceDirect
SECAP of Stintino	Stintino Piano transizione energetica (eumayors.eu)
Energy Environmental Plan of Sardinia (PEARS)	PEARS (regione.sardegna.it)
Monitoring reports of the PEARS of Sardinia	Esiti monitoraggio - SardegnaEnergia (regione.sardegna.it)
Sardinia Regional Strategy2030	Regione Autonoma della Sardegna - Sardinia2030 – english version 4 (regione.sardegna.it)

Table 6. Suggested sources for Type A

4.4.2 Type A1 - Euboea

Medium grid connected islands like Euboea have many advantages when it comes to grid transition due to reliability of belonging to large energy system. Which in turn means that energy production on the island wouldn't need as much investment in smart grid or energy storage.

Euboea island has geography that positions it to become net energy producer with wind energy. Currently, numerous wind turbines have been erected in Euboea, and many more are slated for construction. In the southern part of the island alone, 600 wind turbines are already operational, constituting 40% of Greece's total fleet.

The choice of Euboea stems from its consistent strong winds throughout the year. Euboea's strategic advantage lies in its connection to mainland Greece via a bridge, that facilitates efficient energy supply.

On the other hand, note that little information was found on island-wide transition plans beyond wind energy production.

Proximity and lack of overspecialisation of this type of island allow it to approach large scale energy production.

Suggested sources	
Title	**Link**
The greeks facing their energy future	https://www.csactu.fr/the-greeks-facing-their-energy-future/
Evia's wind power plant	Terna Energy to more than double its wind power capacity in Evia island (balkangreenenergynews.com)

Table 7. Suggested sources for Type A1

4.4.3 Type B – Crete

Big island that doesn't have considerable grid connection to the mainland, are as per rule responsible for energy production for nearby islands. This usually means that during their energy transition journey they have to manage their and nearby islands energy needs.

This is seen in ongoing energy transition of Crete, as they have made significant efforts into establishing innovative solutions but still maintain fossil fuel production alongside it. Regional authorities have established REAC - an official territorial coordinator for the Region of Crete for the "Covenant of Mayors" initiative as well as for the Clear Energy

Transition of the island of Crete; There are some 70 energy related projects on going in Crete such as CRETE VALLEY aiming to create a Renewable Energy Valley 'Living Lab' (REV-Lab) or Hydro Pumped Storage in Amari.

Suggested sources	
Title	**Link**
Crete Renewable Energy Valley	https://cordis.europa.eu/project/id/101136139
The largest hybrid project to produce clean energy in Europe	https://www.terna-energy.com/restories-en/the-largest-hybrid-project-to-produce-clean-energy-in-europe/
Crete Energy Agency	https://fedarene.org/member/crete-regional-energy-agency/

Table 8. Suggested sources for Type B

4.4.4 Type B1 - Rhodes; Mallorca

Islands of this type that are of medium size, playing a considerable role in the region and are often the ones setting the tone for the surrounding islands. Which we see both in case of Rhodes and Mallorca which have developed a plan for energy transition alongside nearby smaller islands. This particular type has advantage of being grid connected allowing them to cover demand fluctuation while also being able to export the surplus of the energy production.

Genera Case Studies: Rhodes
Level of action: island level
CETA: Rhodes is not officially committed to the Clean energy for EU islands secretariat.
SECAP: the island jointed the Covenant of Mayor In the 2010

	Positive	Negative
	STRENGTHS	**WEAKNESSES**
Internal	Connected to the mainland grid.	Strong seasonality of tourist flows and therefore of the variation in energy consumptions.
	OPPORTUNITIES	**THREATS**
External	Well developed transportation to and on the island. Centre of the regional unit.	Overspecialisation of economy on tourism (75% of GDP, employing 60% of work force). Difficult in the measurement and collection of data. The load profile on the island is thus not available.

Table 9. SWOT analysis for Rhodes

Suggested sources	
Title	**Link**
Balearic Islands Government	https://www.caib.es/govern/index.do?lang=ca
IBE	https://institutbalearenergia.com/es/

Balearic Cluster for Ecological Transition (Cluster TEIB)	https://clusterteib.com/

Table 10. Suggested sources for Type B1

4.4.5 Type B2 – Ibiza

Islands of this type have a significant variability of demand primarily due to the tourist influx during high season, which is very prominent in Ibiza. This makes planning energy production quite difficult particularly in a small island.
However, in this typology the transition is greatly aided by connection to the mainland grid that allows to cover fluctuating energy needs.

Genera Case Studies: Ibiza
Level of action: island level /archipelago level
CETA: Part of the Balearic Islands joined the "Clean Energy for EU Islands" initiative in February 2019: Mallorca, Menorca and Ibiza. The island of Ibiza developed the first version of the roadmap in October 2020 (12).
SECAP: 3/5 The municipalities Ibiza (13) , Sant Antoni de Portmany (14) and also the island of Formentera (15) are part of the Covenant of Mayors and have developed or are developing their action plans.
Other Energy Transition plans: Island Territorial Strategic Plan of Ibiza. Energy Transition and Climate Change Plan of Balearic Island. The Investment Plan for the Energy Transition of the Balearic Islands (16).

	Positive	Negative
	STRENGTHS	**WEAKNESSES**
Internal	GAS Inter-connection with mainland and Electric inter-connection with other islands.	Strong seasonality of tourist flows and therefore of the variation in energy consumptions. .
	OPPORTUNITIES	**THREATS**
External	The energy security of the Balearic archipelago is an aim of the national energy strategy. Balearic archipelago is part of the Commission's "30 renewable islands for 2030 initiative" (17) and of the Spanish project "100%-Sustainable Islands" (18)	Grid constraints and inflexible thermal plants. Lack of legal frameworks for system integration of renewable energy Complex and lengthy permitting and authorisation procedures.

Table 11. SWOT analysis for Ibiza

Suggested sources	
Title	**Link**
CETA of Ibiza	[Ibiza | Clean energy for EU islands (europa.eu)]()
SECAP of Ibiza	[Covenant of Mayors - Ibiza]()

SECAP of Sant Antoni de Portmany	[Covenant of Mayors - Sant Antoni de Portmany]()
SECAP of Formentera	[Covenant of Mayors - Formentera]()

Table 12. Suggested sources for Type B2

4.4.6 Type D1 – Menorca; Chalki; Tilos

This type includes a waste range of small islands that have some great successes in energy transition.
For example, Menorca is a rather small islands of 694,72 km^2 that makes up 14% of the Balearic Island region. In early April 2019 Menorca was the first island to publish its ET roadmap (19). Island used to be connected to the larger island of Mallorca, the connection was damages in 2017, however as connection is planned to be repaired as part of SECAP strategy we have concluded it to be sufficient to consider it connected. Island also experiences two and a half times greater levels of human pressure than during high tourist season.
From the SECAP provided by Menorca we can see a lot of similarities with our two pilot islands of Chalki and Tilos. All of them plan to fully cover their energy needs with renewable energy in the near future relying less on their interisland connection, though building a smart grid, energy storage and managing the demand.

Genera Case Studies: Chalki
Level of action: municipality and island level
CETA: In the 2020 Chalki published its roadmap and in the 2022 applied to a call for 'Technical Assistance' in order to Investigate the potential of wind energy and of a solar-powered district cooling system.
SECAP: In the 2020 the island also joins the Covenant of Mayor and submitted its SECAP in February 2023.

The island of Chalki has begun its energy transition through the recently established ChalkiON: a 1 MWp photovoltaic plant that will completely cover the needs of its residents. Such a project was only possible for a small island like Chalki thanks to the intervention of the national government. Indeed, Greece's energy strategy, with the GR-eco Islands national initiative, prioritises precisely the smallest non-connected Islands and the realisation of their energy autonomy, where connection to the national grid is not possible. However, the case of Chalki is peculiar in that the island benefits from the connection to the Rhodes electricity grid.
In April 2022, Chalki also started a project to electrify its transport by changing to electric cars.

	Positive	Negative
	STRENGTHS	**WEAKNESSES**
Internal	Good level of RES infrastructures implementation: started electrifying transport and building photovoltaic plants for the use of its inhabitants. Limited environmental impact and energy demand due to its smaller size and its touristic centred economy.	Lack of technical capacity and economical resources. Highly constrained area in terms of nature and landscape. Strong seasonality of tourist flows and therefore of the variation in energy consumptions.
	OPPORTUNITIES	**THREATS**
External	Interconnection to Rhodes guarantee the security and stability of the energy supply could already act as electricity storage. Climate conditions. Participation in "30 renewable islands for 2030" initiative (17) Small size of municipality - easy management of actions. The whole islands is administrated by one municipality.	Small size of municipality - poor influence in the regional dynamics. Difficult in the measurement and collection of data. The load profile on the island is thus not available.

Table 13. SWOT analysis for Chalki

Genera Case Studies: Tilos
Level of action: municipality and island level
CETA: the 31/01/2022 a Technical assistance report was published and reported the result of the DESALINAID project, where an overview of the regulatory framework and financial opportunities was provided.
SECAP: Tilos joint the Covenant of Mayors in the 2016

Tilos aims to be the first non-interconnected autonomous island in the Mediterranean to power itself through green energy. The island covers large shares of its electricity needs through local renewable energy systems power generation, a hybrid wind-PV battery station on the scale of 1 MW. The plant was founded funded largely by the European Union, with help from the Eunice Energy Group, a Greek renewable energy developer.
TIlos is a typical example of a small tourist island where the number of residents increased 4-5 times during the summer period.
The Tilos project isn't just an energy project that aims for Tilos energy security but also it focuses on island regions which constitute high priority areas limited in Greece.
The strength of TIlos is the high level of engagement of citizens and administration, that allowed a widespread community-scale use of solar and wind.

	Positive	Negative
	STRENGTHS	WEAKNESSES
Internal	Developed renewable energy production capabilities. Conscious and proactive population and government. Renewable energy generation farms providing the excess of the produced energy to neighbouring interconnected islands. Limited environmental impact and energy demand due to its smaller size and its touristic centred economy.	Demand variability Complex permitting procedures Lack of grid connection Lack of essential resources such as fresh water.
	OPPORTUNITIES	THREATS
External	Developed infrastructure and lack of car dependency. Climate conditions. Participation in "30 renewable islands for 2030" initiative (17) Small size of municipality - easy management of actions	Lack of regulation on storage systems Technical constraints for autonomous systems. Small size of municipality - poor influence in the regional dynamics.

Table 14. SWOT analysis for Tilos

Suggested sources	
Title	**Link**
Clean Energy Island - Menorca	https://clean-energy-islands.ec.europa.eu/countries/spain/menorca
Clean Energy Island - Chalki	https://clean-energy-islands.ec.europa.eu/countries/greece/Chalki
SECAP of Chalki	Signatory | Covenant of Mayors - Europe (europa.eu)
The GR-eco Islands national initiative	GR-eco Islands: Turning Greek Islands into models of green & sustainable development | Clean energy for EU islands (europa.eu)
Clean Energy Island - Tilos	https://clean-energy-islands.ec.europa.eu/countries/greece/tilos
SECAP of Tilos	Signatory | Covenant of Mayors - Europe (europa.eu)
S4S Tilos project	Eunice islands | Eunice Group (eunice-group.com)
TIlos' project	Energy Islands - The Case of Greece
TIlos' project	Tilos, the first autonomous renewable green island in Mediterranean: A Horizon 2020 project
Greek Non-Interconnected Islands (NII).	An Overview of the Greek Islands' Autonomous Electrical Systems: Proposals for a Sustainable Energy Future (scirp.org)
San Pietro Island (Sardinia region)	San Pietro | Clean energy for EU islands (europa.eu)

Table 15. Suggested sources for Type D1

4.4.7 Type E –Tenerife

Medium sized island that lacks security of grid connection is a difficult case for energy transition since at all times demand has to be balanced with the supply. This makes Tenerife green energy plan that much more impressive. Island has separated dedicated plans for energy storage, climate action as well as energy production with 65% of the island's municipalities taking actions on their level.

Genera Case Studies: Tenerife
Level of action: island level
CETA: Tenerife island is not officially committed to the clean energy for EU islands secretariat.
SECAP: Majority of municipalities (20 out of 31) participate in the Covenant of Mayors initiative and that have their action plan in process of implementation or have made a commitment in doing so. (9)
Other Energy Transition plans: Strategy for Energy Storage in the Canary Islands, Canary Islands Climate Action Strategy (ECAC) that is which is currently under development, Canary Islands Energy Transition Plan (PTECan) (initial version currently in the public information phase), the Draft Law on Climate Change and Energy Transition in the Canary (LCCTEC) Islands is being processed. has been published in the Official Gazette of the Parliament of the Canary Islands the 23 November 2021.

	Positive	**Negative**
	STRENGTHS	**WEAKNESSES**
Internal	Well-developed plans for energy transition Information and awareness campaigns for population, businesses and tourists. Tax credits and subsidies for citizens and businesses related to Solar panels, electric vehicles, public transport. Smart grids projects.	Not connected to the mainland or other islands. Hight dependence to imported energy fossil sources (fossil fuels). Transport is the sectors with the biggest energy consumption.
	OPPORTUNITIES	**THREATS**
External	Due to the peculiar climate condition, the consumption for cooling and heating are contained. The energy security of the Canary archipelago is an aim of the national energy strategy and it is also part of the Spanish project "100%-Sustainable Islands" (18).	Grid constraints and inflexible thermal plants. Lack of legal frameworks for system integration of renewable energy Complex and lengthy permitting and authorisation procedures

Table 16. SWOT analysis for Tenerife

Suggested sources	
Title	**Link**
WEB Tenerife	https://www.webtenerife.com/investigacion/
Canary Islands Government	https://www.gobiernodecanarias.org/principal/

Canary Islands energy transition plan (ptecan-2030).	https://www.gobiernodecanarias.org/energia/info-publica/PTECan_VersionInicial/

Table 17. Suggested sources for Type E

4.4.8 Type F – Lesbos

There is no island wide plan to decarbonize the island of Lesbos, on the base of the available sources founded.

At present, the primary source of electricity for the island comes from a crude oil power station, supplemented by a limited contribution from renewable energy sources (RES). Given that the island operates on an independent power grid, fulfilling electricity demand becomes notably intricate during periods when wind turbines or solar cells fail to generate the necessary power. The island is located quite far from the mainland and it's geography makes it difficult and costly to interconnect.

The complexity for this type arises from the absence of an external means to deliver electricity to the island. Energy transition plan has to determine the optimal sizing of Renewable Energy Sources (RES) to sufficiently meet the island's electricity demand and future projections.

Suggested sources	
Title	**Link**
Clean energy for EU islands: Study on regulatory barriers and recommendation for clean energy transition on the islands	https://clean-energy-islands.ec.europa.eu/system/files/2022-12/PUBLIC_IslandSecretariatII_Study%20on%20barriers%20and%20recommendations%20GREECE_20221214%20clean.pdf

Table 18. Suggested sources for Type F

4.4.9 Type F1 -La Palma, Egadi archipelago, Aeolian archipelago, Pantelleria

Islands of this type at a small-scale face unique challenge of having simultaneously address all the areas of energy transition while possessing, quite limited resources to do so. With regards to this challenges island of La Palma has been doing great work in mitigating issues of rising demand, outdated grid system as well as ensuring energy security. In 2012, the Canary Islands committed to the Pact of Islands and established an Action Plan for Sustainable Energy Islands. La Palma, in line with these commitments, is in the process of developing a Baseline Emissions Inventory and a Sustainable Energy and Climate Action Plan, with the ultimate goal of joining the Covenant of Mayors. Additionally, the island is an active participant in the Smart Island Initiative, implementing Energy Efficiency and Sustainable Mobility Plans since 2015.

The Aeolian islands are not connected to the national electricity grid, in fact they are equipped with diesel power plants.

In terms of the use of renewable energy, Lipari is home to the largest photovoltaic power plant currently present in the smaller Mediterranean islands: over 1 megawatt (1120 kilowatts) of electrical power to support the operation of the new desalinator. This not

only obtains more than 20 per cent of the energy needed to desalinate seawater from solar energy, but also avoids the import of three times as much fuel oil.
On the island of Vulcano, one of the first photovoltaic power plants was installed in 1984, showing the complete reliability of photovoltaics even in such difficult conditions on a small island. Even today, the Vulcano power plant, with a capacity of over 180 kilowatts, feeds 'clean' electricity into the grid every day, which immediately reaches electricity consumers all over the island.
In 2004, the photovoltaic power station on Ginostra was completed with a 100 kW photovoltaic plant with a low-voltage distribution network, entirely underground, extending 5000 metres and supplying a total of 140 consumers.

Favignana, Levanzo and Marettimo are not interconnected with the mainland and neither among themselves, each Island has a local DSO that provides electric energy using diesel plants.
The Egadi Archipelago is committed to clean energy policies from far, there are several project-oriented to a wide RES penetration in the electric mix.

Suggested sources	
Title	**Link**
Clean energy for EU islands: La Palma	https://clean-energy-islands.ec.europa.eu/countries/spain/la-palma
Smart Islands- Smart archipelagos: Aeolian, Egadi, Pantelleria and others	Home - Smart Island
Pantelleria	Pantelleria | Clean energy for EU islands (europa.eu)
Clean energy islands: ESCAPE Favignana, Levanzo & Marettimo, Italy	https://clean-energy-islands.ec.europa.eu/system/files/2023-01/CETA%20Favignan%20Jan%202023.pdf
Action plan for the dissemination of technologies for the utilisation of renewable energies in the minor islands of the sicilian region	PER Regione Siciliana - Isole Minori

Table 19. Suggested sources for Type F1

5. Guidebook for fast roadmap production

This final chapter aims to create a guide to assist the Local Authorities of the islands in navigating through the multiple sources of information, manuals, guidelines, regulations and tools currently available.
After defining island typologies into which the islands of southern Europe can be grouped, with the intention of categorising best practices and providing initial indications on the possible pathways to follow, it is considered indispensable to provide the tools, in the broadest sense of the term, to be able to define the long-term "vision" towards which a territory can strive and then concretise it into feasible and decisive actions.
Whether it is a municipality, an island or an archipelago, the transition of the energy system from a reality characterised by the massive use of fossil fuels towards a predominance of clean and sustainable energy, must follow precise stages and requires a clear development methodology.

Given these premises, with the main purpose of favouring and incentivising the realisation of decarbonisation roadmaps through the subdivision of the transition process into specific phases, we started from the two main existing instruments supporting local authorities: the Guidebook 'How to develop a Sustainable Energy and Climate Action Plan (SECAP) (20), in the following called “SECAP Guidebook”, delivered by the Joint Research Centre (JRC), the European Commission’s science and knowledge service and the Methodological Handbook created by the EU Clean Energy Islands Secretariat (21), in the following called “Islands Clean Energy Transition Handbook”.

The methodology presented in the Islands Clean Energy Transition Handbook focuses mainly on three stages:

1. **Explore.** The starting point of the islands' transition with the elaboration of the Clean Energy Transition Agenda (CETA).
2. **Shape.** The development of the alternatives identified in the CETA, assessing technical and economic feasibility of project ideas.
3. **Act.** The implementation of the actions.

In the contest of the GENERA project, these three stages were related to the schematisation of the Design Thinking methodology elaborated by the Desing Council.
The creative process is summarised and visualised in a Double Diamond (22) and consists of four stages: Discover, Define, Develop and Deliver.
This has been very useful in the work that has been carried out so far regarding the citizens and stakeholder enegagement. The active involvement of the population and stakeholders is of great importance in all planning and implementation processes related to decarbonisation and thus in the development of CETAs and SECAPs.

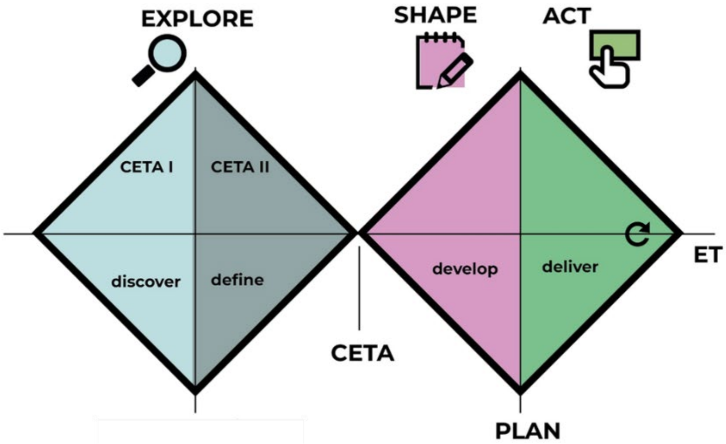

Figure 36. The GENERA Islands' Clean Energy Transition Double Diamond

The GENERA project has produced a manual and toolkit specifically designed to help local authorities in their engagement activities, collected in the document "Co-creation methodology and tools", that correspond to the deliverable D6.2.
This report is intended as a continuation of this work and therefore follows the same structure and intentions.
For this reason, it is the author's intention to use the same steps to summarise the steps in the production of a SECAP.
Exactly as happens in the path of Energetic Transition and creative thinking, the process of a SECAP's development is not linear, and some phases may overlap with others or have to be repeated following an iterative methodology.
The iteration of some steps, and of the whole process, ensures that the quality of the results is continuously monitored and that the insights gathered from civil society and stakeholders involved in the activities are respected. It is important to remember that the involvement of different stakeholder groups, the analysis of their specific needs and their involvement in each step of the process is a pillar of the production of both documents, Clean Energy Transition Agenda and Sustainable Energy Climate Action Plan.
As stated in the SECAP Guidebook, the main phases of the elaboration and implementation of a SECAP are:

1. **Initiation.** The commitment with the Covenant of Mayors.
2. **Planning.** The elaboration of the Action Plan.
3. **Implementation.** The concretisation of the actions.
4. **Monitoring and Reporting.** The regular monitoring of the impacts and the production of official reports.

The following tables detail the steps of the two processes, the CETA and the SECAP creation, and shows the parallelism with the scope to elaborate a common path that is intended to be used as a guide in the presentation of recipes and best practices.

CETA			SECAP			
Phase	**Stage**	**Step**	**Phase**	**Stage**	**Step**	
EXPLORE	Committing to decarbonisation and signing of the Pledge	1.Establish and charge a leadership team (Transition Team)	INITIATION	1.Political commitment and signing of the Covenant		INITIATION
		2.Identify the Island Transition Community		2.Mobilize all municipal departments involved		
		3.Sign the Clean energy for EU islands Pledge				
	CETA part I: Understanding Island Dynamics	Stakeholder mapping		3.Build support from stakeholders		
		Analysis of the Geography, Economy and Population	PLANNING	Assessment of the current framework: Where are we?	Baseline Emission Inventory (BEI) and Risk and Vulnerability Assessment (RVA)	DISCOVER
		Energy System Description				
		Analysis of Policies and regulations			Analysis of relevant regulations	
	CETA Part II: Island transition path	Establishment of the Island Vision		Establishment of the vision: Where do we want to go?	Establishment of a long-term vision	DEFINE
		Definition of the Transition Governance			Coordination and organisational structures	
		identification of the Transition Pathways and Pillars			Setting objectives and targets for mitigation and adaptation actions	
		Definition of Monitoring strategy				
SHAPE	Developing the Project idea	Stakeholder engagement		Elaboration of the plan: How do we get there?	Stakeholder engagement	DEVELOP
		Technology and site selection			Identification of best practices in similar contexts	
					Priorities setting and Key Actions selection	
		Identification of the available Funding sources			Definition of budget and financing modality for each action	
	Pre-feasibility and feasibility studies	Financial and economic analyses				
		Environmental and social aspects			Definition of impacts	
		Technical Assessment				
		Policy and regulatory assessment			Monitoring plan	
		Organisational and scheduling aspects			Definition of timing and responsibilities	
		Risk assessment			Risks analysis	
	Business development	Business model			Draft the Action Plan	
		Financing concept				
				SECAP approval and submission		

Table 20. Comparison of the CETA and SECAP production processes–part I

CETA			SECAP			
Phase	**Stage**	**Step**	**Phase**	**Stage**	**Step**	
ACT	Implementation	Setting up the collaboration with partners	**IMPLEMENTATION**	Implementation of the actions	Setting up management structures: timing, financial and responsibilities	**DELIVER**
		Structuring financing package			Definition of pilots to test measures.	
		Conducting tenders			Creation of an score-card system for tracking and monitoring the plan	
		Risk assessment			Risks and vulnerabilities management. Deviation Analysis	
	Training programme for stakeholders			Creation and delivering of training programme		
	Stakeholder and citizens follow up plan			Stakeholder and citizens follow up plan		
	Monitoring	Impact Assessment	**MONITORING AND REPORTING**	Regular Monitoring	Monitoring Emission Inventory (MEI)	
					Mitigation and adaptations actions monitoring	
					Adaptation scoreboard monitoring	
					Risk and Vulnerability Assessment (RVA)	
	Communicate on the progress and achievements	Communication plan and replicability plan		Reporting and submission of the implementation report	Action reporting (without MEI) and full Reporting (with MEI) alternatively every 2 years	
				Review		

Table 21. Comparison of the CETA and SECAP production processes–part II

The identified phases are:

1. **INITIATION – Commitment and signature**
2. **DISCOVER- Preliminary analysis to understand the context and elaborate the baseline.**
3. **DEFINE - The establishment of the vision and the strategy.**
4. **DEVELOP - The translation of the vision in a realistic and feasible plan.**
5. **DELIVER- The implementation and the monitoring of the actions.**

As can be seen from the tables above, the phases and relative steps are similar for both instruments, but it is important to note that CETA and SECAP present substantial differences in that they are two instruments with different objectives: the agenda is a strategic instrument, which leaves the precise definition of the actions to be undertaken to the implementation phase, while SECAP is to all intents and purposes an implementation plan which, after approval, requires the respect of certain deadlines and the submission of specific reports to an external control body, in this case the Covenant of Mayors.

The two tools are closely connected and it is important to understand what the entire decarbonisation pathway entails, in terms of activities, documents to be produced, procedures to be organised and processes to be managed from the earliest stages of the decision-making process and in the development of the ET roadmap.

In what follows, we will not go into the details of each individual phase, as they are amply described in the various sources and documents available. Instead, the intention is to organise these very sources organically, prioritising those of greatest interest to the islands.

The European Commission, through specific offices and research centres, provides support to all local authorities, be they municipalities, groups of municipalities or administrative bodies of islands, in various ways. In addition to manuals and guidelines available online, there are open access research, webinars, tutorials and collections of best practices of various kinds.

5.1 Initiation phase

At the beginning of the energy transition path, it is necessary identify the management structure and mobilize all administrative bodies involved, at island level and/or at municipalities level. After the engagement of public authorities, it is crucial to engage all stakeholders' groups in this first phase.

KEY Steps:

1. **Establish and charge a leadership team.**
2. **Identify the key actors and stakeholders.**
3. **Signature of the formal commitment document**

Before starting any actions is fundamental establish a governance structure where are included all the key stakeholders' groups starting from the decision makers at the highest level reachable.

The definition of a leadership team (called Transition Team in the contest of the Islands Secretariat) with the assignment of the roles and responsibilities is a pre-requisite to guarantee the coordination of the various actors, especially the local authorities. The integration and alignment between policies and procedures is crucial to avoid legislative barriers.

The formally commitment of the island is demonstrate through the signature of the Pledge by the Transition Team and its submission to the Clean Energy for EU islands Secretariat (23) and, with a similar process, the commitment of a municipalities or a group of them, became real and concrete with the signature of the Covenant of Mayors by the municipal council through an official resolution.

Recommended tools:

Pledge templates
Infographics and descriptive documents

Existing guidelines and tools

Title	Description	Link
Clean Energy for EU islands website	Templates of the Pledge	templates,
Clean Energy for EU islands website	Instructions for the submission.	infographic
Islands Clean Energy Transition Handbook Chapter 1	Definition of the Transition Team and the Transition Community	ET Handbook
Island Transition Handbook	Summary for policy makers	eu_islands_transition_handbook_policy
SECAP Guidebook Part 1. Chapters 3 and 4	Political commitment and administrative structure	JRC Guidebook SECAP
Annex to the Commitment Document of the Covenant of Mayors - Europe	Description of the process and all steps	Annex to the Commitment document
Covenant of Mayors – Europe website	FAQs	FAQs | Covenant of Mayors - Europe (europa.eu)
Covenant of Mayors – Europe website	Template of the Commitment document	eumayors-commitment-2021-EN.docx (live.com)
Transition network guidebook	Community building reference.	Transition Network
UKCIP Adaptation Wizard	Collection of tools and resources for organizations willing to plan adaptation strategies.	UKCIP_Managing_adaptation
Transition management in the urban context: guidance manual. DRIFT, Erasmus University Rotterdam	This guidance manual details the transition management approach.	Transition_management

Table 22. Existing guidelines and tools regarding the Initiation Phase

5.2 Discover phase

The second phase of the decarbonisation process is aimed to research activities within the scope to guarantee the full understanding of the island dynamics and the identification of all actors who will participate in the whole island's transition path. [D6.2]

As highlight before, this document is the continuation of previous document delivered by the GENERA Consortium. In this case, a guideline for mapping stakeholders is presented in the *D2.1- Comprehensive report on Island Dynamics*, according to a common procedure and guidelines provide by the EU Clean Energy Islands Secretariat in its handbooks and guides.

Once the governance structure is defined and after the identification and engagement of all stakeholders, the first action that the team have to approach is the collection, analysis and elaboration of data about the contest. Understanding the geographical, demographic, economic, political-administrative and energy dynamics is the key activity to ensure the linearity of the transition process, i.e. a development of the next steps without unforeseen obstacles. This survey needs technical experts to collect and analyse the best available data and the involvement of citizens and stakeholders in collection of data as secondary sources. In fact, the collection of quantitative data from primary sources must be combined with the research and elaboration of qualitative and secondary data to fill all possible data gaps.

The more detailed and extensive the investigation into the peculiarities of the island, the more accurate the baseline will be. Consequently, the more concrete and relevant to the real needs of the area the proposed interventions will be. A correct baseline also guarantees an exact definition, evaluation and monitoring of targets, risks and impacts.

KEY STEPS:

1. **Stakeholders' mapping**
2. **Assess the baseline.**

Recommended tools:

Community engagement:
Stakeholder engagement register
Population assessment
Registration forms for engagement activities
Insight survey questionnaires based on categories (of citizens and stakeholders)
Empathy map and latent needs analysis

Assess the baseline:
Baseline Emission Inventory (BEI)
Risk and Vulnerability Assessment (RVA)
Strengths-Weaknesses-Opportunities-Threats Matrix (SWOT)
Comparative analysis of goals and objectives in the local regulations
Self-assessment tool of Clean Energy for EU Islands

Existing guidelines and tools:

Title	Description	Link
Islands Clean Energy Transition Handbook	Chapter 2 – island dynamics analysis and stakeholder mapping	ET Handbook
SECAP Guidebook Part 1. Chapter 5	Building support from stakeholders	JRC Guidebook SECAP
Organicity – Another way to do actor mapping	Actors Mapping.	Organicity-Playbook
Stakeholder Engagement - Guidance Note of UNDP Social and Environmental Standards (SES)	Actors Mapping. See specifically: stakeholders' analysis and engagement plans annexes	UNDP SES Stakeholder Engagement
Energy transition playbook – U.S. Department of Energy	Actors Mapping. See specifically: phase 0 and 1	Energy Transitions Playbook
Energy transition playbook – U.S. Department of Energy	Baseline assessment. See specifically phase 2	As above
Clean Energy for EU Islands - self-assessment tool of	The tool helps to select the support category that is best adapted to their islands' needs.	Self-assessment tool
SECAP Guidebook Part 1. Chapter 6.2 Part 2. A	Baseline Emission Inventory (BEI)	As above
SECAP Guidebook Part 1 - Annex I	Example of aspects suggested to be covered in the baseline mitigation reviews	As above
SECAP Guidebook Part 1. Chapter 6.2 Part 2. B	Risk and Vulnerability Assessment (RVA)	As above
SECAP Guidebook Part 1. Chapters 6.3	SWOT analysis	As above
Islands Clean Energy Transition Handbook	SWOT analysis Annex I - Tools for developing transition pillars	As above
Business balls website	SWOT analysis	SWOT – BusinessBalls

Table 23. Existing guidelines and tools regarding the Discover Phase

5.3 Define phase

The focus of this stage is to develop the Island Vision, working with the findings collected during the Discover phase and following the European commitments or also be more ambitious than those.

Identified challenges will be transformed into opportunities with a qualitative approach at first, elaborating the input from decision makers and all groups of community stakeholders.
While in previous stages, the involvement of key ET actors supported data collection and gap filling, at this stage of the process the creation of platforms for collaboration within and outside the local government becomes crucial in defining the city-wide renewable energy vision.
The determination of the best alternatives transition pathways, following a multi-criteria decision-making (MCDM) approach, will then allow the translation of the opportunities into quantitative elements such as specific objectives and targets for mitigation and adaptation actions, based on the indicators selected in the baseline review.
Thanks to these indicators will be possible quantify the impacts of the actions and then monitoring the transition process but also compare the "business as usual" scenario with the various pathways from the current energy landscape to the future one, identified in the Vision statement.

This phase could be considered concluded with the submission of the CETA to the Secretariat. In the case of the elaboration of the SECAP, the official submissions need more detailed analysis carried out in the next phase.

KEY Steps:

1. **Establishment of a long-term vision, identifying challenges and core values.**
2. **Definition of governance structure**
3. **Setting objectives and targets**
4. **Elaborate scenarios**
5. **Define a monitoring strategy.**

Recommended tools:

Stakeholder engagement register
Insight survey questionnaires based on categories (of citizens and stakeholders)
Strengths-Weaknesses-Opportunities-Threats Matrix
Transition Process Timeline (GANTT chart)
SMART targets approach: Specific, Measurable, Achievable, Realistic, and Time-bound
Simulation models with Multiple Criteria Decision Making (MCDM) approach
Benchmarking (comparative analyses)

Existing guidelines and tools:

Title	Description	Link
SECAP Guidebook Part 1. Chapter 7	Establishment of the Vision and setting of targets	JRC Guidebook SECAP
Islands Clean Energy Transition Handbook	Chapter 3– Island transition path: Vision, pathways, pillars and governance	ET Handbook
Energy transition playbook – U.S. Department of Energy	Vision, Scenarios and comparative analytical tools. See specifically phase 2 and related resources table.	Energy Transitions Playbook
Guide to Community Energy Strategic Planning	A step-by-step approach that offers valuable tools, tips, and examples for developing a focused energy vision with the help of the community.	Guide to Community Energy Strategic Planning
IDEO: Design kit.org	The original and best 1:1 design thinking kit	Design kit
Living lab handbook	Produced and published for cities fighting air pollution in 2019	Living lab
The futures toolkit by gov.U	The futures Toolkit provides a set of tools and techniques to help government officials use long-term strategic thinking in policy making	Gov.UK
Futures & Foresight by OECD	Collection of Futures & Foresight tools and methods	OECD
Future Frecuency	Future Frequency is a workshop method for building alternative futures	Sitra
UNaLAB	Vision Development Method	UNaLAB
C40 Knowledge Hub	How to create a roadmap for your city's renewable energy transition	C40knowledgehub.org
The Energy Justice Workbook	A scorecard-based approach, including guideposts, for incorporating energy justice into policymaking process.	iejusa.org
Engage Energy modelling Tool	Modelling tool for cross-sectoral energy system planning and simulation	NREL
How to achieve 100% Renewable Energy - World Future Council	Case studies to identify drivers, barriers as well as facilitating factors and, from these, policy recommendations	Policy handbook - World Future Council
MCDM Methods and Concepts	Taherdoost, H.; Madanchian, M. Multi-Criteria Decision Making Methods and Concepts. Encyclopedia 2023, 3, 77-87.	mdpi.com

Table 24. Existing guidelines and tools regarding the Define Phase

5.4 Develop phase

The further stage of the process is focus on concretely shape the ET, translating in real and feasible, practicable and reasonable actions the solutions proposed in the Transition Pathways and Pillars.

The purpose of this activity of "translation" is defined technical measures, timing and responsibility, budget and financial sources.

The prioritisation and selection of actions should be conducted with an enlarged stakeholder committee from the previous phases, during specific design sprints in which various working groups address specific goals and targets to be achieved.

The results of co-creation activities will be then elaborate in feasibility plans where all management and technical aspects are assessed. Finally, a monitoring plan and a risks assessment complete the list of requirements to ensure a comprehensive Actions Plan.

In fact, in the Covenant of mayors contest, the successful completion of these activities is the official submission of the SECAP.

KEY Steps:

1. **Stakeholder engagement**
2. **Selection of the actions to implement.**
3. **Feasibility study**
4. **Business models**

Recommended tools:

Stakeholder engagement register
Stakeholder matrix
Registration forms for engagement activities
Insight survey questionnaires based on categories (of citizens and stakeholders)
Latent needs analysis
Co-creation process Evaluation form
List of actors of the working group with definition of roles

Risk and Vulnerability Assessment (RVA)
Risk register and matrix
Multiple Criteria Decision Making (MCDM) analysis
Cost-Benefit Analysis (CBA)
Business Model template

Existing guidelines and tools:

Title	Description	Link
Islands Clean Energy Transition Handbook	Part II – Shape and related references	ET Handbook
SECAP Guidebook Part 1. Chapter 8	Secap elaboration	JRC Guidebook SECAP

Energy transition playbook – U.S. Department of Energy	Develop action plans See specifically phase 2 and related resources table	Energy Transitions Playbook
Energy transition playbook – U.S. Department of Energy	Select projects with input from stakeholders. See specifically phase 3 and related tools and resources	As above
Clean energy for EU islands - Technology solutions booklet	Overview of energy technologies available for islands	Technology solution booklet
SECAP Guidebook Part 3	Existing policies and initiatives and good practices for adaptation and mitigation measures	JRC Guidebook SECAP
Covenant of Mayors resource library and signatory database	Best practices compendium	Library | Covenant of Mayors
Methodologies and Tools for the Development and Implementation of SEAPs	inventory of existing methodologies for the development and implementation of SEAP	SEAP elaboration
Clean energy for EU islands - Quick-reference guide on financing	Introduction to the general potential barriers and possibilities for the financing of decarbonisation plans.	guide on financing
Covenant of Mayors - Funding and financing resources	Existing funding and financing resources	Financing opportunities
Clean energy for EU islands - Regulatory inventory	Clean energy for EU islands secretariat's inventory of policy and legislation	Regulatory inventory
Google Design sprints	The Design Sprint is a proven methodology for solving problems through designing, prototyping, and testing ideas with users.	Google Design Sprints
Model Canvas	The Business Model Canvas is a strategic management template used for developing new business models and documenting existing ones.	Business Model Canvas
Pitching templates	Inspiration for pitching templates	Pitch Deck Guide

U.S. General Accounting Office report describing the key principles of strategic workforce planning, including illustrative examples	Identify the Human, Technical, and Financial Resources Needed to Complete Near-Term Projects	Key Principles for Effective Strategic Workforce Planning
NIST Template: Forming a Collaborative Planning Team	Template tables from NIST providing examples of planning team members and their roles.	CR Playbook Template_1-1_Oct 2020.docx (live.com)
C40 knowledge hub - Clean Energy Business Model Manual	Guidance on business models and financial mechanisms	Clean Energy Business Model Manual

Table 25. Existing guidelines and tools regarding the Develop Phase

5.5 Deliver phase

The deliver phase is composed of three main activities: the implementation of concrete actions, the monitoring of the development and the results achieved and the communication.

This last activity consists in the follow up with citizens and stakeholders and in their involvement in the co-monitoring of the development.

The communication plan has to act on two levels: in the discussion with the stakeholders but also, especially in the case of the execution of a SECAP, in the regular reporting and review of the activities.

KEY Steps:

1. **Setting up management structures**
2. **Definition of pilot actions**
3. **Conducting tenders and public procurement**
4. **Stakeholder and citizens follow up plan**
5. **Creation and delivering of training programme**
6. **Monitoring and risks and impacts assessment**
7. **Reporting and communicating**

Recommended tools:

GANTT chart
Co-creation process Evaluation form
Monitoring Emission Inventory (MEI)
Scoreboards for measures monitoring
Reviews reports templates
Lessons learned register and replicability plan

Existing guidelines and tools:

Title	Description	Link
Islands Clean Energy Transition Handbook	Part III – ACT and related references	ET Handbook
SECAP Guidebook Part 1. Chapter 9	SECAP implementation	JRC Guidebook SECAP
European Investment Bank	Information on European Investment Bank's Natural Capital Financing Facility	Legacy mandates (eib.org)
European Investment Bank	European Investment Bank Factsheet on Framework Loans	eib_framework_loans
European Investment Advisory Hub	single entry point for project promoters and intermediaries seeking advisory support, capacity building, and technical assistance related to centrally managed EU investment funds.	EIB Advisory
SECAP Guidebook Part 1. Chapter 10	Monitoring and reporting progress	As above
SECAP Guidebook Part 2. A	Monitoring Emission Inventories (MEIs)	As above
The G20 Global Infrastructure Hub PPP (public-private partnerships)	Risk Allocation Tool on energy	Risk Allocation Tool - G20 INITIATIVE (gihub.org)
Energy transition playbook – U.S. Department of Energy.	Execute projects and ensure quality control See specifically phase 4 and related resources table	Energy Transitions Playbook
Energy transition playbook – U.S. Department of Energy. Phase 4 Template	Template of a periodic report on project implement	Periodic Report
OECD Principles for Integrity in Public Procurement.	A set of principles that serve as a policy instrument for enhancing transparency and integrity throughout the public procurement cycle.	OECD Principles for Integrity in Public Procurement

Table 26. Existing guidelines and tools regarding the Deliver Phase

6. References

1. Organisation for Economic Co-operation and Development (OECD) . OECD.Stat Data Explorer - Regional Demography. [Online] https://stats.oecd.org/Index.aspx?DataSetCode=REGION_DEMOGR.

2. EUROSTAT. Eurostat - Data Browser. [Online] 2023. https://ec.europa.eu/eurostat/databrowser/view/lfsi_emp_a/default/bar?lang=en.

3. European Commission, Directorate-General for Regional and Urban Policy . Eighth Report on Economic, Social and Territorial Cohesion. [Online] 2023. https://ec.europa.eu/regional_policy/information-sources/cohesion-report_en.

4. *The social perspective on island energy transitions: Evidence from the Aegean archipelago.* P. Stephanides, K. J. Chalvatzis, Xin Li, F. Lettice, D. Guan, A. Ioannidis, D. Zafirakis, C. Papapostolou. https://www.sciencedirect.com/science/article/pii/S0306261919314126, 2019, Applied Energy, Vol. 255.

5. International Energy Agency (IEA). Monthly Electricity Statistics. [Online] 2023. https://www.iea.org/data-and-statistics/data-tools/monthly-electricity-statistics.

6. Electricity Maps. Electricity Maps. [Online] https://app.electricitymaps.com/zone/ES-IB-ME.

7. WorldData. WorldData.info. [Online] https://www.worlddata.info/climate-comparison.php?r1.

8. Red eléctrica de Espań. Demanda de energía eléctrica en tiempo real. [Online] https://demanda.ree.es/visiona/home.

9. European Commission. Covenant of Mayors - Signatories. [Online] https://eu-mayors.ec.europa.eu/en/signatories.

10. Indipendent Region of Sardinia. Energy Environmental Plan of Sardinia (PEARS). [Online] August 2016. https://www.regione.sardegna.it/documenti/1_274_20160804102906.pdf.

11. Autonomous Region of Sardinia. Sardinia2030 - Regional Strategy. [Online] 2022. https://www.regione.sardegna.it/sardinia2030-english-version.

12. Consell Insula de Eivissa - Clean Energy for ET islands. *Roadmap for the Energy Transition to Clean Energies - Eivissa.* Ibiza (Spain) : s.n., 2020.

13. European Commission. Covenant of Mayors - Signatory - Eivissa. [Online] https://eu-mayors.ec.europa.eu/en/signatory/28284#actionPlansAndProgress.

14. —. Covenant of Mayors - Signatory - Sant Antoni de Portmany. [Online] https://eu-mayors.ec.europa.eu/en/signatory/28883#actionPlansAndProgress.

15. European Commision. Covenant of Mayors - Signatory - Formentera. [Online] https://eu-mayors.ec.europa.eu/en/signatory/28520#actionPlansAndProgress.

16. Balearic islands Governement. Investment Plan for the Energy Transition of the Balearic Islands . [Online] https://drive.google.com/file/d/1hyVy-ObLHPu2YsN-xPcleHx-rLrY83SW/view.

17. European Commission. Clean energy for EU islands - 30 Renewable Islands for 2030. [Online] https://clean-energy-islands.ec.europa.eu/news/journey-begins-30-renewable-islands-2030-ready-set-30.

18. —. 100%-Sustainable Islands. [Online] https://commission.europa.eu/projects/100-sustainable-islands_en#:~:text=The%20Investment%20Plan%20for%20the,budget%20of%20233%20million%20euros..

19. Consell Insular de Menorca. MENORCA 2030 STRATEGY. Roadmap for decarbonizing the energy system. [Online] Consell Insular de Menorca. http://www.biosferamenorca.org/Contingut.aspx?IDIOMA=3&idpub=1790.

20. European Commission's Joint Research Centre (JRC). *Guidebook `How to develop a Sustainable Energy and Climate Action Plan (SECAP).* Luxembourg : Publications Office of the European Union, 2018.

21. Clean energy for EU islands Secretariat. *From vision to action: how to tackle transition on EU islands? - Methodological Handbook.* s.l. : Luxembourg: Publications Office of the European Union, 2022.

22. Desing Council. Design Council - The Double Diamond. [Online] https://www.designcouncil.org.uk/our-resources/the-double-diamond/.

23. European Commission. Clean energy for EU islands - Join the Initiative with your Island! [Online] https://clean-energy-islands.ec.europa.eu/node/121#:~:text=What%20is%20the%20pledge%3F,the%20journey%20for%20all%20involved..

24. International Association for Public Participation. [Online] https://www.iap2.org.

25. Clean energy for EU islands secretariat. *Engagement Guide.* s.l. : Clean energy for EU islands secretariat managed by the European Commission , 2023.

26. U.S. Departments of Energy. *Energy Transitions Playbook.* s.l. : U.S. Departments of Energy, 2021.

27. Clean Energy for EU Islands Secretariat. *Island Guide to clean energy transition research.* 2019.

28. UNDP Social and Environmental Standards (SES). UNDP SES Toolkit - Guidance Note: Stakeholder Engagement . [Online] 2022. https://ses-toolkit.info.undp.org/sites/g/files/zskgke446/files/SES%20Document%20Library/Uploaded%20October%202016/UNDP%20SES%20Stakeholder%20Engagement%20GN_Final_rev_July2022.pdf.

29. Jansen, S., & Pieters, M. *The 7 Principles of Complete Co-Creation.* s.l. : https://doi.org/10.3724/SP.J.1004.2014.00051, 2017.

30. National Coalition for Dialogue and Deliberation (NCDD), International Association for Public Participation (IAP2), and the Co-Intelligence Institute,. *Core Principles for Public Engagement.* s.l. : Public Engagement Principles Project, 2009.

31. The International Center for Not-for-Profit Law (ICNL LLC). Public Participation: Principles and Best practice. [Online] https://www.icnl.org/wp-content/uploads/Attachment-3-Public-Participation-Principles-and-Best-practice-Eng.pdf.

32. Mahmoud, E. & Morello, I. *CLEVER Cities Project. Guidance on co-creating nature-based solutions: PART I - Defining the co-creation framework and stakeholder engagement.* 2018.

34. *"Tilos, the first autonomous renewable green island in Mediterranean: A Horizon 2020 project.* G. Notton, M. Nivet, D. Zafirakis, F. Motte, C. Voyant and A. Fouilloy. 2017. 15th International Conference on Electrical Machines, Drives and Power Systems (ELMA).