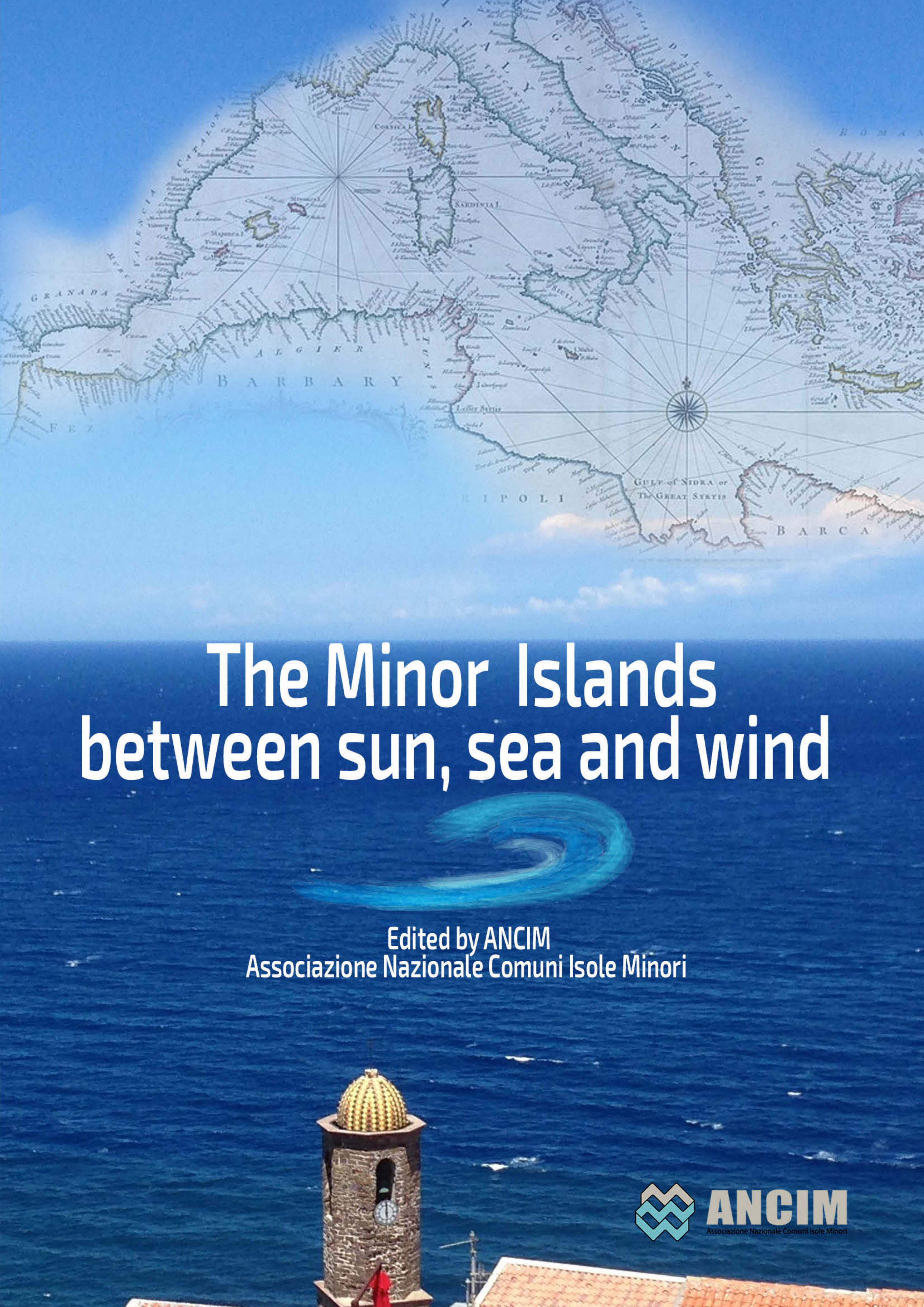

The Minor Islands between sun, sea and wind

Edited by ANCIM
Associazione Nazionale Comuni Isole Minori

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The Minor Islands between sun, sea and wind

Edited by ANCIM – Associazione Nazionale Comuni Isole Minori
(National Association of Municipalities of the Minor Islands)

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An investment fund in the smaller islands

It is absolutely positive to talk a lot about solutions to combat climate change.

This is happening in particular in the last period. Finally, I add immediately.

To discuss this, a “White Paper” focused on the Italian Minor Islands seems to me, however, an unpublished that deserves maximum attention and a convinced applause.

Yes, because the smaller islands represent a privileged observatory to analyse the effects of the progress of global warming and an ideal trench to contain the disastrous effects that they follow and, I really believe, reverse the course, recovering space for a future eco-sustainable: recovering space for nature!

In this then, the wonderful Italian Minor Islands, their beauty and uniqueness -recognized on a level worldwide- have a fundamental role because whatever best practices will be introduced, will be in few days known and, I hope, emulated in every latitude and longitude of the planet.

This “White Paper” of the National Association of Municipalities of the Minor Islands starts from knowledge direct analysis of the problems and critical issues observed in everyday life, analyses them on the merits and, in one positive declination, hypothesizes solutions by launching challenges for the change.

This is extraordinary for me because it is in the essence of man to challenge himself to improve.

I like to underline in this short preface that the Italian government has fully taken up the challenges launched from the “White Book” and daily experiences positive competition for improvement.

In this sense, it is no coincidence that, a few days after the Prime Ministerial Decree of 27 September 2019 with which the President of the Conte Council has delegated me to follow the problems of the Italian Minor Islands and before of the presentation of this same “White Paper”, I can proudly say that in the law of budget for the year 2020 there is a regulation establishing the Presidency of the Council of ministers an Investment Fund in the smaller islands to finance development projects infrastructure or redevelopment of the territory of the municipalities included within them islands.

The establishment of the fund for the Italian Minor Islands fills a “void” which, like ANCIM well you know, it lasted for about 10 years.

My hope is that the use of the resources of the fund will also help win the many challenges launched in this book.

Ambitious goals characterize the future and, among these, taking advantage of this space, I launch mine: accelerate the energy transition of the Italian Minor Islands and, in a few years, make them return by 2023 to a 100% renewable supply.

In short, this book must absolutely be read, because it satisfies the need to know the problems, it indicates an alternative direction and stimulates everyone’s desire to improve the world we live in.

Regional Affairs Minister

Francesco Boccia

The challenges posed by climate change and the contribution of the Minor Islands to energy conversion

To respond adequately to the challenges posed by climate change, it is necessary to put in place act mitigation and adaptation policies, seeking as much as possible to adopt integrated approaches, measures to reduce the impacts and vulnerabilities associated with rising temperatures, extreme weather phenomena and the varied and unlucky effects of climate change.

The small islands, the fulcrum of the "White Paper" drawn up by the ANCIM, may be the most important place suitable for experimenting with new technologies and administrative simplifications. They are places where implement and encourage virtuous behavior, and I hope that the law for the development of smaller islands, passed to the Senate, was soon fired also by the Chamber.

This volume has the merit of relaunching the challenge, which our country has fully grasped, of one solid energy and production conversion.

Italy's integrated national energy and climate plan (PNIEC), considered among the best in Europe, plans to cover 55% of final gross electricity consumption with clean technologies by 2030, objective that we aim to achieve also by promoting distributed generation, self-consumption, the energy communities.

It is a fundamental path for Italy to fully implement a transition-balanced energy, with the ambitious goal of completely freeing our country from fossil sources and to continue to be major players in the fight against climate change.

To do this, we must have the ability to adopt a transversal approach, with analyses and objectives integrated and a coherent vision in all the different aspects of energy and the environment, defining in detail, policies, technological options and financing aimed at accelerating the reduction of greenhouse gas emissions, in line with the long-term goal of a deep decarbonisation by 2050.

The gradual elimination of coal in energy production, diffusion and integration of renewable energies and minimizing environmental impacts, energy efficiency, are the fundamental steps to contribute to the objectives of environmental protection and to reduce the dependence on foreign fossil fuels, while supporting economic growth.

With this in mind, the analysis of the options in the field in the smaller islands, the objectives and any regulatory barriers that make it more difficult to achieve, it can undoubtedly offer an important contribution, which as Minister I can only accept as an incentive to make always better, more and more.

Minister for the Environment
and for the Protection of the Territory
and the Sea

Sergio Costa

Renewable sources, energy autonomy and sustainable tourism for enhance the environmental, cultural and social heritage of the Minor Islands

The contribution made by ENEA to this publication is fully inserted in the topics that are the subject of the protocol of understanding between ENEA and ANCIM and achieves one of its main objectives: integration their respective skills in order to enhance the environmental, natural, cultural and cultural heritage of the Municipalities of the Minor Islands.

The ongoing climate changes, historically unique in speed and intensity, have important consequences for the whole Mediterranean area, and especially on particularly vulnerable territories like the smaller islands.

These consequences can and must be addressed with global mitigation policies and strategies local, adaptation.

The use of renewable energy sources is one of the pillars of the mitigation path outlined at the level worldwide for the containment of the global temperature rise of the planet, like also recently reiterated at the last United Nations climate summit last September.

The massive use of renewable sources in the territorial context of the Minor Islands, using both consolidated and innovative technologies such as those that will allow the exploitation of the potential marine energy, responds to this need as regards, not least, autonomy energy of the island communities.

A fundamental role is played by sustainable tourism which, if developed with a view to economics circular, in addition to offering enormous opportunities for economic development, can be a powerful on instrument of affirmation of a responsible and sustainable management of the territory, maximizing its positive effects in a restricted area and with complex management of resources and waste, as is that of a small island.

President of ENEA

Federico Testa

Collaboration with universities and research is essential for giving solution to the energy and environmental problems of the Minor Islands

Climate change and its effects are now there for all to see and newspapers treat them in continued way.

Instead, what is not sufficiently developed is how to solve these problems.

ANCIM, on the initiative of the previous President, Ing. Giovanni De Martino, and to the Secretary General, Dr. Gian Piera Usai, had the happy intuition of preparing a "White Paper" on alternative energy solutions in the smaller islands.

A study on these issues had never been done before.

The initiative is fully shared and appreciated also by me, the new ANCIM President.

Particularly significant is the method adopted to elaborate the aforementioned "White Paper", it is It has been drawn up with the scientific collaboration of three universities: Rome Sapienza, University of Siena and the Polytechnic of Turin, with the collaboration of ENEA - with which ANCIM had signed a collaboration agreement -, with the CNR and with Legambiente.

Special thanks to Professors Davide Astiaso Garcia, Simone Bastianoni, Cesare Cametti, Daniele Groppi, Carmine Marinucci, Nicoletta Patrizi, Giuliana Mattiazzo, Guglielmina Mutani, Gianmaria Sannino, Angelo Tartaglia; the Engineers Cristiana Biondo, Francesco Petracchini; the Doctors Valerio Paolini, Maria Vittoria Struglia.

Special thanks also go to ENEA, which not only contributed to the realization with important contributions on the energy theme, but also contributed with the editorial realization e printing the text through its Promotion and Communication Service.

The managers of the aforementioned Service also thank the synergy with ANCIM that was made.

Cooperation and collaboration are two of the keywords that, together with "sharing", must be the basis for reading this innovative "White Paper on energy resources in the Minor Islands", the excellent result of a joint work.

President of ANCIM

Francesco Del Deo

Presentation of the past President of ANCIM

The issues covered in this publication see the ANCIM as the fulcrum of the entire initiative. And, more specifically, the territories of the islands that make up the Association.

In fact, the question I immediately asked myself was: "What other territory, outside the small islands, will be able to offer all the conditions required by the topics to be dealt with at the same time?"

Because of its geographical particularities, the island is the only territorial reality where all the ideal conditions come together to constitute a true "laboratory" for the study and experimentation of the technologies covered by the in-depth analysis of this "White Paper".

SUN, SEA, WIND: the energy sources of the future, but also of the present, we find them at the same time only in our island territories and that's why the importance of our realities goes far beyond the only tourist, receptive and environmental aspect for which they are mostly famous.

Therefore, on this aspect, we want to draw the attention of the institutions and stakeholders to the issues in question: what other territory, besides offering the geographical and scientific conditions of study and experimentation, would be able to guarantee a peaceful, hospitable environment quiet and therefore ideal for technicians and scholars for their work?

Our people, in addition to distinguishing themselves in history for their friendliness and hospitality, have always shown great interest and participation in scientific and cultural activities that involved many guest scholars.

Furthermore, the island territories contribute greatly to the national economy by constituting an exceptional tourist attraction pole; consequently, also from a socio-economic point of view, the experiences that could mature in our realities would certainly represent a useful reference and a database essential for the development of initiatives and proposals to be extended to many other realities.

The ANCIM, since its foundation, but especially in recent periods, has shown how much "concreteness" can be given to issues of general interest and, above all, to those in question.

The Municipalities of the Association, when they had the possibility of their own autonomous "governance" of the resources made available by the central organs of the state, repeatedly demonstrated their "entrepreneurial" capacity by transforming programs and projects into works and interventions visible on their own territories, producing employment, improving the quality of life of the islands, protecting the naturalistic, landscape and cultural environment.

For this proven ability, the ANCIM offers the widest availability of the adhering territories to be the protagonist of the initiatives related to the topics of this "White Book", aware of the importance and the role it can assume.

The past president of ANCIM

Gianni De Martino

Chapter I

The reason for the "White Book"

Gian Piera Usai – General Secretary of ANCIM

Premise

The 35 Municipalities of the smaller Italian islands are distributed in seven Regions (Campania, Lazio, Liguria, Puglia, Sardinia, Sicily, Tuscany). They represent approximately 220,000 permanently resident and a far superior number of temporary residents (tourists), since 1986 they have established themselves as an Association (ANCIM), aware that the action of the single Municipality did not have the strength to place the peculiar problems of small island communities for the attention of national, regional and even European governments.

The Mayors were, also, aware that a unitary and cohesive system could be the strength to obtain targeted and effective measures to solve the problems of the "good living" of their citizens, both stable and temporary.

The issues of health, transport, and school, also considered by the European Union as preconditions for development, represent the first problems to be solved.

To follow and closely related to the condition of "good living" in the islands, water, waste and energy supply are the other issues that local institutions find themselves having to solve to ensure a fair system in line with the Constitution and with the same European Constitution.

A ruling by the European Court of Justice also ruled the no to equal standards for unequal.

The whole regulatory framework attaches this principle to specific rules for small islands, but then legal and administrative behavior is often not consistent with what is stated as fundamental principles.

Local institutions and citizens of small islands often find themselves having to apply rules and provisions, corrected for contexts that are not their own and that do not guarantee equality and adequacy, in all fields, of rights and services as for the citizens of the mainland.

The 35 local institutions, since 1986, had understood that it was necessary to strive for a cohesive European system as a means to reduce the imbalances between the levels of development of the same reality and between different island realities; as a means to help eliminate inequalities and promote equality and environmental protection.

They had also given, from their Constitutional Act, a far-sighted reading of the principles of compatibility and consistency to activate the development and the appropriate interventions for that territory or as a requirement to evaluate the correspondence between the objectives to be achieved and the projects put in place.

Cooperation, not only as a method of working together for a competitive global system, but also as a tool to activate all the funding (community, national, regional, local and private) for greater employment, social solidarity, for a modern energy system and to solve the problem of waste, water and sustainable mobility.

The smaller islands, for years, have moved towards a principle of circularity not only as a concept of product that turns from waste into productive reuse, but also circularity between the various sectors.

School, health, transport, water, waste, and energy cannot be considered separately because they have a circularity in the search for their solutions.

Finally, circularity like finance and how local, regional, national, and European institutions act.

A separate action is certainly not the bearer of a new territorial development model, effective and consistent with the challenges of innovation, imagination, and courage that the crisis context in which we still find ourselves requires us.

This new path is also hoped, recently, by the Government Program that makes the green economy the driving force of economic development and more funding is foreseen than in the past so that the concept of green rule does not remain just a virtuous statement and is also a concrete answer for ongoing climate change.

Finally, in line with the principles set out in the Rome Charter of 25 March 2017, which highlights the goal of a different Europe, it is proposed that a "Homogeneous Development Area" be defined and recognized in the Mediterranean.

1.1 Principle of Circularity and Cooperation

The ANCIM has laid the foundations, with various Documents approved in Crete in 2015, in La Maddalena in 2017 and in Rome in 2018, for the implementation of these principles.

In all these documents, the will to act differently is declared to create new development and lasting employment.

These issues have been strengthened by the EU and the new Italian government.

The EU that is pushed by climate changes that require a different way of acting in the environmental field and that leads to an acceleration of the use of alternative energy sources, integrated between various elements, sun, sea, wind, etc. also to optimize other sectors such as transport, waste, water, tourism and land use in general.

The Italian Government, in turn, has made the "green rule" the innovative compass on which to base its program.

Therefore, in the Decalogue of the objectives to be reached, there is 1) that of the increase in the production of energy from renewable sources, 2) interventions for energy efficiency, 3) sustainable mobility programs, 4) development of the circular economy, 5) accompaniment of the entrepreneurial fabric to "green" reconversion.

A challenge already open and to which the municipalities of the smaller islands do not want to miss.

As a first concrete contribution on this "green rule" a "White Book on Energy" was drawn up, aimed at representing and photographing the great innovations and experiments, both in the islands not connected, and in the connected ones, already in place and known only partially.

It is necessary to have the knowledge of all 35 insular realities to also evaluate the affirmation that often defines us a country not too in line with the European objectives.

Knowing better the realities, starting from the small islands, perhaps we can say that we are more virtuous than, with incomplete analyses, they represent us.

The ANCIM, with its 35 island Municipalities, wants to help clarify these issues for its own territories.

The effects of climate change are evaluated in the islands, considering the various energy sources to identify the most suitable ones to be activated in reduced geographical realities and of unparalleled environmental and landscape value.

Among the various sources, sun, sea and wind, attention is also paid to the waste source, which would solve two problems in one, namely energy production and contextual waste disposal on site.

Even water could be a source of solution to two problems: water supply and alternative energy production.

Particular attention is given to one of the most painful points of this theme that is the too cumbersome administrative procedures that often limit the more integrated use of renewable energy sources due to the procedures starting from European ones, national ones and ending with regional ones.

In this regard, the legislation of the Tuscany Region alone is taken into consideration as an example.

The regional regulations are all different, not only among the Regions with Special Statute, but also among the Regions with Ordinary Statute.

This forest of standards is one of the greatest obstacles to overcome in order to become all the more efficient in the use of renewable energies, but also greener in development.

After the cumbersome procedures, the other obstacle, strongly hostile, for an integrated solution of energy sources, appears to be the problem of the Landscape.

This is the other topic he finds in the "White Book", a specific treatise and his analysis leads us to question whether renewable energies and landscape is just an Italian combination.

In fact, in all the documents, especially in the Community, when talking about alternative or renewable energy sources, the key words are: environmental protection, sustainable development.

Both in the Single European Act of February 1986 and in the Maastricht Treaty of February 1992, together with the principle of environmental protection, the principle of "precaution" is explicitly distinguished from that of "prevention" and the need to promote, at the level of international, measures designed to solve the environmental problem at regional and global level.

The Lisbon Treaty, in addition to reaffirming the aforementioned principles, in Chapter I, letter 2f, codifies the objective of "preserving and improving the quality of the environment and the sustainable management of natural resources, in order to ensure sustainable development".

The Green Paper on the European strategy for sustainable, competitive and safe energy, already in the title, makes explicit the main objectives of the energy policy, namely sustainability and security.

In the context of the document, rather than identifying solutions, it highlights other problematic points for a "good energy policy", namely the diversification of supplies, respecting the environment, and the need for a common strategy to face the challenge of climate change, for find a balance between environmental protection, competitiveness and security of supply. Ultimately, what emerges is a common approach on the fundamental objectives connected to energy savings, but flexible in terms of implementation and the type of intervention.

Returning to the starting question of the correlation between renewable energies and landscape - given the terminologies used in community documents- we can conclude that there is no specific legislation for the binomial and it could be said that what the European Community wants to guarantee is only safety and environmental protection, leaving aside the specific aspect of the landscape as a "weakened" interest compared to the other two?

Despite the premises, the conclusion cannot be so simplified and in this direction, since both the concept of integration of energy policy and the concept of protection of cultural and natural heritage, contained in the Paris Convention of 1972, lead us to affirm that if it is true that the specific reference to the landscape is not to be found in the documents and community provisions, however it is included in the more general statements previously highlighted, and its greater or better explanation falls precisely in the way of implementing that concurrent competence and the further one declination, by the member states, of the complex environmental discipline, lowering it with the most particular needs of its own territories. Italy, with its natural and scenic beauty, is one of those states that will pay more attention to the combination of landscape and alternative energy.

In the "White Book" we will not limit ourselves to remarking things that are already known and repeatedly highlighted, but a final chapter will also be drawn up aimed at putting forward proposals for streamlining procedures and also for integrating the various energy sources.

So not only photovoltaic, but also sea, wind, etc.

The ANCIM wants to contribute not only to the analysis and to representation of the various realities, but also to advance some solutions to the existing problems with the presentation of public and private interventions to give impetus to a new green economy.

In illustrating the insular realities and their solutions, it will be discovered that they are also innovative as a method to find finances in situations of limited funds and how private individuals can be important actors contributing to finance public objectives.

We will talk about widespread shareholding as an innovative method to achieve widespread and broad objectives.

Not only the non-connected islands will be studied in depth, to which public funds are destined primarily, but also the connected islands that are actors of change and required to achieve the EU energy saving objectives.

Therefore, the ANCIM hopes that the "White Book" can be a useful tool to reconsider the lines of financial intervention also in view of the new funds that will be allocated for the "green rule".

Chapter 2
CLIMATE CHANGE IMPACT ON ITALIAN MINOR ISLANDS

Gianmaria Sannino, Maria Vittoria Struglia – ENEA

Climate change occurs on a global scale, but its impacts occur on regional and local scales with different intensity. The increase in global average temperature (global warming) is now an established fact, but in the Mediterranean region the rate of increase of atmospheric temperature is even higher than the global average [1] as shown in Figure 2.1, in which the mean temperature anomalies with respect to the pre-industrial period (1880-1899) are shown.

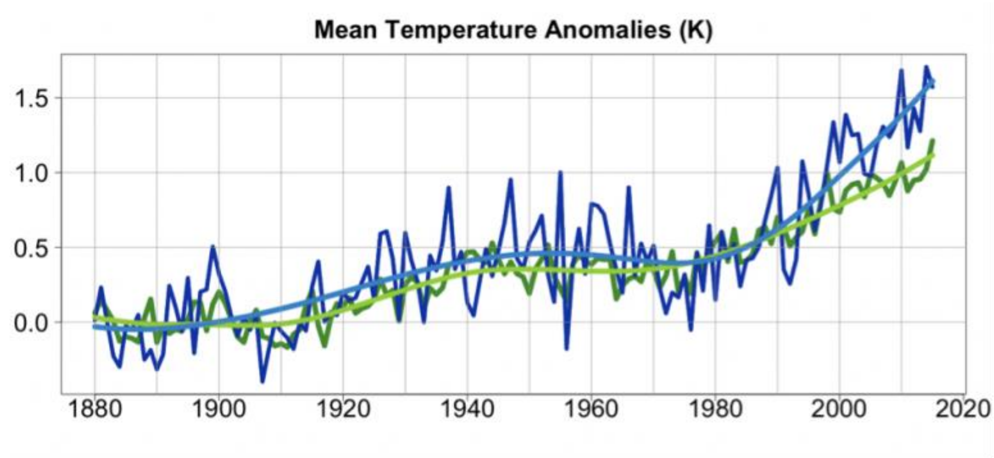

Figure 2.1 Anomalies of the average annual temperature compared to the average of the pre-industrial period (1880-1899). Comparison between the Mediterranean region (blue line) and the global data (green line)
Source: MedECC, 2018 [1]

According to the World Meteorological Organization (WMO) [2] the hottest 20 years have all occurred in the last 22 years, being the last 4 years the highest ones. The WMO also reports that for the decade 2006-2015 the global average temperature had already increased by 0.86 °C compared to that of the pre-industrial period. For the last decade (2009-2018) the average temperature has been around 0.93 °C higher, and for the last five years (2014-2018) the average has stood at 1.04 ° C above than the pre-industrial average. Correspondingly, in the Mediterranean region this average stood at 1.5 °C more than in the pre-industrial period. Hence, the average atmospheric temperature is increasing, and it is doing it with ever more pressing rhythms.

Science has now demonstrated unequivocally that the progressive increase in the concentration of carbon dioxide in the atmosphere is the main cause of current global warming [3]. CO_2 emissions are only partially balanced by some natural absorption mechanisms by the planet. The net effect of fossil fuel combustion and deforestation currently corresponds to an annual release of CO_2 into the atmosphere of 40 billion tons. Only half of these emissions are absorbed by vegetation, soil and oceans. But the other half cumulates with the emissions of previous years, effectively changing the chemical composition of the atmosphere. Since 1850 CO_2 in the atmosphere has increased by 40%, from 270 ppm (parts per million) at the end of the 19th century to today's alarming value of 410 ppm, the highest concentration in the last million years.

In the same period the average surface temperature of the earth has increased constantly, reaching in 2016 the highest value ever recorded since 1850: 1.2 °C more than in the pre-industrial period.

One of the consequences of global warming is climate change, the most evident effects of which are the melting of the polar ice caps, the rise in sea level, the increase in the frequency of extreme weather events, drought, forest fires, floods, the degradation of ecosystems and the loss of biodiversity. In other words, global warming is “disturbing” the climate. It is good to underline that the climate has never been stable; in the history of our planet the climate has always changed, but the current climate crisis is unique in speed, intensity, causes and, above all, consequences.

Climate change has important implications for the Mediterranean area. Numerous studies have recently been published on the evolution of temperature and precipitation in this region, generally agreeing to indicate a tendency to reduced precipitation, accompanied by a high variability over time (Figure 2.2) and in space.

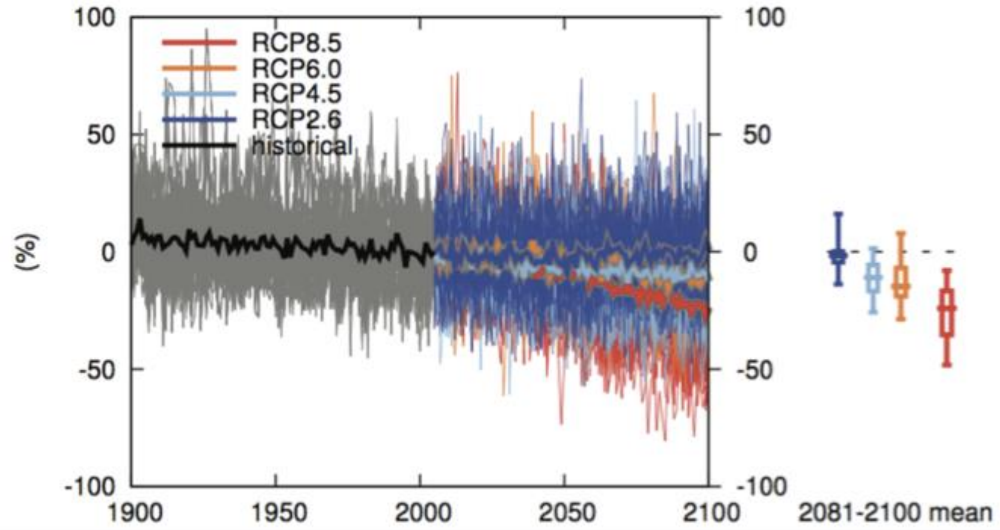

Figure 2.2 Precipitation changes in the April-September period in the Southern Europe/Mediterranean area (30 ° N to 45 ° N, 10 ° W to 40 ° E). The differences are calculated with respect to the average for the period 1986-2005. The colors represent different future scenarios, from the less severe one (RCP2.6) to the more pessimistic one (RCP8.5)
Source: edited by MedECC, 2018 [1]

The analysis of climatic projections shows that the spatial distribution of the average precipitation does not present statistically significant alterations in the future, although a generic increase is observed in central and northern Europe in winter and only in northern Europe in summer, the latter accompanied by an apparent decrease on central and southern Europe. However, extreme precipitation events appear to intensify across the continent.

The increase in temperatures accompanied by changes in the precipitation regimes will lead to a reduced precipitation surplus with respect to evaporation, thus affecting water resources availability.

The general decrease in water resources will be accompanied by more frequent episodes of drought and heat waves, with obvious impacts on the economy and the well-being of populations and geo-political consequences. In fact, the frequency and intensity of drought periods has already increased significantly in the Mediterranean region from 1950 to today, also exacerbated by the increased water demand.

Currently, climate projections provide, for the most severe scenarios, estimates of temperature variations in the European area which amount to about +2 °C along the northern coasts on an annual average, +4 °C in northern and eastern Europe in winter, +3 °C in southern Europe in summer. It should be specified, however, that the uncertainty linked to the estimation of these signals does not imply that the phenomenon does not exist or is not relevant, but only that the efforts of the scientific community must be intensified to arrive at a better understanding of the processes in progress, to adapt models to the complexity of reality to be simulated and to build dense and reliable networks of observational data.

Global warming obviously involves not only the atmosphere but also the seas, having serious effects on both temperature and relative sea level rise.

The sea surface temperature (SST) of the Mediterranean Sea increased on average by 0.4 °C per decade in the period from 1985 to 2006, in particular by 0.3 ° C in the western sub-basin and 0.5 °C in the eastern one, and mainly in the summer. Significant increases (+0.16 °C per year) were recorded in the Tyrrhenian, Ligurian and Adriatic seas [1]. The climate projections to 2100 of the surface temperatures of the Mediterranean indicate an increase compared to the historical period (1961-1990). Figure 2.3 shows the most pessimistic and most optimistic variations expected for the period 2070-2099.

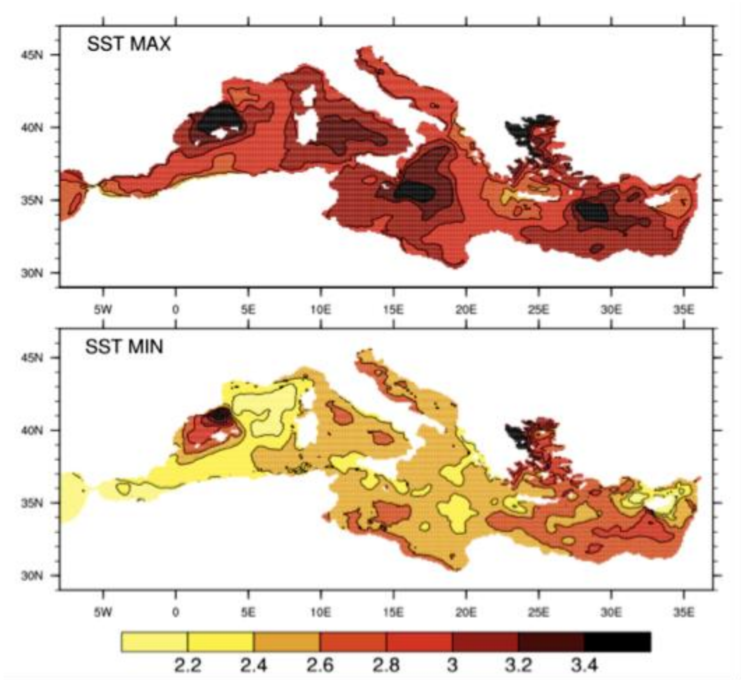

Figure 2.3 Minimum and maximum variations expected in the SST (° C) for the period 2070-2099 compared to the period 1961-1990 on 6 different scenario simulations
Source: MedECC, 2018 [1]

Due to both the temperature rise and the land ice melting, the level of the Mediterranean Sea has increased with a rate of 0.7 mm/year from 1945 to 2000, of 1.1 mm/year if calculated between 1970 and 2006, to reach an increase of 3 mm/year over the last two decades, showing an evident and important acceleration [1].
The global climate projections foresee an average sea level rise of several tens of centimetres in the most pessimistic scenarios, an increase that will surely also involve the Mediterranean area. However, global simulations are inadequate to provide an estimate for the Mediterranean Sea level rise because they do not have enough spatial resolution to represent the Strait of Gibraltar. Currently, high-resolution regional circulation models of the Mediterranean Sea have been developed [5] precisely to estimate this magnitude, the results of which will be available shortly.

For the Minor Islands system, all the considerations we have just made on a Mediterranean basin scale apply. Although the climate projections currently available have spatial resolutions that limit their reliability in small territories, they still allow assessments of the impacts of Climate Change also on an island scale.

The situation described so far highlights how climate changes, whether they are already underway or expected, combined with other factors such as pollution, degradation of the soil and marine ecosystems, can have important consequences on the future availability of food and water, and on the resilience to possible natural disasters.

The relative importance of these impacts obviously depends on the intrinsic vulnerability of the territory with respect to them. The island regions, and in particular the small islands, constitute a unicum that requires independent assessments as it is widely recognized by the international scientific community, that in the framework of the latest IPCC report (Intergovernmental Panel on Climate Change) has devoted an entire chapter to this topic. [3].

The European Union, in the Communication on Adaptation to Climate Change [6], highlights that European islands are particularly vulnerable to the consequences of climate change, while recognizing that the climate models currently available do not allow for adequate assessments for most of them [7].

A tenth of the world's population lives on the islands, however there are no specific results on resilience and risk management strategies for these particularly vulnerable territories, although the climate of the islands responds to specific dynamics such as ocean circulation. Furthermore, while Europe's social and economic development is closely linked to its seas and oceans [8], scientific information and knowledge on the economic impacts of climate change in specific coastal and maritime sectors are scarce and current economic models do not take considering non-monetizable assets, providing only a partial view of the problem. As a matter of fact, several European projects currently underway are dedicated to assessing the impacts of Climate Change on European islands and archipelagos [9].

Anthropogenic climate change has therefore already led to substantial changes in the averages and extremes of many climate variables. Further climate change is now inevitable, but its speed and scale depend on the success of global mitigation policies. For this reason, at the 21st United Nations Framework Convention on Climate Change (hereinafter referred to as COP21) which was held in Paris in 2015, almost all countries on the planet (195) decided to implement a plan to combat global warming. The main points of the agreement foresee that a balance between greenhouse gas emissions and absorptions will be found starting from 2050, keeping the global temperature increase well below 2 ° C; that the results obtained every five years are analysed; that climate actions in favor of developing countries are funded with $ 100 billion a year, until 2020, with a commitment to continue this funding even after 2020.

The agreement also suggests that global warming can be severely limited through the application of incisive energy policies, such as the increase in fossil fuel prices in favor of investments in ultra-low carbon technologies. In other words, the agreement contains a clear message: fossil fuels belong to the past, while in the future energy can only be carbon neutral.

The Paris agreement was signed in 2015 and since then CO_2 emissions related to energy production have increased by 4%. In particular, 2018 saw world energy consumption grow by 2.3%, almost double the average growth rate recorded in the past ten years. This growth was driven by a solid global economy but also by extreme weather conditions which in some parts of the world led to an increase in the demand for heating and cooling. The increased energy demand was mainly met by fossil fuels, which contributed 77% of the entire energy produced. As a result of higher energy consumption, global CO_2 emissions related to energy production reached a record figure of 33.1 billion tons, an increase of 1.7% compared to 2017 [10]. As recently highlighted in the Special Report on Global Warming of 1.5 °C published by the Intergovernmental Panel on Climate Change [2], the gap between expectations and reality in the fight against climate change remains significant. The increase in CO_2 emissions, driven among other things by short-sighted investments in fossil fuels, increases the risk that the world will increasingly move away from the path outlined by COP21.

The report makes clear that an energy transition is urgently needed and that renewable, low-carbon, energy efficiency and electrification are the pillars of this transition. The technologies are already available today, are applicable on a large scale and are competitive in terms of costs.

The climate summit, held at the United Nations in September 2019, reaffirmed the "zero emissions" target by 2050 gaining the adhesion to this commitment of 66 states, and the revision of many of the climate plans of the signatories of the previous agreement. In particular, Italy has expressed its intention to have a leadership position in Europe towards a green turning point, directing the production system towards a "green new deal" through incentive mechanisms.

The next few years are crucial; the most recent scientific analyses [2] have shown that only if we act immediately, drastically reducing CO_2 emissions within the next 10 years, we will be able to contain the increase in the global average temperature well below 2 °C with respect to the pre-industrial average temperature. Nevertheless, to achieve this, a profound review of energy policies at the international level is needed. In other words, the energy transition must take place much faster than is currently expected. According to the recent IRENA [11] report on the transformation of the global energy system, to achieve the climate objectives suggested by COP21, the spread of renewable energy should increase by at least six times compared to the current plans of the major industrialized countries. In fact, if current energy plans were followed, the annual CO_2 emissions linked to energy production would decrease only slightly by 2050, and this would contribute to increasing the average surface temperature of our planet by at least 2.6 °C by 2050 compared to pre-industrial period, with devastating social, political and economic repercussions.

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Chapter 3

RENEWABLE TECHNOLOGIES FOR A SUSTAINABLE ENERGY PLANNING OF SMALL ISLANDS

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Introduction

The energy system of most small islands in the world is founded on a traditional model based on fossil fuels, with an inefficient and expensive energy production. However, in most cases renewable resources are available locally (such as sun, wind, tides, biomass, waste and other renewable sources) and offer different potentials that must be exploited, promoting sustainable development and improving the current energy scenario.

The exploitation of renewable energy sources (RES) in the islands, in particular in the Italian ones, is less diffuse than on the mainland and is characterized by various issues. In fact, the physical separation that occurs on the islands determines a separate management of the networks from the national ones, favoring monopolies for the production and distribution of energy and implying economic and environmental negative effects. The small islands can therefore be defined as "isolated energy communities", becoming an ideal laboratory to face the most urgent and important environmental challenges, where to apply sustainable models in the field of energy, water cycle and waste management. Islands can be the building site of innovative ideas that demonstrate how it is possible to self-produce energy by using locally available renewable sources[1]. In some islands, the energy transition is already producing significant results, also through the potential of coastal areas with waves and tides. Table 3.1 shows the main examples of European islands which, thanks to technological innovation, move towards the energy transition using locally available RES.

Table 3.1 Examples of "European smart islands"

Smart Islands in the world toward 100% renewable					
Island	**Country**	**Number of inhabitants**	**Surface (km^2)**	**Existing RES**	**Goal 100%**
El Hierro	Spain	10,500	269	Hydro, wind	Achieved
Samso	Denmark	4,500	112	Photovoltaic, wind	Achieved
Eigg	Scotland	83	30	Hydro, wind, Photovoltaic	Achieved
Muck	Scotland	40	14	Photovoltaic, wind	Achieved
Pellwom	Germany	1,200	37	Photovoltaic, wind	Achieved
Graciosa	Portugal	4,400	61	Photovol., wind, geothermal	Partially achieved
Tilos	Greece	500 (+3,000 tourists)	64	Photovoltaic, wind	Achieved
Creta	Greece	632,674	8,336	Wind	2030

Source: Legambiente, "Islands 100% renewable", 2016

[1] Directive (EU) 2018/2001 "on the promotion of the use of energy from renewable sources" and Directive (EU) 2019/944 "on common rules for the internal market for electricity".

Today, this challenge must become central in the Mediterranean, where there are hundreds of inhabited islands and where the challenge is both energy and climatic: the final goal is to contain global warming, especially for the most fragile territories such as coastal areas and the urban and agricultural ones.

This chapter presents the methodology of a pre-feasibility study for the evaluation of energy consumption and production, especially by exploiting the available RES.

3.1 GIS tools for evaluating RES availability on small islands: database, tools and energy models

The methodology presented is based on Geographical Information System (GIS) tools that allow to collect, process and represent geo-referentiated data different by nature and scale.

It is possible to conduct feasibility studies processing information and data using the ArcGIS software 10.6, that enables to estimate energy consumption, energy production and energy productivity related to a specific territory, taking into consideration the spatial distribution and the local environmental impact. In particular, it is possible to evaluate the exploitation of RES that follow: forestry and agricultural biomass, waste, hydraulic, wind and solar.

In order to provide the energy supply where the energy demand is located, it is needed to compare energy productivity and energy consumption, evaluating the level of energy security of a territory, but also the environmental impact that energy production can have. Eventually, this methodology analyses all the technical, economic, legislative and environmental restrictions that insist on a specific territory and can limit the exploitation of RES.

3.2 Energy models at territorial scale

Territorial-scale energy models should manage a large amount of data, which is generally inaccurate or outdated, if compared with the models that are used to make assessments on a single energy system. In fact, on a territorial scale information is not always available and it is generally provided on heterogeneous scales. GIS-based models allow to manage information by overlapping databases and creating a single territorial database (DBT). In this way it is possible to quantify the energy consumption related to anthropic activities in a specific territory, depending on variables that describe its typology, its intensity and its relationships with socio-economic features of local population (for example the consumption of buildings according to the characteristics of the building park). This information can be compared with the thermal and electrical energy productivity from RES in the same place. It is therefore possible to hypothesise future scenarios based on energy efficiency measures of the various anthropic activities, also identifying what the most effective energy policies and financial instruments could be to promote the sustainable development of the territory.

Several approaches for territorial-scale energy analysis are described in literature and can be grouped into three categories: top-down, bottom-up and hybrid models. The aim of these models is reconstructing energy trends (historical, current and future) on a large scale, in order to understand how urban transformations affect energy consumption, make assumptions on energy requalification interventions and promoting sustainable development through the exploitation of RES. The variables commonly used are related to socio-economic, climatic, real estate features, etc.

Top-down models start from energy consumption data at urban scale and allow to determine an average consumption of buildings, relating them with the climatic data and the results of the censuses and the statistical surveys. Bottom-up models start from the energy consumption simulations of individual buildings and the evaluation of all of their characteristics; energy consumption is then defined on a wider scale (municipal, regional or national), according to the experience of the reference samples. Hybrid models are top-down or bottom-up engineering models, which can also be used to make simulations of future scenarios.

In this chapter the combined use of bottom-up, top-down and engineering energy models using a GIS tool to geo-reference information will be presented. This methodology is therefore based on hybrid energy models, which allow to predict future energy scenarios by assuming changes in energy parametres or in environmental, socio-economic and legislative variables. Furthermore, the proposed methodology can also support political choices for the sustainable development of the territory.

The methodology used for the construction of energy consumption and production models is described in the scheme of Figure 3.1. As already mentioned, all the information is collected and geo-referenced through a GIS tool and then compared with all the constraints present in the area. By means of engineering models, it is possible to modify the various variables in the energy models, to obtain future scenarios of energy consumption and production.

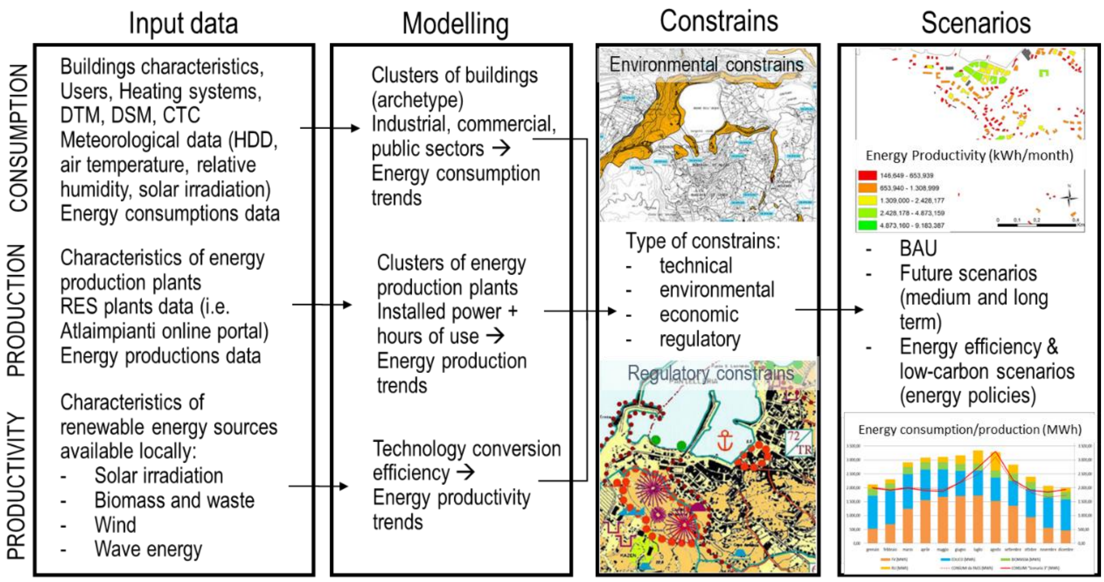

Figure 3.1 GIS-based methodology of energy consumption, production and productivity

Figure 3.2 shows the comparison between energy demand and supply, which is carried out through the definition of hourly, daily, monthly and annual energy consumption and production profiles. Especially when considering RES, which are related to the climatic variables of a territory, it is necessary to make a balance between daily and monthly energy supply and demand, also because the storage systems available on the market do not have yet a seasonal capacity.

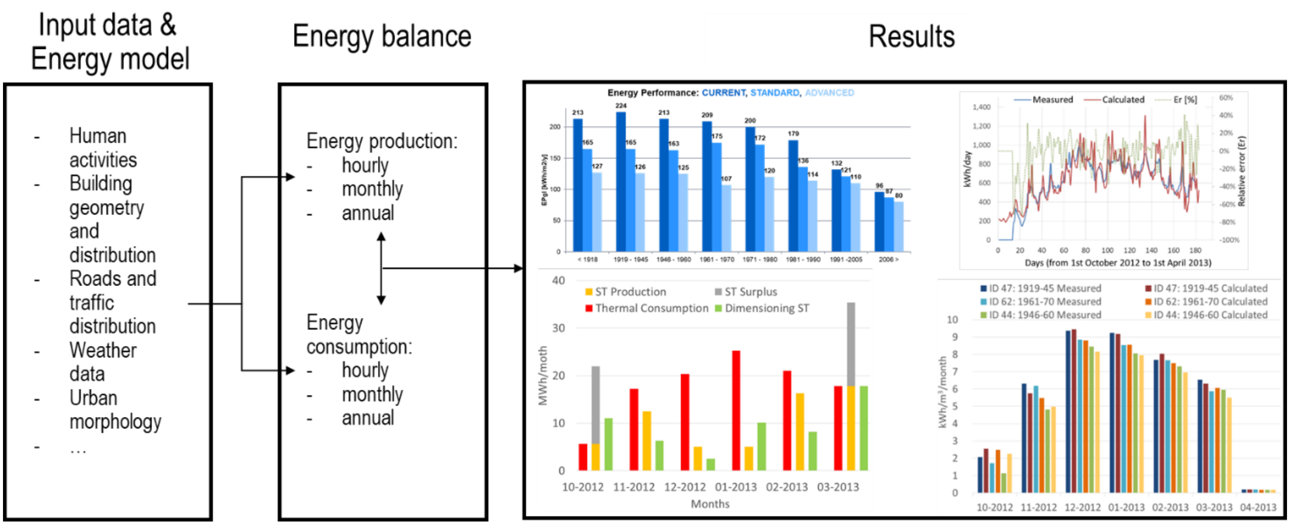

Figure 3.2 Energy model: hourly, daily, monthly and annual energy consumption and production

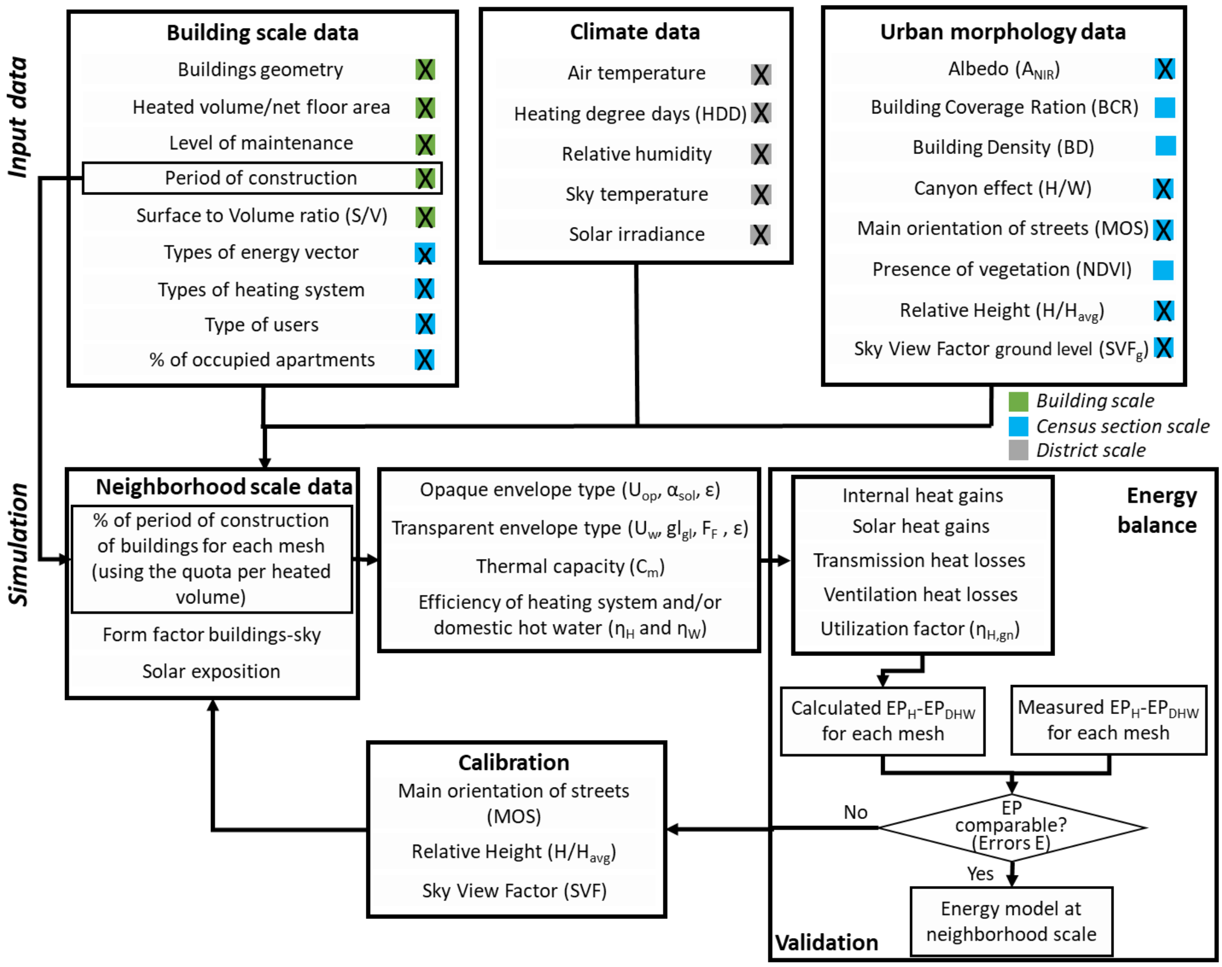

Figure 3.3 Calculation methodology: input data (urban and building scale and climatic data), pre-processing (district scale), simulation and validation of the energy consumption model for residential buildings

A series of variables, on which energy consumption depends, are used for the construction of consumption models. The variables describe the characteristics of the anthropic activities, of the buildings, of the urban context and of the climatic and microclimatic conditions typical of a territory (Figure 3.3).

The assessment of the urban context is based on parameters that describe the relationship between the buildings and the surrounding context. The most influential variables concern the portion of sky visible from each building, the urban building density, the radiative absorption properties of the materials used, the presence of green areas and water (NDVI) and the main orientation of streets.

After collecting and calculating the input data, the next phase consists in the pre-processing one. In this phase, the input data is processed and associated with the territorial unit of the model (neighbourhood, district, municipal scale, etc.). In the simulation phase, the contributions and heat losses that affect the final consumption of the buildings are assessed and the model is applied to the case study being analysed. The results obtained by applying the model are compared in an iterative process with the measured data (validation phase) until an acceptable deviation is obtained and therefore the model can be reliable. In the calibration phase, it is possible to modify the variables that influence the consumption of buildings improving the model. With this type of models, indicators and variables related to energy consumption are identified and then analysed to assess future scenarios through the application of efficiency measures on the systems and thus identifying the most effective energy policies.

For the evaluation of the energy consumption, production, and productivity models on the Italian territory, some examples of input data have been reported in Table 3.2.

Table 3.2 Input data of GIS-based model of energy consumption, production and productivity

Input data	Typology	Input data	Source
Consumption models			
Municipal Technical Map (CTC, CTR, …)	Built-up environment/ Urban morphology/Type of users	National Technical Map	Geoportal: http://download.geofabrik.de/europe/italy/isole.html
Territorial Database (BDTRE)		-	-
Digital Terrain/Surface/Elevation Model (DEM, DSM, DTM)		DEM (precision 20 m)	ISPRA: http://www.sinanet.isprambiente.it/it/sia-ispra/download-mais/dem20/view
Satellite images (i.e.. Landsat 8)		Raster 30 x 30 m	https://earthexplorer.usgs.gov/
Land use/cover		CORINE Land Cover	http://www.sinanet.isprambiente.it/it/sia-ispra/download-mais/corine-land-cover/corine-land-cover-1990/view
Population census	Socio-economic characteristics	ISTAT data	ISTAT: https://www.istat.it/it/archivio/104317 http://dati.istat.it/Index.aspx?DataSetCode=DCIS_POPRES1
Air temperature, relative humidity, wind velocity, solar irradiation, heating degree days (HDD)	Climate data	-	UNI 10349-1, -2, -3:2016 https://re.jrc.ec.europa.eu/pvg_tools/en/tools.html
Sustainable Energy Action Plan (SEAP)	Energy consumption data	SEAP	http://www.smartisland.eu/replicabilita/pantelleria.html
Measurements		'e-distribuzione' portal	https://private.e-distribuzione.it/PortaleClienti/PED_SiteLogin
Surveys/monitoring		-	-
Production models			
Surveys/monitoring	Energy consumption data	-	-
Online portals		'Atlaimpianti GSE' portal	https://www.gse.it/dati-e-scenari/atlaimpianti
Productivity models			
Municipal Technical Map (CTC, CTR, …)	Built-up environment/ Urban morphology	National Technical Map	Geoportal: http://download.geofabrik.de/europe/italy/isole.html
Territorial Database (BDTRE)		-	-
Digital Terrain/Surface/Elevation Model (DEM, DSM, DTM)		DEM (precision 20 m)	ISPRA: http://www.sinanet.isprambiente.it/it/sia-ispra/download-mais/dem20/view
Solar radiation data	Renewable energy sources	Photovoltaic GIS, JRC; Cities on Power Project	https://re.jrc.ec.europa.eu/pvg_tools/it/tools.html http://energia.sistemapiemonte.it/ittb-torino
Biomass data		National organization 'Risi'	http://www.enterisi.it/servizi/Menu/dinamica.aspx?idSezione=17505&idArea=17548&idCat=17552&ID=17552&TipoElemento=categoria
Waste data (i.e. waste production per capita)		Waste institute (ISPRA)	ISPRA: https://www.catasto-rifiuti.isprambiente.it/index.php?pg=&width=1093&height=615
Wind data		Meteorological institute 'ECMWF di Reading'	Wind atlas: http://atlanteeolico.rse-web.it/
Population, housing, industry, and services census	Socio-economic characteristics	ISTAT data	ISTAT: https://www.istat.it/it/archivio/104317 http://dati.istat.it/Index.aspx?DataSetCode=DCIS_POPRES1

3.2.1 Energy consumption models

Energy consumption models are elaborated with a monitoring campaign that allows to predict hourly, daily, monthly and annual energy consumption for at least three consecutive years. The energy diagnoses are methods used to evaluate energy consumption and possibly energy efficiency measures to reduce consumption and emissions of greenhouse gases.

On a municipal scale, energy consumption can also be consulted through the Sustainable Energy Action Plan (in Italian, Piano di Azione per l'Energia Sostenibile - PAES). These are essential for developing adequate analyses and effective plans at a municipality scale.

3.2.2 Energy production models

As the consumption models, the energy production models are also processed with a monitoring campaign that allows to predict the hourly, daily, monthly and annual production according to the technology used and the climatic data. It is necessary to know the current state of the production system present in the studied area: this is possible, for example, through the online geographical portal of Atlaimpianti of the Energy Services Manager (in Italian, Gestore dei Servizi Energetici - GSE). It is possible to evaluate the thermal and electrical energy annually produced from RES by multiplying the installed power by the equivalent hours provided by the webservice.

3.2.3 Energy productivity models

The energy that can be produced from renewable sources on a specific territory mainly depends on the availability of the sources, their technical accessibility and the existing constraints that can hinder their exploitation. It is important to take into account:

- available and emerging technologies;
- energy potential actually available;
- planning of the infrastructures necessary for the prospective management of emerging technologies;
- investment and management costs, through a cost-benefit analysis to ensure an adequate return on investments;
- assessment of risks and environmental impacts;
- interactions, synergies and competitions with other sectors economically relevant to the island.

This paragraph presents some of the renewable technologies that could be used in the Italian small islands and whose potential could be evaluated applying the presented methodology. In particular, the following renewable sources will be treated: solar, forest and agricultural biomass, waste, wind and wave motion.

The productivity models take into account all constraints (territorial, environmental, technical, etc.) that limit the installation of production plants from RES. The new plants should also include environmental redevelopment interventions in the areas adjacent to the plants, to also create greater acceptance of these interventions by the population.

3.3 Renewable energy sources

This paragraph presents the assessment of the energy that can be produced using the technologies available on the market; in Chapter 12 an application will be presented to the case study of the island of Pantelleria.

3.3.1 Solar

The most used solar technologies to produce thermal and electric energy are:

A) Low temperature thermal solar: solar collectors

The main feature that influences the quality of a solar thermal system is the type of solar collector and above all its efficiency. This is the capacity of the system of converting the incident solar energy into thermal energy. Efficiency depends on several factors: the solar flow incident on the collector, the external temperature, the average temperature of the heat convector fluid in the collector and the characteristics of the collector and of the other system components.

The most used types of low temperature solar collectors are:

- *flat glass collectors,* the most popular technology because of to its high efficiency and low cost;
- *vacuum tubes,* which have greater efficiency compared to flat glass collectors, thanks to the lower dispersions by thermal convection inside the vacuum tubes, but they have a higher cost.

The quality of a panel is assessed through the optical efficiency, the ability to transmit the solar flux Fr (τ α), and the heat dispersion Fr UL; therefore the efficiency of a panel increases as Fr (τ α) increases and Fr UL decreases. It also depends on the operating conditions of the panel.

On average, a solar thermal system in Italy has:

- an average annual efficiency of 45% with flat collectors and 55% with vacuum tubes;
- a collection area of 0.7-1.2 m^2/person for flat collectors and 0.5-0.8 m^2/person for vacuum tubes (considering the production of domestic hot water), with the month of maximum solar radiation being considered for the dimensioning;
- a cost of 1000 €/m^2 for flat collectors and 1200 €/m^2 for vacuum tubes.

B) ELECTRIC SOLAR: PHOTOVOLTAIC PANELS

Solar energy is converted into electricity by means of photovoltaic cells whose operation is based on the interaction of solar radiation with the valence electrons of semiconductor materials (e.g. silicon).

For the same incident solar irradiation, the efficiency of converting solar energy into electricity varies mainly according to the photovoltaic module technology chosen. The average efficiency values vary from 22% (high efficiency monocrystalline silicon) to 4% (amorphous silicon). The efficiency of the photovoltaic cells varies according to their temperature (it decreases as the temperature increases), especially for the modules in mono- and polycrystalline silicon.

In Italy, the cost of a photovoltaic solar system depends on the installed power and is around 2000 €/kWp; the capturing surface depends on the efficiency of the module and ranges from 5.5 m^2/kWp for high efficiency monocrystalline silicon, to 11 m^2/kWp for amorphous silicon. In assessing the efficiency of converting solar energy into electricity, it is also necessary to consider the energy losses of all system components, in addition to photovoltaic modules; it is estimated to be around 20-25%.

METHODOLOGY

It is possible to evaluate the share of solar radiation and calculate the energy that can be produced, using GIS tools.

For the evaluation of solar irradiation, the ArcGIS "Area solar radiation" tool is used. It considers the solar geometry and quantifies the amount of solar irradiation using a three-dimensional model of the ground (Digital Terrain Model, DTM) and buildings (Digital Surface/Elevation Model, DSM or DEM that consider the buildings and/or the vegetation). For this analysis, it is necessary to define the monthly characteristics of the sky and sun in the locality analysed, determining these parameters: percentage of diffuse solar radiation, transmissivity or Linke's turbidity factor of the atmosphere. These data can be found in the literature, on the JRC's "PhotoVoltaic Geographical Information System PVGIS" or in the legislation (for example the family of technical standards UNI 10349).

3.3.2 FORESTRY AND AGRICULTURAL BIOMASS

Together with solar and wind energy, biomass is considered one of the most promising RES on the islands because it exploits the waste of anthropic activities that should in any case be disposed of. Furthermore, the combustion of agricultural and forest biomass releases a quantity of carbon dioxide into the atmosphere equal to the one absorbed by plants during their life, and therefore it is said to have zero CO_2 emissions (considering a local exploitation of resources compatible with the regrowth times of plants). In addition, it should be mentioned that, differently from sun and wind that are considered Variable RES (V-RES), energy coming from biomass is dispatchable.

There are essentially two categories of methods of converting biomass into energy:

1. *Biological methods:* aerobic or anaerobic decomposition, in particular anaerobic digestion and alcoholic fermentation. Aquatic crops, some crop by-products, zootechnical waste, some processing waste and heterogeneous biomass stored in controlled landfills are all suitable for biochemical conversion.
2. *Thermochemical methods: direct combustion, pyrolysis and gasification*. The thermochemical conversion processes are based on the action of heat, which enables the chemical reactions necessary to produce thermal energy. The most suitable biomasses to exploit combustion are wood and all its derivatives (sawdust, shavings, etc.), but also wooden-cellulosic crop by-products (cereal straw, pruning residues of the vine and fruit trees, etc.) and some agricultural waste such as husk, chaff, shells, kernels, etc. An in-depth look at pyrolysis is presented in Chapter 5.

METHODOLOGY

It is possible to evaluate the thermal and electrical energy that can be produced from forest and agricultural biomass using GIS tool. The first phase concerns the calculation of the share of biomass available in the area, considering its accessibility according to the slope and type of road. Once the biomass available locally is determined, it is possible to calculate the thermal energy that can be produced by exploiting the available biomass: it is the product of an annual dry matter producibility for the purposes of energy production (compatible with the regrowth of plants and agricultural waste) and the calorific value that is associated to each different crop. In case of electricity production purposes, an efficiency factor should further be applied to the amount of producible thermal energy.

3.3.3 ENERGY FROM WASTE

One of the objectives of European policies is to improve waste management to protect the quality of the environment and encourage the rational use of natural resources. More specifically, the Waste Framework Directive[2] introduces a "hierarchy" in waste management: reduction, reuse, recycling, recovery (also to produce energy) and landfill. Therefore, it is necessary to guarantee alternative management systems to the landfill especially in the islands where disposal of waste has a higher cost both economically and environmentally.

METHODOLOGY

In this case the pre-feasibility analysis is remarkably similar to the one on biomass. In a first phase, the quantity of waste that can be used to produce energy is assessed. The usable energy can be estimated from the data of the "Urban Waste Report" of the ISPRA Waste Service, collecting the lower calorific value from technical reports. The electricity that can be produced is calculated multiplying the amount of thermal energy obtained from the combustion of waste by the efficiency of the system, assuming for example that it is equal to 25%.

[2] Waste Framework Directive (2008/98/EC).

3.3.4 Wind energy

The wind is a renewable source that can be exploited on the coasts and on the islands, where its speed is high and constant throughout the year. The technology that allows to transform the kinetic energy possessed by the wind into electricity is the wind turbine which can have a horizontal or a vertical axis; the wind turns the wind turbine blades and they transmit motion to an electric generator.
The amount of energy that can potentially be produced with the wind source is economically convenient compared to the one that can be produced with other sources, even if in general the wind is highly variable over time and very uneven across the territory.

Methodology

Using GIS tool and knowing wind speed data, it is possible to calculate, analyse and map the average wind speed on a territory. Specific electricity is defined as the annual production of energy per unit of installed power of a sample wind turbine (MWh/MW), starting from the wind maps at different altitudes.

3.3.5 Hydroelectric

Geographical and alphanumeric data relating to the irrigation infrastructures of the territory can be used to evaluate the potential of hydroelectric production. To calculate the jump, i.e. the upstream and downstream heights of each branch, the DTM can be used.

The VAPIDRO-ASTE[3] software produced by the Energy System Research Centre (in Italian, Ricerca sul Sistema Energetico - RSE) allows to automatically calculate the sub-basins related to the rivers, the jumps involved deduced by the DEM and the residual potential, taking into account the measured flow rates, the current multiple uses of the water resource (irrigation, drinking, current hydroelectric uses etc.) and minimum vital flow (DMV) in each section.

The software also evaluates, through correlation functions, the costs of the initial investment and management and the benefits derived from the energy selling of hypothetical plants located along the watercourses. Finally, a module allows the positioning and optimization of future hydroelectric plants for the exploitation of the residual potential. It also maximizes the financial evaluation parameters (VAN, B/C, IRA) and it ensures the compliance with the existing constraints about current multiple uses, which can be introduced in the software using existing shapefiles.

3.3.6 Marine energy

Among the possible renewable sources, the marine energy potential should also be considered. In fact, it can contribute significantly to the energy autonomy of the small islands, while at the same time ensuring sustainable development of marine areas.

To evaluate the energy potential, it is necessary to make specific assessments, both based on observations and on the results of wave prediction models. These need to be implemented at very high spatial resolution.

The existing technologies for the exploitation of marine energy potential are:

- wave energy converters;
- converters for the extraction of energy from marine currents;
- energy converters that take advantage of the tide difference;
- thermal energy converters;
- converters that exploit salinity gradients.

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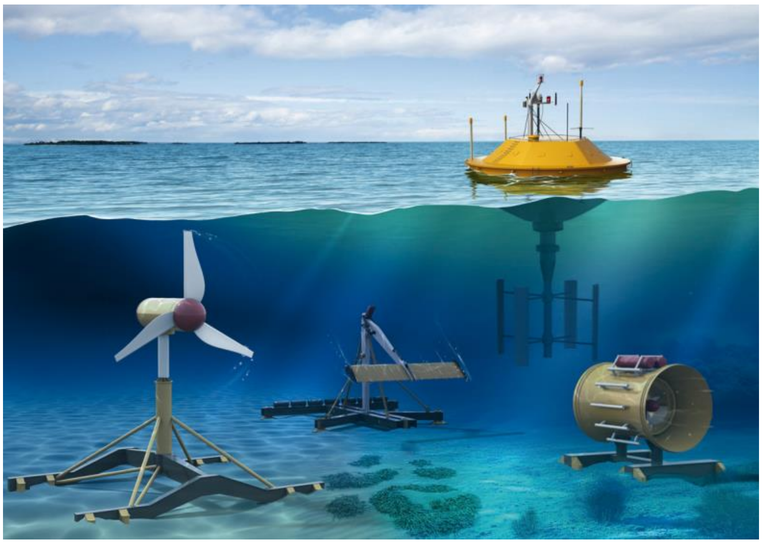
[3] http://www.seehydropower.eu/download_tools/index.php

However, while the exploitation of sufficiently intense marine currents is strictly linked to morphological and dynamic factors (particularly near strait, such as Messina), the exploitation of wave energy requires, among all the available technologies, the identification of the most suitable one, according to the characteristics of the area, both for the availability of the resource and for any environmental and social restrictions.

Wave energy converters are divided into devices that can be placed on the coastline, close to it, or offshore.

The former use the energy of the wave's incident on the coast and are usually housed within the existing ports and protection structures of the coasts (breakwaters). The latter are near the coast, in the presence of shallow waters and can be submerged (lying on the seabed) or floating. The devices that exploit the motion of the waves offshore are instead mostly floating devices that must be anchored to the seabed. However, there is not yet a technology that has reached full commercial maturity: these are all prototypes, some of which have however passed the tests of operations at sea (TRL7) and can be considered pre-commercial.

The other important consideration is that an energy production plant requires the arrangement of multiple devices configured in arrays, optimizing between the total power of the plant and the occupation of the maritime space.



As for any other renewable source, in the case of maritime energy, it must be considered that the production of energy is linked to the availability of the resource and cannot be programmed on the basis of demand. It seriously places the need to plan adequate electrical infrastructures for the management of this type of energy (accumulators/smart grids).

An integrated analysis of environmental risks is also crucial. It is not possible to give a priori general evaluations on these aspects: they are linked both to the environmental characteristics of each territory and to the specific technology adopted. It is important to remind that the possible risk factors are noise and electromagnetic pollution, possible physical alterations (local circulation, water quality, effects on the seabed) that have an effect on biotic and abiotic components, on the interaction with marine fauna, causing a possible loss of biodiversity. On the other hand, it must be considered the reduction of pollution from traditional sources that would be replaced, as well as some positive effects of increased biodiversity and biomass (artificial reef effect), considering overall cost/benefit analysis.

An environmental monitoring plan both in the pre-operational and operational phase can allow the management of the systems (for example with programmed suspensions) to minimize the effects on the surrounding marine environment.

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Chapter 4

SMART ENERGY SYSTEMS FOR THE INTEGRATION AND SMART MANAGEMENT OF RES IN SMALL ISLANDS

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4.1 *Smart Energy Systems*

As already mentioned in the previous chapters, the islands will tend to increase the penetration of renewables in their energy systems, especially for electricity production. This involves new challenges linked to the management of unpredictable and non-programmable energy production which can unbalance the network stability.

Grid flexibility has become a central theme in the technical and scientific community as well as on the political agenda. Briefly, grid flexibility represents the grid ability to quickly respond to any unexpected changes in loads or production. The concept of grid stability can be simplified in the need for production and consumption to match in every instant. Historically, since the load was the unpredictable variable, this condition has always been respected by managing the power plants to always match the load, especially the one with the shorter response times. The advent of renewables, defined as non-programmable sources, has transferred part of the system's unpredictability from consumption to production. Consequently, it was decided to also shift flexibility services to production creating the demand response concepts (closely connected to the phenomenon of consumption electrification). Currently, most of flexibility services (network balancing) are still provided by operating on the production systems. Regarding renewable sources generators, this practice turns into curtailment, thus the lack of production due to the voluntarily blockage of RES generators done to avoid overloading the grid. Inevitably, this procedure means the loss of available energy from a clean source, which is not fed to the grid. Several studies highlight the enormous costs of the renewables' curtailment, which generate an increase in the energy cost [1].

Until now, one of the most effective and efficient solutions to improve the island grid stability has been the connection to the mainland grid, hence guarantying greater inertia and stability [2-3]. However, this is not always the best solution as confirmed by several studies [4-5], usually due to the very high investment cost to connect small islands (with low energy consumption) that are far from the mainland. Several studies proved the benefits coming from energy systems that:

- diversify production from renewable reducing production volatility;
- use energy storage systems based on different energy carriers;
- couple different sectors, through the electrification of consumption (thermal, transport, production and water management, etc.).

These systems are called Smart Energy Systems. They can minimize the curtailment phenomenon [6] and they have a widely studied and confirmed potential [7]. The term Smart Energy System aims to revolutionize the mono-sectorial approach (i.e. the power sector), which has been proved unsuitable for solving problems that affect so many different sectors. Today, energy is an essential part of many sectors, from industrial to residential, and therefore it requires a holistic and comprehensive approach [8]. The advantage of smart energy systems is their ability to direct the power excess from electricity generation towards another consuming sector that needs energy in that right moment or that can store it as different energy vectors and in cheaper storages. This is possible because the electric, thermal, transport and water depuration consumptions have different load profiles as they occur at different times of the day. Furthermore, a smart energy system is also based on the possibility of moving certain energy loads over time. So that the different consumptions occur at the most suitable moment depending on the RES production and the status of the grid.

Simplifying, the possible flexibility services to be provided to the network are summarized in Figure 4.1:

- shift consumption over time;
- reducing the building peak and/or consumption during critical periods;
- increase consumption in a given period of the day.

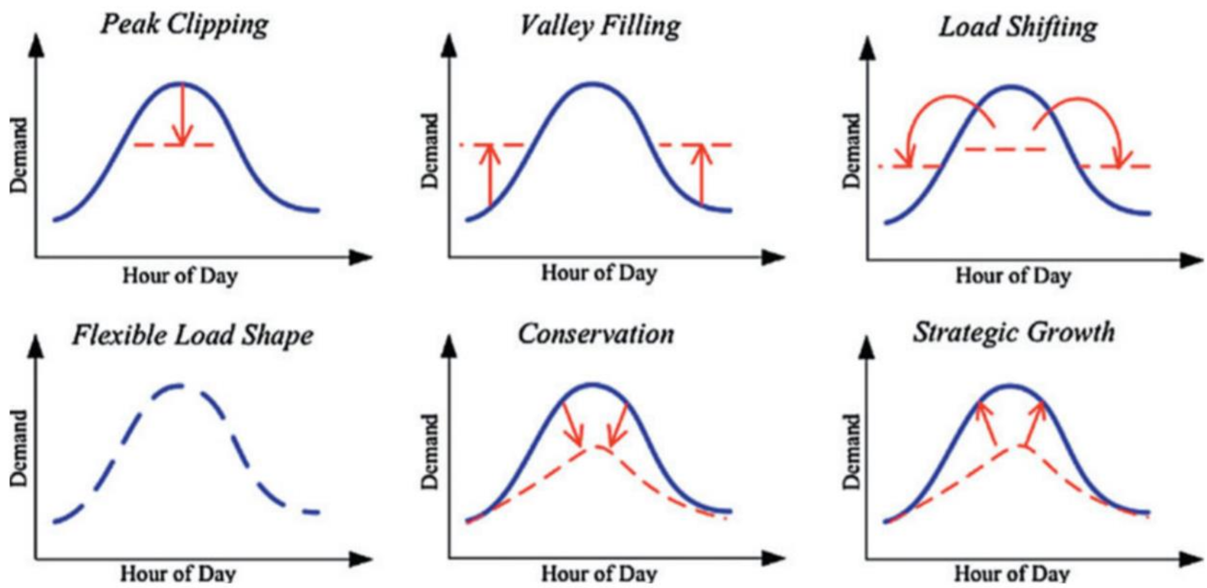

Figure 4.1 Possible flexibility services for the network

To make all this possible, infrastructures and enabling technologies that allow the coupling of different sectors are needed as well as the use of efficient storage systems that uses different energy vectors.

In detail, the energy infrastructures/assets that allow the operation of a Smart Energy System are:

- physical networks for the transport and distribution of different energy vectors such as gas, electricity, district heating, district cooling and the infrastructure for charging electric cars;
- energy conversion units (or enabling technologies) such as gas-to-heat water heaters, CHP plants (gas-to-heat & power), heat pumps (power-to-heat), desalination plants (power-to-water), technologies that provide the conversion of electricity into other carriers such as hydrogen and methane (power-to-gas). In brief, all those technologies that provide the connection between different energy vectors/sectors;
- energy storages to store gas, electricity, heat, cold, water for short or long periods.

4.2 Smart Energy Systems in small islands

In this section, some Smart Energy Systems solutions designed and/or applied in small islands to increase the RES penetration in the islands' energy systems are presented.

As regards the possibility of coupling the electricity sector with drinking water production (as mentioned in Chapter 6), the study by Corsini et al. [9] applied to Ventotene island must be highlighted. Corsini et al. analysed two different solutions according to energy and environmental terms. The two alternative solutions included a reverse cycle desalination plant and a fuel cell (power-to-hydrogen-to-power). Focusing on the opportunities offered by coupling different consuming sectors. Particularly, the management of the desalination plant as a variable/flexible load lead to:

1) exploiting most of the excess production from renewable especially in winter (due to the highly seasonal load linked to the tourist flows);

2) reducing the summer peak, thanks to the application of Demand Response strategies able to smooth the load curve (the summer peak load was reduced by 29.5%).

Regarding the transport sector, the two major solutions that have been studied are those associated to electric cars or liquid fuels. Electric vehicles are equipped with batteries (electrochemical storage) or use hydrogen to produce the electricity through fuel cells. Vehicles that use sustainable fuels can use partially or totally natural gas, mixtures of methane and renewable hydrogen, biomethane or vegetable fuel oils.

An interesting example is provided in the study developed by the Sapienza University for Favignana island [10], different scenarios for the renewal of public transport were estimated, considering:

i) 100% hydrogen buses using fuel cells;
ii) gas-fuelled buses with a gas and hydrogen mixture.

In the same research, the possibility of using a battery to store electricity was also studied. All the scenarios were assumed pondering the renewable penetration as envisaged by the "Ministerial Decree RES in the Minor Islands" published on 14 February 2017. The obtained results showed that the solution with buses fuelled by gas-hydrogen mixture is more advantageous than the 100% hydrogen buses case. In particular, the conversion of excess energy into hydrogen, and its subsequent use to feed public transport, would lead to the reduction of excess (wasted) energy from 1.1% to 0.7% also reducing the total island emissions. It also emerged that the solutions which integrate the use of hydrogen with batteries for storing electricity, it is even more efficient (the excess energy is reduced to 0.4% out of the total energy consumption), demonstrating how a holistic approach and the differentiation of energy management systems brings considerable advantages.

Another interesting study applied to the Italian island of Favignana [11] concerned the analysis of the potential impact due to the introduction of electric vehicles and the associated optimal size of photovoltaic and wind turbine installable on the island. It aimed at evaluating the optimal renewable plants sizes according to the number of electric vehicles able to provide flexibility services to the grid. Thus, the possibility to provide and obtaining a greater RES penetration without compromising the functionality of the electrical infrastructure. In the scenario where all the vehicles on the island are replaced with electric vehicles using night charging, the optimal size of the renewable power plant did not undergo substantial changes. This is since the island electrical load is changed only during the night-time in an energy system whose main RES is solar. Thus, the energy system resulted to use a greater amount of fossil fuel to compensate the new nocturnal load. In the case of electric vehicles able to provide flexibility services to the network through an operation mode called Vehicle-to-grid, the optimal size of solar photovoltaics plants went from 2.8 MWp to 4 MWp, while the size of the wind turbines went from 0.65 MW to 1.75 MW respectively in the case of 0% and 100% electric vehicles penetration, respectively. In this way, the RES penetration could be greatly increased without the need to renew the electric grid, and, in the meantime, considerably reducing the greenhouse gas emissions both for the electric sector and for the transport one.

Interesting results also emerged when coupling the power and thermal sectors, as verified by Neves et al. [12-13] studying the island of Corvo, in the Azores. The research goal was to optimize the use of demand response services of thermal loads (electric boiler and heat pumps) to lower the cost of generating and distributing energy, also avoiding consumption peaks.

The smart management of electric boilers has led to an interesting improvement in the quality of the service offered by the grid, thus improving the island's energy independence. The use of heat pumps has generated considerable energy savings thanks to the significant improvement in the building energy efficiency. However, the electric peak load is excessively increased (i.e. they are more than doubled) creating critical consequences for the electricity grid.

Conversely, the use of optimally managed heat pumps increases the peak load by 25% compared to the case in which the heating relied solely on gas. Despite this, the benefits in environmental and economic terms for the avoided gas use are remarkable.

Conclusions

In this chapter, solutions used to manage the non-programmability and the unpredictability of different RES guaranteeing the grid functionality, respecting the security requirements and the quality of the energy supply service have been briefly presented.

In the same way, the benefits linked to the use of different energy vectors, such as electricity, hydrogen and thermal vectors due to the coupling of different sectors, thanks to their ability to offer flexibility and storage services to small islands energy networks has been presented. These solutions make it possible to increase the grids ability to host a higher penetration of non-programmable renewable energy, as well as to reduce the phenomenon of curtailment and congestion problems, which can lead to blackouts.

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Chapter 5

THE PROBLEM OF URBAN SOLID WASTE IN THE ITALIAN MINOR ISLANDS

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The collection and disposal of urban waste in a specific socio-economic context, as in the case of the Minor Islands, has some peculiar characteristics, which make it particularly difficult to offer evaluations and to suggest general solutions.

If it is true that a common factor in almost all the Minor Islands is tourism, which, more or less, is present at various levels of intensity in all the local realities, the different territorial dimensions, the different resident population (and its different seasonal increases), the different distances from the mainland mean that the identification of homogeneous structural interventions aimed at solving, or, at least, containing, the problem represented by the disposal and use of solid urban waste is extremely complex.

It must also be taken into account that, while some Municipal Administrations have provided, or are providing, for the implementations of certain targeted tools, such as the closure of landfills, the reduction of waste at source, the enhancement of recycled materials, also in compliance with the various legislative provisions, other Administrations, due to the peculiarities of their territories, are unable to operate profitably in the manner desired by the regulations in force.

In general, it must be recognized that the overall management of urban waste (collection, disposal, recycling, etc.) in the territorial specificities of the Minor Islands (also due to the variability of its relevance during the course of the year) represents a problem not easily solved, also in the light of the environmental policies supported by the Government Authorities that correctly consider the environment to be a non-inexhaustible resource.

The UNESCO Aeolian Islands Management Plan (Sicilian Region, Territory and Environment Department, 2008) already indicated the following guidelines:

- reduction (or containment) in waste generation;
- different types of collection suitable for the separate waste disposal aiming at achieving a recycling rate of at least 50% of the total;
- limitation of waste treatment and recovery facilities;
- minimization of the installations related to collection and treatment systems, also through the use of advanced and unconventional technologies.

Similar indications and recommendations have been made, more recently, by the *Foundation for the Sustainable Development* which, in collaboration with the *National Consortium of Recovery and Recycling of the Packaging*, has produced (May 2017) a Report on waste management in 34 Municipalities of 18 Minor Islands (with a total of about 200,000 inhabitants), presenting a certain number of proposals for the improvement of separate waste collection. Among these proposals, the following are worth mentioning here:

- promotion of domestic composting and reduction of undifferentiated waste disposal (EU Directive and Italian Law 221/2015);
- achievement of the recycling targets for paper and packaging boards (relevant fraction of urban waste) proposed by the European Commission for 2030;
- construction of medium-sized plants for the treatment of the biodegradable fraction for the most populous islands, such as Elba and Ischia;
- unification and harmonization of Urban Hygiene Services for the Municipalities of the same island.

The waste problem cannot therefore have a unified solution, valid for all the different local realities, but can be contained only with the concurrence of different methodologies that, for their adaptability to the context in which they must operate, can contribute to achieving, at least partially, the objectives suggested by the guidelines.

With this in mind, here we want to offer some elements of reflection that, based on the analysis of the current situation in the field of disposal, recycling, and recovery of waste in the Minor Islands, may indicate some, albeit limited, solutions.

In particular, some innovative technologies recently available also on the Italian domestic market, such as, for example, the gasification by pyrolysis, can represent a solution, at least partial, for the disposal and conversion into energy of solid urban waste.

5.1 The Data

5.1.1 Municipal Solid Waste Production [MSW]

The production of urban solid waste for the Minor Islands ranges from about 14,000 ton/year for Ischia to around 220 ton/year for Linosa, corresponding to approximately 530 and 330 kg/inhabitant/year, respectively. These values do not differ much from that for the whole European Union (which is around 480 kg/inhabitant/year, in 2016) and that for Italy alone (495 kg/inhabitant/year).

The product composition of urban solid waste is essentially the same for most of the Minor Islands due to the substantial homogeneity of the commercial activities carried out there, in general, with the Italian average composition that sees percentages of around 25% paper, 8% glass, 10% plastic, 4% metals, 4% wood, and 30% organic.

However, the absolute value of urban solid waste production varies greatly from island to island according to the number of residents, but also varies throughout the year due to the different tourist flow. For the islands most affected by summer tourism, the production of urban waste undergoes sharp and substantial increases rising, for example, from 180-200 ton/month in the winter period to 600-800 ton/month in the summer period in the island of Lampedusa or from 15-20 ton/month to 50-100 ton/month in the Tremiti islands.

These different quantities of urban solid waste pose significant problems when it comes to the choice of the technology to be used for their disposal, for their, at least partial, recycling and, above all, for the sizing of the facilities that are necessary, since these industrial plants must be commensurate to the different needs present in the Minor Islands, with the consequent different economic impact that the local economy has to face.

5.1.2 The different local realities

As an example, for the island of Pantelleria, having a resident population of about 8000 people, and an urban solid waste production of the order of 280-300 ton/month, the tourist flow (June- September) leads to an increase in population with peaks of 12,000-15,000 presences per day and the urban solid waste production raises to 700-800 ton/month.

Conversely, for the island of Linosa, with a resident population of about 450 inhabitants, and a waste production of 15 - 20 ton/month, there is a still limited increase in tourist presences during summer, which brings the total population to about 1000 presences per month, with a production of waste of 30-40 ton/month.

We therefore understand how the strategy to follow and the type of interventions that are suggested should be strongly conditioned by the socio-economic reality that is taken into consideration. To this end, it may be appropriate, in the attempt to make them, more or less, homogeneous, to divide the Minor Islands in three sets that have a greater degree of uniformity within them, according to the following criteria:

1. islands that are territorially larger and more populated with a local economy developed throughout the year, although greatly increased by summer tourism;
2. territorially smaller islands whose economy is based almost exclusively on summer tourism with a very strong fluctuation of seasonal presences;
3. smaller islands with a traditional economy, having a still quite limited summer tourism, even if in strong development over the last few years.

Tables 5.1 and 5.2 summarize the most relevant parameters regarding production and collection of urban solid waste for the first two sets of Minor Islands (territorially extended and more inhabited and less extensive and less densely inhabited, respectively).

Table 5.1 List of islands that are territorially more extensive and more populated

Island	Resident inhabit.	km^2	Urban Waste [ton/year]	Separate Waste [SWC] [ton/year]	[SWC]/[UW]
Lampedusa	6124	20.2	8350	1400	0.17
Elba	31800	244.0	9300	6200	0.67
Ponza	3300	7.6	2600	300	0.11
Lipari	12800	88.5	5300	690	0.13
Capri	14200	10.4	11500	6700	0.58
Ischia	64000	46.5	39000	17100	0.44
Procida	10400	3.7	4150	2700	0.65
La Maddalena	10700	20.5	9500	7200	0.75
Favignana	4300	19.3	3800	650	0.17
Pantelleria	8400	83.0	3500	2300	0.65
Sant'Antioco	14000	115.0	8500	6300	0.75
San Pietro	6100	51.0	3600	2100	0.58

Table 5.2 List of smaller and less densely populated islands

Island	Resident inhabit.	km^2	Urban Waste [ton/year]	Separate Waste [SWC] [ton/year]	[SWC]/[UW]
Giglio	1400	23.0	1380	412	0.30
Capraia	410	19.0	355	142	0.40
Ventotene	750	1.5	630	370	0.59
Alicudi	150	5.0	630	...	...
Filicudi	160	2.5	170	...	...
Panarea	300	3.4	600	...	...
Salina (Leni)	2500	26.8	1380	413	0.31
Stromboli	400	12.5	850	...	...
Vulcano	715	21.0	1460	...	...
Ustica	1100	8.0	680	28	0.04
Tremiti Islands	450	15.0	480	62	0.13

As a rough guide, according to what was already noted by the Observatory on the Minor Islands (Legambiente, 2018), local administrations should encourage behaviours aimed at the reduction of urban waste at source (an objective that is certainly not easy to obtain) and encourages separate collection with the twofold purpose of their re-use and their exploitation as an energy resource. At national level (National Waste Catalog, ISPRA, 2017), the typology of urban waste for Italy for the year 2017 is shown in Table 5.3.

Table 5.3 Waste typology

Type of treatment	Amount [ton/year]	Percentage
Waste dump	6.925.000	18.6
Incineration	5.266.000	14.1
Mechanical biological treatment	10.462.000	28.2
Organic fraction treatment	5.902.000	15.8
Household composting	266.000	0.007
Recycling	7.951.000	21.4
Use as energy source	367.000	1.0

As can be seen, at national level, different techniques (separate collection, re-use and recycling, waste-to-energy, gasification) for the valorisation of waste have been added in recent years to the more traditional methods of waste disposal (landfill and incineration).

A particular problem is represented by the landfilling of biodegradable urban waste, which constitutes a considerable percentage of the total urban waste, producing negative environmental effects in terms of gas emission, pollution of surface water, ground water, and soil in general. These effects can be greatly reduced by treating municipal solid waste by gasification based on pyrolysis, as it will be explained in more detail later.

In the Minor Islands panorama, separate waste collection (recycling) varies considerably depending on the local reality considered, going from a value of around 60-65% for Pantelleria, Ventotene and Capri, to around 20% for the Island of Giglio and Lampedusa, and to about 10% for Ponza and the Aeolian Islands. These values, with some exceptions, are below the national values , which, according to the ISPRA Report 2017, reached average values of 52%, although with large differences among macro-regions (64% at North, 49% in the Centre and 38% in the South).

The composition of separate domestic waste collection for the Minor Islands does not differ much from the national one and includes, in addition to metals (9%), plastic (12%), glass (25%), paper and cardboard (22%), and a significant organic fraction (32%).

As mentioned before, the considerable fraction of organic waste could easily be exploited by means of plants capable of generating electric energy from the combustion of the produced biogases (see paragraphs below).

5.1.3 Storage, treatment, and disposal of waste in the Minor Islands

The frequency of collection of urban waste carried out by the Administrations of the Municipalities of the Minor Islands varies significantly from Municipality to Municipality and, above all, varies greatly during the summer period, in consequence of the different needs linked to the tourist flow.

For almost all the islands, except for Capri where the service is daily, the frequency of collection it is on average once a week for the undifferentiated material and 3 times a week for the organic fraction. During the summer period, due to the tourist flow, the service is strengthened, reaching the frequency of 6 times a week for Procida, Ischia and for the Elba Island municipalities. Table 5.4 summarizes the methods for collecting urban waste in the main Minor Islands.

Another aspect that needs to be considered concerns the organization of the collection service which, while it is obviously carried out by a single operator for islands with only one municipality (such as, for example, Capraia, Giglio, Procida, Favignana, Lipari, Pantelleria and Ustica), has a very wide range of situations for the Islands with more Municipalities, with the presence of a single operator for the various municipalities of the Island of Elba (8 Municipalities) and of different operators for the Island of Ischia (6 Municipalities) and for the Island of Capri (2 Municipalities) and Salina (3 Municipalities).

5.1.4 The costs and extent of the existing facilities

The cost of disposal (and collection) of unsorted waste (year 2016) varies, depending on the Municipalities, from 100 to 200 Euro/ton and, as expected, the economic efficiency of the service grows as the quantity of waste treated increases.

For almost all municipalities, unsorted waste disposal takes place by transfer to the continent, with a transport cost that can vary from 30 up to 100 Euro/ton. The method of collection, for most of the Municipalities of the Minor Islands, is the mixed one that is road and door-to-door collection (see Table 5.4). Door-to-door collection is the one that ensures the highest yield in separate collection (with peaks, in some special cases, exceeding 60%, above the national average). Current installations in the Minor Islands are substantially limited to the presence of public drop-off locations only (called “isole ecologiche”, ecological islands, or “Ecocentri”, eco-centres) where the collected material is regrouped.

Table 5.4 Method of collection and treatment of urban waste in the Minor Islands

Island	Municipality	Collection	Eco-centre	Home Comp.	Paper Coll.
Procida	Procida	d2d	Y	Y	N
Capri	Capri	road & d2d	Y	Y	Y
	Anacapri	d2d	Y	Y	Y
Ischia	Ischia	d2d	Y	-	-
Salina	Malfa	road & d2d	Y	N	N
	Leni	road	N	N	-
Favignana	Favignana	road & d2d	Y	N	N
Pantelleria	Pantelleria	d2d	Y	-	N
Ustica	Ustica	-	Y	N	-
Capraia	Capraia	road	N	N	N
Giglio	Giglio	-	Y	N	Y
Elba	Portoferraio	road & d2d	Y	Y	Y
	Marciana	d2d	N	Y	Y
Sant’Antioco	Calasetta	road	Y	N	-
San Pietro	Carloforte	road	Y	N	-
Lampedusa	Lampedusa and Linosa	road	N	N	-
La Maddalena	La Maddalena	road	Y	Y	-
Ventotene	Ventotene	road & d2d	N	N	-

d2d: door-to-door collection; road: road collection

It has not been possible, at this stage, to find data relating to the estimate of urban waste involved in the home composting, but there is evidence to suggest that its relevance in the general management economy general is modest.

Only in the Island of Elba there is a Biological Mechanical Treatment plant with a capacity of 30 kton/year that treated (year 2015) about 63% of the waste produced in the entire island.

The overall situation for urban waste collection and treatment methods is reported in Table 5.4. The high variability of waste production during the year generates difficulties in the planning of waste treatment. Indeed, if the waste treatment were to be planned on the basis of peak values (summer months), it would be heavily uneconomic; vice versa, if it were programmed on yearly average values, it would be heavily inadequate and would enter into crisis during the summer, with all the economic and social consequences that would result.

A solution which would, among other things, avoid the transfer to the continent, could come from the presence of small treatment facilities, characterized by modularity and flexibility, so that they can be activated according to the specific circumstances that may arise. The islands with a population greater than 2000-3000 inhabitants could be equipped with plants, which modern technologies make available today, suitable for serving small towns (see paragraphs below).

For the disposal of solid urban waste, the most commonly used systems are incinerators (which actually burn the waste but release important amounts of harmful substances) and waste-to-energy plants (which produce energy from the combustion of waste) equipped with systems capable of reducing the level of dispersion of pollutants into the atmosphere.

Compared to conventional combustion and waste-to-energy processes, alternative and innovative systems, such as, for example, gasification and pyrolysis, have long been proposed. These are solutions that make it possible to obtain a combustible gas (syngas) from the solid combustible through a thermal process, and then to obtain a production of electricity form the gas. In the case of pyrolysis plants, the treatment takes place without direct combustion of the waste and, most importantly, in absence of oxygen, thus avoiding the formation and release of substances highly dangerous to the environment, such as dioxins.

5.2 A possible solution for the energy valorisation of waste in the Minor Islands

At least in the Minor Islands of greater territorial extension, more populated and with a strong tourist flow (see Table 5.1), the problem of disposal of urban waste and its recycling aimed at the production of electricity could be partly solved or, at least, reduced in importance through the construction of gasification plants of medium/small size employing the pyrolysis technology.

5.2.1 Pyrolysis. The main features

Pyrolysis is a process of thermal degradation of materials in absence of oxygen which, under particular pressure and temperature conditions (400-500 °C, 740-750 mm Hg), transforms the organic substances present in the waste into solid, liquid, and gaseous fuels. Through this thermochemical conversion, the treated material undergoes the splitting of its original chemical bonds, simpler molecules are formed, and, as a final result of the process, one obtains a gaseous fuel (pyrolysis gas or syngas, equal up to 60% by mass of the treated waste) and a solid component (char or pyrolysis biochar, equal to about 30% by mass of the treated waste). The gas produced is retrieved and conveyed into a co-generator (an endothermic engine) from which electricity is obtained, while the solid component is used in many different technology fields. The advantage in providing a gas for the combustion, instead of a solid, consists in a lower volumetric flow in emission, a lower generation of pollutants, and in a greater energy recovery.

A feature, which is particularly in the context of the Minor Islands, is that the process of pyrolysis provides an energy cycle capable of disposing of waste produced directly on site, without having to rely on landfills.

Within this technology, if compared with that based on fossil fuels, the reduction of pollutant loads is not obtained by adding filters or other devices more or less complex and expensive, that require a continuous maintenance, but simply eliminating the source of pollution from the beginning, with no production of ashes, nanoparticles, unburnt fumes, dioxins, furans or the like.

More in detail, the transformation of the organic fraction into simpler substances by pyrolysis gives rise to:

1. a solid carbonaceous fraction (15-20% by weight), named CHAR, with high calorific value (30 MJ/kg), used as solid fuel for thermal treatments;
2. a liquid fraction (15-20% by weight), named TAR, with a calorific value of 20 MJ/kg, made of oily compounds;
3. gaseous fraction (60% by weight), named GAS or SYNGAS, having a calorific value of 30 MJ/kg, is used as fuel for various reactors.

Compared to traditional waste combustion, the advantages of pyrolysis plants are:

- flexibility in the size of the plant (adoption of modular systems) based on local needs and adaptability to the territorial situation where the need for disposal is more limited. Small installations, which can also be placed in an urban context so as to allow for the exploitation of the thermal energy produced through district-heating or cooling;
- versatility in the type of input material (biomass, municipal solid waste and special waste, waste derived fuels, sewage sludge, etc.);
- different possibilities of use of gaseous output products;
- high efficiency in electricity generation (using syngas);
- ease of disposal or reuse of solid output products;
- very low environmental impact due to the absence of combustion of incineration plants, since the biomass is substantially transformed into hydrogen, carbon monoxide, and light hydrocarbons.

A comparison between the main features of a traditional incinerator and a pyrolysis gasifier is shown in Table 5.5 (taken, with modifications, from the web page http://www.isotechweb.com/public).

Table 5.6 shows some additional technical details. All these features should lead to expressing a favourable position towards plants based on pyrolysis techniques that offer an energy cycle capable of disposing of the produced waste directly on site, without having to depend on landfills and without being forced to transfer the produced waste to the continent. The result is the power electric generation with a less polluting process when compared with that obtained from fossil fuel.

Table 5.5 Comparison between the properties and characteristics of a pyrolysis gasification plant and conventional plants

Pyrolysis plants	Conventional plants
Low environmental impact and good reliability	Doubtful environmental compatibility due to the emission of pollutants. Require pollution abatement equipment with complex management and high costs.
Relatively low temperature endothermic process (500°C) with reduction of gaseous outflows	Exothermic oxidative process with temperatures of the order of 1000 °C. Temperature regulation difficult to manage.
Relatively simple gas stream purification. Airless distillation converts halogens and sulphur into hydrogenated acidic compounds that are abated before combustion.	Difficulties in combating the formation of pollution by organic-chlorinated substances.
Sections of moderate size for the treatment of wastewater with obvious economic benefits.	Sections of large size for the treatment of liquid wastewater.
Partial gasification of carbon. Residue mixed with inorganic components.	Complete oxidation of carbon and dispersion of CO_2 into the atmosphere with possible microclimatic variations.
Absence of convective movements within the reactor. No entrainment of particulate matter. Combustion linked only to pyrolysis gas in the aeriform phase.	Presence of dust and particulate in the fumes.
Complete recovery of metals in non-oxidized form.	Combustion of heterogeneous products. Low-melting metal slags.
The carbonaceous component, residue from the pyrolysis of organic substances, is used as a fuel (5500 kcal/kg).	Energy recovery system with limited efficiency with auxiliary fuel consumption in the afterburner.
Almost universal waste disposal system as it can be used for different categories of incoming materials.	Sensitivity of grids to waste with high calorific value.
Relatively simple plants.	Highly complex plants, especially for the treatment of fumes.
Relative simplicity of plant management.	Complex plant management with the need for qualification of operational staff.
Long-term plant reliability.	Need for continuous maintenance.
Possibility to vary the size of the system in a modular way. Relatively short delivery, assembly and start-up times.	Scale rigidity (large installations). Long time for construction and commissioning of plants.

Table 5.6 Comparison between Combustion Process and Pyrolysis Process

	Combustion	Pyrolysis
Reaction environment	Oxidative	Absence of O_2
Temperature	850-1200 °C	500-800 °C
Pressure	Atmospheric	Overpressure
Reagent	Air	No reagent
Output gases	CO_2, H_2O, ...	CO, H_2, CH_4
Pollutants	SO_2, NO_3, HCl	H_2S, HCl, NH_3
Ashes	Dry	Contain carbon
Gas	Released into the atmosphere	Electric power production

5.2.2. Economic commitment and operating costs

The cost of a biogas plant using pyrolysis techniques depends greatly on the its size (i.e., the required power). For a medium-small size plant, the most suitable for the Minor Islands communities, for a nominal power of 100 kW, the financial commitment is of the order of 850-1000 kEuro, to which, of course, one must add the operating, management, and maintenance costs that can be estimated in the order of 0.15 Euro/kWh (equal to about 1000 Euro/kW for a continuous cycle operation, corresponding to 7300 h/year).

The cost of biomass and its transport is variable, depending significantly on the local situation. However, a general indication leads to a cost of the order of 50-75 kEuro/year, for a 100 kW plant. The revenues obtained from the production of electricity must be considered as assets. The electric energy produced by the plant can be sold for 0.28 Euro/kWh (GSE tariff, including government incentives; GSE is a public-interest company devoted to energy efficiency and renewable sources). A system that works continuously (365 days for 24 hours a day) can provide a revenue of 2200 Euro/kW. A comparison between the costs of a pyrolysis and a traditional one is shown in Table 5.7.

Table 5.7 Investment and operating costs for a pyrolysis plant and a combustion plant

	Combustion Euro/ton/year	Pyrolysis Euro/ton/year
Investment costs	300-600	180-300
Operating costs	30-150	60-150

5.3 Pyrolysis of urban waste in Italy

The use of pyrolysis for the treatment of urban waste, despite having reached a consolidated industrialization for more than 20 years now, and despite having developed specific processes of transformation for various types of waste by different companies (WasteGen, Texaco, Compact Power, Ebara, Tecnofin, Takuma), has not yet reached the commercial maturity it deserves.
This situation can be partly attributed to the public opinion that is not yet fully aware to environmental issues related to the re-use of urban waste. The doubts that sometimes have been expressed by various public administrations regarding the treatment of solid urban waste through pyrolysis-based technologies do not appear to have a real foundation, but rather seem to be due to a kind of inertia, which often, in different areas, manifests itself against the use of innovative technologies.
In the ranking of sustainable waste management, starting from the landfill and going up to the production of valuable fuels, pyrolysis occupies an outstanding position, being able to solve the problem of combining sustainable energy production, both from an environmental and an economic point of view, with the need for efficient waste management.
In short, the strengths for the use of pyrolysis in the context of the Minor Islands are:

- environmental compatibility in the socio-economic context of the Minor Islands;
- medium/small sized facilities;
- adaptability to a limited basin of waste collection (Minor Islands);
- possibility of treating waste with variable composition (unsorted solid urban waste, poly-laminate packaging materials, industrial sludges, fuel derived from low quality waste [CDR], waste from the reclamation of disused landfills);
- environmental pollution practically absent or greatly reduced if compared to more conventional systems.

5.4 The most recent technologies

A new technology, known as PEAP (Plasma Energy Arc Process), has been developed over the past few years which is able to convert solid waste (in particular, urban solid waste) into products (with a lower overall volume) which can subsequently be treated by gasification, for the organic component, and used in various industrial processes, for the inorganic component.

Particularly interesting is the fact that this technology is capable, under optimal conditions, of reducing up to 95% of the initial volume of the treated waste and, similarly to pyrolysis plants, can be implemented with modular structures that make it possible to deal with a quantity of waste to be treated variable over time in a reasonable way (as, for example, it happens during the summer in most of the Minor Islands). Elements that lead to caution on the use of this technology may be summarized in the diffusion of these plants which is currently extremely limited (and therefore with a still limited experience) and at a still quite high cost. Moreover, to date, the capacity of waste treatment is still relatively modest (from 1 to 40-50 m^3/h), while, for the more populated islands, a much greater capacity is needed.

However, one can easily predict that technological development in the coming years, even on the basis of the experiences acquired so far, will make it possible to overcome some of the concerns mentioned above, so that, in the face of a certain reduction in costs, this technology can represent an interesting alternative to more traditional systems (including pyrolysis plants), especially in those insular realities where the production of waste is more contained.

6. Conclusions

Due to their peculiar characteristics, the Minor Islands represent different territorial realities characterized by a quantitatively limited production of urban waste (for each of them, of the order of 5000 t/year) with a strong seasonal increase due to tourist flows. Restricting oneself to considering only the problems related to the disposal and use of waste for production of electricity, these two peculiar characteristics lead us to believe that a convincing answer can be found in the use of urban waste gasification plants with pyrolysis techniques.

The proposed technology, which has long since passed the experimental phase, has reached sufficient maturity to prove its validity in the disposal of urban waste in the context of the Minor Islands, where the principle of self-sufficiency and the principle of proximity are of particular importance in the case of environmental sustainability.

Under the European Directive 851/2018/EU, the guidelines provide, among other things, for economic support for innovation in advanced recycling technologies *"... use of best available techniques for waste treatment; ... economic incentives for regional and local authorities, in particular to promote waste prevention and intensify separate collection schemes, while avoiding support to landfilling and incineration*".

In order to respect the aims of the Directive, also in the perspective of moving towards a European circular economy, all these indications can find a suitable application, for the reality of the Minor Islands, in promoting the construction of modular plants with low environmental impact, which can manage the disposal and recycling of urban solid waste in geographically limited areas, along with programmable treatment capacity according to the particular local needs, and in fostering the reduction of the amount of waste currently going into landfills and favouring the waste-to-energy conversion. Pyrolysis can be an answer to all these needs.

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Chapter 6

THE PROBLEM OF WATER IN THE ITALIAN MINOR ISLANDS

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6.1 Water resources and supply

In the great majority of the Minor Islands there is a general lack of water resources and an insufficiency of water supply at the local level, made even more serious by the seasonal consumption trend which shows a strong increase during the period of greater tourist presence (June-September).

The scarcity of water resources, particularly felt during the summer periods, due to both the climate being generally dry and to the remarkable increase in consumption caused by the tourist flow, is addressed mainly through underwater pipelines, transport by tanker ships (barges), and the use of desalination plants. The presence of private wells and storage tanks is generally modest.

A typical case, which can be taken as an example for the totality of the Minor Islands, is represented by many of the islands of the Aeolian archipelago. For geological reasons, the archipelago has an endemic lack of water which has been mitigated both with supplies from tanker ships and tank trucks, and with a desalination plant, built in Lipari by the Sicilian Region about 30 years ago, having a nominal capacity of 6000 m^3 of water per day. The plant is now obsolete and cannot produce more than 2000 m^3 of water per day. Because of this situation, the cost of water for the inhabitants of Lipari is onerous, reaching 4.8 Euro/m^3 for water from the desalination plant, 7 Euro/m^3 for water from tanker ships and 13 Euro/m^3 for water taken from tank trucks.

The Regional Administration manages the problem through Extraordinary Commissioners, without, however, obtaining significant improvements either in the service or from the economic point of view.

A similar situation can be found in the Egadi Islands for which a detailed analysis of the status of water supply was recently illustrated in the "*Piano d'azione per l'energia sostenibile e il clima (PAESC) – Patto dei Sindaci (Gennaio 2017) – Comune di Favignana*"[4]. Again, the conclusions that are exposed can easily be generalized to many of the other Minor Islands.

Because of intensive exploitation of the numerous existing wells which has led to the progressive lowering of the groundwater level and the consequent impoverishment, the water resources now available do not allow the islands of the archipelago of to be self-sufficient. Consequently, the supply of drinking water is ensured by a submarine pipeline (for Favignana and Levanzo) and by tanker ships that significantly integrate the local water resources, especially in the summer season.

The consumption of drinking water consumption is also growing in relation to the increase in tourist presences with an increase in the supply from tankers to the detriment of the supply from submarine pipeline, partly justified by the repeated disruptions of the Trapani-Favignana-Levanzo pipeline with, in addition, a considerable dispersion of water between the production sites and the user sites. Finally, there is a lack of monitoring of the quality of the external and internal water network.

Having in mind these critical issues, water consumption *per capita* in the Minor Islands is high (of the order of 380 liters/inhabitant/day) and is more than twice the national average (of the order of 170 liters/inhabitant/day). Such high values can be, at least in part, justified by the losses in subsea pipelines and distribution pipelines.

[4] Action Plan for sustainable energy and climate -- Covenant of the Mayors (January 2017) -- Municipality of Favignana.

Table 6.1 Mode of supply, purification and annual consumption of water in the main Minor Islands

Archipelago	Island	Mode of supply	Water treatment	Drinking water annual consumption
Campanian	Capri	Submarine pipeline	Y	870,000 m^3
	Anacapri	Submarine pipeline	Y	1,670,000 m^3
Tuscan	Giglio	Desalination plant	N	230,000 m^3
	Capraia	Desalination plant	N	97,000 m^3
Pelagie	Pantelleria	Desalination plant	Y	1,070,000 m^3
	Lampedusa	Desalination plant	N	875,000 m^3
	Linosa	Desalination plant	N	
Egadi	Favignana	Tanker ships Submarine pipeline Wells and tanks	N	900,000 m^3
	Marettimo	Tanker ships Submarine pipeline	N	
	Levanzo	Tanker ships Submarine pipeline	N	
Pontine	Ponza	Tanker ships Desalination plant	N	670,000 m^3
	Ventotene	Tanker ships Desalination plant	Y	165,000 m^3
	Ustica	Tanker ships Desalination plant	Y	350,000 m^3
Aeolian	Lipari	Desalination plant	Y	1,129,000 m^3
	Vulcano	Tanker ships Desalination plant	N	
	Stromboli	Tanker ships	N	
	Panarea	Tanker ships	N	
	Filicudi	Tanker ships	N	
	Alicudi	Tanker ships	N	
	Salina (Leni)	Tanker ships	N	90,000 m^3
	Salina (Malfa)	Tanker ships	-	174,000 m^3
	Salina (S. Marina)	Tanker ships	-	185,000 m^3
Tremiti	Tremiti Islands	Tanker ships	Y	193,000 m^3
	S. Domino	Desalination plant	-	

For example, it is estimated that for the pipeline from Trapani to Favignana the losses can reach values even of up to 50% (see *Kyoto Club, Progetto di sostenibilità ambientale nelle Isole Minori – Le Isole Egadi*[5]).

As mentioned before, see also Table 6.1, the scarcity of water resources is dealt with by means of transport from the mainland (with tankers and submarine pipelines) and with local desalination plants.

The most common solution remains transport by ship (generally once a week in low season and once a day in high season), with significant economic costs.

For example, in the Tremiti Islands, the cost is about 10 Euro/m^3, while for the Aeolian Islands the cost reaches 13 Euro/m^3, compared to an average national water service cost of about 0.60 Euro/m^3 (data taken from *Energy & Strategy, The Group Consulting Group, 2016*).

The desalination plants are currently few, not recently built and are unable to meet the demands of the population in the summer period.

In the short term, the structural shortage of drinking water for the resident population can only be solved, or at least contained, by trying to reduce wastes (losses in the distribution network are estimated at 40-50%) and by increasing the use of desalination plants.

It should be noted that, while originally desalination plants carried out a substantially integrative task, especially for periods of shortage of traditional sources, more recently these plants are considered a major source of supply for the reliability they can provide in the presence of hydrogeological and climatic changes that can affect the water regime. With this in mind, a study by the Commissioner responsible for the water emergency (Sicily Region) envisages the replacement of existing desalination plants in the Pelagie archipelago (Pantelleria, Lampedusa, Linosa) with more modern and cheaper plants. Furthermore, it is planned to build a new plant on the island of Salina for the municipalities of Malfa, Leni and S. Marina Salina.

This type of technology has now reached a considerable level of development and is able to provide equipment with low environmental impact and, for small or medium-sized plants, powered by renewable sources. As noted by *Marevivo*, also in collaboration with ANCIM, desalination can be a valid solution to overcome the difficulties due to a reduced supply of water resources in most of the Minor Islands, as is already happening in various Arab countries, in Australia, in Israel and even in some areas of the United States, with an installed capacity, to date, which has exceeded 100 million m^3/day.

In recent years, reverse osmosis technology has been developed, which has enabled relatively simple plant design and paved the way for small installations that do not require heavy maintenance. Reverse osmosis (RO) is a process in which the passage of solute molecules from the more concentrated solution (brackish water or seawater) to the less concentrated solution (drinking water) occurs by applying a pressure greater than the osmotic pressure to the more concentrated solution. Reverse osmosis can be used for both desalination and removal of traces of phosphates, calcium, heavy metals and many of the polluting molecules.

Table 6.2 lists the main advantages of this technology.

At present, reverse osmosis is the most common technology for large and medium-sized plants, covering more than 50% of the plants currently operating in the world and more than 90% of those being designed and built.

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[5] *Kyoto Club, Environmental sustainability project in the Minor Islands – The Egadi Islands.*

Table 6.2 Advantages and disadvantages of desalination using Reverse Osmosis [RO]

	Advantages	**Disadvantages**
Reverse Osmosis	Can be used for salt water and brackish water	Relatively high production costs
	Flexibility in water production in quantity and quality	Relatively long construction times for large plants
	Rapidly decreasing energy consumption	
	Flexibility at installation sites	
	Ability to provide flexible services for the stabilization of the electrical grid	

While for large plants with a desalination capacity of 300,000 litre/day the costs are still very high, for smaller plants with a capacity of 20,000-30,000 litre/day, suitable for populations of 5,000-10,000 people, the costs are lower and can be amortized within a reasonable time with a sustainable economic commitment. For example, for a medium-sized plant (200 m^3/day), the cost of producing water includes about 12% of capital costs, 3% of energy costs, 34% of costs for chemicals and about 50% of miscellaneous operating costs.

The problems that have so far slowed down the spread of this technology are the high-energy consumption requirements and the environmental compatibility of these plants.

The first problem, however, is finding a reasonable solution in the considerable technological improvements (increasingly efficient membranes) that have allowed a reduction in kWh per cubic meter of water produced (about 4 kWh/m^3) towards values comparable with those of other processes of production of drinking water. While for large-scale desalination plants it seems difficult at the moment to think about their energy supply with renewable sources (sun and wind), in the case of desalination plants with lower performance (and therefore with a lower energy demand) such as those best suited to the needs of the Minor Islands, the use of alternative renewable energy sources is not completely untenable.

Among the various technologies that can be used, that based on the principle of reverse osmosis [RO] is the one that has been used in more recent installations, mainly because of the lower energy consumption per unit of water produced and for its greater operational flexibility, which allows to meet different needs.

It is also interesting to bear in mind that the trend in the technical and economic parameters of medium sized desalination plants foresees a significant reduction in the cost per cubic meter of water produced, from the current values of 0.8-1.2 US$/$m^3$ to values of 0.6-1.0 US$/$m^3$ over the next 5 years to reach values of 0.3-0.5 US$/$m^3$ within the next 20 years, compared to a current energy demand of 3-4 kWh/m^3 at values of 2.8-3.2 kWh/m^3 over the next 5 years and at values of 2.1-2.4 kWh/m^3 within the next 20 years (source: http://www.iwa-network.org/desalination-past-present-future/).

However, desalination will be economically sustainable, bearing in mind that this process still involves a higher consumption of energy than traditional treatments of freshwater purification, only in the presence of a water network with limited dispersion. These are conditions that, to date, are unlikely to occur in the context of most of the Minor Islands, which have an antiquated network and with poor maintenance.

The second problem is the environmental impact due to the disposal of brine, i.e., the disposal of concentrated saline solutions that represent the waste of the desalination process.

In fact, the disposal of brine at sea can create environmental problems, especially in limited basins where damage to the marine ecosystem can also be significant. Chapter 12 presents a technology for recovering electricity from brines (see the paragraph dedicated to the technologies selected for the Giglio Porto site on pages 102-103).

However, it should be noted that, to date, there is a lack of in-depth studies that objectively indicate the environmental consequences that may be encountered, a situation that is also reflected in the lack of adequate legislation for the discharge into the sea of chemicals from desalination processes (see also Decree Law 152/2016 which does not require an environmental impact assessment nor indicates the need for a cost-benefit analysis).

Some indications that suggest caution, however, also come from a recent study conducted by the University of Naples Federico II in which it was observed the state of marine flora and fauna in regions adjacent to those in which the discharge of brine from the desalination plant installed on the island of Lipari takes place. These studies have highlighted an alteration in the development of plants (in particular *Posidonia Oceanica*) that guarantee conditions of stability to the marine environment.

Finally, considering that water from desalination plants costs about 10 times more than groundwater, it should not be overlooked that a modernization of the water distribution network, which, at present, experiences losses of up to 50% of the water flow, could produce significant economic savings and considerably reduce the current consumption.

A more careful management of existing water resources, restoring old methods that have fallen into disuse but are effective, such as rainwater collection tanks that can cope satisfactorily with domestic or agricultural users, should be carefully implemented.

It must be noted that also some existing legal provisions concur in limiting the spread of desalination plants in the Minor Islands and they should be amended. For example, laws are currently in force so that the State provide full financial support for the supply and transport of water, a contribution which would be lost if the island were supplied with water by means of desalination systems (Law 378/1967). Since the installation of desalination plant might lead to the decay of the gratuitousness of the primary water supply, the lack of interest and the difficulties put forward by many local administrations can be understood.

Finally, it is useful to recall the provisions of the Framework Law for the development of the Minor Islands (AC1285) of January 2019, a parliamentary initiative, which, at point o) of Article 2 states that it is necessary "*to ensure the water supply by building new plants and encouraging the installation of drinking water and desalination plants with the use of low energy consumption techniques and rainwater recovery*".

6.2 Purification systems

The treatment of urban wastewater is a profoundly serious problem for most of the Minor Islands that sees these realities outside the legal standards, even more serious in some situations, where there is really no type of purification. Taking as an example the survey carried out by the European Environment Agency (2015), 15 out of 20 Minor Islands have no treatment of urban wastewater, among the islands that have it, 2 exceed the limits of the law on effluents (Pantelleria and Ustica) and one (Lipari) has no data on it. Only for the Municipality of Favignana a plant for the treatment of wastewater is currently being completed and a collector has been built to bring the wastewater to the treatment plant.

For most of the Minor Islands, due to a widespread urbanization of the territory, even outside the existing regulations, most of the drains from private homes are dispersed directly into the subsoil changing the state of the deep waters and thus exacerbating the problem of water supply from local sources. In the islands where there is no treatment plant, all the wastewater is channeled directly into the sea.

Urban wastewater treatment is regulated by a European Council Directive (91/271/ECC) which in particular provides for the implementation of sewer systems (art. 3) and the obligation of a secondary treatment (art. 4) with measurement of the efficiency degree of purification of ingoing and outgoing water.

Table 6.3 describes the situation regarding the sewerage and the existing purification facilities for the main Minor Islands. The data was taken from the Rapporto Legambiente *Isole Sostenibili – Osservatorio sulle Isole Minori*[6] and partly from the answers to a questionnaire prepared by ANCIM (June 2019).

Table 6.3 Sewerage and treatment facilities in the main Minor Islands[7]

Archipelago	Island	Sewer system	Ancillary treatment	BOD Compliance	COD Compliance
Campanian	Capri Anacapri	Compliant Compliant	Non-compliant	Within limits	Within limits
Tuscan	Giglio Capraia	NA NA	NA NA	….. …..	….. …..
Pelagie	Pantelleria Lampedusa Linosa	Non-compliant Compliant NA	….. Non-compliant NA	Out of range ….. …..	Out of range ….. …..
Egadi	Favignana Marettimo Levanzo	Compliant NA NA	Non-compliant NA NA	….. ….. …..	….. ….. …..
Pontine	Ponza Ventotene	NA Compliant	NA NA	….. Within limits	….. Within limits
	Ustica	Compliant	NA	Out of range	Out of range
Eolian	Lipari Vulcano Stromboli Panarea Filicudi Salina	Compliant NA NA NA NA NA	Non-compliant NA NA NA NA NA	NA	NA ….. ….. ….. ….. …..
Tremiti	Tremiti Islands	Compliant	Non-compliant	Within limits	Within limits

Because of the complexity of the problems it presents and the difficulty of finding short-term, technically efficient and economically compatible solutions, the management of water resources and their supply is an issue of great importance for the sustainable development of the Minor Islands.

A positive aspect that should be mentioned is that this problem is strongly felt by the various Municipal administrations, which, perhaps in an uncoordinated way, have put in place initiatives to raise awareness of local populations and are studying various initiatives.

[6] *Legambiente Report "Sustainable Islands - Observatory on the Minor Islands".*

[7] In the table, NA means "information not available"; BOD and COD stand for Biological Oxygen Demand (degree of purification at the inlet) and Chemical Oxygen Demand (degree of purification at the outlet), respectively.

A positive aspect that must be mentioned is that this problem is strongly felt by the various Municipal administrations, which, perhaps uncoordinated, have implemented programs of raising awareness among local populations and studying various initiatives.

It is worth mentioning the already cited "Action Plan for Sustainable Energy and Climate (PAESC)" of the Municipality of Favignana, which indicates as possible interventions:

- reduction of water consumption in the territory and enhancement of local resources through the promotion of more efficient behavior and the implementation of interventions for the exploitation of water available in the territory;
- involvement of citizens and tour operators in the implementation of water-saving devices in residential and hotel structures;
- promotion of the reuse of grey water and of the collection of rainwater for non-drinking purposes.
- enhancement of the use of wells in the islands for irrigation and non-drinking purposes in general;
- installation of measuring instruments in existing submarine pipelines to check the level of dispersion.

To this plan of interventions, valuable and certainly to be supported, must be added the need to increase the construction of new desalination plants, and among these, those with reverse osmosis, which represents the structural solution to the problem of water shortage in the Minor Islands.

A view of Favignana, an island of the Egadi archipelago (Sicily)

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Chapter 7

THE LEGISLATIVE FRAMEWORK FOR RENEWABLE ENERGY: A FOCUS ON MARINE RENEWABLE ENERGY

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Preliminary considerations

With the aim of meeting the requirements established by the Paris agreement 2015, the European Union strengthened measures to promote the energy transition through new acts, directives and regulations to ensure a clear and solid legislative context to accompany member states on the road to decarbonisation. The creation of stable coherent structured laws has a double function: it makes it possible to pursue the requirements of emissions reduction and conservation of environmental quality, and it is a prerequisite facilitating private or public investment in renewable technology installations (Leary and Estaban, 2009).

Despite the European Union's efforts, Italy has not always been quick to implement European laws and acts, and this has hindered work and achievement of the objectives. Obstacles are not limited to implementation of laws setting guidelines for the development of renewable energy but also include the complex bureaucratic and administrative procedures that regulate installation, leading to gaps, legislative confusion and overlapping competences.

These critical aspects are aggravated in developing energy sectors, such as marine renewable energy, already faced with financial challenges. Pursuit of its development is threatened by bureaucratic and administrative procedures.

Despite this, marine renewable energy could benefit Italy, in view of its favourable geographic position. It could be precious for the smaller islands, which are often isolated and have daily logistic energy supply problems.

According to a report by Legambiente and CNR-IIA entitled "Sustainable islands – Observatory on the smaller islands", the greatest limits to development for the smaller islands are not technological and have significantly slowed the development of renewable energy. Here, the contribution of renewable energy to energy requirements does not exceed 6%, whereas in the rest of Italy the figure averages 32% (see Legambiente report https://www.legambiente.it/wp-content/uploads/Isole-Sostenibili-Rapporto-2019.pdf). The report also indicates that the types of renewable energy so far tested on the islands include photovoltaic and wind, ignoring a wide range of innovative marine technologies.

In February 2017, a decree of the Ministry for Economic Development (D.M. 52 of 14/02/2017) was passed to encourage renewable energy installations on the smaller islands. This law defines objectives and incentives for renewable energy on smaller islands not connected to the mainland grid and establishes minimum objectives to produce electric and thermal energy from renewable sources to achieve by 31st December 2020. Moreover, The Ministry more recently decreed contributions to municipalities that plan to begin sustainable development and energy efficiency by 31st October 2020, to promote a reduction in energy consumption and to invest in alternative renewable sources. This decree defines how art. 30 of the Growth Decree 2019 is to be actuated. Such provisions could be an opportunity for the smaller islands, enabling them to overcome the impasse of energy isolation.

Here we provide a panorama of the European and Italian laws regulating the renewable energy sector, with a focus on marine energy. We examine the laws of the Tuscan Government to see those that regulate the sector at regional level. The choice of examining regional laws too comes from the fact that the regions also pass energy laws and therefore have a role in the development of the sector, in terms of authorisations and land governance, and therefore identification of areas unsuitable to host certain technologies. We also discuss possible obstacles to the development of marine renewable energy considering the three levels of legislation (European, national and regional).

7.1 The European laws

The European Union regulates the development of marine renewable energy through a series of directives and regulations (Table 7.1).

Table 7.1 European laws regulating the development of renewable energy

DIRECTIVE	CONTENT
2009/28/EC	Renewable Energy Directive
COM(2015) 80 final	"Union of Energy" package
(EU) 2018/844	Energy Performance of Buildings Directive
(EU) Regulation 2018/1999	Governance of the energy union and climate action
(EU) 2018/2001	The revised Renewable Energy Directive
(EU) 2018/2002	The revised Energy Efficiency Directive
(EU) 2019/941	Regulation on risk-preparedness in the electricity sector
(EU) 2019/942	Regulation establishing a European Union Agency for the Cooperation of Energy Regulators
(EU) 2019/943	Regulation on the internal market for electricity
(EU) 2019/944	Directive on common rules for the internal market for electricity

Directive 2009/28/EC promotes the development of renewable energy, fixing targets to achieve by the end of 2020, namely:

- a 20% reduction in greenhouse gas emissions;
- a 20% increase in renewable energy installations;
- a 20% increase in energy efficiency.

Since 2009, the urgency of an energy transition to counteract the effects of climate change has implied further modification of the objectives and implementation of laws that regulate the development and the incentives of renewable energy.

After COP 21, Paris 2015, the EU elaborated a new strategy to achieve a resilient energy union with a long-term policy on climate change (COM(2015) 80 final) (*Clean Energy package*). The package fixed three main objectives to reach by 2030: a reduction of at least 40% in greenhouse gas emissions (with respect to 1990 levels), a portion of at least 27% of renewable energy and an improvement in energy efficiency of at least 27%. The objectives therefore include adopting cost-effective measures to achieve the long-term objective and an 80-95% reduction in emissions by 2050, as well as laying the foundations for a contribution to the international climate agreement that comes into force in 2020.

European Union strategy divides the Energy Union programme into five dimensions:

- energy security, solidarity and trust,
- full integration of the European energy market,
- energy efficiency to reduce demand,
- decarbonisation of the economy,
- research, innovation and competition.

In order to pursue this strategy, the EU established a framework called *Clean Energy for all European Citizens package*. The purpose of the framework is to provide guidelines and incentives for the formulation of new laws and directives to reach the target fixed by the Energy Union.

Adoption of the *Clean Energy for all Europeans* package has speeded up the formulation process since 2018 and new laws have been produced. The Clean Energy packet contains eight legislative acts.

- Directive 2018/844/EU on the energy performance of buildings involves amendments to the previous directives 2010/31/EU and 2012/27/EU.
- Directive 2018/2001/EU promotes the development of renewable energy setting a 32% increase in renewable energy consumption by 2030.
- Directive 2018/2002/EU on energy efficiency provides amendments to the previous directive 2012/27/EU. By 2030 all states must achieve 32.5% energy efficiency in final consumptions. The directive establishes the principle that puts *energy efficiency in first place*.
- Regulation 2018/1999/EU institutes a mechanism of governance to implement measures and policies to mitigate climate change. At the same time it promotes energy security, transparency of procedures and collaboration between states.

However, a comment regarding art. 19 is in order. This article sets the procedure by which member states present the European Commission with their plans and adaptation strategies to fight climate change. The article does not stipulate the need to simplify the various bureaucratic and administrative procedures for installations and does not encourage new laws to speed up the procedures. This could lead to much delay in reaching the objectives described by member states in their strategic plans.

- Regulation 2019/94/EU establishes rules regarding cooperation between member states to prevent, prepare and manage electrical energy crises in a spirit of solidarity and transparency and in full agreement with the requirements of a competitive internal electricity market.
- Regulation 2019/942/EU sets up an Agency of the EU, ACER, for cooperation between national energy regulators. ACER has the aim of helping regulatory authorities and of creating common high-quality practices for regulation and control, thus promoting coherent, efficient and effective application of EU law to further EU objectives on climate and energy.
- Regulation 2019/943/EU on the internal electricity market lays foundations to meet the objectives of the Energy Union efficiently, through market signals that indicate better efficiency, a higher percentage of renewable energy sources, supply security, flexibility, sustainability, decarbonisation and innovation.
- Directive 2019/944/EU sets common laws for the internal electricity market and amends Directive 2012/27/EU. This directive establishes common laws for the generation, transmission, distribution, storage and supply of electrical energy, together with consumer protection provisions.

Figure 7.1 illustrates the *Clean Energy framework*.

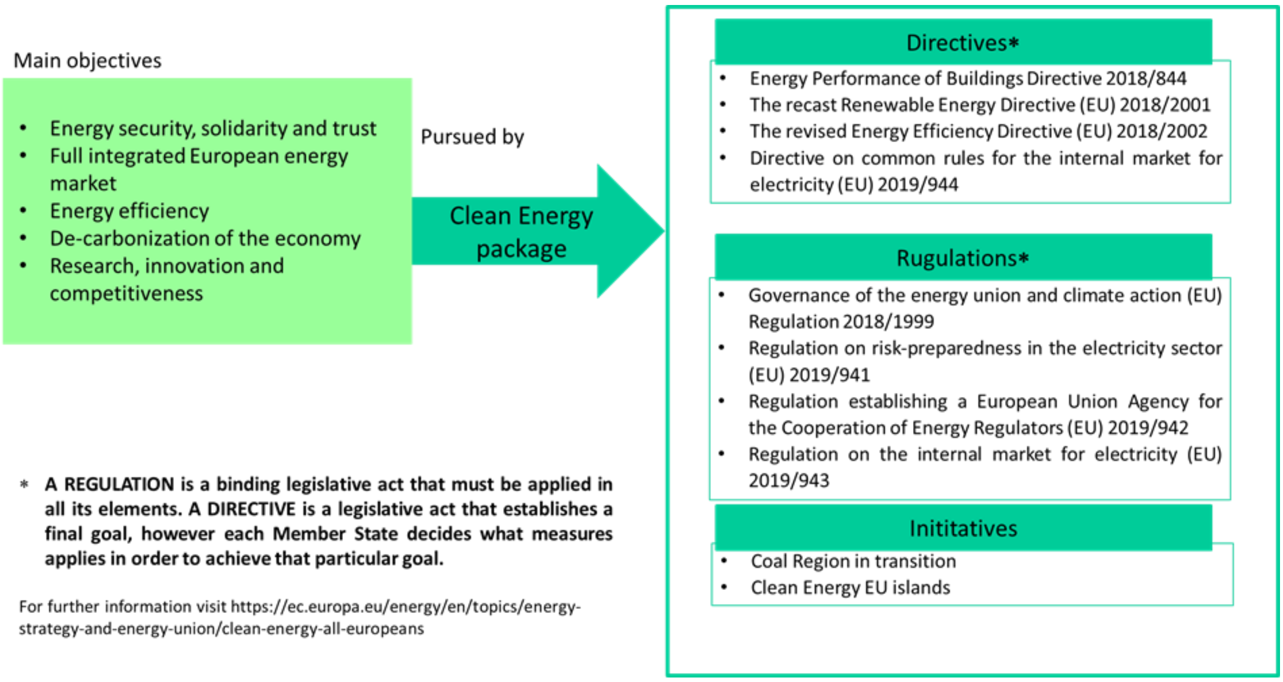

Figure 7.1 Clean Energy Framework

Besides the above legislative measures, the *Clean Energy* packet also envisages two initiatives: *Coal Region in transition* and *Clean Energy EU islands*. The island initiative aims to reduce energy costs, increase production of renewable energy and construct energy storage plants and demand-response systems using the latest technologies. It also aims to ensure better energy security for the islands, making them less dependent on external supply and reducing their environmental impact by reducing emissions and protecting ecosystems.

All the actions will also bring jobs and better economic self-sufficiency. The initiative was launched in Malta in 2017 and in 2018 the *Clean energy for EU islands secretariat* was established to help and support to islands during their energy transition. This initiative is subject to the measures of the *Clean Energy for all Europeans* packet. To join this plan, it is necessary to sign an agreement, commonly called pledge. The following organisations can sign the pledge: local authorities, citizens organisations, local business associations, schools, and universities. To begin the process, the secretariat establishes that at least two stakeholders must collaborate and where possible, it is always opportune to involve the local authorities. When the island has joined the initiative, a *Clean Energy Transition Agenda* is drawn up, consisting of four phases:

- creation of a transition team;
- description of island dynamics;
- deciding a transition pathway;
- monitoring of processes and dissemination of results.

Thanks to support from the secretariat, islands can begin an energy transition process to transform policies into reality within a year. A European island organisation level favours exchange of information and knowledge and makes it easier to solve problems common to all islands.

Thanks to the new directives 2018/2001/EU and 2019/944/EU, island communities can become energy communities, active in the production and sale of the energy they produce and enjoying major collective economic and environmental benefits.

Figure 7.2 illustrates the *Clean Energy for EU Islands* initiative.

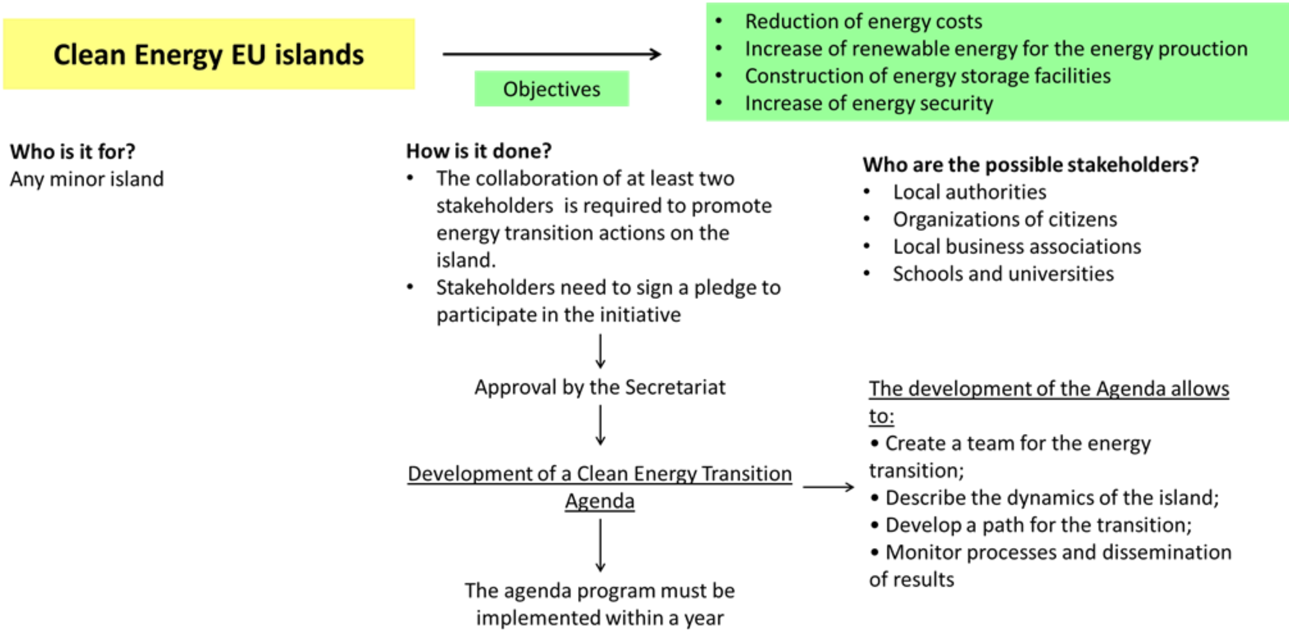

Figure 7.2 The *Clean Energy EU islands* initiative

Focusing on marine renewable energy, it is also necessary to consider the European directives (Table 7.2). These regulate marine ecosystem quality and offer help with marine spatial planning.

Table 7.2 European laws on marine spatial planning and conservation of marine areas

DIRECTIVE	CONTENT
2008/56/EC	Marine Strategy Framework Directive
2014/89/EU	Marine Spatial Planning Directive
92/43/EEC	Habitats Directive
2009/147/EU	Directive on the conservation of wild birds (ex Directive 79/409/CEE)

Directive 2008/56/EC concerns the ecological health of the marine environment, whereas the Habitats and Birds directives concentrate on the protection of ecosystems and fauna. The latter two directives, together with the Marine spatial planning directive (2014/89/UE), envisage spatial management of marine environments through identification of protected marine areas (92/43/EEC and 79/409/EEC) and marine areas dedicated to specific economic sectors (2014/89/UE) with the aim of reducing impacts and ensuring efficiency of the various activities.

7.2 National legislative framework

At national level (Italy), energy planning began in 2017 with the National Energy Strategy (NES), a ten-year government plan aimed at addressing and managing decarbonisation of the energy system, among other things. The NES envisages an acceleration of decarbonisation of the energy system, starting with a sharp cut in the use of coal from 2025, and a series of simplifications and rationalisations of the energy system to obtain significant reductions in the costs of renewable technologies. The NES also defines measures to reach the targets of sustainable growth established by COP21.

In this context, NES is an essential link in the Integrated National Plan for Energy and Climate (INPEC) for the period 2021-2030, published on 31st December 2019. However, when the European Commission examined the INPEC draft proposal, it suggested that Italy be more ambitious in the plan to reach climate targets by 2030 and transition to a zero climate impact by 2050 through greater use of renewable sources and energy efficiency.

At national level, the laws indicated in Table 7.3 regulate the installation of technologies for the use of renewable energy sources.

Table 7.3 National renewable energy laws

ACT	CONTENT
Legislative decree 112/1998	Assignment of state administrative functions and tasks to the Regions and local government
Constitutional law 3/2001	Amendment of title V, part 2 of the Constitution
Legislative decree 387/2003	Actuation of Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market
Ministerial decree 10th Sept 2010	Guidelines for the authorisation of plants fuelled by renewable energy sources

The Regions first acquired administrative functions regarding energy with legislative decree 112/1998 and these functions were confirmed with reform of Title V of the Constitution (constitutional law no. 3/2001). The competences and responsibilities of state and Regions in the energy sector concur: the state fixes the guidelines and major objectives, while the Regions exercise their legislative power considering the general requirements set by the state.

Legislative decree 112/1998 and constitutional law 3/2001 define the repartition of competences, legislative decree 387/2003 implements Directive 2001/77/EC and aims to simplify the bureaucratic procedure for installation of renewable energy plants. Specifically, legislative decree 387/2003 (Art. 12) provides that the Regions issue a Single Authorisation (SA) for plants with an installed thermal power less than or equal to 300 MW. If the installed thermal power is greater than 300 MW, the SA must come from the Ministry for Economic Development. The procedure involves three steps:

- application for the SA;
- initiation of an environmental impact assessment procedure with convocation of the relevant authorities (Conference of services) by the Region within 30 days of presentation of the application;
- completion of the SA procedure must not go beyond 90 days, unless further information is requested (30 days).

Since these deadlines are not strict, the procedure may take longer than indicated in Figure 7.3.

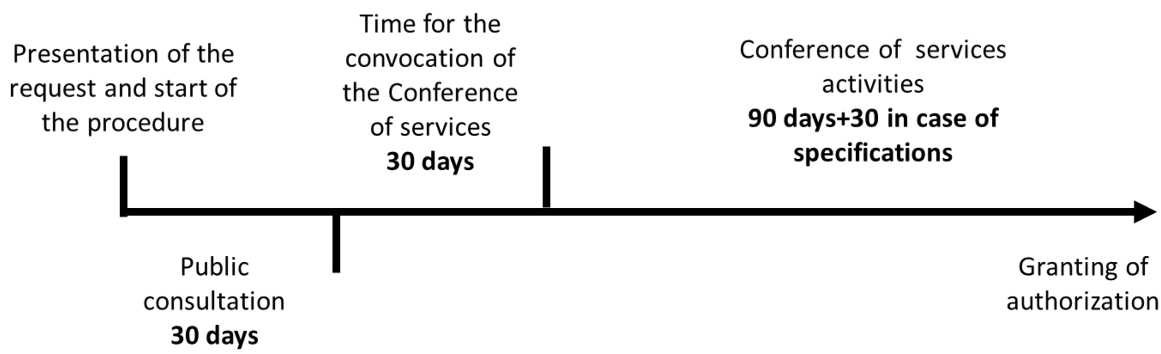

Figure 7.3 Regional environmental impact assessment procedure

Legislative decree 387/2003 also establishes that authorisation of offshore installations is decided by the Ministry for Infrastructure and Transport once cleared with the Ministry for Economic Development and the Ministry for the Environment and Land and Marine Conservation (Ministero dell'Ambiente e della Tutela del Territorio e del Mare – MATTM). It is necessary to obtain concession to use maritime waters from the maritime authorities according to art. 36 of the Navigation Code – Regulation of Maritime Traffic. Also in this case, the relevant authorities are involved in assessment of the project. Once the project is approved, the Regions cannot oppose offshore installations, as confirmed by the State Council (Supreme Court).

Authorisation allows the applicant to proceed with construction and to manage the plant according to project, observing any conditions imposed during the authorisation process and the obligation to report questions of safety and to comply with the national electricity supply and environmental protection regulations.

However, despite the attempted simplification, the process to obtain authorisation can be more complicated than expected and its timing is difficult to predict. Although only one authority is responsible (Ministry for Infrastructure and Transport), the applicant has to apply to all three ministries and a parallel application has to be made to the Ministry for Infrastructure and Transport to occupy maritime space (Figure 7.4).

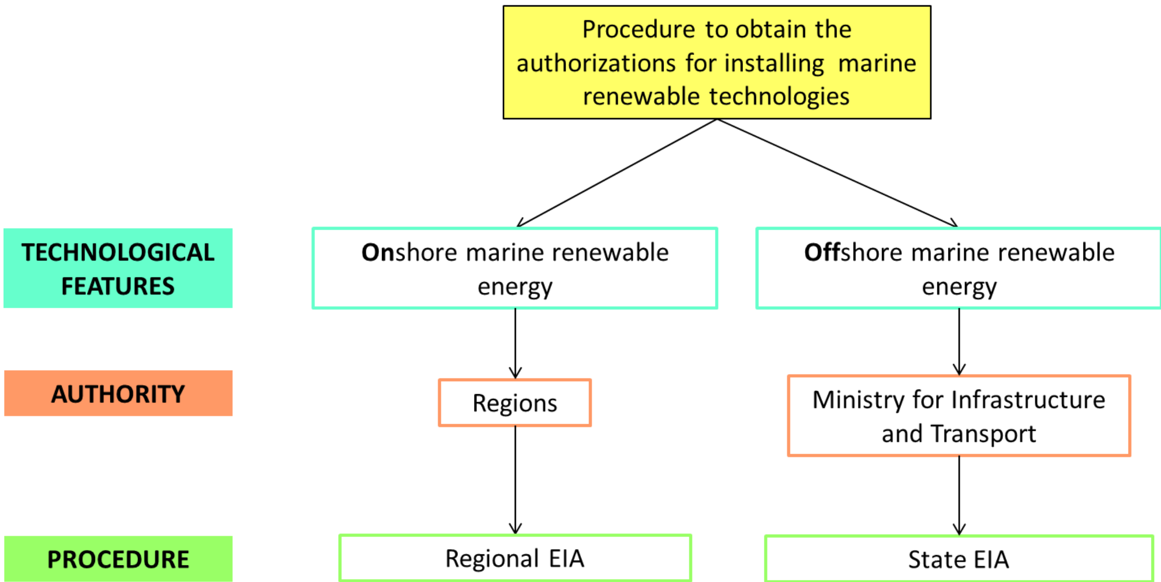

Figure 7.4 Situations where Environmental Impact Assessment is necessary

If Environmental Impact Assessment (EIA) is necessary, application to the Ministry for the Environment and Land and Marine Conservation cannot be made until a preliminary positive assessment is received regarding occupation of maritime space. This ministry then issues the EIA measure according to arts. 19-29 of Legislative decree 152/2006, as amended by Legislative decree 104/2017. The time necessary to issue the EIA statement can range from 150 to 330 days if further studies are required.

When the Ministry for Infrastructure and Transport receives approval from the Ministry for the Environment due to a positive EIA statement, within 30 days it summons the relevant authorities to evaluate the application and to issue the authorisation within 90 days (if all vote in favour). Although the starting date for calculating this interval is virtually that of the application, the period is suspended until the EIA statement is issued and formal notification of the right to occupy maritime space is received. The whole duration of the process can therefore exceed one year (Figure 7.5).

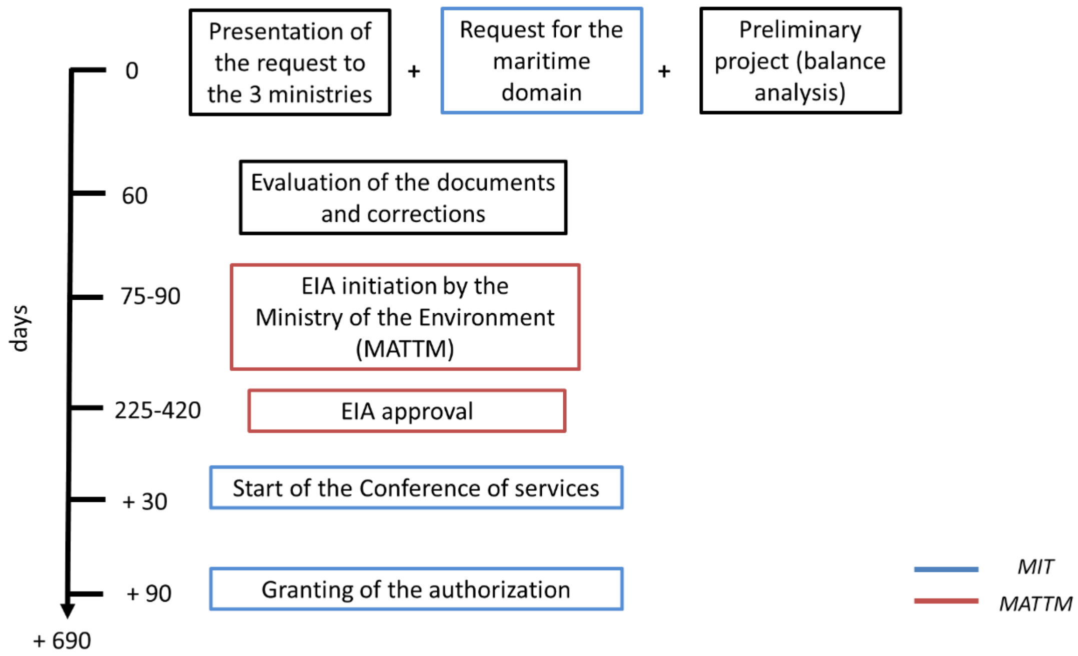

Figure 7.5 EIA procedure at State level

At state level, the laws regulating protected marine areas and landscape are listed in Table 7.4.

Table 7.4 Laws that could prevent installation of energy plants

LAW	CONTENT
Law 394/1991	Protected areas framework law
Legislative decree 157/2006	Amendments to legislative decree no. 42 of 22nd January 2004 regarding landscape

The Protected areas framework law defines the procedures for creating protected areas. In general, the state and regions can create national and regional protected areas, respectively. Regional protected areas are managed by the Regions.

Legislative decree 157/2006 regarding landscape regulates the procedures for installation of plant and machinery. Art. 12 sets the areas protected by law, one of which is: "coastal land, including a belt extending 300 m inland from the shoreline, also in the case of elevated land". Art. 136 strengthens art. 142, defining the concept of property and areas of public interest such as "beautiful views and publicly accessible lookouts or vantage points, where those views can be enjoyed".

Art. 146 states that owners or those with any title to property or areas of landscape interest, protected by law, cannot destroy or make modifications that prejudice the protected landscape values.

7.3 Regional legislative framework of Tuscany

Table 7.5 shows the laws of Tuscany concerning renewable energy.
As stipulated by the national legislation, Tuscany is charged with issuing SAs for onshore renewable energy installations. Regional law 39/2005 describes the procedure (art. 14) in line with art. 12 of legislative decree 387/ 2003. Moreover, according to the 2010 guidelines, the Tuscan government established a list of areas unsuited to hosting renewable energy production plants or installations.

Table 7.5 Regional laws concerning renewable energy

REGIONAL ENVIRONMENT AND ENERGY PLAN, REEP (2013)
REGIONAL ENVIRONMENT AND ENERGY PLAN, REEP (2015)
Regional law 3/2005 Land governance law
Regional law 39/2005 regarding energy
LR 11/2011 regarding installation of plants to produce electric power from renewable energy sources. Amendment to Regional law no. 39 of 24th February 2005 and Regional law no. 1 of 3rd January 2005 (Land governance law) in force since 24/03/2011.

Regional law 3/2005 sets the rules for land governance, promoting the sustainable development of public and private activities that affect regional land. To that purpose, any such activities and use of land and environmental resources must be conducted in such a way as to ensure protection and maintenance of commons and equality of rights to the use and enjoyment of commons, respecting the need for the best possible quality of life for present and future generations.

The Regional Environmental and Energy Plans (REEP) establish an environmental and energy strategy to pursue at regional level. REEP belong in a European Community planning context that aims to sustain the transition to a low carbon emissions economy in a framework designed to combat and adapt to climate change and to prevent and manage risks. At the same time, REEP contain actions to protect and valorise the environment, but in an integrated ecosystem context that places special attention on renewable energy and on resource saving and recovery. REEP take into account the constraints imposed by the Region.

The planning envisaged by the two REEPs so far published, besides being in line with the national and regional legislation so far considered, also consider the list of unsuitable areas identified by the Region. At the moment, the Region has identified areas unsuited for plant that exploits wind, geothermal, hydroelectric, photovoltaic and biomass energy.

In the REEPs of 2013 and 2015 it emerges that the main renewable energy source in Tuscany is geothermal (>72%), followed by hydroelectric, onshore wind and photovoltaic (Tables 7.6 and 7.7). Biomass also has a prominent role.

It is evident from REEP 2013 that in 2020, no energy is expected to come from wave motion or tides (Table 7.6). Marine renewable energy is not considered in REEP 2015 (Table 7.7).
The absence of marine renewable energy suggests that there is a legislative gap or a lack of knowledge of these technologies. Moreover, no list has yet been made of the areas unsuited to host installations exploiting marine renewable energy.

Table 7.6 Renewable energy in Tuscany (adapted from REEP 2013)

ENERGY SOURCE											
Hydro-electric	*Geo-thermal*	*Solar photovoltaic*	*Solar concentr.*	*On shore wind*	*Offshore wind*	*Biomass from urban solid waste*	*Other solid biomass*	*Biogas*	*Bioliquids*	*Tides and waves*	*Total*
[GWh]	[GWh]	[GWh]	[GWh]	[GWh]	[GWh]	[GWh]	[GWh]	[GWh]	[GWh]	[GWh]	[GWh]
933	6,450	263	-	358	-	300	159	232	218	-	8,913
[ktoe]	[ktoe]	[ktoe]	[ktoe]	[ktoe]	[ktoe]	[ktoe]	[ktoe]	[ktoe]	[ktoe]		[ktoe]
80	555	23	-	31	-	26	14	20	19	-	767

Table 7.7 Renewable energy in Tuscany (adapted from REEP 2015)

	Current production (2011, except solar PV 2013)	Predicted and Burden Sharing	Current situation compared to Burden Sharing objective	2020 estimate for Tuscany	Difference between Burden Sharing objective and Tuscan estimate	Notes on current production	Notes on 2020 estimate
	[ktoe]						
Hydraulic (normalised)	**64.00**	**80.26**	**-16.26**	**69.00**	**-11.26**	Source GSE 2011 Simerì	Linear interpolation of 2005 data with y = 0.5357x + 60.429
Wind (normalised)	**6.00**	**30.79**	**-24.79**	**30.31**	**-0.48**	Source GSE 2011 Simerì	+ 96.25 MW from plants already in function/authorised + 70 MW of new authorisations by 2020
Solar	**63.19**	**22.63**	**40.57**	**100.05**	**77.43**	Estimated current production based on 668 MW installed Source Atlasole 28/05/2013, multiplied by 1100 h functioning equivalent and converted to ktoe	Estimate based on 900 MW per year of growth at national level without incentives (Energy & Strategy Group - POLIMI), functioning 1100 h/y, regionalised on population % basis and converted to ktoe
Geothermal	**486.00**	**554.70**	**-68.70**	**631.13**	**76.43**	Source GSE 2011 Simerì	+15 MW from 3 pilot permits + 40 MW Bagnore 4 + 20 MW Milia + 150 MW from pilot plants
Solid biomass from urban waste	**5.89**	**25.78**	**-19.89**	63.46	-14.72	Source TERNA/GSE 2011 converted to ktoe	Linear interpolation of 2003 data with y = 4.245x + 285.59 converted to ktoe
Other solid biomass	**7.85**	**13.72**	**-5.87**			Source TERNA/GSE 2011 converted to ktoe	
Biogas	**11.30**	**19.95**	**-8.65**			Source TERNA/GSE 2011 converted to ktoe	
Bioliquids	**7.28**	**18.73**	**-11.45**			Source TERNA/GSE 2011 converted to ktoe	
TOTAL	**651.52**	**766.55**	**-115.03**	893.95	127.39		

7.4 Possible impediments to the development of marine renewable energy

The first problem that can arise with the development of marine renewable energy lies in its definition. Indeed, marine renewable energy has not yet been defined at national, regional or European level. At European level there is a first internal communication in which blue energy is mentioned. It contains a preliminary classification of the technologies based on the energy source exploited (tides, waves, salinity gradients, thermal gradients). However, basic factors such as collocation and the distance of installations from the coast are not subject to legislation, despite the fact that they have major implications in terms of authorisation.

On the basis of the literature, if collocation of plant is considered, technologies that exploit blue energy can be divided generically into three groups (Dolores et al., 2017):

- onshore
- nearshore
- offshore.

Onshore technologies are installed on the coast near ports or exploiting existing man-made structures. Nearshore technologies are installed in shallow water but there is no agreement or any clear definition of what is meant by "shallow" (Drew et al., 2009). Offshore technologies are collocated in the open sea where the water is deep.

Hence there is no clear definition that distinguishes shallow water from open sea sites that could enable diversification of nearshore and offshore technologies and the type of procedure to adopt and potential limits or constraints to consider.

- What is the maximum depth of shallow water?
- To what depth can installations be considered nearshore?
- Is distance from the coast a factor affecting the definition of nearshore technology?
- Who is responsible for authorising nearshore technologies: The Ministry for Infrastructure and Transport or the Regions?

From an administrative viewpoint, the 2010 guidelines suggest that the Ministry for Infrastructure and Transport has competence for offshore blue energy installations, and the Regions for onshore marine technologies.

At regional level there are no clear indications on the procedures to follow for installation (Figure 7.6), nor are there guidelines or references to onshore marine renewable energy suggesting Regional competence in the dedicated pages of the website of the Tuscan Regional Government (http://www.regione.toscana.it/imprese/energia/autorizzazionirinnovabili).

However, it seems that some blue energy is treated as hydroelectric. We find "Hydroelectric energy can also be produced by exploiting wave motion, tides and sea currents" (http://www.regione.toscana.it/-/fonti-rinnovabili). This declaration raises two further problems:

- it only concerns marine energy from wave motion without considering for example thermal or salinity gradients as sources;
- it partly disagrees with the classification used in REEP 2013.

Indeed, in REEP 2013 hydroelectric and wave or tide technologies come under different headings. It remains to clarify whether hydroelectric and marine renewable energy are treated in the same way with the same procedures. The Regional website also lacks any list of sites considered unsuited for installation of marine renewable energy plant.

- Di seguito quindi, divisi per fonti energetica, sono riportati gli impianti a cui si applica l'autorizzazione unica energetica regionale e i casi in cui questa è sostituita da una SCIA, o da una PAS (Procedura Abilitativa Semplificata ai sensi del DLgs 28/2011) o dalla Comunicazione preventiva (in quanto "attività libera") al Comune.
- Per alcune di queste fonti la Regione ha individuato criteri e limiti di installazione (lr 11/2011 e Piano Ambientale Energetico 2015). Vedi i riferimenti in fondo ad ogni paragrafo.

- Impianti eolici (produzione di energia elettrica)
- Impianti fotovoltaici (produzione di energia elettrica)
- Impianti a biomasse (produzione di energia elettrica)
- Impianti di cogenerazione a biomassa (produzione combinata di calore e di energia elettrica)
- Impianti idroelettrici (produzione di energia elettrica)
- Solare termico (solo produzione di calore)
- Biomassa termica (solo produzione di calore)
- Impianto geotermico senza prelievo di fluido o di limitata potenza

Sugli impianti in questione si segnalano le seguenti norme in ordine cronologico:

a) **le Linee Guida nazionali sulle fonti rinnovabili** (DM 10 settembre 2010) applicate direttamente anche in Toscana a partire dal 2 gennaio 2011;
b) **la Legge regionale 21 marzo 2011, n. 11** *"Disposizioni in materia di installazione di impianti di produzione di energia elettrica da fonti rinnovabili di energia. Modifiche alla legge regionale 24 febbraio 2005, n.39 (Disposizioni in materia di energia) e alla legge regionale 3 gennaio 2005, n.1 (Norme per il governo del territorio)"*, entrata in vigore il 24/03/2011;
c) **il Decreto Legislativo 3 marzo 2011, n. 28** "Attuazione della direttiva 2009/28/CE sulla promozione dell'uso dell'energia da fonti rinnovabili, recante modifica e successiva abrogazione delle direttive 2001/77/CE e 2003/30/CE", entrato in vigore il 29/03/2011;
d) **la LR 69/2012** *"Legge di semplificazione dell'ordinamento regionale 2012"* con cui è stata aggiornata la LR 39/2005 *"Disposizioni in materia di energia"* alle norme statali succitate, nonché è stata preso atto della sostituzione dell'istituto della Dia con la Scia (Segnalazione Certificata di Inizio Attività).
e) **la LR 22/2015 e la LR 13/2016** con cui la Regione ha riassunto dal 1° gennaio 2016 le competenze in materia di autorizzazioni energetiche che erano state assegnate alle Province.

Figure 7.6 List of Tuscan Regional authorisations by source

On 17th October 2017, Italy passed Legislative decree no. 201 recognising Directive 2014/89/EU dated 23rd July 2014, which defines a framework for marine spatial planning. However, no marine planning in line with the directive has yet been established.

In 2017, guidelines were published without reaching any concrete results. Comparing for example Italy (Figure 7.7) and Holland (Figure 7.8) on the European MSP Platform (https://www.msp-platform.eu/countries/italy), a sharp difference in marine spatial planning is evident.

Figure 7.7 Marine Spatial Planning Italy

Figure 7.8 Marine Spatial Planning The Netherlands

Marine spatial planning could have procedural advantages. Waiting times for assessment of applications could be shortened by pinpointing areas suited for installation of marine renewable energy plant. National marine spatial planning would also automatically help the Regions to make their lists of areas unsuited for the installations, as provided by paragraph 17 of the 2010 guidelines.

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Chapter 8

ITALIAN AND EUROPEAN BEST PRACTICES

Cristiana Biondo, Edoardo Zanchini - Legambiente

This chapter presents the good practices implemented by the Italian Islands in terms of environmental protection and five good practices implemented by the Mediterranean Islands in terms of greenhouse gas emissions to reach a 100% renewable scenario. The interest of these experiences is also in the fact that the results have been achieved by enhancing the local natural resources and stimulating the economy of the territory, involving the communities of residents. Moreover, these islands are, a good example to be replicated anywhere in the Mediterranean. Many islands could look in this direction and contribute in the fight against climate change. Phenomenon that has already started in these territories with the reduction of rainfall and at the same time the higher frequency and intensity of floods and heat waves, with the contamination of soft water with saltwater, and the loss of biodiversity in agriculture and fishing.

8.1 Best practices from Italy

8.1.1 Italy plastic free: here who said stop among Municipalities belonging to the smaller Italian islands

On the wave of the EU directive that, starting from 2021, will prohibit the production and the marketing of single-use plastic products in all the member countries of the European Union, many Italian cities have chosen to anticipate the application of the European Directive. Now, which are the Municipalities belonging to the smaller Italian islands that have already taken measures to ban single-use plastic products, which objects have they chosen to replace and when have they made this decision?

- CARLOFORTE (SARDINIA): The Municipality of Carloforte issued, in March 2019, an order concerning the ban on the use and marketing of non-biodegradable bags, containers and disposable tableware (plates, glasses and cutlery).
- USTICA (SICILY): The Mayor of Ustica signed an order that prohibit both use and sale of disposable plastic containers and dishes. The new rules came into force on May 30, 2019 and are valid for residents, homeowners on the island, commercial activities (restaurants, supermarkets, bars and street vendors) and tourists. For offenders are provided fines from 25 to 500 euros.
- ISCHIA (CAMPANIA): The six Municipalities of the island, through the assembly of the Inter-municipal Consortium Services Ischia (CISI), in March 2019 decided to ban disposable plastic food products. The ordinance concerns the ban on the entire island territory, including beaches and the entire coastline, on the use, possession, marketing and import of disposable and food-grade plastic products. The fine provided, in case of ascertained non-compliance, reaches up to 500 euros.
- SALINA (SICILY): The Municipality of Malfa, on the Island of Salina, has said stop to the use of plastic since July 2018. The union provision bans the sale and use of single-use plastic glasses, plates, cutlery, straws and bags in the Municipality. Instead, allows biodegradable or compostable materials.
- LIPARI (SICILY): In June 2019, the Mayor of Lipari signed an order for the minimization of wastes and the reduction of the environmental impact by prohibiting the use and the sale of shoppers (bags for take-away goods) in polyethylene, disposable dishes and other non-biodegradable materials. In this way, the Municipality of Lipari has been included among the cities committed to reducing the use of plastic, in line with European addresses. However,

will integrate gradually the provided measures to guarantee a correct and extensive information and, above all, to permit the disposal of warehouse stocks of commercial activities: the entry into force of the provision is set from 10 January 2020.

- LAMPEDUSA AND LINOSA (SICILY): From September 2018 to all residents and non-residents of the municipality of Lampedusa and Linosa and to the owners of shops, operating in the municipal area, both permanent and itinerant, is forbidden to use and/or supply plastic bags (shoppers) not biodegradable. In replacement, is possible to use certified biodegradable and compostable bags, such as those in bioplastic materials of vegetable origin, cellulose, paper, canvas or natural fiber. Moreover, is also prohibited the use of non-biodegradable disposable containers and dishes. For offenders, are provide fines from 25 to 500 euros.
- PANTELLERIA (SICILY): Pantelleria, from January 1st, has become plastic-free. With a specific ordinance, the Mayor ordered to the owners of the shops, artisan activities and business that distribute food and drink to use disposable cutlery, plates, glasses, bags in biodegradable and compostable material. Even residents on the island must use for shopping disposable paper bags or in any case reusable mesh bags in fabric. For offenders, are provide fines from 25 to 500 euros.

8.1.2 Seabin LifeGate PlasticLess® also in Capraia

Thanks to the collaboration between Whirlpool Emea, LifeGate and the technical partner Poralu Marine, participating in the LifeGate PlasticLess® project and with the purpose to contribute in a concrete way to reduce plastic pollution in our seas, 13 Seabin LifeGates have been positioned in as many ports and Italian sailing clubs, ideally covering the peninsula from north to south.

MARINA DI CAPRAIA also took part in the initiative. The Seabin looks like a real basket inserted in water that, operating 24 hours a day, is able to capture about 1.5 kg of plastic per day, equal to the weight of 100 bottles, or over 500 kg of waste per year. These wastes include micro plastics from 2 to 5 mm in diameter and 0.3 mm microfibers that, by attaching themselves to algae ingested by fish, enter the food chain directly.

Fundamental for the development of the initiative was the collaboration of the Municipalities that, through the companies selected for the collection of waste, will periodically empty the Seabin LifeGates and differentiate the collected materials.

The involvement of the Municipality of Capraia Isola in the project is generating important results in terms of raising awareness of citizenship and public administrations.

8.1.3 Some best practices from other smaller Italian islands

ISOLA DEL GIGLIO is a candidate for becoming an Italian laboratory for the use of blue energies from sea waves (see Chapter 12, on pages 100-103, for a detailed description).

THE EGADI ISLANDS are committed on the front line for sustainability and respect of the environment. In fact, in Favignana, in the occasion of the meeting of the Greening the Islands Observatory held on the island on 28 and 29 May 2017, the priorities of the analysis that will be the basis of the sustainable development plan of the Egadi islands were identified. Thanks to the comparison between the participants, starting from the Municipal Administration, the electricity companies, the Sicilian Region, the Marine Protected Area, the experts of the Greening the Islands Observatory and the members of its Observatory (Enel X, Hitachi, Axpo and Terna Energy Solutions) it was possible to carry out an analysis of what problems the island has to face and what technological solutions and regulatory constraints/opportunities has to take in consideration. The Municipality of Favignana, with its three islands, has ensured that will put in place all possible actions in all sectors, from energy to mobility, from water to waste, to achieve the goal of a drastic reduction of emissions in a few years and of being in the front line among the most sustainable islands by 2030.

During the meeting, the Sail Cargo Brigantes project was presented for the transport of goods in the Mediterranean and the Caribbean by sailboat. Decarbonised sea transport guarantees the missing link in the sustainable production and consumption chain. The hull of the ship, which dates back to 1911, was launched last May in the port of Trapani. The Sail Cargo Brigantes project started in 2016 when the motor ship, created more than 100 years old, lay in the abandoned port of Trapani. Now the boat, after a year of work, was inaugurated with the name Briganti and in 2020 it will be able to take off for carrying goods between the Sicilian islands in the summer months and in the Atlantic sea during the winter months.

Moreover, the Egadi Islands have also been among the first Municipalities in Sicily adopting the ordinance that prohibits, from 1 March 2019, the marketing and therefore the use of plates, glasses, cutlery and bags in plastic.

Finally, VULCANO E LIPARI could use the desalination and purification plants. The regional council has in fact approved the proposal of the Councilor for Energy to allocate 2.6 million euros to allow the commissioning of strategic works for the smaller islands.

This resolves a long history that began in 2013 with the award of a tender that had been blocked for several years due to a dispute with the temporary association of companies that had won the contract. The amount allocated by the government will serve to definitively close the dispute that has arisen, thus putting the plants into operation. During the works, in fact, the company had expressed doubts about the contract, assuming additional costs of almost 13 million euros. Therefore, the decision of the regional Water and Waste department to sign a settlement agreement - for three million euros - which also provides, pending the Region publish of a call for the final management, the temporary assignment for twelve months of the Vulcano desalination plant and the Lipari and Vulcano purification plants.

In this way, the full use of the works that guarantee drinking water and the correct management of the wastewater will be ensured, and the public finances will save millions of euros that they would have been otherwise spent to supply the Aeolian Islands with drinking water.

8.2 Best practices from Mediterranean Sea

8.2.1 Tilos 100% renewable thanks to Horizon 2020

Tilos, the Aegean island belonging to the Dodecanese, is the first in the Mediterranean to produce electricity entirely from renewable sources, thanks to the European project Tilos Horizon 2020 - Technology Innovation for the Local Scale, Optimum Integration of Battery Energy Storage.

The project involved the construction of plants from renewable sources for a power of almost 1000 kW (800 from wind and 160 from solar energy) and storage systems for the storage of electricity. Thanks to the new systems, the island is now able to meet the electricity demand for the 500 inhabitants during the winter period, but also for the 3 thousand tourists registered in August. The old submarine power line hooked up to the Kos oil-fired power station – the one that guaranteed electricity up to a few months ago – now works when needed.

8.2.2 Crete zero-emission island by 2030

The island of Crete, one of Greece's main tourist destination, has identified key actions to become a zero-emission island by 2030.

The Greening the Islands Observatory, together with the technical departments of the region and the government of Crete, the public service companies, universities, local SMEs, international companies that are members of the Observatory, defined the priorities required to develop a new sustainable development strategy for the island.

From the point of view of energy supply, Crete has an isolated system and all its consumption is produced locally: there are three thermoelectric plants, working with gasoline and diesel fuel, and the renewable energy plants on the island cover 20-24% of the annual energy demand. The total renewable capacity of the island is 299 MW, which includes 200 MW of wind farms, 98 MW of photovoltaic energy, 0.3 MW of hydroelectric energy and 0.5 MW of biogas.

The observatory will work on the implementation of storage systems to support renewable energies. Energy efficiency solutions for hotels, buildings and streetlamps will be improved and an information campaign will be planned to increase the acceptance of renewable energy among the population.

Concerning water management, some solutions to increase the water supply will be studied taking into account seasonal fluctuations in demand due to tourism. Therefore, a strategy will be developed to prevent water scarcity situations in case of drought, among the described solutions there are innovative desalination plants.

About mobility, policies will be developed to promote the use of electric boats and electric cars and taxes on polluting vehicles in urban areas will be imposed. Crete is also examining the possibility of carrying out a V2G (Vehicle to Grid) pilot project as well as creating bike and pedestrian paths to encourage the use of the bicycle.

As regards waste, the GTI observatory will propose new methods to increase separate collection from hotels and markets, and then move on to the collection of domestic organic waste. Biogas plants for the management of organic waste and home composting as well as the treatment and reuse of biological sludge for agriculture will be evaluated.

8.2.3 Balearic islands 100% renewable by 2050

In February 2019, the regional parliament of the Balearic islands approved the law on climate change and the energy transition that provides the total transition to renewable energy by 2050, in addition to a series of green measures such as the ban on the registration of diesel cars to starting from 2025 (from 2035 for petrol ones) and the exclusive use of electric cars by 2050.

Currently the Balearic Islands are lagging in the production of energy from unconventional sources: only 3% is produced from renewables, while 70% derives from fossil fuels and 20% is imported from the mainland. The green revolution of the Spanish archipelago therefore still has a long way to go, but from government sources it is estimated that for the installation of photovoltaic panels and wind turbines, sufficient to guarantee the needs of the four islands, just over 1% would be enough of their surface.

The law represents only a very first step towards a broader and more complex objective. There will be a first phase of the transition in which the combined cycle gas plants will be used, the use of which will gradually give way to renewable energy. However, the goal remains the abandonment of coal, the fossil source most used by the islands (43%), also because since 1984 it has hosted a power plant (Es Murterar) in the northeast of Mallorca.

8.2.4 Porto Santo, towards energy independence

Porto Santo, a Portuguese island in the Madeira archipelago, has 5 thousand inhabitants and a thousand means of transport and a perfect size to become a laboratory to experience an "intelligent" future, looking for solutions to improve energy assistance, the circular economy, electric and shared mobility.

The Smart Fossil Free Island project aims to make Porto Santo the first European Smart Island to get rid of dependence on fossil fuels. Launched in 2018 by the Madeira regional government (on which the island depends, also energetically), it focuses on the use of smart and sustainable technologies to increase the energy independence of its inhabitants and promote the production of renewable energy. In the forefront of the partners EMM, the Madeira Electricidade Company, the energy supplier that provides the port islands of the archipelago and Renault, involved in the project with an experiment that aims to implement new shared and electric mobility solutions, widening the perimeter to the use of second life batteries, the so-called intelligent charging.

Porto Santo, as many smaller islands, from an energy point of view, requires a connection to an external source (in this case Madeira). This fact entails critical issues such as the use of ships for supplies, or the use of generators diesels needed to cover summer tourism peaks. The aim of the experimentation is therefore to focus on the use of renewable sources, to produce clean energy. Then we will need a sustainable mobility plan to reduce its environmental impact by proposing car-sharing solutions of electric cars powered thanks to a smart grid model.

8.2.5 El Hierro (Canary Archipelago)

The island of El Hierro, the smallest of the Canary archipelago, a Biosphere Reserve, reached a real energy transition, by representing so a model in terms of consistency between energy management and conservation of the environment and landscape.

With a territory of 269 sq km and its 11,000 inhabitants, El Hierro has an area that exceeds three times the largest Italian minor island, Pantelleria, and about inhabitants, it is comparable to the two most populous Italian small islands: Capri and Lipari.

Since the end of 2013, El Hierro is the first energy-insulated area in the world capable of being entirely powered by renewable energy sources. For the first time, the traditional problem of intermittent renewable energy sources is overcome by combining the energy production of a wind farm with a hydraulic storage system.

The hydro-wind system consists of a wind farm (11.5 MW), two water tanks, a pumping unit, a hydroelectric plant and a sea water desalination plant.

The wind farm supplies electricity to the grid and the excess energy keeps the pumps working that raise the water to a higher basin that functions as an energy storage system. The power plant uses the stored potential energy, such as to ensure the power and stability of the network.

El Hierro's energy sustainability strategy does not aim exclusively at electricity self-sufficiency, but it bets on electric vehicles and alternative transport systems, on the effective desalination of sea water with the aim of increasing water resources also for the use of agricultural irrigation. It also promotes domestic solar thermal systems, widespread photovoltaic micro-generation, the use of biomass resources and supports an effective energy saving campaign.

The experience of El Hierro shows that through a strategic overview and the activation of a single innovative quality project, it is possible to easily reach energy self-sufficiency by using renewable energy sources, even fragile and valuable landscape contexts.

Furthermore, in opposition to the widespread opinion that sees wind, photovoltaic and hydroelectric plants as a deterrent for tourism development, El Hierro has developed a highly successful tourist model based on innovation, technology, sustainability, environment and structured scenario to attract new types of aware visitors.

El Hierro Hydrowind Power Plant

Chapter 9

THE ENERGY TRANSITION ON THE SMALL ISLANDS, WHILE RESPECTING THE LANDSCAPE. A CULTURAL CHALLENGE

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The small islands are considered the perfect places to implement initiatives and experiments for the transition towards clean energy, while becoming an international model.

There are many initiatives in Europe to support and network activities on islands, first and foremost those promoted by the **Clean Energy for EU Islands Secretariat.**

Following the community strategies, the Italian Government has launched an ambitious program and identified measures dedicated to the small islands not yet interconnected with the national electrical system.

The purpose is to transform small islands into open-air laboratories, in which innovative and economically sustainable solutions can be tested: renewable sources, networks, production plants and utilities, sustainable mobility, adaptation to climate change impacts. All these tests can provide useful indications for the future national system too.

The energy transition towards renewable sources is strongly supported by the international community and is considered a strategic action, inescapable and cannot be postponed; however, it is not only a technical challenge but, as Dirk Sjimons points out, it's also a landscape challenge, and therefore a cultural one.

"The landscape becomes a mediator between the new energy infrastructure and the place where this infrastructure will be placed. Spatial planning and spatial design are therefore of great importance to the energy sector. Conversely, the energy transition will be a huge challenge for administrators, planners and designers.

The energy transition is not only a technical challenge, but also a landscape challenge, and thus a cultural one. The transition will take place in unison, or otherwise it will not take place in unison, or otherwise it will not happen at all". [Dirk Sjimons - Landscape and Energy: Designing Transition]

These ideas make a contribution to the concrete implementation of the energy transition, addressing in particular the delicate and controversial issue of landscape integration and environmental restriction; the aim is to discuss and open a comparison around the construction of "**new landscapes of energy**" able to face, with suitable proposals, the ecological and environmental demands.

For each new energy resource there is a different use of space in terms of both size and shape. The energy transition is therefore implemented in close interaction with spatial transformations. Working on the energy transition in spatial terms, we transform this primary objective, often treated in numerical and abstract terms, into a concrete and visual question that develops under multiple levels and scales. The production of renewable energy and its spatial organization become an extraordinary cultural and design opportunity.

As Sjimons points out, energy and space can both be quantified and synthesized with the **kWh/m^2** formula. But more than the dimensional aspect, we are interested in the quality of space.

In any context, both exceptional and ordinary, and in particular in areas so delicate for environmental and landscape aspects such as islands, the proposals for intervention must be conceived as a "Landscape Project", which assume a multidisciplinary approach and the application of advanced design methods.

The territorial transformation choices, if properly addressed, can contribute to the growth of virtuous development process.

The concepts of landscape and development can thus be combined while respecting the principles of the European Constitution that calls our country to work for:

"… the sustainable development of Europe based on balanced economic growth and price stability, a highly competitive social market economy, aiming at full employment and social progress, and a high level of protection and improvement of the quality of the environment". (European Constitution, art. 3).

The word "landscape" today has a broad and innovative meaning, which has found expression and codification in the European Landscape Convention, of the Council of Europe (Florence 2000), ratified by Italy (May 2006), in the Code of the Cultural and Landscape Heritage (2004 and subsequent amendments), in the initiatives for the quality of architecture (European Community Architecture Directives, laws and activities in individual countries, including Italy), in the regulations of Regions and Local Bodies, in actions of participation of the populations in the choices.

"… Landscape means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors". (European Landscape Convention, art.1).

The landscape issue is no longer limited to pursuing a "sustainable" development, able to ensure the health and physical survival of men and nature: it is the affirmation of the right of populations to the quality of all places of life, both extraordinary and ordinary, through the protection/construction of their historical and cultural identity.

The landscape is too often thought as a constraint, rather than a point of view able to activate a different planning, aimed at adding value to neglected resources, at recovering situations of degradation, at ensuring the best insertion of new works with the aim of producing new quality landscapes.

The much debated theme of landscape insertion is therefore much more complex and radical than the simple visual impact (often the only object of evaluation and debate), because it involves the social structure of the territories and imprints signs and transformations, even physical ones, that go beyond the same evaluated life of a plant.

The aim of combining the plant characteristics with the demands of landscape quality and enhancement of the territory must therefore orient each phase of the project, from the choice of the site to the settlement organization, from the routes and interactions with the tourism system to the more general socio-economic implications, and must be pursued in any project action, on all the areas and on all the levels of intervention.

The works, including technological ones, should not be conceived as separate forms, a mere engineering overlap to an irrelevant substrate. In the case of plants using renewable sources, adequate tools can be activated to analyse and evaluate aesthetic-visual relationships, from which the criteria for inclusion in the landscape can be deduced, for a compositional design that, although not in contrast with the aesthetic features of the landscape, implements it with appropriate relationships, underlining, contrasts, like a "intrusion" of quality.

Concerning to the theme of landscape and energy production from renewable sources, in contrast to what happened in other European countries, in Italy the ideological conflict at inter-ministerial level caused by the complex relationship between landscape values and environmental values in the strict sense has prevailed (meaning, in other words, to prevent and reduce emissions and pollutant inputs into the environment).

On several occasions in the past, the MIBAC (Italian Ministry of Cultural Heritage and Activities) has repeatedly pointed out that the public interests in protecting the environment/ecology and electricity supply (Law No 10/1991; Legislative Decree No 387/2003) have no leading position in relation to the primary public interest in protecting the landscape.

The protection of landscape, according to this approach, fully preserves its autonomous relevance and cannot be compressed or precluded by the environmental purpose of developing renewable sources.

In the last years, great strides have been made to resolve this conflict and the compatibility between landscape and renewable energy has been subject of discussion at the Ministry of Economic Development of the Burden Sharing Observatory (Ministerial Decree 15/03/2012, art. 5, paragraph 5), which involves both State representatives of the various interested Departments and especially of the Regions, becoming a profitable place for exchanging experiences, but above all a place for practical determinations to achieve the goals of reducing climate altering gases.

The MIBAC, with the General Direction of Archaeology, Fine Arts and Landscape, is member of the Observatory in order to monitor the achievement of the 20/20/20 goals (but also of longer term goals for 2030 and 2050 through the new National Energy Strategy) for electricity production from RES by the Regions, where it works consistently with the powers reserved to it for the protection of cultural heritage and landscape.

The Observatory also worked for the identification of criteria for environmental and landscape assessment for the supply of electricity from renewable sources in the areas of the so-called "small islands" not connected to the national electric transport system.

Another important aspect for the development of renewable energy in protected areas is the MIBAC's decree for the simplification of the authorization procedures in protected areas: Presidential Decree No 31 of 13 February 2017, "Regulation identifying interventions excluded from landscape authorization or subject to simplified authorization procedure" (published on the Official Gazette No 68 of 22 March 2017), in which there are specific simplified landscape authorization procedure for the installation of solar or photovoltaic systems in restricted areas (please refer to points A.6, A.7, B.8 and B.9).

Presidential Decree 31/2017 is a useful reference for the development of interventions in restricted areas, but the complexity of the morphological and constraining situation of the small islands and in general the combined provisions of regulations and subsequent interpretative and applicative circulars of the Decree (in particular, the Circular of MIBAC No 42 of July 2017), risk limiting the application of simplification rules in the island contexts, with particular reference to "free" interventions.

In terms of substantial support for the energy transition of the small islands, the application of an already expressed approach within the MIBAC would certainly be extremely effective: it should lead to the activation of a specific regulatory process for each island context, which would allow to face the feasibility of complex strategic projects of greater productivity along with the implementation of small-scale interventions.

As for the active policies that promote the energy transition of the small islands, the good news is that in the last years there has been an important attention at parliamentary level (§ several specific decrees and lastly the proposal framework law for the Development of the small islands of 2019) and there are new possibilities of developing renewable sources through a new incentive system approved in 2017 and that, after the resolution of ARERA (Italian Regulatory Authority for Energy, Networks and Environment) allows new interventions.

Considering the current favourable legislative and regulatory context, the challenge for the small islands is indeed of great interest and fascination because in a few years it can make an energy model fully based on renewable sources and keep together the objectives linked to the closure of the material cycle and a virtuous model of water resources management.

With regard to energy supply and networks, most of the small islands not interconnected with the National Transmission Grid (NTG) are managed by vertically integrated small electricity companies (IEM) while eight of those are managed by Enel Produzione.

The production plants are currently made up of diesel groups, whose overall power is always oversized to guarantee the quality and continuity of the service.

The supply of fuel takes place with tankers, with inevitable environmental risks, and the generation method is particularly polluting and a source of greenhouse gas emissions.

To overcome this negative emergency, it is essential to implement concrete actions to make the transition to an energy model based on the use of renewable sources in respect of the environmental and landscape characteristics of each island context.

However, it must be clarified what "**energy transition**" refers to, since this is an objective that everyone is talking about, especially with respect to the time frame in which it is expected to be implemented.

The current State policies and actions, although useful above all to highlight the unsustainability of the current energy supply of the non-interconnected small islands, appear very small in relation to the topic of expected results (starting from the current objectives gradually reaching 10% use of RES, it is clear that the transition will take place perhaps in decades).

Even considering the delicacy of the insular contexts, starting from the analysis of the climatic resources existing in the islands and the relatively low energy needs to be covered (excessive consumption cannot be reached even considering the peak summer loads), the conditions are favourable to reach relevant quotas of energy production from plants powered by Renewable Energy Sources. The goal of complete transition is not at all a fantasy and could be achieved in a short time, if we have the courage to propose truly significant solutions in terms of energy production and to overcome the resistance of local electricity companies.

It is necessary that each island activates a plan aimed at achieving 100% renewable energy and that, while respecting the environment and the landscape, regulates the methods of localization and implementation of strategic interventions (mix of concentrated large and medium plants nominal power) and that at the same time specifies the settlement and typological rules necessary for the application of the simplification rules for the landscape authorization of the widespread interventions (in accordance to the Presidential Decree No. 31 of 13 February 2017).

In such a scenario, the fossil fuel generation systems currently in operation would progressively change their role from the basic production to the management of RES plants inputs, ensuring the safety and stability of the system. Through a coordinated plan, shared with local operators, the same power plants with diesel generators could be subject to significant interventions to improve plant efficiency that can guarantee maximum environmental sustainability.

Renewable energy plants that can be used immediately and effectively because they are based on mature and consolidated technologies, are mainly photovoltaic and wind power plants. To offer an effective contribution to energy needs the two sources (both intermittent) must be combined and integrated with each other.

With regard to emerging RES, such as oceanic resources and low and medium enthalpy geothermal energy, their use should be considered case by case depending on local resources. It will also be considered the possibility of realizing small biomethane plants in some islands produced from organic fraction in anaerobic plants.

However, the penetration path of renewable sources must necessarily be calibrated to ensure the stability of the network, also taking into account the high seasonality of consumption.

Integrated and innovative projects must be designed according to the climatic, environmental and landscape specific to each island features. In order to determine the conditions for a correct integration in the landscape of plants powered by renewable sources that can guarantee a significant contribution in terms of energy production, the following actions are necessary:

- identifying strategic areas where the largest and most powerful measures integrated with storage systems can be concentrated, to cover basic consumption;
- involving RES energy production plants in existing production areas, in the areas occupied by current power plants, in port docks, in airports and heliports; in technological systems and desalination plants;
- identifying a multiplicity of widespread interventions both in public and private sectors; proposing renewable energy plants with integrated projects aimed to redevelop public space involving buildings and existing areas, car parks, street furniture, public lighting, etc.
- enhancing the built-up areas for the installation of diffused systems designed for self-consumption, integrated with storage facilities connected to charging systems to promote electric mobility.

The true energy transition, set according to the criteria described above, was reached on El Hierro island, the smallest of the Canary Islands, a biosphere reserve, which represents a model in terms of coherence between energy management and conservation of the environment and landscape.

With a territory of 269 square kilometres and its 11,000 inhabitants, El Hierro has an area that is three times greater than the largest Italian small island, Pantelleria, and by inhabitants it is comparable to the two most populous Italian islands: Capri and Lipari.

Since the end of 2013, El Hierro has been the first energy-isolated area in the world able to feed itself entirely from renewable energy. For the first time, the traditional problem of the intermittency of renewable energy is overcome by combining the energy production of a wind farm with a hydraulic storage system.

The hydro-wind system consists of a wind farm (11.5 MW), two water basins, a pumping unit, a hydroelectric plant and a sea water desalination plant.

The wind farm supplies electricity directly to the grid and the excess energy feeds the pumping unit that lifts the water to a higher basin that works as an energy storage system. The plant uses the potential energy stored, ensuring the power supply and the stability of the network.

El Hierro energy sustainability strategy aims at electric self-sufficiency, bets on the generalization of electric vehicles and alternative transport systems, on the effective desalination of seawater by increasing water resources also for use in agricultural irrigation; promotes domestic solar thermal systems, widespread photovoltaic microgeneration, exploitation of biomass resources and, in particular, supports an effective energy saving campaign.

El Hierro demonstrates that through a strategic overview and the implementation of a single innovative quality project, it is possible to achieve energy self-sufficiency by using renewable energy sources, including fragile and valuable landscape contexts.

Furthermore, in contrast to the widespread opinion that wind, photovoltaic and hydroelectric plants threaten tourism development, in El Hierro a highly successful tourism model based on innovation, technology, sustainability, environment and landscape able to attract new types of aware visitors has been developed.

In conclusion, we can say that only through a strategic and culturally evolved approach, the energy transition in the small Italian islands can be achieved by combining the implementation of energy production interventions with the protection and enhancement of landscape and environment.

Wind farm in El Hierro, island of the Canary Archipelago

Chapter 10

ENERGY TRANSITION IN SMALL ITALIAN ISLANDS: EXPLOITING THE WIND ENERGY SOURCE PROTECTING BIODIVERSITY AND LANDSCAPE

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Nowadays, the climate crisis is undoubtedly considered one of the greatest global challenges of this century. Due to data published by the scientific community, policymakers are planning new strategies and regulations to increase renewable penetration in the energy mix to reduce the use of fossil fuels and thus greenhouse gas emissions. This is happening at all scales of action: from the regulations produced by the supranational institutions such as the European Parliament, through the enactment of the implementing Decrees of the European Directives, up to the development of regional and municipal laws aimed to facilitate the energy transition.

Driven by the results attained by the international scientific community, wind power, together with other renewable energy sources and energy efficiency, has been selected by the main world organizations, as well as the European Union, as an effective action to face climate change and attenuate it and other environmental impacts. Those institutions have bet on this technology to counteract the environmental impacts, to increase citizens' safety and to avoid the economic and political repercussions due to energy dependence on foreign countries.

The development of renewable sources, such as wind power, which represent a valid answer to the serious environmental threats due to greenhouse gas emissions caused by the energy supply, promote the protection of biodiversity and the protection of natural habitats and flora.

On the other hand, the regulatory framework imposes several restrictions as regard the installation of renewable energy plants for environment and landscape protection. This are particularly accentuated in small islands, thus generating a paradoxical condition in the Italian context; indeed, currently, it is practically impossible to install certain renewable energy plants, such as wind turbine generators, regardless of the evaluation and quantification of impacts any plant would entail. The decision whether or not to authorize the construction of a plant should be taken against an evaluation of a pool of experts and not independently of it; this is especially true when dealing with plants that have positive impacts on the environment due to the avoided greenhouse gas emissions and other pollutants. Additionally, it must be considered the wind farm installation reversibility besides the limited life span of a plant, as well as the rate at which new renewable technologies are maturing towards market competitiveness.

The energy transition has proceeded faster than anyone would have ever imagined, especially for technologies like wind turbines and photovoltaics, and it is now foreseeable that new technologies will enter the market in the next decades, starting from blue energy, e.g. floating wind offshore and wave energy.

As specified in the Italian Integrated Energy and Climate National Plan (PNIEC), Italian 2030 objectives will be achieved almost entirely thanks to the contributions of photovoltaic and onshore wind power, while at the same time, it will be necessary to develop new emerging technologies so as to become competitive on the market in the near future.

In other insular contexts, quite similar to those of the Italian small islands, such as Tilos Island in Greece, an 800 kW wind turbine was installed, with a diameter of 59 meters and a hub height of about 60-70 meters (Figure 10.1). Additionally, a storage system was also designed and installed.

Figure 10.1 800 kW wind turbine and storage system installed on the island of Tilos in Greece

A similar layout would be practically impossible in small Italian islands due to regulatory constraints, and to the negative opinions that will be probably get from the Superintendence delegated to decide for the project authorization.

Instead, the island of Tilos managed to obtain all the required authorizations to start the installation and it has even been rewarded by the European Commission in 2017 the Sustainable Energy Award as Energy Island.

This chapter will present a summary about the two main types of impact related to wind power plants: environmental impact by means of nature and biodiversity preservation, integrated on the avifauna and chiropteran fauna, and the landscape impact.

10.1 Environmental aspects and biodiversity protection

In agreement with the European Commission (2010), the impacts caused by a wind farm must be assessed case-by-case according to the species involved. The European Union underlines how the loss of few individuals can be insignificant for some species, while it can become significant for others, especially those listed as "threatened" in the IUCN red list (International Union for the Conservation of Nature). Indeed, the European Commission guidelines propose to analyse the availability of alternative habitats nearby also considering the impacts related to habitat loss and changes in population area (possibly due to noise), to assess the significance of the impacts. This does not mean that it is not necessary to study the local environmental impact of wind turbines to minimize the possible repercussions on the surrounding environment and on the biodiversity both at the regional and local scale.

Regarding the effects on flora and fauna connected to the development of wind turbine generators, ISPRA (formerly APAT, 2006) writes: "The only effect that has been encountered is the possible impact of birds with the turbines rotor. However, the number of birds died in rotor collision is lower than that caused by cars and light or telephone poles accidents". Although in line with what ISPRA has affirmed, in order to protect local and global biodiversity, it is necessary to holistically analyse the potential problems related to environmental impacts, also considering possible interactions of wind turbines with avifaunal populations and other species, as well as the fragmentation of natural habitats. In any case, the importance of each different impact, depend on several factors (once again, underlining the need for a detailed analysis and evaluation for each project): geographical context in which the plant is inserted, individual generators location, wildlife populations structure, use of the habitat by the local fauna, flight modes and activity for bird species and bats (Barrios & Rodriguez 2004; Drewitt & Langston 2006; Madders & Whitfield 2006; Kunz et al. 2007; Arnett et al. 2008).

Another fundamental factor is the presence of protected species or habitats at local or international level. Indeed, the scientific methodology, which has been outlined decades ago within the "conservation biology" field, aims at safeguarding the biodiversity in terms of species and intraspecific genetic diversity. Those assessments should not be based on sentimental or aesthetic issues, which were in fact the milestone of the first conservation interventions and movement, but today too often are still the main driver in the planning of conservation strategies overcoming the scientific reasons. Instead, the scientific approach is based on the evaluation of damages (death of individuals, alteration of the Habitat use, etc.) and how those will affect the species conservation at global and local level. Regarding the wind farms installations in the most critical areas (from an environmental point of view), i.e. those in which species or ecosystems are most at risk, the designers should refer to the European Commission guidelines for the development of wind farms in the Natura 2000 Network. Special attention must be paid to the SCI (Sites of Community Importance) and SPAs (Special Protection Areas), set up precisely because they contain habitats, animals and plant species that are considered priorities by the Member States of the European Union, pursuant to the Community Habitat Directives (92/43/EEC) and Birds (2009/147/EC, 79/409/EEC).

However, although these areas contain priority habitats and bird species that are protected at the European Community level, the guidelines of the European Commission do not exclude the possibility to build wind farms. Instead, they recommend evaluating the project feasibility case by case, because the development of well-designed wind farms do not generically represent a threat to the conservation of biodiversity. Contrarily, local biodiversity can benefit of their presence, as reported in some Scottish wind farms. In any case, the mortality of birdlife due to collision with wind turbines is only 0.01% of the total[8] (Erickson et al., 2005). Therefore, wind generators do not fall among the major causes of human-induced action which must be revised to prevent bird mortality.

ANEV (Italian National Wind Energy Association) and Legambiente (national leader in environmental protection and promotion of energy from renewable sources), with the active collaboration of ISPRA (Higher Institute for Environmental Protection and Research), established The National Aeolian and Fauna Observatory in 2011. The Observatory was instituted to strengthen environmental protection and, at the same time, to promote the conscious development of wind farms on the Italian territory.

The Observatory activities have led to the drafting of a Monitoring Protocol, containing technical-scientific indications to plan and carry out monitoring activities. The observing activities of birds and bat adjacent the wind farms, must be done before and after the installation. Therefore, "The Monitoring Protocol" proposes a scientific methodology that can be used on the Italian territory to estimate, from a qualitative and quantitative point of view, the possible impacts of wind power on birdlife and bats.

The protocol aims to produce a guide to the implementation of these interventions to mitigate and/or compensate their effects. Furthermore, to guarantee the scientific validity of data, it is necessary to carry out measurements using standardized conventions, which must be drawn up and approved by scientifically prepared personnel.

Hence, the criteria and methodologies reported in the Protocol have been proposed and assessed within a Scientific Committee set up by the Observatory, which involved ISPRA experts.

[8] On 10,000 dead birds, only 1 is caused by wind turbine generators; furthermore, the "American Bird Conservancy" states that only the 0.088% of birds deaths are caused by wind turbine generators over the 500 million that are killed every year by domestic pets.

The results were shared with academics and industrial personalities who offered their know-how to the initiative. The sole purpose was to obtain a final product based on the most accredited scientific methods recognized internationally.

Moreover, the WWF (2006) has published a Report where, based on more than 200 scientific papers, notes massive impacts of climate change on birdlife in every part of the globe, highlighting how scientists have found birds populations in decline up to 90% or with total reproductive failure regardless of wind farms presence.

The IUCN in 2008 reinforced the alarm, declaring climate change the leading extinction cause for eight bird species. Therefore, to conserve bird species (and biodiversity), urgent action is needed to strengthen the implementation of strategies, such as the development of wind and other renewables, which will mitigate the current levels of greenhouse gas emissions.

10.2 Wind turbine generators and landscape

As discussed in the present chapter, the analysis of the repercussions on environmental protection connected to the installation of wind turbines aims mainly at the conservation of biodiversity and at the preservation of plant and animal species, ecosystems and natural habitats.

Otherwise, as explained in the rest of this chapter, landscape protection is based on aspects that are much more anthropocentric than ecological. Since the concept of landscape is associated with how man perceives a given territory, natural and man-made components, particular importance is given to historical-cultural aspects of the area, and to how the territory was remodelled over time according to the population necessities. According to the words of the philosopher Ritter, the landscape is to be considered as the result of the metamorphosis caused by human to adapt natural and artificial environments to his needs. The landscape is also evaluated considering aesthetic, emotional, historical and spiritual parameters that have nothing to do with ecology.

In fact, in Italy, it is quite easy to find areas that are subject of landscape constraints that, from an ecological-environmental point of view, are not considered of great importance. On the other hand, there are natural habitats that host protected species or species characterized by high biological productivity, such as the numerous wetland marshes protected by the Ramsar Directive, which do not receive the deserved attention from the landscape conservation policy because of their low historical and cultural relevance. For instance, a wind farm in the heart of the Chianti hills would involve an alteration of the local landscape, but it would not affect biodiversity conservation as also confirmed by the definition of landscape provided by the European Landscape Convention previously exposed. Therefore, the landscape preservation, compared to the ecological-environmental protection, is based on more subjective perceptive parameters, changeable over time and difficult to base on quantifiable data by scientific studies. In any case, the presence of a wind farm, being temporary, does not cause irreversible changes to the landscape, but only during the time when the wind turbines are producing clean energy. These changes to the landscape can be significant and welcomed. The change perception varies according to wind turbines placement, the territorial context where they are located. In addition, the strong elements of the subjectivity of individuals can affect the awareness of the installed technology. It often happens that the same wind farm is considered an added value to its territory and a positive landscape innovation by a part of the population, while the other part sees it as an intrusion into the same landscape.

According to Battistella (2010), professor of landscape design, the conflicts created by wind farms installation are generated by a substantial inability to interpret the landscape as a dynamic element; wind farms are able to build new landscapes with a strong dignity, representative of the values of our age; indeed, the landscape evolves continuously, and the wind farms represent, in some ways, a further evolution of the Italian landscape of these times. Finally, regarding land use, wind power is the energy source that occupies less territory (Serrecchia, 2010), leaving the possibility of not varying the end-use of the nearby soil, whether it concerns agricultural plots or areas destined to sheep farming.

In order to minimize the impact on the landscape, the Italian Ministry of Cultural Heritage and Activities (Di Bene & Scazzosi, 2006) has published the guidelines for the insertion of wind farms within the landscape, in response to the ratification by the Italian government of the European Landscape Convention. Concisely, among all the methods recognized for minimizing the wind farm landscape impacts, there is the analysis of landscape variations by estimating the alteration of the view emerged before and after the installation, employing photo simulations to estimate the *ex post*.

Furthermore, to broaden the wind farms landscape integration, ANEV, Legambiente and Greenpeace have signed a Memorandum of Understanding for the promotion of wind energy in Italy and its proper integration into the landscape.

10.3 Other potential impacts: noise and electro-magnetic issues

According to RSE (Ricerca Sistema Energetico, 2011), the company controlled by the GSE for energy research activities, the constant technological advances recorded both as individual components and as integrated systems, as well as the soundproofing of the spacecraft containing some of the noise source elements, made the actual acoustic impact tolerable. Therefore, at 200 meters, the noise produced by the turbine (of 40-50 dB) is noticeably not very distinguishable from the usual windy area background noise. On the other hand, most of sites are in rural areas with low population density, which provided to affirm the scarce relevance of the disturbance to public peace. Analysing the electromagnetic disturbances, the RSE (2011) sustains low-frequency electromagnetic interference (50 Hz industrial frequency) is of minor relevance. Those frequencies essentially concern interference with radio waves and are determined by the wind turbine electrical components and, however, the effects are lower than those due to the installation of radio, television and telephone antennas or those caused by power lines. In any case, these values are always below the current legislation limits. Nonetheless, turbines are shielded to limit electromagnetic pollution.

Conclusions

The construction of renewable energy power plants in small islands, not only wind turbines, represents a particularly arduous challenge that cannot be solved by setting unconditioned bans. Everyone must try to guarantee energy independence from fossil fuels, while respecting the characteristics and peculiarities of each territory. It is necessary to give to every small island the chance to develop its own strategy and an action plan, agreed with the Superintendence and other competent institutions, to pursue energy self-sufficiency by means of renewable sources.

Such action plans will certainly consider the grid modernization, storage systems, but also an energy source that is not limited to the exploitation of a single technology (i.e. diversification). The installation of photovoltaic only, is certainly not enough to obtain significant electricity percentages of renewables penetration, principally due to the scarce land availability that characterizes most of the small islands.

Nowadays, no Italian island exceeds 6% of the electricity demand supplied by renewable energy sources, except for Capraia. In this latter, there is a plant fuelled with biodiesel, although it derives from an importation of processed soy oil, sunflower, and rapeseed.

Finally, it is noteworthy that the Ministerial Decrees support the penetration of renewables in small islands also including those currently interconnected to the national electricity grid. This will enable not only to limit the phenomenon of blackouts but above all, it will give the possibility to these territories to take their part to the national and global energy transition, producing the thermal and electrical energy they need, locally and from a clean source.

Ultimately, environmental protection, climate change fight and landscape protection are shared objectives that must be conquered synergistically with an inclusive and multidisciplinary approach. Avoiding, what unfortunately is happening today, to allow to a single objective to limit the pursuit of others, with the refusal to build wind farms in small islands due to the current landscape constraints.

Therefore, it is necessary to work cohesively towards the planning of specific solutions for each individual small island, starting from a fruitful interaction with Superintendences. This latter should incorporate in their plans the crucial change-taking place, without sacrificing the beauty of the territory. Nonetheless, they should encourage the installation of renewable energy plants well integrated in the local context.

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Chapter 11

RENEWABLE ENERGY SOURCES IN THE MINOR ISLANDS: EXPERIENCES

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Small Islands energy situation presents critical elements that could be largely removed by abandoning the electricity production plants based on old and polluting diesel power plants. Nevertheless, it is necessary to take advantage of the potential offered by renewable sources that can contribute to completely changing the current energy scenario.

Small islands are considered an ideal laboratory for testing new technologies and new strategies aimed at increasing the penetration of renewable energy sources (RES) into energy production systems (Italian Ministerial Decree of 14 February 2017 concerning the renewable sources in the not connected islands). The development of RES, as demonstrated by experiences already successfully launched in other territorial realities (some of these experiences are described in Chapter 8), can have extremely positive repercussions also from an economic and social point of view, especially in the islands context.

The recognised Italian small island municipalities are 35 in total, many of which are not connected with the national electricity grid. In Table 11.1, for each of those islands the following data are presented: data related to the surface area, resident population (Source: istat.it - Resident population as of 1st January 2019), electricity produced and the power source of the plants currently in operation (data from Legambiente - Sustainable Islands. Energy, Water, Circular Economy, 2017) are summarised.

Table 11.1 Current status of 20 small Italian islands not connected to the mainland electricity grid

Islands	Municipality	Province	Area [km^2]	Population	Power Plant Fuel	Production [MWh]
Capri	Capri, Anacapri	NA	10.9	14,121	Diesel	4,700
Capraia	Capraia Isola	LI	19.3	405	Biodiesel	2,760
Isola del Giglio	Isola del Giglio	GR	21.5	1,439	Diesel	10,300
Pantelleria	Pantelleria	TP	83.0	7,759	Diesel	44,170
Lampedusa	Lampedusa and Linosa	AG	20.2	6,565	Diesel	37,660
Linosa			5.4		Diesel	2,800
Favignana	Favignana	TP	19.3	4,351	Diesel	15,470
Marettimo			12.4		Diesel	2,040
Levanzo			5.8		Diesel	600
Ponza	Ponza	LT	7.6	3,366	Diesel	11,500
Ventotene	Ventotene		1.4	775	Diesel	2,700
Ustica	Ustica	PA	8.2	1,307	Diesel	4,870
Tremiti Islands	Tremiti Islands	FG	3.2	490	Diesel	3,920
Lipari	Lipari	ME	37.6	12,819	Diesel	34,800
Vulcano			21.0		Diesel	7,280
Stromboli			12.6		Diesel	3,870
Panarea			3.4		Diesel	3,170
Filicudi			9.3		Diesel	1,400
Alicudi			5.1		Diesel	400
Salina	Leni, Malfa, Santa Marina Salina	ME	26.2	2,556	Diesel	9,160

Table 11.2 RES coverage in 20 small Italian islands not connected to the mainland electricity grid

Island	Archipelago	RES penetration [%]
Capri	Campanian	0.35%
Capraia	Tuscan	0.78%
Isola del Giglio		0.45%
Pantelleria	Pelagie	2.12%
Lampedusa		0.48%
Linosa		
Favignana	Egadi	2.24%
Marettimo		
Levanzo		
Ponza	Pontine	1.39%
Ventotene		5.11%
Ustica		4.46%
Tremiti Islands	Tremiti	0.64%
Lipari	Eolie	1.07%
Vulcano		
Stromboli		
Panarea		
Filicudi		
Alicudi		
Salina		0.00%
Average		**1.59%**

Table 11.2 describes the current situation of small Italian islands concerning the RES penetration in electricity total consumption. The RES penetration over the electricity demand was calculated by relating the theoretical producibility of the electrical RES with the annual production from fossil sources, as extrapolated from Annex I of the MiSE (Italian Ministry of Economic Development) Decree of 14 February 2014. The RES data refer to the individual Municipality. In the case of islands comprising more Municipalities, the data has been aggregated.

Although some islands have promising daylight and wind potential, the RES installations are among the lowest at national level.

Despite the fact that in all the small Italian islands the RES production - according to all the most recent scientific studies - could be particularly high, the electricity consumption coverage from RES never rise to 6% when, in the rest of Italy, this value exceeds 32%. A specific situation is represented by the island of Capraia where a large biomass plant was installed to produce electricity that is able to cover the entire island demand. However, the effect cannot be considered completely renewable since the biomass is entirely transported from the mainland, which imply a considerable energy consumption with additional costs and emissions.

To date, the small Italian islands could take advantage of some important opportunities offered by the Decree of the MiSe, approved in February 2017, concerning the promotion of renewable sources in these territories (see Chapter 7).

Table 11.3 lists the objectives set by the small Italian islands Decree.

Table 11.3 MiSE decree, small Italian islands 2020 objectives

Island	RES power objective [kWe][1]	Thermal Solar Surface objective [m^2] [2]	Fossil fuel reduction in electric production objective[3]
Capraia	180	250	50%
Isola del Giglio	700	780	50%
Ponza	720	870	50%
Ventotene	170	200	50%
Tremiti*	240	290	50%
Favignana	900	1.070	50%
Levanzo	40	40	50%
Marettimo	120	150	40%
Pantelleria	2,720	3.130	40%
Ustica	280	370	40%
Alicudi	20	20	30%
Filicudi	80	90	20%
Lipari	2,110	2.520	20%
Panarea*	130	200	20%
Salina	580	570	20%
Stromboli*	220	250	20%
Vulcano*	300	470	20%
Lampedusa	2,140	2.370	20%
Linosa	170	210	20%
Capri	1.000	4.850	20%

Source: Legambiente; elaboration on Annex 1 of the MiSE Decree 14.02.2017, published in the Italian Official Journal of 18.05.2017

NOTES

[1] The types of power plants contributing to the purpose are not defined (technological neutrality). The new installations are counted, including the electric charging stations, the plants already in construction, the upgrades of existing plants, the systems integrated into new buildings or major renovations (art. 11 Legislative Decree No. 28/2011) and reactivations of existing plants.

[2] To achieve this objective heat pumps are included only if they replace electric water heaters.

[3] This objective is valid only if two innovative integrated plants are installed as described in Art. 6.

* The objectives for the islands of Panarea, Vulcano, Stromboli, and Tremiti have been established at a more contained level because there are concerns about system safety due to the high difference between the winter and the summer load.

Table 11.4 Mean solar radiation values and related electricity producibility in small Italian islands

Island/Archipelago	Annual mean solar radiation [kWh/m^2/y]	Daily mean solar radiation [kWh/ m^2/d]	Electric producibility [kWh$_{el}$/kW$_p$/d]
Isola Palmaria	1,750	4.80	1,330
Capraia	1,880	5.14	1,420
Elba	1,760	4.82	1,310
Giglio	1,910	5.24	1,440
Arcipelago di La Maddalena	1,970	5.39	1,460
Asinara	1,950	5.36	1,470
Isola di San Pietro	2,080	5.69	1,560
Sant'Antioco	2,080	5.70	1,560
Ponza	1,990	5.44	1,490
Ventotene	1,970	5.40	1,480
Ischia	2,000	5.47	1,510
Capri	1,900	5.20	1,410
Procida	1,980	5.42	1,480
Eolie	2,130	5.83	1,630
Egadi	2,040	5.59	1,530
Pantelleria	2,110	5.77	1,570
Lampedusa	2,210	6.05	1,650
Ustica	2,090	5.73	1,580
Tremiti Islands	1,910	5.22	1,430

The above-mentioned objectives are considered easily achievable given the high RES potential, especially in terms of solar radiation as shown in Table 11.4.

The highest values are found in the southern islands where a value of 2000 kWh/m^2/y is reached. It leads to a yearly electricity production of more than 1500 kWh$_{el}$/kW$_p$/y.

In Table 11.5, the wind speed and producibility data for the 19 non-interconnected small Italian island that have been analysed are described.

Table 11.5 Mean wind and producibility values in the 20 small Italian islands for different heights above the ground

Island Archipelago	Annual mean wind speed at 25 m [m/s]	Producibility at 25 m [kW_h/kW/y]	Annual mean wind speed at 50 m [m/s]	Producibility at 50 m [kW_h/kW/y]	Annual mean wind speed at 75 m [m/s]	Producibility at 75 m [kW_h/kW/y]
Isola Palmaria	5.5	1,750	6.0	2,000	6.5	2,250
Capraia	6.5	2,500	7.0	2,750	7.5	3,000
Elba	6.0	2,000	6.5	2,500	7.0	>4,000
Giglio	6.0	2,000	7.0	2,500	7.5	3,000
Arcipelago di La Maddalena	8.0	3,500	8.5	3,750	9.0	4,000
Asinara	6.5	3,000	7.0	3,250	8.0	3,750
Isola di San Pietro	7.5	3,750	9.0	4,000	10.5	>4,000
Sant'Antioco	8.0	>4,000	9.5	>4,000	10.5	>4,000
Ponza	5.0	2,000	5.5	2,250	6.0	2,500
Ventotene	4.0	1,250	5.0	1,750	5.5	2,000
Ischia	5.0	2,000	6.0	2,400	7.0	2,500
Capri	5.0	2,000	6.0	2,500	7.0	2,750
Procida	5.0	1,750	5.5	2,000	6.0	2,250
Eolie	6.0	2,500	7.0	2,750	8.0	3,000
Egadi	6.0	2,750	7.0	3,000	7.5	3,250
Pantelleria	8.0	3,500	8.5	3,750	9.	4,000
Tremiti Islands	6.5	2,500	7.5	3,000	8.0	3,250
Ustica	6	2,500	7	2,750	7.5	3,000
Lampedusa and Linosa	-	-	6	2,750	-	-

Table 11.6 shows the power and technologies from renewable sources currently installed in the 20 small Italian islands that are not connected to the mainland grid. The use of thermal RES is still extremely limited. Until now, the only source used is solar thermal (solar collectors).

Table 11.6 shows the installed surfaces (in square meters) per island. The data relating to the use of heat pumps for winter air-conditioning are not currently readily available.

Lastly, it should be pointed out that most of the islands with a desalination plant for water supply, as already mentioned in Chapter 6, continue to cover their water requirements mostly by means of ship delivery especially in summer. For cost-benefit reasons, in fact, the desalination plants have been designed based on winter consumption and are not able to cover summer loads.

An increase in RES production and in the capacity of storage reservoirs could give the possibility of accumulating drinking water produced with excess energy from RES during the winter season, which could cover the increase in demand during the tourist season. To make a faster transition to renewable sources, new energy and environmental policies, more sensitive to these challenges, are needed.

Table 11.6 Installed RES and renewable penetration in the 20 small Italian islands not connected to the mainland

Island	Photovoltaic [kWp]	Wind [kW]	Biofuels [kW]	RES, electric penetration [%]	RES, thermal solar [m^2]
Favignana	123.00			1.07	
Giglio	35.00	6.0		0.57	10.0
Tremiti	18.00			0.63	
Capri	12.00			0	118.9
Lampedusa	69.00			0.26	55.1
Levanzo				0	
Linosa				0	
Lipari	304.00			1.18	79.9
Marettimo				0	
Pantelleria	470.00	32.0		0.81	28.8
Ponza	11.00	0.6		0.14	28.8
Alicudi				0	
Filicudi				0	
Panarea				0	
Salina				0	4.0
Stromboli	100.00			3.48	
Ustica	29,33			0.94	
Ventotene	47,15			2.70	
Vulcano	183.00			3.39	
Capraia			2788 (el)	-	

An opportunity could be linked to the contribution coming from the landing tax on the islands. In fact, the Italian Law 221/2015 has established, for travellers who land on small Italian islands, the obligation to pay the "landing contribution", a form of environmental taxation to replace all the tourist tax normally applied by Municipalities on the mainland.

The revenues must be destined to finance and support the collection and disposal of waste, recovery and environmental protection, as well as for social interventions.

However, these resources could also be used for development and transition to renewable sources. Table 11.7 shows, for the individual Municipalities, the amount of the contribution introduced, the revenue and its intended end use, reconstructed through a questionnaire sent to the Municipalities.

However, the desired increase in the use of energy from renewable sources must be accompanied by interventions aimed at improving energy efficiency, capable of reducing the electricity needs while offering the same services, through an infrastructure development, using technologies that allow an active management and optimization of energy flows.

Table 11.7 Landing contribution: contribution value per person, yearly revenue and end use

Municipality	Landing contribution per person [€]	Revenues [€ /year]	End use
Anacapri	2.50	NA	The revenue deriving from the application of the Landing Contribution is intended to finance waste collection and disposal interventions, recovery interventions and environmental protection, as well as interventions and activities concerning tourism, culture, local police, and mobility.
Capraia	1.50	20200	Waste collection and disposal interventions and environmental recovery and protection measures.
Capri	2.50	NA	The revenue deriving from the application of the Landing Contribution is intended to finance waste collection and disposal interventions, recovery interventions and environmental protection, as well as interventions and activities concerning tourism, culture, local police and mobility.
Favignana	2.50 toward Favignana; 1.50 toward Levanzo e Marettimo	NA	The revenue deriving from the application of the contributions is intended to finance waste collection and disposal operations, recovery, and environmental protection interventions as well as interventions in favour of tourism, culture, local police and mobility in the island.
Giglio	1.50	NA	The revenue raised will then be allocated in proportion to landings, to implement interventions in individual islands: collection and disposal of waste, environmental enhancement, maintenance, cultural promotion, events.
Lampedusa e Linosa	1.50 from 01/01 to 30/05 and from 01/10 to 31/12; 3.00 from 01/06 to 30/09	NA	The revenue from the application of the Landing Contribution is intended to finance recovery and environmental protection interventions and then interventions in favour of tourism, culture, local police, mobility and waste collection and disposal.
Leni	None	NA	
Lipari	2.50; 5.00 from 01/06 to 30/09	NA	The revenue deriving from the application of the Landing Contribution is intended to finance interventions for the collection and disposal of waste, restoration and environmental protection, as well as interventions and activities concerning tourism, culture, local police and mobility in the Minor Islands.
Malfa	2.50; 5.00 from 1/06 to 30/09	76.68	Culture.

Municipality	Landing contribution per person [€]	Revenues [€ /year]	End use
Pantelleria	2.50 from 01/01 to 30/06 and from 01/09 to 31/12; 5.00 from 01/07 to 31/08	NA	The revenue from the landing contribution and the contribution for access to areas regulated near active volcanic phenomena, is intended to finance interventions with the following priorities: recovery and environmental protection and tourism interventions, culture, local police, mobility and waste collection and disposal operations.
Ponza	2.50	NA	The revenue deriving from the application of the Landing Contribution is intended to finance waste collection and disposal interventions, recovery interventions and environmental protection, as well as interventions and activities concerning tourism, culture, local police and mobility.
Santa Marina Salina	2.50 from 01/10 to 31/05; 5.00 from 01/06 to 30/09	120000 (forecast)	Tourist services such as opening the museum circuit and information points, cleaning services, increasing separate waste collection, cleaning beaches, beach surveillance.
Tremiti	2.50	NA	NA
Ustica	2.50 In the case of secondary volcanism, the fee will be doubled	NA	NA
Ventotene	2.50	NA	The proceeds of this tax are destined for 20% in favor of the Marine Protected Area and for the remaining 80% to finance interventions in the field of tourism, including those in support of accommodation facilities, as well as maintenance, use and recovery of local cultural and environmental assets, as well as related local public services.

Chapter 12

EXAMPLES OF NATIONAL AND INTERNATIONAL COOPERATION ON SMALL ISLANDS AND IN THE "PINEROLESE" OIL FREE ZONE

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Introduction

This chapter will present some examples of cooperation between public institutions and industry in collaboration with small Italian islands. Many of those benefitted of national or international financing for research and development projects. The idea is to show some of the possibilities that can be applied to small Italian islands to start the desired energy transition and to use them as lighthouses for future projects and initiatives that will boost the national energy transition. Hence, the experiences of the island of Favignana, Procida, Giglio, Pantelleria and the island of Porto Torres will be shown.

Furthermore, it is considered appropriate to briefly describe the experience of Pinerolo and the Piedmont region. Indeed, Pinerolo represents the first Italian Energy Community and Piedmont is currently the only Italian region that allows the creation of this type of community. The importance of this case study relies in the fact that energy communities have been identified by the European Union as the future of our energy system. Those are based on the following concepts:

- distributed generation;
- smart and digitalised management of resources and loads; and
- citizen-centred energy systems.

This experience could be exported and replicated in the small Italian islands that, given the physical insularity, offer the perfect ground for establishing an energy community.

12.1 FAVIGNANA

12.1.1 The PRISMI Project– Promoting RES integration for Smart Mediterranean Islands

The PRISMI project, coordinated by Sapienza University of Rome, is a successful example of the potential offered by international cooperation funded by the EU for Research in the field of RES.

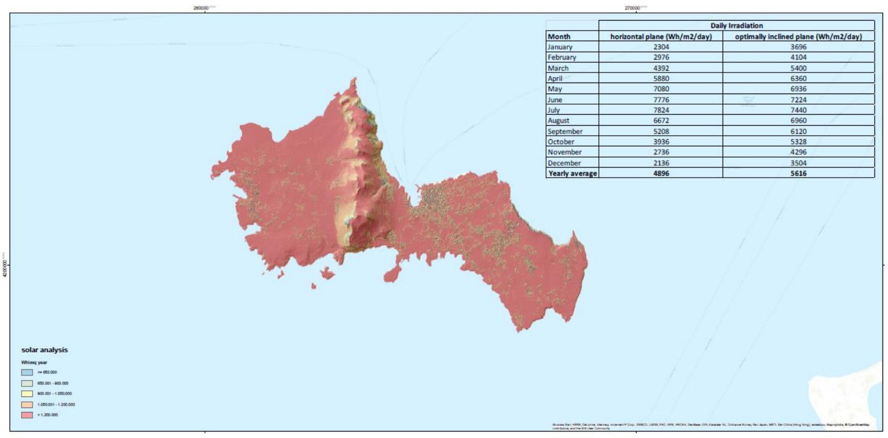
The main purpose of the project was to support the transition of Mediterranean islands towards a low-carbon, autonomous, clean and safe energy system through the development of an integrated and transnational approach to assess and exploit the potential of local RES. The developed methodology allows to estimate, map and promote the use of new hybrid systems that integrate RES, the latest storage systems and different demand response solutions (see Chapter 4 for further information on demand response) in order to increase the RES share thus contributing to the sustainable development in the Mediterranean area. The specific objectives of the project were 1) to develop an integrated "toolkit" for evaluating and mapping local RES 2) devise and analyse energy scenarios and technical-economic feasibility analysis related to the case study islands and 3) support the effective elaboration and implementation of SECAP (Sustainable Energy and Climate Action Plan). The supported procedure was then tested and validated on 6 case studies in 5 different Member States, the Italian case study was represented by the island of Favignana.

The methods and results obtained during the project will be briefly described below, referring to the website for a more exhaustive comprehension on the project (https://prismi.interreg-med.eu/).

12.1.2 Guidelines on methods for RES potential assessment and GIS database development

Guidelines have been developed for a comprehensive methodology tailored to Mediterranean islands. The process started from data collection necessary for energy analysis of the Mediterranean islands, different open source database was identified for this purpose. From the analysis, the solar data were found to be the most widely available, while data on tidal and wave energy usually come from secondary sources; whereas other data sources, such as geothermal energy, are not readily available. In particular, the project has noted a lack of availability of hourly wind speed data. To overcome this inadequacy, the PRISMI Wind Power Calculator was developed. This software allows to easily obtain wind power profiles and wind speed with an hourly resolution based on long and reliable historical data series offered by NASA.

A geo-referenced database was then created containing layers and thematic maps that show RES energy potential in the various islands (solar, wind, waves and tides) as well as information on environmental constraints and the currently used energy systems. Below, two of the thematic maps that have been developed for the island of Favignana are shown as example. To understand the real availability of the useful surface for the installation of photovoltaic systems on roofs, an analytical analysis was carried out and the useful surface was calculated to be 185,906 m^2, which is equivalent to a maximum of installable power equal to 26,558 kW_p.



	Daily Irradiation	
Month	**horizontal plane (Wh/m2/day)**	**optimally inclined plane (Wh/m2/day)**
January	2304	3696
February	2976	4104
March	4392	5400
April	5880	6360
May	7080	6936
June	7776	7224
July	7824	7440
August	6672	6960
September	5208	6120
October	3936	5328
November	2736	4296
December	2136	3504
Yearly average	**4896**	**5616**

a)

Monthly electric energy production in a typical year kWh	
January	905.082
February	879.408
March	902.041
April	935.144
May	1.188.024
June	1.672.640
July	2.483.946
August	2.782.944
September	1.886.880
October	1.097.768
November	791.040
Dicember	856.384
Annual	**16.381.301**

b)

Figure 12.1 a) Favignana solar potential,
b) Favignana electrical consumption and residential areas

12.1.3 Feasibility study for RES plants installation and comparative energy scenarios analysis and SECAP drafting

In second instance, detailed technical-economic analyses were carried out through the study of different scenarios to identify solutions that could be replicated in other Mediterranean islands. The aim of the analyses was the draft of a SECAP. During the project, there were developed:

- an approach for modelling energy scenarios, the tool identified for scenario simulation has been identified in EnergyPLAN;
- a tool for processing the EnergyPLAN results, to facilitate the interpretation for SECAP drafting;
- guidelines for data collection and SECAP development.

Guidelines to support the end-user were developed for each of the above-mentioned points. All the scenarios analysed the RES production diversification and the synergies between the energy and transport sectors. Concerning Favignana, the most interesting results are briefly reported. First, some information on the island's consumption is needed. Diesel consumption for maritime transport is 49,647.5 MWh/y. On the other hand, consumption related to land transport is lower, equivalent to 3,800 MWh/y for diesel and 5,500 MWh/y for gasoline. Electric consumption is 12,560 MWh/y while thermal consumption is only 3,410 MWh/y (2011 data). The scenarios that have been studied analysed the optimal size of RES generators on the island. To do this, scenarios were analysed by introducing solar collectors and heat pumps for domestic hot water and indoor heating and introducing electric mobility on the island. The new technologies introduced to cover the thermal load and land transport lead to an increase in electricity consumption due to the electrification of loads.

The electrification of thermal and transport consumption and the increased production from renewable give the results shown in Figure 12.2a (RES penetration on primary energy consumption of the whole island) and Figure 12.2b (RES penetration on electric energy consumption).

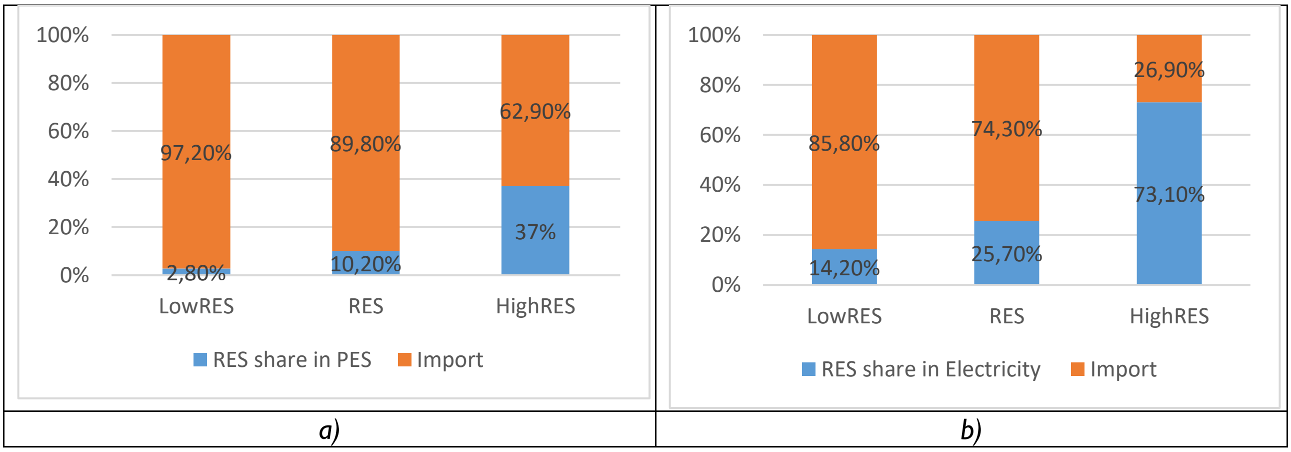


Figure 12.2 a) RES penetration in Primary Energy Consumption and **b)** RES penetration in electric energy consumption

Figure 12.3 shows the contribution that each technology provides in the different months of the year. It can be noticed the importance of diversification of generators technologies. Indeed, different technologies use different RES and have higher production in different seasons/months; thus, having diverse generators enables to have a flatter production curve along the whole year. It is worth mentioning the electric mobility importance especially when it can provide flexibility services for the network through the application of Vehicle-to-Grid (V2G) concepts.

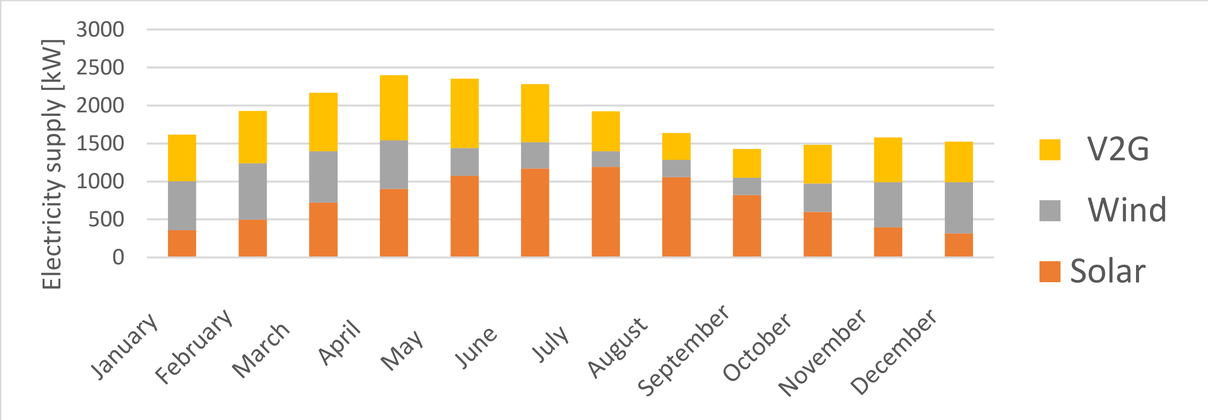


Figure 12.3 Different technologies monthly contribution in High RES scenario

Furthermore, a preliminary analysis was carried out to identify the number of new jobs that would be created by the installation and management of new plants. Table 12.1 shows the results.

Table 12.1 Equivalent number jobs created per installation, management and maintenance of the technologies

2030	Photovoltaic	Wind	Solar collector	Heat pump
LowRES	1	0	1	0
RES	1	0	1	5
HighRES	2	1	1	9

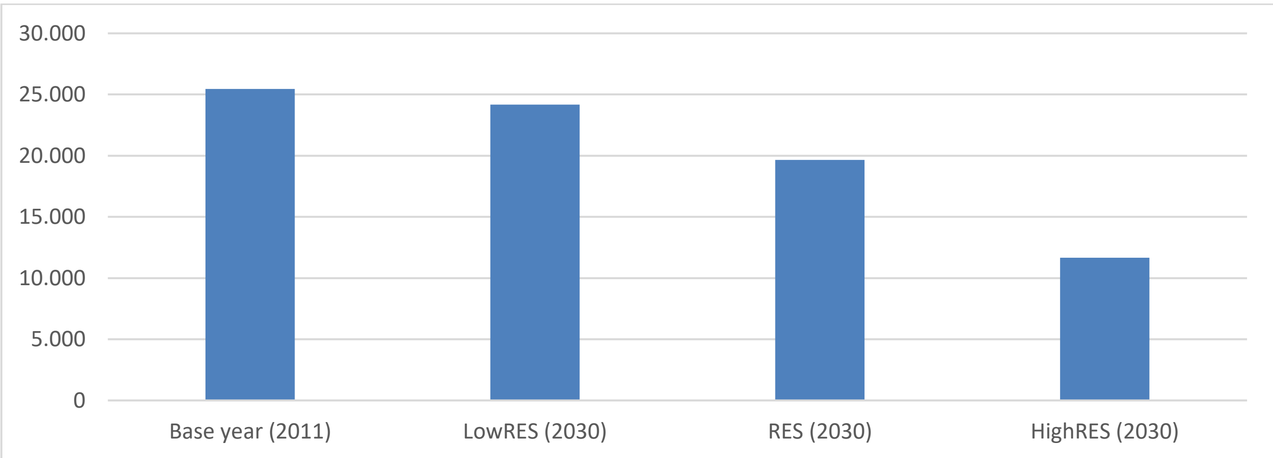


Figure 12.4 CO_2 equivalent emissions to 2030

Furthermore, guidelines have been developed to support the users in developing a SECAP. These guidelines can be of great help to all those local authorities, islanders or not, who want to approach the writing of a SECAP. Following the approval of the guidelines, all project partners developed a preliminary SECAP for each of the six studied areas. Therefore, an inventory of energy demand and emissions was carefully carried out and subsequently, thanks to the results obtained from the energy analyses, the actions to increase RES penetration and mitigate the effects of climate change were identified and evaluated.

Among the various measures proposed in the various case studies, several common points emerged among the studied Mediterranean communities. All SECAP aimed to 1) diversify production from RES using photovoltaic, biomass and wind; 2) increase building energy efficiency and lighting systems (both for interiors and for street lighting); 3) promote the use of electric vehicles, biomass in transport, bike sharing (including e-bikes), car sharing and alternative transport methods in general; 4) increase awareness and community knowledge.

12.1.4 SWOT analysis and citizens surveys

The SWOT analysis (Strength, Weakness, Opportunities, Threats) showed a very promising potential for RES in all studied areas in all areas of the Mediterranean. However, there are several difficulties both internally and externally that must be overcome for a complete implementation of feasible, but at the same time ambitious, energy plans.

Among these difficulties, regulatory confusion and cumbersome legislative conditions are the main obstacles that need serious efforts to be overcome, possibly also within the framework of the EU and not only at the level of individual countries (see Chapter 7 for deepening). Two surveys were developed, one addressed to the community and one to the stakeholders. Regarding the questionnaire addressed to the community, it emerged that most of the respondents have a medium knowledge level about RES and the specific situation of their country. Additionally, reported problems against the development of RES were identified in the funding scarcity (thus, citizens believe that more should be done to support RES) and also the legislative-bureaucratic structure is too complex and discourages investments.

12.2 Procida

12.2.1 GIFT experience – Geographical Islands FlexibiliTy

GIFT is an innovative project funded under the Horizon2020 programme. GIFT aims to decarbonise the European islands energy mix. It proposes innovative systems to guarantee the supply of a significant amount of renewable energy without creating problems to electricity infrastructures. Sapienza University of Rome and the Municipality of Procida are the only Italian partners within the consortium. Through the development of various innovative solutions, the GIFT project will increase the RES penetration in the islands' grids, thus reducing their need for fuels and therefore decreasing the emission of greenhouse gases. In the 4-year project duration, the partners will develop and demonstrate solutions in two islands, Hinnoya, the largest island in Norway and Procida, in Italy. The partners will also study the possibility of replicating these solutions on at least one Greek island and another Italian island, the island of Evia and Favignana, respectively. Overall, these islands, in terms of climate, energy mix, population and activities have been considered as places where it is possible to find solutions adaptable to different situations.

The project objectives are shown below:

- allow a high RES penetration

One of the most important project targets is to increase the RES integration in the various energy networks (electricity, heating and transport networks) in order to effectively decarbonise the energy mix. Indeed, the difficulties in integrating renewable energies into existing grids hamper the development of these energies and therefore the decarbonisation of the energy mix. The developments that will be implemented in the GIFT project concern the installation of various Energy Management Systems (EMS) and the development of multi-vector storage systems, specifically aimed at increasing the RES penetration in the grid. Also, GIFT will integrate a flexibility market system, managed by the Virtual Power System (VPS), which will allow a competition for flexibility services to be provided to the network (for example to solve congestion problems and therefore blackouts) or within an energy community to optimally manage energy fluxes. Moreover, the GIFT solution will integrate a distribution network management system with advanced monitoring of the network status, forecasting methods and functionality management and compatibility with the flexibility market.

- development of a georeferenced monitoring system for the electricity grid to better manage the flexibility demand through a flexibility market

The GIFT project will develop a GIS platform that will consent to model and, thanks to an innovative predicting model, forecast the energy production and demand. This will allow to have a better view of the network at any time, to identify any network congestions and to control the flexibility available to solve them. Based on this information, the EMS and the storage system will offer flexibility services that will be managed by the VPS that will select the most advantageous offers, thus transforming the network into a smart grid. GIFT will establish an (almost) real-time market system, which, similar to existing spot or intraday markets, will allow hundreds of DR (Demand Response) suppliers and consumers to negotiate localized and/or aggregate flexibility. The market system will allow different stakeholders to optimally exploit the available flexibility, thus opening new opportunities and business models. It will be shown how DSOs can benefit from prosumers flexibility for mitigating congestion problems in the distribution network in an economically and efficient way.

- develop synergies between electricity, heating, cooling, water and transportation networks

The GIFT project will deal with this objective dedicated to synergies through multi-vector storage that will connect the gas network, the electricity network and the thermal sector through a reversible Solid Oxid fuel cell (rSOC) capable of functioning as a Combined Heat and Power (CHP). Indeed, the storage system will use both a lithium-ion battery and the rSOC to store the excess energy in form of electricity and hydrogen, respectively. The accumulated hydrogen will be used subsequently, pure or in a mixture with gas, to produce electricity to be fed into the grid when necessary. Synergies will also be completed with the transport sector through the development of V2G solutions (both naval and land-based).

- guarantee the solutions sustainability and replicability in other islands

To be successful, the GIFT project will study the solutions replicability and scalability, which will be implemented in the demonstration sites and similarly in follower islands. Moreover, it will focus on the dissemination and exploitation of results, with the development of complete investment plans that will increase the potential replicability of the solutions.

12.2.2 The GIFT proposal

In this section, the principles that will be developed during the GIFT project will be briefly illustrated. The general connection between the different technologies can be described as shown in Figure 12.5.

The VPS is the centre of the global system, connecting the different actors, who are consumers and prosumers (Producers + Consumers) of electricity, with the BRP (Balance Responsible Parties) or the part responsible for balancing the network. The scheme also offers the possibility to identify the companies, enterprises and agencies involved along the supply chain and to assess the consistency of the entire system.

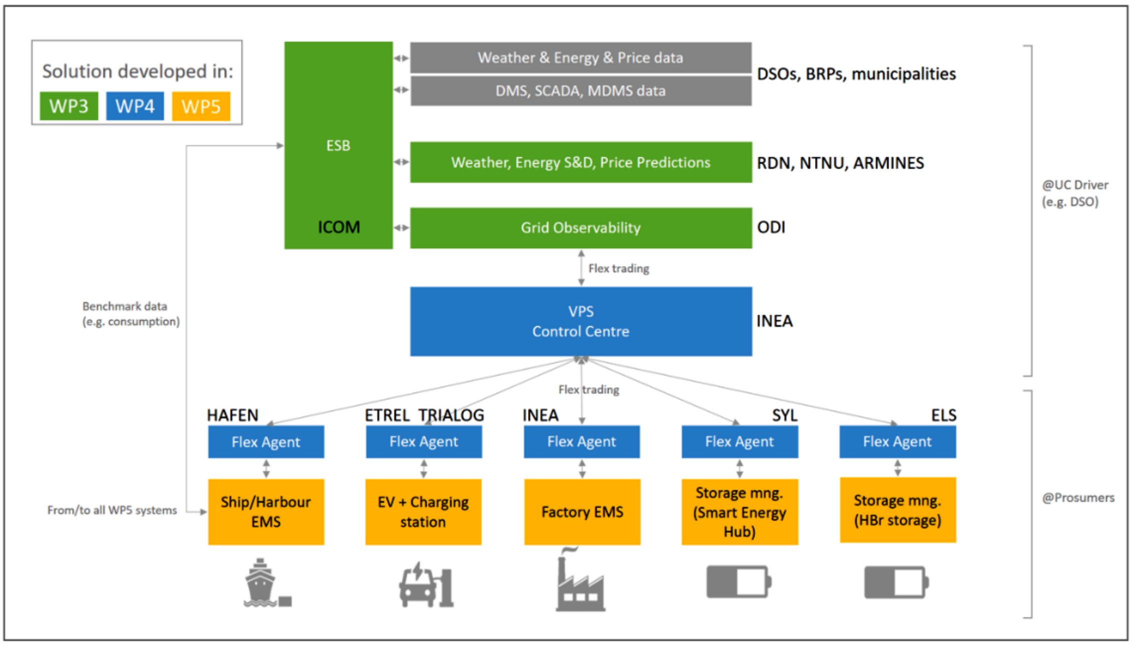


Figure 12.5 General structure of the concept of the project

Among the technologies and actors that are shown in Figure 12.5, only those described below will be implemented in Procida.

Grid observability**:** a software based on IoT (Internet of Things) technologies will be developed using data from smart meters and already existing data to build the distribution network virtual model that will be used for:

1. building and improving the distribution network map;
2. providing an estimate of the status (load and voltage) of each node and line of the network;
3. predicting the status (load and voltage) of each node and line according to the forecasts of consumption and production of electricity to organize a strategy to prevent congestions and blakcouts;
4. predicting the impact of new distributed energy resources (DER) and provide recommendations regarding the optimal placement and/or network reinforcement.

VPS (Virtual Power System): it is an automatic and decentralized demand response trading platform which connects the various players in the flexibility market, namely the flexibility providers (consumers, producers, prosumers, intermediaries such as aggregators) and receivers (BRP, DSO, TSO). The VPS has the role of analysing the DSO requests and assessing the flexibility offers to optimize its use, while considering other consumption sectors that can benefit from an integrated and holistic energy system management. The main VPS functionality is the effective exchange of energy flexibility, described in terms of time, energy and price, as well as various other technical and economic parameters.

EMS (Energy Management System): by using EMSs it is possible to manage the electricity consumption of industries and buildings to optimize the use of energy generated by non-programmable renewable sources. In this way, it will be possible to solve local network congestion problems while preventing the frequent blackouts especially during summer periods.
Systems that can offer flexibility services can include HVAC systems, ovens, CHPs and even more complex cases, such as production lines. Often, factories require different energy vectors and therefore this could be an interesting prerequisite for the prosumer sectoral coupling. The business case, for Factory EMS, is like other EMS systems: the flexibility is obtained and offered to VPS to answer to the flexibility demand.

Smart Energy Hub (multi-vector battery): at the centre of the innovative technology offered by SYLFEN, and which will be installed on the island of Procida, there is a reversible fuel cell, which offers new features: (i) it works as electrolyser to store the excess electricity in the form of hydrogen and (ii) works as fuel cell to produce electricity and heat from that same hydrogen - or from biogas - iii) it is equipped with lithium-ion battery pack to respond to fast requests for energy storage/injection that the fuel cell cannot deal with (battery response times are much lower than those of the reversible fuel cell). With a single device, it is now possible to store large energy capacities and return to users whenever necessary. This unique access point makes installation and maintenance more economical.

12.2.3 The Procida case study: an island energy community

The main objective is to physically implement, on the island of Procida, the solutions developed by the various partners of the consortium. To this end, the main areas of interest for this specific work will be the following:

• implementation of the VPS combined with innovative storage solutions;
• modelling and forecasting of energy supply and demand;
• synergy between the various energy networks, in particular, the electricity and thermal network;
• creation of a local energy community.

Once the system is integrated on the island, an important phase will be the collection and analysis of data in order to determine the efficiency of the implemented solution. Consequently, it will be possible to analyse the impacts and give some recommendations to optimize the use and management of the system.

The case study that will be carried out in Procida consists of creating a Local Energy Community to reduce the island's electrical dependence to the mainland and improve the efficiency of its energy networks. The Energy Community will also be the engine for the development of renewable electricity production using photovoltaics. Similarly, the Municipality will take part to this experience, with some designated public buildings, which are equipped with heat pumps and have a relatively high-energy consumption. In addition, the reduction of electricity consumption by public lighting (currently one of the highest consumptions on the island) will be studied within the project.

12.3 GIGLIO ISLAND

The MAESTRALE project aims to promote development of blue energy in the Mediterranean as a key sector for sustainable growth, fostering the creation of interconnected innovative clusters within a transnational network.

The project is financed by the Interreg MED Programme and co-financed by the European Regional Development Fund. It is coordinated by the University of Siena (Lead Partner) and involves 10 European partners from Portugal, Spain, Italy, Slovenia, Croatia, Greece, Cyprus and Malta.

One aim is to create preliminary conditions, necessary to fully exploit marine renewable energy sources while preserving Mediterranean environmental and cultural values. The project studies the most innovative technologies for the use of marine renewable energy, indicating their potential and problems. The technologies are investigated from the viewpoint of legislative, economic and social feasibility, of energy and technical potential and environmental impact in order to find the best solutions for the commercial and experimental phases.

Since blue energy is still in an early stage of development in the Mediterranean area, the project will strengthen cooperation between public authorities, research organisations, firms and society and increase regional and transnational links so as to promote knowledge and technological transfer, generating a critical mass and ensuring the environmental conditions necessary for improving innovative capacity and competitiveness.

With this aim, the project envisages the creation of transnational and regional Blue Energy Laboratories (BELs), workshops where the different stakeholders can meet and interact. Transnational BELs have the aim of bringing together the different actors who interact in each region of the ten project partners. Regional BELs involve public authorities (local, regional, national), local firms, research centres, associations and private citizens, constantly bringing them up to date on project developments and sharing knowledge and information. The Regional BELs are created in each of the ten Regions and eight countries participating in the project. Each is composed of four meetings, after which two pilot projects could be built, selected from two technological solutions that will undergo feasibility and sustainability studies, including environmental impact assessment, creation of consensus among the public and the authorities, economic feasibility and technological feasibility.

Each feasibility study aims to provide data on the conditions necessary for the plant to function, a business plan, technological requisites, environmental sustainability and acceptance by society, involving the various stakeholders in the study design. The expected result is to create at least 20 projects that could be implemented soon, financed by a strong public private partnership and access to European structural funds.

Technologies for converting kinetic or chemical potential or exploiting the thermal properties of seawater are included in the definition of Blue Energy (BE). These energy sources are derived from waves, tides, marine currents, tidal currents, thermal gradients and salinity gradients and also include offshore wind and the cultivation of algae.

Analysis of available potential exploitation of BE indicates that the commercially most practicable sources in the Mediterranean are wave motion, osmotic gradient and wind.

In general, systems enabling energy capture from wave motion are called wave energy converters (WEC) and the project has particularly identified oscillating water column (OWC) plants. These systems can be installed on piers or can be anchored to the bottom or floating. The system seems suitable for many environments and indeed prototypes have been developed for shoreline, nearshore and offshore installation.

Other systems that seem promising exploit osmotic gradient to produce electricity. These devices exploit the chemical potential between the different salinities of seawater and freshwater. The energy is produced by the pressure of cations and anions on a semipermeable membrane, exploiting electrochemical reactions between saltwater and freshwater in reverse electrodialysis processes.

With regard to wind potential, floating offshore wind turbines could be the best solution considering Mediterranean bathymetry. However, this technology needs more specific detailed study especially regarding environmental and landscape impact (protected areas and limits), and regarding interference with shipping routes, fishing and tourism.

Researchers of the Ecodynamics Group of Siena University have organised regional MAESTRALE laboratories in Tuscany in parallel with local workshops by project partners in their regions.

12.3.1 Involving the population

The first Regional BEL entitled "Development of blue energy: limits and opportunities", organised by researchers of the Siena Ecodynamics Group in the Municipal Council chamber of Grosseto, aimed to lay the foundations for a development strategy for marine energy along the Tuscan coast, by installations blended into the landscape and capable of valorising local resources while maintaining the environmental and cultural values of the area.

The various discussions and presentations between and by ENEA, CNR, the Association of Minor Island Municipalities, the Council and Chamber of Commerce of Grosseto, the Tuscan Archipelago Park and Legambiente helped to orient research on the transition to renewable energy sources.

After the first BEL, Giglio Island was nominated as Italian blue energy laboratory, where innovation in renewable sources, circular economy, and sustainable management of water, transport and tourism will be tested.

The island is the second largest in the Tuscan archipelago, population 1426, and has three towns: the medieval Giglio Castello, the economic centre Giglio Porto and the major beach location Baia del Campese.

Many limits are encountered on a small island like Giglio (see previous chapters on this and other small islands): landscape criteria, park regulations, and municipal laws. Other difficulties are due to large annual differences in energy requirements, trapped between objective logistic and operational limits (isolation) and unable to exploit economies of scale typical of the energy industry.

The challenge faced by MAESTRALE is to identify possible technologies for the generation of electric power so as to ensure greater autonomy, and eventually energy independence, to small communities, progressively tapering the use of fossil fuels.

Accordingly, the University of Siena organised the second regional BEL at Giglio Castello, promoted together with local government and the mayor Sergio Ortelli, to lay the foundations for a feasibility study of a first pilot project. Based on a memorandum of understanding with the Tuscan Regional Government in 2015 for the development of renewable energy on the island, the meeting was attended by Acquedotto del Fiora, SIE Srl, Terna Plus, University of Rome La Sapienza, and the Park of the Tuscan Archipelago. Using a down-up method that decides the best choices for the future with the local community, the researchers presented and analysed possible models of energy production. The BEL was preceded by several visits to sites on the island suited for the exploitation of blue energy, such as the pier at Giglio Porto and the desalination plant that would offer the possibility of making use of salinity gradients.

Finally, a listening and sharing campaign was held with the island population during the feast of St Mamiliano, the patron saint (15th September 2019). From an information point at Giglio Castello, researchers of Siena University presented and shared the results of their studies. Thus, the people of the island could obtain information and express their opinions by completing a questionnaire. This encounter enabled an exchange of views regarding land governance and development. Involvement of the citizenship and the various stakeholders regarding the margins of possibility for blue energy was a key for the success of the initiative.

12.3.2 Technologies chosen for the Giglio Porto site

The feasibility studies indicated that the pier at Giglio Porto could be suitable for the installation of a breakwater unit of the REWEC 3 type, which besides protecting the port, often damaged by storm surges, would enable electricity to be generated from wave motion.

The existing desalination plant offers a further opportunity. It could be coupled with a reverse electrodialysis system to produce electricity. Exploiting the osmotic gradient between the concentrated salt solution at the outlet of the desalination and grey/wastewater, energy could be produced. The type of reverse electrodialysis investigated was that of the project REAPower.

Resonant Wave Energy Converter release 3 - REWEC 3

This is a sea dam for conversion of wave motion designed by Prof. Paolo Boccotti and tested at the Natural Ocean Engineering Laboratory NOEL at the Mediterranean University at Reggio Calabria, directed by Felice Arena. The basic unit is a reinforced cement caisson that transforms the conventional port breakwater into an active structure that generates electricity. The device captures wave energy by the oscillating water column principle, whereby air is sucked in and out. Each REWEC caisson has a seaward entrance and a chamber in which the water oscillates vertically, compressing and decompressing an air pocket. When a wave fills the chamber, it compresses the air which is pushed out through a horizontal tube fitted with a turbine-generator that produces electricity. When the water piston falls, the air pocket decompresses and air is drawn in.

The REWEC 3 model is equipped with a self-rectifying turbine of the Wells axial flow type, of about 20 kW, that always rotates in the same direction as it does not distinguish air flow direction. The project has eight entrances per caisson, each with its turbine.

Since this is an onshore device, installation is easier, and maintenance is cheaper. Closeness to the grid and the absence of deep-water anchorage are other advantages. Since REWEC 3 can be part of an ordinary breakwater, it reduces back-reflection of waves, improving breakwater function.

REAPower

The REAPower project, coordinated by Michael Papapetrou and prof. Giorgio Micale of the University of Palermo and built at the Ettore Infersa saltworks in Marsala, aims to develop a device that extracts osmotic energy from the salinity gradient between two salt solutions (Salinity Gradient Power - SGP). The basic technology developed by REAPower is so-called reverse electrodialysis that exploits the difference in concentration between seawater and brackish water to produce low-cost renewable energy.

Freshwater has a much lower salt concentration than seawater and when the two solutions mix, the osmotic pressure generated leads to equilibrium. Osmotic pressure is caused by a current of ions that can be captured and used to produce electricity by means of an osmotic membrane.

To fuel the process, two flows of water with different salinity are necessary. So far SGP research has concentrated mainly on the combination of freshwater, as the low salt solution, and seawater as the high salt solution. The aim of REAPower is to demonstrate the overall potential of the system for producing electricity simply by exploiting water with different salt concentrations. This technology is designed to produce direct current, unlike other intermittent sources. The official site of the project estimates that a unit with a membrane of 42,000 m^2 and input flows of 130 l/h would produce 450 kW of power.

12.4 PANTELLERIA

This section shows the energy analysis made for the island of Pantelleria (Sicily), based on the methodology presented in Chapter 3.

The electric and thermal energy consumption data come from the Action Plan for Sustainable Energy (in italian, Piano d'Azione per l'Energia Sostenibile - PAES): the monthly energy data refer to the year 2011, while the trend of energy demand refers to 1990-2013, as shown in Table 12.2a. Data are classified by sector and by energy vector. The input data of the energy production models come from the on-line geographycal database Atlaimpianti, provided by the Italian Energy Service Manager (in Italian, Gestore dei Servizi Energetici - GSE). In Pantelleria some RES power plants are already installed:

- 2 on-shore wind plants that have 4-30 kW of installed power;
- 66 photovoltaic plants that have 1.08-60 kW of installed power;
- 67 solar thermal flat collectors that have 2.6-15.5 m2 of surface extention;
- Furnace-stove-fireplace-pellet or woodchips biomass boiler that have 8.1-23.9 kW of installed power.

In Table 12.2b are displayed the installed power, the annual utilisation hours and the amount of electric and thermal energy produced by all the energy plants from each RES technology system. According to these data, the RES energy production covers the 2.3% of the energy demand of Pantelleria. This result is in line with the average value calculated for the other small islands in Italy.

Table 12.2 a) Energy consumption; b) Installed power and utilisation hours

a [MWh]		Energy vector				Total
		Electricity	Petrol	Diesel	LPG	
Sector	Household	11770	0	0	3568	15338
	Tertiary	11704	0	0	856	12560
	Production activity	14113	0	0	0	14113
	Transport	0	18411	18537	0	36948
Total		**37587**	**18411**	**18537**	**4424**	**78959**

b RES plants	Installed power kW	Equivalent utilisation hours h/y	Power generation MWh_{el}/y	Thermal Energy production MWh_{t}/y
Wind	32	1700	54.4	-
PV	451	1200	541.2	-
Thermal solar	349 m^2	600 $kWh/m^2/a$	-	209.4
Biomass	86	484	-	41.6

12.4.1 Solar Analysis on Pantelleria

A pre-feasibility study of the roof-integrated solar photovoltaic panels on buildings in Pantelleria is presented in this paragraph. The analysis takes into consideration the geomorphological features of the territory and all the environmental restrictions. In order to limit the visual impact, the Regional law (DPR 31/2017 and Sicily Regional Law 5/2019) allows roof-integrated PV panels only on existing buildings and new constructions.
The solar analysis is developed into different phases:

1. Calculation of the monthly incident solar irradiation on the territory
   In Figure 12.6a is presented the result of the monthly solar irradiation calculated using the national DEM (20m accuracy).
2. Calculation of solar irradiation over the rooftop of buildings.
   Thanks to the information contained in the national technical cartography (in Italian, Carta Tecnica Nazionale) is been possible to identify all the existing buildings in Pantelleria. Then the annual and monthly incident solar irradiation that rests on the rooftop of the buildings has been quantified. Hystorical stone buildings named “dammusi”, that are characteristic building in Pantelleria, have been excluded from this calculation because of their particular lime finishing layer of the rooftop that is incompatible with the installation of PV panels.
3. Calculation of electric energy productivity.
   The amount of electric energy productivity from all the available buildings in Pantelleria has been calculated supposing a PV technology with the average efficiency around 18% and an index of performance of the system around 75% (Figure 12.6b and Table 12.3).

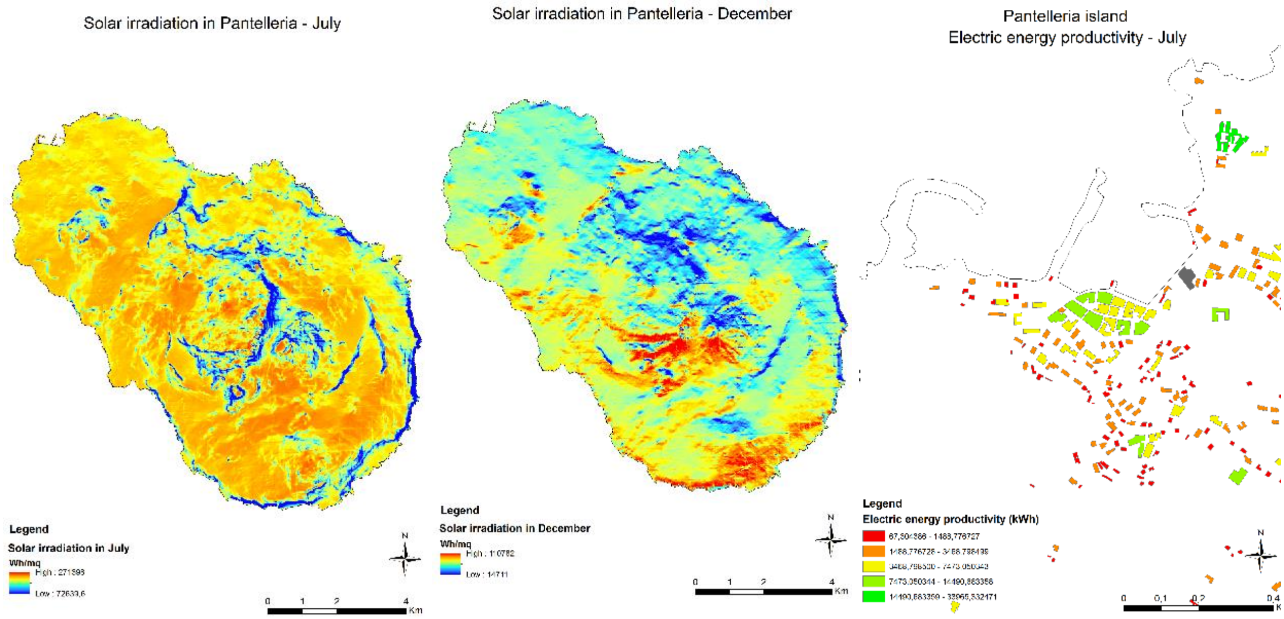


Figure 12.6 a) Monthly average solar irradiation in Pantelleria calculated in July and December (Wh/m²); **b)** Electric energy productivity in July (kWh)

Table 12.3 Electric energy productivity by PV technology integrated on the building's rooftop

Month	Total Energy productivity (kWh)	Energy productivity in urban area (kWh)	Energy productivity in productive area (kWh)	Energy productivity in agricultural area (kWh)
January	497.978,99	218.325,59	77.658,02	201.995,37
February	657.563,44	290.153,35	102.675,03	264.735,06
March	1.195.323,25	530.438,31	186.599,61	478.285,32
April	1.503.576,85	672.598,77	235.253,50	595.724,58
May	1.615.406,95	726.515,22	253.212,91	635.678,81
June	1.649.022,56	743.425,63	258.648,73	646.948,20
July	1.659.576,37	747.279,33	260.222,00	652.075,04
August	1.464.631,93	656.063,01	229.324,14	579.244,28
September	1.302.563,53	579.457,01	203.485,63	519.620,88
October	901.175,02	397.235,94	140.358,36	363.580,71
November	525.732,30	230.817,51	82.004,66	212.910,13
December	432.444,21	189.200,95	67.379,01	175.964,25
YEAR	13.404.995,40	5.981.511,13	2.096.821,62	5.326.662,64

12.4.2 Agricultural and forestry biomass analysis in Pantelleria

The biomass analysis is developed into different phases:

1. Calculation of the agricultural and forestry biomass availability in the territory.
   The territorial extension of each existing agricultural and forestry category has been quantified thanks to the Territorial Information System of the Sicily Region.

The wooded area in Pantelleria is 898 hectares wide and it has a woodiness index of 10.6%. The agricultural area is 5250 hectars wide, corresponding to the 62.1% of the municipal territory and it is mainly characterized by vineyards.

2. Calculation of the agricultural and forestry biomass accessibility.
   In order to ensure the biomass withdrawal, it is necessary to evaluate the accessibility of the resources. The means of transport must be able to reach the areas using the road network, including the forestry road network. (The road network in Pantelleria has been identified using the *OpenstreetMap* database[9] , while the land slope of the land has been calculated using the national DEM (20m accuracy)[10]. For the assessment of the accessible area, a width of the strip accessible from the road has been estimated, considering the most common logging systems and the slope of the territory.
   As a result of this analysis, the accessible wooded area in Pantelleria is reduced to 664 hectares and the woodiness index is around 7.9%. The accessible agricultural area extension has not changed in comparison to available one due to its location in the part of the island that is characterised by flat land.
3. Calculation of the electric energy productivity from agricultural and forestry biomass.
   The amount of electric energy productivity of a biomass plant has been calculated supposing an average efficiency of the system around 25%.

Table 12.4 Energy productivity from agricultural and forestry biomass

Forestry category	Wooden Area [ha]	mc [kg_{ss}]	Thermal energy [kWh]	Electric energy [MWh]
Maritime pine forests	510,04	219.316	964.991	241,25
Oaks (Lecci)	154,28	92.566	388.777	97,19
			Total	338
Agricoltural category	**Agricultural Area [ha]**	**mc [kg_{ss}]**	**Thermal energy [kWh]**	**Electric energy [MWh]**
Vine branch	5250,05	2.283.770	5.024.295	1256,07
Marcs and stalks	5250,05	3.034.527	6.675.959	1668,99
			Total	2.925

As shown in Table 12.4, the total amount of electric energy produced by forestry biomass is around 338 MWh, less than the total amount of electric energy produced by agricultural biomass that consists of 2,925 MWh. The energy usage of biomass can cause environmental impact due to the emission of fine dust (PM 2.5) and nitrogen oxide (NOx). For this reason, there are limits to this technology, particularly in territories that have air quality issue[11].

12.4.3 Analysis of the energy productivity from waste in Pantelleria

The analysis of the energy productivity from waste is developed into different phases:

1. Calculation of the amount of waste production in the territory.

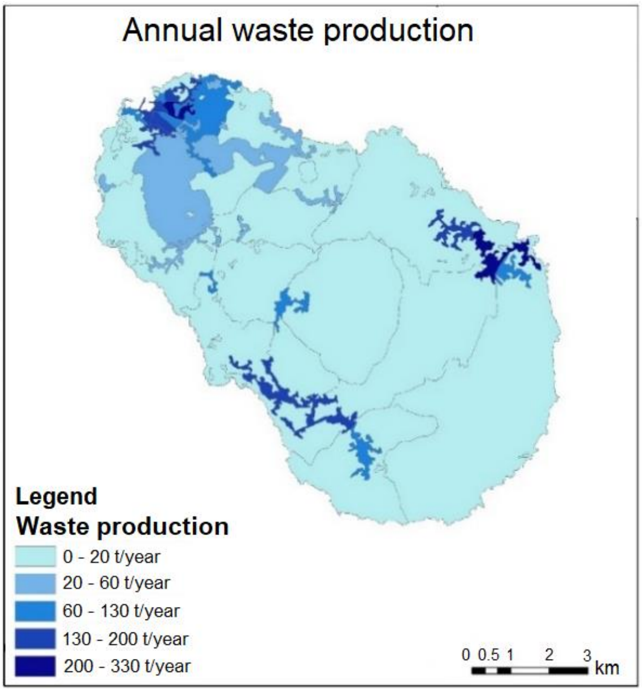
[9] http://download.geofabrik.de/europe/italy/isole.html_(Sistemi Informativi per il Territorio e l'Ambiente; http://www.logis-srl.it/?page_id=81).

[10] http://www.sinanet.isprambiente.it/it/sia-ispra/download-mais/dem20/view (Rete del Sistema Informativo Nazionale Ambientale ISPRA).

[11] https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/7138

The data of the waste production in Pantelleria (469.66 tons/year) comes from the waste observatory of ISPRA (in Italian, Osservatorio Rifiuti), in particular it refers to the "total production of urban waste per-capita in each municipality" and it is dated 2017.

2. Calculation of available waste for the energy production.
   The amount of waste produced is classified in categories. For each one it is possible to identify the "usable fraction" and determine the lower calorific value. The share of waste that can be used to produce energy has been assessed in the "Urban Waste Report" (in Italian "Rapporto Rifiuti Urbani") by the waste service of ISPRA.
3. Calculation of energy productivity.
   The electric energy productivity is calculated multiplying the amount of the thermal energy produced from the waste combustion to the average efficiency rate of the technological system, supposed equal to 25%.
   The map in Figure 12.7 shows the waste to energy productivity and it can be used to decide where to install the incinerator, taking into consideration all the environmental restrictions.



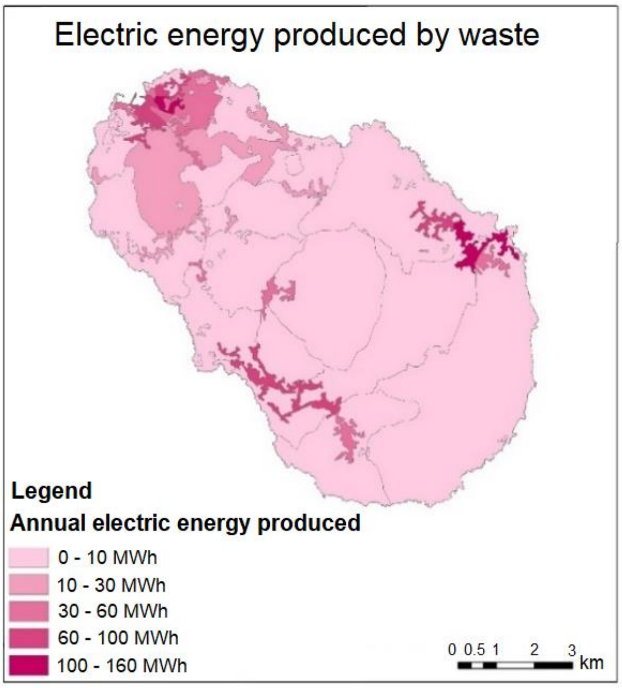


Figure 12.7 a) Annual waste production **b)** Annual electric energy produced by waste

12.4.4 Wind energy analysis in Pantelleria

Based on the Italian Wind Atlas (in Italian, Atlante Eolico Italiano[12]) the wind energy analysis is developed into different phases:

1. Calculation of the amount of wind in the territory.
Knowing the high-altitude data, made available by the ECMWF meteorological institute of Reading, the wind speed data have been simulated.

[12] http://atlanteeolico.rse-web.it/

2. Calculation of the specific electric energy productivity.

All the unsuitable areas for the installation of wind turbines [13] have been localised on the territory. They include areas of environmental value such as Site of Community Importance (SCI), Special Protection Area (SPA) and Special Areas of Conservation (SAC).

Comparing the area where there is energy productivity and the unsuitable areas for these power plants, it is possible to evaluate the amount of the effective energy productivity from wind turbines.

A compromise between good productivity and a not excessive landscape impact, should be reasoning on the specific productivity values at 50 meters.

The amount of energy produced by a 2 MW with 50 m high wind turbine is equivalent to 12,372 MWh/year (Figure 12.8).

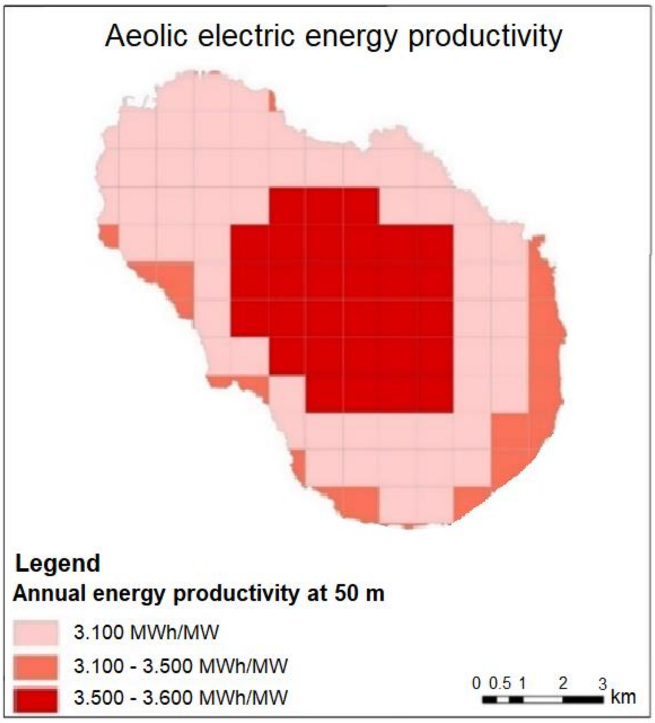


Figure 12.8 Annual energy productivity (MWh/MW) at 50 m

Figure 12.9 shows the industrial area where the wind turbines can be installed. It is in the west side of the city centre of Pantelleria, it is far enough away from housing and it should be requalified thanks to such an intervention. A second wind turbine in Pantelleria can be installed near the electric power plant, where another wind turbine already exists. The hypothesized areas are between 325 m and 350 m far from the shoreline and, there are no households for a radius of 200 m [14].

The installation of new plants for the energy production from RES should also include interventions of restoration and requalification of the areas adjacent to those plants, in order to create a greater acceptance of these systems by the population.

[13] "Criteri e l'individuazione delle aree non idonee alla realizzazione di impianti di produzione di energia elettrica da fonte eolica" pursuant to art. 1 of the Regional Law 29/2015.

[14] Ministerial Decree 10.09.2010 "Guidelines for the authorization of plants powered by renewable sources", art. 4: each wind turbine must be placed at a distance of at least 200 m from civilian homes.

Figure 12.9 Localization of two wind turbines (1) and (2) with buffer around 200 m

12.4.5 Energy harvesting from sea waves in Pantelleria: the ISWEC experience in Pantelleria

The Mediterranean Sea has an exploitable wave sea energy potential especially localized in the west part of Sardinia, in the Sicilian channel and near the strait of Messina. In this compound the main suitable technological systems are few: technologies that exploit the tidal energy and the ones that convert energy from the sea waves. Wave energy has a vast potential and is expected to consistently contribute to the European energy mix in the next decades.
The ISWEC[15] (*Intertial Sea Wave Energy Converter*) is a device for the exploitation of wave energy developed at the Department of Mechanical and Aerospace Engineering (DIMEAS) of the Politecnico di Torino and implemented by the spin-off Wave for Energy Srl. It is a pitching device, whose working principle is based on the gyroscopic effect deriving from the combination of the motion of a hull, due to the energy of the incoming sea waves, with the one created by a flywheel rotating around its own axis.

Pantelleria, in addition to sun and wind, can count on a high availability of wave energy, with an annual average of 7 kW/m (specific power per sea front unit of length). The 1:1 scale ISWEC prototype was installed off the northwestern coast of Pantelleria in August 2015 and operated for several months. The studies of recent years will allow the addition of considerable upgrades to the device, in order to increase its producibility and reduce its costs.

The experience of the ISWEC in Pantelleria shows how the unconnected Small Islands can be a valuable laboratory for the experimentation on innovative technologies for the energy production. In fact, the absence of connection with the National Electric Grid entails very high costs of energy production through fossil sources: innovative technologies such as the ISWEC, able to exploit non-traditional Renewable Energy Sources, can therefore achieve grid parity and become competitive with fossil sources even before that on the continent.

[15] https://www.waveforenergy.com/tech/iswec; http://www.enea.it/it/seguici/events/energia-dal-mare/Mattiazzo1.pdf

The ISWEC (Intertial Sea Wave Energy Converter) prototype was installed off the northwestern coast of Pantelleria in August 2015 and operated for several months. The studies will allow the addition of considerable upgrades to the device, to increase its producibility and reduce its costs. A view of the device at sea
Source: www.waveforenergy.com

Small Islands are also often characterized by areas of very high landscape value, which is not always compatible with the extensive exploitation of traditional renewable sources (on-shore wind power and photovoltaic): the research for innovative solutions with low visual impact is then more than motivated. The exploitation of ocean energy, in particular wave and off-shore wind power on floating platforms at a great distance from the coast, can contribute to further reducing the environmental impact of energy production; ocean energy harvesting ensures zero land use and avoiding subtracting land to other human activities.

12.5 Porto Torres- Asinara Island

12.5.1 Reddito Energetico – Energy Revenue

The Energy Revenue is developed by the Municipality of Porto Torres - Isola dell'Asinara and is an innovative project that has an environmental, social and energy value.

The aim of the project is to change the social assistance method, encourage the green energy use and the resource sharing through a free solar panels supply. Around 50 eligible citizens have received a solar panel, allowing them to save on their electricity bills.

The users cannot accumulate or re-sell energy, but only use it when it is available. The energy produced but not consumed is returned to the market. The gain is set to increase the Solar Panel Fund, which is managed by the Municipality and serve to finance new solar panels' purchase. The long-term goal is to exponentially increase the number of beneficiaries and make citizens energetically independent.

The Energy Revenue officially started on July 27, 2017 with the signing of the agreement between the Municipality of Porto Torres and the GSE (Gestore dei Servizi Energetici), partner and cornerstone for all technical aspects.

The Municipality budgeted 500.000 euros, half of it have been spent during 2018. During this year, 49 citizens chosen through a public tender have received a free solar panel.

The relation between the Municipality and citizens are governed by a bilateral agreement. Solar panels can be freely used up to 25 years, while the installation, maintenance and uninstallation lie on the Municipality.

The total power developed by the 49 panels amounts to 107.5 kW. The single panel's power varies from a minimum of 0.81 kW to a maximum of 9.99 kW.

The 49 plants develop an average energy production of 150.000 kW/h per year, together with a significant reduction in CO_2 and a saving on household bills from 20% to up 50%.

In a year of activity of the Energy Revenue project the city of Porto Torres has produced 96 green megawatt and cut 67 tons of CO_2.

12.6 The Oil Free Zone in Pinerolese territory

The Pinerolo area administratively corresponds to zone 5 of the Metropolitan City of Turin and includes 47 municipalities. The population is just under 150,000 inhabitants and the territory is quite varied: most of the area sets on mountain (approximately ¾ of the total area, equal to 1348 km^2). From an energy point of view, it may have characteristics similar to those of the small islands: territory delimited by natural borders, single point of connection with the national grid, energy dependence despite the abundance of local resources that could guarantee a substantial energy independence.

A preliminary feasibility study of an energy community involved a sample of five neighbouring municipalities (around 19,000 inhabitants) and it was based on existing legislation. The result was positive, both from an economic and an environmental point of view. A further development has taken place according to the National Law 221/2015, which provided for municipalities the possibility to establish, on homogeneous territories, Oil Free Zones. In this area pilot projects are allowed in order to experiment technological, economic and organizational energy market solutions.

The aim is to reduce the dependence on fossil fuels. Finally, in 2016, the Piedmont Regional drafted the first regional law which provided for the possibility of creating energy communities. The law was approved in August 2018 (Regional Law 12/2018).

The working team of the Polytechnic of Turin collaborated in the drafting of the energy plan and strategic document of the future community. The data were collected from several companies of the Pinerolo Energy Consortium (in Italian, Consorzio Pienerolo Energia - CPE) by establishing (April 16, 2019) the first Italian Oil Free Zone called "Sustainable Territory". A draft statute of the energy community in the form of a cooperative has been drawn up by the CPE legal working team. A first group of municipalities, businesses and citizens was involved as the funding core of the future energy community. Beyond the technical aspects, the difficulties that were encountered arise from a complex of technical regulations that constrain the national energy market. It is legitimate that different energy users can come together to produce and purchase energy, but they cannot exchange energy using a physical network that is not owned by them. Only historical cooperatives can do that. In order to discuss those aspects, contacts have been initiated both with the manager of energy services (GSE) and with the Authority for the Regulation of Environment and Network (ARERA): it has ascertained that exist solutions that overcome the difficulties relating to the energy exchange. The Energy Community can be launched by ensuring the partecipation of three different actors: Producer (API Acea Pinerolese Industriale), Associated Consumer (CPE) and Distributor (APE Acea Pinerolo Energia).

This experience, which has revealed highly positive aspects, can be replicated by following the indications that have also been obtained from the case study of the small Italian islands.

12.7 Financial instruments for the energy transition in Italy

12.7.1 Economic incentives

In the scenario of energy policies, national and regional resolutions have decreed over time a vast number of different types of incentives, aimed at supporting the energy transition objectives. They can help promoting investments, creating opportunities and allowing the dissemination of good practices, for achieving the objectives set for energy and environmental sustainability. In addition, they facilitate the initiative of different categories of end users, providing for different types of intervention and supporting their economic accessibility.

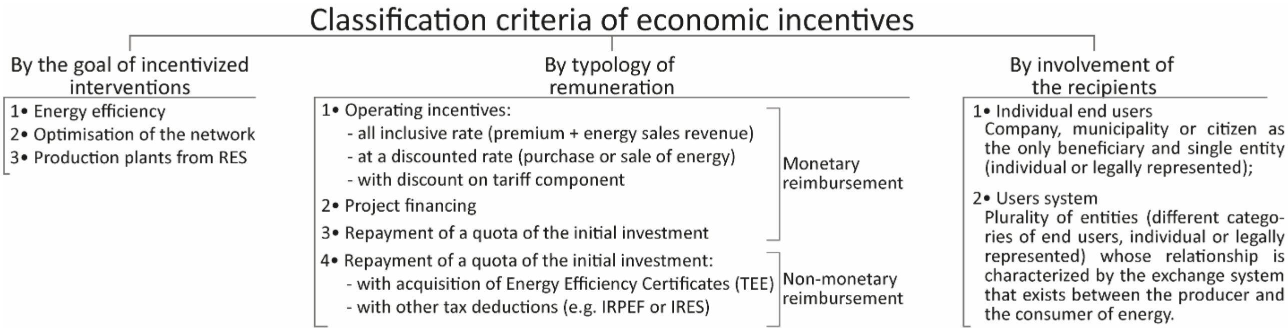


Figure 12.10 Classification criteria of economic incentives in Italy

It is possible to describe the economic incentives on energy, currently in force in Italy, classifying them according to different criteria, presented in Figure 12.10. All the information comes from the national energy service manager (GSE)[16].

12.7.2 Incentives for small island

For small islands not connected to the continental network the D.M.14/02/2017[17] defines the minimum objectives of development to produce energy from renewable sources to be reached by December 31, 2020. Specifically, the objectives concern the reduction of energy dependence through experimentation of new systems and technologies, to guarantee greater protection of the environment and also to develop innovative projects that may be applied to the mainland. The small islands involved must have a territorial extension of at least 1 km^2 and a resident population of at least 50 people. The interventions admitted to remuneration are distinguished by energy carrier considered and cannot be combined with other public incentives. Interventions of new construction, upgrading or reactivation of plants to produce electricity from renewable sources (installed power > 0.5 kW) are permitted. The expected remuneration is a monetary reimbursement of operating account with an all-inclusive tariff that lasts for 20 years. Additional tariff premiums are provided for PV modules installed on roofs where eternit or asbestos is carried out. The permitted interventions also include the installation of solar collectors and heat pumps for domestic hot water, replacing electric hot water heaters. The incentive corresponds to a monetary reimbursement, delivered in a single solution that varies from 50% to 65% of the expenditure incurred, depending on the capacity of the product purchased.
The Law decree 30/12/2019[18] ("Decreto Milleproroghe" Italian Decree) has proposed specific derogations, some already approved, to enhance and speed up pollution mitigation and environmental protection measures in the context of small island. An investment fund of € 14,5

[16] Gestore dei Servizi Energetici (GSE), (https://www.gse.it)

[17] Ministerial Decree 14.02.2017, "Copertura del fabbisogno delle isole minori non interconnesse attraverso energia da fonti rinnovabili", in Italian.

[18] Law decree n. 162 - 30.12.2019, "Disposizioni urgenti in materia di proroga di termini legislativi, di organizzazione delle pubbliche amministrazioni, nonché' di innovazione tecnologica", (Decreto Milleproroghe), in Italian.

million in 2020 and so on for another two years, is allocated and address project for infrastructure or redevelopment of the territory.
It also concerns:

1. incentive plan for the energy production by RES, up to 100 percent of the energy demand, in agreement with the landscape protection authority
2. provisions for the strengthening and speeding up of interventions to mitigate the hydrogeological instability and the safeguarding of the territory (Legge CantierAmbiente)
3. tax relief to encourage the spread of vehicles powered by electricity
4. promotion of waste recovery at sea and for the circular economy (Legge Salvamare)
5. use of fishing units for the collection of solid waste at sea and for the protection of the marine environment
6. control of land consumption, reuse of built land and for the protection of the landscape.

The synergic operation between Region, institutions, citizens and other local authorities has led to the creation of a legislative framework useful to pursue common target of sustainability; such an approach could bring significant benefits also in application to the emerging continental Energy Communities.

12.7.3 Energy Aggregation Models in Italy

In the energy transition process, energy aggregation can play a key role facilitating the integration of non-programmable and distributed resources in the electric system, such as renewable energy sources and contributing to the increase in decentralized systems. This procedure involves the reorganization in the management of the resources and cannot be separated from the use of smart technologies and systems.

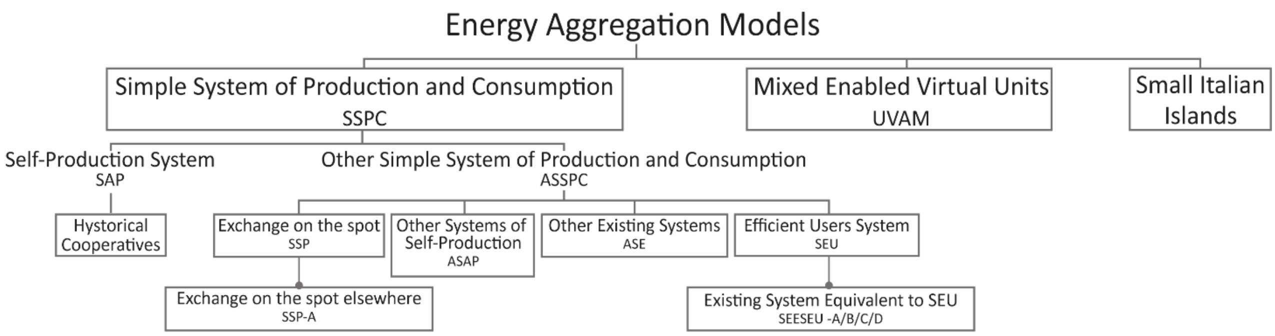


Figure 12.11 Energy aggregation models in Italy

Some existing models ("Sistemi Semplici di Produzione e Consumo" SSPC, in Italian) and others under experimentation ("Unità Virtuali Abilitate Miste" UVAM, in Italian) are described below.
The energy aggregation models that still exist in Italy are shown in Figure 12.11.

Simple Systems of Production and Consumption ("Sistemi Semplici di Produzione e Consumo" SSPC, in Italian)

As described by the reference legislation[19], SSPCs are electrical systems connected to the national public network consisting of the presence of at least one consumption unit and one production unit connected together. They can be made up of single entities or a plurality belonging to the same corporate group. The transport of electricity is configured as an activity of self-supply of energy.

[19] ARERA, Delibera 578/2013/R/EEL del 12.12.2013, Testo Integrato delle disposizioni per la regolazione dei sistemi semplici di produzione e consumo (TISSPC), in Italian.

All participants benefit from an exemption from the payment of the tariff component for the dispatching service, only on the share of the exchanged self-consumed energy.

Mixed Enabled Virtual Unit ("Unità Virtuali Abilitate Miste" UVAM, in Italian)

The UVAM systems are enabled to enter the market as operators of the dispatching service[20]. They are made up of the Enabled Virtual Units of Consumption (UVAC) and Production (UVAP), they can use programmable or renewable energy sources and storage systems. The minimum aggregate must be 5 MWh/year and have a modular capacity of 1 MWh. The responsible for market participation is the Balancing Service Provider (BSP) that estimates energy data measurements in real time. Its main function therefore concerns the balance between energy demand and supply inside the UVAM, managing the quantity of energy producted to be offered on the market. The remuneration is defined by the Authority according to a fixed and a variable fee. If a storage system is present, the tariff rates referring to system and transport charges are not applied only to the share of electricity that it requires.

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[20] ARERA, Delibera n. 422/2018/R/eel, Approvazione del regolamento, predisposto da Terna SpA relativo al progetto pilota per la partecipazione di unità virtuali miste al mercato per il servizio di dispacciamento (msd), in Italian.

Chapter 13

ENVIRONMENTAL AND SOCIAL IMPACTS IN THE SMALL ISLANDS

Francesco Petracchini – CNR

All the small islands – 35 municipalities, over 200,000 resident people who become millions during the summer season – face different limits: the scarcity of their territory, the scarcity of natural resources (water and energy), additional costs of transport and communications, difficulties in waste and waste water management and marine and coastal pollution.

Isolation from the mainland does not only concern environmental energy problems but also concerns the supply of basic goods, the health of citizens, the justice administration, the solidity of the business ecosystem the greater financial charges required for the development of new productive sectors.

The cost of living for an island citizen is higher than that of a mainland citizen, and the income is similar. The island economy is mainly based on tourism, with all the problems that have always been highlighted: seasonality, difficulty in connections and the cost of life. All factors that affect the quality of life and the social well-being.

Small Islands are isolated systems that can become the ideal laboratory to face the most urgent and important environmental challenges facing the world, where is possible to apply and test innovative models in the field of energy, water cycle and waste management. The Italian and Mediterranean islands are also extremely fragile contexts affected to strong anthropogenic pressures where the research and experimentation of innovative solutions becomes even more important and urgent to reduce damage to biodiversity.

These contexts can be transformed from inefficient models dependent on the flows of energy and goods from the mainland into innovative models in the direction of sustainable systems for the supply of clean energy and water, for waste management and for zero-emission mobility.

For the energy production, the coverage of electricity needs in the Minor Islands is still guaranteed today by diesel thermal power plants with private companies that control both production and distribution.

Up to now the particularity and complexity of supplying the islands has in some way "justified" the paradox of such an inefficient and expensive system; to guarantee the continuity of the service according to ARERA (Regulatory Authority for Energy, Networks and Environment), the average cost of power electric generation in the non-interconnected Minor Islands is in fact about 6 times higher than the national one.

Every year almost 80 million euros are withdrawn from bills, within the UC4 component of system charges, and paid to energy local companies. The scheme described, for companies operating without any competition, coincides with an incentive to use the fossil source (diesel) which over the years has penalized and displaced the competition of technologies from renewable sources.

These data show a serious delay not only in comparison with the islands of the rest of the world, but also compared to what happens in the rest of the Italian municipalities. Still in 2018, the changes carried out were truly marginal. Photovoltaic solar is the most widespread renewable source on the islands, while wind power, despite the favorable conditions, is present only in Pantelleria (with 2 micro-generators) and in Ventotene.

The production systems through diesel plants generate impacts related mainly to the direct emissions of diesel fuel combustion; to these must be added all the indirect impacts connected to the fuel transport systems from the mainland to the island.

As regards to drinking water in some Italian islands, problems are related to the scarcity of the water resources which force the islands to depend on the transport through barges or desalination plants. Another probles is related with the absence or inadequacy of the purification systems of the wastewater.

Desalination plants can eliminate the need to transport water from the mainland and, moreover, if combined with energy production plants from renewable sources they would allow the elimination, or at least the reduction, of emissions and the production of fresh water locally.

A well-defined planning strategy is needed to remedy defaults that impact also on the tourist appeal of the islands. It is necessary to proceed t with careful approaches to push the completion of the purification systems of existing discharges, also adopting innovative types of treatment for the reuse of waste water (such as refining and phytodepuration plants), also for isolated users.

In many Italian islands, waste is a real environmental priority because the numbers of separate collection plants are low and the only solution adopted is the transfer of waste by ship, when instead it is possible to switch to management models capable of creating economic and environmental benefits. The introduction of an integrated management of the waste cycle, which does not leave its natural perimeter, is a significant challenge, especially in the summer season, when numbers of tourists are high on the territory. It is therefore really important from the local administrations the adoption of prevention policies to reduce the production of waste at source, implementing information and containment measures, and in parallel to accelerate separate collection, thereby increasing the quality of the waste (and of secondary raw materials).

The goodness of separate waste collection can contribute to a second life for raw material, re-introducing it into production cycles or enhancing it as a sustainable energy resource. In most of the municipalities of the islands there is an eco-center or ecological platform (except in Capraia), while domestic composting plants are still not widespread, only present on the island of Capri. Similar situation for paper and cardboard collection centers. One of the items that certainly represents high costs for the administrations is the transport of waste to mainland, by ship. An efficient waste management on the islands, with consequent environmental protection and economic savings for local administrations and citizens, must have as its objectives: a separate waste collection through the door-to-door collection service, which contributes to job creation local and, at the same time, the promotion of home and community composting.

In islands, the system mobility presents a double negative aspect: the connection with the mainland and the local transport system, with all the problems related to the summer tourism peaks. In territories characterized with a limited surface, a complex morphologies, with a road network designed to serve a population of few inhabitants, the exorbitant increase in the number of motor cars in tourist periods involves congestion and very significant peak in emissions. The challenge here also lies in defying a profound innovation of the system mobility , which aims to give an alternative to private transport through efficient local public transport and to it stimulates projects with zero environmental impact: electric vehicles, safe pedestrian and cycle paths. Meanwhile, to reduce the traffic summer congestion, many islands have approved policies of limiting access to private motor vehicles. Regarding the public service, all the Minor Islands are equipped with a local public transport system that connects the areas of greatest interest, such as the inhabited centers, the port, and the beaches.

With regard to the socio-economic aspects characterizing the Minor Islands, it is sufficient to take a quick look at the indicators of the island regions of the EU to note that, if on the one hand there is no absolute rule applicable to all these regions, certain trends and critical issues can, however, be considered common: for example with regard to unemployment, almost half of the islands have higher, unemployment rates than the European average. In terms of economic activity, there is an almost always lower per capita GDP, hyper-specialization and a high degree of dependence on a limited range of activities or sectors, such as agriculture, fishing and the tertiary sector, in particular tourism and non-commercial activities.

Chapter 14

SUSTAINABLE MINOR ISLANDS: A PROPOSAL THAT STARTS FROM THE ROLE OF TOURISM

Carla Creo, Cristian Chiavetta, Grazia Barberio, Claudia Brunori, Giovanna Armiento, Sergio Cappucci, Marcello Peronaci – ENEA

Mediterranean Small islands represent an extremely complex system to be addressed in terms of implementation of a sustainable resources management since they face, at the same time, geographic isolation and the strong pressure given by the seasonality of the mass tourism dynamics.

Nevertheless, these features make small islands a living laboratory for holistic and integrated approaches addressing issues usually faced independently: energy, environment and natural resources, logistics, tourism, productive sectors, occupational issues and, of course, cultural and traditional issues which are characterizing peculiarities of any island in the Med area.

Focusing on tourism, it could have a contradictory effect on small islands: it often monopolizes the use of territories and public and private resources and efforts, going to the detriment of other initiatives, which could diversify the economic proposal. On the other side tourism offers tremendous possibilities of economic development for neglected areas, as small islands have been considered in the past due to their remoteness. Therefore, the goal is combining the high potential of economic development of tourism with a sustainable management and exploitation of resources. In this context, the implementation of a circular economy model applied to the resource management could support a general transition to a more sustainable and responsible tourism proposal on small islands. ENEA developed an approach aimed at defining circular economy strategies based on a preliminary analysis of the local needs and potentials at territorial level and focused on the resource flows mapping. The approach can tackle one or more sectors, as starting point, to use the selected sector as catalyst for a general implementation of a circular and integrated resource management at territorial level. The ENEA approach suit effectively to small islands because the preliminary analysis of resource mapping is favored by the naturally defined system boundaries of the system modelled.

The following part of this publication focuses on the description of some pilot actions developed in the Egadi Islands aimed at supporting a transition to a more sustainable tourism. The project tackled the problem of the water scarcity, addressed the waste management, and supported a sustainable exploitation of natural resources in the touristic sector.

Moreover, the project developed a sustainable tourism certification and directly involved companies from the sector in the definition of local labels to support a more responsible touristic model.

A list of some of the actions realized by ENEA in the small islands to promote a circular resource management and an inclusive economic model respectful of the local communities needs and traditions.

Implementation of sustainable waste management models

The main goal of the action is the definition of approaches and strategies aimed at reducing the waste production and valorising the discard at local level. Specific activities of this pilot action are focusing on the organic waste: i.e. definition of integrated and innovative waste management plan; installation of pilot plant for waste composting for small communities and promotion of domestic composting.

Sustainable management of water resource

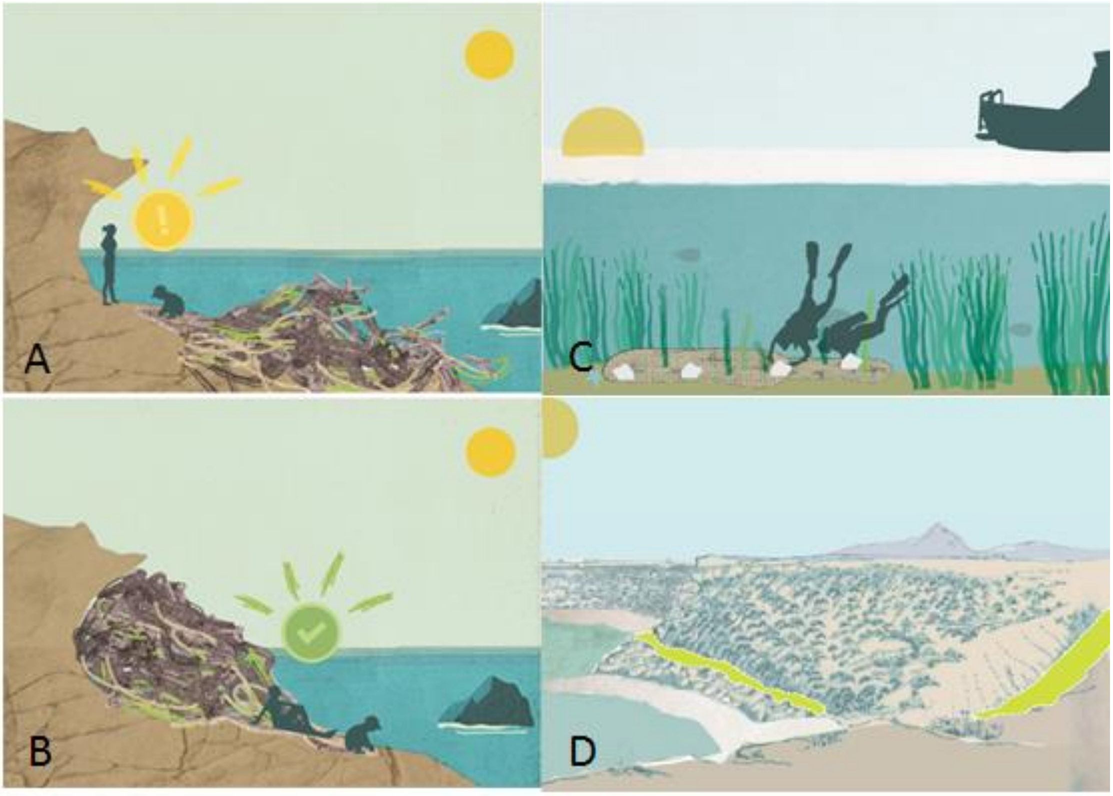
With regard to the problem of water supply in small islands, ENEA has experience of pilot cases in schools (or in other public buildings) to encourage the water saving and the reuse of wastewater, through identification and installation of the best technical solutions. ENEA performs also hydrogeological studies of the groundwater based on the rainfall on the island, which allow the definition of the best exploitation and rationalization in the water use in water supply since small islands are dramatically exposed to the effects of climate change.

Management of beached plant biomass

ENEA has carried out criteria and guidelines for cleaning the beaches from the biomass and use the biomass collected for various purposes. The guidelines are based on experimental studies and analyses conducted on the management of beached plant biomass (*Posidonia oceanica*). Thanks to the ENEA patent no. 1424765 (filed on 24.3.2014 and released in 2016), beached Posidonia can be valorised by creating multifunctional structures (padded pillows) for naturalistic interventions along the coastal shoreline and the creation of beach & outdoor furniture (i.e. pillows).

The technology has been tested in various national and international projects (TornoSubito, STRATUS, ES-PA, BARGAIN) and the patent, for the use only in an emerged environment, has been exclusively licensed to the Ecofibra company. In 2019, in order to promote the distribution of these “pillows” as beach & outdoor furniture element, ENEA also registered the European “Sidonia” trademark.

Extremely interesting is the experimentation for the re-qualification of the damaged *Posidonia* meadow: the beached biomass, after appropriate treatment, can be put back on the seabed, in order to create a substrate on which replanting the mother meadow, with an innovative technique.



A and B) Schematic representation of in situ deposit displacement carried out in Favignana (Egadi Islands). The "mats", stuffed with seagrass collected from the beaches, make them eligible to avoid accessibility of tourists close to unstable and rocky cliffs and to cover on rocky and rough areas. C) Example of immersion of the bio-mats on the seabed. D) Example of application of bio-mats to create paths in Cala Azzurra (Favignana)

A public-private collaboration is being launched to evaluate the benefits of the solution in terms of environmental accounting and carbon credits.

Study of the cover-up of the port basin

Studies and analysis on sediment samples allow to identify hypotheses for the management of dredged sediments, aimed at a beneficial reuse of these in the construction of sports plants (e.g. beach volley or soccer fields), in the environmental requalification of the foot of the cliffs, in the port expansion through special confined disposal facilities, or in the commercialization of this resource as secondary raw materials.

Environmental certification

In order to promote tourism through the improvement and enhancement of environmental quality, ENEA has developed a methodological pathway for environmental certification of marine tourist locations, starting from what established for the EMAS certification of production districts. This pathway is based on an in-depth analysis of the environmental problems of the area and on a survey on the perception of the area by tourists, residents and tour operators, as a basis for defining an environmental improvement program.

The approach foresees the involvement of tour operators through the creation of a local environmental quality brand, this allows to raise awareness and inform operators on the role of environmental quality as a factor in promoting tourism, on the concepts and requirements for obtaining environmental quality brands, on possible interventions on structures to cut energy and environmental costs and on economic incentives for tourism business.

Interactive communication actions: Citizen Science activities, fish tourism and creation of smart bays

The dissemination of knowledge about the environment is a fundamental tool for the involvement of citizens and tourists (Citizen Science) for the consequent enhancement of the natural heritage and its conservation and sustainable management. The initiatives to be promoted include the training and awareness of local operators (e.g. operators of protected areas, fish farmers, fishermen, etc.), educational tourism and the activation of research programs in which students, citizens and tourists can participate.

ENEA has long experience in education and dissemination actions related to the marine culture. Some actions include monitoring plans for "key" marine organisms (sensitive, vulnerable or non-indigenous species) that are easy to implement and that can be carried out regularly to allow the acquisition of long-term data and in areas of particular interest. Through the "Guardians of the Coast" project, promoted by the Costa Foundation, ENEA involves high school students from all over Italy in: monitoring the coral alga *Ellisolandia elongata*, which represents an oasis of biodiversity and contributes to the mitigation of climate change thanks to its important role in the carbon cycle, and in the census of macro and micro-plastics on beaches.

Dissemination activities also include initiatives in which fishing boats are exploited in certain periods of the year (e.g. seasonal commercial fisheries stop) for tourism fishing activities, for environmental dissemination and promotion of local fish specialties in a slow-fish perspective. The cooperation also involves restaurateurs near the port with the possibility of eating the zero km catch of the day, so multiplying the outcomes of the initiative.

The creation of Smart Bays concerns the protection of small bays that can become focal points of study and experimentation with advanced sensor systems (temperature, oxygen, pH, salinity, light radiation) for long-term monitoring and to support production activities, also in a climate change perspective. This type of initiative can create integrated research platforms to support local activities (aquaculture, sustainable tourism, development of technologies for the marine environment) and Municipalities, which take into account the different needs of the public and private sectors, and that preserve and enhance biological resources.

Chapter 15

Conclusions and proposals

Gian Piera Usai - ANCIM General Secretary

The concluding notes will move between two concepts: **criticalities and challenges**.

Challenge

The islands, precisely because of the factors we can consider of fragility: the environment and the landscape particularly valuable and in need of protection, the water and marine resources, the transports turn out to be the ideal territories to test new technologies and new processes with all the stakeholders, namely public authorities, utilities and network managers, market operators and citizens and also to experiment with innovative and socially inclusive governance models.

The same conclusive document of the "Intelligent Islands" Forum, held in Athens in June 2016, highlighted these factors and stated that in the islands there is "the ability to implement integrated solutions for the management of infrastructures and natural resources, such energies, transport and mobility, waste and water and, simultaneously, the islands are able to implement innovative and socially inclusive forms of governance and financing ".

The Italian islands have achieved this:

- the governance model is certainly the most innovative at the Italian level and I would say European: 35 Municipalities located in seven different Regions both as economic and social development (convergence and competitiveness) have been able to equip themselves with a DUPIM integrated between the islands, among the Municipalities, the Regions and the State;
- integrated between public and private subjects;
- integrated between the various sectors of intervention (tangible and intangible infrastructure projects) and also between the water, waste, energy, etc. sectors. These additions **to sectors** or **the circularity of development** have also been clarified in the La Maddalena Manifesto in which the integration of the aforementioned sectors the correct path has been taken to achieve the 2020/2030 objectives.

Neither the State nor the European Union have, until now, closely linked things, it is enough to see how we continue to proceed with not only sector calls, but even separated by areas of intervention, for different Ministries for the same sector of intervention , weakening the results that can be obtained.

More local autonomy and more self-determination favor innovative, courageous and intelligent systems, as Durão Barroso himself indicated as a road to development.

Challenge

Another element the smaller islands have identified in requesting implementation reinforced by art. 19 of the European Directive of 2012 on the subject of energy efficiency, which speaks of measures aimed at eliminating obstacles and indicates incentives, the repeal or modification of legal provisions and/or regulations and above all the simplification of procedures administrative.

Measures not sufficient to generate effective behavior in all European countries and which should be correlated to the mandatory provision of an implementation time frame.

This challenge the smaller islands want to face by equipping themselves with a "training school" precisely in the energy sector, not only to explore new technologies and their applicability in the various territories, but initially starting from the analysis of various regulations from Region to Region for to develop a new single authorization procedure for the 36 Municipalities and more streamlined, precisely to overcome one of the critical issues that hold back and slow down the implementation of new energy policies. (model of governance Ministries-Regions-Municipalities-Private).

The path of simplification indicated by the ministerial notices is primarily photovoltaic, because it has the simplest authorization path, preventing the use of surely more adequate systems for areas of small surface area such as the islands, I speak of wind power, wave, etc. .

Challenge

How to produce energy from waste treatment, there is a proposal focused on pyrolysis, a system that allows to solve two problems: waste disposal and production of energy and hot water and, therefore, savings for citizens and virtuous objective of alternative energy production.

Financial **challenge**

Give the funds directly to the Municipalities to activate not only photovoltaic, but to activate new and integrated projects different by territory (no equal clothes for unequal)

Critical issues

- • Administrative centralization;
- • Long and discouraging procedures, particularly penalizing behavior because we talk about sectors in which technological innovations are constantly evolving and in the time of a normal authorization process the technology is outdated or the entrepreneur's interest changes;
- • Reduced and highly valuable geographical areas that require targeted and non-standardized interventions at national level.

The solution of these critical issues could be resolved within the Minority Islands bill which provides for a Joint State, Regions and Local Autonomies Committee to approve the operational proposals for the smaller islands in a kind of three-year plan of interventions.

It concludes with some proposals

- the EU is asked to better explain and make that art more binding. 19 of the 2012 Directive that I mentioned in the introduction;
- the State and the Regions to engage in the challenge of governance;
- to Individuals to work within governance and the principle of circularity;
- to Citizens to be actors in this Challenge.

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