UNIVERSITAT POLITÈCNICA DE VALÈNCIA

MOOC 2

Energy transition measurement and monitoring tools

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Course Index

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UNIT 1

INTRODUCTION

MOOC 2: Energy transition measurement and monitoring tools

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UNIT 1. INTRODUCTION

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1.1 Evolution of the energy transition

Policymakers face two challenges inherent in the energy transition: what is needed to accelerate the improvement of energy systems, and what should be the conditions necessary to take advantage of the transition's emerging opportunities? The evaluation of a country's energy system performance revolves around these three key premises. Balancing these aspects is crucial for a successful energy transition.

Security

Ensure security of supply through the energy mix, trading partners and electricity generation.

Equity

Ensure fair distribution, accessibility and affordability of energy for everyone.

Sustainability

Incorporate metrics to reduce carbon intensity, improve efficiency, and promote renewable energy sources.

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1.2 Regional overview

Prioritize Equity

Address disparities in equity, which represent the most significant divergence in system performance between advanced economies and emerging nations.

Reduce Regulatory Disparity

Work towards reducing the regulatory gap between regions with advanced economies and those that are developing.

Balance Equity and Sustainability

Address the global imperative to balance equitable transition with decarbonization efforts.

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1.3 Decision Support Models

Nowadays, decision making mainly in the environmental field requires information from different scientific disciplines and this gives rise to integrated assessment models.

The main objective of integrated assessment models is to provide a political view of global environmental change and sustainable development through a quantitative description of processes and interactions.

Analytical Role

Analyze the feasibility, costs, and impacts of different energy transition routes. Provide information on technology deployment, policy implications, and socio-economic factors.

Integrated Assessment

Combine information from different scientific disciplines to provide a comprehensive view of global environmental change and sustainable development.

Quantitative Description

Offer a quantitative description of processes and interactions in the energy system, enabling policymakers to make informed decisions.

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1.3 Decision Support Models

➢ **Modeling Approach for Integrated Assessment Systems**

Define Scope
1

Determine the sectors of the economy and focal points to be included in the model.

Select Methodology
2

Choose between general equilibrium and partial equilibrium models based on the complexity required.

Gather Data
3

Collect relevant data on energy production, consumption, and environmental impacts.

Develop Scenarios
4

Create various scenarios to explore different policy options and their potential outcomes.

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1.3 Decision Support Models

➢ Challenges in Modeling Integrated Assessment Systems

Data and Uncertainty

High levels of uncertainty due to hard-to-access data and assumptions about future technological advances, political decisions, and social behavior.

Intermittency and Storage

Modeling the intermittency of renewable sources and advances in energy storage technologies requires sophisticated algorithms.

Regional Differences

Systems must consider regional variations in renewable resource availability, energy demand, and infrastructure.

Socioeconomic Factors

Incorporating social, political, and behavioral factors that are difficult to quantify but crucial for a comprehensive analysis.

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UNIT 2

PARTICULARITIES OF TOURIST ISLANDS

MOOC 2: Energy transition measurement and monitoring tools

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UNIT 2. PARTICULARITIES OF TOURIST ISLANDS

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2.1 Importance of island regions

Importance of Island Regions

EU islands offer unique opportunities for modern energy planning, with potential for energy efficiency, renewable energy, and innovative solutions. Their small size and remoteness make them ideal testbeds for energy autonomy.

Specific Challenges

Islands face challenges such as land scarcity, climate risks, high seasonality of demand, isolation, and data scarcity. These factors complicate energy planning and require tailored solutions.

Energy in Isolated Microgrids

Microgrids offer potential solutions for electrifying remote areas, supporting isolated regions energetically, and facilitating the integration of renewable energy sources.

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2.2 Challenges specific to tourist islands

Land Scarcity

Limited space for renewable energy deployment. Solutions include offshore floating photovoltaics, rooftop solar, offshore wind, and innovative technologies like vertical photovoltaics and agrivoltaics.

Climate Risks

Islands are particularly vulnerable to climate change impacts. Incorporating distributed energy systems and storm-resistant technologies can enhance system resilience.

High Seasonality

Tourism-driven demand fluctuations require comprehensive seasonal storage solutions and explicit demand modeling beyond typical continental load curves.

Isolation and Data Scarcity

System stability issues and lack of data affect demand forecasting. Solutions include physical connections to neighboring systems and use of global demand databases.

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2.3 Use of energy in isolated microgrids

Definition

Interconnected energy system operating as a controllable entity within defined electrical boundaries

Objectives

Support isolated areas, integrate renewable sources, reduce emissions

Challenges

Complex optimization needed to manage renewable uncertainty and maintain service quality

The adoption of isolated microgrids remains limited due to the uncertainty produced by renewables and intrinsic load demand. Therefore, the use of intermittent energy resources along with conventional ones could resolve the uncertainty.

It is of utmost importance to incorporate efficient optimization strategies that reduce energy costs, pollution, fuel consumption, etc. and ensure the highest quality of service.

Optimization strategies are a complex process involving different variables such as the time frame, the existing constraints, the objective function, the optimization framework, the treatment of uncertainty or the optimization algorithm.

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2.3 Use of energy in isolated microgrids

1 — Time Frame

Consider the time horizon and resolution time of the optimization algorithm.

2 — Constraints

Address technical, environmental, and logical constraints specific to isolated microgrids.

3 — Objective Function

Define the function to be optimized, typically involving minimization of network costs and pollutant emissions.

4 — Optimization Framework

Choose between centralized, decentralized, or distributed architectures for information processing.

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2.4 Renewable islands

Ameland, Netherlands

Installed a 23,000-panel solar park in 2015, producing enough electricity for 1,500 households annually. The community plays a key role in developing a holistic and sustainable energy vision.

Menorca, Spain

Plans to increase renewable generation to 85% of electricity consumption by 2030, reduce fossil fuel use by 50% for transportation and 30% for buildings. High environmental awareness drives the transition.

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2.4 Renewable islands

Tilos, Greece

The local community and City Council are motivated to undertake a deeper energy transition, including clean electromobility and the development of a prosumer cluster on the island. Plans include increased automation and flexibility of the local electricity distribution network, showcasing the potential for small islands to lead in renewable energy adoption.

Pantelleria, Italy

As it is not connected to the national grid, the island's electricity is produced locally in a 22 MW diesel power plant.

Focusing on electrifying local public transportation, including a large photovoltaic system to cover 100% of electric bus consumption annually.

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UNIT 3

AVAILABLE TYPES OF ENERGY PLANNING AND MONITORING TOOLS

MOOC 2: Energy transition measurement and monitoring tools

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3.1 Integrated Assessment Models (IAMs)

As discussed in Unit 1, Integrated Assessment Models are very useful for addressing societal challenges, specifically those related to environmental policy and the path towards decarbonization.

Scope

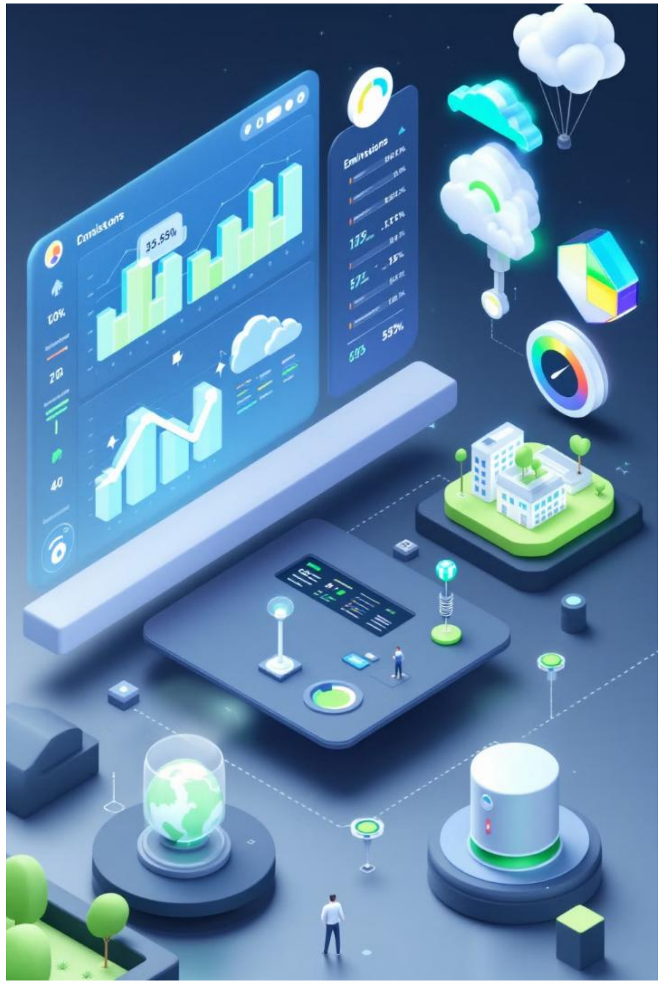
Cover multiple sectors of the economy and focal points, addressing the multidisciplinary nature of energy transition challenges.

Program

Consider programming and software requirements for implementing and running the models.

Economic Complexity

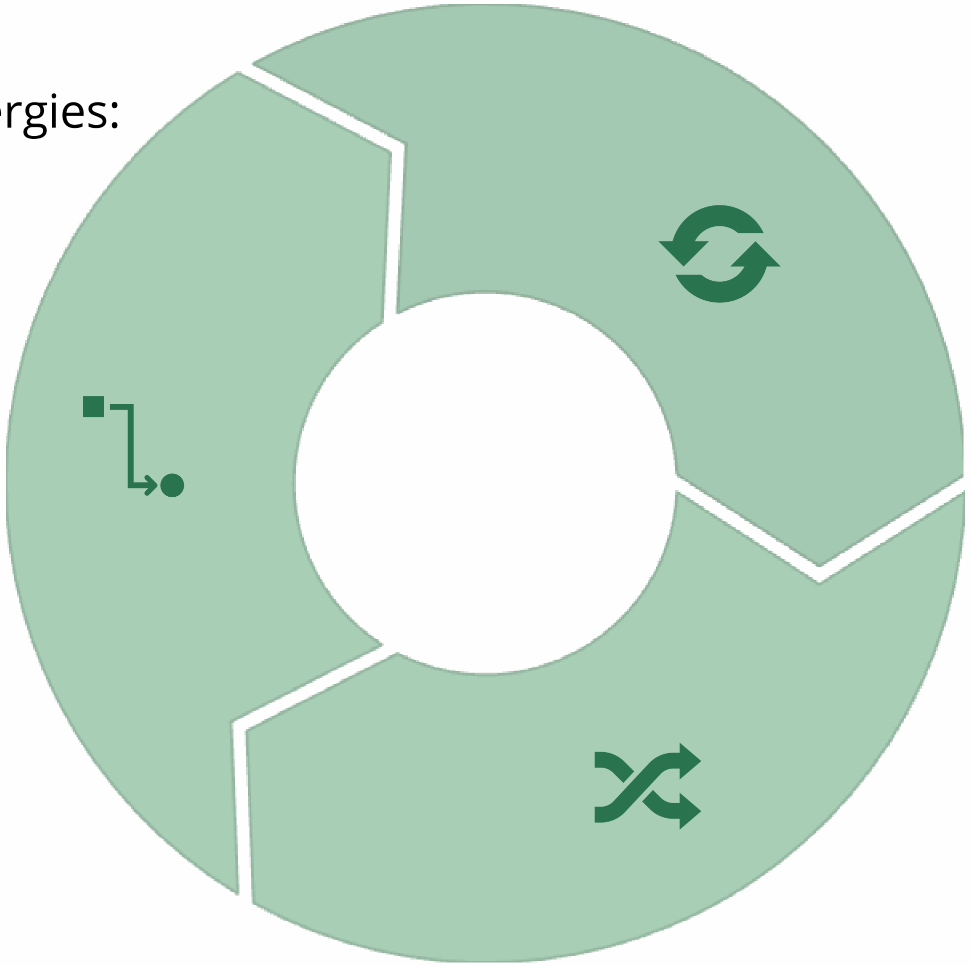
Choose between general equilibrium and partial equilibrium models based on the level of detail and interactions required.



3.1 Integrated Assessment Models (IAMs)

Understanding these synergies is crucial for developing holistic approaches to decarbonization pathways and associated socioeconomic narratives.

There are three main types of synergies:



Complementary

Two or more models work together to achieve a result, with each model being essential to the overall analysis.

Cooperative

The output of one model is used as input to another model, creating a chain of analysis.

Independent

Models create their own results independently, but can be merged to provide a more comprehensive analysis.

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3.1 Integrated Assessment Models (IAMs)

➢ Significant IAMs for Energy Transition

G4M (Global Forest Model)

Compares income from forests with potential income from alternative land uses, such as growing food grains or biofuels.

IBC (Integrated Benefits Calculator)

Converts LEAP emissions scenarios into estimates of health problems, ecosystem impacts, and climate impacts.

PRIMES

Simulates energy consumption and supply in the European Union, modeling energy market equilibrium for each member state.

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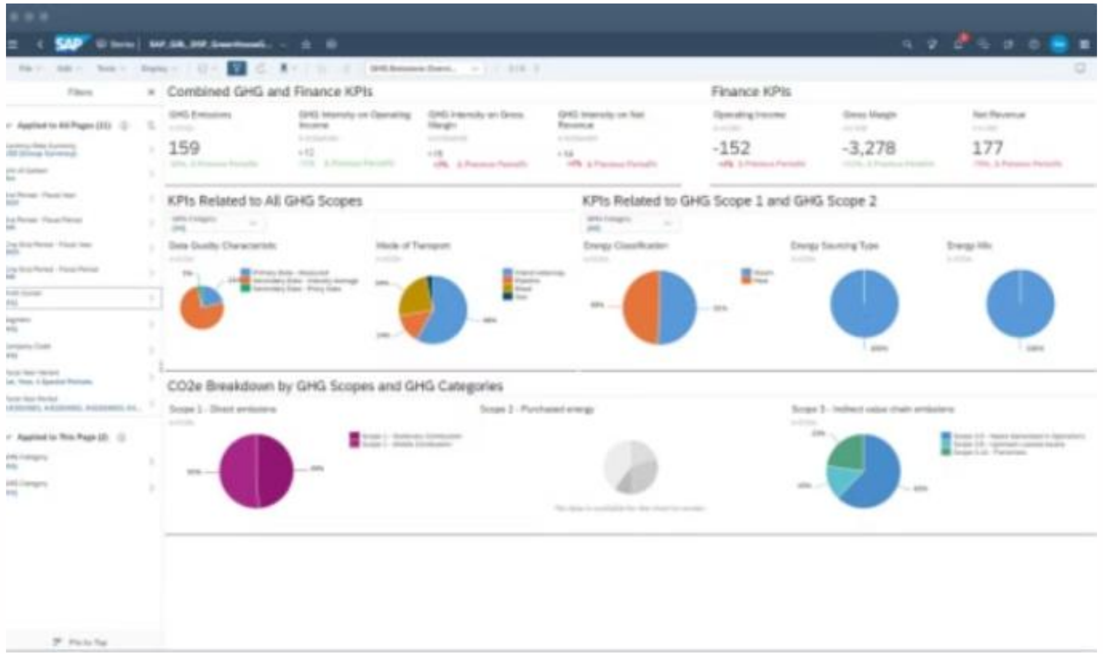
3.2 Available Tools

➢ SAP Temperature Calculator

Purpose

Calculates annual temperature changes based on input of all relevant emissions affecting temperature.



Features

Shows the degree of influence of different warming and cooling substances over time. Uses globally averaged coefficients for temperature change calculations.

Application

Useful for quick assessments of emission scenarios and their potential temperature impacts.

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3.2 Available Tools

➢ LEAP-IBC

Description

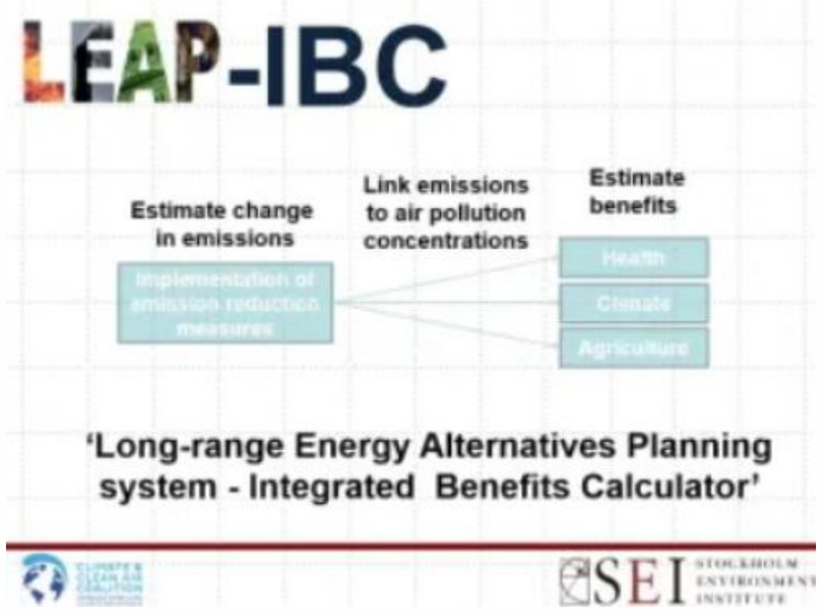
LEAP-IBC (Long-range Energy Alternatives Planning system - Integrated Benefits Calculator) is an integrated modeling and scenario planning tool for energy and greenhouse gas planning.

Key Features

Considers the location of emissions, which significantly affects the temperature impact at different points on the globe. Useful for quantifying the impact of various existing plans.

Limitations

Requires an elaborate database on the study site and a medium level of knowledge from users.



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3.2 Available Tools

➢ H2RES

Purpose

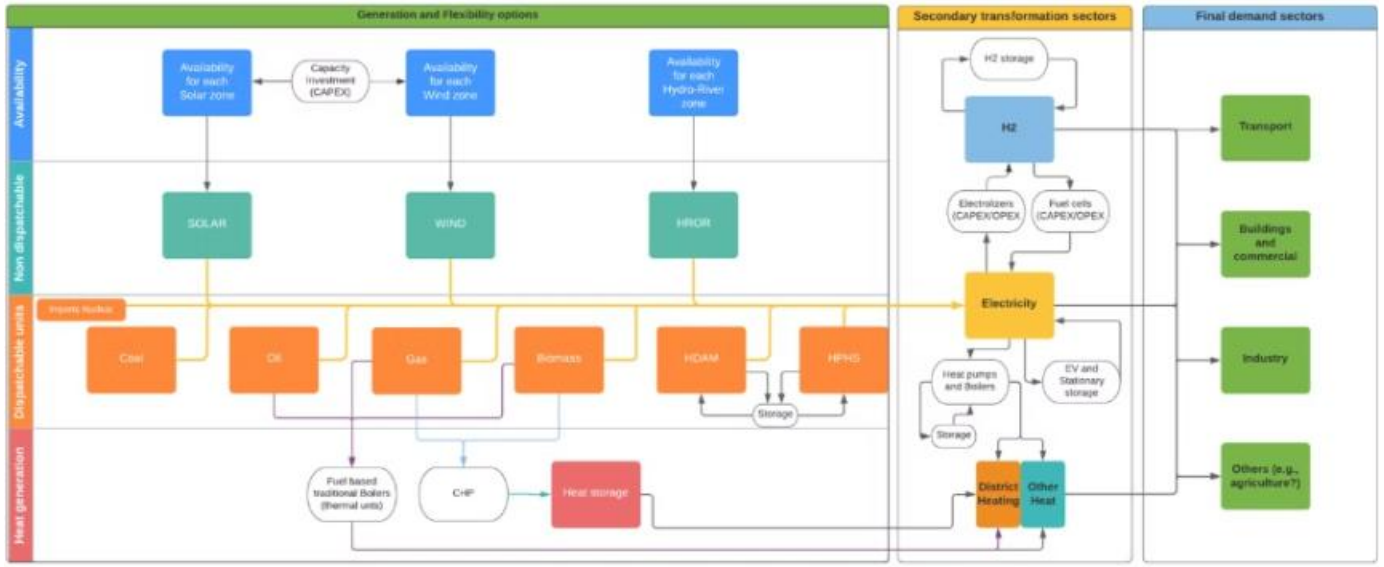
Specifically designed to increase the integration of Renewable Energy Sources (RES) in stand-alone systems. Used as a planning tool for individual energy systems.

Advantages

Tailored for island systems, offering detailed analysis of renewable integration in isolated grids.

Limitations

Not sold to external users, requires up to two months of training, and has limited accessibility due to its complexity.



3.2 Available Tools

➢ GAINS

Greenhouse Gas – Air Pollution Interactions And Synergies assesses GHG and air pollutant emissions from main emitting sectors. It evaluates the effect of different emission control strategies.

➢ SWEET

Solid Waste Estimation Tool quantifies GHG emissions and other air pollutants from the municipal solid waste sector. It can estimate historical emissions and assess impacts of waste sector policies.

➢ Roadmap Model

Developed by ICCT, it estimates GHG emissions and pollutants from road transport. Useful for developing historical inventories and projecting future emissions under different policy scenarios.

➢ EnergyPlan

A simulation model for evaluating different energy system alternatives. Free to download but requires expert knowledge. Assists in designing national or regional energy planning strategies.

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3.3 Challenges for Tool Improvement

In short, the creation of a CETA or SECAP is necessary to achieve the objectives set by the EU, for this the use of some tools acquires a fundamental role. In this unit we have reviewed some of them, and we have also identified some of the challenges that need to be addressed so that the energy transition can be tackled from the municipal level:

Generic Guidelines

Existing tools offer guidance to policymakers, but provide very generic guidelines that may not offer concrete solutions.

Lack of Regional Specificity

Many tools do not integrate data specific to certain regions, such as islands, limiting their applicability in these contexts.

Technical Complexity

Use is often limited to personnel with technical knowledge, making them less accessible to policymakers.

Monitoring Limitations

Difficulty in easily monitoring progress towards energy transition goals, as tools often only provide quantifiable scenarios or results for different strategies.

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3.3 Challenges for Tool Improvement

GENERA PROJECT

Objective

GENERA aims to help public authorities transform the energy context of European regions to facilitate a rapid transition to a decarbonized and sustainable economy.

Focus Areas

EU and island energy context, identification of existing monitoring tools, key players and stakeholders, financial mechanisms, and best practices at the municipal level.

Approach

Provide municipalities with simple and accessible Energy Transition monitoring tools for all interested parties, addressing the limitations of existing tools.

- Identification of existing monitoring tools
- EU and island energy context: Canary, Balearic, Greek and Italian islands
- Identification of key players and stakeholders
- Financial mechanisms
- Raising awareness of the energy transition
- Best practices applied at the municipal level

3.3 Challenges for Tool Improvement

GENERA PROJECT

The GENERA project proposes to provide municipalities with simple and accessible ET monitoring tools for all interested parties:

- Monitor their progress towards established commitments (such as the Covenant of Mayors).
- Create a knowledge database integrating holistic information related to ET (specifically in Mediterranean islands).
- Provide a package of specific energy solutions for tourist islands, transforming information into added value for policy and decision makers.
- Introduce a co-creation approach to the decision making process by using a multi-criteria methodology for identifying the most promising solution.

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UNIT 4

GENERA TOOLS: ENERGY PLANNING

MOOC 2: Energy transition measurement and monitoring tools

UNIT 4. GENERA TOOLS: ENERGY PLANNING

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4.1 Objectives of the Energy Planning Module

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➢ Objectives of the GENERA Project

Business As Usual (BAU) Scenario

Analyze the current scenario and its evolution over the considered time interval as a reference point.

Alternative Scenarios

Compare alternative energy scenarios with the same time horizon and demand constraints to explore different transition pathways.

Comparative Analysis

Provide insights into the potential outcomes of different energy strategies and policy decisions.

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4.2 Features

Scenario Evaluation

Assess and optimally match energy sources and their conversion to the energy needs of different demand sectors (commercial, industrial, residential, etc.).

Annual Rate Projections

Use annual rates of change to define the energy demand of each sector over time.

Comparative Analysis

Compare the BAU scenario with an Energy Transition (ET) scenario based on renewable energy and policy-driven sustainability goals.

Macro-level Insights

Provide a macro-level comparison between scenarios to inform high-level decision-making.

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4.3 Key Indicators

Primary Indicators

- Primary energy demand by energy source
- Electricity generation by each energy source
- Total CO2 emissions from each energy sector

Secondary Indicators

- Percentage of foreign dependence on primary energy supply
- Percentage of renewable energies in total energy consumption
- Energy intensity (ratio of energy consumption to GDP)

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4.4 Tool sections

1 **Introduction**

Brief explanation of the tool's contents and purpose

2 **Growth Rates**

Calculation of growth ratios used for estimations

3 **Auxiliar**

Data entry from external sources (e.g., IEA database)

4 **ESC-BAU**

Calculation of Business-As-Usual scenario and future trends

5 **ESC-ET**

Calculation of Energy Transition scenario with new projections

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4.4 Tool sections

Recommended Database

The tool is adapted to use information from the IEA's "World Energy Balances Highlights" database.

Data Selection

Use the latest year containing the most complete information possible for accurate analysis.

Importance

Reliable and standardized data ensures consistency and comparability in energy planning across different regions.

Country	Product	Flow	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023 Provisional
Spain	Coal, peat and oil shale	Production (PJ)	228	176	160	138	111	103	74	68	52	31	47	37	0	0	0	0	0
Spain	Coal, peat and oil shale	Imports (PJ)	613	525	415	329	398	542	338	399	458	339	467	399	232	124	155	256	176
Spain	Coal, peat and oil shale	Exports (PJ)	-54	-61	-38	-46	-39	-57	-21	-34	-30	-14	-10	-14	-42	-52	-18	-38	-93
Spain	Coal, peat and oil shale	Total energy supply (PJ)	834	578	432	325	522	638	464	479	559	441	536	471	211	123	130	158	112
Spain	Coal, peat and oil shale	Electricity, CHP and heat plants (PJ)	-735	-471	-357	-255	-448	-546	-390	-431	-498	-358	-446	-369	-135	-60	-57	-82	..
Spain	Coal, peat and oil shale	Oil refineries, transformation (PJ)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	..
Spain	Coal, peat and oil shale	Total final consumption (PJ)	60	55	35	37	46	31	40	26	22	23	37	31	27	27	27	29	..
Spain	Coal, peat and oil shale	Industry (PJ)	45	40	23	26	38	23	35	20	17	16	26	20	20	20	21	23	..
Spain	Coal, peat and oil shale	Transport (PJ)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	..
Spain	Coal, peat and oil shale	Residential (PJ)	9	9	9	7	5	5	4	4	4	3	3	3	3	2	2	1	..
Spain	Coal, peat and oil shale	Commercial and public services (PJ)	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	..
Spain	Coal, peat and oil shale	Other final consumption (PJ)	5	5	2	2	3	3	2	1	1	4	7	8	5	4	5	5	..
Spain	Crude, NGL and feedstocks	Production (PJ)	6	5	4	5	4	6	16	13	10	6	5	4	2	1	0	0	0
Spain	Crude, NGL and feedstocks	Imports (PJ)	2496	2560	2366	2378	2388	2638	2690	2709	2859	2842	2928	2951	2921	2477	2578	2788	2731
Spain	Crude, NGL and feedstocks	Exports (PJ)	0	0	0	0	0	-103	-159	-141	-114	-145	-169	-109	-122	-133	-126	-118	-141
Spain	Crude, NGL and feedstocks	Total energy supply (PJ)	2501	2551	2405	2386	2368	2578	2549	2566	2761	2723	2769	2859	2762	2373	2487	2655	2604
Spain	Crude, NGL and feedstocks	Electricity, CHP and heat plants (PJ)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	..
Spain	Crude, NGL and feedstocks	Oil refineries, transformation (PJ)	-2555	-2584	-2443	-2460	-2418	-2618	-2582	-2588	-2778	-2779	-2827	-2907	-2815	-2395	-2498	-2698	..
Spain	Crude, NGL and feedstocks	Total final consumption (PJ)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	..
Spain	Crude, NGL and feedstocks	Industry (PJ)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	..
Spain	Crude, NGL and feedstocks	Transport (PJ)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	..

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4.4 Tool sections

➢ Growth Rates

Data Input

Enter total energy consumed by each sector for the last reference year from the IEA database. Include recent population and Gross Domestic Product data for the country under study.

Calculation

Growth rates are calculated based on the last year entered in the tool, providing a basis for future projections.

Importance

Accurate growth rates are crucial for realistic scenario modeling and energy demand forecasting.

Growth Rates

ktep

Year	Industry	Transport	Services	Domestic	Agric. And Fisheries
1990	19,259	21,281	3,413	9,153	1,668
1991	19,713	22,147	3,718	9,664	1,799
1992	18,829	23,373	3,936	9,745	1,920
1993	18,343	23,033	3,828	9,785	1,959
1994	19,315	23,855	4,174	10,252	2,079
1995	19,830	24,134	4,321	9,997	2,193
1996	19,020	25,710	4,703	10,557	2,173
1997	21,084	25,705	5,259	10,740	2,099
1998	21,795	28,137	5,422	11,085	1,944
1999	21,648	29,493	5,886	11,793	2,203
2000	24,641	30,206	6,702	11,985	2,561
2001	26,346	31,550	7,049	12,605	2,387
2002	26,709	32,151	7,246	12,938	2,351
2003	28,761	33,822	7,132	13,881	2,929
2004	29,564	35,216	7,734	14,638	3,325
2005	30,401	36,510	8,403	15,091	3,095
2006	24,860	37,518	8,918	15,529	2,799
2007	26,856	38,595	8,811	15,604	2,928
2008	25,255	36,811	9,289	15,444	2,682
2009	20,710	34,460	9,398	15,866	2,348
2010	20,904	33,889	9,790	16,866	2,229
2011	20,674	32,158	10,196	15,597	2,391
2012	20,134	29,549	10,037	15,489	2,703
2013	19,944	27,975	9,606	14,871	2,839
2014	19,231	28,106	8,838	14,698	2,758
2015	18,044	29,472	10,056	14,864	2,485

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Year	Population	GDP (Mil Millones 2010 USD)
1,990	39	737
1,991	39	756
1,992	40	763
1,993	40	755
1,994	40	773
1,995	40	795
1,996	40	816
1,997	40	846
1,998	40	883
1,999	40	923
2,000	41	971
2,001	41	1,009
2,002	41	1,037
2,003	42	1,068
2,004	43	1,101
2,005	44	1,141
2,006	44	1,188
2,007	45	1,231
2,008	46	1,242
2,009	46	1,195
2,010	46	1,197
2,011	47	1,187
2,012	47	1,152
2,013	47	1,136
2,014	47	1,152
2,015	46	1,196

1. Rates of demand variation (%)

Sector	%
Industry	0.1
Transport	1.1
Services	3.1
Domestic	1.3
Other (Agriculture, fishing)	4.9

2. Other growth rates (%)

Population	0.6
GDP (M€2005)	1.9

4.4 Tool sections

➢ Auxiliary Section: Data Entry

Energy Sources

Enter information for each energy source: coal, crude oil, oil products, natural gas, nuclear, renewables, biofuels, electricity, and heat energy vectors.

Sector Contribution

Input each source's contribution to different sectors: industry, transportation, residential, commercial, and others.

Unit Conversion

Data is provided in PJ but must be converted to kteps. The tool includes auxiliary sheets for automatic conversion.

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➢ Auxiliary Section: Data Entry

2022 DATA

	Coal	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Renewables and waste	Biofuels and waste	Electricity	Heat	Total
	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Production	0	0	0	1	639		813		0		1454
Imports	256	2788	700	1446	0		68		29		5287
Exports	-38	-118	-727	-221	0		-93		-100		-1297
International marine bunkers											
International aviation bunkers											
Stock changes											
Total energy supply	158	2655	-544	1186	639		792		-71		4815
Transfers											
Statistical differences											
Electricity plants, CHP, Heat Plants	-82	0	-90	-570	-639		-545		1037		-889
Gas works											
Oil refineries	0	-2698	2627	0			0		0		-72
Coal transformation											
Liquefication plants											
Other transformation											
Energy industry own use											
Losses											
Total final consumption	29	0	1777	549			246		808		3409
Industry	23	0	86	295			86		255		745
Transport	0	0	1260	15			57		14		1347
Residential	1	0	102	131			89		264		587
Commercial and public services	0	0	50	78			10		253		391
Other (Agriculture, fishing)	5	0	279	31			3		20		338
Fishing											
Non-specified											
Non-energy use											

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4.4 Tool sections

➢ Auxiliary Section: Data Entry

2022 DATA

	Coal	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Renewables and waste	Biofuels and waste	Electricity	Heat	Total
	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Production	0	0	0	1	639		813		0		1454
Imports	256	2788	700	1446	0		68		29		5287
Exports	-38	-118	-727	-221	0		-93		-100		-1297
International marine bunkers											
International aviation bunkers											
Stock changes											
Total energy supply	**158**	**2655**	**-544**	**1186**	**639**		**792**		**-71**		**4815**
Transfers											
Statistical differences											
Electricity plants, CHP, Heat Plants	**-82**	**0**	**-90**	**-570**	**-639**		**-545**		**1037**		**-889**
Gas works											
Oil refineries	0	-2698	2627	0			0		0		-72
Coal transformation											
Liquefication plants											
Other transformation											
Energy industry own use											
Losses											
Total final consumption	**29**	**0**	**1777**	**549**			**246**		**808**		**3409**
Industry	23	0	86	295			86		255		745
Transport	0	0	1260	15			57		14		1347
Residential	1	0	102	131			89		264		587
Commercial and public services	0	0	50	78			10		253		391
Other (Agriculture, fishing)	5	0	279	31			3		20		338
Fishing											
Non-specified											
Non-energy use											

4.4 Tool sections

➢ ESC-BAU

Inputs Section

Assumptions are made and input data is automatically entered from pre-filled sheets (growth rates and auxiliary).

Outputs Section

Automatically calculates estimates for future years. Provides evolution of growth rates, energy source contributions to each sector, and emissions produced.

Time Frame

Years can be entered manually or automatically, allowing for flexible scenario planning.

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4.4 Tool sections

➢ ESC-BAU

INPUTS

Application example:	SPAIN

SPAIN ENERGY SIMULATION - BAU

HYPOTHESIS

** BAU scenario, which keeps the contribution percentages of each source to the consumption of each demand sector CONSTANT OVER TIME.*
** Electricity is generated with average generation output deducted from 2016 data.*
** The nuclear contribution remains constant at the 2016 value, given the impossibility of increasing installed capacity.*
** The increase that nuclear should contribute is allocated to renewables.*

INPUTS

Data	Calculation	Constant Value

1. Average annual rate of change in demand (%)

Sector	%
Industry	0.1
Transport	1.1
Services	3.1
Domestic	1.3
Other (Agriculture, fishing)	4.9

2. Other growth rates (%)

Population	0.6
GDP (billion 2010 USD)	1.9

OUTPUTS

OUTPUTS

YEAR	2023								
		Population	*GDP*	*Industry*	*Transport*	*Services*	*Domestic*	*Other (fishing and agriculture)*	
Annual growth rate		0.6	1.9	0.1	1.1	3.1	1.3	4.9	
Total growth for the period		1.006	1.019	1.001	1.011	1.031	1.013	1.049	
	Total	47.61	1197						
			CONTRIBUTION (ktep)						
SECTOR		*Electricity*	*Coal*	*Oil*	*Natural Gas*	*Renewables*	*Nuclear*	*Total*	%
Industry	*ktep*	6,098	550	2,057	7,054	2,057	0	17,815	22
	%	34	3	12	40	12	0		
Transport	*ktep*	338	0	30,410	362	1,376	0	32,486	39
	%	1	0	94	1	4	0		
Services	*ktep*	6,232	0	1,232	1,921	246	0	9,631	12
	%	65	0	13	20	3	0		
Domestic	*ktep*	6,387	24	2,468	3,169	2,153	0	14,202	17
	%	45	0	17	22	15	0		
Other (fishing and agricultur	*ktep*	501	125	6,990	777	75	0	8,468	10
	%	6	1	83	9	1	0		
Electricity Generation	*ktep*		1,987	2,181	13,812	13,430	15,262	46,671	
	%		4	5	30	29	33		
Total source	*ktep*	19,556	2,687	45,336	27,096	19,336	15,262		
Electricity balance	*ktep*	-1,696							
Electricity generated	*ktep*	21,252							
Total primary energy	*ktep*							108,021	
	%								
Total final energy	*ktep*							82,602	

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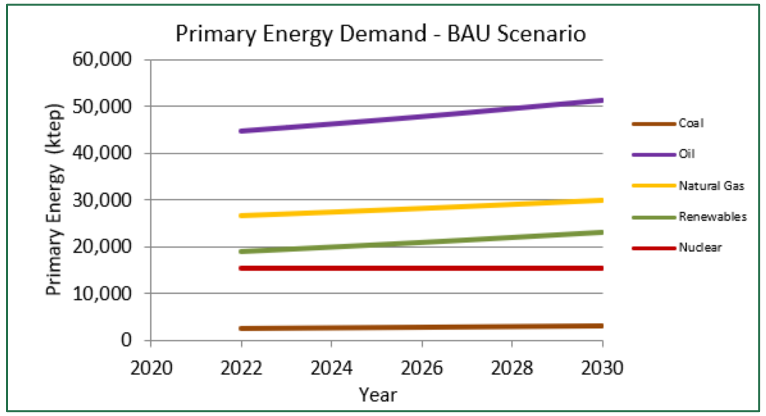
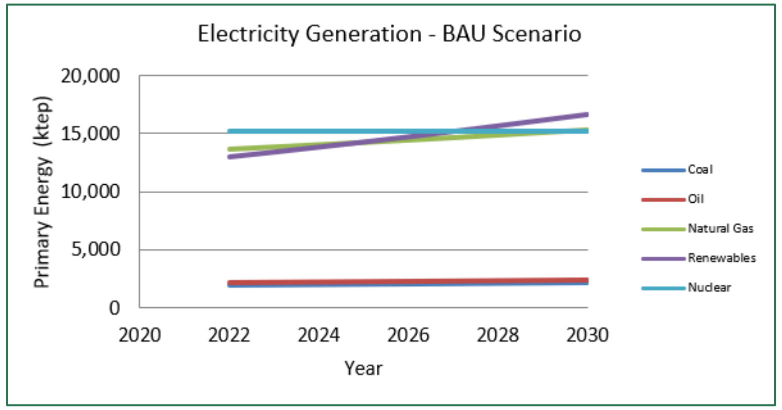
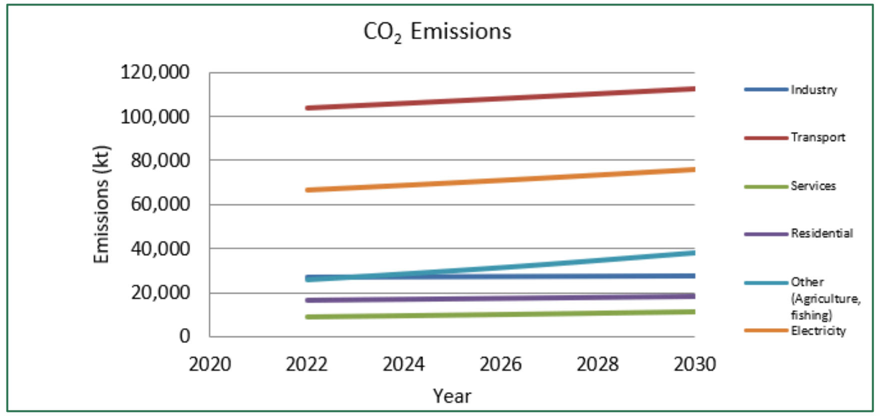
4.4 Tool sections

➢ ESC-BAU: Results Visualization







Energy Demand Projection

Visualizes the projected energy demand over time for different sectors.

Electricity Generation Mix

Illustrates the projected electricity generation by source over the years.

CO2 Emissions Trend

Shows the projected CO2 emissions from different energy sectors over time.

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4.4 Tool sections

➢ ESC-BAU: BAU Diagram

Purpose

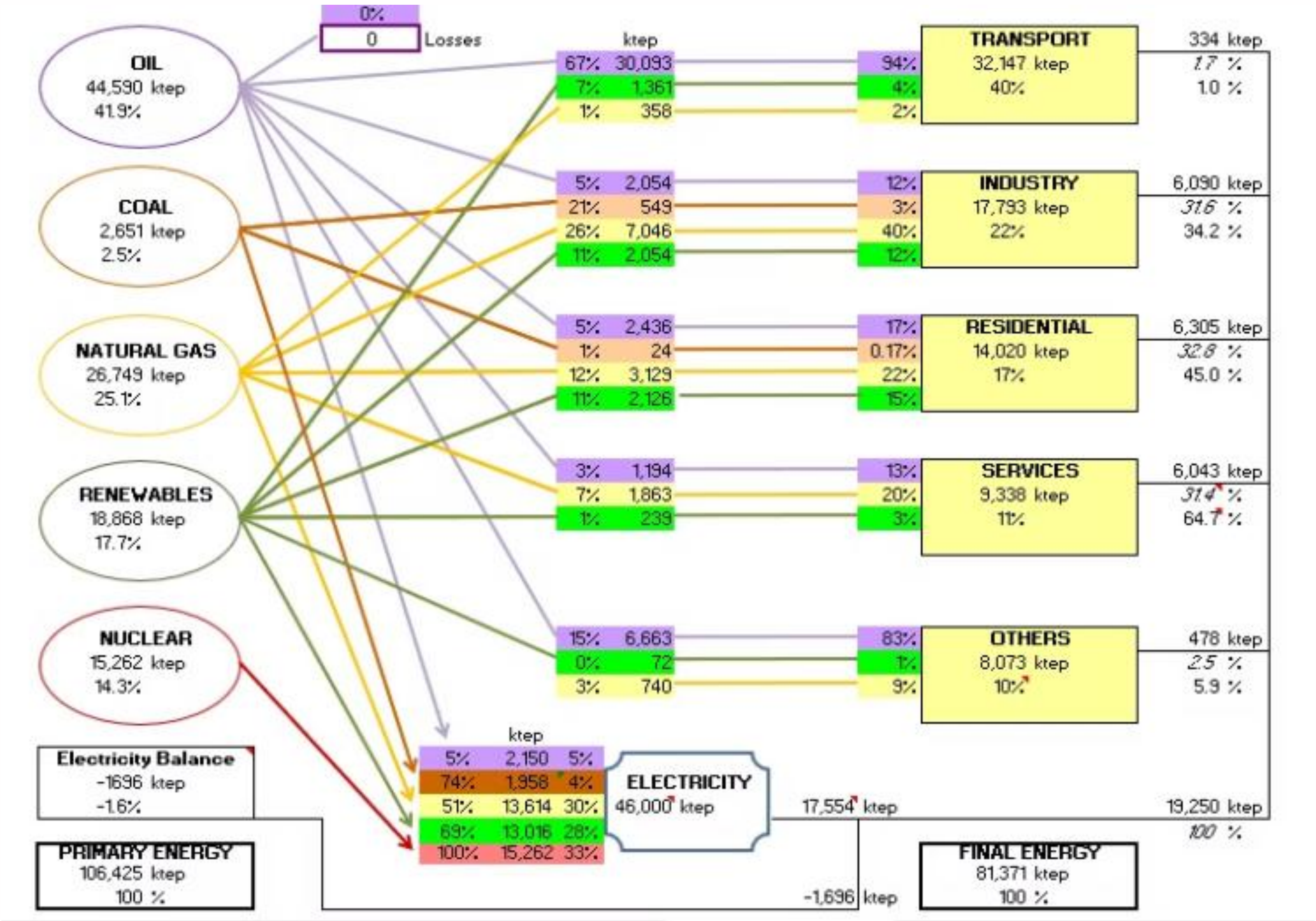
Provides a comprehensive overview of the country's energy context in the Business-As-Usual scenario.

Content

Illustrates the contribution of each energy source to each sector, showing the conversion of primary energy to final energy.

Utility

Helps visualize the current energy flow and identify areas for potential improvement in the energy transition process.



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4.4 Tool sections

- ESC-ET

Purpose

Models an energy transition scenario proposing sustainable improvements for the country.

Inputs Section

Allows modification of previously established assumptions to create different transition scenarios.

Outputs Section

Can be modified according to the criteria deemed necessary for the specific ET scenario being evaluated.

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4.4 Tool sections

➢ ESC-ET

SPAIN ENERGY SIMULATION - ET

Application example: **SPAIN**

HIPOTESIS

* BAU scenario, which keeps the contribution percentages of each source to the consumption of each demand sector CONSTANT OVER TIME.
* Electricity is generated with average generation output deducted from 2016 data.
* The nuclear contribution remains constant at the 2016 value, given the impossibility of increasing installed capacity.
* The increase that nuclear should contribute is allocated to renewables.

*2% annual substitution of oil by biofuels introduced

INPUTS

Data	Calculation	Constant Value

1. Average annual rate of change in demand (%)

Sector	%
Industry	0.1
Transport	1.1
Services	3.1
Domestic	1.3
Other (Agriculture, fishing)	4.9

2. Other growth rates (%)

Population	0.6
GDP (billion 2010 USD)	1.9

OUTPUTS

YEAR 2023

	Population	GDP	Industry	Transport	Services	Domestic	Other (fishing and agriculture)
	1.0059						
Annual growth rate	0.6	1.9	0.1	1.1	3.1	1.3	4.9
Total growth for the period	1.006	1.019	1.001	1.011	1.031	1.013	1.049
Total	46.43	1183					

CONTRIBUTION (ktep)

SECTOR		Electricity	Coal	Oil	Natural Gas	Renewables	Nuclear	Total	%
Industry	ktep	6,098	550	2,057	7,054	2,057	0	17,815	22
	%	34	3	12	40	12	0		
Transport	ktep	338	0	29,802	362	1,984	0	32,486	39
	%	1	0	92	1	6	0		
Services	ktep	6,232	0	1,232	1,921	246	0	9,631	12
	%	65	0	13	20	3	0		
Domestic	ktep	6,387	24	2,468	3,169	2,153	0	14,202	17
	%	45	0	17	22	15	0		
Other (fishing and agric.	ktep	501	125	6,990	777	75	0	8,468	10
	%	6	1	83	9	1	0		
Electricity Generation	ktep		1,670	1,833	11,608	8,851	15,262	39,223	
	%		4	5	30	23	39		
Total source	ktep	19,556	2,369	44,380	24,892	15,366	15,262		
Electricity balance	ktep	-1,696							
Electricity generated	ktep	17,860							
Total primary energy	ktep							100,573	
	%	-2	2	44	25	15	15		
Total final energy	ktep							82,602	

INPUTS

Shows the input fields for modifying assumptions in the Energy Transition scenario.

OUTPUTS

Displays the calculated results based on the modified assumptions for the ET scenario.

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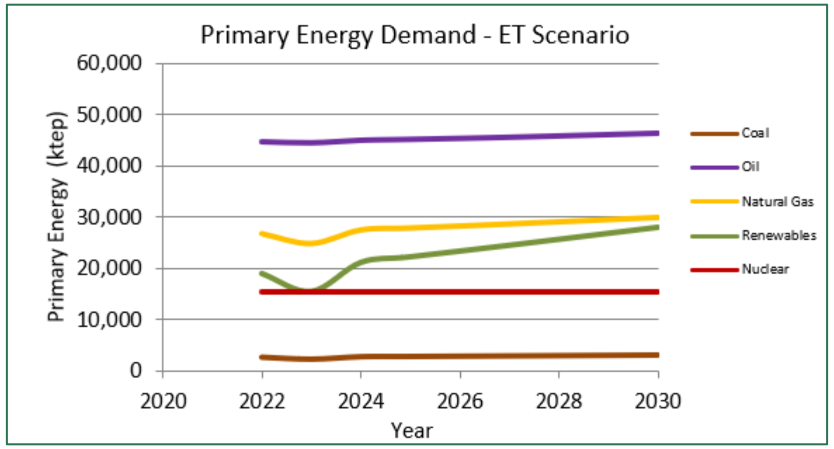
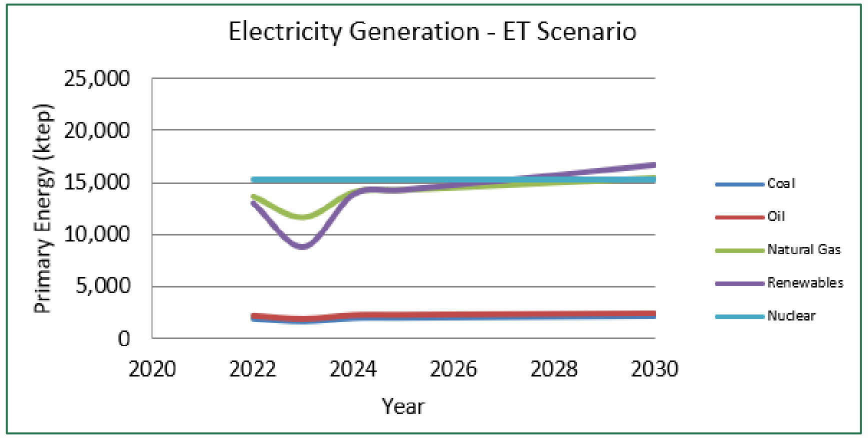
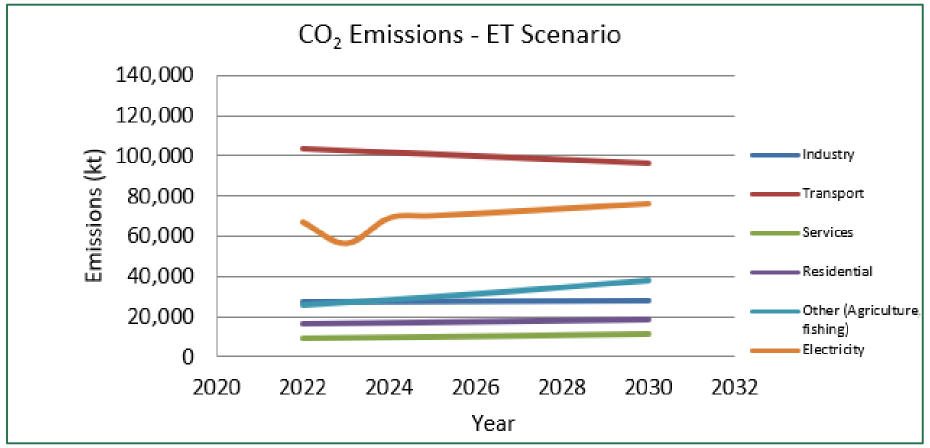
4.4 Tool sections

➢ ESC-ET: Results Visualization







ET Energy Demand

Visualizes the projected energy demand in the Energy Transition scenario.

ET Electricity Mix

Illustrates the projected electricity generation mix in the Energy Transition scenario.

ET CO2 Emissions

Shows the projected CO2 emissions trend in the Energy Transition scenario.

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4.5 Application example

It is proposed as an example to create an energy transition scenario for Spain in which the following hypothesis is introduced:

Hypothesis

Introduce a 2% annual substitution of oil by biofuels in the energy mix.

Implementation

Modify the output section formulation to reduce oil use for fuel and replace it with renewable sources.

Goal

Demonstrate how small changes in energy policy can impact the overall energy transition scenario.

YEAR	2023	Population	GDP	Industry	Transport	Services	Domestic	Other (fishing and agriculture)
		1.0059						
Annual growth rate		0.6	1.9	0.1	1.1	3.1	1.3	4.9
Total growth for the period		1.006	1.019	1.001	1.011	1.031	1.013	1.049
	Total	46.43	1183					

		CONTRIBUTION (ktep)							
SECTOR		Electricity	Coal	Oil	Natural Gas	Renewables	Nuclear	Total	%
Industry	ktep	6,098	550	2,057	7,054	2,057	0	17,815	22
	%	34	3	12	40	12	0		
Transport	ktep	338	0	29,802	362	1,984	0	32,486	39
	%	1	0	92	1	6	0		
Services	ktep	6,232	0	1,232	1,921	246	0	9,631	12
	%	65	0	13	20	3	0		
Domestic	ktep	6,387	24	2,468	3,169	2,153	0	14,202	17
	%	45	0	17	22	15	0		
Other (fishing and agriculture)	ktep	501	125	6,990	777	75	0	8,468	10
	%	6	1	83	9	1	0		
Electricity Generation	ktep		1,670	1,833	11,608	8,851	15,262	39,223	
	%		4	5	30	23	39		
Total source	ktep	19,556	2,369	44,380	24,892	15,366	15,262		

4.5 Application example

Therefore, the following equations must be entered for each year of calculation in the outputs section.

SECTOR		Electricity	Coal	Oil	Natural Gas	Renewables	Nuclear	Total	%
		CONTRIBUTION (ktep)							
Industry	*ktep*	6,098	550	2,057	7,054	2,057	0	17,815	22
	%	*34*	*3*	*12*	*40*	*12*	*0*		
Transport	*ktep*	338	0	29,802	362	1,984	0	32,486	39
	%	*1*	*0*	*92*	*1*	*6*	*0*		
Services	*ktep*	6,232	0	1,232	1,921	246	0	9,631	12
	%	*65*	*0*	*13*	*20*	*3*	*0*		
Domestic	*ktep*	6,387	24	2,468	3,169	2,153	0	14,202	17
	%	*45*	*0*	*17*	*22*	*15*	*0*		
Other (fishing and agriculture)	*ktep*	501	125	6,990	777	75	0	8,468	10
	%	*6*	*1*	*83*	*9*	*1*	*0*		
Electricity Generation	*ktep*		1,670	1,833	11,608	8,851	15,262	39,223	
	%		*4*	*5*	*30*	*23*	*39*		
Total source	*ktep*	19,556	2,369	44,380	24,892	15,366	15,262		
Electricity balance	*ktep*	-1,696							
Electricity generated	*ktep*	17,860							
Total primary energy	*ktep*							100,573	
	%	*-2*	*2*	*44*	*25*	*15*	*15*		
Total final energy	*ktep*							82,602	

$$Renew_{transport(2023)} = Transport_{total}(ktep) \cdot \left[\frac{Renew_{transport\ (2022)}(\%)}{100} + 2\% \cdot \frac{Oil_{transport(2022)}(\%)}{100}\right]$$

$$Oil_{transport(2023)} = Transport_{total}(ktep) \cdot \frac{Oil_{transport(2022)}(\%)}{100} \cdot (1 - 0.02)$$

$$Renew_{total(2023)} = Total_{energy(2023)}(ktep) - Nuclear_{total(2023)} - NG_{total(2023)} - Oil_{total(2023)} - Coal_{total(2023)}$$

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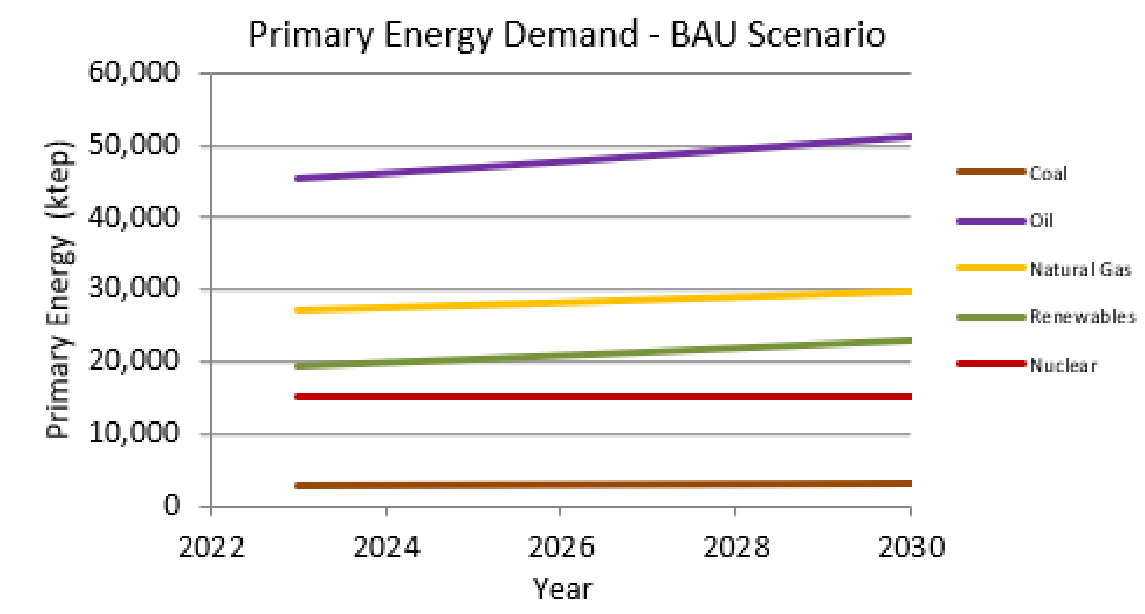
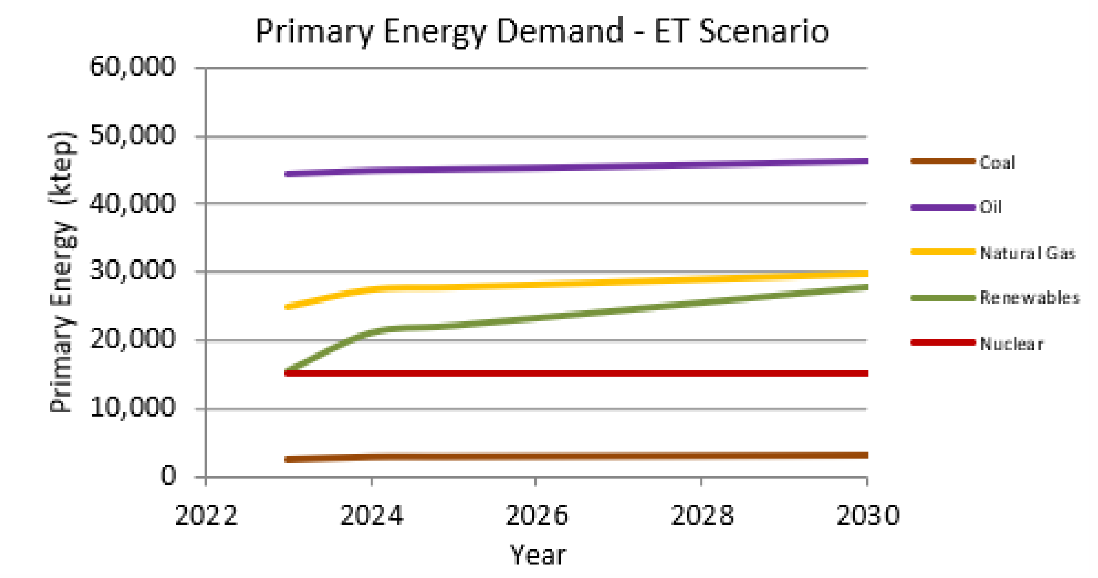
4.5 Application example





Energy Mix Comparison

Visualizes the difference in energy mix between the Business As Usual and Energy Transition scenarios.

Emissions Reduction

Illustrates the potential reduction in emissions achieved through the Energy Transition scenario.

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Key Takeaways from the Energy Planning Module

1 **Scenario Comparison**

The tool enables a clear comparison between Business As Usual and Energy Transition scenarios, highlighting potential benefits of policy changes.

2 **Flexibility**

Users can easily modify assumptions and inputs to model various energy transition strategies and their impacts.

3 **Comprehensive Analysis**

The tool provides insights into energy demand, electricity generation mix, and CO2 emissions, offering a holistic view of the energy system.

4 **Decision Support**

By visualizing potential outcomes, the tool aids policymakers in making informed decisions about energy transition strategies.

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UNIT 5

GENERA TOOLS: STRATEGY EVALUATION

MOOC 2: Energy transition measurement and monitoring tools

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UNIT 5. GENERA TOOLS: STRATEGY EVALUATION

INDEX

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5.1 Strategy evaluation method

Purpose

This unit focuses on tools and methodologies for evaluating different energy transition strategies using the GENERA framework.

Key Components

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

Outcome

The Analytical Hierarchical Process (AHP) method is proposed to be used to obtain the solutions that best meet the municipal needs. Participants will learn how to effectively compare and evaluate various energy transition pathways to inform policy decisions.

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5.1 Strategy evaluation method

Method

The method proposed by the GENERA project consists of facilitating training in quantitative energy terms (calculation of energy saved per measure and CO_2 emissions mitigated), as well as providing training in the use of multi-criteria techniques that allow the joint evaluation of quantitative and qualitative aspects.

1. Calculation Module

Energy savings (kWh/year)	567445.943
CO2 emissions saved per year (kgCO2 eq)	453956.7544

- **Actions to be included in the action plan**
- **Quantitative results**
- **Provides technical information to policymakers**

2. Strategy evaluation module

Graphic	Alternatives	Total	Normal	Ideal	Ranking
	CA1.1 Improving the insulation of municipal buildings	0.0181	0.0549	0.2733	8
	CA1.2 Improvement of municipal lighting	0.0101	0.0306	0.1522	11
	CA1.3 Heating, ventilation and air-conditioning systems	0.0664	0.2008	1.0000	1
	CA1.4 Introduction of renewable energies and self-consumption	0.0605	0.1831	0.9118	2
	CA1.5 Municipal Transport Reposition	0.0197	0.0596	0.2967	7
	CA2.1 Industrial Process improvement	0.0031	0.0094	0.0469	13
	CA2.2 Renewal of industrial equipment	0.0034	0.0104	0.0517	12
	CA2.3 Improvement of Industrial buildings	0.0031	0.0093	0.0461	14
	CA2.4 Change of energy vector	0.0110	0.0333	0.1656	10
	CA3.1 Cycling Routes	0.0373	0.1130	0.5625	3
	CA3.2 Network of EV recharching points	0.0277	0.0837	0.4169	5
	CA3.3 Promoting public transport	0.0272	0.0823	0.4100	6
	CA4.1 Ecomovil	0.0130	0.0394	0.1962	9
	CA4.2 Information stands	0.0298	0.0902	0.4490	4

- **Qualitative and quantitative evaluation of actions**
- **Ranking of the most promising measures**

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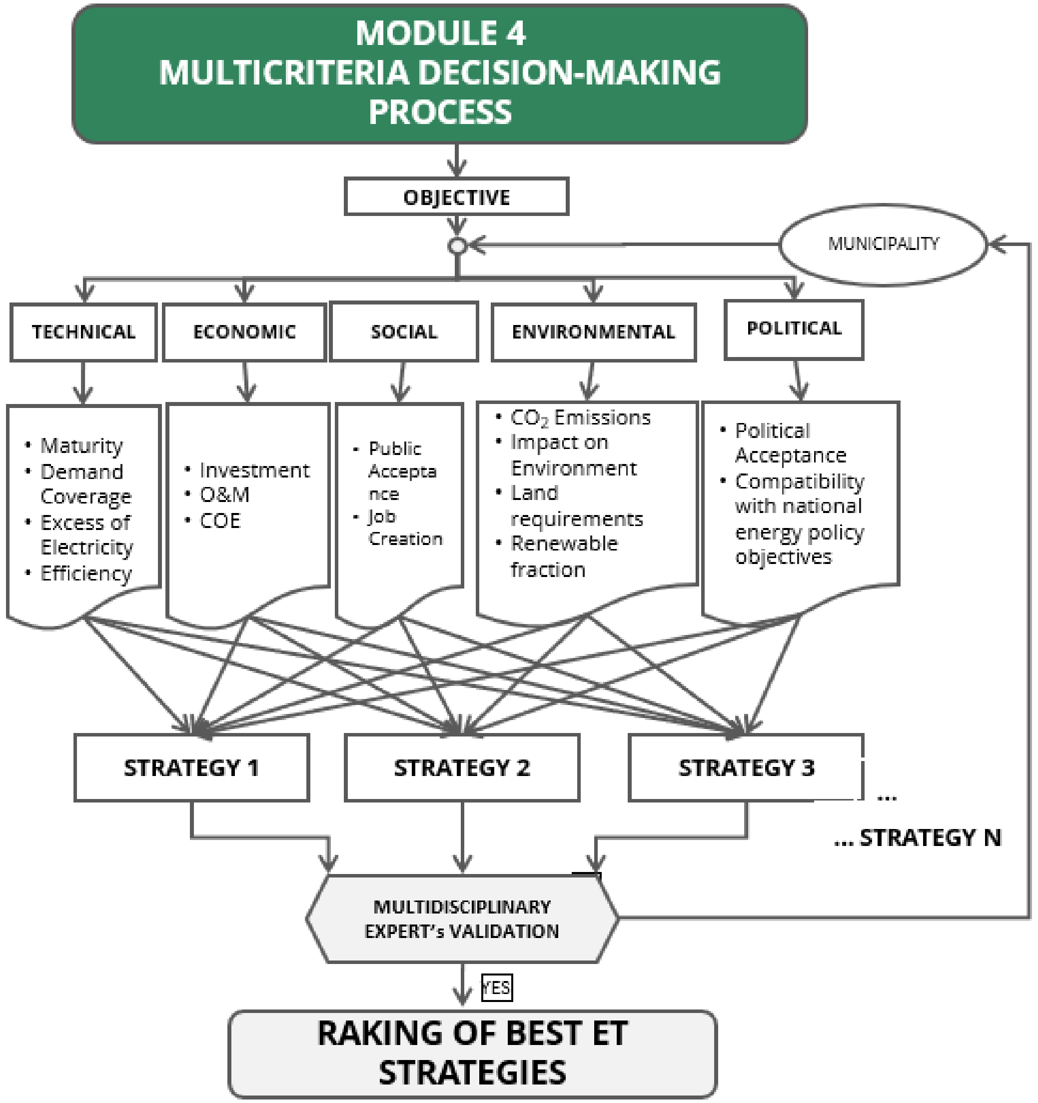
5.1 Strategy evaluation method

2. Strategy evaluation module

Representing the problem in a hierarchical structure allows to get an overview of the whole process and at the same time to analyze whether the model adequately represents the relative magnitude of each criterion.

- **Level 1:** in reference to the different areas that affect the municipal level.
- **Level 2:** the indicators that affect each level.
- **Level 3:** each of the strategies is evaluated according to the previous levels.

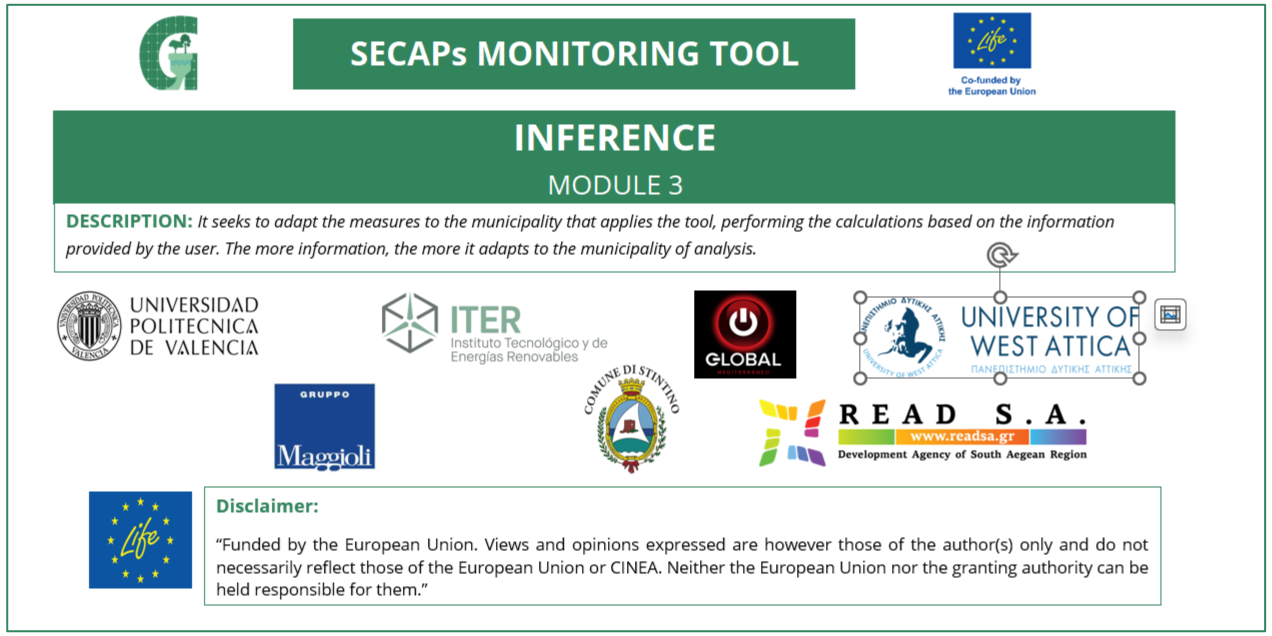


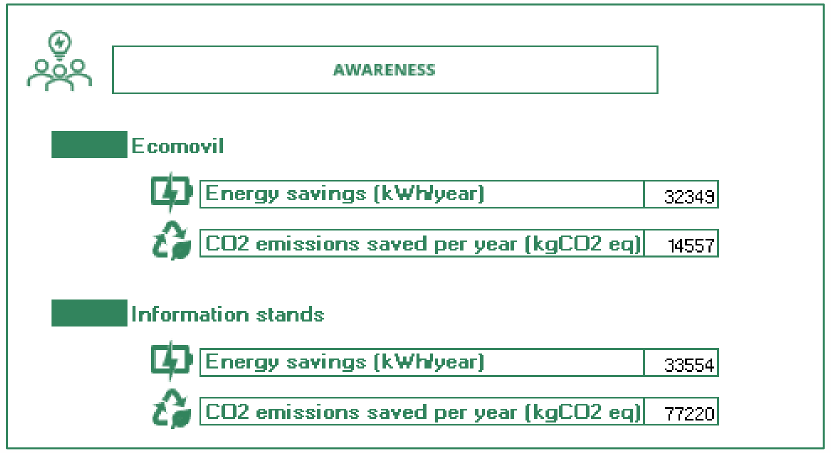
5.2 Calculation Tool

Method

Tool implemented in excel spreadsheet that allows to calculate emission and energy savings for certain measures of municipal interest, performing the calculations based on the information provided by the user. The more information, the more it adapts to the municipality of analysis.

- **Municipal Buildings and Public Facilities:** This section includes all actions related to municipal buildings and equipment under the responsibility of the city council.
- **Industry:** This section includes all industry-related actions and an incentive programme for energy saving and efficiency and the use of renewable energy in housing and SMEs. This section has the aim of reducing final energy consumption and CO_2 emissions
- **Transport:** This section includes information and actions related to the improvement of transport at municipal level.
- **Awareness:** This section includes information and actions related to recycling and environmental awareness of citizens





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5.2 Calculation Tool

Municipal Buildings and Public Facilities

Improving the insulation of municipal buildings	Window improvements (replacement of glass) and façade insulation.
Improvement of municipal lighting	Replacement of luminaires with more efficient luminaires
Heating, ventilation and air-conditioning systems	Improvement 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 municipal level.
Municipal vehicle fleet	Current municipal vehicles: retired versus purchased with new technologies (hybrid and electric).

Industry

Process improvement	It focuses mainly on actions to improve energy metering and monitoring elements, as well as energy optimisation.
Renewal of equipment	Replacement, renovation and improvement of process machinery with more energy-efficient ones.
Industrial buildings	Improvement of insulation, renovation of installations, air-conditioning and lighting systems.
Change of energy vector	Diversification of energy sources to less polluting ones and replacement of heating and pumping equipment with more efficient sources.

Input Data

- **Window's materials and isolation**
- **Nº of Bulbs and replacements**
- **Heating and cooling Demand**
- **Type of heating/cooling systems, Fuel, Equipment available, coolant, fans etc.**
- **Annual Electrical Demand: type of building, Surface, DHW Demand etc.**
- **RE Available and technologies**
- **Vehicles to replace with EV**

- **Incentive lines depending on the industry sector**
- **Actions to be implementend througout the sector: equipment, efficiency, energy generation, type of process etc.**

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5.2 Calculation Tool

Transport

Cycling Routes	Emission savings per km of cycling compared to conventional vehicles.
Network of EV recharching points	Emission savings per installed recharging point
Promoting public transport	Municipal transport-related awareness-raising measures

Input Data

- **Inhabitants**
- **Distance of the cycleway to be builted-up**
- **Nº of EV Chargers and power**
- **Measures related to promotion of public transport: speed zones, fees, tolls etc.**

Awareness

Ecomovil	Installation of ecomovils in municipalities to promote recycling
Information stands	Different measures to promote environmental awareness and responsible consumption at the municipal level

- **Inhabitants**
- **Awareness plan**
- **Events: school, associations, citizens etc.**
- **Recycling points**
- **Bonuses for self-consumption**

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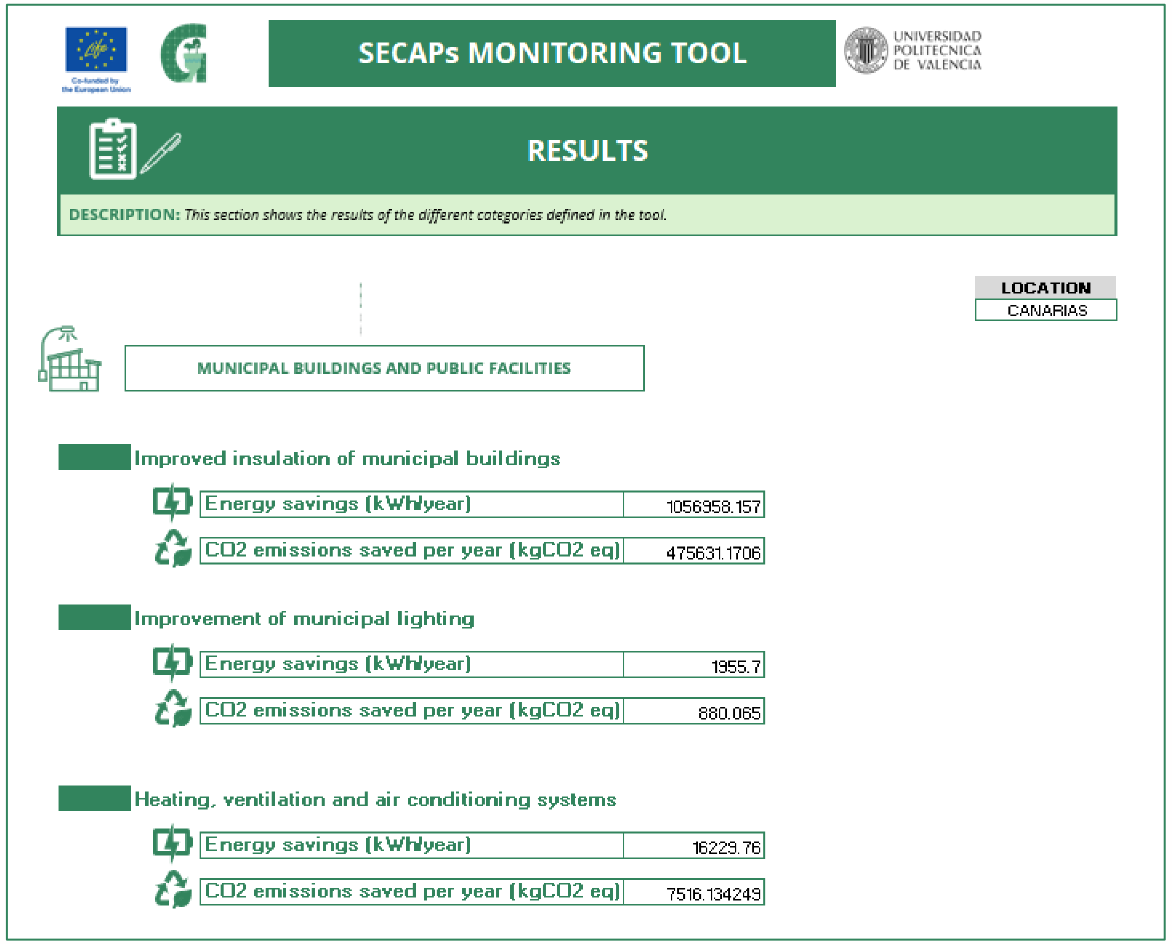
5.2 Calculation Tool

Results

- For each action is obtained:
  - Energy Savings (kWh/year)
  - CO2 emissions saved (kgCO2 eq)

- The results will be used as quantitative information for the next module.



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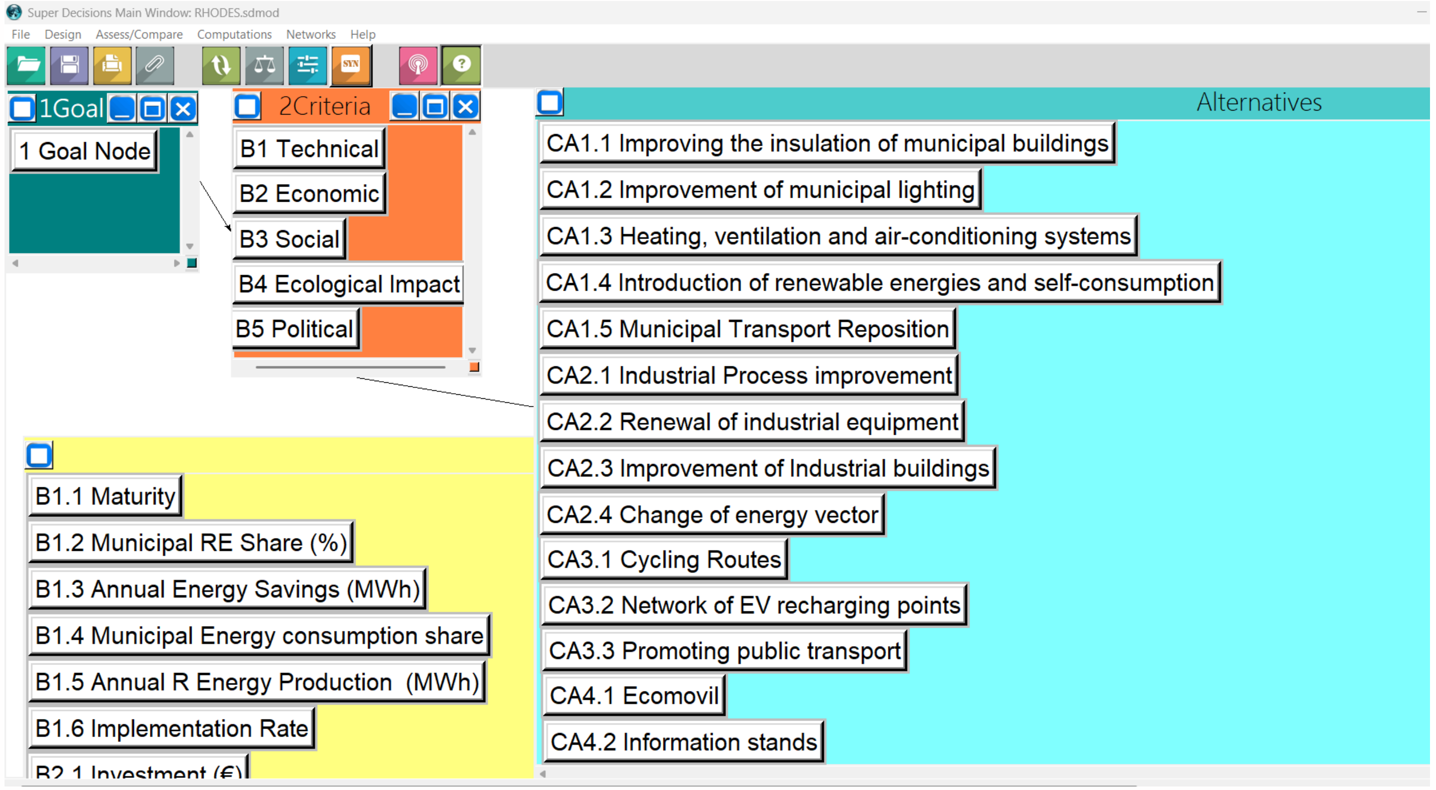
5.3 Strategy evaluation tool

Tool

As a support tool, the “Super Decisions” software is used as a decision support method that implements the AHP. The objective would be to achieve a planning of measures according to the municipal casuistry.



Features

- Free software
- Allows you to easily define the elements, their relationships, enter the importance of the relationships and obtain the results.
- The program is implemented in Spanish and English, selectable from the menu

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5.3 Strategy evaluation tool

Level 1 and 2 are entered into the tool, and the corresponding connections are made between them according to the following table.

- Technical
- Ecological impact
- Economic
- Social
- Political

Indicator	Criteria to which it applies
Maturity	Technical
Municipal RE Share (%)	Technical, Ecological impact
Annual Energy Savings (MWh)	Technical, Ecological impact, Economic
Annual RE Production (MWh)	Technical
Implementation Rate	Technical
Investment	Economic
Annual Profitability (kWh/€)	Economic
Available Funding and Grants	Economic
Public Acceptance	Social, Political
Job Creation	Economic, Social, Political
CO2 Emissions Reduction (tCO2)	Ecological impact, Political
Biodiversity Impact	Ecological impact
Land Change of Use	Ecological impact, Social, Political
Political Acceptance	Political
Compatibility with national Policies	Political
Compatibility with regional Policies	Political
Compatibility with EU Policies	Political

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5.3 Strategy evaluation tool

Evaluation

Each of the indicators should be evaluated and weighted according to the relative importance of each criterion (technical, ecological, social, economic and political impact).

Weighting

For this purpose, weights (from 1 to 10) are assigned to each of the indicators.

Procedure

The same procedure is carried out for each of the alternatives or proposed actions.

Comparisons wrt "B1 Technical" node in "4 Indicators" cluster
B1.2 Municipal RE Share (%) is moderately more important than B1.1 Maturity

1.	B1.1 Maturity	>=9.5	9	8	7	6	5	4	3	2	1	2	**3**	4	5	6	7	8	9	>=9.5
2.	B1.1 Maturity	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	**5**	6	7	8	9	>=9.5
3.	B1.1 Maturity	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	**5**	6	7	8	9	>=9.5
4.	B1.1 Maturity	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	**5**	6	7	8	9	>=9.5
5.	B1.1 Maturity	>=9.5	9	8	7	6	5	**4**	3	2	1	2	3	4	5	6	7	8	9	>=9.5
6.	B1.2 Municipal ~	>=9.5	9	8	7	6	5	4	3	2	1	2	3	**4**	5	6	7	8	9	>=9.5
7.	B1.2 Municipal ~	>=9.5	9	8	7	6	5	4	**3**	2	1	2	3	4	5	6	7	8	9	>=9.5
8.	B1.2 Municipal ~	>=9.5	9	8	7	6	5	4	3	2	**1**	2	3	4	5	6	7	8	9	>=9.5
9.	B1.2 Municipal ~	>=9.5	9	8	7	6	**5**	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5
10.	B1.3 Annual Ene~	>=9.5	9	8	7	6	5	**4**	3	2	1	2	3	4	5	6	7	8	9	>=9.5
11.	B1.3 Annual Ene~	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	**5**	6	7	8	9	>=9.5
12.	B1.3 Annual Ene~	>=9.5	9	8	7	**6**	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5
13.	B1.4 Municipal ~	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	**5**	6	7	8	9	>=9.5
14.	B1.4 Municipal ~	>=9.5	9	8	7	6	5	4	3	2	1	**2**	3	4	5	6	7	8	9	>=9.5
15.	B1.5 Annual R E~	>=9.5	9	8	7	6	**5**	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5

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5.4 Selection of the most promising energy policies

After performing the simulation or synthesizing the whole model, the results will be obtained for each of the alternatives or actions in this case.

- The **Normal column** presents the results in the form of priorities. This is the usual way of reporting the results.
- The **Ideals column** is derived from the Normals column by dividing each of its entries by the highest value in the column.
- The **ranking column** shows the final result of the order of alternatives.

Graphic	Alternatives	Total	Normal	Ideal	Ranking
	CA1.1 Improving the insulation of municipal buildings	0.0181	0.0549	0.2733	8
	CA1.2 Improvement of municipal lighting	0.0101	0.0306	0.1522	11
	CA1.3 Heating, ventilation and air-conditioning systems	0.0664	0.2008	1.0000	1
	CA1.4 Introduction of renewable energies and self-consumption	0.0605	0.1831	0.9118	2
	CA1.5 Municipal Transport Reposition	0.0197	0.0596	0.2967	7
	CA2.1 Industrial Process improvement	0.0031	0.0094	0.0469	13
	CA2.2 Renewal of industrial equipment	0.0034	0.0104	0.0517	12
	CA2.3 Improvement of Industrial buildings	0.0031	0.0093	0.0461	14
	CA2.4 Change of energy vector	0.0110	0.0333	0.1656	10
	CA3.1 Cycling Routes	0.0373	0.1130	0.5625	3
	CA3.2 Network of EV recharching points	0.0277	0.0837	0.4169	5
	CA3.3 Promoting public transport	0.0272	0.0823	0.4100	6
	CA4.1 Ecomovil	0.0130	0.0394	0.1962	9
	CA4.2 Information stands	0.0298	0.0902	0.4490	4

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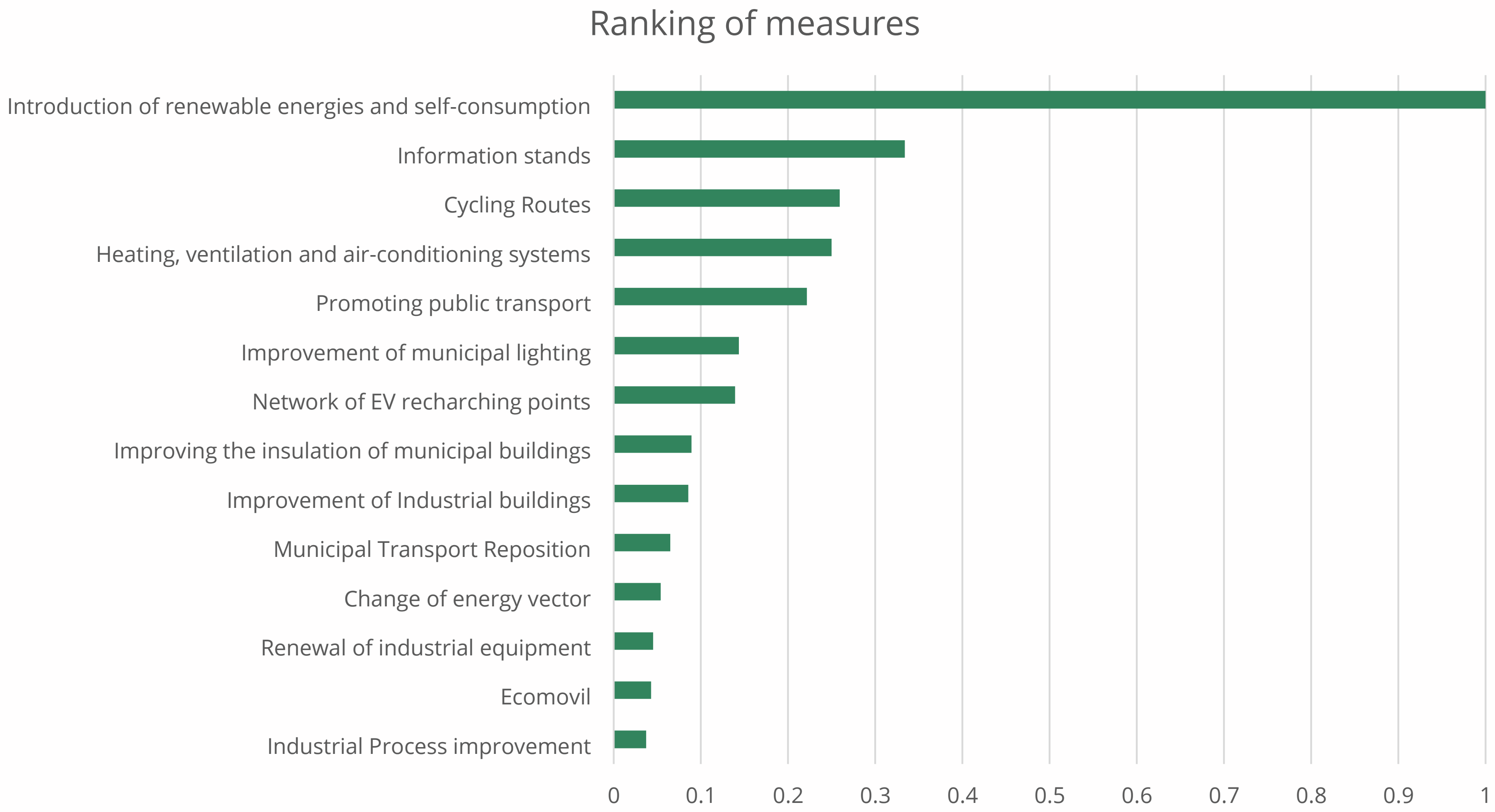
5.4 Selection of the most promising energy policies

- The results can be exported and more visual graphs can be obtained.



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UNIT 6

CASE STUDIES USING THE MONITORING TOOL

MOOC 2: Energy transition measurement and monitoring tools

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UNIT 6. CASE STUDIES USING THE MONITORING TOOL

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

INDEX

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6.1 Introduction to Case Studies

Purpose

This unit presents real-world case studies demonstrating the application of the GENERA Monitoring Tool in various contexts.

Learning Objectives

Understand how the tool is used in practice, interpret results, and apply insights to different scenarios.

Outcome

Gain practical knowledge on using the GENERA tool for energy transition planning and monitoring in diverse settings.

Case Studies

The case studies to be evaluated are located on the island of Ibiza (Spain), Sardinia (Greece) and Rhodes (Greece).

Sardinia (Italy)

Ibiza (Spain)

Rhodes (Greece)

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6.2 Case Study 1: Ibiza (Spain)

➢ **Study of the Spanish National Context**

GENERA tool

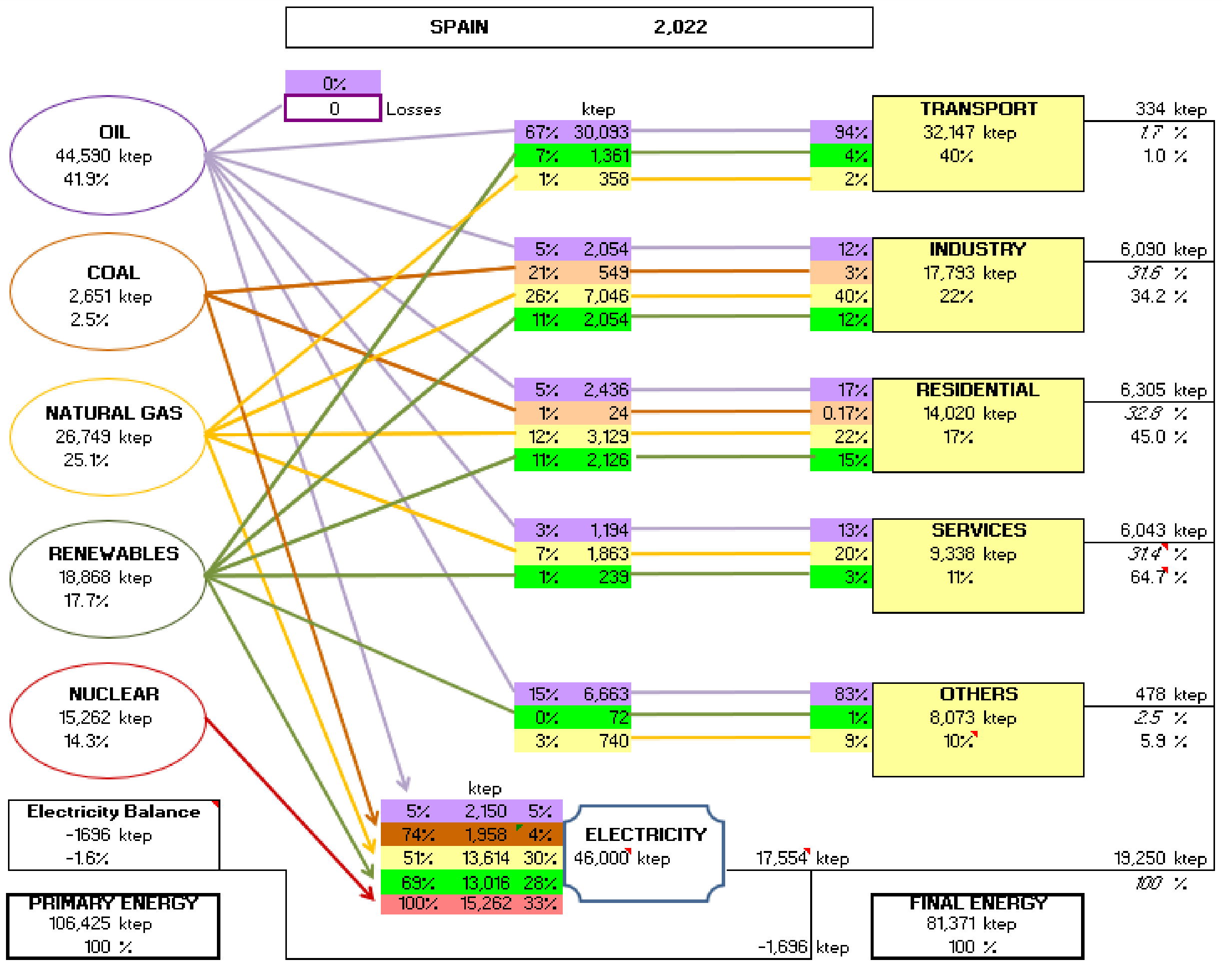
Application of GENERA's energy planning tool

Reference Data

Data entered in the tool take 2022 as the reference year (since 2023 is incomplete for some sectors) (International Energy Agency).

Energy Balance

Oil is the main source in the transport sector and in other sectors such as agriculture, fishing, etc. On the other hand, natural gas is more involved in the industry, residential and service sectors. In addition, in electricity production, natural gas and renewables are the main producers.



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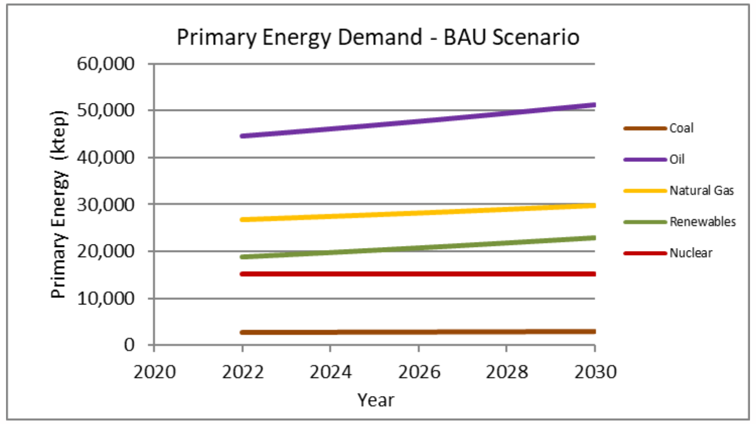
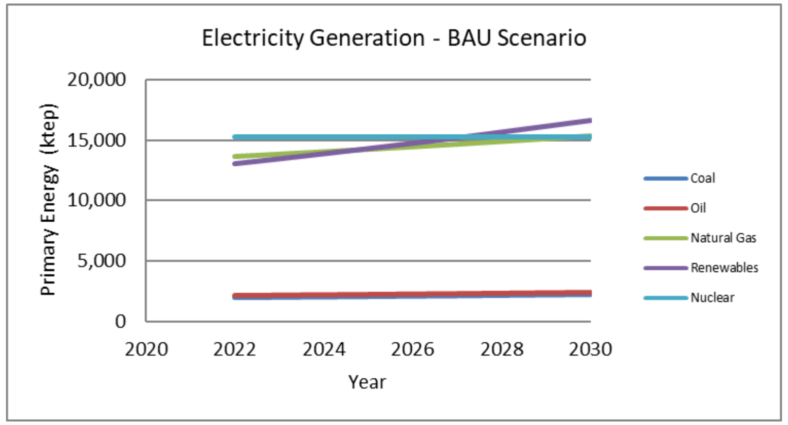
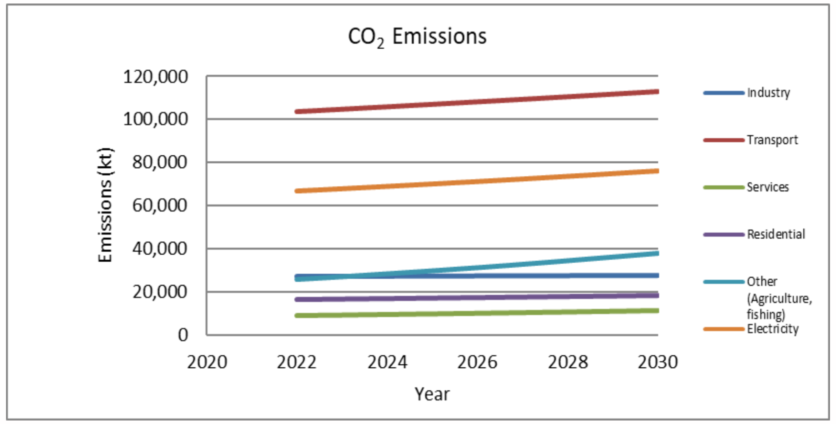
6.2 Case Study 1: Ibiza (Spain)

➢ Study of the Spanish National Context







Spain's energy context is characterized by the use of **oil** mainly for the transport sector, which in turn generates most of the country's emissions. There is a **growing trend** towards the use of **renewable energy**, mainly for electricity production, but also for residential use.

Natural gas also shows a growing trend and greater involvement in the **industrial**, **residential** and **service sectors**.

In terms of **emissions**, the most damaging sector is **transport**, followed by **electricity generation**.

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6.2 Case Study 1: Ibiza (Spain)

➢ Summary of actions of Sant Antoni de Portmany (Ibiza)

Context

Located in the northwest of the island of Ibiza. The municipality has an area of 12,662 hectares and a population of 27,431 inhabitants.

After signing the Covenant, it should consider “the adaptation of structures including the allocation of adequate human and economic resources” as a formal commitment

Challenges

- It has set the promotion of renewable energies so that they represent at least 32% of the energy consumption of the municipality in the year 2030.
- Increase the city's energy efficiency by 32.5% by the year 2030, with respect to 2005 energy consumption.
- The global emissions reduction target for the year 2030 represents a reduction of 63,838.23 tons of CO_2.

GENERA tool

Application of the GENERA inference module.

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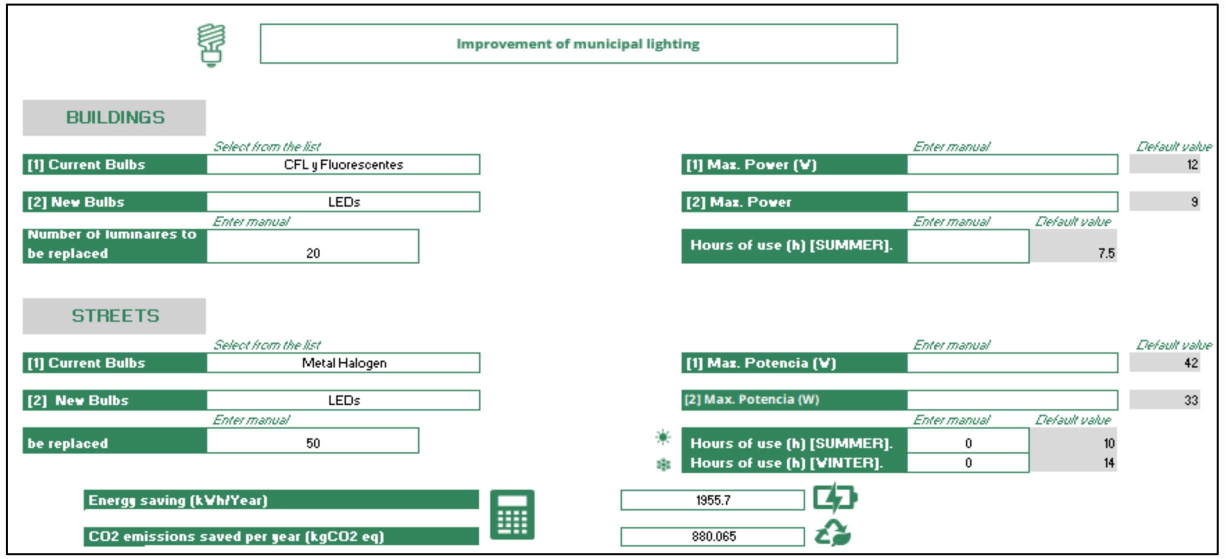
6.2 Case Study 1: Ibiza (Spain)

➢ Summary of actions of Sant Antoni de Portmany (Ibiza)

Actions

The main actions included in the generation tool are as follows



Municipal Buildings And Public Facilities

- Indoor lighting renovation
- Substitution Of Lights For More Efficient Ones
- Installation of aerothermal energy in municipal facilities
- Photovoltaic solar energy installations
- Replacement of municipal vehicles with more efficient ones

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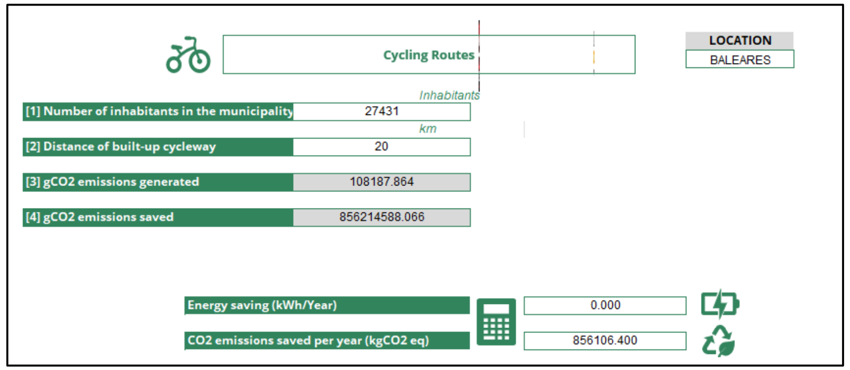
6.2 Case Study 1: Ibiza (Spain)

➢ **Summary of actions of Sant Antoni de Portmany (Ibiza)**

Actions



Transport

- Increase of cycling routes
- Network of EV recharging points
- Measures to promote public transport and reduce private vehicle use

Awareness

- Awareness-raising information stands

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6.2 Case Study 1: Ibiza (Spain)

➢ Multicriteria Decision in Sant Antoni

Municipal priorities

Considering the priorities established by the municipality, the criteria used to prioritize the different levels are as follows:

- Raise awareness and educate citizens about climate change.
- Promote energy efficiency and the use of renewable sources.
- Encourage responsible resource management
- Design a sustainable and efficient municipality

GENERA tool

Application of the multi-criteria module and software SuperDecisions

Alternative Rankings

Graphic	Alternatives	Total	Normal	Ideal	Ranking
	CA1.1 Improving the insulation of municipal buildings	0.0181	0.0549	0.2733	8
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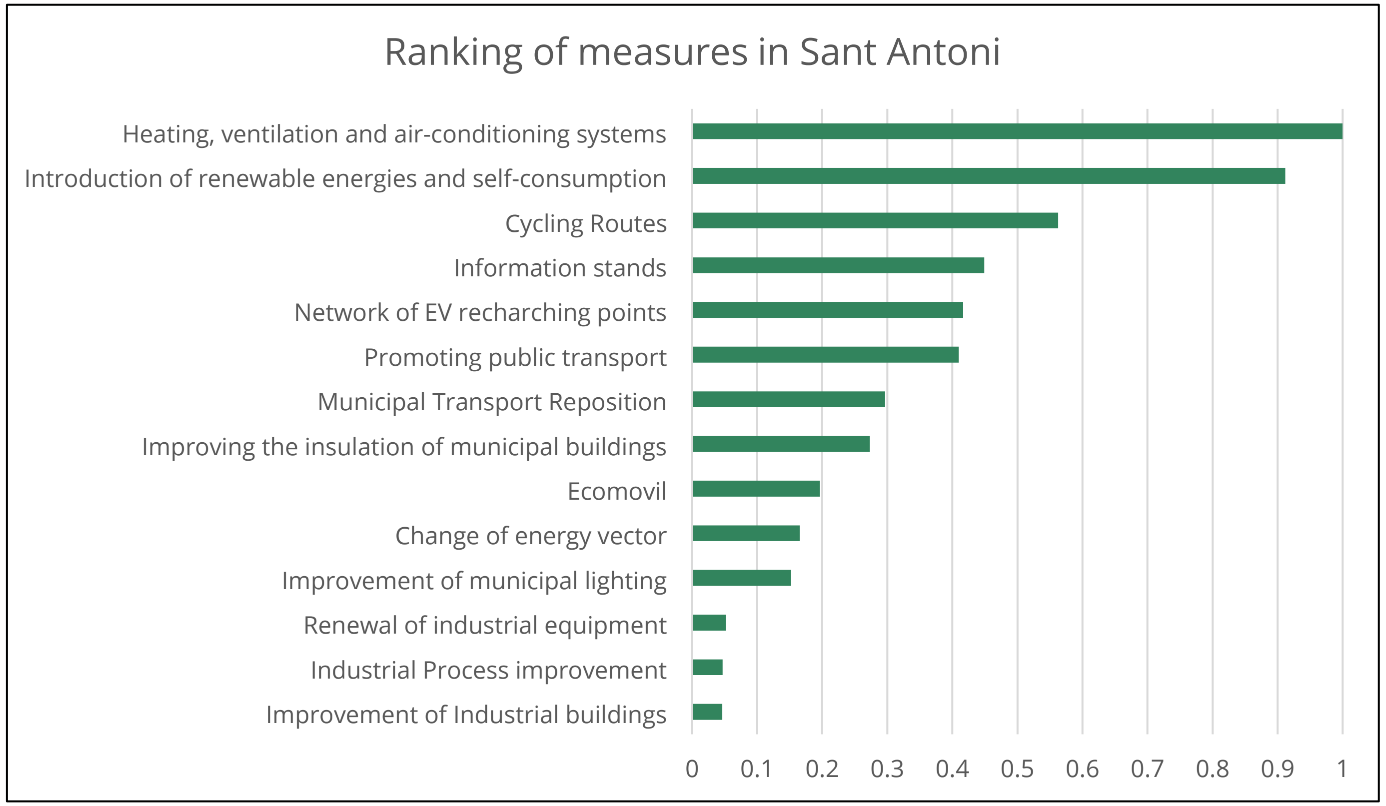
6.2 Case Study 1: Ibiza (Spain)

➢ Results



PRIORITY	ACTION	ENERGY SAVINGS (MWh/year)	CO_2 SAVINGS (tCO2e)	CATEGORY
1	Heating, ventilation and air-conditioning systems-	16.23	7.51	Municipal facilities
2	Introduction of renewable energies and self-consumption	56.10	25.24	Municipal facilities
3	Cycling Routes	-	856.10	Transport
4	Information stands	33.55	77.22	Awareness
5	Network of EV recharging points	-	2931.68	Transport
6	Promoting public transport	-	37.86	Transport
7	Municipal Transport Reposition	-	18.93	Municipal facilities
8	Improving the insulation of municipal buildings	1056.95	475.63	Municipal facilities
9	Ecomovil	-	-	Awareness
10	Change of energy vector	-	-	Industry
11	Improvement of municipal lighting	1.95	0.88	Municipal facilities
12	Renewal of industrial equipment	-	-	Industry
13	Industrial Process improvement	-	-	Industry
14	Improvement of Industrial buildings	-	-	Industry
	TOTAL	1164.78	4430.95	

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6.3 Case Study 2: Sardinia (Italy)

➢ Study of the Italian National Context

GENERA tool

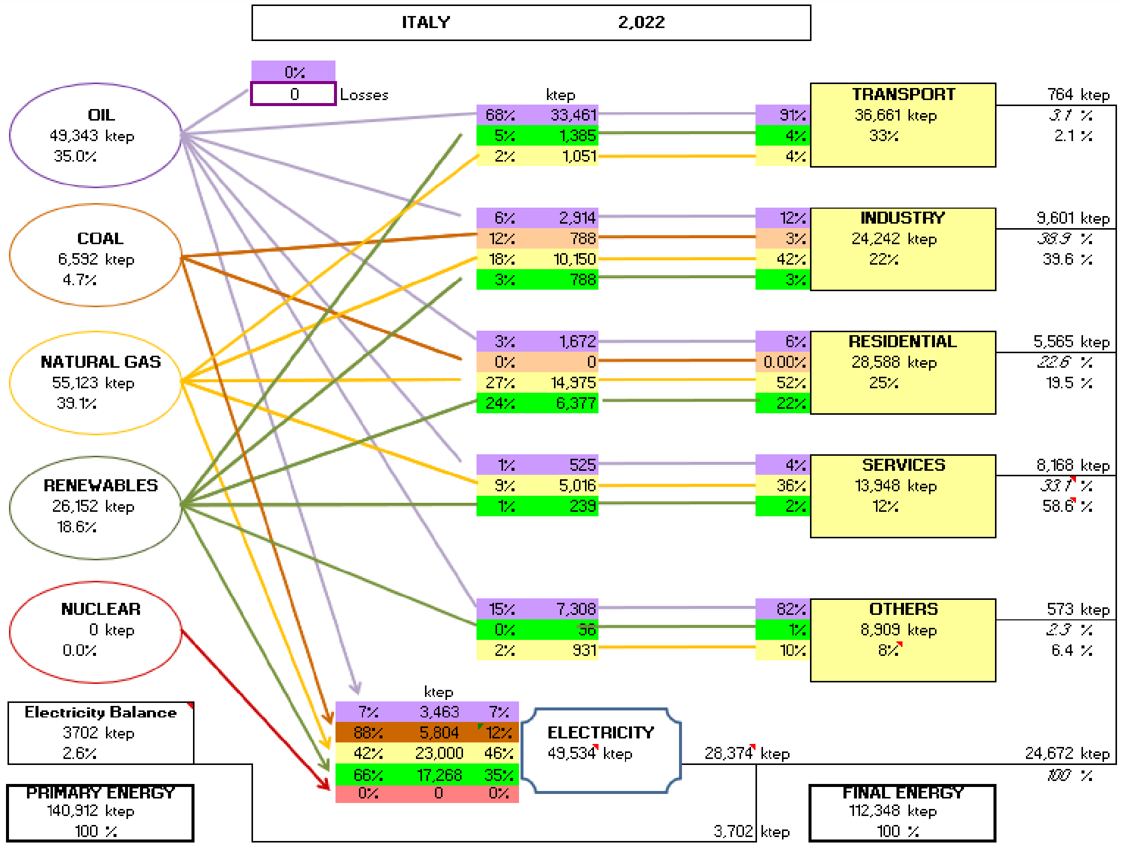
Application of GENERA's energy planning tool

Reference Data

Data entered in the tool take 2022 as the reference year (since 2023 is incomplete for some sectors) (International Energy Agency).

Energy Balance

The use of fossil fuels such as oil, mainly for the transport and agriculture/fishing sectors, and natural gas for the industrial, residential and services sectors, as well as for electricity generation, are particularly relevant. In addition, renewables are also especially significant in the residential sector



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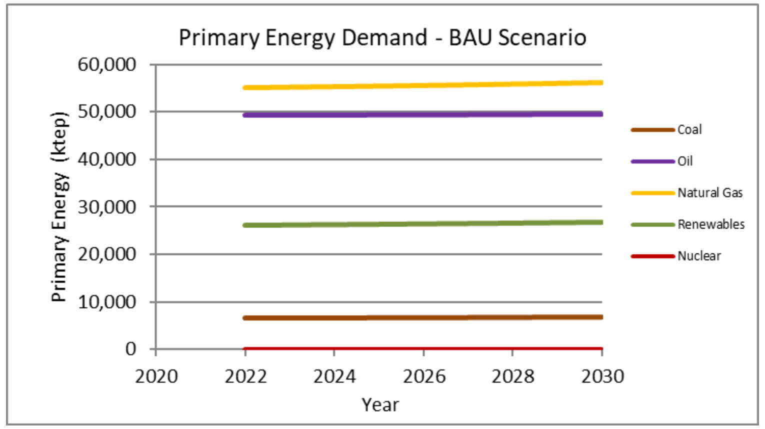
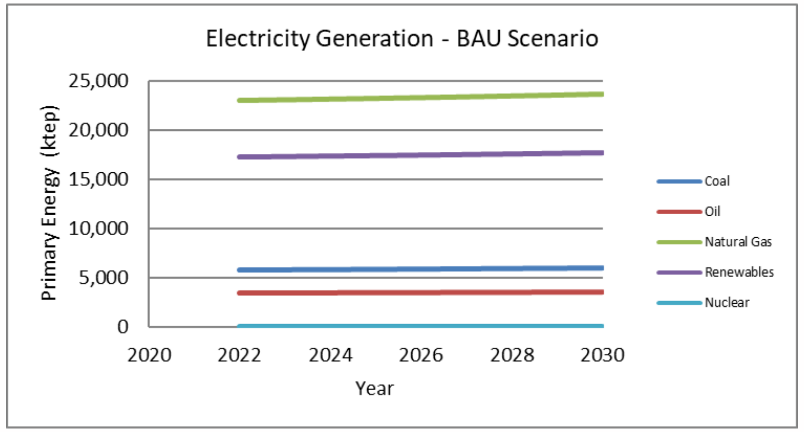
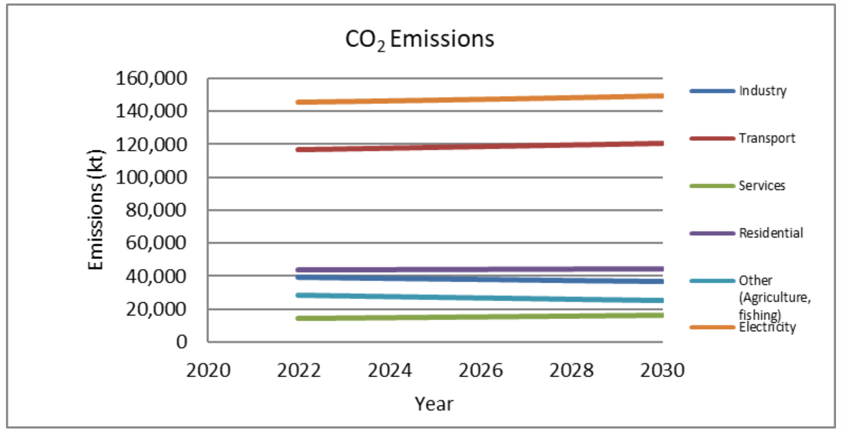
6.3 Case Study 2: Sardinia (Italy)

➢ Study of the Italian National Context







Italian energy context is characterized by the **use of natural gas** and **oil** mainly, whose major contribution is divided between the **transport and electricity generation** sectors. **Renewable energies** are more involved in the **residential and electricity** sectors and there is a growing trend mainly for electricity production.

Natural gas also shows a growing trend and **greater participation in the industrial, electricity generation, residential and services** sectors.

The most damaging sector in term of **emissions** is **electricity generation**, followed by **transport**.

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6.3 Case Study 2: Sardinia (Italy)

➢ Summary of actions of Stintino (Sardinia)

Context

Stintino is a town in the Italian province, region of Sardinia, with 1,212 inhabitants.

The municipality of Stintino joined the Covenant of Mayors initiative with the main objective of reducing CO_2 emissions by 20%.

GENERA tool

Application of the GENERA inference module.

Challenges

- Actions planned in relation to new buildings and the increase of existing buildings with higher performance.
- Improvement of accessibility conditions in the urban area: transportation methods, bicycle lanes and pedestrian areas.
- Reduced dependence on conventional energy sources.
- Implementation of awareness, training and citizen participation processes to improve sustainability and education in terms of energy consumption.

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6.3 Case Study 2: Sardinia (Italy)

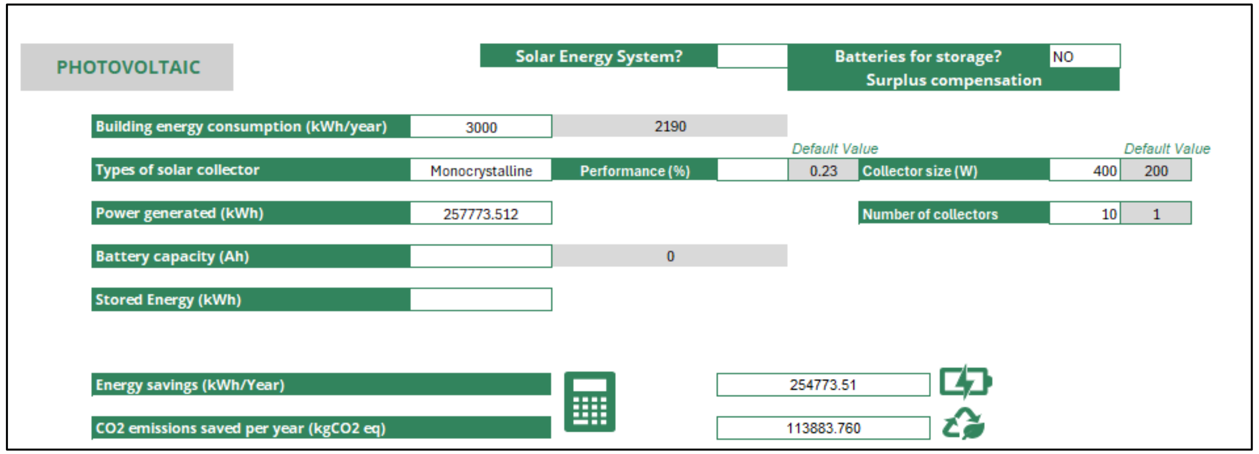
➢ **Summary of actions of Stintino (Sardinia)**

Actions

The main actions included in the generation tool are as follows

Municipal Buildings And Public Facilities

- Improving energy efficiency in municipal buildings
- Substitution Of Lights For More Efficient Ones
- Improvement of building conditioning
- Introduction of renewable energies in public buildings
- Replacement of municipal vehicles with more efficient ones



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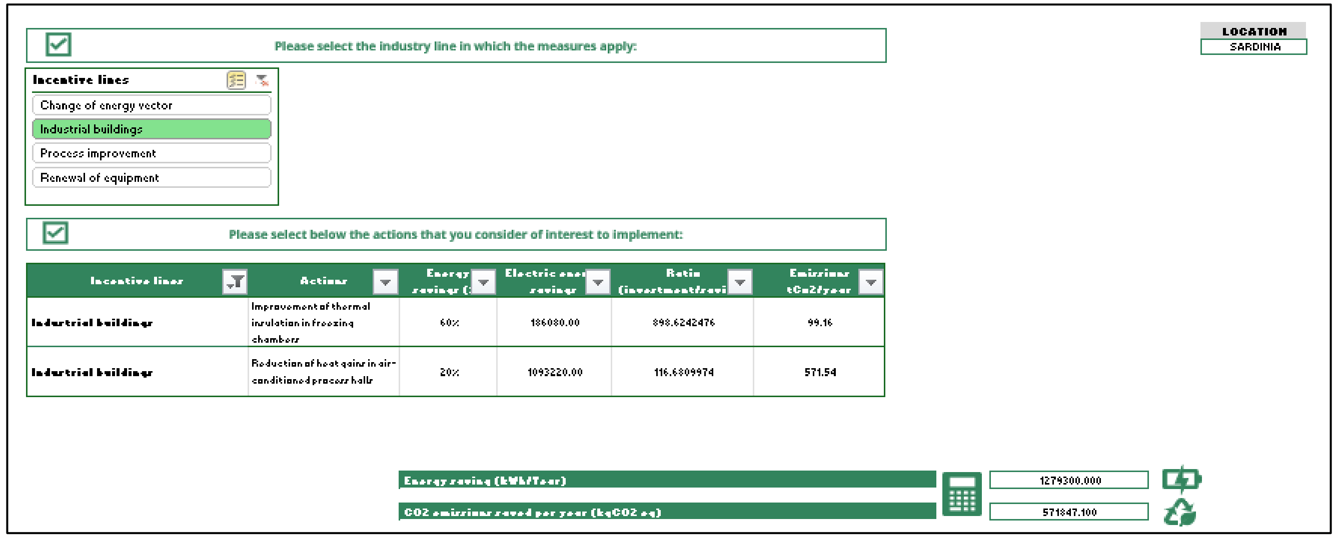
6.3 Case Study 2: Sardinia (Italy)

➢ Summary of actions of Stintino (Sardinia)

Actions

Industry

In the tertiary and productive sector, measures and promotion of environmental management tools are also introduced to improve industrial buildings.



Transport

- Increase of cycling routes
- Network of EV recharging points
- Measures to promote public transport and reduce private vehicle use

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6.3 Case Study 2: Sardinia (Italy)

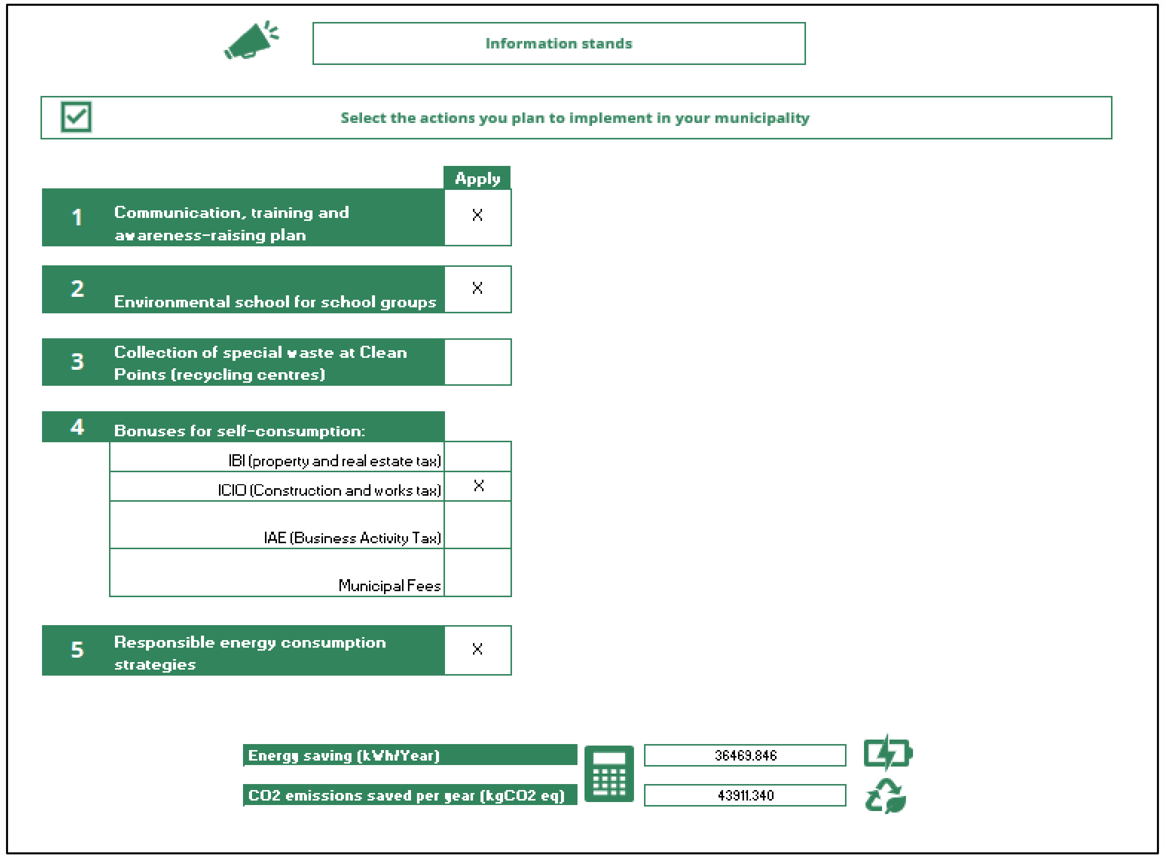
➢ Summary of actions of Stintino (Sardinia)

Actions

Awareness

This category includes raising public awareness, creating communication and awareness plans, workshops for schools and energy consumption reduction strategies.

In addition, discount rates for sustainable bioclimatic constructions are also proposed.



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6.3 Case Study 2: Sardinia (Italy)

➢ Multicriteria Decision in Stintino

Municipal priorities

Considering the priorities established by the municipality, the criteria used to prioritize the different levels are as follows:

- Adapt the municipality's public facilities.
- Involve civil society to develop and improve the action plan with citizen awareness.
- Reduce energy consumption through actions in municipal buildings.
- Inclusion of PV systems in buildings and land in the municipality, as well as promoting their installation at the individual level.
- Development of heating with cogeneration plants.

Alternative Rankings

Graphic	Alternatives	Total	Normal	Ideal	Ranking
	CA1.1 Improving the insulation of municipal buildings	0.0146	0.0441	0.1219	8
	CA1.2 Improvement of municipal lighting	0.0190	0.0571	0.1578	6
	CA1.3 Heating, ventilation and air-conditioning systems	0.0268	0.0809	0.2234	4
	CA1.4 Introduction of renewable energies and self-consumption	0.1201	0.3622	1.0000	1
	CA1.5 Municipal Transport Reposition	0.0085	0.0257	0.0711	11
	CA2.1 Industrial Process improvement	0.0044	0.0134	0.0370	14
	CA2.2 Renewal of industrial equipment	0.0060	0.0182	0.0501	12
	CA2.3 Improvement of Industrial buildings	0.0121	0.0366	0.1010	9
	CA2.4 Change of energy vector	0.0091	0.0273	0.0755	10
	CA3.1 Cycling Routes	0.0337	0.1015	0.2803	2
	CA3.2 Network of EV recharching points	0.0185	0.0556	0.1536	7
	CA3.3 Promoting public transport	0.0215	0.0649	0.1790	5
	CA4.1 Ecomovil	0.0055	0.0167	0.0460	13
	CA4.2 Information stands	0.0317	0.0956	0.2640	3

GENERA tool

Application of the multi-criteria module and software SuperDecisions

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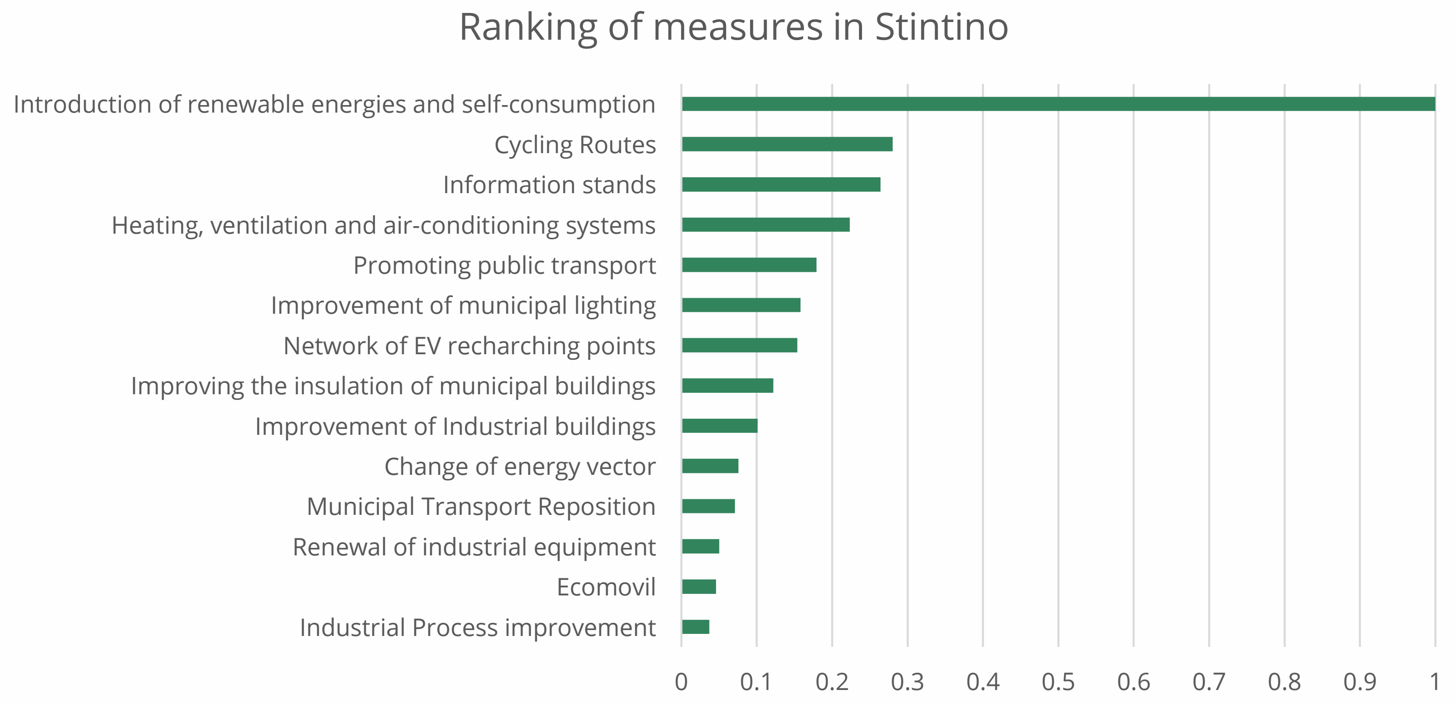
6.3 Case Study 2: Sardinia (Italy)

➢ Results



PRIORITY	ACTION	ENERGY SAVINGS (MWh/year)	CO_2 SAVINGS (tCO2e)	CATEGORY
1	Introduction of renewable energies and self-consumption	277.77	124.12	Municipal facilities
2	Cycling Routes	-	26.80	Transport
3	Information stands	36.47	43.91	Awareness
4	Heating, ventilation and air-conditioning systems	15.52	6.94	Municipal facilities
5	Promoting public transport	-	0.015	Transport
6	Improvement of municipal lighting	27.60	12.33	Municipal facilities
7	Network of EV recharging points	-	366.55	Transport
8	Improving the insulation of municipal buildings	1.45	0.65	Municipal facilities
9	Improvement of Industrial buildings	1279.30	571.85	Industry
10	Change of energy vector	-	-	Industry
11	Municipal Transport Reposition	-	1.15	Municipal facilities
12	Renewal of industrial equipment	-	-	Industry
13	Ecomovil	-	-	Awareness
14	Industrial Process improvement	-	-	Industry
	TOTAL	16019.74	1154.32	

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6.4 Case Study 3: Halki (Greece)

➢ Study of the Greek National Context

GENERA tool

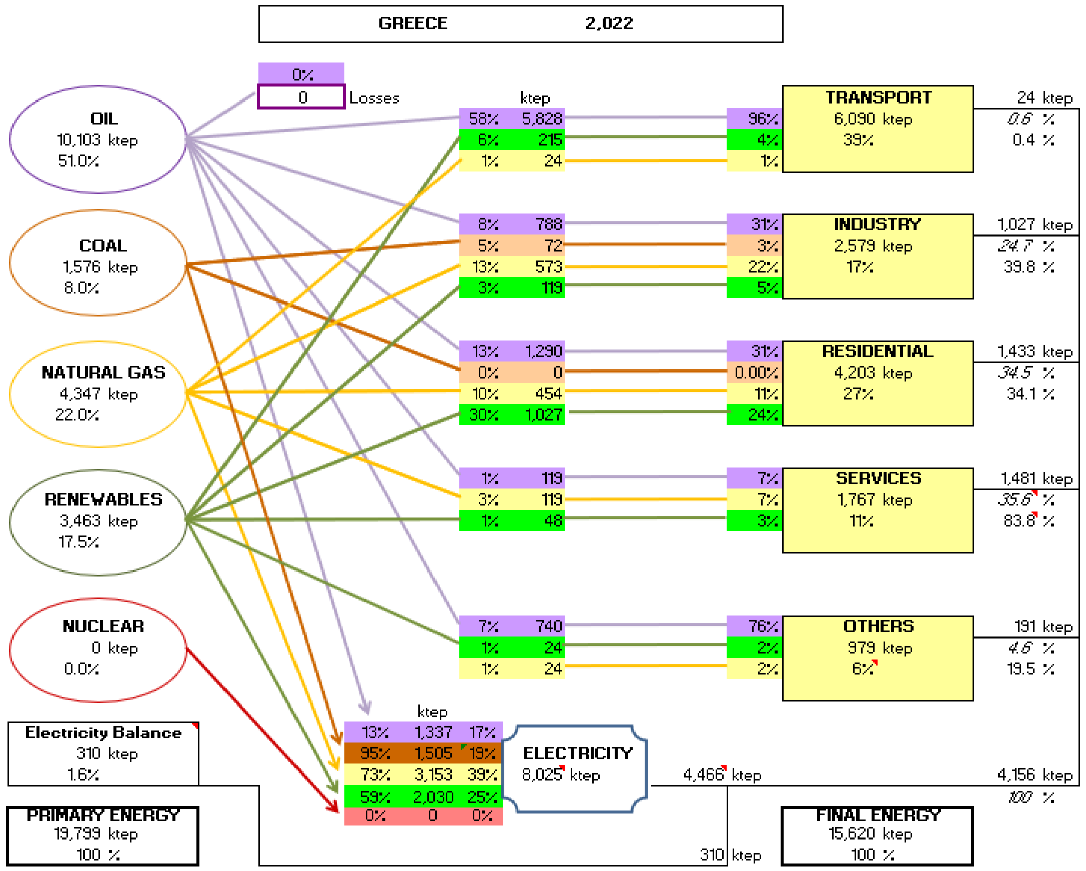
Application of GENERA's energy planning tool

Reference Data

Data entered in the tool take 2022 as the reference year (since 2023 is incomplete for some sectors) (International Energy Agency).

Energy Balance

High presence of oil in all sectors, although it stands out mainly in the transport sector, and others such as agriculture and fisheries. Natural gas is most involved in electricity generation, followed by the industrial and residential sectors. Renewable energies are also producers of electricity and have a great impact on the residential sector



MOOC 2: Energy transition measurement and monitoring tools

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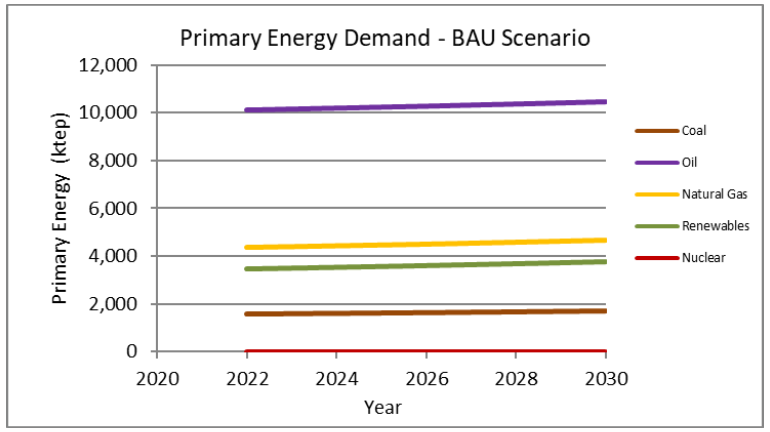
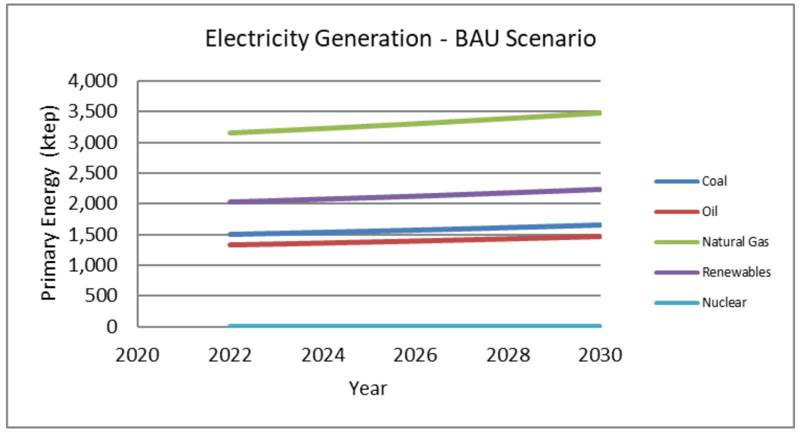
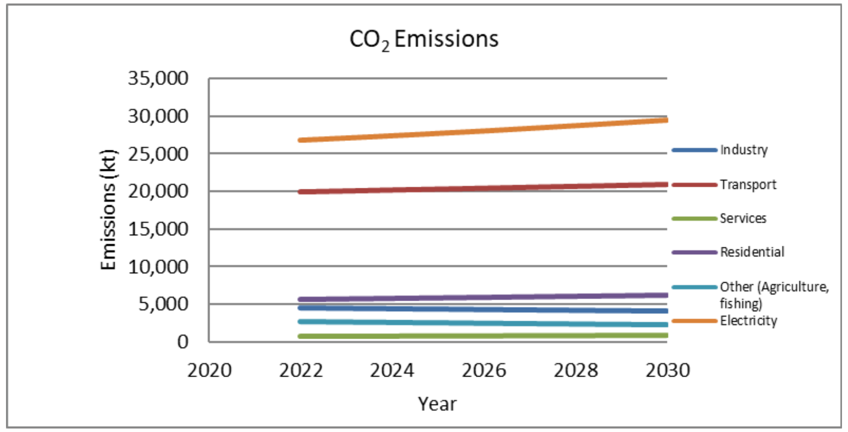
6.4 Case Study 3: Halki (Greece)

➢ Study of the Greek National Context







The Greek energy context is mainly characterized by the use of **oil and natural gas** in sectors such as **transport and agriculture** and fishing.

Renewable energies are more involved in the **residential and electricity** sectors. There is a **growing trend** in the use of **renewable energies**, mainly for **electricity production**.

The sector that emits the **most emissions** is the **electricity generation** sector due mainly to coal, and it is followed by **transport**.

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6.4 Case Study 3: Halki (Greece)

➢ **Study of the Greek National Context**

Context

Smallest inhabited island of the Dodecanese with an area of 28 km2. It is part of the regional unit of Rhodes. It has a permanent population of 330 inhabitants (increasing during the summer months).

GENERA tool

Application of the GENERA inference module

Challenges

- It has a large photovoltaic park and the installation of solar energy facilities is planned. It is estimated that the island's energy needs can be covered.
- The municipality has set itself the target of reducing CO_2 by 105% by 2030, which exceeds the required 40% by far, so the emissions must be very demanding.

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6.4 Case Study 3: Halki (Greece)

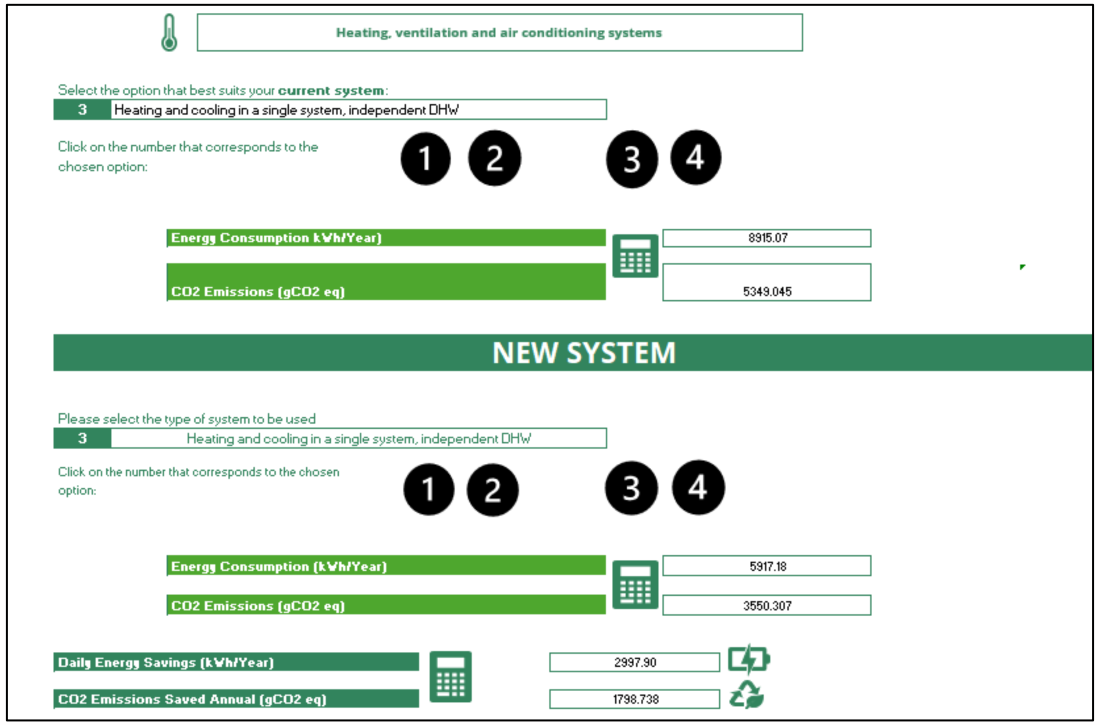
➢ Summary of actions of Halki (Greece)

Actions

The main actions included in the generation tool are as follows

Municipal Buildings And Public Facilities

- Improving energy efficiency in municipal buildings
- Substitution Of Lights For More Efficient Ones
- Improvement of building conditioning
- Introduction of photovoltaic solar energy for power production
- Replacement of municipal vehicles with more efficient ones



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6.4 Case Study 3: Rhodes (Greece)

➢ Summary of actions of Halki (Greece)

Actions

Transport

- Increase of cycling routes
- Promoting public transport

Awareness

- Implementation of Ecomovil
- Awareness-raising information stands

Promoting public transport

Please select the measures applied in the promotion of public transport:

	Share CO2 savings	Apply	Emissions saved by municipality (kg of carbon dioxide)
Reduced Speed Zones	25%		0.00
Increase in the frequency of PT passage	10%	x	0.09
Reducing fees for Youth and Pensioners	5%	x	0.05
Ecozone (ZBE)	97%		0.00
Tolls (depending on rush hour or not)	30%		0.00
Congestion charging (reducing the number of cars entering the city	20%		0.00
TOTAL			0.14

Ahorro energético (kWh/Año)	0.000
Emisiones CO2 ahorrada al año (kgCO2 eq)	64.125

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6.4 Case Study 3: Halki (Greece)

➢ Multicriteria Decision in Halki

Municipal priorities

Considering the priorities established by the municipality, the criteria used to prioritize the different levels are as follows:

- Promotion of recycling and organics reduction.
- Energy audit in municipal buildings.
- Information to users to improve the behaviour and optimal use of the different equipment.
- Substitution of LED lamps in lighting systems.
- Development of heating with cogeneration plants.

Alternative Rankings

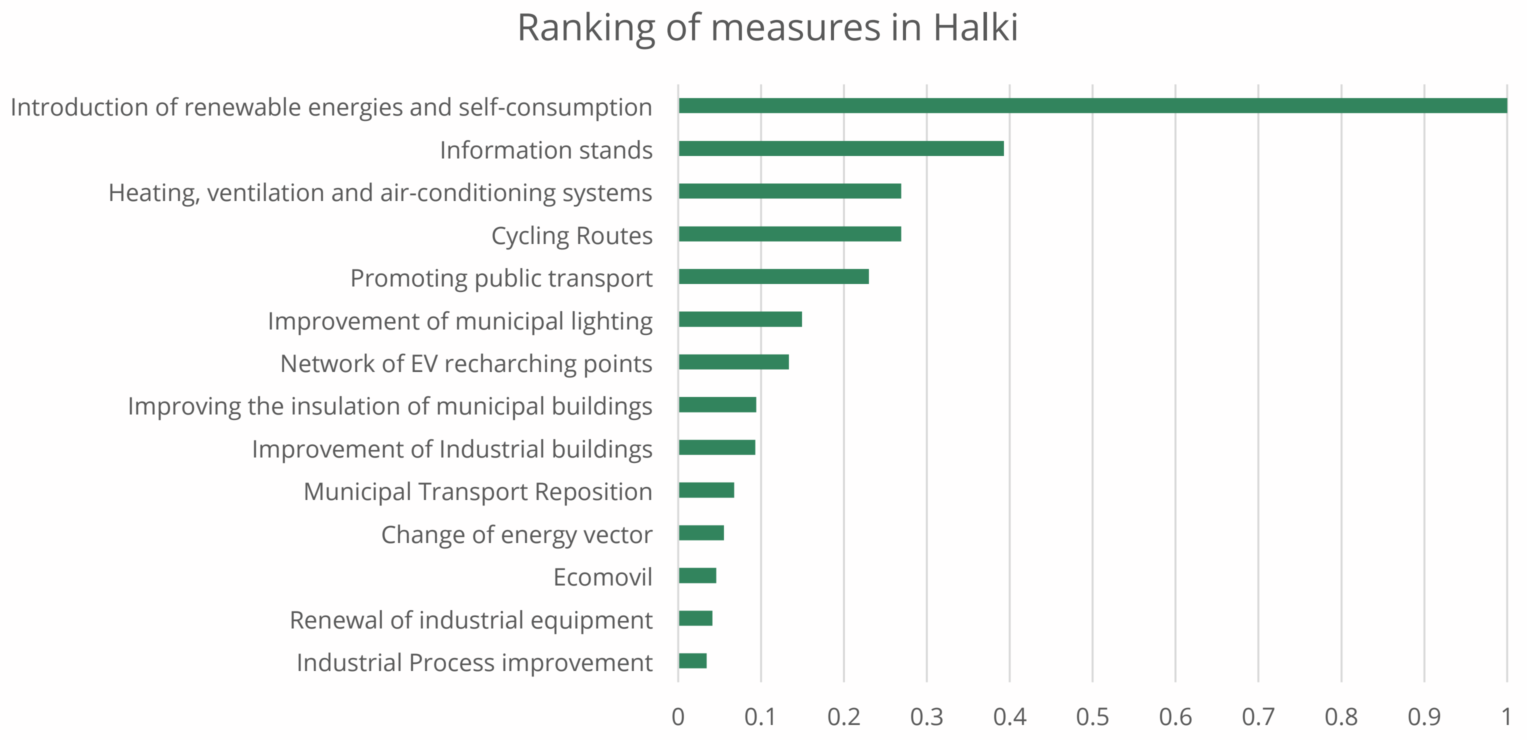
Graphic	Alternatives	Total	Normal	Ideal	Ranking
	CA1.1 Improving the insulation of municipal buildings	0.0108	0.0327	0.0940	8
	CA1.2 Improvement of municipal lighting	0.0172	0.0520	0.1494	6
	CA1.3 Heating, ventilation and air-conditioning systems	0.0310	0.0936	0.2690	3
	CA1.4 Introduction of renewable energies and self-consumption	0.1154	0.3479	1.0000	1
	CA1.5 Municipal Transport Reposition	0.0078	0.0234	0.0674	10
	CA2.1 Industrial Process improvement	0.0040	0.0119	0.0343	14
	CA2.2 Renewal of industrial equipment	0.0048	0.0143	0.0412	13
	CA2.3 Improvement of Industrial buildings	0.0107	0.0323	0.0928	9
	CA2.4 Change of energy vector	0.0064	0.0192	0.0552	11
	CA3.1 Cycling Routes	0.0310	0.0935	0.2688	4
	CA3.2 Network of EV recharching points	0.0154	0.0464	0.1334	7
	CA3.3 Promoting public transport	0.0266	0.0801	0.2301	5
	CA4.1 Ecomovil	0.0053	0.0160	0.0461	12
	CA4.2 Information stands	0.0453	0.1366	0.3928	2

GENERA tool

Application of the multi-criteria module and software SuperDecisions

6.4 Case Study 3: Halki (Greece)

➢ Results



PRIORITY	ACTION	ENERGY SAVINGS (MWh/year)	CO_2 SAVINGS (tCO2e)	CATEGORY
1	Introduction of renewable energies and self-consumption	2.62	1.57	Municipal facilities
2	Information stands	0.33	0.68	Awareness
3	Heating, ventilation and air-conditioning systems	3.00	1.80	Municipal facilities
4	Cycling Routes	-	5.79	Transport
5	Promoting public transport	-	0.06	Transport
6	Improvement of municipal lighting	4.38	2.63	Municipal facilities
7	Network of EV recharging points	-	-	Transport
8	Improving the insulation of municipal buildings	6.27	3.76	Municipal facilities
9	Improvement of Industrial buildings	-	-	Industry
10	Municipal Transport Reposition	-	-	Industry
11	Change of energy vector	-	1.15	Municipal facilities
12	Ecomovil	0.053	0.031	Industry
13	Renewal of industrial equipment	-	-	Awareness
14	Industrial Process improvement	-	-	Industry
	TOTAL	16.65	17.47	

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Key Lessons from Case Studies

1
Purpose of the GENERA Tool
Developed to assist municipalities, particularly on islands, in creating energy transition action plans with national, regional, and local insights.

2
Modular and Tailored Approach
The tool includes different modules, allowing qualitative data integration for better adaptability to smaller municipalities.

3
Comprehensive Data Management
It provides precise context through national, regional, and local data, helping policymakers set clear sustainability goals.

4
Usability and Future Improvements
Designed to be user-friendly but could benefit from enhancements, such as a manual and improved information visibility.

5
Pilot Testing and Expansion
Tested in several island municipalities in Spain, Italy, and Greece, yielding energy-saving measures and CO_2 reductions, with plans for further refinement and expansion

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MOOC 2

Energy transition measurement and monitoring tools

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