MOOC 1

Energy sustainability and municipal roadmaps

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Energy sustainability and municipal roadmaps

Energy sustainability

Main focus of MOOC 1

Municipal roadmaps

Key tools for energy transition

EU Financing

Project supported by European funds

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UNIT 1

INTRODUCTION

MOOC 1: Energy sustainability and municipal roadmaps

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UNIT 1. INTRODUCTION

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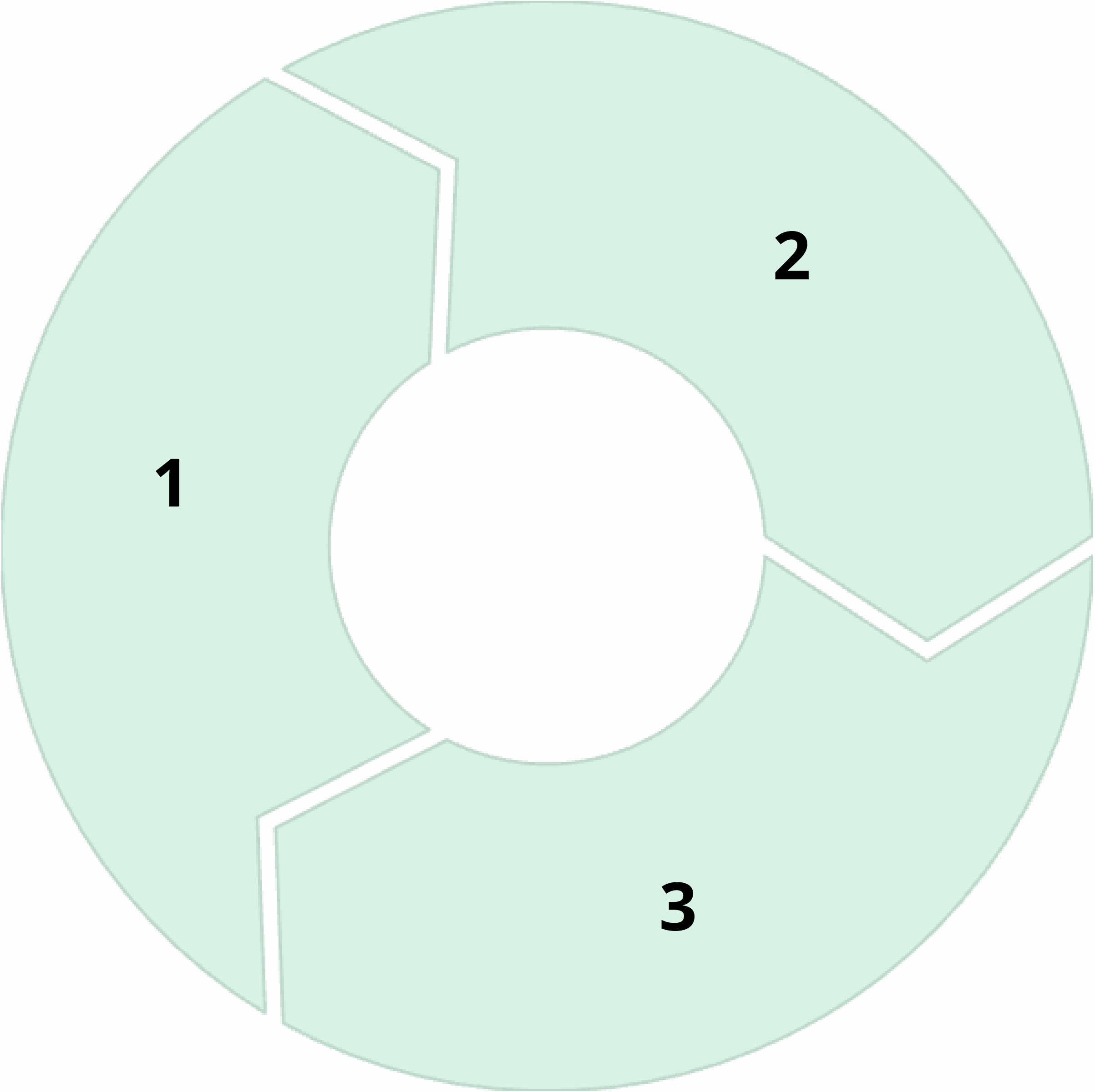
1.1 Climate Situation



Greenhouse gas emissions emissions

The main cause of climate change, altering rainfall, transforming ecosystems and affecting our economy, health and quality of life.

Global warming

1.5°C increase (2030-2052).

Transformation towards a Sustainable Economy

Fundamental transformation of our economies, promoting the appropriate use of natural resources and the development of clean and safe energy sources.

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1.1 Climate Situation

1

2

2015: Paris Agreement

Main objective: to **contain the global average temperature increase** to below 2°C above pre-industrial levels, with efforts to limit it to 1.5°C.

2019: European Green Pact

Communication from the European Commission to achieve **climate neutrality** for the European continent by **2050**.

European energy and climate policy is currently defined by the **Paris Agreement**. The **European Green Deal**, on the other hand, seeks to boost the economy, improve health and the quality of life of citizens through these key areas:

🔋 Clean Energy

Clean, affordable and secure energy supply

🚗 Mobility

Accelerating the transition to sustainable and smart mobility

🌿 Ecosystems

Preservation and restoration of ecosystems and diversity

🏗 Building

Energy and resource efficiency in construction and renovation

🏭 Industry

Mobilising industry for a clean and circular economy

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1.2 Europe's energy challenges: island territories

Studying **Energy Transition (ET)** at different levels requires attention to island territories, as they vary enormously in terms of **electricity grids**, **geographical specificities, local population, tourism** and other aspects, all of which affect the stability of the energy grid and create **energy planning challenges.**

The **European Union (EU)** has a wide variety of islands and is therefore paying particular attention to studying them as they offer specific opportunities well suited for modern energy planning, both in terms of **potential for energy efficiency, renewable energy and innovative solutions**, and for creating a broad and strong community-driven transition process.

Variations in island territories

Electricity grids, geographical specificities, local population, tourism

Energy planning challenges

Energy grid stability and specific planning

Opportunities on EU islands

Energy efficiency, renewable energies, innovative solutions

Community-driven transition

Comprehensive and robust transition process in island territories

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1.2 Europe's energy challenges: island territories

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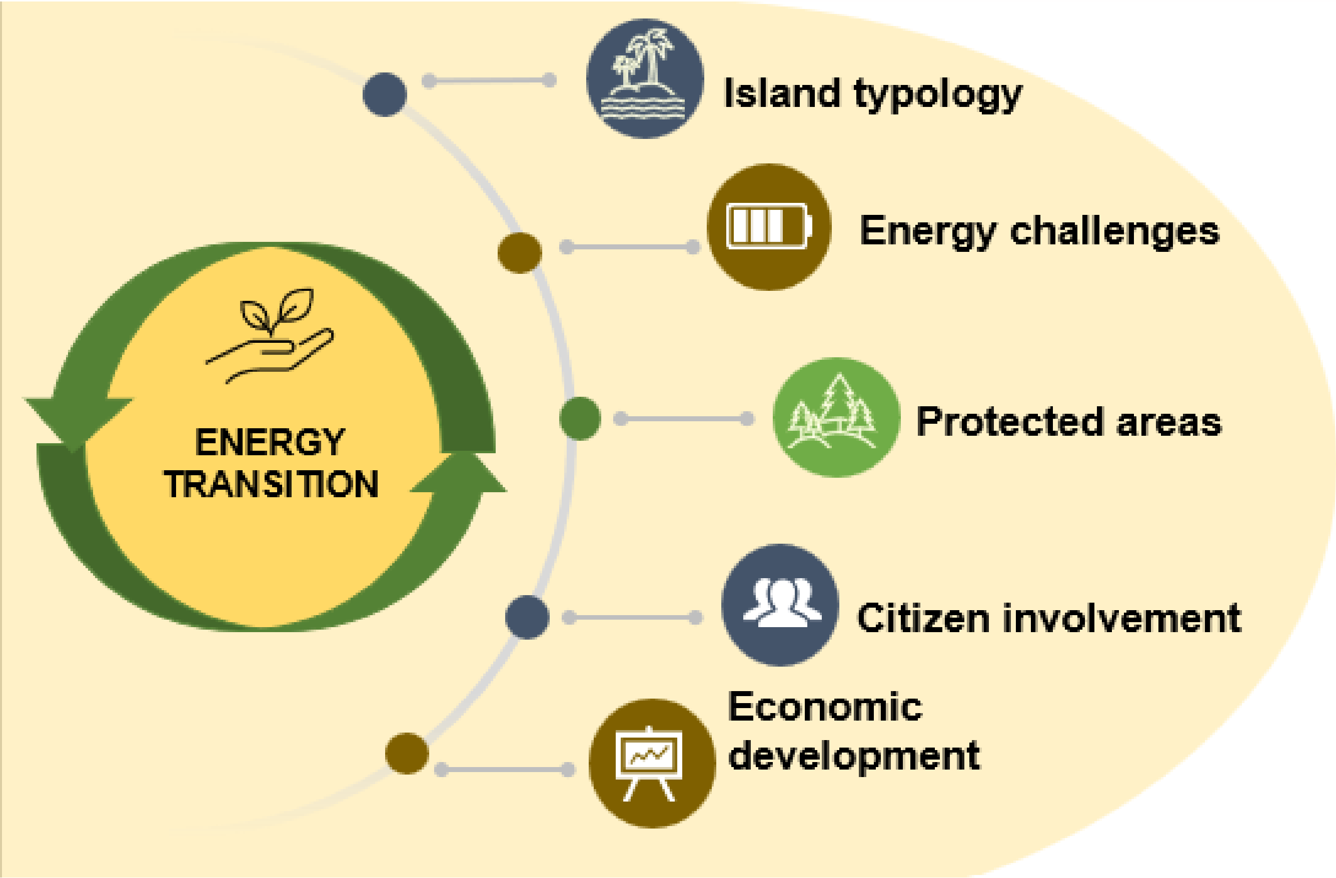
The **"Clean Energy for EU Islands"** initiative or the **"Smart Islands"** initiative are proof that the EU is taking a special interest in island regions. Some of the energy challenges facing tourist islands are:



- **Island typology** in terms of distance from the mainland, available resources, accessible renewable energy sources, climate, etc.
- **Energy challenges** such as limited space for the implementation of renewable energy sources, energy dependence, etc.
- **Protected areas** in natural spaces such as environmental parks.
- **Citizen participation** in ET through awareness-raising measures, existing initiatives to promote self-consumption, etc.
- **Economic development** represented through variations in tourist flow, productive capacity of the island, port and maritime connections, land use, etc.

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1.2 Europe's energy challenges: key actors

Cities are at the core of the **transition to a sustainable economy**, being crucial actors in the **energy transformation.**

1

Cities as a Base

Rationale for sustainable transition

2

Adaptation and Mitigation

Clean energy and sustainable mobility

3

Covenant of Mayors

Climate and Energy Alliance

The **Covenant of Mayors for Climate and Energy** represents the highest commitment to this transition, creating an alliance of local governments dedicated to facilitating access to sustainable and affordable energy for all.

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1.3 The key role of the municipalities

Moving towards ET, **decarbonization and the smart cities** of the future involves a series of **key actors** such as **prosumers**; people capable of producing and consuming energy. This is a term that emerged in 1980 and is set to lead the energy transformation. **Citizens** will take on the role of prosumers by **bringing flexibility to the power grid** and ultimately becoming a stakeholder that addresses societal challenges.

There are different concepts into which prosumers can be classified:

Individual households

Families installing solar panels on their roofs to generate their own electricity.

SMEs and public institutions

Businesses implementing energy efficiency measures and own generation.

Collective prosumers

Groups of citizens coming together to produce and consume energy collectively.

Energy communities and cooperatives

Democratic organisations that manage renewable energy projects for their members.

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1.3 The key role of the municipalities

➢ Individual households

1 Installation of photovoltaic panels

Individual households have installed PV panels on the roof or on the balcony, possibly in combination with a battery.

2 Own heat production

The energy from the solar panels can be used to power a heat pump, so that the consumer produces his own heat.

3 Flexibility to the electricity system

Such battery-powered homes capable of feeding energy into the grid offer flexibility to the electricity system.

4 Participation in energy communities

In addition, they can also be part of an energy community.

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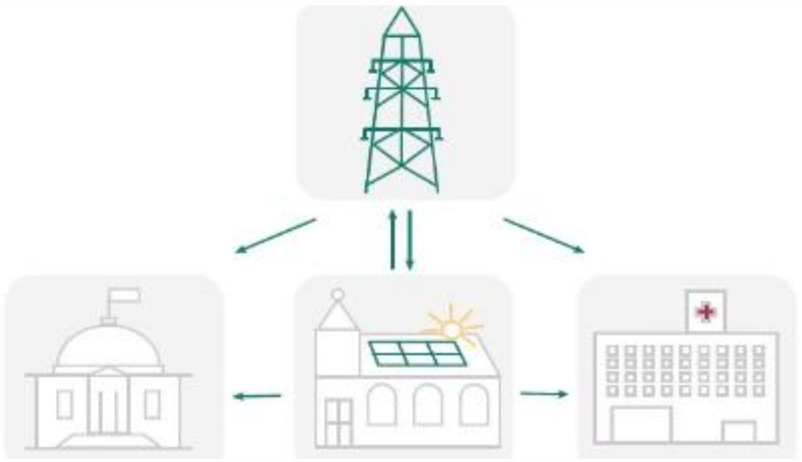
1.3 The key role of the municipalities

Collective prosumers in a building

This is another case in which the **residents of a building** or complex install solar panels and batteries and benefit from the **consumption of their own energy**, in addition to contributing to the **self-consumption** and demand services of the electricity grid.

SMEs and public institutions

Companies and public institutions can install **panels on their roofs for self-consumption** of their energy. This energy can be **shared between** different public **buildings** or **exchanged with the grid**.



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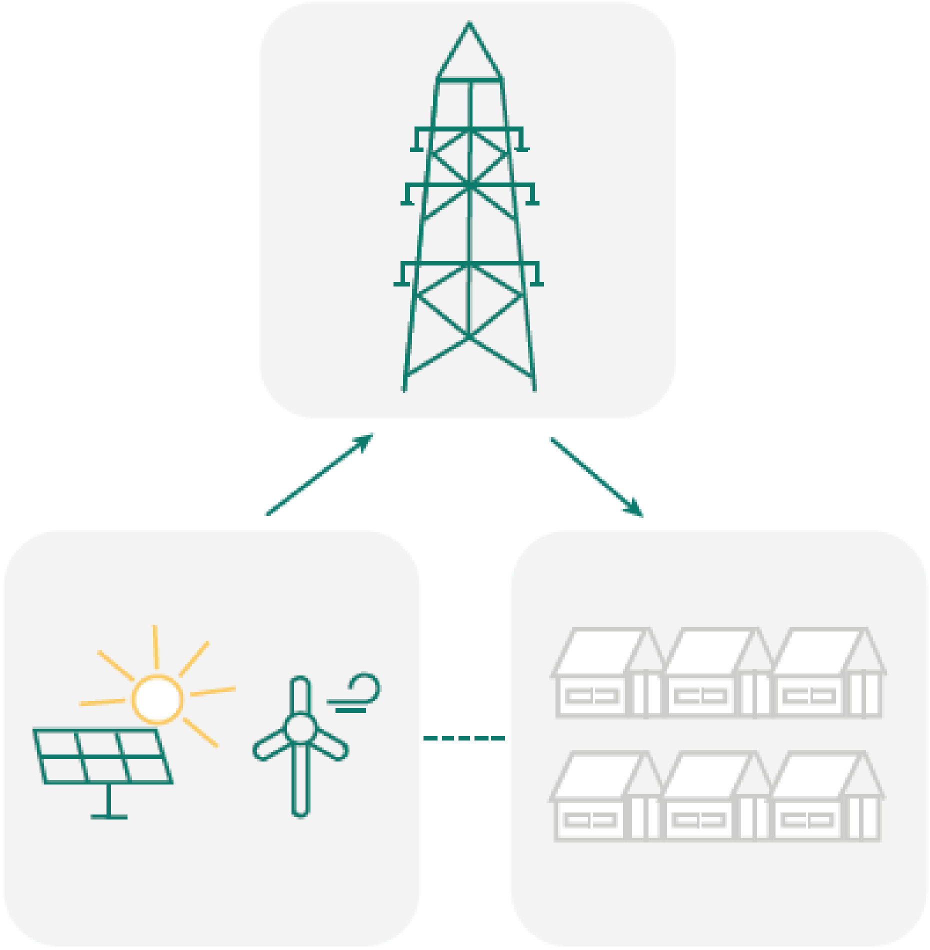
1.3 The key role of the municipalities

➢ Energy communities and cooperatives

This is the **most diverse group of prosumers** that varies in different forms and ranges. In both cases the community must invest in its **own Renewable Energy Sources (RES).**



Model contribution

Energy community where **members pay regular** contributions to the community itself to maintain and develop shared energy resources.

Shareholding model

Structured energy community with **shareholders** who own and control the entity, participating directly in decision making and profits.

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UNIT 2

CURRENT ENERGY CONTEXT

MOOC 1: Energy sustainability and municipal roadmaps

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UNIT 2. CURRENT ENERGY CONTEXT

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2.1 Energy objectives

Decarbonisation of the electricity system

The EU has set ambitious targets such as **decarbonisation of the electricity system** by **2030** or **carbon neutrality by 2050**, as presented in 2019 in the European Green Deal.

Substitution of fossil fuels

Eliminate and gradually replace fossil fuel assets with clean alternatives, especially renewables, accompanied by incentives to achieve TE solutions.

Increase in renewable energies

Increasing the share of renewables in electricity generation to 65% by 2030 as the most realistic pathway to halving emissions by 2030.

Promoting green hydrogen

Promote green hydrogen from niche to mainstream by 2030, as well as bioenergy.

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2.1 Energy objectives

Promotion of electric vehicles

Increase electric car sales by 2030, as well as financial and fiscal incentives to promote the adoption of electric vehicles, charging mandates and bans on combustion vehicles.

Efficient buildings

Achieve energy-efficient building requirements.

Innovation and recycling

Innovation, recycling and the circular economy will play an important role in the search for efficiency in the medium and long term.

Awareness

Raise awareness to reduce travel demand and encourage the use of public transport and cycling wherever possible.

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2.2 Factors to determine the national energy context

Analyzing the **sustainability of a study region** is done on the basis of a series of **indicators**, which allow **quantitative measurement of energy sustainability**, including CO2 emissions, and its evolution over time.

1 Energy chain

Energy flow from primary production to final energy use.

2 Primary energy

energy that has not undergone a conversion or transformation process.

3 Secondary energy

Energy that has been produced by conversion or transformation of primary energy ("energy vectors" or "energy carriers").

4 Final energy

energy made available to the consumer before final conversion.

5 Useful energy

Energy made available to the consumer **after** its final conversion.

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2.2 Factors to determine the national energy context

In order to determine the national energy context, it is important to collect some data such as:

1 **Performance and sustainability indicators**

Fraction of electricity in final energy and total CO_2 emissions

2 **Energy consumption metrics**

External dependence, consumption per capita and consumption normalised to GDP

3 **Basic economic indicator**

Gross Domestic Product (GDP) as a key macroeconomic measure. On this basis, energy consumption is analysed, culminating in performance and sustainability indicators such as CO_2 emissions and the share of electricity in final consumption.

Besides understanding the energy context, **strategic energy planning is necessary**.

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2.3 Comprehensive energy planning

Energy planning consists of **forecasting future energy needs** and the **actions** to be carried out to ensure their coverage.

It is **crucial** to analyze and quantify all the **influencing mechanisms** (demographics, economics, politics, learning curves, etc.). The transition to a low carbon society will mean living in energy neutral buildings, integrated electric vehicles, etc.

Classical energy demand planning used to focus on establishing the **relationship between economic variables** and **energy consumption**. This is usually done based on the **analysis of different historical data** and **processing** them in a relatively simple method.

1. **Forecasting future energy needs**
2. **Analysis of mechanisms of influence**
3. **Classic planning**
4. **Analysis of historical data**

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2.3 Comprehensive energy planning

Short-term planning

Over a 5–10-year period with known technologies and known system efficiency (for electricity and power system up to one year).

Medium-term planning

New technologies can have an impact on production and consumption within a reasonable timeframe of 10 to 20 years.

Long-term planning

In this case, technologies that are in the research and development phase can play a big role, but most of the technologies in use will be used significantly in 20-30 years.

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2.3 Comprehensive energy planning

Points to consider in planning:

Energy balances

Mainly energy balances, consumption, supply, production, specific areas, specific time periods, etc.

Sectoral balance

Sectoral energy balances or growth rates (industry, residential, services, agriculture, construction, transport etc.)

Reliable data

Use of reliable methodologies and databases.

Political and economic variables

These types of variables must be considered holistic view of the different sectors that impact on the sector. different sectors that have an impact on the sector.

Reference scenario

Obtain a reference scenario, also called 'Business As Usual'.

Future scenarios

Possible future political scenarios.

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2.4 Case study:
Spain's energy context

In order to understand in essence the process of analysing the **energy context**, a case study is proposed to analyse the **energy context in Spain**. The methodology chosen consists of

1	2	3	4

1. Data collection

Obtain **data for Spain** in relation to **primary energy**, **final energy**, the **contribution of each energy source** in each sector etc. The source to be used is the [International Energy Agency (IEA).]

2. Future projections

Obtaining **future growth rates** for each of the sectors.

3. Reference scenario

Definition of the **reference scenario** or **'Business As Usual'** with recent **baseline data** and **current policies** in place.

4. Analysis of results

Obtaining **indicators** and **upcoming trends** in each sector, following **current policies and actions**.

A graphic of the proposed methodology is shown in the next slide.

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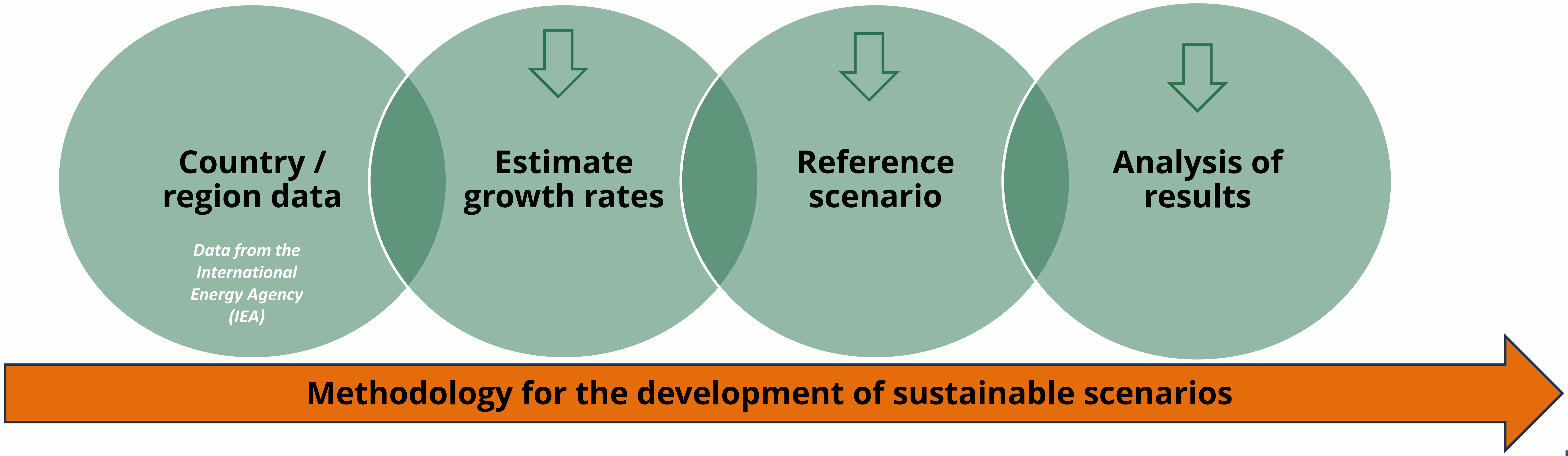
2.4 Case study: Spain's energy context

The methodology for analysing Spain's energy context consists of the following steps:

Sector
Industry
Transport
Services
Domestic

Current rate scenario



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2.4 Case study: Spain's energy context

After obtaining input data, the **hypotheses that make up the reference scenario** or BAU for Spain are studied and proposed.

BAU HYPOTHESIS

- The percentage contribution of each source to the consumption of each demand sector remains constant over time.
- The electricity balance remains constant over time.
- Electricity is generated with an average generation output deducted from the base year data.
- The contribution of nuclear power remains constant at the starting year value, given the impossibility of increasing installed capacity.
- The increase that nuclear should contribute is allocated to renewables.

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2.4 Case study: Spain's energy context

This table shows the **evolution of indicators proposed** to analyze the energy transition, continuing the policies outlined in the previous slide during the forecast time period.

INDICATORS **TIMELINE OF ACTION**

BAU

Indicators	Units	2022	2015	2020	2025	2030	2035
Inhabitants	Million	74.9	60.5	70.5	82.0	95.5	111.2
GDP per capita	$M€_{2010}$	52,200,000	50,735,761	51,777,386	52,840,397	53,925,232	55,032,338
Electricity consumption	TWh	7.9	7.1	7.6	8.3	9.0	9.8
CO2 emissions	Mt	4.53	2.84	3.96	5.55	7.83	11.09
Primary Energy	ktep	28,713	23,732	27,175	31,215	35,983	41,656
Primary Energy Generated	ktep	20,057	16,892	19,094	21,598	24,448	27,693
Exported-Imported	ktep	92	82	89	97	105	115
Electricity generated	ktep	587	525	568	617	671	731
External dependence	%	30.15	28.82	29.74	30.81	32.06	33.52
GDP per capita/inhab	$M€_{2010}$/inhab	0.70	0.84	0.73	0.64	0.56	0.49
TEP/inhab	tep/hab	0.383	0.392	0.386	0.381	0.377	0.375
TEP/GDP	tep/$M€_{2010}$	0.55	0.47	0.52	0.59	0.67	0.76
Electricity/capita	kWh/inhab	0.11	0.12	0.11	0.10	0.09	0.09
CO2/TEP	t/tep	0.16	0.12	0.15	0.18	0.22	0.27
CO2/GDP per capita	t/$M€_{2010}$	0.09	0.06	0.08	0.11	0.15	0.20
CO2/Inhab	t/inhab	0.060	0.047	0.056	0.068	0.082	0.100
% Renewable energy in PE	%	69.9	71.2	70.3	69.2	67.9	66.5
% Renewable energy in EE	%	86.5	86.5	86.5	86.5	86.5	86.5

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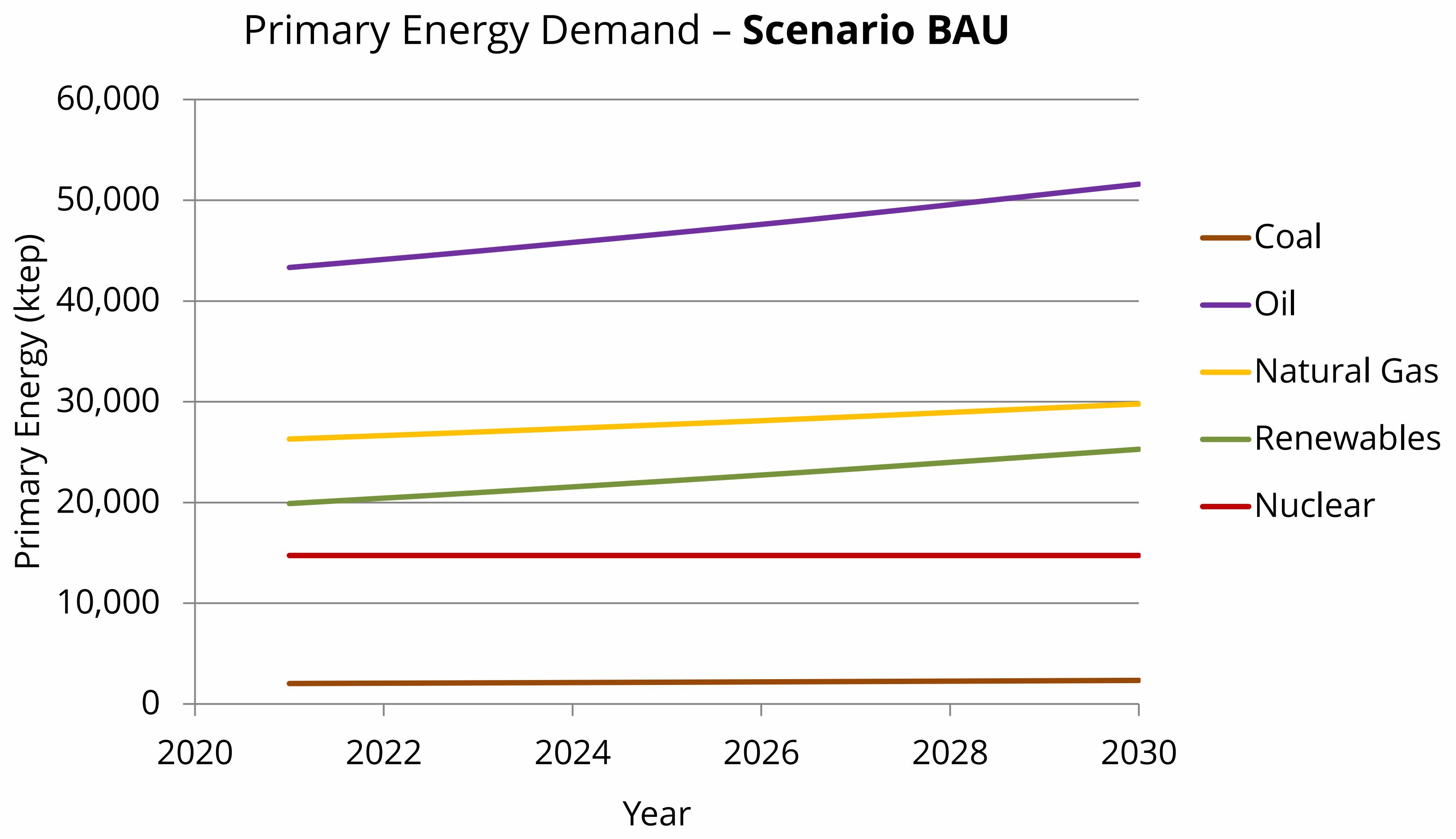
2.4 Case study: Spain's energy context

Considering all the **values collected in the indicators**, graphs can be made that visually show the **trend over the set period**. An example is the graph shown in this slide. The trend of each energy source in primary energy production under current policies can be observed.

BAU



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UNIT 3

METHODOLOGIES FOR THE CREATION OF ROADMAPS

MOOC 1: Energy sustainability and municipal roadmaps

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3.1 Need for roadmaps at the municipal level

In 2019, the EU launched the energy regulation "**Clean Energy for all Europeans**" in favor of **clean energy and the reduction of fossil fuels**. Its objectives include:

- ✓ Prioritize **energy efficiency,** increase **renewable energies** and present **new opportunities to decarbonize** the entire EU economy**.**
- ✓ **Create synergies** between the different member countries, which will result in a balanced legislative impact at all levels: **EU, national and local**.

The visualization and planning of the **2050 goals (climate neutrality)** greatly affect all **governance processes** and schemes, and **cities** are collaboratively developing **cross-cutting roadmaps** that affect all areas and sectors of society.

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3.1 Need for roadmaps at the municipal level

Energy planning is an essential technique for achieving EU objectives, but it also has two other main objectives:

1
Guidance and discussion

Energy planning provides guidance and material for discussion of future energy systems.

2
Support to policy makers

It supports policy makers in the development of short- and long-term energy strategies.

3
Scope of EU objectives

Energy planning is an essential technique for achieving EU objectives.

4
Energy models

Several authors have studied the use of energy models to aid policy decision making, and the classification of energy models dates back to the 1990s.

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3.2 Covenant of Mayors and Roadmaps

The **Covenant of Mayors for Climate and Energy** brings together local and regional authorities that voluntarily commit to implementing the European Union's **climate and energy objectives** on their territory.

Objective of the Covenant of Mayors for Climate and Energy

- Increase **support for local action** at the municipal level.
- Providing a **coherent and transparent platform t**o involve more cities
- Increasing **public awareness**
- Proposed as an action as part of the European adaptation strategy

Signatories' commitments

- **Reducing CO2 emissions** by at least 40% by 2030
- Increasing its resilience to the effects of climate change

Scope of the initiative

- Creating **decarbonized and resilient cities**
- Citizen access to **safe, sustainable and affordable energy**

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3.2 Covenant of Mayors and Roadmaps

In order to achieve the objectives, **the Covenant of Mayors for Climate and Energy** encourages the **elaboration of a Sustainable Climate and Energy Action Plan (SECAP)**. This consists of a roadmap to define **priorities at the municipal level**, in line with the vision of regional public authorities. Some interesting facts:

- The SECAP should clearly **specify** the **Covenant's mitigation target** (i.e., a reduction of at least 40% of CO_2 emissions by 2030) and **adaptation** target.
- The SECAP should be **based on** and include the results of a comprehensive **Baseline Emission Inventory** (BEI) and a **Climate Risk and Vulnerability Assessment** (CRA).

Covenant of Mayors for Climate and Energy

Encourages the development of a Sustainable Energy and Climate Action Plan (SECAP).

Municipal Roadmap

Defines priorities at the municipal level, in line with the vision of the regional public authorities.

PACES Objectives

It specifies the Covenant's mitigation target (reduction of at least 40% of CO_2 emissions by 2030) and adaptation target.

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3.2 Covenant of Mayors and Roadmaps

PACES Presentation and Update

PACES Presentation

PACES must be submitted through the **MyCovenant reporting platform..**

Minimum Data

In addition to the Action Plan document itself, you will be asked to report a minimum data set in MyCovenant in English.

Updating or New Plan

It is up to the signatory to decide whether an **update of the existing plan** is sufficient or whether a **new action plan should be developed to achieve its renewed objectives.**

Framework Flexibility

The Covenant framework in Europe will continue to be flexible enough to adjust to the local context and municipal procedures.

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3.3 Existing tools for roadmap development

Classifications to address **existing methods for roadmapping** date back to the **1990s** and since then, there have been considerable revisions and modifications to date.

Several authors have studied the use of energy models to aid **policy decision making** and their classifications.

All this has given rise to a large number of energy models classified according to criteria such as purpose, **analytical approach**, **mathematical approach**, **geographic coverage**, **time horizon**, etc.

This section names those methods that are considered to be of interest to islands, policy makers and, in general, to the Energy Transition (ET).

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3.3 Existing tools for roadmap development

Governance Method

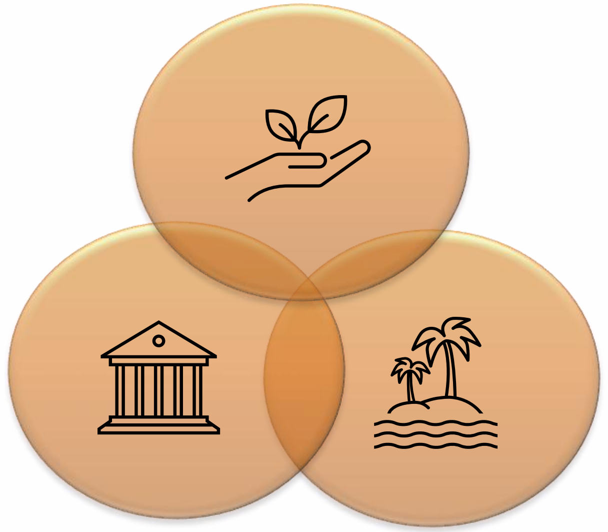
Advantages

- Targeted directly at policy makers and stakeholders
- Provides clear and simple information
- Valuable information for climate policy decisions
- Methodologies available for islands

Inconveniences

- Does not provide technical information on future scenarios
- Does not reflect the impact of actions

An example of this method would be the **Methodological Manual** created by the **Clean Energy for EU Islands** Secretariat as a methodological guide to steer projects in any of their phases towards ET and to **initiate**, **restart and boost the decarbonization** of islands.



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3.3 Existing tools for roadmap development

➢ Governance methods: initiative ***"Clean Energy for EU islands"***

The methodology focuses mainly on three actions or phases: *Explore, Form and Act*.

Explore

The first phase of the methodology focuses on exploring options and possibilities for energy transition on EU islands.

Form

The second phase involves shaping concrete ideas and plans for implementing clean energy solutions on the islands.

Act

The third and final phase focuses on action, carrying out the plans and projects developed in the previous phases.

CLEAN ENERGY FOR EU ISLANDS

Provides islands with templates and technical assistance for energy system analysis, easy-to-access and user-friendly self-assessment tools that allow monitoring of actions.

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3.3 Existing tools for roadmap development

Modeling Method

Advantages	Inconveniences
• Suitable for prediction	• Requires specific technical skills

	Ventajas	Inconveniences
Simulation *Represents a system and estimates its performance under given conditions.*	• Suitable for forecasting • Fast and detailed to compare different scenarios • More qualitative results of the studied scenario	
Optimization *Minimizes or maximizes an objective function subject to constraints.* *There are different methods such as linear program ming or mixed integer linear programming.*	• Prescribes the optimal future • Quantitative results of the scenario studied	• Slow models

Both models are advisable for energy planning, but the **simulation** model allows more **variables** to be included in the analysis and provides a **more qualitative** result of the scenario.

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3.3 Existing tools for roadmap development

Decision Making Method

Advantages

- Analysis of the different scenarios
- Emphasizes the value of the authority's decision
- Takes into account the knowledge and experience of policy makers and stakeholders
- Can be integrated with the above methods to create tools such as LEAP

Inconveniences

- Requires specific technical skills

Multi-criteria analysis method

Decision support for complex problems where several criteria must be taken into account to arrive at a satisfactory solution. In particular, the Analytic Hierarchy Process (AHP) method can help policy makers obtain the best strategy for a given problem.

Multi-objective analysis

Methodology used to illustrate the trade-off between parameters and help select a compromise solution.

Fuzzy Cognitive Maps

Consists of fuzzy structures similar to neural networks and is often used as a powerful tool for modeling complex systems, such as climate change mitigation policies.

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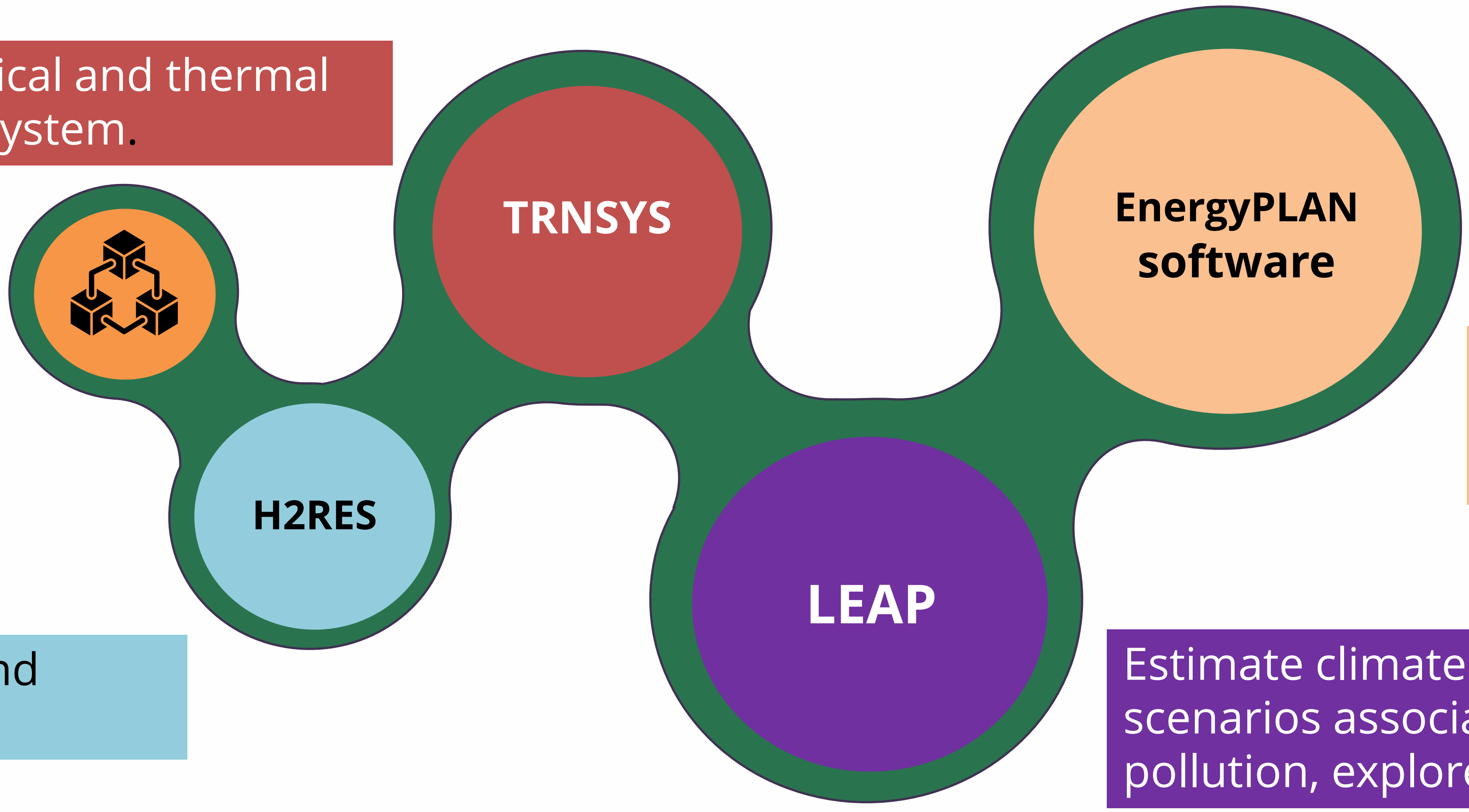
3.3 Existing tools for roadmap development

There are tools that integrate different methods to involve policy makers and stakeholders in energy modeling processes.

Simulates the electrical and thermal sectors of a power system.



Evaluation of different energy system alternatives by testing different energy combinations.

Planning tool for island energy systems

Estimate climate impacts, estimate different scenarios associated with health impacts of air pollution, explore mitigation scenarios.

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3.4 Model for the creation of a municipal roadmap

There is no single criterion for the creation of a **municipal roadmap**, however, it is necessary to address the following points:

1. Compilation of energy data and current municipal information
2. Identify the municipal sectors in which action measures should be taken (higher energy consumption, improvement of services, etc.).
3. Propose action measures in coherence with the municipal government plan and objectives set.
4. Temporary planning of measures according to municipal casuistry
5. Calculation of indicators and results (greenhouse gases, reduction of energy use, etc.)

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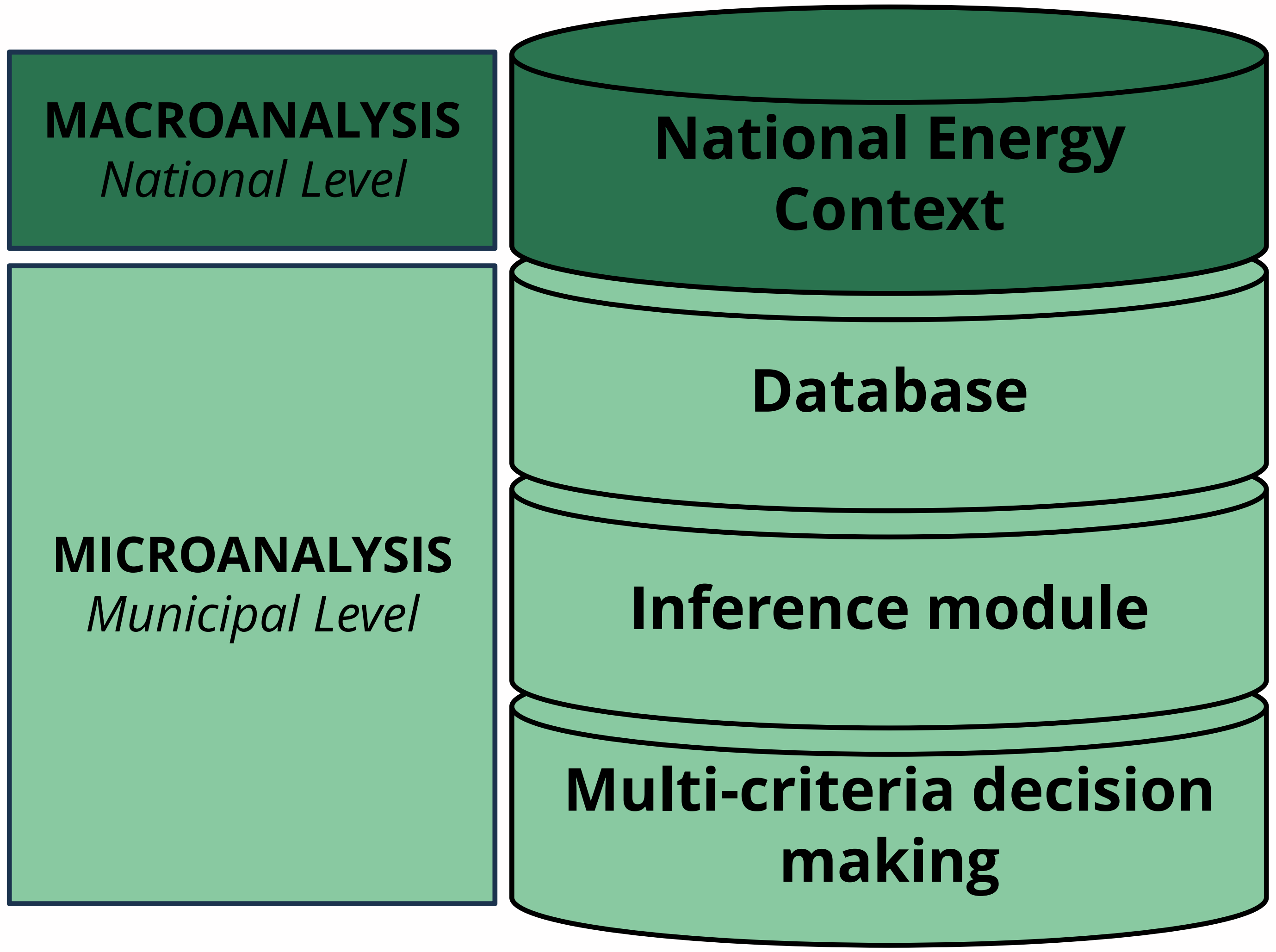
3.4 Model for the creation of a municipal roadmap

The **GENERA project** proposes the following methodology for the creation of a municipal roadmap.

It is important to involve the **voices of policy makers** in order to ensure a coherent **implementation of measures**, therefore, the last module is an innovative point that will characterize the roadmap.



Comparison between the **Business-As-Usual scenario** and the **Energy Transition scenario.**

Compendium of actions included in the **Municipal Action Plans**

Calculation of the **quantitative impact** of the **actions** at the **municipal level**

Most Promising Municipal Energy Transition **Strategies**

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UNIT 4

LOCAL ENERGY TRANSITION PACKAGE

MOOC 1: Energy sustainability and municipal roadmaps

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4.1 Identification of local energy resources

➢ ELECTRICITY GENERATION

At the municipal level, it is of great importance to use the **local resources available** to them (**wind, solar, biomass**, etc.), which implies achieving **good autonomy** and decreasing **dependence on external energy**.

In order to **manage its own energy** and generate it **efficiently** and from renewable energy sources, it is important to identify electricity **generation technologies** that can be used for self-consumption, among other things

Solar Energy

Local renewable resource for electricity generation and self-consumption.

Wind Energy

Harnessing wind as a clean, local energy source

Biomass

Use of local organic resources to generate energy.

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4.1 Identification of local energy resources

➢ **ELECTRICITY GENERATION**

PHOTOVOLTAIC SOLAR ENERGY

Solar photovoltaic energy plays an important role, especially in a municipal context, where special consideration must be given to **space constraints** and **particle emission level limitations.**

- Easy to install and simple implementation method.
- Technology that requires mainly the solar resource and a correct installation of the panels (orientation, panel performance, etc.).
- The energy generated can be used instantly for self-consumption, injected into the grid or stored in batteries.
- Requires space for installation, but can take advantage of the roofs of existing buildings.
- It is an inexpensive technology with very competitive prices.
- The main existing ecological impact is that of panel manufacturing.

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4.1 Identification of local energy resources

➢ ELECTRICITY GENERATION

WIND ENERGY

Wind turbines come in **many sizes**, from small hand-held devices of a few watts to large multi-MW turbines reaching more than 150 m above the ground.

In addition, they can be **classified** according to the **direction of the shaft**, the number of **blades,** and whether they are located on **land or at sea**, so this versatility is beneficial for the local area.

- The wind energy industry is mature in Europe, but the wind resource must first be studied.
- Adequate resources are a function of both wind speed and, within the same region, the frequency of wind occurrence.
- Technology that requires mainly the wind resource, so it is an intermittent source.
- Wind turbines occupy a small area and the surrounding areas can be used for agriculture.
- It represents one of the cheapest ways to generate electricity. Large systems produce electricity at a lower cost than small systems.
- There are environmental impacts such as to the natural wildlife of the ecosystem.

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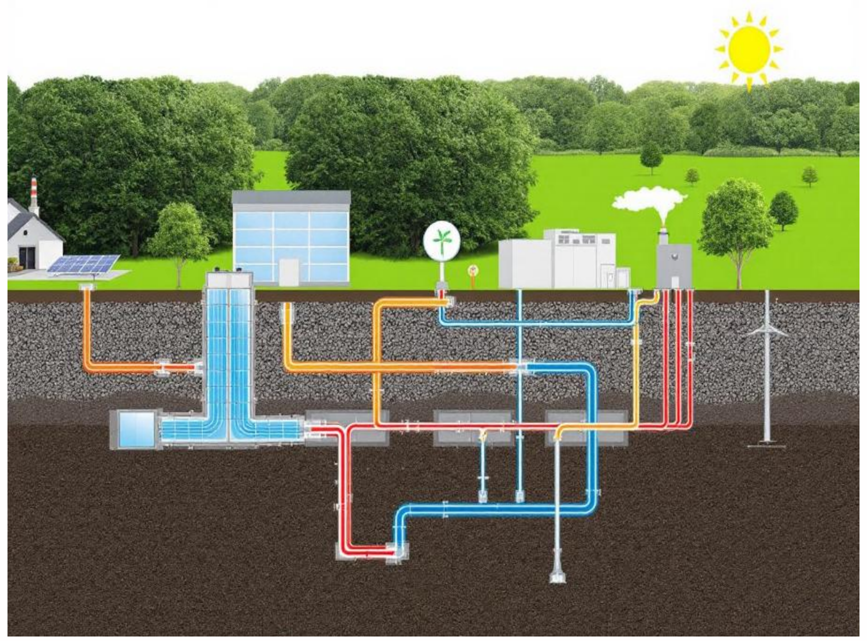
4.1 Identification of local energy resources

➢ ELECTRICITY GENERATION

GEOTHERMAL ENERGY

Geothermal energy is also available in the ground near the surface due to **absorbed solar energy and thermal inertia**.

This energy can be used for **heating spaces in winter** or **cooling in summer** by means of **geothermal heat pumps**.



- Determining the potential of a particular reservoir requires geological knowledge and accurate measurements.
- The resources required depend on the heat of the earth, although it is limited to regions with shallow volcanic activity to make drilling costs affordable.
- May be used for base load production or for industrial heating processes..
- It occupies a relatively small land area, since it uses subway deposits and does not require fuel extraction or import from other areas.
- They are characterized by high initial start-up costs and low operating costs.
- Geothermal systems generate very low greenhouse gas emissions during their operation.

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4.1 Identification of local energy resources

➢ **ELECTRICITY GENERATION**

- ## Energy consumption in the EU

Currently in the European Union, almost **half of the energy consumed** is used for **heating and cooling**. **Energy generated** from **fossil fuels** entails a **high environmental cost** associated with its production, as well as more pollutants in its final use.

- ## European objectives

Following **European regulations and objectives**, both **heating and cooling** sectors must necessarily be more efficient, using **100% renewable sources and taking advantage of waste heat**.

- ## Urban district networks

Addressing the energy transition at the municipal level involves **integrating urban district networks**. They contribute to **optimizing energy supply** and **reducing the environmental footprint**. In addition, they integrate **various energy sources**, and allow **consumers not to depend on a single source of supply** (biomass, solar thermal, etc.).

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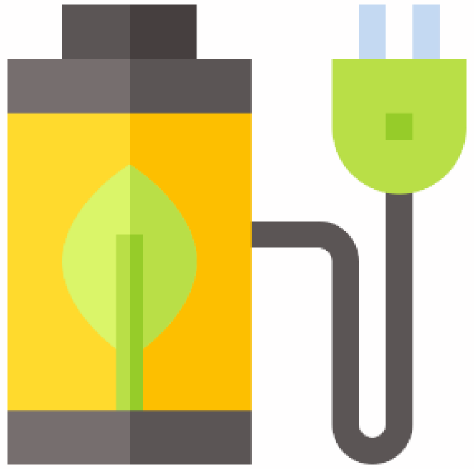
4.1 Identification of local energy resources

➢ HEATING AND COOLING GENERATION

BIOMASS

Biomass includes organic materials such as **wood products**, **plants and waste** (animal, agricultural and fishery). When it comes to generating heat, biomass can be used in **centralized generation plants** connected to **district heating systems** or in individual **home heating systems**.



- Biomass technologies can supply energy to a single building or, through district heating, to several buildings.
- The required resource/fuel supply must be predictable, sustainably sourced, low-cost, local and adequate in the long term.
- Organic waste that cannot be recycled or reused can be used for energy purposes.
- Biomass technology is usually planned in the existing district heating plan or waste management facility.
- Biomass-based energy represents one of the cheapest renewable energy systems. The cost may increase if a new heating network needs to be installed. .
- The ecological impact of the biomass source is the major concern.

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4.1 Identification of local energy resources

➢ HEATING AND COOLING GENERATION

COGENERATION PLANT

It consists of the **simultaneous production** of electricity and **useful heat** by an engine running on a single fuel. The **heat** is **recovered** instead of being **released to the atmosphere** or lost through the **cooling system** and can be used as **hot water or steam for heating, cooling**, **domestic hot water or industrial processes**.

- Cogeneration units usually fit in standard-sized containers, which facilitates their transport and deployment.
- Cogeneration units need a fuel to operate, which can be fossil, such as natural gas, or renewable, such as biogas and biomass.
- Operating on the basis of the user's heat demand, as excess or curtailed heat is more complicated to manage than electricity.
- The cogeneration units are compact and have a high power/volume ratio.
- Cogeneration units offer economic and CO_2 savings compared to separate production of heat and electricity in two different units. .
- The ecological impact of cogeneration depends on the fuel used to run the engines.

4.1 Identification of local energy resources

➢ HEATING AND COOLING GENERATION

HEAT PUMPS

They can be used as **individual units** in dwellings or apartments or as **district heating systems** driven by heat pumps.

A **heat pump transfers thermal energy** to or from a **renewable heat source**, such as **air, water or ground**, with the help of external energy (electricity or gas).

- They are usually easy to install in single installations, but can also do larger ones.
- Heat pumps consume electricity and need access to a heat source or sink, such as ambient or exhaust air, water (groundwater, lakes, sea, ocean, sewage) or ground (geothermal).
- They provide at least twice as much energy as they consume.
- Land is necessary in the case of district heating or geothermal technology.
- Very cost-effective solution depending on the potential of the available energy source, electricity prices and the energy needs of the application.
- Negative effects of heat pump appliances can come from refrigerant leakage.

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4.1 Identification of local energy resources

➢ HEATING AND COOLING GENERATION

DISTRICT HEATING

Technology that **supplies heating**, **hot water or cooling** through a system of insulated pipes from a **central or distributed generation plant** to customers. They are mostly deployed in **densely populated urban areas**.

Recently, they are being increasingly adopted throughout Europe, as they allow the **integration of different types** of **low-temperature heat sources** with local renewable sources.

- They require distribution piping and are therefore relatively complex to implement unless the distribution piping system is already in place.
- Can utilize local sources and even waste heat from existing industrial systems or commercial buildings, thus increasing energy efficiency.
- Satisfy local heating/hot water/cooling needs, also as a storage system for renewable electricity generation.
- Require land for the central plant and for the distribution piping system and are recommended for urban areas.
- Economically it depends on the local resources available, the size and load of the system.
- Allow the use of a local renewable resource or waste heat to meet heating/cooling energy needs, making a fully sustainable energy system possible.

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4.1 Identification of local energy resources

➢ HEATING AND COOLING GENERATION

THERMOSOLAR

Thermosolar technologies extract heat from solar radiation and store it **in liquid or gaseous form**.

There are **two main thermosolar systems**: **high temperature and low temperature**.

High-temperature systems use concentrating technology that **concentrates solar irradiation** on a small surface area to **increase energy absorption**, and are most commonly used to **generate electricity**.

The **low-temperature** ones **absorb the sun's energy** through **flat-plate collectors** or vacuum tubes and are used in domestic and **industrial applications**.

- Thermosolar technology can be incorporated into existing heating systems.
- Most suitable for hot climates, although it can be implemented in existing infrastructure and used in cold climates to partially replace existing energy sources.
- Can operate independently to supply the heating or cooling needs of a stand-alone energy installation, or in an existing system.
- Can be integrated into buildings, such as roof-mounted systems, or can be installed as ground-mounted systems.
- Consist of mechanical and piping systems, which require a high capital cost. However, they offer good payback over the life of the project.
- Very low ecological impact

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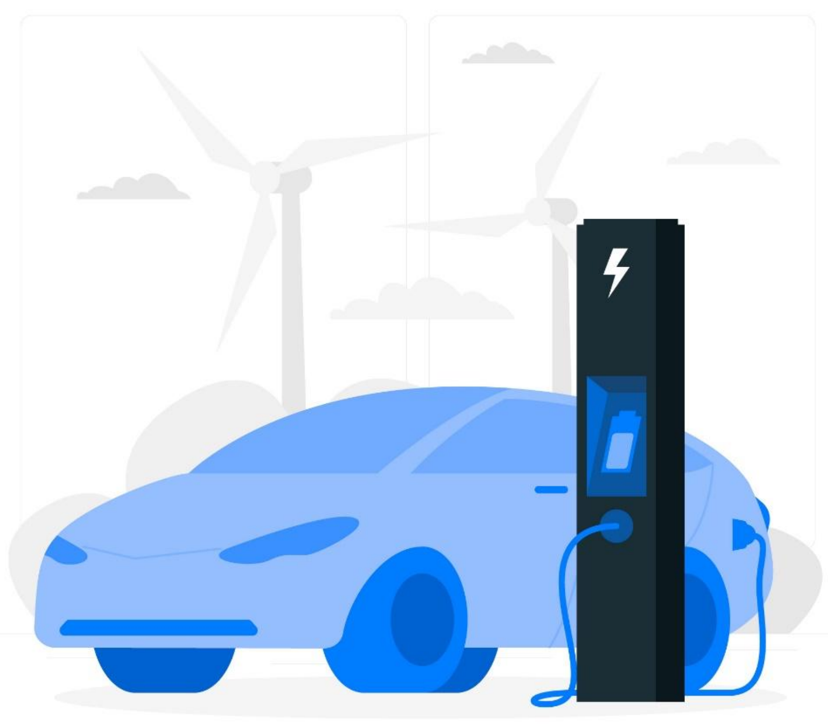
4.1 Identification of local energy resources

➢ **TRANSPORT**

The transport sector represents one of the largest consumers of energy, with a cycle that spans from the production of vehicles to their daily operation and eventual decommissioning. The transition to more sustainable models is transforming both consumption patterns and the necessary infrastructure.



Energy end use

Energy consumption in the transportation sector represents one of the largest energy end uses

Vehicle operation

Daily operation constitutes the main energy consumption in transportation systems.

Electrical infrastructure

Development of new infrastructure needed to support electric vehicles

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4.1 Identification of local energy resources

➢ TRANSPORT

CHARGERS FOR EV

Technical Aspects and Network

Electric vehicles require high charging power (3.6 kW - 11 kW) compared to typical domestic consumption (2-3 kW). In cases of bi-directional smart charging, they can help to balance the local power grid.

Benefits and Opportunities

- Recharging by local renewable energies
- Transport without direct air pollution
- Coupling between transportation and energy sectors
- Improved battery technology

The EV charging infrastructure can have a significant impact on the local electricity grid. In case of smart (bi-directional) charging, the EV fleet can contribute to balancing the grid.

The energy used for recharging can be produced locally by renewable energy sources.

EVs offer a sectoral coupling between the transport and energy sectors.

The charging infrastructure does not require a large area of land. The chargers are small (< 1 m²) and can be integrated into existing buildings or parking lots.

The initial investment costs may be significant (about 1,000 euros/charger), but they guarantee the coordination of the charging system and operation of EVs.

Allow road transport without direct atmospheric pollution.

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➢ TRANSPORT

ELECTRIC BOATS AND FERRIES

Electric ships and ferries are very important for the decarbonization of **maritime transport in the EU.** Mainly important for **island areas**.

Electric ships have batteries on board and **electric motors** to propel them 100% of the time, while **hybrids** only use **electric propulsion** near coastal regions to reduce emissions and noise pollution.

All-electric boats are usually **used as ferries**, while **hybrids** are preferred for **cruising or fishing**.

- Require a recharging infrastructure in the port or marina, which should be implemented in coordination with the grid operator and a local municipality.
- Locally produced renewable electricity can be used as fuel, avoiding the import of fossil fuels.
- Sustainable solutions for passenger transport, tourism and the island industry (fishing).
- Recharging of electric boats can be organized in existing ports and marinas without the need for additional land use.
- Electric vessels have higher initial costs due to the need for large batteries and their still low production numbers.
- Lower environmental impact during operation by reducing emissions, noise pollution and vibrations.

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4.1 Identification of local energy resources

- **TRANSPORT**

HYDROGEN

Hydrogen offers **higher energy density** compared to **electric storage systems**, allowing for **longer range transportation**.

Green Hydrogen

It is produced by electrolysis, which splits water into hydrogen and oxygen using electricity. It is the only production process that is virtually carbon-free.

Blue Hydrogen

It is also produced by steam reforming, but the production plants are retrofitted with carbon capture, utilization and storage (CCUS) technology.

Gray Hydrogen

It is produced from fossil fuels by steam reforming, mainly from methane.

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4.2 Existing energy transition measures at the municipal level

Local Action Plans

Due to the **need** to create **Local Action Plans**, the different **existing initiatives** in which they are framed include different **types of actions**.

Analysis of Island Municipalities

In reference to the **Covenant of Mayors initiative**, plans of **municipalities located on tourist islands in Spain, Italy and Greece** have been reviewed in order to identify the main actions proposed at the municipal level and specifically.

Categories of Actions Identified

Based on the analysis of the plans, the actions were mainly divided into the following:

- **Municipal buildings and facilities**
- **Industry**
- **Lighting**
- **Buildings**
- **Local electricity production**
- **Resource management**
- **Transport and awareness**

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4.2 Existing energy transition measures at the municipal level

It is important to consider the **casuistry of the municipalities**, i.e., in this case, since they are located on tourist islands, the following is considered:

Canary Islands

They are dependent on fossil fuels, so most of the actions are focused on improving energy efficiency, introducing renewable energies, promoting electric vehicles (EV) and energy communities, as well as raising awareness in society.

Greek Islands

Their diversity in typology makes it difficult to identify needs, but there is an involvement in improving the energy efficiency of municipal buildings and lighting, as well as in promoting public transport and the purchase of EVs.

Italian Islands

There is a greater interest in energy efficiency actions in municipal buildings and equipment, as well as in the promotion of sustainable transport and public awareness.

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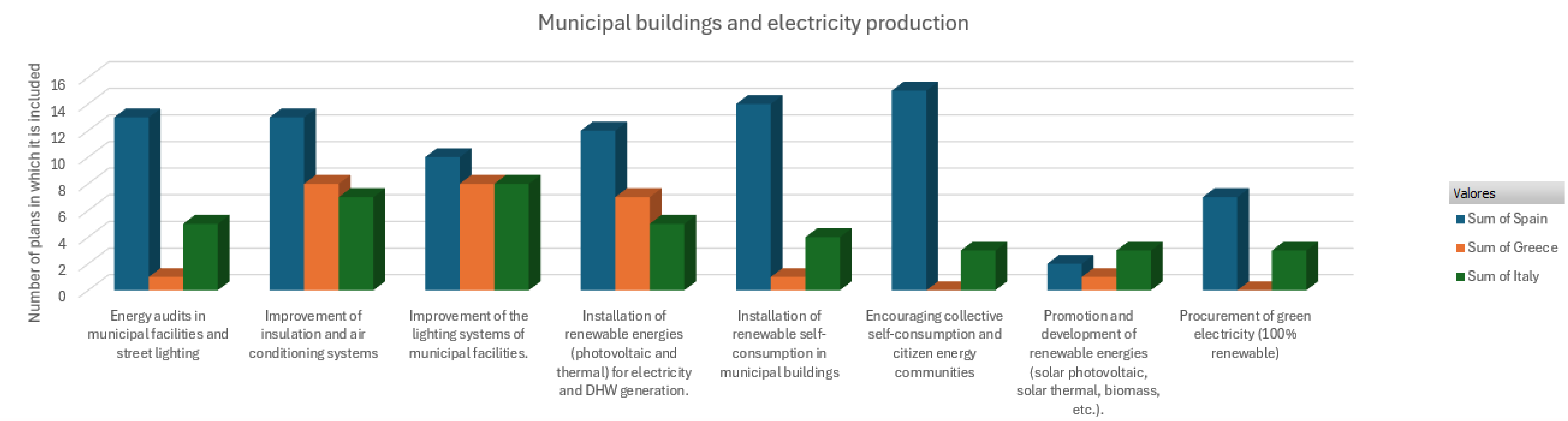
4.2 Existing energy transition measures at the municipal level

Municipal buildings and electricity production

Municipal buildings are a crucial starting point for TE. Energy efficiency in these spaces is a model for the community, and renewable electricity production, through solar panels or wind turbines, can reduce dependence on fossil fuels.



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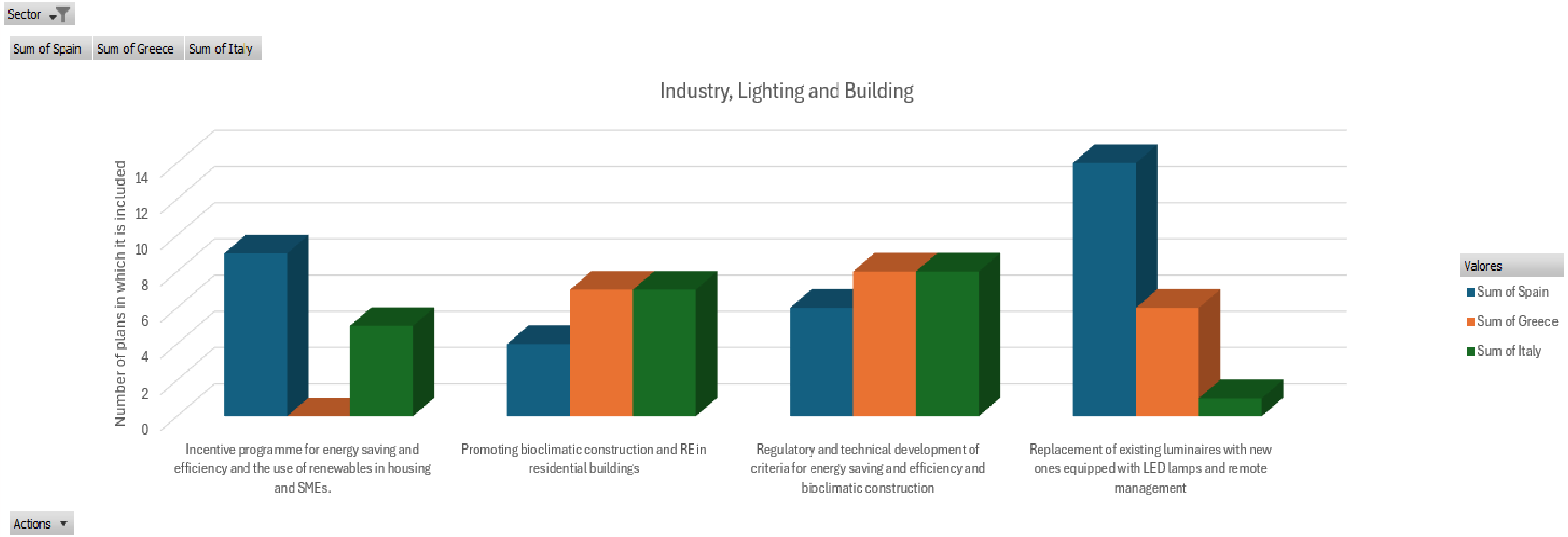
Industry, Lighting and Building

Industry is another key sector for the energy transition. The implementation of more efficient processes, the use of renewable energies and the reduction of emissions are vital for sustainable development. Energy efficiency measures in public lighting and buildings are equally important to reduce energy consumption.



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4.2 Existing energy transition measures at the municipal level

Awareness

Promoting awareness of the importance of the energy transition is essential. Information campaigns, training and public awareness are essential to encourage the efficient use of energy and the adoption of sustainable practices.

Resource Management

Efficient resource management is a key component of the energy transition. Optimizing water consumption, waste management and promoting recycling are crucial to reducing environmental impact and promoting a more sustainable development model.

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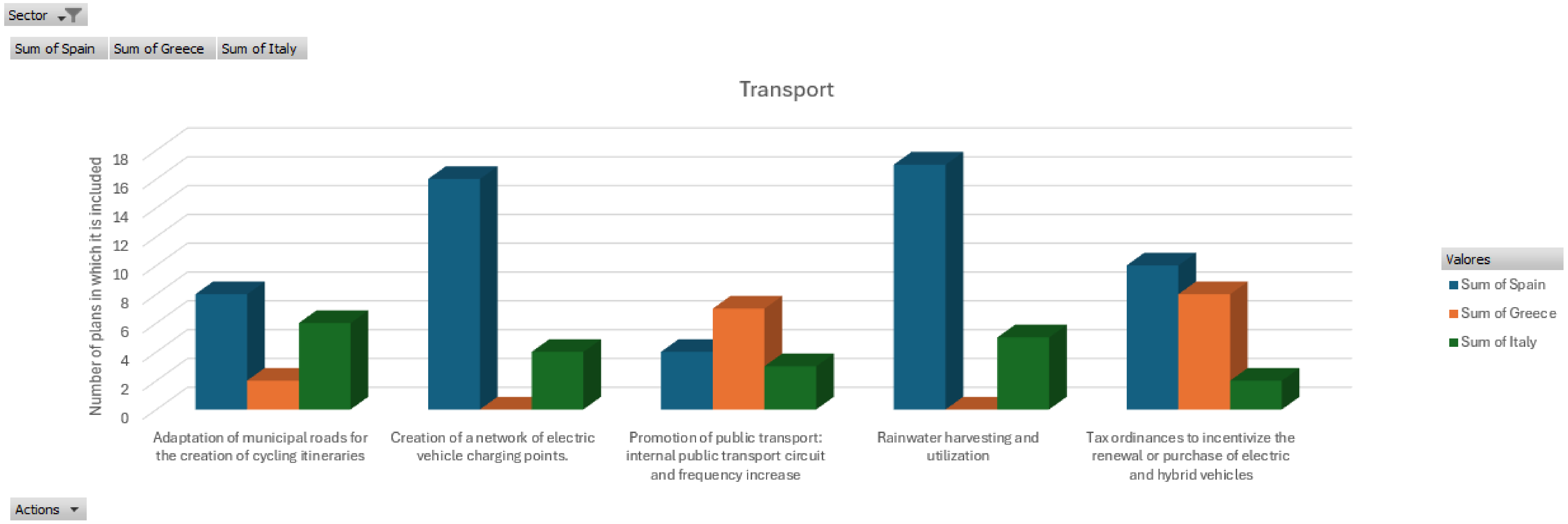
4.2 Existing energy transition measures at the municipal level

Transport

Encouraging the use of public transport is essential to reduce traffic and emissions. Improving the frequency and accessibility of public transport, as well as promoting electric vehicles, are important measures for the energy transition. Promoting active mobility, such as walking and cycling, is essential for public health and sustainability. Creating safe bike lanes and promoting cycling for short trips are key measures for the energy transition.



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4.3 Identification of energy transition indicators

1 **Evaluating the effectiveness** of **energy transition plans** is crucial to ensure that **objectives** are being met and to make informed **adjustments**.

2 It is important to **review the initiatives** and reports to study the **measures implemented** and the **objectives to be achieved.**

3 Identifying **key indicators is critical** to **assessing the progress** of the **energy transition**. Key indicators include **energy savings, renewable energy production and CO2 reduction.**

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4.3 Identification of energy transition indicators

Total electricity produced (GWh)

Calculates the total energy produced annually on each island as the sum of the energy produced by each available energy source. It only includes the energy produced or, in other words, generated in the municipality itself.

Total electricity produced per capita (GWh/person)

It represents the amount of electricity produced per person and gives an idea of the total amount of energy generated per municipality per inhabitant. Therefore, this indicator will be influenced by climatic and social characteristics.

Average annual electricity production by source (GWh/time period)

Calculates the average electricity production over a period of time by energy source, from both renewable and non-renewable sources.

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4.3 Identification of energy transition indicators

Energy independence (%)

This indicator calculates the percentage of energy independence of either the island or the municipality, calculated as the total renewable electric energy over the total energy produced.

Carbon Intensity (gCO_2eq/kWh)

It refers to the grams of carbon dioxide released to produce one kilowatt hour of electricity. It is therefore an indicator of the degree of purity of the electricity. Depending on the generation sources, the electricity generated will be more or less carbon intensive.

Carbon intensity per capita ($gCO_2eq/(kWh\text{-}person)$)

This indicator is based on the previous "Carbon Intensity" and indicates the grams of carbon dioxide emitted to produce one kilowatt hour of electricity per inhabitant.

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4.4 Selection of local energy transition actions

- After studying different local action plans, a compilation was made of the main actions carried out.
- The actions were grouped into different categories, according to those considered in the action plans.
- To evaluate the actions, measurement indicators were used to measure annual energy savings, annual CO_2 emissions savings and the cost of implementation per 1000 inhabitants.
- The categories of actions analyzed are: awareness, industry, transportation and municipal buildings and facilities.

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4.4 Selection of local energy transition actions

Awareness actions	Energy savings (MWh/year)	CO2 Savings (tCO2e)	Cost (€)
Communication, training and awareness plan	22	8.3	666.67
Energy saving information program for schools	7	3.3	666.67
Campaign to promote sustainable mobility	500	80.0	833.33
Promotion of walking and electric vehicles for personal mobility	500	300.0	10000.00

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4.4 Selection of local energy transition actions

Industry Actions	Energy savings (MWh/year)	CO2 Savings (tCO2e)	Cost (€)
Incentive programme for energy saving and efficiency and the use of renewables in housing and SMEs	57	42.9	1714.29

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4.4 Selection of local energy transition actions

Transport Actions	Energy savings (MWh/year)	CO_2 Savings (tCO_2e)	Cost (€)
Creation of a network of electric vehicle charging points	1050	65.0	7500.00
Adaptation of municipal roads for the creation of cycling itineraries	153	49.4	43529.41
Promotion of public transport: internal public transport circuit and frequency increase	550	275.0	17500.00
Tax ordinances to incentivize the renewal or purchase of electric and hybrid vehicles	375	825.0	23125.00

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4.4 Selection of local energy transition actions

Municipal buildings and facilities Actions	Energy savings (MWh/year)	CO2 Savings (tCO2e)	Cost (€)
Improvement of insulation and air conditioning systems	15	9.8	32500.00
Energy audits in municipal facilities and street lighting	2	6.3	1666.67
Improvement of the lighting systems of municipal facilities	1000	46.7	33333.33
Installation of renewable self-consumption in municipal buildings	10	45.0	40000.00
Replacement of existing luminaires with new ones equipped with LED lamps and remote management	17	8.0	20000.00

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4.4 Selection of local energy transition actions

Municipal buildings and facilities Actions	Energy savings (MWh/year)	CO2 Savings (tCO2e)	Cost (€)
Renewal of the municipal fleet with electric or plug-in hybrid vehicles	57	42.9	1714.29
Procurement of green electricity (100% renewable)	17	9.0	2500.00
Installation of renewable energies (photovoltaic and thermal) for electricity generation and DHW	500	500.0	6666.67
Regulatory and technical development of energy saving and efficiency criteria and bioclimatic construction	533	333.3	2500.00

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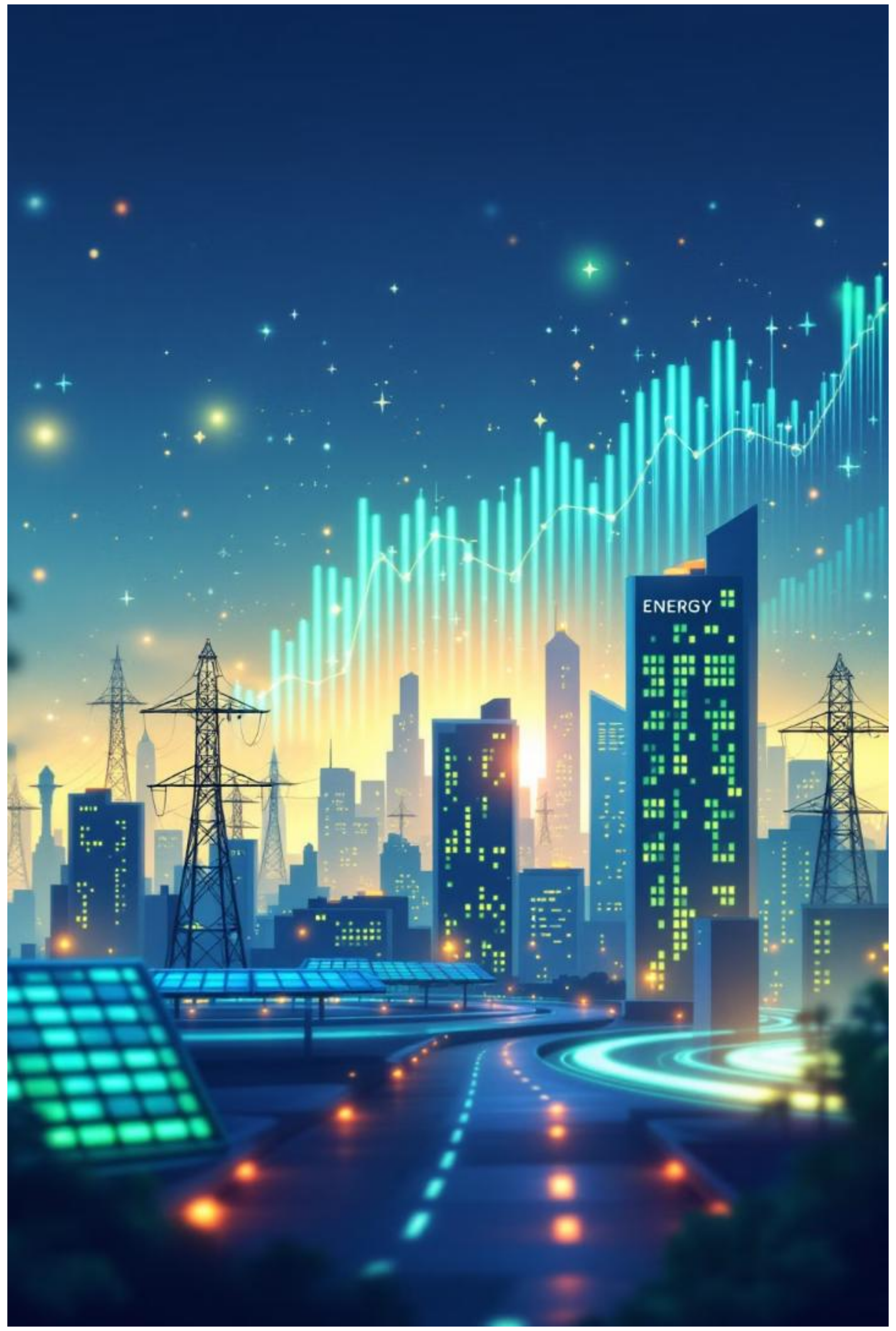
4.5 Energy impact assessment

1 Evaluating the locally available resources that have been seen throughout the unit allows to identify the input parameters that will give a first estimate of the local energy impact.

2 It is essential to evaluate the local area including factors such as climate, size of the municipality in terms of inhabitants and available territory, available energy sources and what the local economy is based on.

3 It is also important to consider the current governance policy, its priorities and how it intends to address the objectives set by the EU.

4 Define the indicators through which the progress of local actions and their contribution to the achievement of the objectives will be measured.



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4.5 Energy impact assessment

4.5 Energy impact assessment

As a summary, the following outline is presented to represent the proposed **methodology** for assessing the **energy impact** of the local area.

The **local characteristics** will be used as **input data** for the **indicators.** The results will make it possible to **evaluate the energy situation** of the municipality.

- Weather
- Size of the municipality
- Inhabitants
- Energy sources
- Economy
- Governance

Identify input values that impact the energy transition at the local level

- Total Electricity Produced /Produced per capita
- Average annual electricity production by source
- Energy independence
- Carbon intensity indicator/per capita

✓ Provides added value on the energy situation of the municipality.
✓ In line with the objectives of the European Union.
✓ Provides a current energy scenario at the municipal level

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UNIT 5

SELECTION OF THE MOST PROMISING ET SOLUTIONS

MOOC 1: Energy sustainability and municipal roadmaps

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UNIT 5. SELECTION OF THE MOST PROMISING ET SOLUTIONS

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

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5.1 Importance of decision making at the municipal level

Multi-criteria decision making

Multi-criteria decision making is a methodology that considers the simultaneous analysis and evaluation of more than one criterion according to the preferences of the decision maker and the proposed objective.
It allows to obtain an analysis of the different scenarios generated, highlighting the value of the authority's decision, an important approach to address the issue of ET at the municipal level.

Sustainable development

The need for sustainable development means that the multi-criteria approach has a major impact on the EU. Sustainability and its implications for the environment are intertwined with decarbonization and climate change mitigation.

MCDM techniques

Specifically, multi-criteria decision making (MCDM) is applied using various techniques, such as WSM, WPM, PROMETHEE, ELECTRE or TOPSIS, although AHP is the most popular method.

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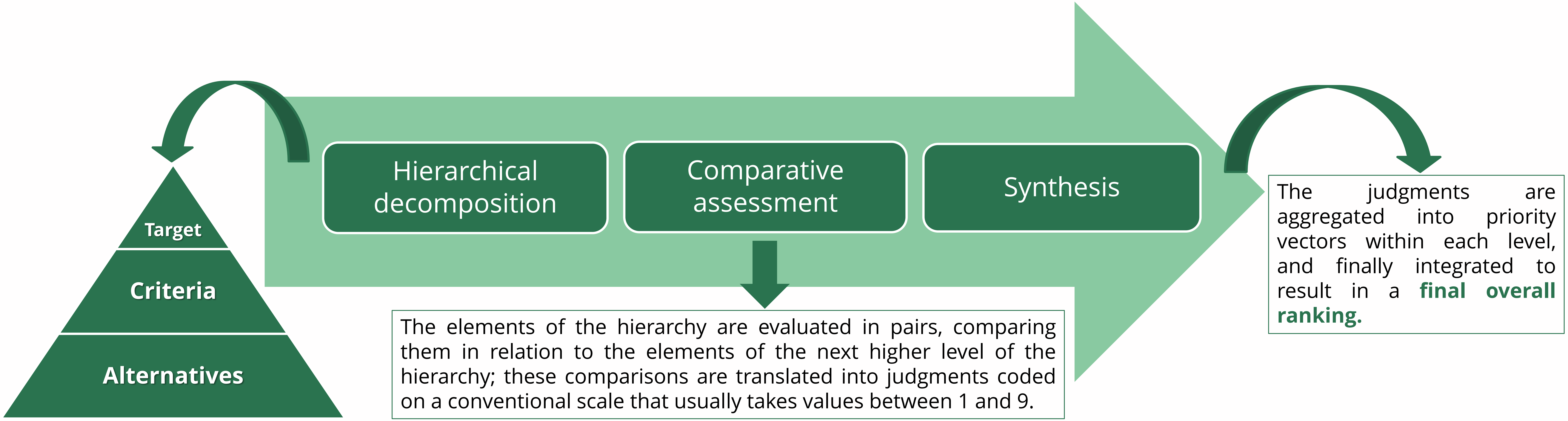
5.2 The Analytical Hierarchical Process (AHP)

AHP is a discrete multi-criteria technique that aims to provide a quantitative evaluation for the alternatives inherent in multi-criteria problems, without the need for decision-makers to make their preferences explicit.

Preferences are inferred from successive comparisons coded according to a conventional scale. Judgments are aggregated into priority vectors within each level, and finally integrated to yield a final overall ranking.



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5.3 Definition of local characteristics

In the **municipal case**, the **multi-criteria evaluation** of alternatives is applied to analyze and evaluate feasible solutions to be implemented in SEAPs from a broader approach. Not only are the technical or economic parameters of the implementation of sustainability-related measures, such as photovoltaic solar energy in isolated communities, considered, but also the **environmental, social and political** variables involved in the final decision. The multi-criteria approach makes it possible to **integrate quantitative and qualitative aspects** of the solution in the evaluation process.

The **main objective** is to select the best set of solutions for the **Municipal Action Plans** to achieve **sustainability and decarbonization** of the municipality in accordance with **municipal priorities and requirements.**

For the municipal case, a first selection of alternatives has been proposed, classified according to the studies carried out in: **municipal buildings, industry, transport and awareness-raising**.

As for **the criteria** for the local level when classifying alternatives, the following are considered: **technical, social, economic, environmental and political.**

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5.3 Definition of local characteristics

The **criteria** for weighting and weighting the different actions have been classified into the **5 types** set out below. Specifically, at the local level, each criterion should take into account **aspects** such as those introduced in the following tables:

Technical

- **Urgency** of action
- **Effectiveness** in the face of climate change
- **Impact** at the municipal level

Social

- **Impact and improvement** for the municipality
- **Acceptability** by the involved parties

Economical

- **Financing/cost** ratio or financial capacity of the municipality.
- **Benefits** generated in relation to the cost of the action.

Environmental

- **Innovation and progress** for the municipal area
- **Relevance for** the climate risk of the municipality

Political

- **Visibility** from the point of view of the media
- Possibility to **collaborate** with other companies and interested agents.

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5.4 Selection of the most promising energy policies

Selecting the **most promising energy policies** involves assessing the local criteria described above, for which a number of **indicators** have been defined. These indicators are also used in part as information within the SECAPs, and are therefore relevant information.

TECHNICAL

- Technology maturity
- Percentage of renewable energies installed at the municipal level (%)
- Annual energy savings (MWh)
- Municipal Energy Consumption (%)
- Annual renewable energy production (MWh)
- Technology implementation rate (%)

ECONOMICAL

- Financing and funds available at the municipal level (m€)
- Annual profitability (kWh/€)
- Investment (m€)

SOCIAL

- Job creation
- Public acceptance

POLITICAL

- Political acceptance
- Compatibility with national policies
- Compatibility with regional policies
- Compatibility with European policies

ENVIRONMENTAL

- Reduction of CO2 emissions (tCO2)
- Impact on biodiversity
- Change in land use

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5.4 Selection of the most promising energy policies

After studying different **initiatives at the local level** (Covenant of Mayors for Climate and Energy, Municipal Action Plans, Clean Energy for the EU Islands, etc.), as well as **existing action plans**, some of the most commonly used **energy actions or policies** are presented below. The actions have been classified according to the above mentioned classification: **municipal buildings, industry, transport and awareness raising**.

MUNICIPAL BUILDINGS

- **Improve insulation of municipal buildings.** Window improvements (glass replacement) and facade insulation.
- **Improvement of municipal lighting.** Replacement of lighting fixtures with more efficient ones.
- **Heating, ventilation and air conditioning systems.** Upgrading of heating, cooling and DHW systems.
- **Introduction of renewable energies and self-consumption.** Possibility of integrating renewable energies such as: solar thermal, photovoltaic and biogas, as well as introducing self-consumption at the municipal level.
- **Municipal vehicle fleet.** Current municipal vehicles: retired versus acquired with new technologies (hybrid and electric).

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5.4 Selection of the most promising energy policies

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INDUSTRY

- **Process improvement.** Actions to improve energy measurement and control elements, as well as energy optimization**.**
- **Renewal of equipment.** Replacement, renovation and improvement of process machinery with more energy efficient machinery.
- **Industrial buildings.** Improvement of insulation, renovation of facilities, air conditioning and lighting systems.
- **Introduction of renewable energies and self-consumption.** Possibility of integrating renewable energies such as: solar thermal, photovoltaic and biogas, as well as introducing self-consumption at the municipal level.
- **Change of the energy vector.** Diversification of energy sources towards less polluting ones and replacement of heating and pumping equipment with more efficient sources**.**

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5.4 Selection of the most promising energy policies

TRANSPORT

- **Cycling routes.** Emission savings per km cycled compared to conventional vehicles.
- **Network of EV charging points.** Reduction of emissions per charging point installed.
- **Promotion of public transport.** Municipal transport awareness measures.

AWARENESS

- **Ecomovil.** Emissions savings per km traveled by bicycle compared to conventional vehicles.
- **Network of EV charging points.** Reduction of emissions per recharging point installed.
- **Promotion of public transport.** Municipal transport awareness measures.

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UNIT 6

ROADMAP DEVELOPMENT

MOOC 1: Energy sustainability and municipal roadmaps

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6.1 Compilation of ET objectives and strategies

1 To tackle climate change, energy transition, decarbonization and the demographic challenge, the role of small municipalities is essential.

2 It is important to be familiar with the right tools, since these municipalities are a key element in the change of energy model that we need so much, which also implies a social, cultural and environmental change.

3 All agencies and entities must be aligned and have the necessary tools to make quick and correct decisions that contribute to solving the problems we have in terms of pollution, energy dependence, inefficiency and increased resource costs.

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6.1 Compilation of ET objectives and strategies

Energy transition initiatives

➢ **Covenant of Mayors for Climate and Energy**

Initiative launched by the European Commission to support municipalities. The aim is to encourage municipalities to make political commitments and begin to take measures to anticipate and adapt to the inevitable effects of climate change that are already occurring.

The commitments of the adhering municipalities include reducing CO2 emissions by 40% by 2030, increasing energy efficiency by 27%, increasing the use of energy from renewable sources by 27%, drawing up an inventory of emissions, creating an Action Plan for Climate and Sustainable Energy, as well as monitoring reports.

Pacto de las Alcaldías
para el Clima y la Energía
EUROPA

6.1 Compilation of ET objectives and strategies

Energy transition initiatives

➢ **Clean Energy Package**

Package of tools and new legislative proposals presented by the European Commission at the end of 2016, whose objectives in terms of matter and energy include:

- 40% reduction in GHG emissions, compared to 1990.
- 32% of renewables in the EU's gross final energy consumption in 2030.
- 26% reduction in EU primary energy consumption compared to 2005.
- 20% reduction in EU final energy consumption compared to 2005.
- At least 32.5% improvement in energy efficiency compared to 2005 at EU level, expressed in primary or final energy consumption.
- 15% electricity interconnection of Member States

In addition, some directives were also included in the package:

- **Energy Efficiency in Buildings Directive (Directive 2018/844).** This is a long-term strategy to support the renovation of the entire building stock, with the aim of achieving high energy efficiency and decarbonization by 2050.

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6.1 Compilation of ET objectives and strategies

Energy transition initiatives

- **Clean Energy Package**

  - **Energy Efficiency Directive (Directive 2018/2002).** It proposes the improvement of energy efficiency to reach at least 32.5% at EU level by 2030.

  - **Directive for the promotion of the use of energy from renewable sources (Directive 2018/2001).** It proposes an important novelty, which is the recognition of self-consumers of renewable energies, both individual and collective, acquiring the right to be able to generate, consume, store, manage and sell their own electricity.

  - **Regulation on the Governance of the Energy Union and Climate Action (Regulation 2018/1999).** This regulation aims to lay the necessary legislative foundations for reliable, inclusive, integrated, cost-efficient, transparent and predictable governance, ensuring the achievement of the objectives set for 2030 and in the long term, through complementary, coherent and ambitious efforts, while limiting administrative complexity.

  - **Directive on common rules for the internal electricity market (Directive 944/2019)3 and Regulation on the internal electricity market (Regulation 943/2019).** It allows and encourages demand-side management through the aggregation of electricity markets thus facilitating that active citizens, through their consumption, storage capacity or self-generated electricity, can participate in the electricity markets alongside large producers, facilitating the flexibility of the electricity market.

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6.1 Compilation of ET objectives and strategies

Energy transition initiatives

➢ **European Green Deal**

This is a long-term plan created in December 2019 to make Europe the first continent to achieve climate neutrality by 2050. Among the various actions, the following stand out:

- **NextGeneration EU Funds.** NextGenerationEU temporary recovery instrument, subsequently approved and with more than €800 billion, which seeks to mitigate the effects caused by the pandemic and achieve a greener, more digital, resilient and better adapted Europe, both to current and future challenges.

- **Fit for 55" program.** Following the COVID10 pandemic, new regulatory and legal tools were proposed that stand out for their relevance, impact and innovation to accelerate European climate action, such as:
  - Increase in the financial amount of the Innovation and Modernization Funds.
  - Revision of the Energy Taxation Directive proposing to align the taxation of energy products with EU energy and climate policies.
  - The GHG emissions reduction target is raised by 55% by 2030.
  - The Energy Efficiency Directive will be revised by increasing the current target from 32.5% to 36% for primary energy consumption and 39% for final energy from 2005..

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6.1 Compilation of ET objectives and strategies

Energy transition initiatives

- **European Green Deal**

  - **European Climate Law.** Framework to make the commitment made in the "Paris Agreement" to achieve climate neutrality in the EU by 2050 a binding obligation for EU partners.

  - **REPowerEU Plan.** The energy crisis caused by the invasion of Ukraine, with the problem of the cessation of exports, forced the EU to reduce its dependence on fossil fuels from Russia, as well as to make rapid progress in the ecological transition. To this end, in May 2022 the EC presented this plan, the purpose of which is to further increase the energy efficiency targets set in the FF55, which proposed an improvement of 9%, from the projection made in 2020, to 13% by 2030, in addition to an advance in the generation of renewables in the electricity system from 40% to 45%.
    - The EU Solar Energy Strategy, which aims to install more than 320 GW of solar PV and 600 GW by 2030.
    - A rooftop solar initiative with a legal obligation to install solar panels on new public, commercial and new residential buildings.
    - A Methane Action Plan to increase production to 35 million cubic meters by 2030.

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6.1 Compilation of ET objectives and strategies

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

Energy transition initiatives

➢ **Electrifying demand**

Electrifying demand means replacing fossil fuels with electricity in all economic sectors and activities. This implies a series of benefits such as:

- Reduction of CO_2 emissions
- Improved energy efficiency
- Enables energy independence by not relying on fossil fuels from other regions, which can lead to political conflicts
- Can cover different sectors: from transport, residential to industrial
- It would allow to increase energy self-sufficiency with clean, efficient and cheap energy

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6.1 Compilation of ET objectives and strategies

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

Energy transition initiatives

- **Democratization of energy**

Since energy is a scarce commodity and a basic necessity for all citizens, democratizing it would mean allowing all citizens to buy, sell, manage, generate and store their own energy.

- **Adaptation to climate change**

It consists of taking measures that help and facilitate the management of the current consequences of climate change. In other words, anticipating possible impacts, such as heat waves, droughts, floods or desertification, implies adapting to climate change.

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6.2 Alignment with municipal objectives and available local resources

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Energy sustainability

To achieve energy sustainability and decarbonization in municipalities, it is necessary to make energy consumption as efficient as possible, eliminate the use of fossil fuels and progressively replace them with clean and renewable energy sources.

Lines of action

The main lines of action proposed at the municipal level and on which each municipality should study the current status are as follows:

- **Distributed renewable energy generation and self-consumption.** It allows obtaining one's own energy and managing it according to one's own needs, in addition to being sustainable and cheap, and thus ceasing to depend on fossil fuels. **Distributed energy generation and self-consumption**, unlike centralized generation, does not require large extensions of land.
- **Energy refurbishment.** This consists of **reducing the energy consumption of homes through efficiency measures**, such as the replacement of gas boilers with heat pumps, and building renovation, such as insulation work on the building envelope.
- **Sustainable mobility.** It intends to use active mobility as a substitute for own combustion vehicles, promoting public transportation and the use of electrified vehicles for when it is necessary to move to other more distant points.
- **Urban regeneration.** Transversal line that is based on creating a correct connection between all the actions and that allows the integration of the rest of the measures within the urban space, conferring much more scope and strength.

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6.3 Planning of measures

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Each measure to be adopted within a roadmap must contain the necessary information to classify and temporarily organize the measure, understand its objective and the resources needed to implement it during the time required.

Categorization of measures

This refers to the categories into which the measures can be classified, for example: those mentioned in unit 4 (municipal buildings and equipment, industry, lighting, buildings, local electricity production, resource management, transport and awareness) or the action lines in the previous slide.

Information on each measure

The information to be included for each measure is:

- Category or line of action
- Duration, Objective and description of the measure
- Investment

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6.3 Planning of measures

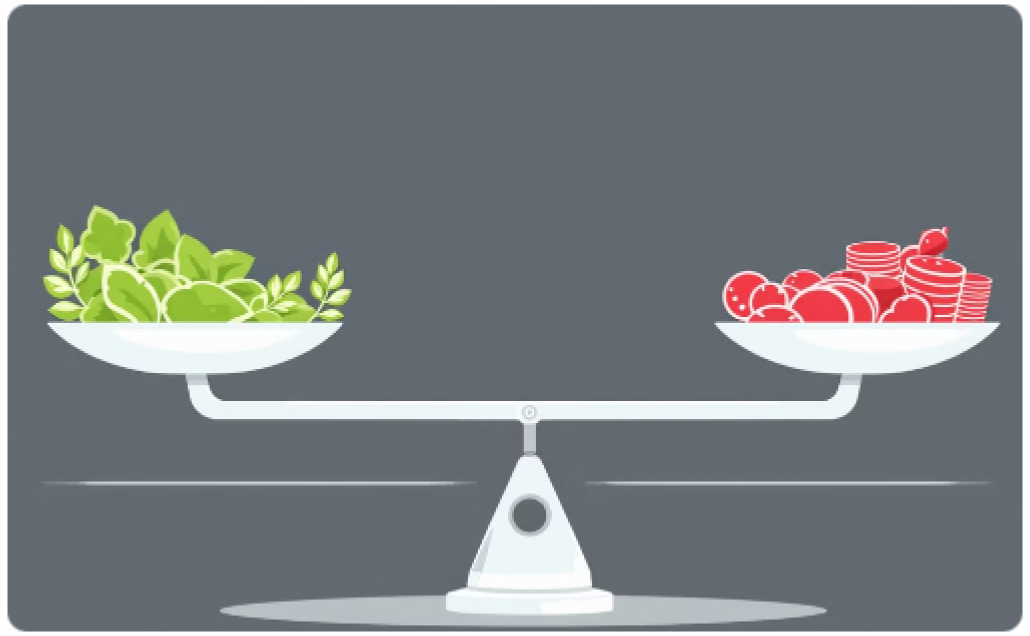
Timeline

Use of the Gantt Chart as a graphical tool to show the expected time commitment for different tasks to achieve the goals in 2030 or 2050.

Sectors involved

Coordination between multiple sectors including:

- Public Sector (administration)
- Residential Sector
- Primary sector
- Secondary sector (industrial)
- Tertiary sector (services)



Implementation considerations

Each measure requires a detailed analysis of:

- Main benefits at the municipal level
- Possible difficulties during implantation
- Resources required for implementation

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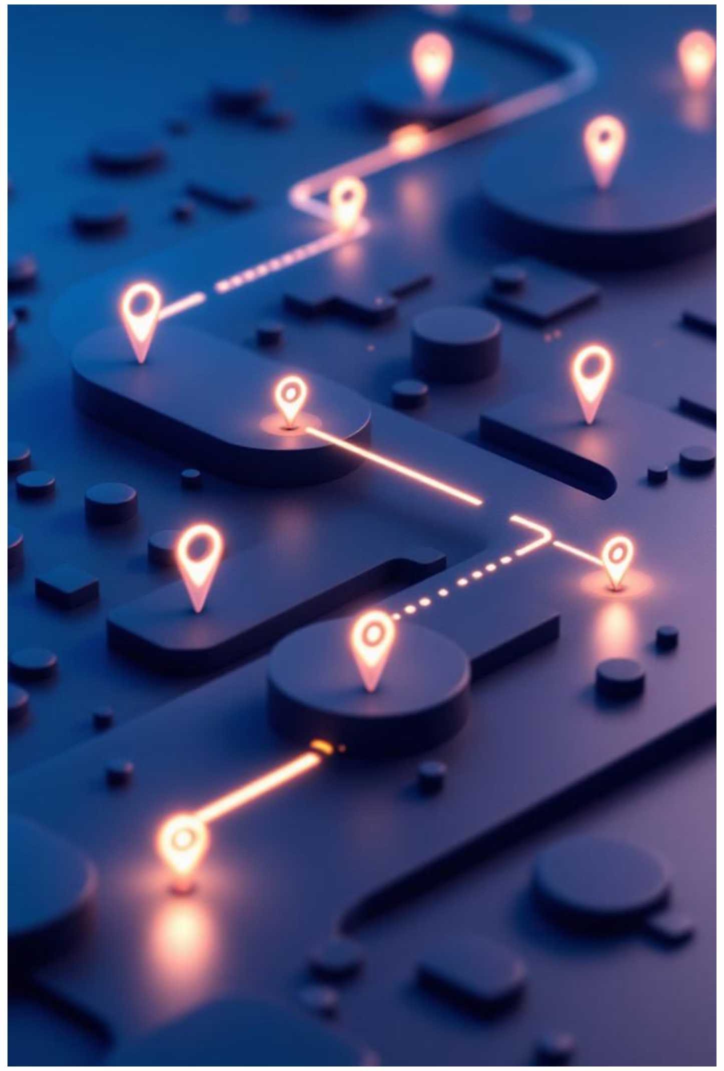
6.4 Definition of the indicators needed to achieve and measure the strategies

These are the indicators or also called KPIs (Key Performance Indicator) that allow quantifying the evolution of the objective to be achieved. Depending on their scope, they can be classified as general or specific.

➢ KPIs GENERALES

Son These are indicators that are transversal to all the measures and that together will give a general idea of the scope of the action plan. Some of them are:

- **Energy consumption savings (MWh):** Savings in energy consumption with the implementation of the measure.
- **Emissions savings (tCO_2):** Reduction in greenhouse gas emissions with the implementation of the measure.
- **Economic savings (€):** Economic savings achieved once the measure has been implemented.
- **Degree of self-sufficiency:** Energy capacity of the municipality to meet its consumption demand.



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6.4 Definition of the indicators needed to achieve and measure the strategies

➢ SPECIFIC KPIs

These are indicators specific to the measures that allow the development and progress of each of them to be evaluated. Depending on the measure, some of the indicators could be

➢ Municipal buildings and facilities

- Installed self-consumption capacity in the municipality (MW)
- Self-consumption production in the municipality (GWh)
- No. of self-consumption installations
- Installed power of renewable energy in the municipality (MW)
- Buildings rehabilitated in full (No. and %)
- Boilers in vulnerable buildings (no., % and fuel type)

➢ Transport

- Vehicles replaced (No. and %)
- Diesel and gasoline vehicles replaced (no. and %)
- Vehicles registered annually (no. and growth/decrease previous year)
- Electric bicycles (no. and % of population)
- Bicycle lanes (km and % of total)

➢ Industry

- Number of computer equipment with programmed shutdown.
- Number of companies with energy management system or monitored.
- No. of buildings with optimized air conditioning demand.
- No. of industries adhered to a local energy community.
- Energy consumption of equipment and facilities (kWh/year).
- No. of contracts that include clauses with environmental and energy efficiency criteria.

➢ Awareness

- No. of citizens trained in energy saving and efficiency.
- No. of courses carried out.
- No. of self-consumption installations.
- Installed power of renewable energy in the municipality (MW)
- Buildings fully rehabilitated (No. and %)
- Boilers in vulnerable buildings (no., % and fuel type)

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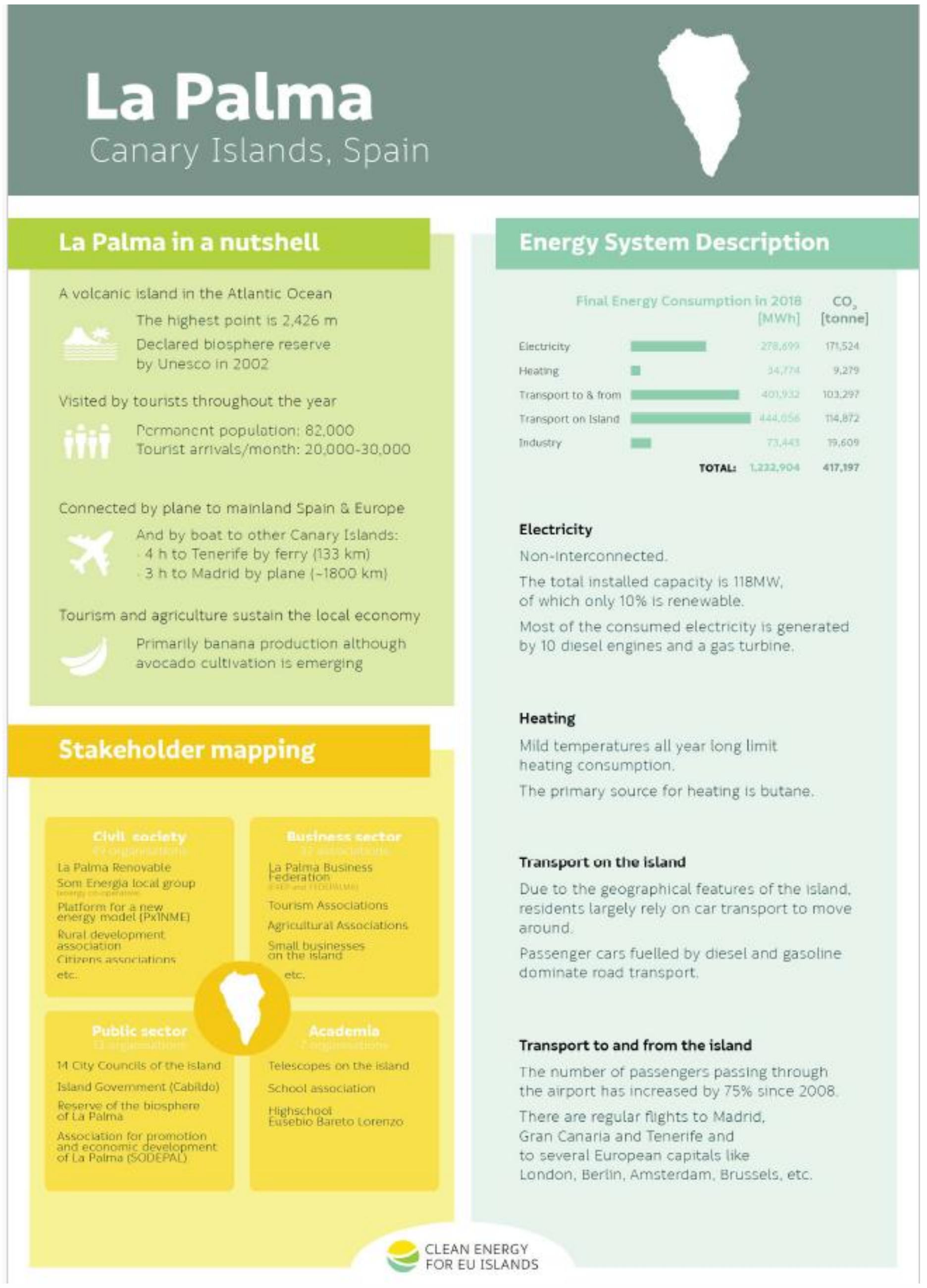
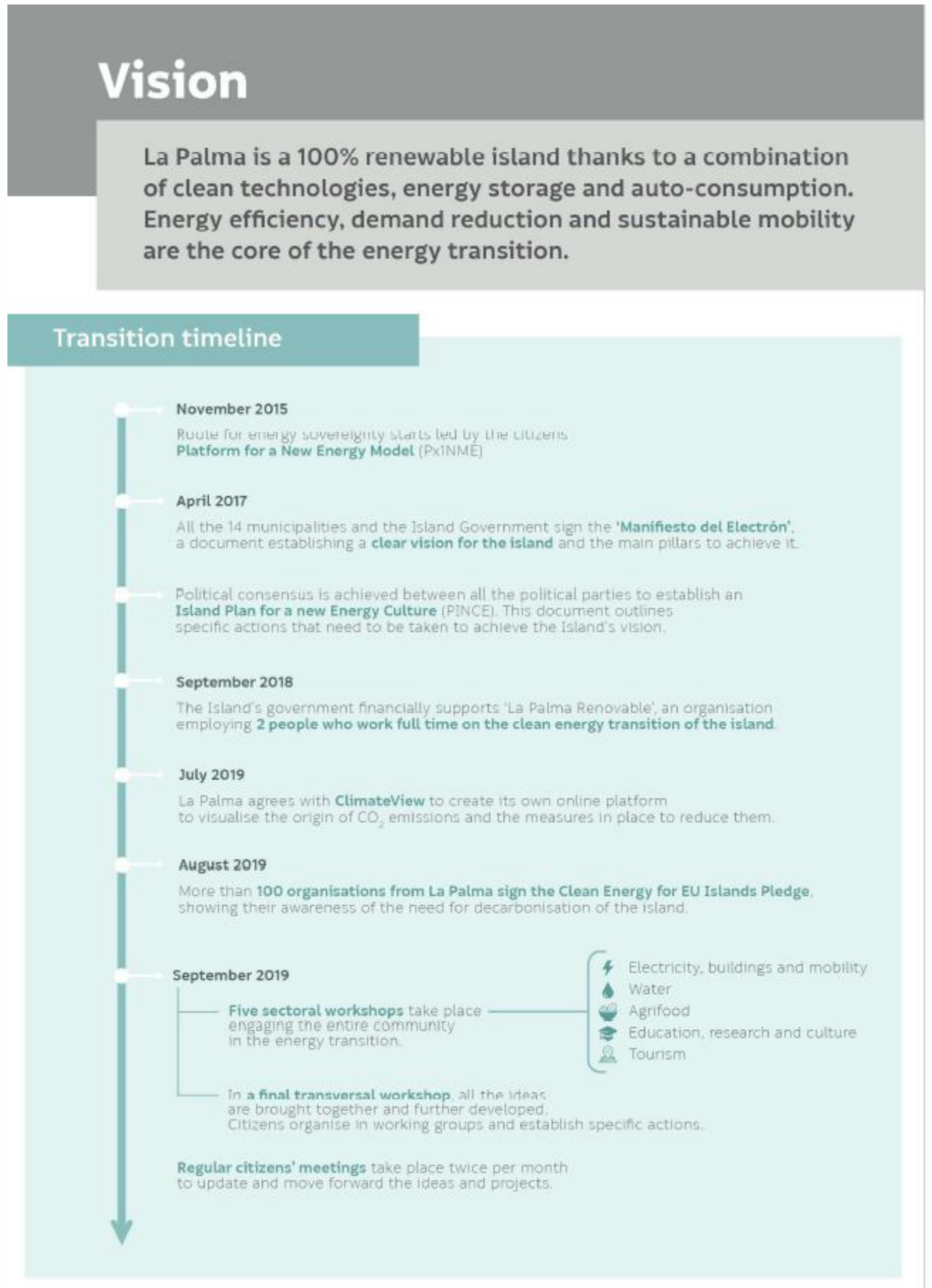
6.4 Definition of the indicators needed to achieve and measure the strategies

6.5 Roadmaps Examples

As we have seen throughout the course, a **roadmap** can be given and developed in different ways, its scope can be at **island, regional, city or municipal level**, and it includes actions that favor the achievement of **objectives**.

The format of representation depends on the initiative in which it is framed, if applicable. For example, for the “**Clean Energy for the EU Islands**” initiative, the format adopted is the one shown on the right for the island of La Palma (Canary Islands, Spain).





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6.4 Definition of the indicators needed to achieve and measure the strategies

6.5 Roadmaps Examples

Another context in the creation of a roadmap is framed in order to achieve a **specific objective**.

This is the example of the **decarbonization of the energy system** of the island of Menorca (Balearic Islands, Spain). It is a roadmap created in conjunction with the European Commission, the **Clean Energy Initiative for EU islands** and other local companies, to achieve the **transformation of the current energy model to one based on renewables by 2030**. In this case, specific actions are proposed as shown in the image on the right.

Figure 2. Menorca 2030 specific objectives.

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6.4 Definition of the indicators needed to achieve and measure the strategies

6.5 Roadmaps Examples

Finally, another way to approach a roadmap is to make a **detailed description** of each of the actions proposed within the **action plan**. On the right is an example of one of the actions at the municipal level of Sant Antoni de Portmany on the island of Ibiza (Balearic Islands, Spain).

Describing in detail each of the **actions allows to define responsibilities**, to carry out a correct **monitoring of the action**, to properly **manage the necessary resources**, to know all the stakeholders involved and their implication throughout the implementation of the action.

ALUMBRADO PÚBLICO EXTERIOR SOSTENIBLE				Nº 9
Línea de actuación	Regeneración urbana			
Prioridad	Alta		Duración	7 años
Meta	Sustitución de las luminarias anitguas por led, ilumación para el peatón y relojes astronómicos para el encendido y apagado			
Descripción de la medida				
Existen tres actuaciones para transformar el alumbrado público exterior en sostenible. La primera es sustituir el tipo de lámpara y luminaria a unos que minimicen la contaminación lumínica y que sean LED para conseguir el mínimo consumo por punto de luz. La segunda es la optimización del alumbrado con la instalación de relojes astronómicos que ajustan las horas de encendido y apagado de cada luminaria. La tercera tiene que ver en cómo hemos construido nuestras ciudades y pueblos alrededor del coche, y por tanto la iluminación de nuestras calles. El nuevo modelo de ciudad, diseñado a escala humana, deberá tener una iluminación viaria en consonancia, priorizando la buena iluminación para el peatón por delante de los vehículos.				
Beneficios	Disminución de la contaminación lumínica, mejora de la eficiencia energética y de la seguridad vial para peatones y ciclistas. Ahorro energético y economico.			
Sectores implicados	Admón- locales.			
Posibles dificultades	Es una medida sencilla, quizá lo más dificil sea el cambio de perspectiva de dotar de más iluminación al peatón y menos a los vehículos.			
Inversión	Ahorro consumo	Ahorro emisiones	Ahorro económico	Grado autosuficiencia
Aprox. 500€-1.000€ por unidad	Hasta un 65%	Hasta un 50%	Hasta un 65%	Incremento por disminución del consumo
Objetivos		KPIs		Cronograma
Inventariado del alumbrado público exterior y señales viarias luminosas		Puntos existentes (nº, tipo de alumbrado, ubicación y tipo de luminaria)		2023
Estudio de eficiencia y contaminación lumínica		Tipos de luminarias y eficiencia de cada una.		2023
100% LED y relojes astronómicos en alumbrado público exterior y señales viarias luminosas		Puntos de alumbrado público (nº, ubicación y tipo de luminaria y si tiene reloj astronómico).		2024-2026
Incremento de la iluminación viaria para peatones en detrimento de la de coches		Cantidad de iluminación viaria destinada a peatones (nº y % sobre el total)		2024-2030
Relevancia para la transición ecológica				
Al ser tres medidas actuamos en tres aspectos de la transición ecológica. El primero es la contaminación lumínica, que al igual que ocurre con la mala calidad del no es algo inherente a las grandes ciudades si no que los pequeños municipios también tienen el problema, aunque a escala más pequeña. El cambio de luminarias también implica eficiencia y es que la transición ecológica se basa en eficiencia siempre, siempre tenemos que buscar la forma de consumir menos. Por último, tocamos la transformación de nuestros municipios devolviéndoles la escala humana con calles y plazas diseñadas para el uso y disfrute de las personas en detrimento de los coches.				

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MOOC 1

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