The ETU Toolbox Handbook

Renewable Energy Community

WP4 Transferring

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Project co-financed by the European Regional Development Fund

Contents

List of Figures

List of Tables

List of Boxes

Introduction

The Interreg MED Renewable Energy Community Project is a transnational cooperation project that promotes the ETU (Ecosystemic Transition Unit) Initiative as a capitalisation strategy for transferring the outcomes from Interreg MED Renewable Energy's modular projects dedicated to implementing renewable energies in rural areas, and for promoting a holistic energy transition model that takes into account the territorial, economic and social needs of rural areas. The Interreg MED Renewable Energy Community consists of over 110 institutions in 10 EU member states and 3 neighbouring countries, all located in the Mediterranean region.

The contribution of the Interreg MED Renewable Energy Community is the provision of holistic energy transition strategies that guide decision making to support the territorial, social and economic development of rural areas.

The project's main targets are the rural and island areas of the Mediterranean, due to their high vulnerability to climate change; through the ETU Toolbox the project aims to provide municipalities in these regions with actions they can take despite a scarcity of resources.

The Interreg MED Renewable Energy Project will boost the production of renewable energy sources (RES) in rural and island areas by: Supporting municipalities to apply the ETU Toolbox in energy planning, through sectoral plans; strengthening energy communities through citizens' awareness of the energy transition; expanding energy governance through the implementation of green fiscal policies; and building energy facilities through the design and implementation of microgrids, storage systems, photovoltaic panels, and others.

The renewable energy transition can be a catalyst for revitalising rural and island areas, and the Interreg MED Renewable Energy Community aims to highlight the opportunities that exist, using its ETU Toolbox to create solutions for rural needs.

1. The Context of the Handbook

The Ecosystemic Transition Unit (ETU) is a governance model developed by the Interreg MED Renewable Energy Community through the ETU Initiative. The aim of the ETU Initiative is to promote a clean energy transition roadmap for rural areas and islands built upon the knowledge acquired during the recent years through EU Funding Projects. As energy transition represents a process linked closely to planning, management and governance of a territory, the Project proposes the ETU model and Toolbox as an instrument to mainstream it on real cases.

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The objective of the ETU Toolbox is to gather tools and methodologies that give support to energy transition initiatives as an open source for citizens and communities. The ETU Toolbox has as a first basis the most relevant outcomes and results obtained from the community of projects of the Interreg MED Renewable Energy from 2016 to 2019: The COMPOSE, ForBioEnergy, PRISMI, LOCAL4GREEN, StoRES and PEGASUS projects. All of these projects are the main contributors of the results exposed in this handbook.

At this stage, the ETU Toolbox is open to other tools that aim to gather the principles of the ETU Initiative and give support to a clean energy transition for rural villages and islands. This Handbook focuses on the ETU Toolbox, describing its logical framework as a manual for training purposes.

This Handbook is designed for the following target groups:

Local authorities, professionals and businesses dedicated to renewable energy and energy efficiency projects, academia and researchers.

2. Description of the ETU Toolbox

The ETU Toolbox organises the tools according to the following four pillars:

1. Energy Planning – the territorial pillar

The first pillar corresponds to the territorial component of the ETU model, the energy planning. In this case the pillar addresses to the urban and land use planning parameters that involves the local RES potential (wind, solar, biomass, geothermal) and design of a distributed grid and microgrids. The ETU Toolbox gathers for energy planning all those tools that support energy technicians/engineers and urban planners in the development of the Energy Plan.

The type of tools targeted to support energy planning are:

- Estimation of RES potential
- Estimation of energy demand
- Dimensioning of the energy infrastructure
- Optimisation of energy demands (orientation, greening strategies, etc.)
- Indicators’ estimation (emissions and energy balance)

2. Energy Facilities – the technological pillar

The second pillar represents the technological pillar of the ETU model, the energy facilities and equipment required for the functioning of the local energy community. The ETU Toolbox addresses for this pillar, all those tools that support the design, deployment, management of the Ecosystemic Transition Unit based on innovative, smart and green solutions.

The type of tools and methodologies targeted for the technological pillar are:

- RES infrastructure
- Microgrids' monitoring tools
- Digital tools for RES community management
- Monitoring tools and devices

3. Energy Communities – the social pillar

The third pillar responds to the social component of the ETU model, the energy communities. The ETU Toolbox gathers the tools that are useful for the management of the community, especially when it is the case of prosumers producing and sharing renewable energy at local levels.

The type of tools targeted are related to the following topics:

- Awareness campaigns
- Training tools for community facilitators
- Guidelines for community management
- Energy consumption monitoring tools
- COMPOSE sustainable energy planning tool
- PEGASUS business model

4. Energy Governance – the organisational and legal pillar

The fourth pillar of the ETU model focuses on the energy governance. The ETU Toolbox offers a set of policy recommendations at local level that encourage the multilevel coordination for a green local economy. This pillar will need to adapt to the regulatory framework of the allocated country and region. On the other side, energy governance should include the supporting tools for the ETU co-creation process.

The type of tools and methodologies targeted for the legal pillar are:

- Green fiscal policies
- Tax bonifications
- RES trade agreements among territories
- Funding subsidies and grants
- Financial schemes – crowdfunding
- Local energy community's legal entity

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3. Application of the ETU Toolbox

1. Key concepts regarding the scope of application

The scope of application of the ETU Toolbox is under the umbrella of transferring the results of EU funded projects in order to extend their application all over the Mediterranean Regions. For that purpose, the Project promotes the use of the ETU Toolbox mainly for the following applications:

- Supporting local authorities in the development of their energy transition initiatives
- Encouraging knowledge transfer to research and academic studies
- Supporting professionals and planners to develop projects that deal with energy efficiency
- Promoting citizens' awareness on renewable energies and energy efficiency

A set of training and dissemination tools have been provided to ensure the maximum transferring. This Handbook forms part of the training tools.

2. Training methodology

The ETU Toolbox encourages a training methodology that is complementary to the ETU model mainstreaming[1]. The Toolbox integrates the results produced within the six modular projects of the RES community a training methodology is suggested to follow.

- Dissemination of the Toolbox
    - Cycle of webinars address by project pilot cases and tools
    - Tutorials for each tool
- Application of the Toolbox in flagship cases
    - Identifying the necessities of target groups in each flagship case
    - Cycle of coaching working sessions (presential or online) to learn how to use the Toolbox
    - Application of tools and validation of results by experts (modular projects)

3. Joining the ETU Toolbox

The ETU Toolbox is open to adding tools that support clean energy transition. In the case of an EU Project interested to sum its tool into the ETU Toolbox, they must address the petition to the Interreg MED

[1] ETU White Paper explains the mainstreaming methodology of the overall governance model.

Renewable Energy Project. The Interreg MED Renewable Energy Project will evaluate the tools through the Scientific and Flagship Committees to validate their quality and coherence with their contribution to the ETU model.

The ETU Toolbox

- ENERGY GOVERNANCE
- ENERGY FACILITIES
- ENERGY PLANNING
- ENERGY COMMUNITIES

1. ENERGY PLANNING: The Sustainable Energy Planning of renewables respecting the natural and environmental constraints

1.1. Brief introduction

There are over 2,000 inhabited islands in the EU that are home to over 4% of European citizens. EU islands are facing unique challenges in terms of high energy costs and local CO_2 emissions, security of supply and system stability. Many of them have become energy innovation testbeds, where investing in renewable energy sources' (RES) exploitation is an effective way to meet their energy needs. In the Mediterranean area, despite the high potential of renewable energy, clean energy transition is a slow process, while Mediterranean islands (Misl) still depend highly on fossil fuels.

In the past few years, the focus has shifted towards finding ways to tackle these key challenges. This can eventually be possible by supporting the transition to a clean, secure, low-carbon energy system – in line with the overall EU Energy Union package and EU 2030-50 Strategies. For this, an integrated transnational approach is needed to assess and exploit local RES potential. The setting up of this new model for local renewable energy production has to be based on the integration of three pillars:

- Scientific knowledge
- Local authorities' engagement
- Citizen participation

Merging these three aspects, the new approach will be able to assess, map and finally promote the use of new hybrid systems that combine RES and state-of-the-art storage devices, in order to increase the share of RES, contributing to sustainable development and inclusive growth in the MED Programme area. This approach aspires to change the current energy model dominated by fossil fuels and strongly centralised, towards a new one based on distributed generation from RES and focused on territorial resources and local community needs.

PRISMI, with its useful Toolbox, aims to become the vehicle that addresses these challenges based on the aforementioned ideas effectively.

1.2. The PRISMI Toolbox: Sustainable energy planning in Mediterranean islands

PRISMI project is coordinated by the Sapienza University of Rome and it had 6 partners: The Centre for Renewable Energy Sources and Saving, University of Zagreb, the Cyprus Energy Agency, Piraeus University of Applied Sciences, Malta Intelligent Energy Management Agency and the Municipality of Favignana.

Project specific objectives:

Develop an integrated toolkit able to assess and map local renewable energy sources for the elaboration of targeted energy scenarios and related techno-economic feasibility analysis in MED islands

Support effective design and implementation of Sustainable Energy Action Plans (SEAPs)

Establish a Network of specialised agencies, public authorities and scientific institutions able to increase and exchange knowledge, skills and acceptability of RES in MED islands.

Figure 1 The PRISMI - Project specific objectives

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Project results:

Load-flow analysis for RES integration in island grids	The tool consists of a software application able to use GIS data jointly with electrical grid characteristics. The user can identify cases in which the installation of RES plants at specific points of the island grid could cause violation of the operating limits
GIS geo-database	The developed database contains data layers and queried thematic maps in case studies. It contains data about RES potential, environmental constraints, exsistent energy systems and buildings.
RES feasibility study and comparative analysis	The EnergyPLAN has been identified as the main simulation tool for energy scenarios; post-processing tools have been developed to facilitate the understanding of the EnergyPLAN results and thus to ease the development of SEAPs.
Preliminary SEAPs	Guidelines have been developedto help users to develop preliminary Sustainable Energy Action Plans (SEAPs). All SEAPs are aimed at diversifying the energy production by using RES where possible, increasing energy efficiency in buildings and in lighting systems, promoting the use of EVs and raising public awareness.
Results transferability report	•In this deliverable the main activities that have been carried out during the Project are presented, in order to establish the PRISMI Network, the two surveys and the regional engagement events, as well as their outcomes.

Figure 2 The PRISMI - Project results

Introduction, concept and functionality of the tools

In general, the PRISMI approach is outlined comprehensively in **Figure 3**, describing the logical action flow when using the PRISMI toolbox and overall approach.

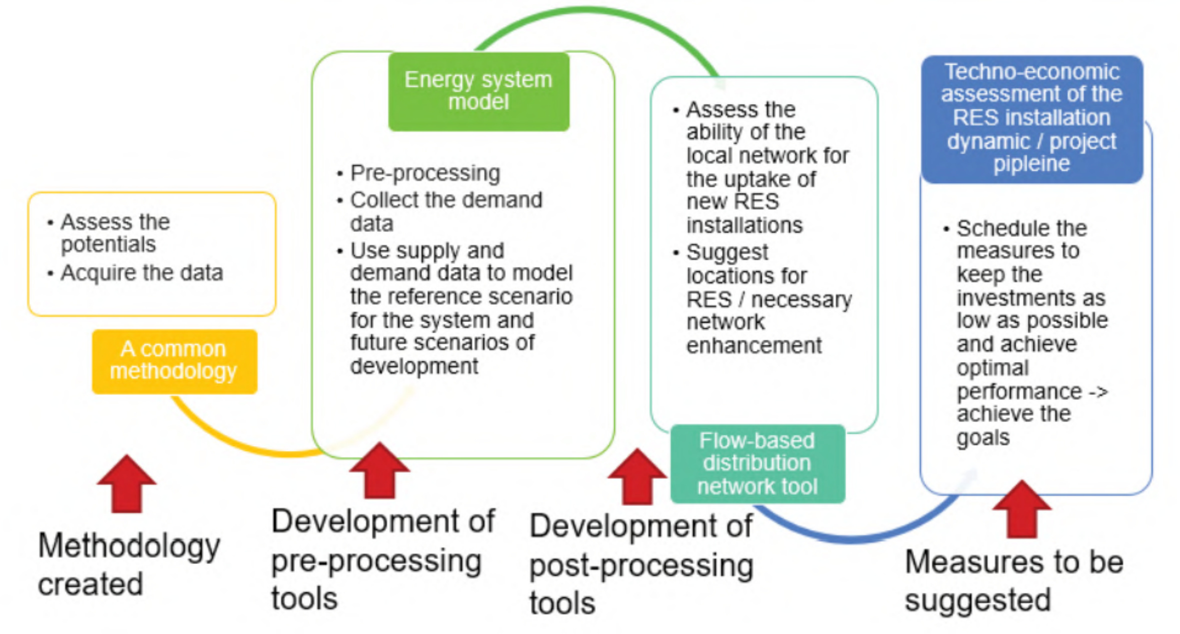

Figure 3 The PRISMI approach step-by-step

As the first step to devise the scenarios, the following methodology should be used for each case study.

1. Mapping the needs of the island community: In this step, needs are analysed and organised qualitatively in the Tables. Also, information must be acquired, such as electricity and heating/cooling demand.
2. Mapping the locally available resources: Data on the potential of local renewable energy sources is collected for analysis and further research. This part of the process is supported by the pre-processing tool – wind power calculator.
3. Technologies` overview for bridging the gap between needs and resources: Appropriate technologies, which can use locally available resources and can be deployed on the island, are taken into account.
4. Division of scenarios: Three scenarios are created to examine the energy system development of any island (LowRES, RES and HighRES).

In this way, each case study will have a short overview of available resources, present needs and available technologies as the basis for devising the scenarios.

LowRES scenario

- This scenario can represent the 'business as usual' case, based on current policies and documents of the Municipality or region. In this scenario, no additional measures would be suggested, and it will serve as a benchmark for other considerations. If there are no local policy guidelines, the scenario constraints can be extrapolated from the next nearest level of government, such as a Regional Development Strategy or National Development Strategy. Also, no additional technologies (unless proposed by the local strategic documents), such as vehicle-to-grid concept for electric vehicles, ice banks, heat storages, hydrogen generation and storage facilities or desalination facilities are planned in this scenario. This scenario can alsobe checked with the load-flow analysis tool.

RES scenario

- This scenario is formed by the technical limitations of the case study in question:
  - RES potential
  - Transfer capacities (if grid connected) and distribution capacities on the island
  - Critical excess electricity produced in island mode (to be kept under 5% of production from variable RES)
  - Environmental constraints limit the number of possible RES projects
- Within these limitations, the scenario proposes the highest possible integration of RES in the island's energy system, and forms a reasonable suggestion for improvements in SE(C)AP-s. It also includes demand response technologies such as EV-s in V2G mode, hydrogen production and storage, desalination units and other, if available. The influence of such technologies and their economic feasibility can be investigated in multiple RES scenarios. Scenarios should be checked with the load-flow analysis tool to verify the network availability against the siting of the RES installations.

HighRES scenario

- This scenario investigates the possibility for an island to become 100% renewable and independent. It aims to use most of the RES potential and all the additional technologies and modifications to the local grid, which would help to achieve the aim. It also provides the costs analysis for such approach.

The PRISMI Toolbox

PRISMI aims at developing an integrated tool, tailored to MED islands, able to assess and map RES potential. The integration of GIS and energy system models allows taking into consideration spatial constraints, and enabling factors offering a complete picture for energy systems` design. PRISMI methodology is based on three tools:

1. EnergyPLAN used for energy scenarios' modelling
2. Wind Power Calculator generating a wind power production hourly time series
3. Load-flow Tool analysing the RES impact on the grid

Figure 4, **Figure *5*** and **Figure 6** present three tools.

The last tool is the post-processing tool, that helps users interpret results and use them for SEAPs` development.

1. Wind speed and energy production calculator

The PRISMI Wind Power Calculator tool calculates the expected wind power output in the form of a yearly long hourly time series for sites in the Mediterranean islands. A tool operation representation is shown in **Figure 4**. The tool should be used for advisory purposes and rough estimations, and can in no case substitute standardised procedures and measurement campaigns for site assessment for wind energy developments. The scope of the tool is to deliver a yearly wind power time series for energy planning calculations. The requirements for the development of the tool were:

- Simple use in a Windows environment
- Compact data bases > Use of Open Data (i.e. MERRA wind speed estimations)
- Use of local data if available for more accurate estimations (met mast yearly data)
- Portability and direct run without installation procedures and dependencies

The tool is composed of the following components:

i. The MERRA wind speed database (all referenced to 50m agl). MERRA data deliver reliable results in terms of the diurnal, seasonal and yearly variation, yet a calibration is advised for correcting the average wind speed for the specific site. To this end, the estimation of the average wind speed can be retrieved either from an available Wind Atlas, or from measured wind potential campaigns. It must be noted that one can calibrate MERRA data with measurements either on the site or on a neighbouring site with similar topography.

ii. The calculator receives input data from a command line, selects the appropriate information from the data bases and delivers the hourly power output time series.

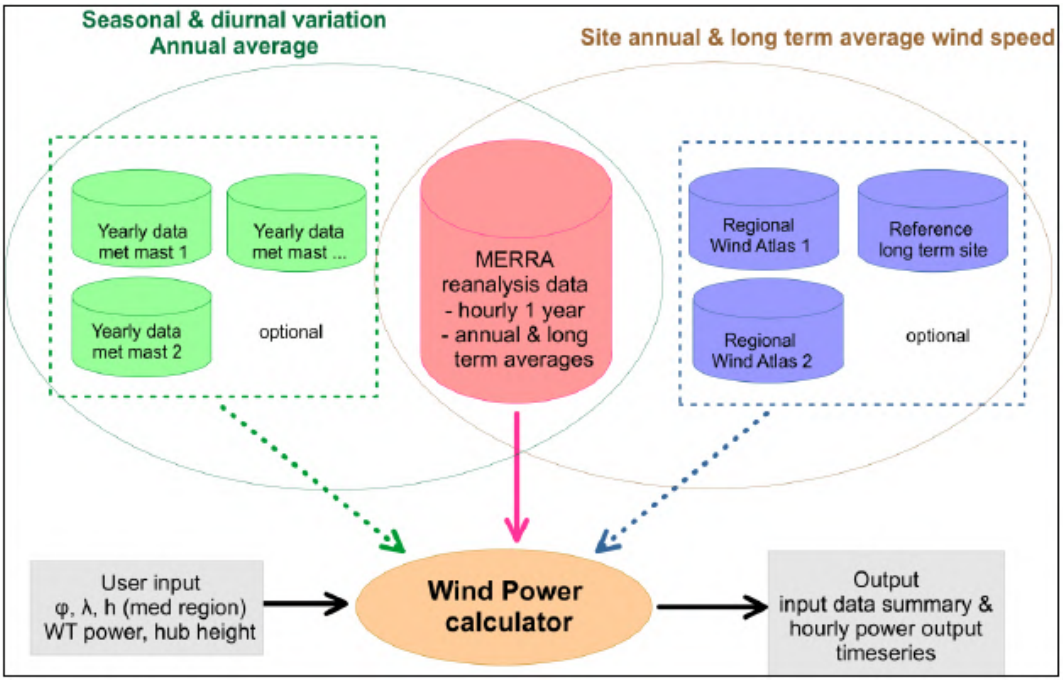

Figure 4 Wind speed and energy production calculator operation representation

2. EnergyPLAN model- Energy system modelling tool

The main purpose of the model is to assist the design of national energy planning strategies on the basis of technical and economic analyses of the consequences of different national energy systems and investments. A tool operation representation is shown in **Figure 5**.

The EnergyPLAN is an input/output model which incorporates heat and electricity supplies, as well as the Transport and Industrial sectors. It has already been used for the scenario analysis of energy systems with a high share of variable sources, as well as for the 100% renewable energy systems and various other analyses, which made it an established tool for similar applications. Details regarding EnergyPLAN in general can be found in the documentation, which is included in each new, downloadable version of the programme, and on the official website of the EnergyPLAN model. In the course of the PRISMI project, EnergyPLAN has been updated and tested on several case studies. New features, which have been tested in the Project and in several research papers, demonstrated the capacity of EnergyPLAN to simulate specific systems such as Mediterranean Islands with no fossil fuels for electricity generation.

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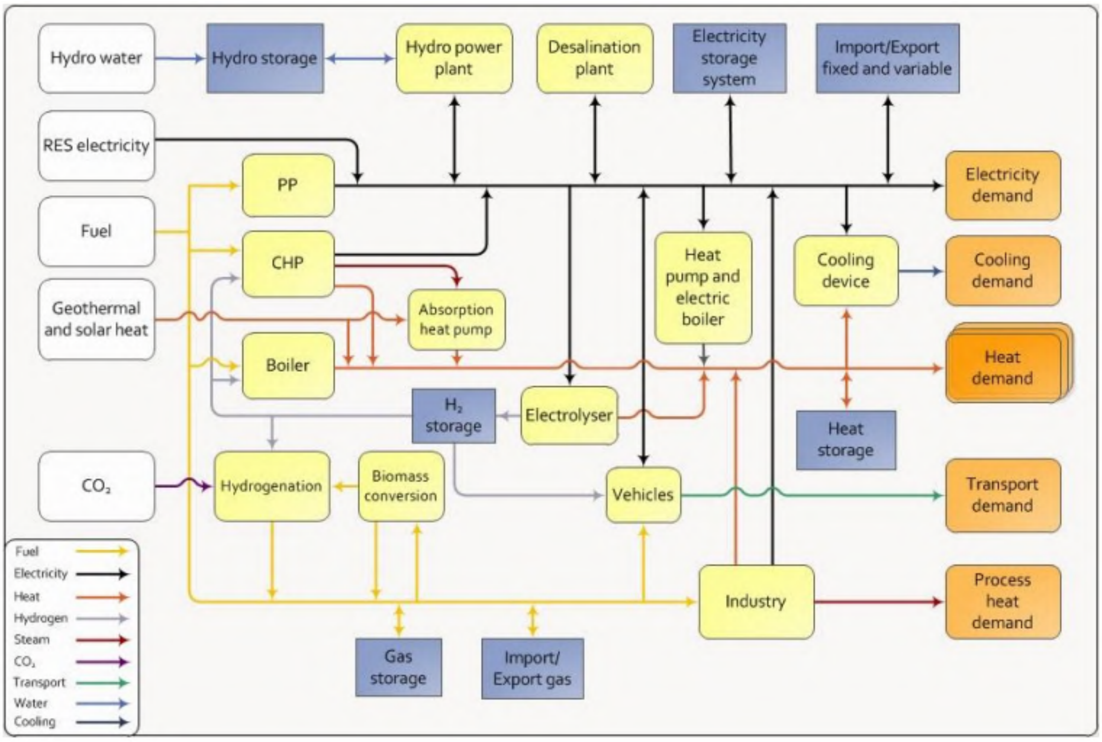

Figure 5 Energy PLAN model - Energy system modelling tool operation representation

3. Load flow tool

A tool for load-flow analysis has been developed as one of the key innovative features of the PRISMI project. The user can select among a number of pre-set system models or define their own grid parameters. Parameters can be changed in order for the user to be able to modify each scenario. The analysis can show potential conflicts in terms of voltage or power capacity at the selected connection points. The tool's interface connects all features in order for the user to be able to import data, illustrate the situation before and after processing, and identify potential conflicts graphically in terms of operating limits. The PRISMI load-flow tool has been developed as a standalone application of MATLAB®. A tool operation representation is shown in **Figure 6**.

To this end, a source code was developed in MATLAB. Subsequently, the standalone application was generated with the use of the MATLAB Compiler. In terms of the load-flow methodology, the calculation of the voltages is based on the well-known Newton-Raphson method. Also, the types of buses taken into account in the methodology are three: Slack (type 0), PQ (type 1) and PV buses (type 2). It is worth noting that, for the PV buses, the reactive power limitation is also taken into account.

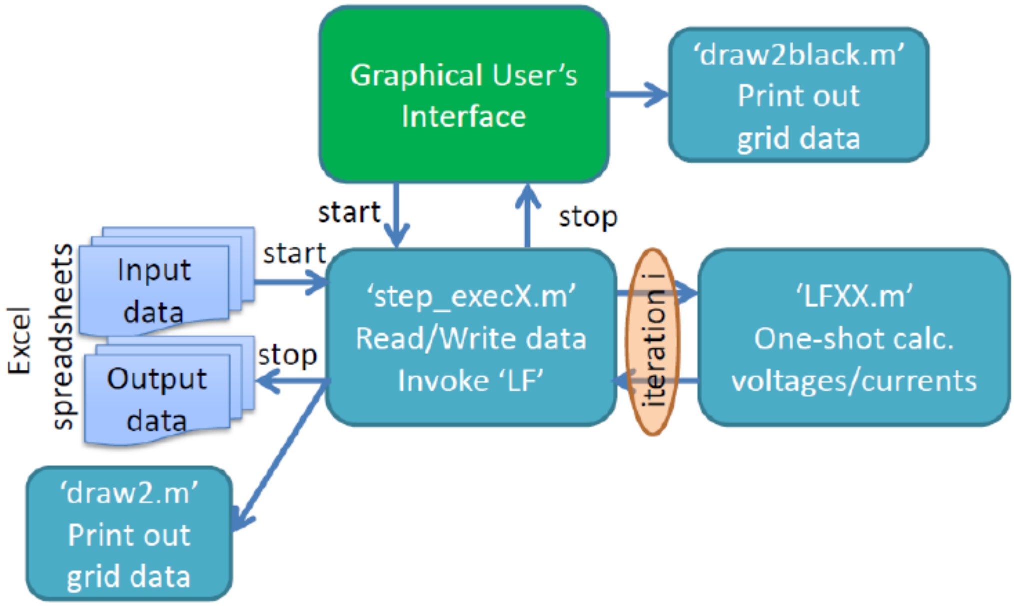

Figure 6 Load flow tool operation representation

Post-processing tool

In order to interpret the results easily, a post-processing tool has been developed in Microsoft Excel, which is a platform familiar to most users. This works simply by copying and pasting the outcomes of the simulation in EnergyPLAN. The most significant numerical results of the analysis will be presented in hourly diagrams and pie charts. An example of the results produced by the tool is depicted in **Figure 7**.

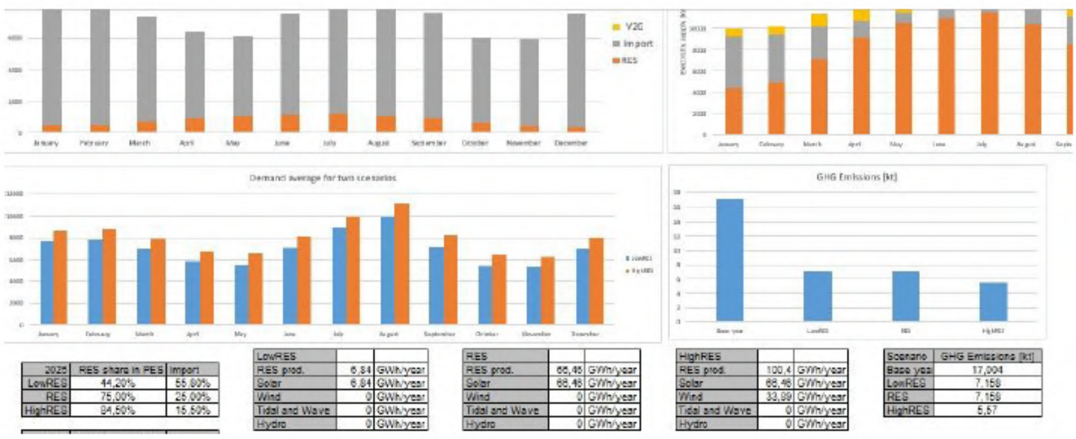

Figure 7 Post-processing tool results example

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The results are provided in several sheets, from overall results, techno-economic analysis, to hourly data. Also, in the socio-economic sheet, the tool provides information about the costs of each scenario, and about the full-time equivalent jobs created due to renewable energy installations, considered locally (downstream jobs such as engineering, operation and maintenance and installation). The goal of this tool is to make it as easy as possible for users to bridge the gap between software analysis of their energy system and creation of a strategic document, such as SEAP or SECAP. With this tool, most of the results are available immediately, and can be used for presentations or reports, as well as for the strategic documents. The PRISMI integrated toolbox (based on a transnational approach) addresses island energy issues by assessing and mapping Renewable Energy Sources for the elaboration of targeted energy scenarios in the electrical systems of the Mediterranean islands. The toolbox has been tested during the Project by developing Sustainable Energy and Climate Action Plans (SECAPs) in six study areas in the Mediterranean area.

Step-by-step instructions of using the tools

The whole PRISMI toolbox is distributed free of charge after filling in the PRISMI Network: Registration Form and sending it to the Project Coordinator davide.astiasogarcia@uniroma1.it on the PRISMI website.

Step-by-step instructions have been developed, and are included in the toolbox as part of PRISMI project activities for each of the tools. They have been prepared in English and are comprised of:

1. Wind speed and energy production calculator user guide
2. EnergyPLAN model- Energy system modelling tool user guide
3. Load flow tool user guide

Specifically for EnergyPLAN, a documentation of the tool and a guide for finding and inputting data into the tool (FIDE) are also available in the tool website.

Target groups

The main target groups of the Handbook are:

- Local authorities' employees and decision-makers
- Consultants specialised in energy planning and energy management
- National and regional authorities
- Stakeholders interested to promote and invest in renewable energy sources

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Case study (1 pilot action)

PRISMI methodology is applied to 5 Mediterranean islands taken as a case study:

Akamas Peninsula - CYPRUS -	Korčula & Vis Islands - CROATIA -	Tilos Island - GREECE -	Favignana Island - ITALY-	Gozo Region - MALTA -

Tilos island – Case study

Tilos island, comprising the demo-site of the TILOS system, is located at the south-eastern part of the Aegean Sea. The current electricity needs of Tilos (3.2 GWh per year, with an annual peak demand of approximately 1MW) are covered exclusively by the operation of the oil-fired power station of Kos island through an undersea cable of 20 kV that reaches the north side of the island after first crossing through Nisyros island. A depiction of the Tilos island sites of interventions is shown in **Figure 8** .

Figure 8 Tilos island sites of interventions

Concerning the breakdown of energy needs, out of the total electricity consumption of approximately 3.2 GWh, almost 300 MWh derive from public-use loads such as street lighting and water pumping, with the rest being attributed to the local residential and service sectors. This is largely owed to the fact that, due to the mild climate conditions, the islanders rely largely on the operation of air conditioning units for both space heating and cooling needs, while approximately 1/3 of the local building sector uses electrical water heaters for hot water needs.

Modelling results are presented in single figures for all three scenarios, to be easily comparable. For each scenario, a combination of RESs are used, as presented in **Figure 9** .

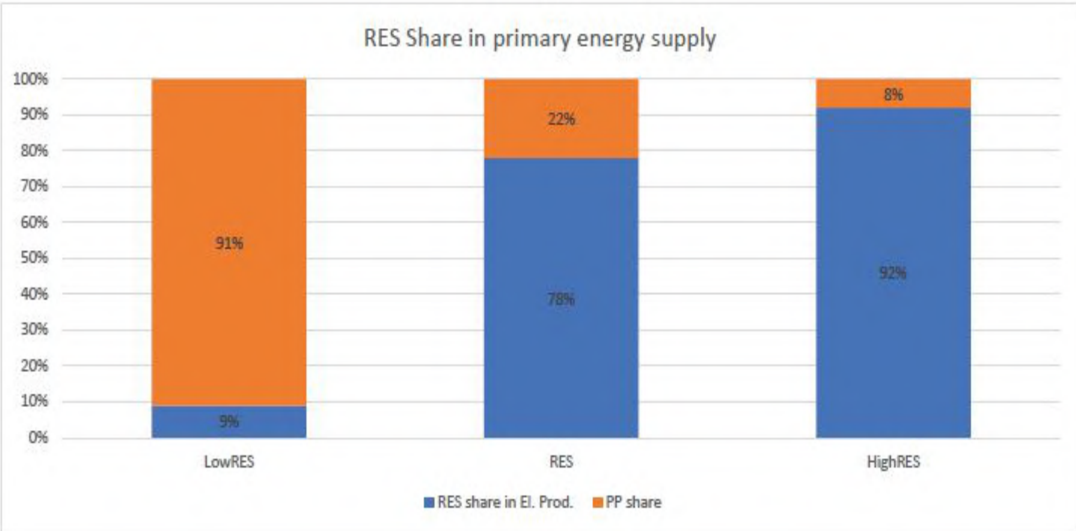

Figure 9 The combination of RESs used for each scenario

For each scenario, the combination of RESs used, as presented in **Table *1***

	LowRES	RES	HighRES
RES prod. (GWh/y)	0.27	2.29	2.69
Solar (GWh/y)	0.27	0.27	1.31
Wind (GWh/y)	0	2.02	1.38

Table 1 The combination of used RES for each scenario

Figure 10, GHG emissions are presented for each scenario. Also, for comparison, emissions in the base year are given.

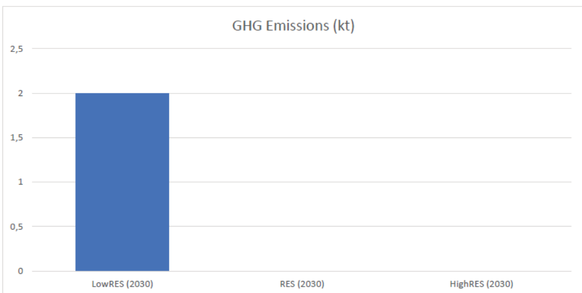

Figure 10 GHG emissions for each scenario

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The methodology has been applied to each of the case study areas, 6 in total, covering all countries involved in the Project. The tools elaboration includes a description of the case study and input data, results of modelling with discussion, socio-economic feasibility of adopted solutions and environmental considerations. All the energy scenarios analysed the diversification of RES production and the synergetic effects of connecting transport and energy production sectors through smart charging and the vehicle-to-grid concept by studying the introduction of EVs in both public and private mobility.

Potential barriers

Barriers identified are common to energy planning and energy management with RES integration. A list of some potential barriers is given below, **Figure 11**.

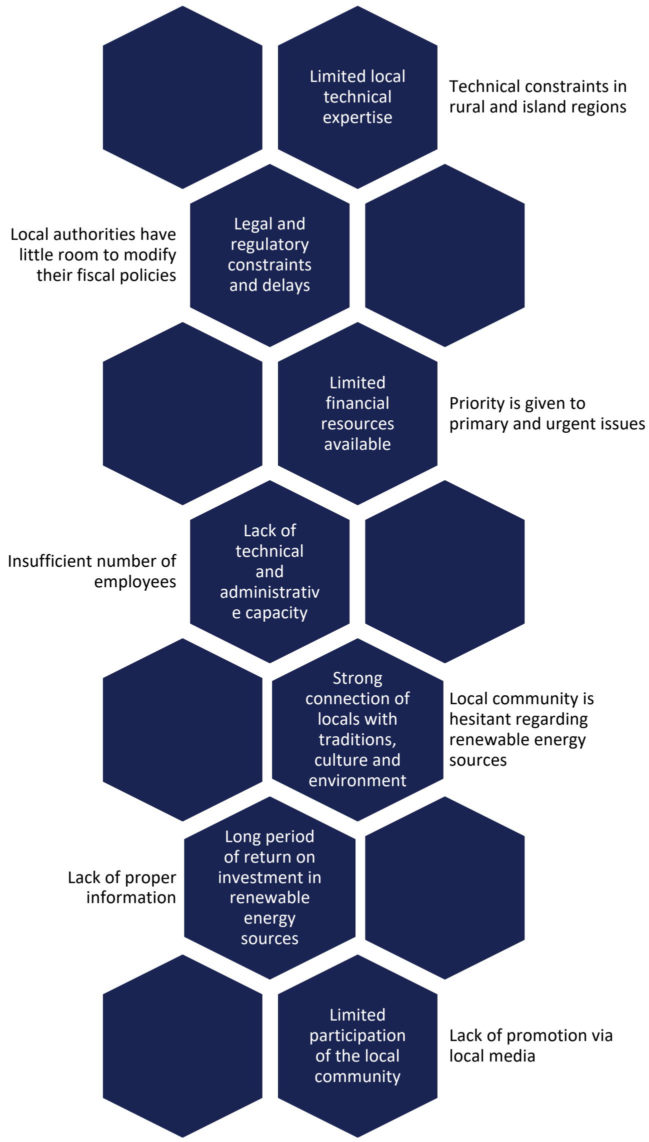

Figure 11 GHG emissions for each scenario

1.3. The ForBioEnergy tool: Assessing the degree of accessibility of forest surfaces and woody biomass availability in protected areas

Introduction, concept and function of the tool

In the framework of the ForBioEnergy project, a **Decision Support System** (DSS) tool has been developed to support the forest management and the biomass energy production in protected areas. Indeed, the main goal of the project is the enhancement of the forest biomass resources and bioenergy to provide a sustainable economic growth in rural areas of the Mediterranean (*see the box below 'The ForBioEnergy project'*).

After a survey analysis on the weaknesses and potentialities of the Bioenergy sector in the Mediterranean regions, the ForBioEnergy team has proposed a number of tools and guidelines to support decision-makers and rural communities in their action through the transition energy and the valorisation of their local resources. For this purpose, the DSS is the tool created to support decision-makers to define planning strategies for the development of wood-energy supply chains at local level. Two models were implemented and validated to support decision-makers analysing the spatial patterns of the woody biomass in a given area and its accessibility through the road network. Specifically, decision-makers are supported in the following topics:

- Forest accessibility assessment: i) To make aware maintenance of the forest road network and ii) To get information related to firefighting activities, pre-fire precautionary measures and post-fire operations
- Biomass supply basin definition;
- To propose planning strategies that minimise the overall costs and maximise the benefits for energy production from woody biomass.

The degree of accessibility of forest surfaces and identification of the potential biomass areas to set up the energy plant within the likely biomass supply chain are the main outputs of the tool.

The DSS is provided in the English language, and implemented on a GIS platform, both in ArcGIS and open-source QGIS software. From a practical point of view, the tool looks like a toolbox composed of two elements, defined as Base and Advanced Models, to be applied according to the different level of strategic analysis requested by the user.

The DSS is a tool with strategic and planning purposes involving public authorities directly, and, after a more deeply and advanced analysis, private actors and communities following the pillars of a sustainable territorial development. Its added value is the combination of an information system supporting the decision-making process with the GIS territorial analysis. Indeed, the visualisation and dissemination characteristics of the GIS software, combined with a decision-making tool, represent a winning solution for the land monitoring and strategic planning procedures.

The ForBioEnergy Project: Forest Bioenergy in the protected Mediterranean areas

The overall objective of the ForBioEnergy project is to foster the bio-energy production from forest in the protected areas of the Mediterranean, providing transnational solutions to reduce barriers hindering the development of the sector and planning models, in order to exploit the full potential of biomass and, at the same time, to preserve the biodiversity of the natural areas. ForBioEnergy transnational cooperation has had a dual function:

1. Identifying the most significant gap of administrative systems that prevent the use of forest biomass for energy purposes in the participating regions
2. Identifying best practices that will enable the regions to remove barriers and overcome obstacles that till now have not found a solution within its borders.

Budget:

1. Project total budget: 2,048,847.48 €
2. Duration: 32 months (from 2016 to 2019)

Countries involved: Italy, Slovenia, Spain, Croatia

Partners and associated partners:

LP Sicily Region – Councillorship for Agriculture, Rural Development and Mediterranean Fishing – Regional Department for the Rural and Territorial Development (IT)

1. Municipality of Petralia Sottana (IT)
2. Enviland ltd (IT)
3. Slovenian Forestry Institute (SI)
4. Regional Development Agency Green Kast Ltd (SI)
5. The Forestry Municipalities Association of Comunitat Valenciana (SP)
6. Valencia Official Chamber of Commerce, Industry, Services and Shipping (SP)
7. Zadar County (HR)
8. Public Institution Nature Park Velebit (HR)

Box 1 The ForBioEnergy project

Step-by-step instructions for using the tool

As a first step, the identification and finding of all useful information to apply in the tool is necessary. The data are mainly geographical vector files concerning forest and agricultural data, a territorial model, administrative boundaries and road network. Most of them are freely available from national-regional geographical platforms or from international ones, such as the Copernicus website, providing data for each European country. Since part of the information regarding forest and timber assortments can be related to regional land management plans, some of these specific data (biomass district area for example) are often easy to find among regional or public administration's users. This finds a strict correlation with the final target group though, for the tool, meaning decision-makers and public authorities dealing with territorial and strategic planning.

Coming to the DSS tool, two steps characterise it: The Base and the Advance Models. They are complementary for the final establishment of a bioenergy plant, and each of them provides results required for different steps of the biomass energy strategy's design: The degree of accessibility of forest surfaces and the availability of woody biomass in a given area of interest for managing biomass supply chains.

The DSS basic version: The Base Model

As a first step, the application of the tool on the open-source QGIS software (GRASS, SAGA, GDAL included) consists of its uploading on the 'Graphical Modeller' from the 'Processing' menu (**Figure 12**): The Modeller reads the models directly from the user's folder, then runs the tool by clicking on the right control at the top bar (**Figure 13**).

Figure 12 The menu Processing provides access to Graphical Modeller

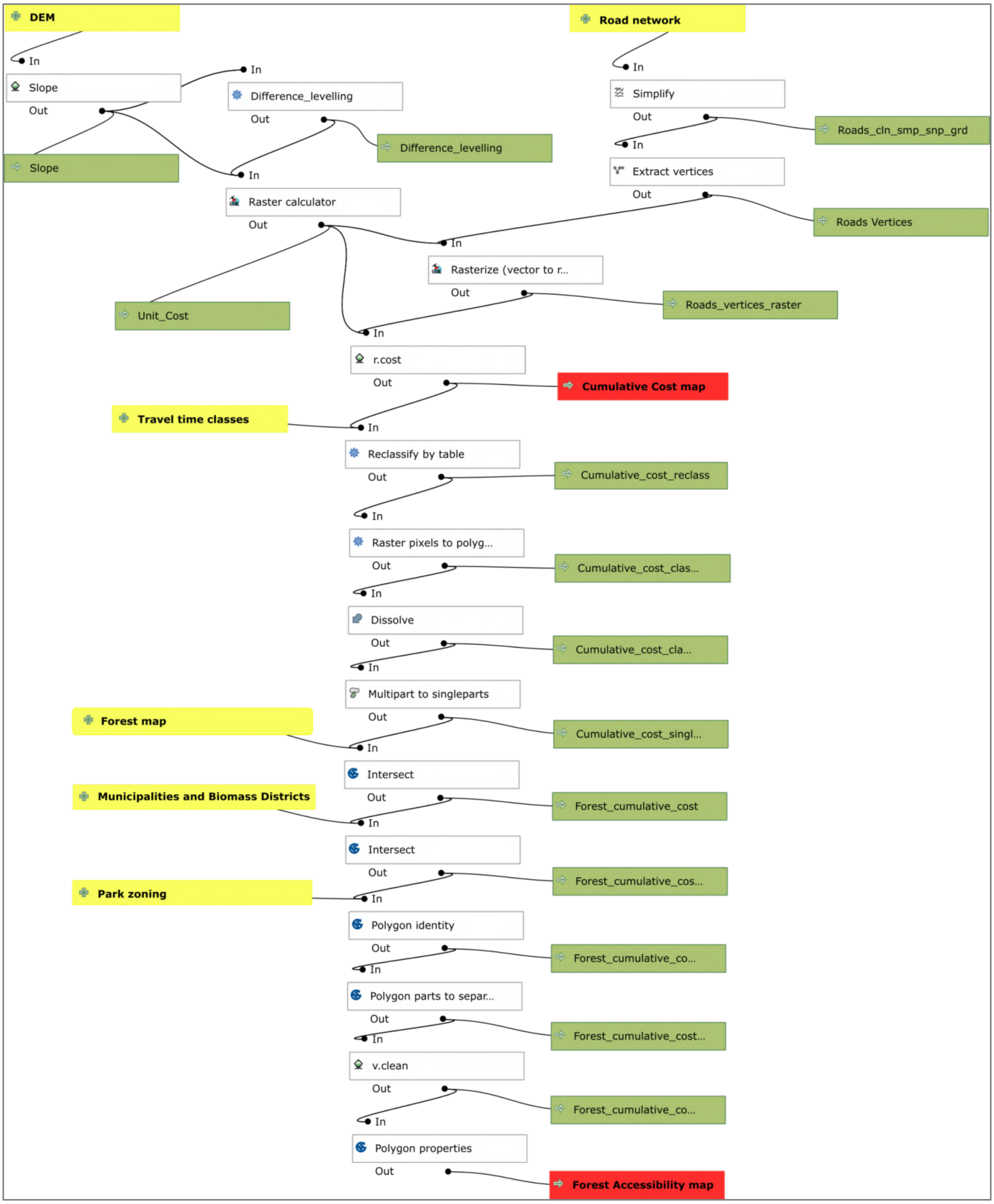

Figure 13 Implemented Workflow of the base model: Inputs in yellow, applied algorithms in white, temporary outputs in green, main outputs in red.

The first step was the **Input** dataset definition, including raster and vector layers:

- **DEM** (raster layer) = Digital Elevation Model, with 10x10m resolution and background pixels filled in with null values and not zero;
- **Natural protected area map** (vector layer);
- **Forest areas** (vector layer) within the protected area, and codified according to the Forest Type classification (CLC classification level IV if the Forest Type is not available);
- **Biomass district** and **Municipalities** (vector layers) included into the protected area;
- **Road network** (vector layer) with relative classification, and including main roads, secondary and forest roads.

So, the workflow (**Figure 14**) is defined by adding algorithms and selecting how they use those inputs, or the outputs generated by other algorithms already in the model. The layers generated by the **Algorithms** are just temporary outputs that will be used as the input of another algorithm or definitive **Outputs**.

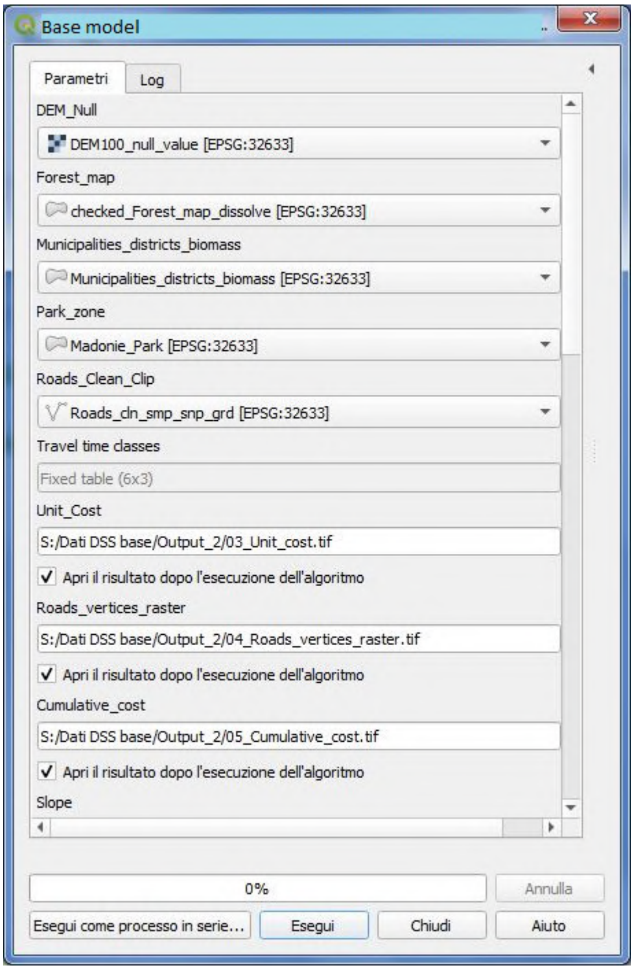

Figure 14 The dashboard of the Base model

The DSS basic version will read the data uploaded into the tool, design and set up the database required to apply a spatial-temporal analysis and hypothesise different scenarios visualised on QGIS graphically.

During the elaboration, the tool expects to calculate the time of accessibility to the biomass districts using small classes of 10 minutes and considering a maximum time of 1 hour. Here, accessibility means the time required for a forest worker to make a round trip on foot from the nearest road to a given point in the forest. Conventionally, the climbing speed used to calculate this time of access is fixed at 400 m/h for slopes between two points higher than 10%, and at 4 km/h for slopes lower than 10%.

The core of the tool are the data referred to the available biomass in protected areas studied, so that the biomass district and Municipalities layer assume a relevant importance: For biomass district is meant the area with a certain bioenergy potential, and it can be identified by the user, or come from territorial management plans at regional or national levels.

The main outputs are: i) The **Cumulative Cost map**, a raster including the information concerning the crossing time for each pixel, starting from a generic position of the roads network, and ii) The **Forest Accessibility map (Figure 15)**, that is a vector layer containing information regarding the forest type, the access time classes within a 60 minutes walking round trip, biomass district, Municipalities, park zoning and surface area.

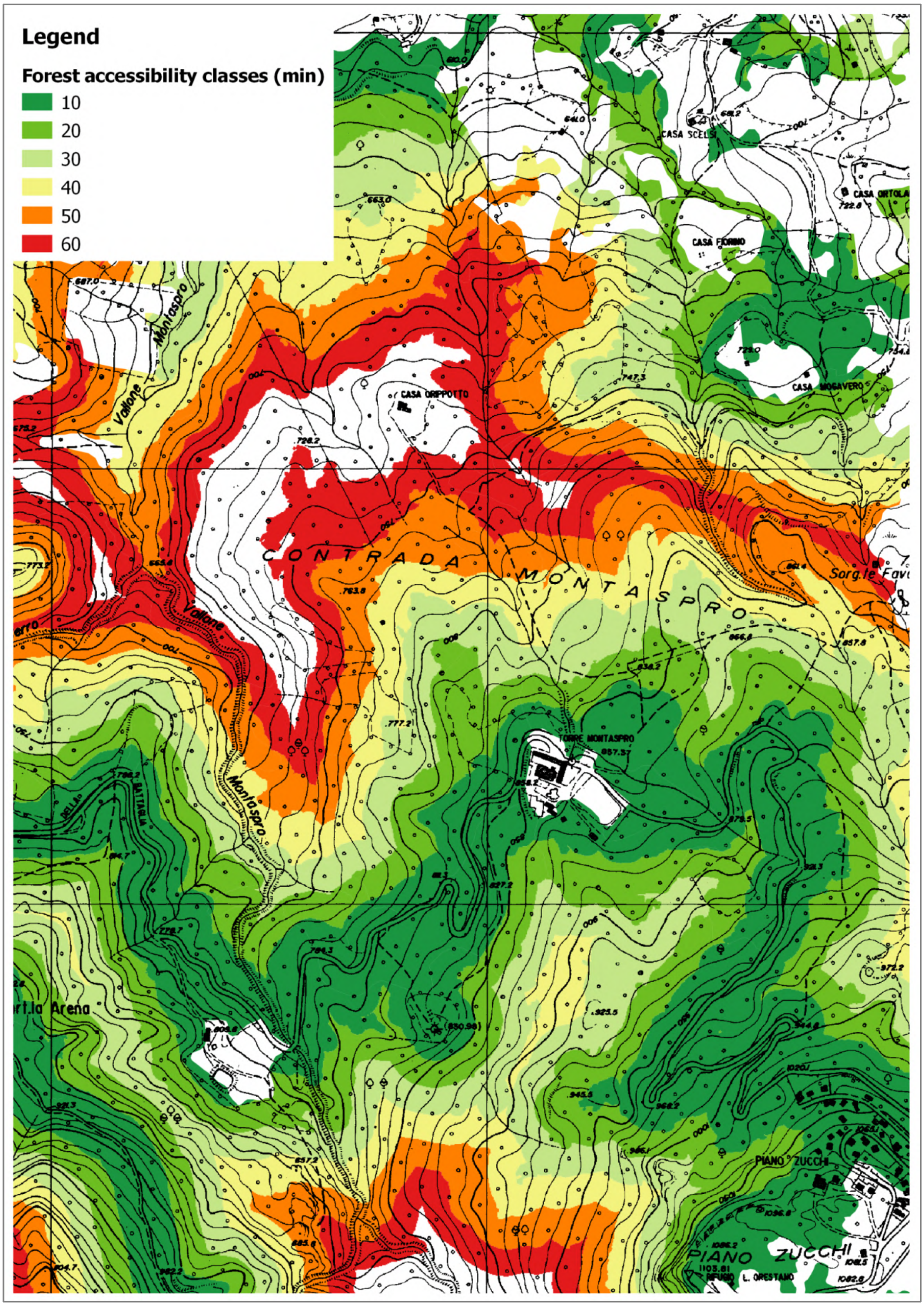

Figure 15 The detail of a Forest accessibility map

At this basic level of analysis, several considerations can be carried out: The accessible biomass can be identified and analysed according to the protected area, the territorial zones in which the park is divided, the districts and the Municipalities involved. For each analysis the accessible area, effectively, the available forest type category and the time class of access are the main factors carrying on the discussion (Figure above).

The DSS advanced version: The Advance Model

Ongoing with the forest availability analysis, it proceeds with the second step and loading the DSS Advanced Model tool in the 'Processing' menu as before (**Figure 16**). This model aims to assist decision-makers for i) Accessing the Forest Management Plan database, and ii) Quantifying the woody biomass available for energy and heat production in a test area.

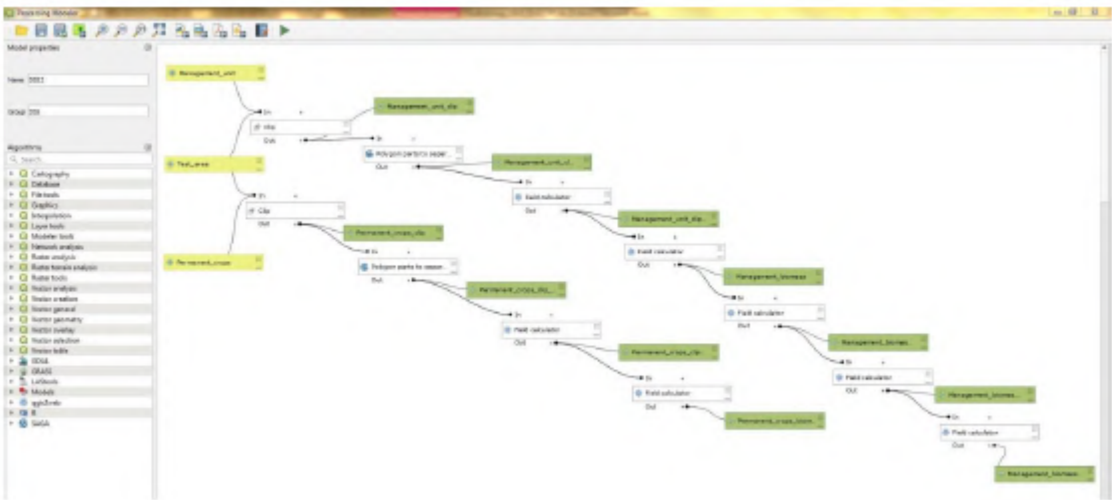

Figure 16 Implemented Workflow of Advance model

The input data are now concerned with the following themes:

- **A Management units** vector layer, resulting from a Forest Management Plan (FMP) prepared for a selected biomass district. For each forest management unit, are described: ID unit, ID sub-unit, surface, ownership (public or private), Municipality, forest type, prevailing topography (altitude, slope and aspect), prevailing function (protective, productive or naturalistic), main dendrometric and biomass parameters at stand scale (species` composition and density, basal area, average diameter, average height, growing stock volume, total biomass yield and biomass yield for energy purposes), stand structure (e.g. coppice or high forest), silvicultural treatments and timings;
- **A Permanent crops** vector layer, resulting from anFMP prepared for a selected biomass district. The following information is described for each unit: Land use class according to the CLC level-3

nomenclature (221-vineyard, 222-fruit trees and berry plantations, or 223-olive groves), surface, available woody biomass per unit surface and total available woody biomass.

- **Test area** (vector layer), added by the user.

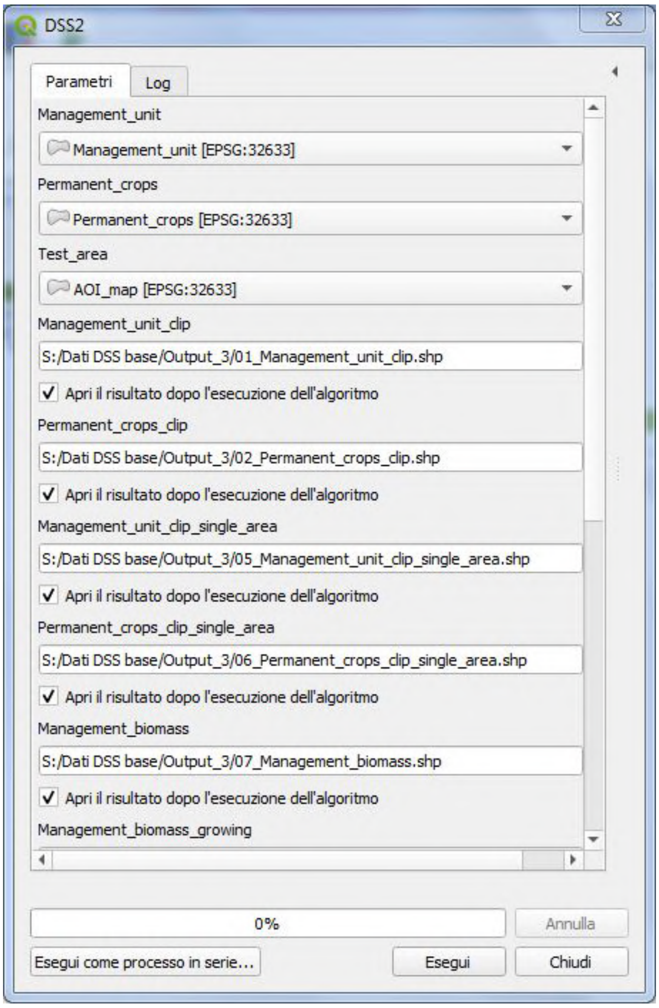

Figure 17 The dashboard of the Advance model

This model is structured in two sub-models that recalculate the biomass data (*e.g.,* growing stock volume, total biomass, biomass yield for energy purposes) associated to a test area. Each sub-model can be run individually by deactivating the other one.

As a final output, the DSS advanced model provides the biomass supply area required to build a biomass energy plant that satisfies the energy needs of the Municipalities served, and that rely on the available woody biomass.

Specifically, the results are two vector layers called **Management Unit Clip** and **Permanent Crops Clip** (**Figure 18**): The first one identifies the biomass area in terms of Municipalities and protected areas involved, surface, quantity of growing stock, biomass and timber assortments; the second layer identifies the biomass area in terms of surface and quantity of permanent crops available in the test area set by the user.

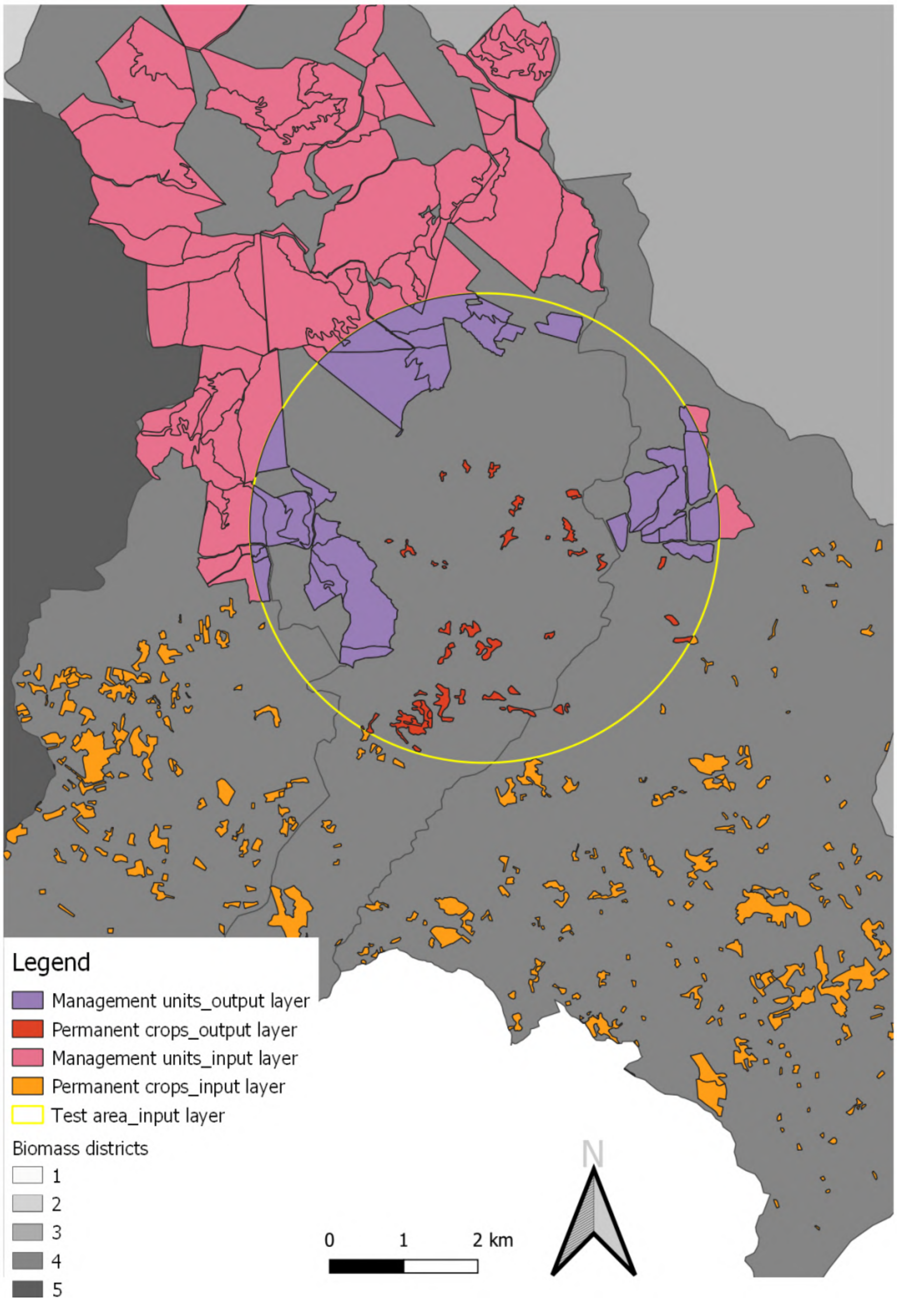

Figure 18 Map of woody biomass availability in a given test area

From the knowledge of woody biomass availability, the decision-makers can finally hypothesise different scenarios of bioenergy planning, testing the feasibility of a biomass energy plant, the power needed to respond to the energy needs and the available biomass resources.

After this advanced step, all the supporting information for the strategic planning has been released, and it is for the decision-maker in charge to promote the action and valorise the biomass potentiality to boost the local economic development of the rural areas.

Target groups

The tool has been designed to support authorities and decision-making bodies whose first activities are land monitoring and strategic planning procedures. Then, the main target group are public authorities at regional or sub-regional levels involved directly in the territorial strategic planning (such as regional public bodies, provincial public bodies or Local Action Groups LAG), for which the tool would represent a simplification analysis and comparison among different scenarios.

Since the DSS is available on a GIS platform, competences and experience in spatial analysis software (and python languages eventually) are mandatory skills required in order to run it and manage the data. Therefore, authorities with these kind of skills or their supporting technicians are the final receivers.

Case study

In support of the DSS tool description, its application in one of the pilot areas identified in the ForBioEnergy project is reported here: The Madonie Regional Natural Park, located in Sicily (Italy).

The DSS Base Model has revealed a wide area of the Madonie Park accessible within the time interval of one hour as established in the tool. The results related to the zones identified in the park show a minimum of 85% of accessible forest area, with a maximum of 100% in C zone, as shown below in

Park zone	Total forest area	Accessible forest area	
	ha	ha	%
	a	*b*	*c=b/a*100*
A	4.124,94	3.531,98	85,6
B	8.521,37	8.232,53	96,6
C	133,52	133,52	100,0
D	4.587,17	4.580,69	99,9
OUT	13.886,20	13.688,80	98,6
Total	**31.253,20**	**30.109,25**	---

Table 2.

Table 2. Accessibility of forest areas in the different zones of the Madonie Natural Park

The respective biomass districts and Municipalities of this zone are identified with Geraci Siculo, Petralia Sottana and Caltavulturo in different biomass districts, while the lowest value is registered only for the Municipalities of District 2 -see below

Table 3.

Biomass District	Municipality	Forest area in the Municipality	Forest area in the District	Accessible forest areas in the Municipality		Accessible forest area in the District	
		ha	ha	ha	%	ha	%
		a	*b*	*c*	*d=c/a*100*	*e*	*f=e/b*100*
1	Cefalù	2.406,07	9.845,86	2.347,50	97,6	9.677,64	98,3
	Pollina	2.190,67		2.154,60	98,4		
	San Mauro Castelverde	5.249,12		5.175,54	98,6		
2	Collesano	1.898,72	6.347,64	1.738,33	91,6	5.560,49	87,6
	Gratteri	1.535,64		1.521,75	99,1		
	Isnello	2.913,28		2.300,41	79,0		
3	Castelbuono	2.352,79	6.362,42	2.317,24	98,5	6.326,87	99,4
	Geraci Siculo	4.009,63		4.009,63	100,0		
4	Castellana Sicula	476,88	4.583,54	472,99	99,2	4.504,66	98,3
	Petralia Soprana	643,96		643,96	100,0		
	Petralia Sottana	3.462,70		3.387,71	97,8		
5	Caltavuturo	501,66	4.113,74	501,66	100,0	4.039,59	98,2
	Polizzi Generosa	1.714,98		1.710,53	99,7		
	Scillato	531,79		494,13	92,9		
	Sclafani Bagni	1.365,31		1.333,27	97,7		
Total		**31.253,20**	**31.253,20**	**30.109,25**	**---**	**30.109,25**	**---**

Table 3 Accessibility of the forest areas in the Municipalities and Biomass Districts of the Madonie Natural Park

If focusing on one of the Municipalities with the best results, like Petralia Sottana, it is possible to continue the analysis identifying the specific class time of access and the related amount of surface as shown in the following tables:

Forest access time (minutes)	ha
10	1.856,69
20	488,59
30	350,89
40	307,88
50	241,36
60	142,30
Total	**3.387,71**

Table 4 Accessibility of forest areas in the Municipality of Petralia Sottana.

For Petralia Sottana, half of the forest surface area is easily accessible within a time of the 10 minutes class, while the remaining area shows different accessibility, distributed in the other time classes included in the 60 minutes limit (**Table 4**, **Figure 19**).

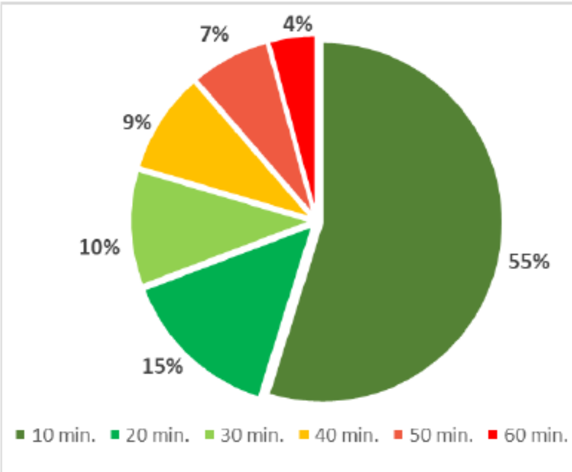

Figure 19 The accessibility of forest areas distributed in the different access time classes (in %) in the Municipality of Petralia Sottana

The tool also identifies the forest type of access and, with the advanced tool application, even the amount of wood and crop assortments available in the area where the energy plant should be set up (**Table 5**, **Figure 20**).

Forest category	Total forest area	Accessible forest area	
	ha	ha	%
	a	*b*	*c=b/a*100*
BA	316,17	316,17	100,0
BS	2,95	2,95	100,0
CA	37,07	35,49	95,7
FA	1.072,85	1.032,07	96,2
FR	306,39	290,10	94,7
LE	371,89	359,70	96,7
QU	708,62	708,62	100,0
RI	646,76	642,61	99,4
Total	**3.462,70**	**3.387,71**	**---**

Table 5 Accessibility of forest areas by forest category in the Municipality of Petralia Sottana.

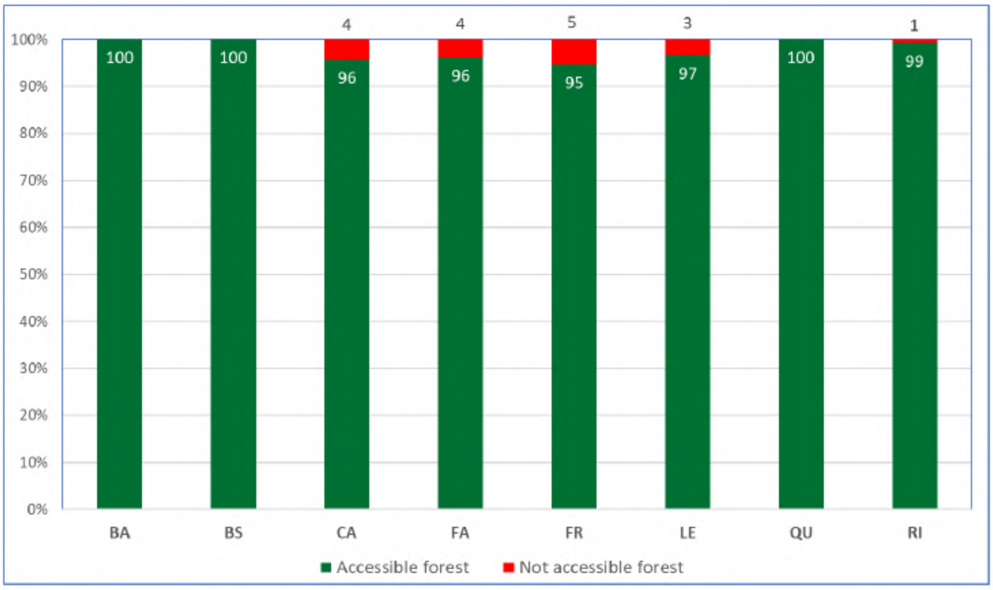

Figure 20 Percentage distribution of the accessibility of forest areas by forest category in the Municipality of Petralia Sottana

COD.	
CATEGORY	NAME
BA	"Woods of other broadleaf trees";
BS	"Pioneer and secondary formations";
CA	"Chestnut woods";
EC	"Turkey oak forests";
FA	"Beech forests";
FR	"Riparian formations";
THE	"Holm oak forests";
PM	"Mediterranean pine forests";
QU	"Downy oak forests";
RI	"Plantations";
ON	"Cork oak forests".

Table 6 Forest type classification

Potential barriers

Analysing the DSS tool in its whole, some potential barriers that could affect the effectiveness of its application could be the data availability and the information processing during the initial phase.

An intermediate knowledge of the GIS software use is mandatory in order to run the two versions of the tool correctly, during its launching and in the previous step of the shapefile processing. It is not only necessary to have GIS skills in order to elaborate the input data in the right format, but also to know where to find them in free online platforms or in other websites.

As already mention before, some of the data are also not always available at all levels, but often common among regional and sub-regional public bodies dealing with territorial planning, besides representing the final target group for which the DSS tools have been designed.

2. ENERGY COMMUNITIES:
How to empower and engage the community

The European legislation plans the possibility to create forms of collective self-consumption of renewable and non-renewable energy, identifying two types of new legal entities: The Renewable Energy Community (REC) in the Directive 2018/2001 (to be transposed into the national legislation by June 30, 2021) and the Citizen Energy Community (CEC) in the Directive 2019/944 (to be transposed into the national legislation by December 30, 2020).

REC: An autonomous entity based on the voluntary participation of public and private entities, whose main objective is to provide through renewable energy production and sharing, also by means of storage, environmental, economic or social benefits at community level, rather than financial profits. The activity of electricity distribution is not contemplated.

CEC: An autonomous entity whose purpose, participation and social mission are the same as those provided for REC, but whose definition is independent of the renewable nature of energy. It may include possession and management of the electricity grid within the community (electricity distribution service), and can provide the provision of energy efficiency services or energy services in the broad sense to the community members.

Both EU Directives introduce new consumers` typologies:
The ‘prosumer’ (Art. 21 EU Directive 2018/2001) coincides with a ‘self-consumer of renewable energy’ who, individually or through aggregators, is authorised to:

- Produce renewable energy, also for its own consumption
- Store and sell production surpluses through Purchase Agreements without being subject to discriminatory or disproportionate charges
- Install and manage electricity storage systems combined with RES generation plants for self-consumption purposes
- Maintain rights and obligations as an end customer

The Active customer (Directive 944/2019), similar to the Prosumer, intended as an end customer or group of consortium end customers who consume or store or sell electricity (independently from the source) considering that these activities do not constitute the main commercial or professional activity.

With these two Directives, citizens have the possibility to become active in their energy consumption process and, consequently, protagonists of the energy market at local level. Once the EU Directives will be transposed at national levels, citizens will have to be informed about the different possibilities. Citizens and Municipalities will have to be supported to create energy communities.

The Sustainable Energy Planning model and decision support online toolbox developed by the COMPOSE Project represents a methodological, legislative and technical asset for the creation of an energy community, and not only, generally speaking, for the implementation of energy efficiency and energy transition actions at local level.

2.1. Citizens' awareness raising to implementation of concrete actions: The COMPOSE tool

Introduction, concept and function of the tools

The Sustainable Energy Planning Toolbox is a tool built in the framework of the Interreg MED project 'Rural Communities Engaged with Positive Energy - COMPOSE'. The tool was carried out between 2016 to 2019 by the Technical University of Crete, in collaboration with a variety of regional partners. The Sustainable Energy Planning Toolbox is a step-by-step, bottom-up methodological approach for designing, planning, implementing, and evaluating sustainable energy projects.

Through the Toolbox you get access to:

- Planning and design tools to support RES and energy efficiency projects
- Databases to help you define your project's baseline
- Technical guides and useful links that can assist in the development process
- Sustainable energy case studies, and
- The most recent EU energy policies and supporting instruments

Step-by-step instructions for using the tools

The COMPOSE Toolbox is divided conceptually into two parts, the first one refers to the COMPOSE model and indicators structured in six steps. Then the second part refers to the access to useful resources for your energy action plan.

Overview of the COMPOSE model and indicators

This Handbook supports policy makers, development planners and local authorities who are involved in the development and implementation of local and regional energy plans, and in the creation of low carbon communities. The Handbook will help these users to exploit the potential in their local areas, and integrate technical, socio-economic, and environmental factors into their planning.

The COMPOSE model suggests the following six steps to carry out an energy action plan:

1. Choose a problem
2. Create a local action group
3. Develop a local action plan
4. Create local partnerships
5. Identify implementation procedures
6. Ensure monitoring and evaluation

Furthermore, the COMPOSE model is based on with two horizontal actions:

1. Empowering local skills and policies
2. Raising awareness

Step 1. Choose a problem

The first step is to identify the local energy needs and evaluate the existing local RES. A preliminary analysis of the energy needs of the local community is essential to define the most adequate proposals and measures for energy efficiency and renewable energy sources. In order to do this, the tool offers useful resources including databases, EU policies and links to reports on efficient buildings and renewable energy implementation.

To estimate the local renewable energy and energy efficiency potential, the online tool offers links to reliable sites to help assess a region's energy potential for various renewable energy sources: Wind, solar, biomass, bioenergy, and geothermal. Users will also have access to recommended online tools for analysing energy efficiency, such as the CommonONEnergy Tool.

Step 2. Create a Local Action Group

The second step of the COMPOSE model is the creation of a Local Action Group, as engaging local communities and stakeholders in sustainable energy planning is essential to successful results. Establishing a Local Action Group facilitates cooperation amongst decision-makers, public authorities, and local and regional stakeholders, and is recommended for all renewable energy implementation plans.

The main objective of this step is to assess the target region's energy priorities and local needs. This is followed by an assessment of different technical solutions and plans, local capacity building activities, and the identification of tools to increase public awareness and monitor project progress.

Building trust is key for engaging local stakeholders, and it is, therefore, necessary to develop a participatory process that encourages dialogue to define the best common solutions, willingness to explain project proposals clearly, willingness to cooperate in the long-run, and commitment to continue with the project despite possible initial failures.

Step 3. Develop a Local Action Plan

The Local Action Plan translates the long-term strategy into immediate actions. For this step the COMPOSE model suggests summarising the inputs from the Local Action Group and shaping it into an action plan. There are several elements to bear in mind with this step: Technical and economic capabilities, achievability of the plans, and the potential contribution of these plans to a wider circular economy approach.

Step 4. Create local partnerships

The COMPOSE model's fourth step focuses on the creation of local partnerships, with both public sector actors and private investors. Local partnerships may be linked to the Local Action Groups created, and will aim to boost the development of solutions, energy efficiency projects, or even a local energy community.

Building local partnerships begins by assigning specific roles and tasks clearly, studying similar initiatives, best practices, and opportunities, and developing a detailed and realistic financial plan. This step includes consideration of the financing opportunities from EU and national subsidies, EU Project assistance, and alternative financing schemes (loans, grants, etc.).

Step 5. Identify implementation procedures

This is one of the model's most important steps. The implementation procedures and supporting mechanisms must be in line with the regulation and licensing systems of the country and region in which the renewable energy project will take place. The main challenge of this step is to put ideas into practice, and requires the following: Assign a qualified and experienced management and implementation team, set a realistic timeline of actions, provide all necessary documentation, develop a risk mitigation plan, and an implementation plan approved by all actors involved.

Step 6. Ensure monitoring and evaluation

The project assessment system proposed by the COMPOSE model is divided into four thematic groups of indicators: Environmental, energy, economic, and social. Indicators for each of these thematic groups include:

- Environmental: Greenhouse gas emissions, impact on air quality and noise pollution, and management of waste generated by the Project.
- Energy: Share of energy coming from RES and natural resources in energy consumption and production.
- Economic: Number of jobs created, , RES investment achieved, and new policies developed as a result of the Project.
- Social: Improvements in the health and well-being of local residents, knowledge and innovation, and increased employment.

Horizontal approaches

The Toolbox proposes two horizontal approaches for the whole cycle, which are: Empowering local skills and policies, and secondly, raising awareness. The approaches are:

1. Empowering local skills and policies

Lack of knowledge and skills is a common obstacle that local authorities face to implement their local energy action plan successfully. This Sustainable Energy Local Planning Toolbox provides links to several guidelines for assessing local needs for capacity and assets, and training materials and methodologies for target groups, including policy makers and development planners.

2. Raising awareness

Engaging people to understand the benefits of supporting their local energy action plan requires an awareness campaign, and includes:

- Identification of the target groups,
- Definition of the communication channels for each target group
- Development of marketing messages for each target group, and
- Estimation of the budget and resources required for the awareness campaign.

Accessing useful resources for your energy action plan

The Sustainable Energy Planning Toolbox website offers links to various databases, project maps, recommended indicators, design tools, practical guides, and EU policies, amongst others. To access this information from the website navigate through 'RESOURCES' in the top menu.

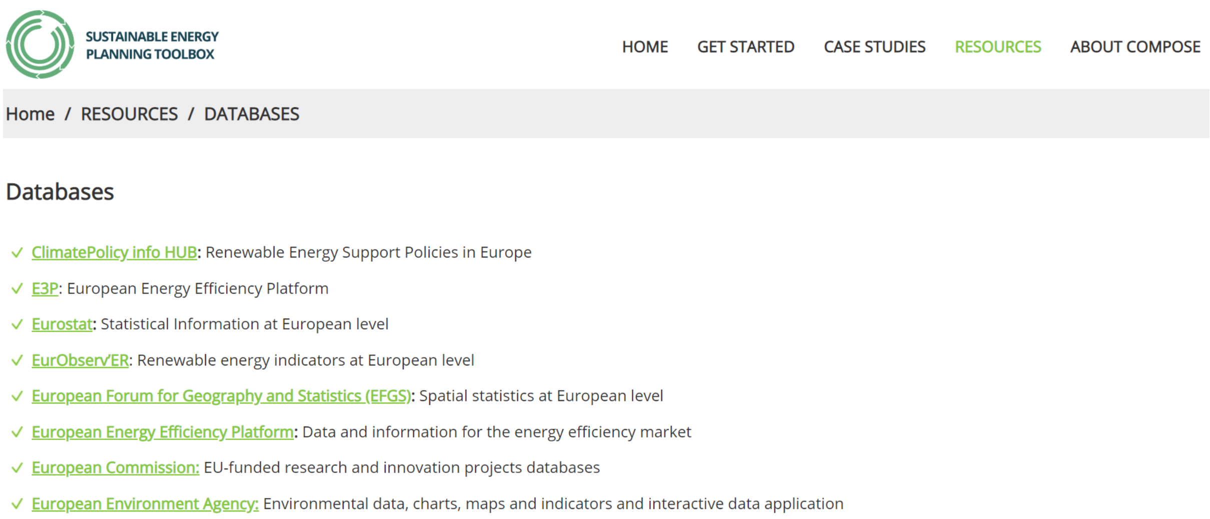

Figure 21 COMPOSE Sustainable Energy Planning Toolbox databases: https://reselplan-toolbox.eu/resources/databases/index.html

Design tools and practical guides

Having the correct tools for evaluating local renewable energy potential is a common concern. A number of tools and software already exist, and the aim of this Toolbox is to select the clearest and most updated of these, which are free of charge. The Tool's website offers links to selected design tools and practical guides organised by the type of renewable energy source: Wind energy, solar energy, biomass energy, and geothermal energy. The website also includes links to energy efficiency tools and modelling software provided by EU projects and initiatives that support the energy planning process.

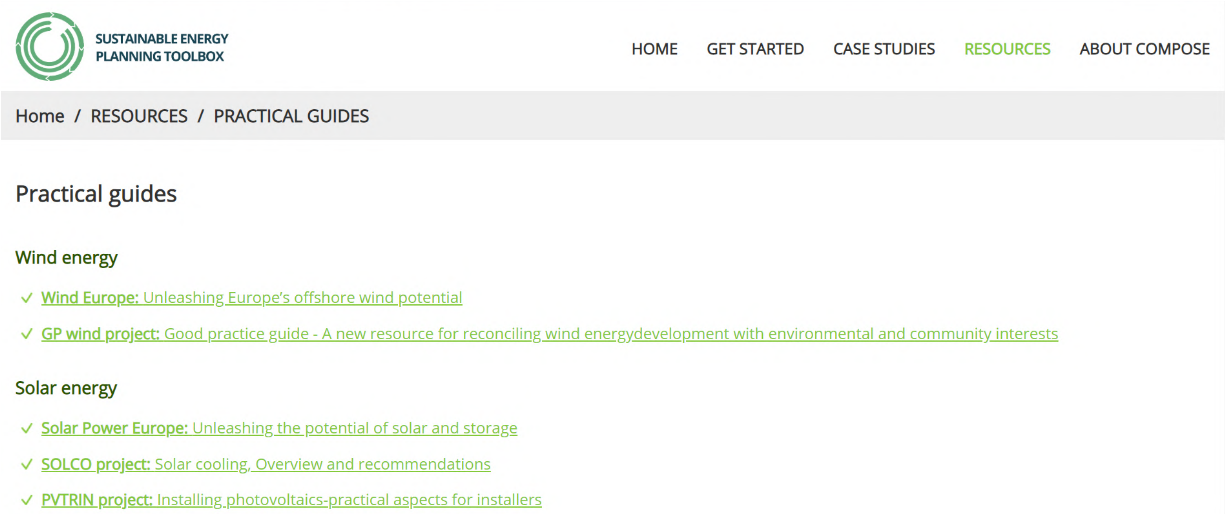

Figure 22 COMPOSE Sustainable Energy Planning Toolbox design tools: https://reselplan-toolbox.eu/resources/ /online-tools/index.html

This Toolbox suggests consulting the practical guides for stakeholder engagement from the REScoop project, the European Parliament's funding guidelines, and the Covenant of Mayors' resources. All these resources may support climate and energy policy planning, capacity building, and awareness raising.

EU Policy and Funding Programmes

Regarding EU policies, the COMPOSE Sustainable Energy Planning Toolbox website offers links to the most relevant energy policies at the European level. These include the Energy Efficiency Directive (2018), the Clean Energy for all Europeans package, the Directive on common rules for the internal market in electricity (2019), and the EU policy framework for climate and energy (2020 to 2030).

The website also highlights funding programmes that address energy efficiency and renewable energies.

https://reselplan-toolbox.eu/resources/eu-policy/index.html
https://reselplan-toolbox.eu/resources/useful-links/index.html

Target groups

The Sustainable Energy Plan Toolbox supports policy makers, development planners and local authorities who are involved in the development and implementation of local and regional energy plans, and in the creation of low carbon communities. The Handbook will help these users to exploit the potential in their local areas, and integrate technical, socio-economic, and environmental factors into their planning.

Case study (2 pilot actions: 1 regarding awareness raising and 1 on the implementation of concrete actions)

FROM ENERGY SAVINGS TO RES INVESTMENTS

Location: Provence-Alpes Côte d'Azur – France
Pilot action leader: Group for Environment, Renewable Energies and Solidarity (GERES)
Budget: 85,800€

The pilot action raises public awareness on energy related issues, focusing on people with lower income. Home energy visits enhance energy diagnosis, aiming to reduce energy consumption and encourage behavioural change of households and impulse a dynamic on green economy in the area. 40 households were supported directly, and 500 vulnerable households were reached, with the collaboration of local companies and authorities.

The key elements of the action included:

- Enhancement of the local housing retrofitting plan due to the identification of energy needs and appropriate solutions, through targeted energy visits to vulnerable households identified by social support organisations.
- Capacity building activities on energy savings tips and measures, for the local social organisations' staff.
- Awareness raising activities on renewable energy development through participative approaches (crowd funding, project development by citizens, cooperative economy).

Impacts to be achieved by 2030:

- CO_2 emissions saved: 510 t/year;
- Electricity generated from RES: 12,000 MWh/y;
- Energy saved through EE: 1,200 MWh/y.

GREENING CAPALBIO ENERGY

Location: Capalbio, Italy.
Pilot action leader: Kyoto club
Budget: 55,000€

The pilot action aims to challenge behavioural changes of citizens and tourists towards energy efficiency and RES best practices. A 10 kW PV plant was installed on the roof of the Municipality building, with a monitor display informing citizens on the energy production and CO2 emissions savings achieved.
An Energy Development Plan for the Municipality of Capalbio was also developed, assessing different sustainable energy solutions, aiming to increase the RES share in the local energy mix.

The impact achived by 2030:

- CO_2 emissions saved 175 t/y;
- Electricity generated from RES: 304.500 kWh/y.

ENERGY UPGRADING IN HISTORICAL RURAL MUNICIPALITIES

Location: Giove, Italy.
Pilot action leader: Kyoto club
Budget: 38,000€

The pilot action demonstrates the feasibility and benefits of the integration of a PV system into the roof of the Town hall. A 4 kW BIPV plant with red panels was integrated into the roof of the historic municipal building. The system includes a display, demonstrating the energy production achieved and greenhouse gas emissions saved.

A study providing recommendations to Giove Municipality's staff for potential future investments on RES and energy efficiency, and a targeted campaign focused on raising citizens' interest in BIPV systems on historic buildings, aimed at fostering replications to nearby communities and other historic MED cities.

Impacts to be achieved by 2030:

- CO_2 emissions saved: 78t/y;
- Electricity generated from RES: 110,000 kWh/y.

Potential barriers

The tool needs to update some of the data uploaded, and could have some gaps, specially for current EU policies or the reference values for indicators.

3. ENERGY GOVERNANCE:
Encouraging and mapping the energy transition at local level

3.1. Why focus on local fiscal policies aimed at promoting renewable energy sources?

The atmosphere is warming and the climate is changing with each passing year. Global warming refers to the rise in global temperatures, due mainly to the increasing concentrations of greenhouse gases in the atmosphere.[2] One million of the eight million species on the planet are at risk of being lost. Forests and oceans are being polluted and destroyed.[3]

3.2. Differences between fees, taxes, tariffs and charges

One of the challenges in promoting renewable energy sources through local fiscal policies is the differences that exist among local legal systems. Figure 23 below shows the differences between fees, taxes, tariffs, charges and concession.

[2] Communication from the Commission, The European Green Deal, Brussels, 11.12.2019

[3] Sources: (i) Intergovernmental Panel on Climate Change (IPCC): Special Report on the impacts of global warming of 1.5°C; (ii) Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services: 2019 Global assessment report on biodiversity and ecosystem services; (iii) The International Resource Panel: Global Resources Outlook 2019: Natural Resources for the Future We Want; (iv) European Environment Agency: The European environment — state and outlook 2020: Knowledge for transition to a sustainable Europe

Taxes and fees	Tariffs and charges	Concessionaire
• **Taxes**: have to be paid on receiving an income, being the owner of property and undertaking a particular activity (Income Tax, Immovable Property Tax and VAT). • **Fees**: have to be paid for using a public service or for occupying public-owned property (fees for occupying a stall in a municipal market, entering a municipal swimming pool, studying on a training course taught by the municipality, receiving a healthcare service provided by the municipality, receiving a waste collection service and a water supply service, etc).	•**Tariffs: Are** the amount to pay for using a property or facility, or for the provision of a public service when it is managed through a public-owned company, or when it is paid to a concessionaire of a public service. •**Charges: A**re both the amount a public authority pays a concessionaire to provide a service and the amount paid by a concessionaire to the public authority in order to provide such service.	•**A Conncesion** is a right granted by a public authority or public company to another actor, usually private, to operate public property or services for a fixed period of time. The management and, occasionally, the tariff collection, is transferred to the concessionaire through what is known as a Public–Private Partnership. The public authority holds the ownership and policing power of the service, while the concessionaire provides itphysically, receiving a payment called a T**ariff**.

Figure 23 Fees, taxes, tariffs and charges and concessionaire[4]

[4] Participatory method-based preparation of local fiscal policies to promote renewable energy sources at a municipal level. Published by: MUSOL Foundation.
ISBN: 978-84-697-3365-3 Coordinators: Rafael García Maties and Francesco Filippi.

3.3. Local Fiscal Policies: A way to incentivise and finance energy transition at the local level by LOCAL4GREEN

Project objective: Support Local Authorities to define and implement innovative local fiscal policies to promote renewable energy sources. Ten Project partners are from nine Mediterranean area countries. The project partners are:

- Valencian Federation of Municipalities and Provinces (VFMP), Lead Partner, and MUSOL Foundation (MUSOL), from Spain
- Malta Intelligent Energy Management, MIEMA, from Malta
- North-West Croatia Regional Energy Agency, REGEA, from Croatia
- Development Agency of Eastern Thessaloniki's Local Authorities, Centre for the Development of Human Resources and the Support of Local Economy (ANATOLIKI S.A), from Greece
- National Association of the Italian Municipalities – Lazio (ANCI LAZIO), from Italy
- Building and Civil Engineering Institute ZRMK (GI ZRMK), from Slovenia
- Cyprus Energy Agency (CEA), from Cyprus
- University of Algarve (UAlg), from Portugal
- Association of Albanian Municipalities (AAM), from Albania.

Project results:

- 78 pilot Municipalities involved in 9 countries: Albania, Croatia, Cyprus, Greece, Italy, Malta, Slovenia, Spain and Portugal, and
- 173 fiscal policies designed to promote renewable energy sources by the 78 pilot Municipalities supported by 10 partners. Kind of fiscal policies designed: Immovable Property Tax ,tax on economic activites (or Trade Tax), fees for use or occupation of public land, fee for construction of a new building/refurbishment, Tourist Tax, Municipal Tax on real-estate transmission, tax on vehicles, Municipal buildings leasing/renting revenues, waste collection and Lighting fees, parking fees, Trade Licenses etc.
- 79 green fiscal policies have been approved by 34 pilot Municipalities, 30 rural Municipalities and 4 island Municipalities
- 753,682 rural population covered by green local fiscal policies
- 113,217 population of islands covered by this kind of policies.

Introduction, concept and function of the LOCAL4GREEN methodology

A Handbook for green taxation formulation with the participatory methodology to design, implement and evaluated the local fiscal policies to promote renewable energy sources has been prepared as part of the LOCAL4GREEN project activities. The Handbook is designed for small and rural Municipalities and islands.

Project co-financed by the European Regional Development Fund

The Handbook it is available in English, French and in all partners languages. The Handbook is available on the Interreg Mediterranean website: https://local4green.interreg-med.eu/what-we-achieve/deliverable-database/?tx_elibrary_pi1%5B%40widget_0%5D%5BcurrentPage%5D=5&cHash=a48be5208153cfc3cd3c665cff6b36e1

In the subchapter below the instructions for using the Handbook are explained step-by-step.

Step-by-step instructions for using the methodology

LOCAL4GREEN methodology is based on 19 steps based on the Deming cycle: Plan, Do, Check and Act:

- Planning stage: 9 steps
- Doing stage: 5 steps
- Checking stage: 3 steps
- Acting stage: 2 steps.

Figure 24 shows the Deming cycle and its 19 steps.

The 19 steps of the Deming cycle:

PLAN

0 Generating the political will to implement local fiscal policies to intervene in RES at a municipal level.

1 Analysis of the potential of RES in the Municipality.

2 Legal analysis of the potential of local fiscal policies to intervene in RES at a municipal level.

3 Financial-administrative analysis of the potential and economic sustainability of local fiscal policies to intervene in RES at a municipal level.

4 Analysis of gender and social inclusion perspective regarding local fiscal policies to intervene in RES at a municipal level.

5 Analysis of alternatives to local fiscal policies to intervene in RES at a municipal level.

6 Systemisation of the analyses in a viability study on the local fiscal policies aimed at promoting RES.

7 Consultation with the specific sector, association or collective affected by the local fiscal policies aimed at promoting prioritised RES.

8 General citizen participation regarding local fiscal policies aimed at promoting prioritised RES.

9 Establishment of the fiscal measures to introduce in accordance with citizen input and the political criteria of the decision-maker.

DO

10 Drawing up of the appropriate instrument for adopting the fiscal policy.

11 Approval of the appropriate instrument for adopting the fiscal policy.

12 Undertaking of the appropriate administrative and management adaptations.

13 Drawing up of a resolution of political impact to improve the legal framework that regulates a set of local fiscal policies in order to facilitate municipal action in the area of renewable energy, and

14 Launching of a publicity and awareness-raising campaign on the approved local fiscal policy promoting RES.

ACT

15 Drawing up of a series of indicators to evaluate the adopted local fiscal policies in order to promote RES.

16 Establishing the collection and communication protocol of the indicator monitoring data, and

17 Evaluating the local fiscal policy.

CHECK

18 Review of the appropriate instrument for adopting the fiscal policy, and

19 Approval of the appropriate and amended instrument for adopting the fiscal policy.

Figure 24 The Deming Cycle

There are the three main factors to prepare green local fiscal policies.

Project co-financed by the European Regional Development Fund

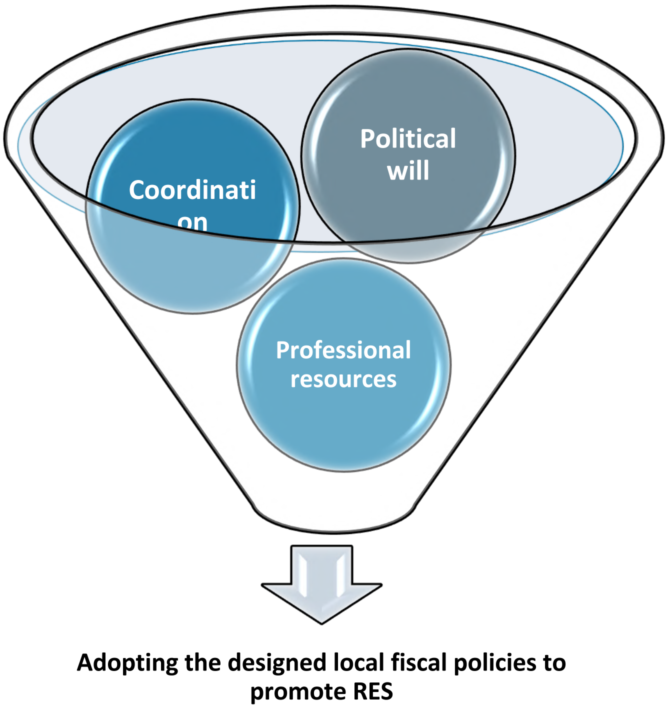

Figure 25 The main factors of process to prepare local fiscal policies to promote renewable energy

Target groups

The three main target groups of the international Handbook are:

- Local authorities' employees and decision-makers
- Consultants specialised in public management
- National and regional authorities decision-makers, and
- Other stakeholders interested in the promotion and advocacy for renewable energy sources.

Tax System description

A short description of all types of taxation and local tariffs in project partners countries is explained in this subchapter. A detailed description of Tax systems is available in National Handbooks on green local fiscal policies models, available on the Interreg Mediterranean website.

Albania	**1. Shared taxes:** Vehicle Tax, mineral rent and personal Income Tax. **2. Local taxes:** Local taxes on the economic activity of small businesses, tax on real-estate, taxes on buildings, taxes on agricultural land and tax on land, hotel accommodation tax, tax on impact on infrastructure, tax on billboards, the tax on the transfer of ownership of immovable property and temporary local taxes.

	3.Local tariffs: Tariffs on occupation of public spaces, tariffs on public services (fee for waste collection and disposal, fee for water supply, parking fee and fee on Vet services) and local fees for administrative services. [5]
Croatia	**1. Government Taxes:** VAT, Corporate IIncome Tax and **s**pecial Taxes and Excise Duties (special taxes on motor vehicles, special tax on coffee and non-alcoholic beverages, the tax on liability and comprehensive road vehicle insurance premiums and Excise duties). **2. Country Taxes:** inheritance and Gifts Tax**,** tax on Road Motor Vehicles**,** tax on Vessels and **t**he Tax on Coin Operated Machines for Games for Amusement. **3. City or Municipal Taxes:** Surtax on Income Tax**, c**onsumption Tax**,** tax on Holiday Houses, tax on the Use of Public Land and **r**eal Government Transfer Tax **4. Joint Taxes :** Income Tax **5. Taxes on winning from games of chance and fee for organising games of chance:** lottery Games**,** casino Games**,** betting Games**,** fees for Organising Slot Machine Games and**,** fee for Organising Occasional One-Time Games of Chance. **6.Fee for organising award games.** [6]
Cyprus	**1.Taxes:** Property Tax**,** professional tax**,** hotel accommodation tax and **e**ntertainment tax. **2.The tariffs/fees:** Waste management fees**,** Building Permit fees**,** business premise license fees**,** public space utilisation license fee and water Supply fee. **3.The revenues from:P**arking places**,** parking cards**,** parking meters and revenues from swimming pools. [7]
Greece	**1.Leases** **2.Fees for cleaning and lighting services** **3.Real-estate fee** **4.Fees from gross revenue - Accommodation in hotels** **5.Fees from Gross Business Income - Fees from clubs, restaurants and related revenue** **6.Other Fees and Revenues - Fees for communal spaces** **7.Other fees and income - RE charges** **8.Possible offsetting fees** **9.Electricity tax for buildings and other spaces** **10.Other costs and revenues - Parking fees 11. Other Fees and Revenues - Construction/Building Permits/Licenses** [8]

[5] National Handbook on green local fiscal policy models Albania, project partner in charge: PP9 Association of Albanian Municipalities. The Handbook it is available on the Interreg Mediterranean website: https://local4green.interreg-med.eu/fileadmin/user_upload/Sites/Renewable_Energy/Projects/LOCAL4GREEN/National_Handbooks/D4.1.2_Albanian_National_Handbook_AAM.pdf

[6] http://www.porezna-uprava.hr/en/EN_porezni_sustav/Pages/THE-CROATIAN-TAX-SYSTEM.aspx

[7] National Handbook on green local fiscal policy models Cyprus, project Partner in charge: Cyprus Energy Agency. The Handbook is available on the Interreg Mediterranean website: https://local4green.interreg-med.eu/fileadmin/user_upload/Sites/Renewable_Energy/Projects/LOCAL4GREEN/National_Handbooks/D4.1.2_National_Handbook_CEA.pdf

[8] National Handbook on green local fiscal policy models Greece, project Partner in charge: PP 3, ANATOLIKI S.A. The Handbook it is available on the Interreg Mediterranean website: https://local4green.interreg-med.eu/fileadmin/user_upload/Sites/Renewable_Energy/Projects/LOCAL4GREEN/National_Handbooks/D4.1.2_NATIONAL_HANDBOOK_GREECE.pdf

Malta	There is no reference in the Local Councils Act allowing for the collection of taxes by Local Councils. [9]
Portugal	**1.National taxes:** VAT, Stamp Duty, Special Taxes and Excise Duties (vehicle tax, tax on alcohol and alcoholic beverages and sugar-sweetened beverages, oil and energy products tax, excise duties on tobacco, lightweight plastic bags contribution), special tax on gambling and special tax on online gambling. **2.Municipal Taxes:** Municipal Tax on Real Property, Municipal Tax on Real-Estate Transfer, construction, Installations and Works Tax and Municipal tourist tax. **3.Tariffs/Fees:** Subsoil occupation fee, Municipal Fee for Rights of Way, water Resources Fee, Waste management and sanitation fees, audiovisual contribution fee **4.Joint Taxes:** Personal Income Tax, Corporate Income Tax, Municipal Surtax, State Surtax.
Slovenia	Municipal own tax sources: property tax, vessel tax, tax on real-estate transactions,inheritance and gift tax, tax on winnings from conventional games of chance and any other tax where so provided by the Act governing taxes. Municipal own non-tax (other) sources: imposed contributions, fees (dues), fines, concession fees, payments for local public services, etc.[10]
Spain	**1. Property Tax** **2. Tax on Economic Activities** **3.Tax on motor vehicles** **3.Tax on constructions, installations and works** **4.Tax on increase in value of urban land** **5.Municipal tax on luxury** **6.Fees for municipal waste and fees for the provision of sanitation services** **7.Public prices: concessions, concessions of public domain assets, other services** **8.Special contributions** **9.Changes in tax ordinances for the approval of green policies**

Figure 26 Tax system description

[9] National Handbook on green local fiscal policy models Malta, project Partner in charge: Malta Intelligent Energy Management Agency – MIEMA. The Handbook it is available on the Interreg Mediterranean website. https://local4green.interreg-med.eu/fileadmin/user_upload/Sites/Renewable_Energy/Projects/LOCAL4GREEN/National_Handbooks/D_4.1.2_MIEMA_National_handbook_on_green_local_fiscal_policy_models_Malta_L4G_pdf.pdf

[10] National Handbook on green local fiscal policy models Slovenia, project partner in charge: Building and Civil Engineering Institute ZRMK. The Handbook it is available on the Interreg Mediterranean website: https://local4green.interreg-med.eu/fileadmin/user_upload/Sites/Renewable_Energy/Projects/LOCAL4GREEN/National_Handbooks/D4.1.2_National_Handbook_SLOVENIA.pdf

Potential barriers

Local Authorities face many barriers for implementing local fiscal policies to promote Renewable Energy Sources. A list of some potential barriers/problems it is given below:

- Investment gap not filled
- Local authorities internal calendars
- Technical (legal) inertia
- Local authorities have little room to modify their fiscal policies
- Limited financial resources available
- Lack of knowledge
- Lack of technical and administrative capacity
- Lack of necessary knowledge and motivation
- Insufficient number of employees
- Lack of interest from the local authorities to adopt fiscal policies (potential loss of budget income);
- Doubtful reaction from citizens regarding Renewable Energy Sources
- Long period of return on investment in Renewable Energy Sources
- Lack of information
- Lack of promotion via local media.

Pilot case study

The International handbook on green local fiscal policy models corresponds to a summary document of the work that has been developed by the different countries partners under the LOCAL4GREEN pProject.

The International Handbook on green local fiscal policy models intends to summarise the green local fiscal policies that were designed with the Municipalities of the different countries, and respective implementation proposals. LOCAL4GREEN project has achieved 89 local and regional authorities from 9 MED countries engaged to increase share of local Renewable Energy Sources in the energy mix, through the implementation, dissemination and transferring of green local fiscal policies

This subchapter gives an overview of 1 pilot action by the country project partners of the LOCAL4GREEN Project:

- Approved green fiscal policies by the Vau i Dejes Municipal Council, Alabania
- Approved green fiscal policies by the Brdovec Municipal Council, Croatia
- Approved green fiscal policies by Nicosia’s Municipal Council, Cyprus
- Approved green fiscal policies by the Edessa Municipal Council, Greece
- Approved green fiscal policies by the San Lawrenz Municipal Council, Malta
- Approved green fiscal policies by the Križevci Municipal Council, Slovenia
- Approved green fiscal policies by the Dolores Council, Spain

In the boxes below is given a description of each of the approved green fiscal policies Box 2, Box 3, Box 4, Box 5, Box 6, Box 7 and Box 8.

The Mnicipality of Brdovec has adopted a Decision on a reduction of the Public Utility fee for new buildings using RES in the Households sector (Nearly Zero Energy Buildings (nZEB) as follows:

- *RES share of 30% in the primary energy required to meet the building energy requirements – proposed adopting a Decision on a 50% reduction of the Public Utility fee*
- *RES share between 30-50% in the primary energy required to meet the building energy requirements – proposed adopting a Decision on a 75% reduction of the Public Utility fee*
- *RES share more than 50% in the primary energy required to meet the building energy requirements – proposed adopting a Decision on a 100 % reduction of the Public utility fee.*

Expected results:

- Estimated energy savings: 5,654 MWh that become renewable
- Estimated CO_2 emissions reduction: 1,159 t t CO_2 eq.

***Box 2** Approved green fiscal policies by the Brdovec Municipal Council, Croatia*

The municipality of Vau i Dejes, as part of the Fiscal Package and Budget 2019, has proposed some specific measures to encourage residents and businesses to use photovoltaic installations to produce electricity as follows:

- *30% reduction on the taxation level of Tax on Buildings for families` houses and businesses (tertiary sector)*
- *30% reduction on Local Services Fees for businesses (tertiary sector)*

Expected results:

- Estimated energy savings: 1,018.16 MWh that become renewable
- Estimated CO_2 emissions reduction: 9.16 t CO_2 eq

***Box 3** Approved green fiscal policies the Vau i Dejes Municipal Council, Albania*

Nicosia's Municipal Council and the Mayor officially approved on 10 January 2019 the increase of 5% (instead of 20%) in the hotel accommodation tax per room per night, for the years 2019-2021. According to the design of this fiscal policy, the money for the first 3 years that will be raised through the increased taxation, beginning in 2019, will be ringfenced in a green mechanism-fund, and used to provide free energy audits to hotels in the Nicosia region, as well as the funding of two awareness events to promote energy efficiency and RES in the Hotel sector.

Expected results:

- Estimated energy savings: 2,933 MWh that become renewable
- Estimated CO_2 emissions reduction: 2,563 tonnes CO_2eq

***Box 5** Approved green fiscal policies by Nicosia's Municipal Council, Cyprus*

Reduction of Fee for Municipal Real-Estate Leasing when using RES

In Edessa there are 12 Municipal buildings that will be leased in 2019, for which the investors have agreed to install PV systems of installed capacity of 10 kw per buidling. These PVs are able to produce a total 150 MWh per annum.

Expected results:

- Estimated energy savings: 150 MWh that become renewable
- Estimated CO2 emissions reduction: 172,35 t CO2 eq per annum.

***Box 4** Approved green fiscal policies by the Edessa Municipal Council, Greece*

Approved Local Fiscal Policy Green Mobility at San Lawrenz - Fiscal Policy in relation to the rental of 4 electric bikes/vehicles from the local council:

Fiscal policy related to the rental of electric bikes, aiming to reward residents that have RES installations; promote new installations in the locality, as well as electro mobility.

• Reduce the rental fee (50%) for the electric bikes in the case of residents who have an RES installation, or have submitted an application for a new RES system.

•Eligible residents shall receive a specific code/card to benefit of the discounted fee with respect to the full fee envisaged through the «Green Mobility in San Lawrenz» Project.

Expected results:

- Tons of CO_2 avoided by ebikes renting: 3.1
- Tons of CO2 avoided by rewarded citizens with PVs: 0.7

Box 7 *Approved green fiscal policies by the San Lawrenz Municipal Council, Malta*

Measures of the Municipality for promotion of the Renewable Energy Sources

Updating the Local Energy Koncept (LEK).

Subsidising the installation of solar power plants on all tourist objects and public buildings by 20%.

Subsidising the installation of solar collectors for water heating by 10%.

Subsidising the systems for heating with RES on all tourist objects 10%.

Expected results:

- Estimated energy savings: 350 MWh/a that become renewable energy
- Estimated CO2 emission reduction: 145 tCO2/a

Box 6 *Approved green fiscal policies by the Križevci Municipal Council, Slovenia*

Fiscal Ordinance Tax on Constructions, Installations and Works (ICIO). This Ordinance was approved at the extraordinary session of the City Council of Dolores held on November 16, 2018, and after following the procedure established in the LRHL, it has entered into force.

Expected results:

- Estimated energy savings: 105,980 KWh that become renewables (83,270 KWh in homes and 22,710 KWh in companies)
- Estimated CO2 emission reduction: 40,802 kg (32,059 kg in homes and 8,743 kg in companies).

Box 8 *Approved green fiscal policies by the Dolores Council, Spain*

4. ENERGY FACILITIES:
Energy storage systems for remote areas

4.1. Brief Introduction

The intermittent nature of RES poses a challenge for maintaining system reliability. Energy Storage Systems (ESS) are proven to be effective, and viable in solving fluctuating generation and demand. Battery energy storage technologies are in the spotlight as an essential grid asset that can provide services to increase the resiliency of the grid and integrating variable Renewable Energy resources. The market for stationary Battery Storage Systems (BSS) is growing in a variety of applications from utility scale to commercial and industrial and, finally, to residential. The combination of PV and ESS increases the solar self-consumption in private homes, while it is key for the transition towards a sustainable energy system. The most significant barrier to deployment is high capital costs, which are expected to decrease.
StoRES is able to resolve the challenge concerning grid reliability with higher Renewable Energy Sources deployment in islands/rural areas, giving a cost-effective option to the public on a more affordable and sustainable energy supply.

4.2. An online tool to design energy storage systems for residential photovoltaics by the StoRES project

Introduction, concept, and functionality

Two tools have been developed for simulation and optimisation of PV systems in combination with storage technologies: The 'StoRES Online PV and Storage Optimisation Tool' and the 'StoRES Living Lab'. Both tools have been built in the framework of the 'Promotion of higher penetration of Distributed PV through storage for all - StoRES' Project.

The objective of the 'StoRES Online PV and Storage Optimisation Tool' is to optimise residential energy consumption by boosting PV self-consumption through a storage solution. The tool calculates the optimal size of a hybrid PV and storage system in financial terms (e.g. net present value, internal rate of return, and levelised cost of energy). The latter outcomes are products of the financial analysis which is undertaken for 20 years, taking into consideration technical and financial parameters and a variety of energy policy options. The operation of the model-tool is based on the principle of 'learn by comparison', testing alternative solutions in different pilot sites considering local parameters. The tool is easy to use, both by professionals and non-professionals. The required inputs are electrical consumption, solar irradiation, PV and battery size, and electricity costs.

The second tool ('StoRES Living Lab') gives the possibility to experiment with different factors that affect energy storage, using as a basis the pilot locations presenting real data. The tool is an interactive web platform hosted by the project website. It displays multiple indicators concerning energy profiles in different pilot installations, facilitating their comparison. The user can easily perform various tests according to the pilot sites analysing such indicators as self-consumption and Self-Sufficiency Rate.

Step-by-step instructions for using the tools

The '**StoRES Online PV and Storage Optimisation Tool**' is based on 8 steps. The next figure visualises these steps, describing their context briefly.

Supplementary information and additional clarifications are given below.

Step 1: PV System Data

The user can either import PV power measurements of a specific installation, or can indicate the coordinates of the installation position and, optionally, the orientation of the panels. Both options need the PV capacity (in kWp).

Step 2: Consumption Data

The user can either use a predefined country-specific consumption profile by introducing their monthly or yearly consumption, or upload a customised profile of the installation.

Step 3: Electricity Costs

The user can choose between either a 'flat pricing' scheme or a 'dynamic pricing' scheme, where more than one time zones are valid.

Step 4: Storage System

The user is able to perform an analysis for different Battery Energy Storage System sizes. The characteristics of the battery should also be included (e.g. number of cycles, charge/discharge rate).

Step 5: Policy

The user is able to choose between three (3) policies.

a) 'Pure self-consumption'

b) 'Self-consumption'

c) 'Partial net-metering' (only under a 'Flat Pricing' scheme step No3).

Any added cost or added income coming from prosumers services.

Step 6: Financial

The user should define the CAPEX and OPEX of the hybrid PV and storage system, the subsidy, the discount rate, the inflation rate and the electricity inflation rate.

Step 7: Inputs` Validation

The user has to validate the inputs as long as all the data have been inserted. The system will check automatically and indicate a relevant message.

Step 8: Getting the results

Once the inputs` validation is successful, the user must confirm the analysis. The results will be visualised on the user's screen and they can be exported.

Figure 27 StoRES Online PV and Storage Optimisation Tool

Step 1: PV System Data':

Regarding the option of importing specific PV measurements, the data should be entered using the sample template (that can be downloaded from the corresponding button). Then, the user must enter the PV systems characteristics. Specifically, the degradation and inverter efficiency have to be introduced in terms of percentages (%). Finally, regarding 'Type of Analysis', the user can choose between a single PV size and various PV sizes according to their installation.

'Step 2: Consumption Data':

Concerning the customised profiles, the user has the option to upload their own consumption using the provided template. Power should be imported in kW, considering a 15-min time interval. Consumption should be inserted in the specified columns per month, taking into consideration a classification between working and non-working days.

'Step 3: Electricity Costs':

With regard to the 'flat pricing' scheme, it represents constant electricity charges throughout the period of a day, while for the 'dynamic pricing' scheme, more than one time zones are valid. More specifically, the user should specify if two or three charge zones exist. The starting hour of each zone should be declared in ascending order, beginning from Zone A. The ending hour is filled in automatically. Electricity costs should be inserted accordingly. A dynamic pricing scheme cannot be selected when a 'Partial net-metering' policy is selected in the 'Policy step 5'. The current step also requires the insertion of prices before (VAT). In short, production cost, network cost, taxes, fixed cost, and VAT.

'Step 4: Storage System':

Concerning the cycles of the BSS, the tool requires the expected 'overall number of charge/discharge cycles' as declared by the manufacturer of the BSS. In addition, the 'maximum charge/discharge rate' of the nominal BSS capacity, is a measure that imposes a limit on the rate at which the system can charge/discharge, determining the change in battery capacity over time.

'Step 5: Policy':

Regarding policy options, the 'Pure self-consumption' policy represents the scenario in which the PV excess energy exported to the grid is not compensated at all. On the other hand, the 'Self-consumption' policy simulates the scenario in which PV excess energy exported to the grid is compensated at the price specified in the corresponding box further down. The third option is available only under a 'Flat Pricing' scheme (step 3). It refers to a 'partial net-metering' policy, where the prosumer is charged on the net consumed energy by the production cost price, at the end of each billing period. If there is a surplus of produced energy (net consumed energy is zero in this case) over a billing period, this amount of energy is transferred - in the form of renewable energy credits - to the next billing period. At the end of each year, any renewable energy credits are erased. The prosumer is charged on the imported energy by the network costs and taxes declared in the 'Electricity costs'.

'Step 6: Financial':

Concerning the PV and inverter, the capital cost includes the cost of PV panels, the hybrid inverter, engineering, administrative and balance of systems costs (per kWp installed), whereas 'BSS cost' refers to the Battery Storage System cost (per kWh), and includes only the cost of the battery module.

The '**StoRES Living Lab**' includes three layers that operate independently. The next Figure represents those sub-tools schematically, providing their context purpose briefly. Supplementary and clarification information is given below.

01 PRESENTATION OF THE DATA

This sub-tool presents the data for the extracted profile of a pilot site for a selected period.

A] First the user chooses the site of interest. Information and description with the main characteristics of the pilot to come up.

B] Then, the user should choose either 'Raw data' (15-minute resolution) or 'Average profiles' (seasonal profiles) for the data display.

02 SITES COMPARISON

This sub-tool is used for comparing various indicators and results among different pilot sites.

The user must select the pilot sites for comparison (up to 5 simultaneously). The system compares load consumption with power production, the annual average profiles, and the storage system efficiencies in graphical representation.

03 PARAMETRIC STUDY

With this sub-tool, the user can modify the sizes of the main elements (PV & ESS) observing the impacts on the energy indicators.

The user must select the pilot site, the storage capacity and the PV capacity. The sub-tool then performs a sensitivity analysis, taking into consideration the user inputs and the technical characteristics of each technology, providing a graphical representation of the results.

Figure 28 StoRES Living Lab

'Presentation of the data'

Regarding raw data, the user must select the dates for displaying energy characteristics such as power production, load consumption, battery charge, battery discharge, grid import, grid export, state of charge.

Concerning average profiles, the user can select different time periods while the platform keeps using the 'raw data', but this time according to the specific timeframe. The available time periods are year, summer working and non-working days, winter working and non-working days and interseason working and non-working days. The demonstrated indicators for average profiles include total energy produced, total energy consumed, total energy self-consumed, total energy injected to the grid, total energy received from the grid, total energy charged to the energy storage system, total energy discharged from the energy storage system, total number of equivalent full cycles, average monthly state of charge of the battery, self-consumption rate with and without a battery, self-sufficiency ratio with and without a battery.

'Sites comparison'

Regarding the comparison of the annual average profiles, the graph correlates the following indicators: Power production, power storage discharge, power grid import, load consumption direct use, power storage charge, power grid export.

'Parametric study'

Concerning the parametric study, the self-consumption ratio and the self-sufficiency ratio are illustrated in graphs, taking into account the size of the energy storage system and PV capacity, with an Optimisation Table focused on the size combinations. Additionally, the prosumer ratio in linear relation with the PV capacity is also illustrated.

Target groups

The three main target groups for the Handbook are:

- Energy consultants
- Employees of local authorities and decision-makers
- National and regional authorities decision-makers
- Residential prosumers
- Universities and students
- RES investors
- Other stakeholders interested in the promotion and advocacy for Renewable Energy Sources.

Case study (1 pilot action)

The '**StoRES Online PV and Storage Optimisation Tool**' was tested Initially. The pilot site of Kozani in Greece was selected as a case-study. The input comes from the second tool 'living lab' and feature 'presentation of the data' (platform code name: Greece 01).

Main Inputs

PV system

Location: Kozani (Greece)
PV power: 10 Wp

Consumption data

Yearly consumption: 19.238 kwh

Electricity costs

Pricing (€/kWh): Dynamic pricing - Greece (Zone A: 0.10, Zone B: 0.14, Zone C: 0.08)

Storage

Overall number of charge/discharge cycles: 8.000
Charge/discharge rate (%) = 67%
Usable capacity: 50%
Min battery size: 10 kwh
Max battery size: 25 kwh

Policy

Pure self-consumption

Financial

PV system and inverter cost (€/kWp) = 1600
BSS cost (€/kWh) = 200

All the inputs are imported for the pilot site of Kozani, except for the size of the battery, in order to validate the outcome of the tool. In other words, if the recommended size of the battery equals, or is close to, the installed size of the pilot project, the tool is verified.

Output

The installed size of the battery was 20 kwh, which is very close to the recommendation of the tool, which is 22 kwh. The difference between them was most probably caused by the overall number of charge/discharge cycles for which an approximation was made, since the 'living lab tool' provides only the 'Battery Equivalent Full Cycles' instead of the 'overall number of charge/discharge cycles'. To sum up, the tool was verified estimating that the pilot in Kozani would have a payback period of almost 13 years if the 'pure self-consumption' policy continued to apply.

Optimal System Parameters	Output
Net Present Value of the Investment (€)	2420.57
Internal Rate of Return of the Investment (%)	5.22
Simple Payback Period (Years)	12.73
Optimal PV System Size (kWp)	10
Optimal Battery System Size (kWh)	22

Table 7 Results of Kozani case study: StoRES Online PV and Storage Optimisation Tool

Concerning the second tool, the '**StoRES Living Lab',** the feature of the 'presentation of data' was tested successfully, providing all the necessary info for the Kozani pilot project. Next is the 'site comparison' feature with which the user can compare two to five pilot sites.

The comparison between the pilot site of Kozani and the pilot site of Koilada (Greece 02) shows similar indicators, with almost similar average year profiles, due to the fact that the same size of PV and storage systems were installed in both sites. However, it is worth noting that Koilada is a much smaller city than Kozani, thus the Grid Injection is twice the level of Kozani due to the lower energy demand. Similarly, no power grid imports are presented at Koilada, since the load peaks can be covered by the BSS, contrary to Kozani.

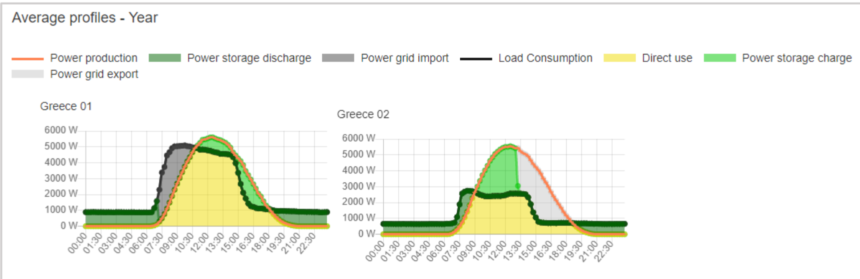

Figure 29 Results of Kozani case study: StoRES Living Lab

Finally, the 'parametric study' feature of the 'StoRES Living Lab' tool studies the variations of self-consumption rate and self-sufficiency rate among different sizes of PV and ESS, highlighting installed optimal sizes in each pilot site.

Potential barriers

Both tools are user-friendly for both professionals and non-professionals. However, a few issues were identified during multiple tests.

Concerning the '**StoRES Online PV and Storage Optimisation Tool':**

- At the PV system tab (step 1), the bar that the user types the address is not functional. A message appears indicating that the specific page can't load Google Maps correctly. However, the user can still move the cursor on the map indicating the case-study location.

- At the storage system tab (step 4), If the user chooses to import extremely small cycles of battery (e.g. 100), the system does not respond after the calculation button (Step 8).

Regarding the '**StoRES Living Lab':**

- At the parametric study feature, there is a limitation on the available PV and BSS sizes, depending on the location of the pilot. For instance, in Kozani, the available testing range of PV sizes is 1-11 kWp compared to Vatero (option: Greece 05), for which the range reaches up to 30 kWp.

Conclusion

The ETU Toolbox Handbook is key for the capitalisation of the Interreg MED Renewable Energy Community. Its methodological approach, based on four pillars, aims to support the mainstreaming of the project's outcomes into local and regional planning. The main contribution of this Handbook is to provide the technical tools that enable local authorities and local entities to develop their own energy plans in an integrated way.

It is recommended to use this Handbook together with the ETU White Paper. For further information about this Handbook contact the Interreg MED Renewable Energy Community (https://renewable-energies.interreg-med.eu).

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