D2.4 • REFEREE Policy Support System's Design

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REFEREE: Real Value of Energy Efficiency

Results from the scoping analysis

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Partners

Partner	Short name	Principal Investigator
MCRIT	MCRIT	Mr Oriol Biosca

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1 Approach

1.1 About REFEREE

REFEREE is a European-funded Horizon 2020 project that started in October 2020 and will run until April 2024.

In order to deliver the European Green Deal, which sets out the roadmap making Europe the first climate-neutral continent by 2050, we need to accelerate our efforts to improve the energy efficiency of our buildings, transport, and industry. In this context, REFEREE aims to analyse and quantify the direct and indirect non-energy impacts of energy efficiency investments and develop an easy-to-use tool to support policy makers at the national, regional and local level. Modelling and quantification will build on E3ME model.

REFEREE will help households, businesses, financing institutions, policy makers and other relevant stakeholders to evaluate the multiple impacts of their energy efficiency choices.

To maximise the impact of the REFEREE policy support tool, stakeholders will be involved from the inception of the project, through concrete opportunities for its co-development, pilot studies, and focused dissemination and communication actions.

1.2 Objectives of this report

The main objectives can be summarised as follows:

- Identify the most relevant policy support systems (PPS) and derive criteria for the REFEREE system to be developed.
- Get more clarity on the definition of user-needs, taking stock of how these have been assessed in already existing systems.
- Get clarity on the project focus and ensure utility of the results at the earlier stages of the project.

1.3 Activities carried out

This report describes the results and literature gathered from the assessment of the best practices to be used to propose the REFEREE policy support system's design and its detailed development process. We evaluate the identified practices against the REFEREE stakeholders' needs.

This process has been carried out in 2 parts:

1) A more analytical part where we gathered good practices of policy support systems and analysed features of cost-benefit assessment and Multicriteria policy-assessments.

2) A contrast part, where we could contrast our first impressions concluded from the first part with key stakeholders (potential users).

The results from the analytical part are fully developed in the Delivery "D2.1 Taking stock from the existing state of art". Following the tasks that were carried out:

- **Benchmark of 40 policy-support systems.** We identified and gathered 40 good practices of user-friendly policy-support systems at all scales. They were selected according to their effectiveness and relative interest for REFEREE. This has allowed us to get a better picture on how user-needs were addressed in the past in already existing systems. In the Deliverable "D2.1 Taking stock from the existing state of art",

- **Assessment methodologies and evaluation literature.** Features of Cost-benefit Assessment and Multicriteria policy-assessments were also analysed. The actual Cost-benefit and Multicriteria policy assessments, particularly Environmental Strategic Assessment and other official impact assessment methodologies at European and national scale were considered in order to start developing the module design able to convert the policy impacts being forecasted in measures related to social welfare. The Territorial Impact Assessment methodology developed in the frame of the ESPON Program and applied by the Committee of Regions (useful to disaggregate impacts by territories), and the RAILPAC developed by the European Investment Bank (useful to disaggregate impacts by stakeholders) were considered, among others, as key references and starting points.

- **Specific analysis of key policy-support systems in detail**. We reviewed in detail relevant Decision Support Tools: 1) PRIORITEE TOOLBOX, as an example of a toolbox integrating policy relevant resources (databases, guidelines, best practices, self-assessment EE tests for public buildings); 2) HIGH-TOOL - Strategic high-level transport model, as an example of user-friendly policy support system aiming at allowing access to a complex forecast model for non-modeller specialists; 3) APEX APP as an example of an easy to use online tool for assessing energy impacts in developing cities (energy, water, waste and public transport) and 4) Urban Footprint Tool, as an integrated urban oriented tool, spatially oriented, to support sustainable and healthy urban planning.

- **Working hypothesis and critical questions for assessing user-needs and opportunity windows**. We identified that: 1) tools that tend to be more disaggregated usually work in a micro/local level and are formed by simpler tools such as calculators and facility simulators, all sectors are well covered; 2) tools working in an intermediate spatial domain level tend to simulate more complex realities at a more aggregated level, they

are usually powered by GIS data and perform analyses at a neighbourhood and even at a city level. Most of the tools are focused in air quality, urban planning, mobility and housing, we identified a large gap when it comes to the industry, logistics and urban infrastructure sectors and 3) at the most aggregated level, we can find strategic tool usually addressing the air quality, mobility, and sometimes (but now always) the housing sector.

As for the contrast analysis tasks:

- **PAG Workshop**. Potential users and stakeholders discussed in a workshop what the non-energy benefits are important to consider, what policy links there are, what sectors, what policy/intervention tools are appropriate and how these link to REFEREE's model.
- **Personal interviews with potential users and developers.** After the identification and gathering of good practices of user-friendly policy-support systems at all scales and considering the policymakers needs, we selected a few policy-systems considered as potentially more interesting as reference to support the needs-assessment. Personal contacts were carried out with both system's developers like Marko Čavar, João Gouveia, Norberto Fueyo (developers of the PrioritEE Toolbox) and Efrain Larrea (developer of the HIGH TOOL), and potential key users like Sergi Pérez (expert technician in sustainable building and energy projects at the AMB an Spanish regional public administration) to get more precise information from them through personal interviews and questionnaires (interviews available in the Annex).
- **Consultation on user-needs with 80 European experts**. In order to reach out to a wider audience and not only to PAG members, we carried out and online survey that was sent and responded by 80 potential users. The survey contained question regarding the profile of the interviewee, to which kind of policy questions the REFEREE tools should answer and in which operative way. The questionnaire results and detailed analysis is fully available in the deliverable "D2.3 Scoping analysis".

2 Contrast of initial hypothesis with stakeholders

In order to analyse user needs, we organised a workshop with the Policy Advisory Group (PAG) members, conducted personal interviews to potential users and tool developers, performed an expert consultation through an online survey, and participated in the Kick-off meeting of the PrioritEE Plus project.

The purpose of those were to identify the most relevant topics to be addressed by the Policy Support System and the typology of the system (integrated-disaggregated or spatialised-analytical), all in order to develop an attractive tool well aligned with potential user-needs.

Following we present the activities carried out.

2.1 PAG Workshop

The objective of this first PAG meeting is to present the project to PAG members and collect preliminary ideas for the upcoming modelling and tool design.

The session was held via online on 25 March 2021, with the participation of the members of the Policy Advisory Group composed of 18 key stakeholders.

Below is the list of the participants together with the organisation they belong to and the position they hold.

Table 1 PAG Workshop participants.

Organisation	Name	Position
ENEA	Alessandro Federici	Head of Monitoring Energy Policies for Energy Efficiency Laboratory
EptaPrime - financial advisory consultancy	Gianpiero Poddighe	Founder
IKEM	Bénédicte Martin	Team Lead Energy Law
German Federal Ministry for Economic Affairs and Energy	Florian Knobloch	Policy Advisor
Rénovons!	Danyel Dubreuil	Coordinator
Area Metropolitana de Barcelona	Gil Morales (replacing Elena Lacord)	Head of Office Energy Transition

Buildings Performance Institute Europe	Judit Kockat	Executive Director
EVN Bulgaria	Anna Dimitrova	Head Of Department, Energy Policy
Emilia Romagna Region	Apollonia Tiziana De Nittis	Expert
EIT Urban Mobility	Pierre Serkine	Public Affairs and Stakeholder Relations Officer
Municipality of Gabrovo	Koleva Desislava	Senior Expert
University of Exeter	Jean-Francois Mercure	Senior Lecturer
Regione Emilia Romagna	Attilio Raimondi	Senior expert
Macao University	Aileen Lam	Lecturer
Royal Society of Chemistry	Tanya Sheridan	Policy and Evidence Manager
FIRE Italian Federation for the Rational Use of Energy	Dario Di Santo	Managing Director
CNR-IMAA institute	Carmelina Cosmi	Researcher
ADEME	Didier Bosseboeuf	Scientific and technical advisor
IKEM	Aleksandra Novikova	Team Lead

Apologies: Nuria Parpal, Environmental Program Manager, Diputacio de Barcelona

After presenting the project to the PAG members, they were asked to participate in 2 particular activities, the first one identifies critical topics related to energy efficiency for being considered in the Policy Support System, and a second one know the type of system the participants find more suitable.

The contents of the activities are described in detail in Annex 1.

2.1.1 Results

Activity 1. Relevant topics

The following graphs show the rates that were granted by the PAG members divided in 3 groups. Each member had 4 votes to distribute among the defined topics.

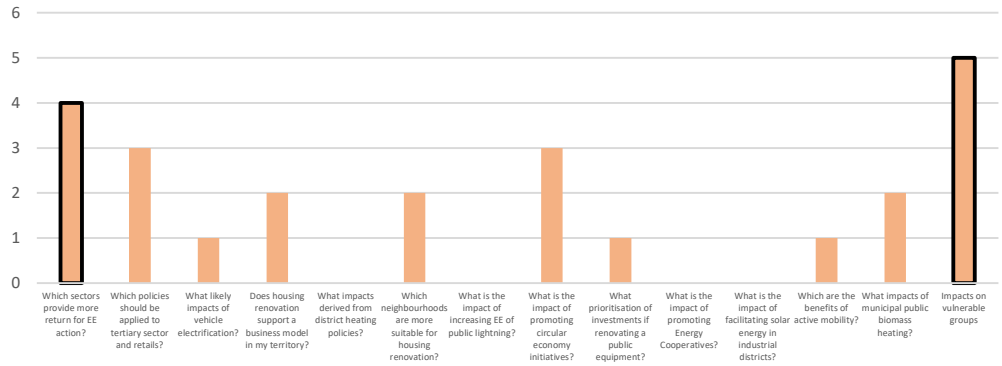


Figure 1 Most relevant topics to be considered in the Policy Support system according to the Group 1.

According to the Group 3, the most relevant topics to be included in the decision-support tool were the impacts on vulnerable groups (5 votes) and the sectors that provide more return for EE investments (4 votes). During the group discussions participants highlighted the need to study the impact not only on vulnerable consumers but also on the middle class. In terms of the type of neighbourhoods, it was mentioned that one should consider not only social groups living in different neighbourhoods but also the different type of buildings they inhabit.

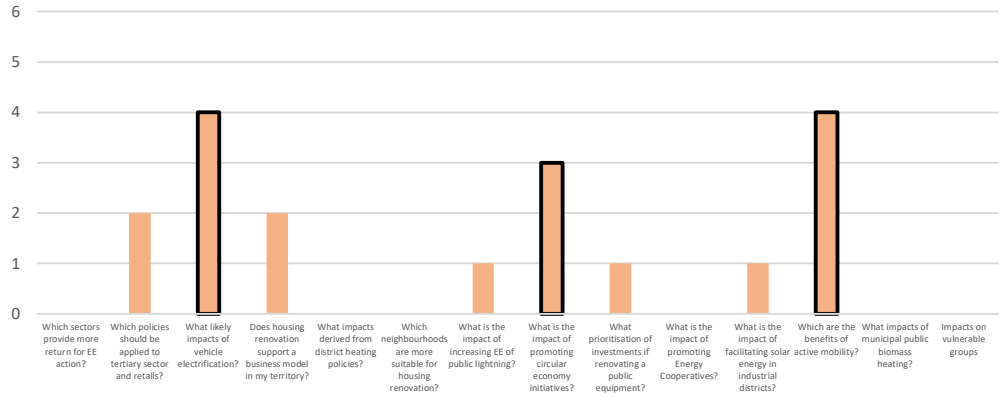


Figure 2 Figure 3 Most relevant topics to be considered in the Policy Support system according to the Group 2.

According to the Group 2, likely impacts of vehicle electrification and benefits of active mobility are the most relevant topic to be included in the decision-support tool according to group members (4 votes each). Circular economy promotion is also deemed relevant (3 votes).

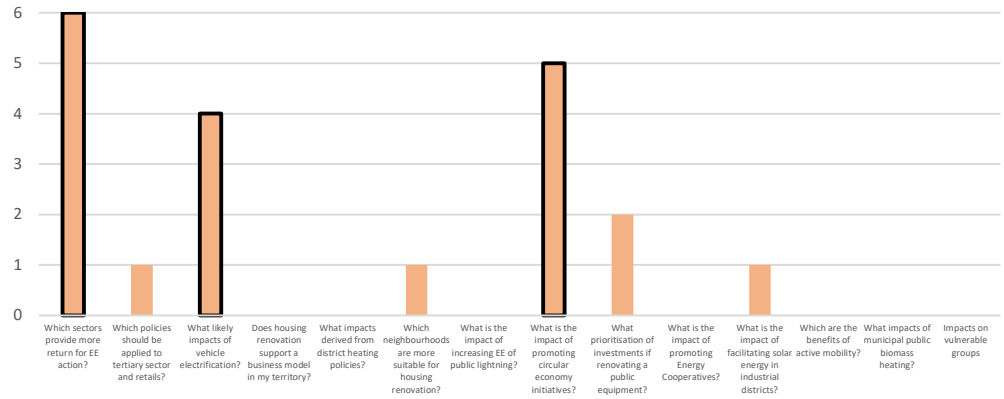


Figure 4 Most relevant topics to be considered in the Policy Support system according to the Group 3.

According to the Group 3, the most relevant topics to be included in the decision-support tool were the sectors that provide more return for EE investments (6 votes), circular economy activities (5 votes) and the most likely impacts of vehicle electrification (4 votes). During the group discussions participants highlighted the need to study the impact on vulnerable groups.

Considering the same weight for each of the PAG members, the following table and figure show the overall results. The topics were classified by 4 level of relevance (high, moderate, low and none).

	Group 1	Group 2	Group 3	TOTAL
Which sectors provide more return for EE action?	4	0	6	10
Which policies should be applied to tertiary sector and retails?	3	2	1	6
What likely impacts of vehicle electrification?	1	4	4	9
Does housing renovation support a business model in my territory?	2	2	0	4
What impacts derived from district heating policies?	0	0	0	0
Which neighbourhoods are more suitable for housing renovation?	2	0	1	3
What is the impact of increasing EE of public lightning?	0	1	0	1
What is the impact of promoting circular economy initiatives?	3	3	5	11

What prioritisation of investments if renovating a public equipment?	1	1	2	4
What is the impact of promoting Energy Cooperatives?	0	0	0	0
What is the impact of facilitating solar energy in industrial districts?	0	1	1	2
Which are the benefits of active mobility?	1	4	0	5
What impacts of municipal public biomass heating?	2	0	0	2
Impacts on vulnerable groups*	5	0	0	5

Figure 1 Topic relevance activity overall results, high (green), moderate (yellow), low (white) and none (red) relevance.

As an overall result, the most relevant topics to be included in the decision-support tool were the circular economy activities (11 votes), sectors that provide more return for EE investments (10 votes), and the most likely impacts of vehicle electrification (9 votes). On the opposite site, the less relevant topics are the promotion of energy cooperatives, district heating policies and the increase of energy efficiency of public lighting.

Other topics to be considered, defined as moderate relevant, are the policies to be applied to tertiary sector and retails (6 votes), benefits of active mobility (5 votes) and impacts on vulnerable groups (5 votes).

Activity 2. System typology

The following graphs show the rates that were granted by the PAG members divided in 3 groups. Each member had to place a sticker in their preferred quadrant and then the second desired one. To analyse the results the first choice has been given a weight of 3 and the second one a weight of 1. When the location of the sticker on an axis, the value was divided between the quadrants on both side of the axis.

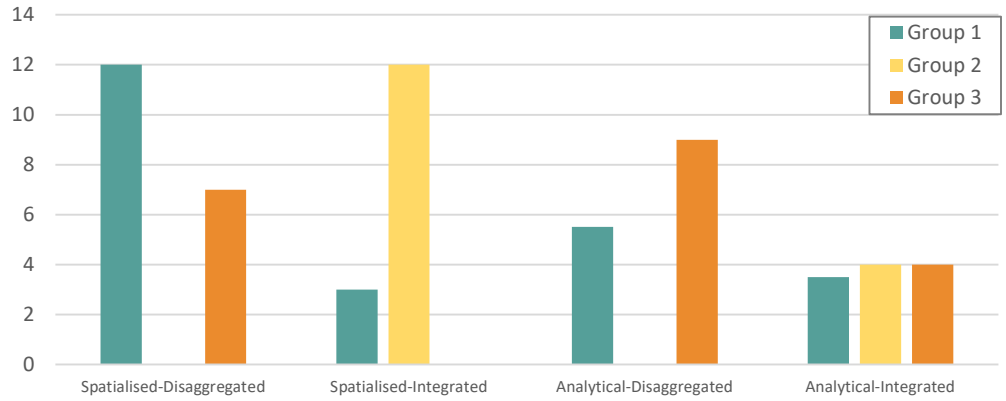


Figure 5 System typology desired by the PAG groups.

The first (blue) and the third group (orange) would like to use the simpler tools to assess the benefits for different kinds of buildings, facilities and services (spatialised-disaggregated), as well as a knowledge and data integration tool for policy making support (analytical-disaggregated).

The second group (yellow), preferred a more integrated type of tool, first with spatialisation features, and as a second best integrated with rather analytical features. The need for an integrated policy-support tool was especially highlighted by participants working in the public sector. Databases often exist but do not dialog with each other, making it difficult to see interactions between them.

As regards the overall preferences on the type of Policy Support Tool, the category of disaggregated tools is the one that has had the greatest preferences with a focus on the analytical ones. On the contrary, the analytical tools but with an integrated approach were considered less important and no vote was given to the integrated tools with a spatialised approach.

2.1.2 Conclusions

- The PAG members show logical interest in emerging and innovative topics such as “vehicle electrification” and “circular economy initiatives”, and in the more strategic components to support policy making like “identification of sectors that provide more return (economic and social) for energy efficiency action”.
- As expected, stakeholder interest is also focused on structural areas of the urban energy efficiency management, like “identification of policies to be applied to tertiary sector and retails”, “benefits of active mobility” and impacts on vulnerable groups, the last one proposed by the participants.

- Topics indicated to a lower extent are those including the more specialised ones, either sectorial or geographical, with stronger challenges for their generalisation: “promotion of energy cooperatives”, “district heating policies” and the “increase of energy efficiency of public lighting”.
- There is not a clear preference regarding the type of tool that is preferred by the PAG group. From the type of tool exercise, the results were quite heterogeneous. From the 4 typologies defined, only the Analytical-Integrated type of tools referring to “tools for aggregated strategic energy policy impact assessment” was not preferred by any group but at the same time was the only type that was voted for all the groups.

2.2 Interviews to potential users and developers

After the identification and gathering of good practices of user-friendly policy-support systems at all scales in the Deliverable “D2.1 Taking stock from the existing state of art”, we selected a few policy-systems according to their effectiveness and relative interest for REFEREE. Personal contacts were carried out with both system’s developers and potential key.

More precisely we interviewed:

- Marko Čavar, developer in the PrioritEE Toolbox and Project Manager at North West Croatia Regional Energy Agency (REGEA).
- João Pedro Gouveia, developer of “Menu Verde” and the “PrioritEE Toolbox” at the School of Science and Technology of the Nova University Lisbon (FCT NOVA).
- Norberto Fueyo, developer in the PrioritEE Toolbox and professor in the Department of Science and Technology of Materials and Fluids (Universidad de Zaragoza).
- Efrain Larrea, developer of the HIGH TOOL EU high level transport strategic policy support system (MCRIT).
- Sergi Pérez, energy efficiency manager, expert in sustainable building and energy projects at the Barcelona region Metropolitan Authority (AMB), user of EE policy support systems. Specialist in sustainable construction and advisor ”BREEAM ES” and in ”Use, GREEN and LEED AS”. He has carried out more than 70 energy audits of existing buildings, the energy management of 18 buildings, more than 5 sustainable construction certifications (BREEAM and VERDE), more than 20 renewable energy projects and various strategic energy studies.
- Núria Parpal, environmental program manager at the Barcelona Provincial Council (DIBA), user of EE policy support systems. The Diputació de Barcelona (DIBA) is a public body that encourages the progress and well-being of citizens of the province of Barcelona. It plays a direct role in the provision of services (technical, economic and technological aid to local councils) and, above all, in collaboration with the city councils

themselves. Its Department of the Environment is responsible for the planning and development of the formulation of environmental policies on climate change mitigation and sustainability, on environmental assessment and management, as well as in environmental education.

The content of the interviews and the answers are available in Annex 2.

2.2.1 Results

Interviews with developers

Developers have been involved in the development of various policy support tools. Some of the tools they mentioned are presented below:

- PrioritEE DST. A decision support tool (DST) that helps local and regional authorities to quickly evaluate the possibility for energy (and financial) savings by applying energy efficiency measures in public buildings.
- EPC Toll. The Living EPC Tool analyses data from collected energy performance certificates and provides combinations of cost-optimal measures for reaching nZEB requirements in public buildings.
- SEE RE SEEties. The main outcome of this project was a methodological toolkit and criteria for assessment aimed to support municipalities in creating a sustainable and resource efficient future through coherent and appropriate planning practices
- MARKAL-EFOM System. A model generator, based on long term energy scenario analyses, was used to build up energy-technology models at different spatial scales (Pan-EU, National, Local scale) to build up to conduct in-depth energy and environmental analyses, assess policy measures and define energy-technology roadmaps.

Regarding the major issues encountered while developing this type of tools:

- One of the main problems was in the customization of the tools to local characteristics, it was a problem related to the involvement of the personnel of Public Local Authorities for data mining, training and testing. However, the possibility of utilising basic input data and the involvement of other parties like regional agencies that provided some of the data required allowed to partly overcome the difficulties.
- Regarding data availability, when developing the Policy Support System for the PrioritEE project, most of the partners did not have energy certificates of their buildings, they contain basic inputs for the tool. They had to be estimated by partners or building codes regulations.

- They also declared that struggled creating default elements (e.g. building typology), they had to create different default elements for each country that the tool covered based on empiric data gathered by the project partners.
- Some users also encountered problems trying to gather all the comprehensive data required for the tool, they find the data required sometimes too technical and too extensive. It is important to find a balance with the detail level of the set of data that had to be gathered.

When asked about what could be improved in these tools the answers were:

- There should be the possibility to better organize the data collection in order to simplify the usability, so it does not appear too technical for the average user. They would focus more on the tutorials, not just the content but also the format, adding some video tutorials.
- The also remarked that it is important to better define which assumptions to make if the users do not have data available, informing which predefined data will be used (automatically selected by the tool or selected by the user) and the implications this limitation will have on the results.

Interviews with potential users:

Potential users were asked to rate their interest on a list of 10 topics related to energy efficiency in a scale from 1 to 5 (1 representing the minimum level of interest and 5 the maximum).

Table 2 Level of interest declared by potential users on topics related to energy efficiency.

Topics	AMB	DIBA
Which sectors provide more return for EE action?	4	1
Which policies should be applied to tertiary sector and retails?	2	2
Which policies should be applied to housing?	5	2
Which neighbourhoods are more suitable for housing renovation?	5	2
Which policies should be applied to public equipment?	5	5
Which are the benefits of active mobility?	2	5
What is the impact of promoting circular economy initiatives in industrial areas?	1	3
What likely impacts of vehicle electrification?	5	2

Topics	AMB	DIBA
What is the impact of increasing EE of public lightning?	5	5
What impacts derived from district heating policies?	4	3

The topics declared as more interesting were the "policies that should be applied to public equipment" and the "impacts of increasing energy efficiency in public lighting". Active mobility it is also a topic of interest, the AMB pointed out that even though his department do not address active mobility directly, other departments in the AMB may be interested in quantifying the benefits of this area. The topics of lesser interest were policies to be applied to tertiary sector and retail, and the promotion of circular economy in industrial areas.

Potential users were asked which kind of plans, studies and tasks are they usually involved with in their day-to-day work and the tools they use to assist them:

- AMB has a departments in in charge of public equipment and lighting projects, waste treatment and transport projects, quantification of impacts of energy efficiency on these areas would be useful. They have their own tool (xls based) for the analysis of the most suitable neighbourhoods to implement energy efficiency measures. They mentioned that a more user-friendly tool (web based tool) would be really useful, also a specialized features to prioritize the actions to be carried out, it is important that this tool takes into account the subsidies given by the administration.
- More specifically, AMB is working in "Roof plans", they select public facilities with the greatest potential for photovoltaic power generation in order to identify were to allocate funds more efficiently.
- Municipal Energy Efficiency Optimization Plan (Known as POEM in Catalonia), the project covers the planning of energy saving measures of municipalities, control audits, and monitoring of the plan after its implementation. AMB have developed a tool for monitoring the measures of the POEMs, each measure has its associated impacts in energy and monetary units.
- AMB is also involved in "electric charging stations" planning projects, they are currently working on planning projects of charging stations with photovoltaic installations integrated.
- DIBA have worked in many Sustainable Energy and Climate Action Plan (SECAP), specifically in local and regional (group of municipalities) adaptation plans. To elaborate this plans, they have developed their own tool in an excel format. They are currently updating the tool so that it will be powered by an external database to be more operational, the Excel already contained too much data. The new system will automate

the collection and processing of the required data. The tool includes mitigation data and is trying to include adaptation data to have more information on vulnerability issues.

- They also work on European projects related to issues of adaptation to climate change, looking for nature-based solutions such as cleaning forests with grazing and promoting green spaces to promote water retention.
- They also ¡also carried out mobility projects such as the Business Displacement Plans (known in Spain as PDE). In this projects they evaluate the demand for mobility of workers and the mobility offer available to give recommendations where the use of Public Transport, active mobility (bicycles and on foot) and shared use of private vehicles are promoted.

Both AMB and DIBA generally work in short and medium-term timeframes. For instance, AMB annual targets in energy efficiency are set to achieve a 50% reduction in energy consumption by 2030. DIBA, for SECAPs have a horizon of 2030, mobility projects have a horizon of 5 years and for few European projects usually have a long-term vision.

2.2.2 Conclusions

- **Data availability for testing**. To test the tool in different regions/countries data must be available for all the testing regions. In the PrioritEE Toolbox development process, most of the partners involved did not have key data (energy certificates of their buildings), containing basic inputs for the tool. They had to be estimated by partners or building codes regulations.
- **Lack of data depending on the country.** The applicability of the tool will depend in a great measure on the data availability. It is important to note that the data that is may vary depending on the country/region/area to be analysed. Even when covering a specific area, different countries may collect different type of data and indicators. It is important to consider this fact when defining the data that will be required from potential users to use the tool.
- **Data requirements and accuracy balance**. It is quite important to find a balance between the required data by the tool and the accuracy of the results. Data requirements and results accuracy are in some level correlated, if a model is well defined and you have reliable data,
- **Inconsistency in data through time**. Tool often use data that often come or are made from databases that do not always have continuity, the information collected periodically may change, the data collected is less exhaustive or it can be different. So the defined indicators can no longer be calculated with the methodology established,

making the indicator system obsolete or requiring more resources to update the methodology to redefine the model with the new set of data.

2.3 Expert consultations

As part of the scoping analysis, the project team conducted an expert consultation through an online survey among stakeholders, based on pre-defined lists of contacts, suggested by the project's partners.

The survey was conducted in the period between 18th of May and 7th of June among 311 stakeholders, some 80 of them answered the questionnaire.

The goals of this consultation were twofold: the first was focused on general development work of REFEREE project, the second to source various stakeholders' opinion regarding the development of a policy support tool that meets the real needs of its potential users.

The analysis of the outcome of the first part is developed in detail in the Deliverable "D2.3 Scoping analysis", while the second one, addressing the issues relevant for the system's design development, is laid out in chapter 3 of this report.

2.3.1 Results[1]

Organization scope. Regarding the primary scope of work of the respondents' organizations, respondents working at international/European level represent 50% of the cases, followed by those working at regional and national level (30 % each).

Work topics. The work of the majority of respondents is mainly focused on energy efficiency (75%), followed by general energy and climate policies (54%), environment (42%), and local or regional governance (27%). Public health (5%) and business sector development (6%) are the topics chosen least by respondents as their main focus area.

Policy making involvement. The majority of respondents are usually more involved in the policy design and planning phase (73%) of the policymaking process. Just over half of them (53%) acknowledge the implementation phase as the one where they are more involved, while only 40% are involved in the monitoring and reporting stage. Considering the type of organisation, the respondents from the public sector prevail among the group of stakeholders, dealing mostly with policy design and planning.

[1] As both the scoping analysis and that carried out to set up the REFEREE system design make use of the same source of information (the expert survey) part of these of results are commented in both the deliverables D2.3 and D2.4, even if with different purpose.

This could mean, that the needs of the majority of the policymakers on all levels of governance from software support tools are focused on the design phase and much less on monitoring implementation and even lesser – on assessing progress and reporting.

Topics of interest to respondents. As the topics of specific interest to their work, the most selected topics were "impacts of energy efficiency in housing" (58%), followed by "impacts of energy efficiency in public buildings" (48%), and "impacts of energy efficiency in industry" (35%). The least selected topics were "prioritization of housing renovations in neighbourhoods" (6%), and "impacts of electric micro-grids in industrial districts" and "impacts of energy efficiency in public lighting" (9% each).

Out of the group of respondents, who deals with "Impacts of energy efficiency in housing", the biggest sub-groups work with a focus on "general energy and climate policies" (34.2%) and "energy efficiency and savings" (50.6%).

Non-energy Impacts that need to be quantified. The most important impacts that need to be quantified for assessing energy efficiency investments are the "cost of energy resources for end-users" (69%) and "air pollutant emissions / air quality" (60%). The third most popular choice was "material consumption, including reuse of materials and circle economy" (41%). On the other hand, only 6% identified healthcare costs as one of their three most important impacts. Among the respondents, who chose "cost of energy resources for end-users" as an important, the prevailing groups is from public sector (37.1%%), business associations (12.9%) and business enterprises (4.8%).

Software support tools experience/interest. The usage of software support tools is quite high among the respondents – 40% of them either use and/or develop such tools and 81% of them perceive them to be moderately or highly relevant to their work' needs, while only 3.4% think they are non-relevant. From the ones that have never used or developed such tools (60%), most of them (83%) are interested to find out more about such tools. These results show that there is a huge room for improvements, in order to make future policy support tools more relevant to the every-day working needs of the stakeholders.

Areas already covered by software support tools. The most covered areas of work by the software tools (used by the respondents), include "energy and climate" (31.5%), "air quality, air pollutants and emissions" (15%) and "energy and urban infrastructure" (9%). Note that the former and the latter represent more general areas, the rest of them remain uncovered by the used tools. This may be due to the prevalence of general policies in respondents' work or the lack of specialised tools for more specific policies.

Other areas to be covered. Respondents were asked to propose features that would be of use to them in their tools (see next figure). Clustering the answers to broader categories revealed that the most requested feature was the provision of data and analysis on different level of aggregation (e.g. territorial, municipality, national), and an availability for regular update of this data (incl. in real time). General technical characteristics of the tools (e.g. interoperability,

customization and user friendliness) have been ranked on the second place by the numbers of answers.

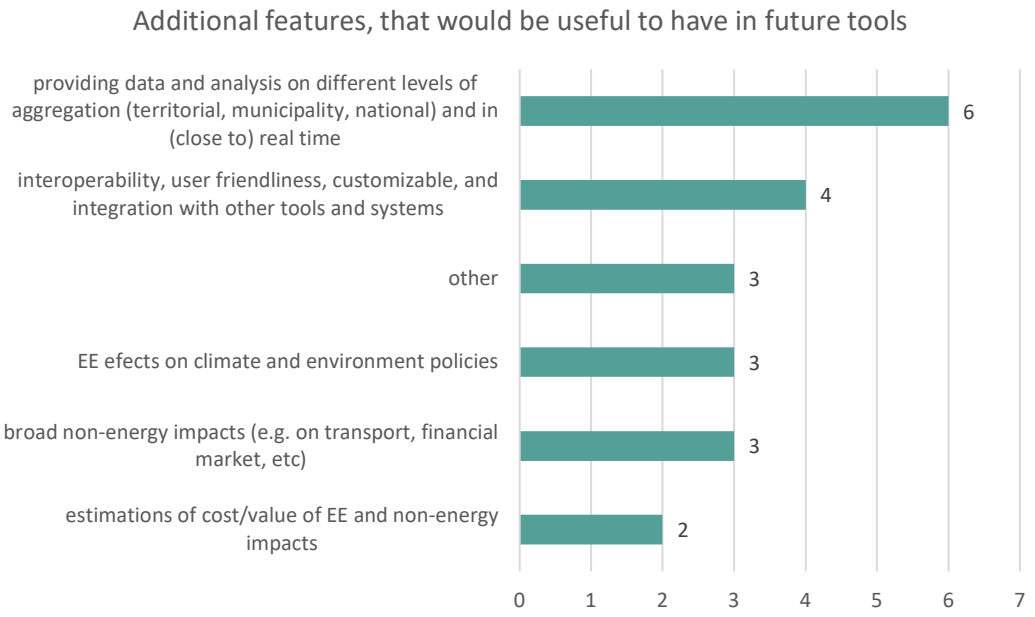


Figure 6 Requested additional features. Source: Own elaboration.

Tailored tool desired. Respondents were asked about which phase and which sectors the tool should cover, and also the complexity level it should have:

- Regarding the phase, two-thirds (67%) of the respondents claimed they would use a tool that addresses the design and planning step primarily. One third (17%) "implementation" and the other third "monitoring, verification, and reporting systems".
- Regarding the sectors, nearly 20% said they would use a software tool covering the "energy and climate activity sector". This is the highest share of respondents but also the most general and wide area. Almost a 15% chose the "air quality, air pollutants, and emissions sector", while 13,5% opted for "energy and urban infrastructure". The least popular activities were "economic, business or industrial development" and "employment policies" (4% each).
- Regarding the complexity, more than half of them (54%) would prefer a software tool with medium-level functionalities delivering more defined outcomes. Nearly 30% would choose one with basic functionalities with simple outcomes. The remaining 17% would prefer a software tool with highly user-customizable outcomes.

Integration and spatialisation level. Respondents were asked about the level of integration of a specialized software tool that would be most useful to them (1- fully disaggregated, 5- fully integrated[2]) and the spatialisation level (1- fully spatialised, 5- fully analytical[3]).

- Regarding the integration level, 25% have opted for Level 4, which indicates a fairly high level of integration. 23% have chosen Level 5 (the highest level of integration) and Level 3 each. Only 16% prefer a Level 1 (disaggregated) tool.
- Regarding the spatialisation level, 27% have shown their preferences for a Level 1 (Spatial Planning) tool, while a similar number of respondents have selected Level 5 (21%), Level 4 (20%), and Level 3 (19%), respectively. A Level 2-type tool has been chosen by 13%.

2.3.2 Conclusions

- More than 70% of the respondents declared that are usually more involved in the "policy design and planning phase", more than half of them (52%) in the "implementation phase" and a significant part (40%) the "monitoring and reporting phase". To ensure the usability for a wider group of users, the Policy support-system should be focused on addressing problems and tasks related the planning phase but without forgetting functionalities and features to address the other ones.
- Most of the respondents declared to be interested in policy-support systems, 40% of them are already involved in developing and/or using such tools, and from the ones that have never used or developed such tools (60%), more than 80% are interested to find out more about them. These results indicate that there is room for improvements, in order to make future policy support tools more relevant to the every-day working needs of the stakeholders that have not used such tool yet but are eager to learn about them.
- When respondents were asked about their ideal preferences, nearly 20% of the respondents declared they would use a policy-support tool covering the "energy and climate activity sector". This is the highest share of respondents but also the most general and wide area. In more concrete sectors, almost a 15% chose the "air quality, air pollutants, and emissions sector", while 13,5% opted for "energy and urban infrastructure". On the other hand, the least popular activities were "economic, business or industrial development" and "employment policies" (4% each).

[2] 1 = Disaggregated: Closer to a calculator, database or benchmarks of individual buildings, services, facilities; 5 = Integrated: Holistic, integrating many sectors, services and facilities together

[3] 1 = Spatial planning: Based on maps and impact assessment for different locations and territories; 5 = Analytical: Based on few aggregated indicators and analytical graphs

- When asked about the complexity for their ideal tool, more than half of them (54%) would prefer a software tool with medium-level functionalities delivering more defined outcomes. Nearly 30% would choose one with basic functionalities with simple outcomes. The remaining 17% would prefer a software tool with highly user-customizable outcomes. It will be important to find a balance between the complexity and the extent of the data required and the accuracy of the results that the system will provide.

2.4 PrioriteEE Plus Workshop

PrioritEE PLUS is a project that aims to capitalize on the experience of the previous PrioritEE project and improve, through transnational cooperation, the capacities of public authorities in the energy management of Public Buildings and local sustainable energy planning.

REFEREE was invited to attend the launching meeting of the project organized by the Institute of Methodologies for Environmental Analysis of the National Research Council of Italy (CNR-IMAA) and its five project partners (NOVA University of Lisbon and the University of Zaragoza, National Laboratory of Energy and Geology - LNEG, Federacion Aragonesa De Municipios Comarcas y Provincias - FAMCP, Municipality of Narni).

Figure 7. PrioritEE plus launch conference and kick-off meeting. Source: PrioritEE Plus website (PrioritEE, 2021).

REFEREE members along with other participants currently working on Energy Efficiency projects could share their experiences and make brief presentations about the ongoing work.

During an interactive session, participants were asked to respond an online survey.

According to the results shown, the main “Main opportunities arising from the use of decision support tools” are “Comparison and prioritisation of different options according to different indicators and scenarios”, “Training and awareness implementation of measures aimed at increasing knowledge and engagement among technicians and stakeholders” and “Definition of realistic targets for achieving EE and Renovable Energy Sources legislative objective”.

The Main socio-economic advantages deriving from energy improvements of infrastructures are “Training and awareness: increasing the knowledge of energy-environmental issues among the stakeholders” and “Support for an integrated political vision for the territory (socio-economic development, educational models, and productive settlements)”.

The tools they find particularly useful to support decision making are “Easy to use software” and “Key performance indicators”.

3 System's design orientation

3.1 Introduction

The system's design orientation has been based on the results and literature gathered from the assessment of the best practices to be used to propose the REFEREE policy support system's design (deliverable D2.1) and the evaluation of the identified practices against the REFEREE stakeholders' needs as outlined in the previous paragraphs.

It has been carried out in 2 parts,

1) A more analytical part where we gathered good practices of policy support systems and analysed features of cost-benefit assessment and Multicriteria policy-assessments, from which we were able to draw our first impressions on what may be of interest to users.
2) A contrast part we could contrast those impressions with key stakeholders (potential users) through the PAG workshop, interviews and surveys.

3.2 Identification of windows of opportunity based on analysis of literature

The REFEREE Policy Support Tool will be developed basing on existing tools and the suggestions or the expectations of possible users. In order to do so we have identified good practices of user-friendly policy-support systems at all scales, this will contribute to get more clarity on the definition of user-needs, taking stock of how these have been assessed in already existing systems.

More than 40 tools/systems were reviewed and documented, the factsheets illustrating each of them is fully available in the Deliverable "D2.1 Taking stock from the existing state of art". The tools are sorted by activity sector (cross-sectorial, energy, mobility, pollutant emissions, industry, and others) and spatial domain (national to local). The sheets provide a quick view on the functionality of each example, it contains information about the sectorial and spatial domain, input and outputs, and an infographic section. The following figure shows the different revised tools classified by spatial domain and activity sector.

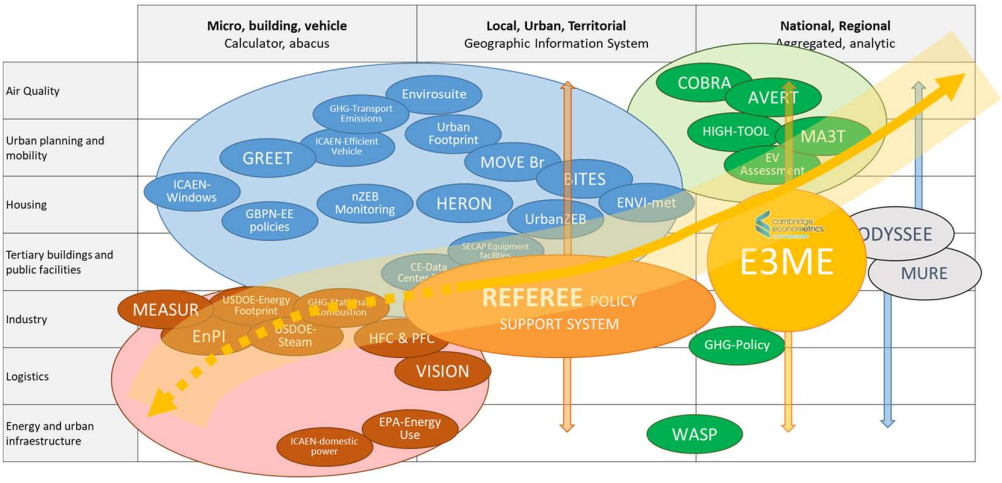


Figure 8 PSS classification according to spatial and sector domain.

Tools interlinked in blue tend to represent tools linked to citizens, so housing, tertiary buildings and public facilities. They can be much disaggregated (plain calculators, on the left side of the chart) or more aggregated e.g. at city level in the centre of the figure (middle column).

On the other hand, tools in red/brown tend to be linked more to the industrial and logistics sectors, or the urban infrastructure services, like wastewater treatment, or water pumping. It is interesting to note that there is a gap in this more "industrial" dimensions, as most tools tend to address single individual facilities but not integrated industrial districts.

We see opportunities in this gap, as this seems an unexplored area especially for what concerns the circular economy approach. It thus seems that there is the need of tools targeting integrated and spatialised systems for analyses of conventional industrial districts with mixed pools of companies like logistics, manufacturing, large retail, etc. There are thousands of such districts across Europe, with very little planning initiatives currently, at least at the energy efficiency level. It could be then interesting to create a module targeting this gap, it could provide users already using tools linked to these sectors with a more integrated tool with spatial features and also attract users that were missing this new functionality.

3.3 Identification of user-needs

- From the PAG workshop we could identify that PAG members show interest in emerging and innovative topics such as “vehicle electrification” and “circular economy initiatives”, and in the more strategic components to support policy making like “identification of sectors that provide more return (economic and social) for energy efficiency action”.

- As expected, stakeholder interest is also focused on structural areas of the urban energy efficiency management, like “identification of policies to be applied to tertiary sector and retails” and “benefits of active mobility”. Topics indicated to a lower extent are those including more specialised topics, either sectorial or geographical, with stronger challenges for their generalisation: “promotion of energy cooperatives”, “district heating policies” and the “increase of energy efficiency of public lighting”.

	Group 1	Group 2	Group 3	TOTAL	
Which sectors provide more return for EE action?	4	0	6	10	strategic
Which policies should be applied to tertiary sector and retails?	3	2	1	6	tertirary
What likely impacts of vehicle electrification?	1	4	4	9	Emerging topic
Does housing renovation support a business model in my territory?	2	2	0	4	housing
What impacts derived from district heating policies?	0	0	0	0	
Which neighbourhoods are more suitable for housing renovation?	2	0	1	3	
What is the impact of increasing EE of public lightning?	0	1	0	1	
What is the impact of promoting circular economy initiatives?	3	3	5	11	Emerging topic
What prioritisation of investments if renovating a public equipment?	1	1	2	4	equipment
What is the impact of promoting Energy Cooperatives?	0	0	0	0	
What is the impact of facilitating solar energy in industrial districts?	0	1	1	2	industrial
Which are the benefits of active mobility?	1	4	0	5	mobility
What impacts of municipal public biomass heating?	2	0	0	2	
Impacts on vulnerable groups*	5	0	0	5	

Figure 9 Topic relevance activity overall results.

- From the expert consultation, in a similar way, nearly 20% of the respondents declared they would use a policy-support tool covering the “energy and climate activity sector”, a more strategic sector covering several areas. In contrast, when selecting more specialised sectors, almost a 15% chose the “air quality, air pollutants, and emissions sector”, while 13,5% opted for “energy and urban infrastructure”.

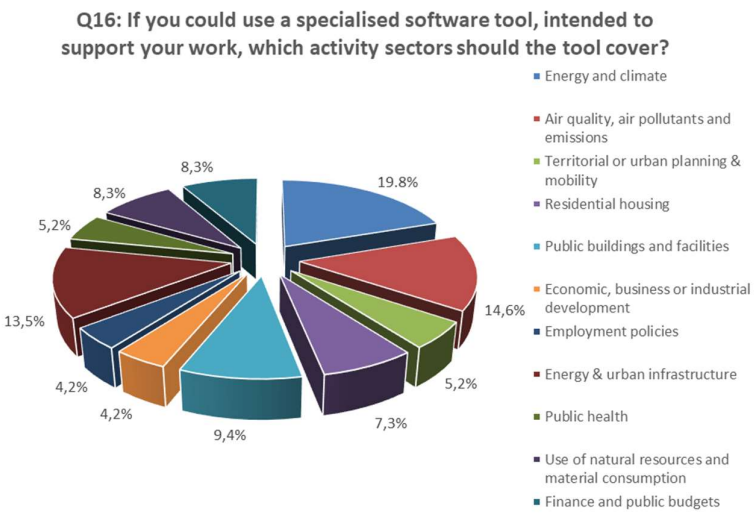


Figure 10 Sectors that a policy support too should cover.

- There is not a clear preference regarding the type of tool that is preferred by the PAG group. From the type of tool exercise, the results were quite heterogeneous. From the 4 typologies defined, only the Analytical-Integrated type of tools referring to "tools for aggregated strategic energy policy impact assessment" was not preferred by any group but at the same time was the only type that was voted for all the groups.

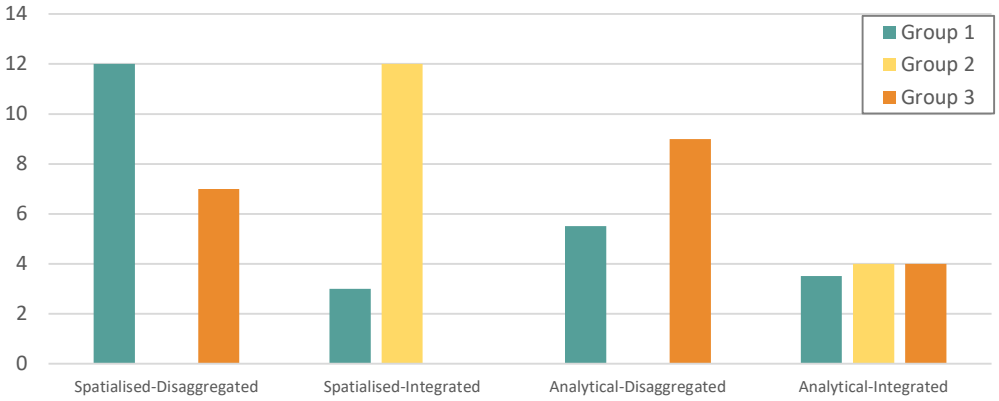


Figure 11 System typology desired by the PAG groups.

- Following a similar patron, from the expert consultations (survey to 80 experts), there was also no consensus in the aggregation level (integrated or disaggregated) or spatialisation level (analytical or spatialised) that the tool should have. This may indicate that there is a user group target for each of the 4 typologies defined. This aspect should

be addressed again with potential users once the first prototypes of the tools are ready. A functional tool will give users a better understanding of the pros and cons of the different typologies.

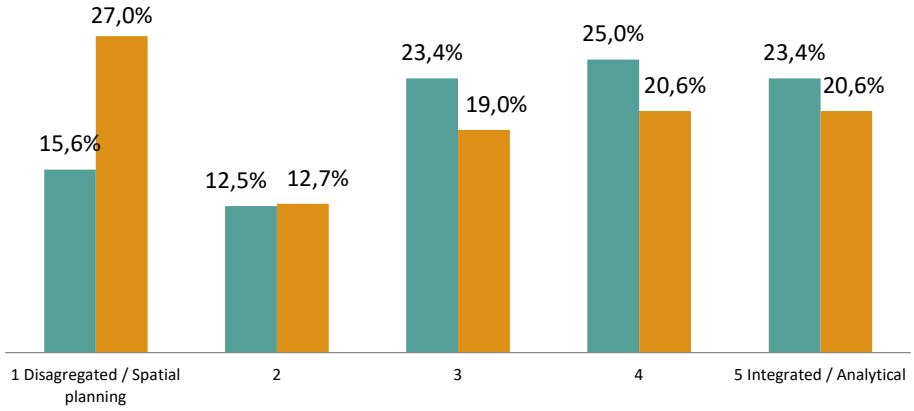


Figure 12 System typology desired by the expert consultation (survey).

- **Data availability for testing**. To test the tool in different regions/countries data must be available for all the testing regions. In the PrioritEE Toolbox development process, most of the partners involved did not have key data (energy certificates of their buildings), containing basic inputs for the tool. They had to be estimated by partners or building codes regulations.
- **Lack of data depending on the country.** The applicability of the tool will depend in a great measure on the data availability. It is important to note that the data that is may vary depending on the country/region/area to be analysed. Even when covering a specific area, different countries may collect different type of data and indicators. It is important to consider this fact when defining the data that will be required from potential users to use the tool.
- **Data requirements and accuracy balance**. It is quite important to find a balance between the required data by the tool and the accuracy of the results. Data requirements and results accuracy are in some level correlated, if a model is well defined and you have reliable data,
- **Inconsistency in data through time**. Tool often use data that often come or are made from databases that do not always have continuity, the information collected periodically may change, the data collected is less exhaustive or it can be different. So the defined indicators can no longer be calculated with the methodology established, making the indicator system obsolete or requiring more resources to update the methodology to redefine the model with the new set of data.

3.4 Modular approach

The tool will be designed separating the functionality of the system into independent, interchangeable modules, such that each contains everything necessary to executed by themselves, only running selected aspects of the desired functionality.

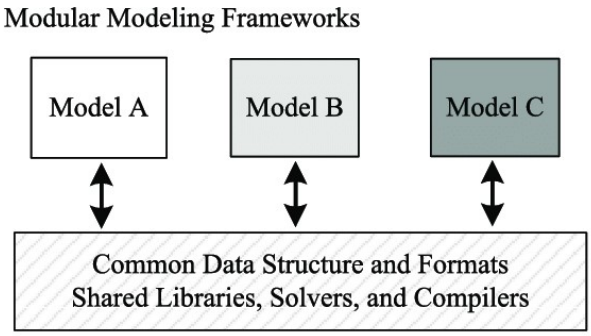


Figure 13 contrasting the more common modular approach for structuring model codes with a component-based approach.

The system might be then composed by several modules that can operate individually to analyse single problems at the level of specific sectors or facilities, but also in combination to handle more complex scenarios involving several sectors or facilities, addressing thus many of the needs of different kind of potential users in the private or the public sector:

- **Strategic pre-assessments**. For different sectors (e.g. residential, tertiary, mobility…) this strategic pre-assessment module will allow performing quick sensitivity analyses to seek possible energy efficiency improvement combinations from these sectors aiming at achieving desired target improvements for key impact variables (e.g. GHG, premature deaths from low air quality levels…).
- **Calculator modules**. Individual calculators for different sectors or facilities performing its analyses at a micro level (facilities, buildings, vehicles…). These analyses at calculator level can help in identifying impacts of single policies or assisting the management of particular buildings or facilities.
- **Aggregation module**. Modules will be combined to aggregate the impacts in the calculator modules, either spatially (neighbourhood, regions, city…) supported by a geographic information system to support and inform processes of allocation of policies or investments in the territory, or simply analytically for more strategic and aggregated analyses. These analyses will help identify critical sectors of opportunity.

- **Assessment module**. This module will process results and return then in a meaningful way contrasted to main policy documents and targets currently existing (e.g. European taxonomy. European Green Deal, 2011 Energy Efficiency and Resource Efficiency policy packages). It could be able to extrapolate and aggregate the results for the spatial domain analysed, these analyses will allow to identify territorial hotspots for policy measures.

3.5 Interaction with E3ME

The E3ME model is an econometric model used for policy assessment, forecasting and research purposes, it will provide an integrated method to assess the co-benefits of energy efficiency.

A set of indicators will be produced to capture the full range of energy efficiency benefits and their impacts on four macro impact-areas, these indicators still are to be determined:

- Industrial productivity: changes in competitiveness, product quality and market value
- Socio-economic development: changes in GDP, net new jobs, energy prices
- Environment & climate: changes in GHG and air pollutant emissions, material consumption
- Health & well-being: changes in mortality and morbidity, healthcare costs

The REFEREE Policy-support system will include a simplified version of E3ME (E3ME lite), that will allow to:

- The system will provide an interface to cover of E3ME Lite simulations, based on pre-calculated scenarios.
- Evaluate the impacts of different energy efficiency in policy scenarios designed by users.
- Calculate of short- to medium-term forecasts for each defined scenario.

3.6 Assessment approaches

Results will be provided in a policy relevant and policy meaningful way, in order to maximise the added value for decision makers, policy analysts, and energy efficiency operators. In this sense three orientations are proposed:

1) Results contrasted to environmental and health target in-force, and wider socioeconomic targets

2) Differentiated impacts for different kind of stakeholders (cost and benefits): impacts for general citizens, local residents, public administrations, business entrepreneurs...
3) Differentiated impact for different territories (neighbourhoods, municipalities, regions) to support territorial impact assessment discussions (e.g. identify territorial hotspots for policy measures).

3.6.1 Results contextualised with existing policy targets

The tool will consider the following main European Commission targets outlined in the "2030 climate and energy framework" to provide meaningful trends over time:

- At least 40% cuts in greenhouse gas emissions (from 1990 levels)
- At least 32% share for renewable energy
- At least 32.5% improvement in energy efficiency.

A detailed recollection of this and former Environmental policy packages 2011-2021 is available in Annex 3.

Once the impact forecasts are obtained, the tool will put these results in perspective with the European targets in a graph format where the impact forecast for different scenarios, and the European targets set in different periods, can be visualised.

These analyses will help users that are not familiar with the magnitudes on different impacts to have a reference from which they will be able to determine if the impacts of the measure or group of measures can be considered a success or need to be improved.

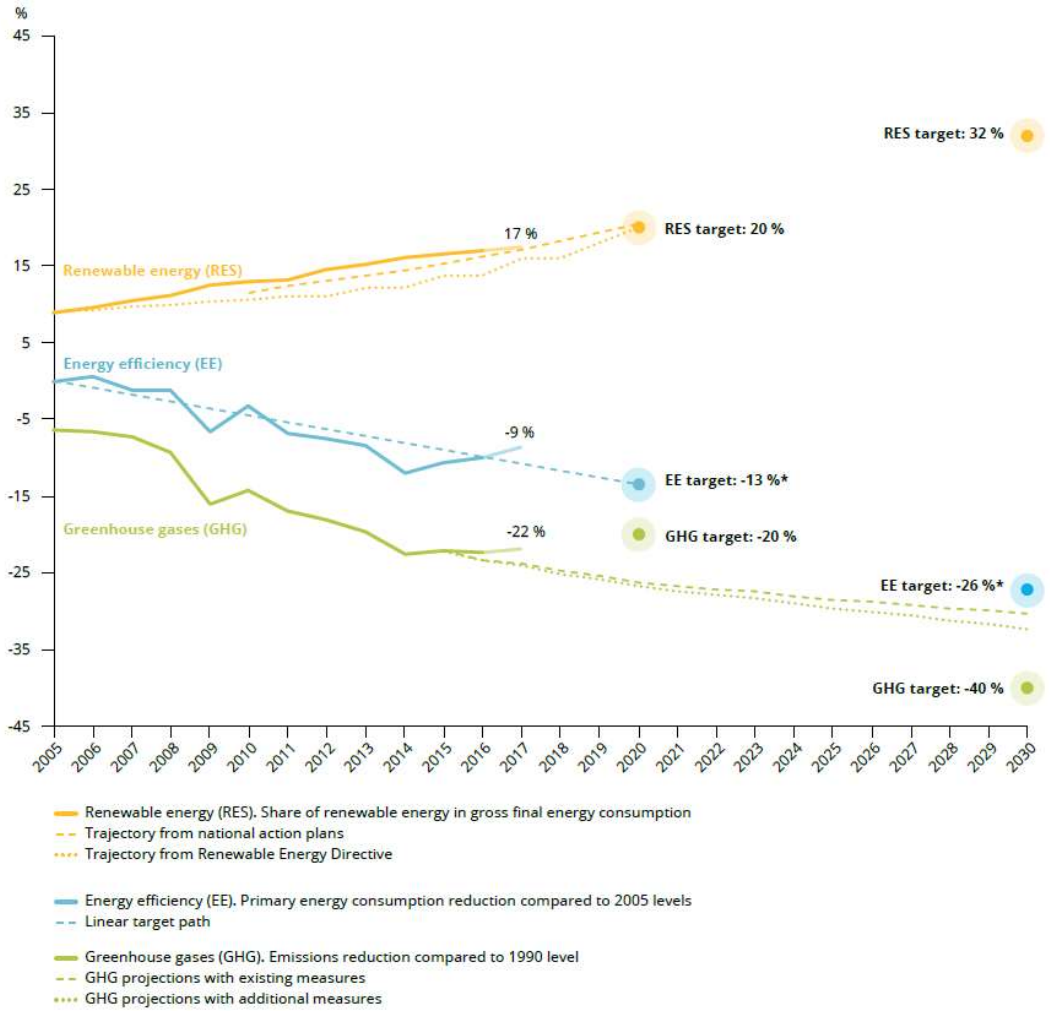


Figure 14 EU progress towards 2020 and 2030 targets on climate and energy. Source: Trends and projections in Europe 2018, EEA (2018).

These kind of analyses could also be carried out at a local level, considering local targets like the those available in SECAPs. The following figure shows an example of a forecast on GHG emissions compared to the 2009 and 2016 SECAP targets.

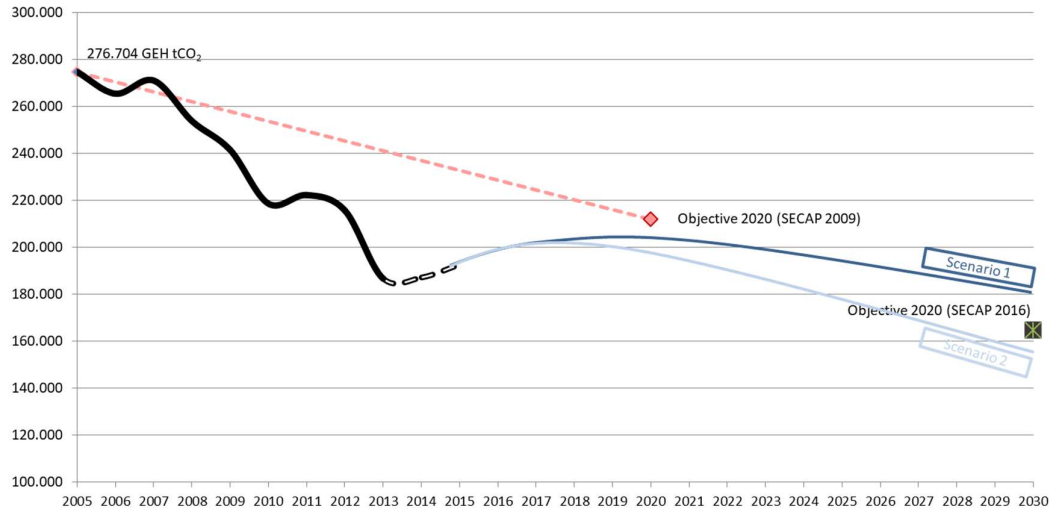


Figure 15 Forecast on GHG emissions for different scenarios compared to the 2009 and 2016 SECAP targets.

3.6.2 Stakeholder matrix

Another outcome of the Policy Support System will be a stakeholder matrix linking the different impacts with key stakeholders. The implementation of a stakeholder matrix will allow to complement the impact assessment with socio-economic analyses.

In order to aggregate the different impacts considered by the tool in this matrix, the tool will convert the different impacts into a reference monetary, unit. The SE matrix provides thus an indication of the economic and financial implications for the different involved stakeholders and the relative weight assumed by the various elements considered in the cost and benefit impact analysis. These analyses can help identifying key stakeholders that are both strongly affected by the measures proposed, and the ones that are affected the less.

An example concerning this feature is provided by the Stakeholder/Effects Matrix proposed by the RAILPAG appraisal method developed by Mateu Turró at the European Investment Bank (EIB, 2014) as a relevant reference for presenting financial and socioeconomic appraisal in an integrated and consistent manner (see Figure 16).

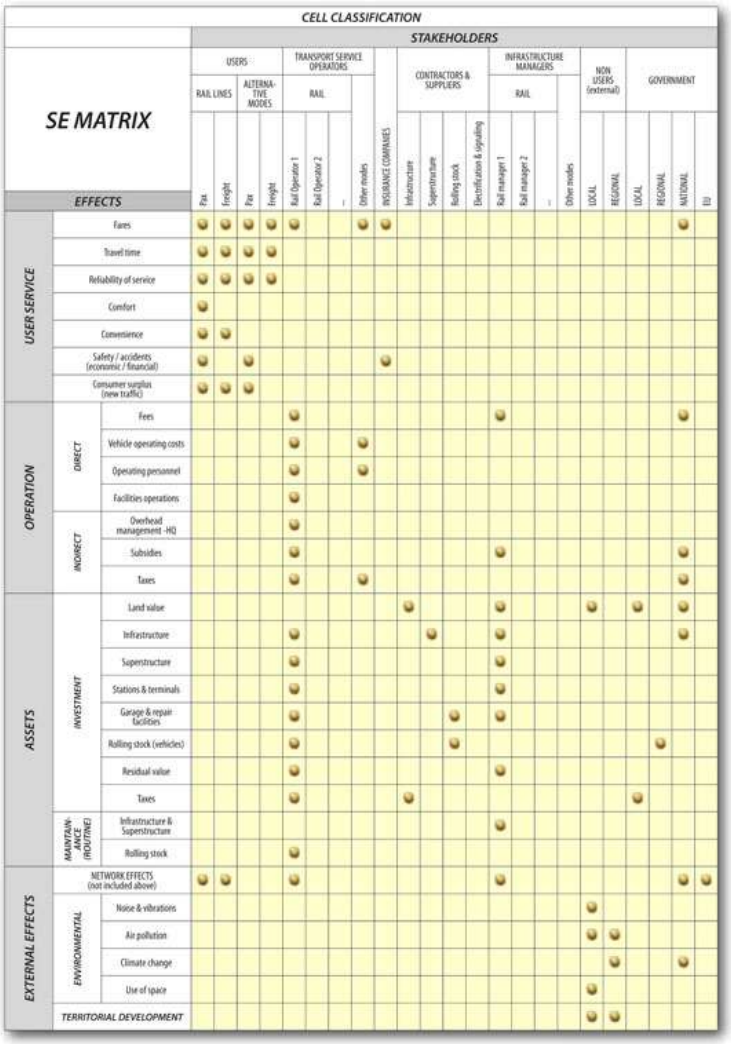


Figure 16. Stakeholders-Effects matrix proposed by RAILPAG. Source: Rail Project Appraisal Guidelines (European Commission; EIB, 2005)

3.6.3 Territorial impact assessment

The implementation of Territorial Impact Assessment (TIA) features in the tool will help understand the territorial impacts of policy proposals and/or specific measures.

Firstly, a list of all different actions/measures and policies to be implemeted will be elaborated addressing the energy efficiency targets of the area to be analysed (city, region, country…).

Then, for each action and policy, the tool will associate the impact of the action on each territorial element at the most disaggregated level possible (census, neighbourhood, municipality…). Those impacts will be defined by the E3ME Lite model at a more aggregated level, the same model will disaggregate the impacts when possible.

Finally, the results will be represented in different maps and a visual tool to visualize the impacts territorially disaggregated of the action and/or policies selected over the region analysed.

Following an example on how the maps and tool could look:

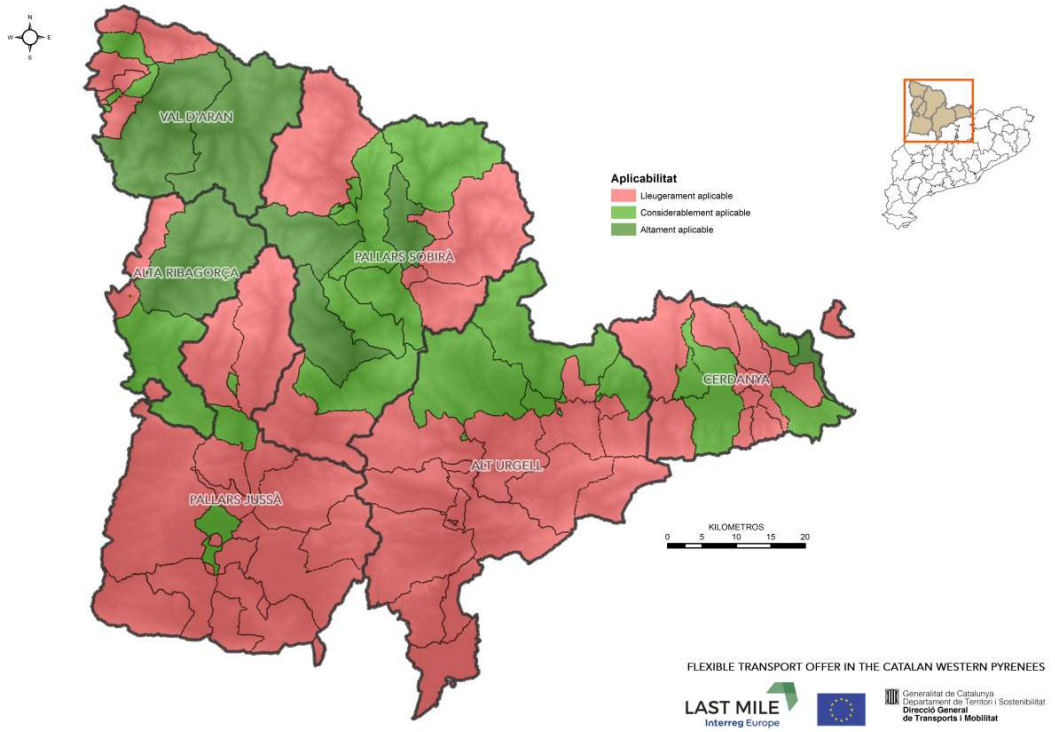


Figure 17 Aggregated feasibility map for action "Implementation of bike carriers in public buses". Source: LAST MILE – Sustainable mobility for the last mile in tourism regions, MCRIT for the Catalonian Government (2018).

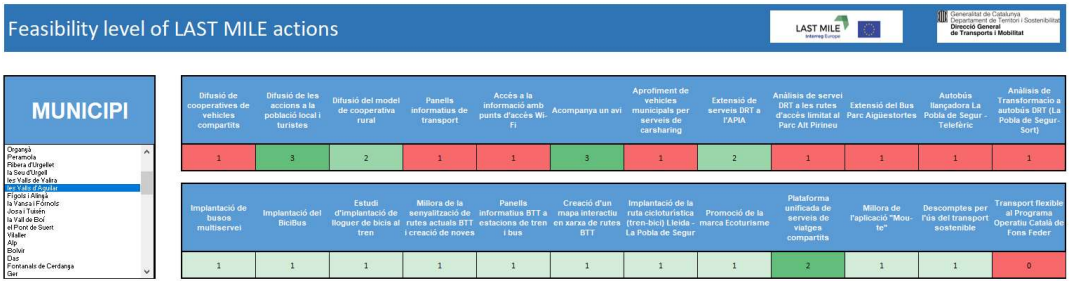


Figure 18 Feasibility level of the LAST MILE actions for the Les Valls d'Aguilar municipality. Source: LAST MILE – Sustainable mobility for the last mile in tourism regions, MCRIT for the Catalonian Government (2018).

Annex 1. PAG workshop activities

Activity 1. Relevant topics

Based on the below image, participants were asked to add any missing topic, and then to select three critical topics and to rate them in relation to their relevance for being considered in the Policy Support system.

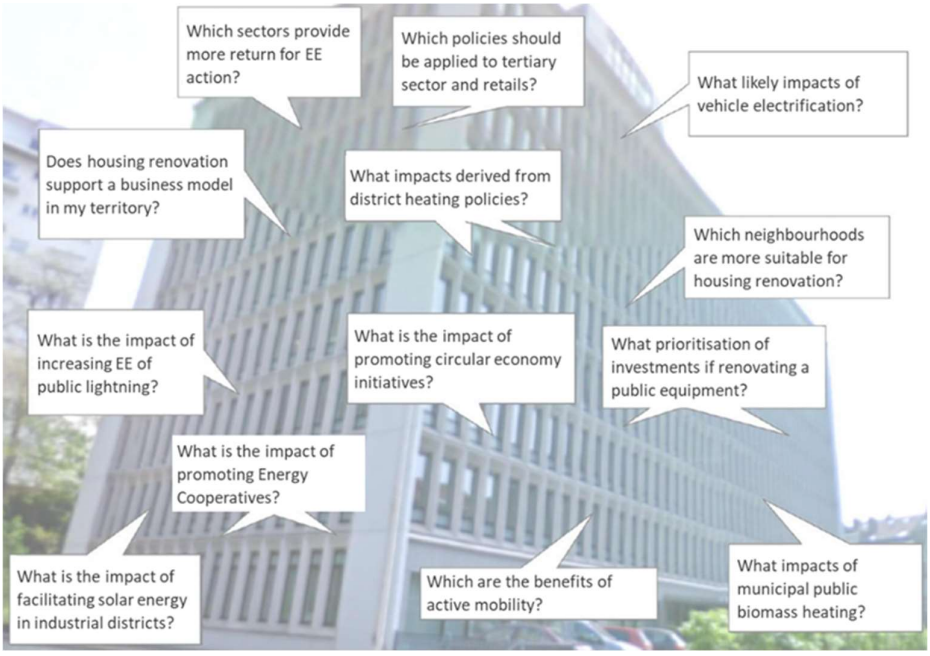


Figure 19 Potential topics to be addressed by the Policy Support System.

Activity 2. System typology

Participants were asked how they would imagine REFREE policy-support tool:

- Spatialised-Disaggregated: a tool box made out of simple tools to asses non-energy benefits for different kinds of buildings, facilities and services?
- Spatialised-Integrated: a spatialised tool for urban energy management to support energy efficiency plans?
- Analytical-Disaggregated: knowledge and data integration tool for policy making support?
- Analytical-Integrated-: An analytical tool for aggregated strategic energy policy impact assessment?

They rated their two best preference by putting stickers on the below graph (choosing along Spatialised / analytical, disaggregated / integrated dimensions).

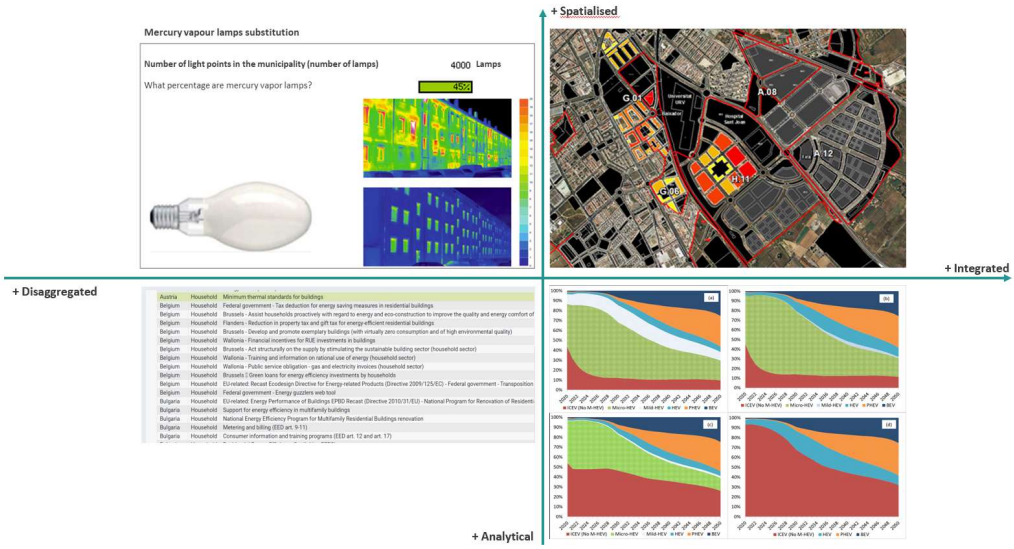


Figure 20 System typology diagram (Integrated-Disaggregated & Spatialised-Analytical).

Annex 2. Interviews

Interview to Marko Čavar, developer of the PrioritEE Toolbox and Project Manager at North West Croatia Regional Energy Agency (REGEA).

1. What projects related to decision support tools (or similar) have you been involved with? Could you briefly describe the tool/s?
   - Besides PrioritEE DST, as a Public Energy Agency (REGEA) we have developed different tools for building management and energy efficiency. The tools aim to identify "worthy" energy efficiency measures and renewable energy integration.
   - We have developed the Living EPC Tool, based on similar inputs as in the PrioritEE DST and national building codes that apply to the building, the Living EPC Tool analyses data from collected energy performance certificates and provides combinations of cost-optimal measures for reaching nZEB requirements in public buildings.

http://dst.thorium.software/

https://nzeb.thorium.software/

2. How did you establish the contents and organization of the toolbox (database, DST, guides & repository of good practices)? Did you perform any kind of requirement analysis for the toolbox or the DST module?
   - Each feature was developed by different partners, defined by the project. REGEA collaborated with Nova University Lisbon to develop the PrioritEE DST.
   - Based on the technical capabilities of the tool to measure technical and financial aspects we organized several workshops with public authorities where they had the possibility to use the tool adding their own public building and selecting which measures they would prioritize depending on the cost investment, payback time and/or highest energy saving. After the workshops they were asked to answer surveys about the aspects they found useful and the reasons.

3. Which were the major problems you encountered while developing the tool?
   - We started with Excel but it was kind of hard to share it with partners so we decided to change to a Web based tool.
   - One of the main problems was the inclusion of some technologies in the technical aspects of the web-based tool, the switch to a web-based tool was decided halfway in the project and we did not have the proper time to implement it properly.

- Regarding data availability, most of the partners did not have energy certificates of their buildings, containing basic inputs for the tool. They had to be estimated by partners or building codes regulations.
- We also struggled creating a default building typology, a default typology was defined for each country based on empiric data gathered by the partners.
- Some users also encountered problems trying to gather all the comprehensive data required for the tool.
- We had to find a balance with the detail level of the set of data that had to be gathered, it was adjusted several times during the project.

4. What were the challenges in moving from an Excel tool to a web-based tool? Which aspects do you consider that were improved or worsened?
   - The visual improvements were a real step forward, especially when showing the results. We got more flexibility in user-friendliness. The users can filter the results that they want to be displayed.
   - The possibility to create a better algorithm in keeping systems, the excel was too limited, now we could add 15 or 40 building parts.
   - We also had some issues with the translations, at first we had to translate all the elements in 5 languages of the tool in an excel sheet that would be later implemented in the tool, we are working on a module that will translate directly all the parts.

5. Which issues (positive and negative) have you received from users after using the toolbox?
   - We sent a survey to all the users asking about different aspects such as functionality, calculations, accuracy and interface, among others.
   - We are planning on put it this questionnaire online as a part of the tool so future users can give feedback after using it directly from the tool.

6. If you had to remake the tool, what would you do differently?
   - We would try to gather better data, and also simplify the usability. It looks to technical for some users. We would focus more on the tutorials, adding some video tutorials.
   - Try to better define which assumptions to make if you do not have data available.

7. The tool predefined data is calibrated for Mediterranean zones, did you think about expanding the spatial domain?
    - In the manual you can find all the assumptions that have been made and formulas.
    - There is a ”calculation” tab where you can define some variables to calibrate the calculations to your case to increase accuracy of the calculations.
    - Some variable are a predefined value for any case, other variables are predefined for each country that was part of the PrioritEE scope.
    - We are working on updating the data at national level and expand the scope to other EU countries as part of the PrioritEE Plus project. We may add new set of predefined values at a more detailed level (regional level) in Portugal.

Group Interview to Filomena Pietrapertosa (CNR-IMAA), João Pedro Gouveia (Nova University Lisbon), Norberto Fueyo (Universidad de Zaragoza) and other members of the PrioritEE Toolbox project.

1. What projects related to decision support tools (or similar) have you been involved with? Could you briefly describe the tool/s?
    - Interreg MED PrioritEE: PrioritEE toolbox: database, DST, guides & repository of good practices. The objective that led to the development of this set of tools was to provide public authorities, key stakeholders and citizens in general, with different instruments to increase their skills and their knowledge about energy efficiency and RES. The set of tools can be therefore useful to different end-users for different purposes. The DSTool, the key tool to support decision-making at local scale, allows a ranking of measures for improved EE and increased RES adoption in groups of municipal public buildings for a particular municipality or region

Key documentation:

- “Improving policy making and strategic planning competencies of public authorities in the energy management of municipal public buildings: The PrioritEE toolbox and its application in five Mediterranean areas” By M. salvia et al. https://doi.org/10.1016/j.rser.2020.110106 (2021)
- “How to Prioritize Energy Efficiency Intervention in Municipal Public Buildings to Decrease CO^2 Emissions? A Case Study from Italy” By F. Pietrapertosa et al. DOI: 10.3390/ijerph17124434) (2020)
- “A Decision Support Tool to rank energy efficiency options in services buildings” By: JP Gouveia et al., (2019)

- **SEE RE SEEties**: The main outcome of this project was a methodological toolkit and criteria for assessment aimed to support municipalities in creating a sustainable and resource efficient future through coherent and appropriate planning practices

Key documentation:

Creating a sustainable and resource efficient future: A methodological toolkit for municipalities

By M. Salvia et al. http://dx.doi.org/10.1016/j.rser.2015.05.027 (2015)

- **FP6 NEEDS, IEE RES2020, FP7 REACCESS, H2020 Smart Basilicata**: the IEA-ETSAP TIMES (The Integrated MARKAL-EFOM System) model generator, based on long term energy scenario analyses, was used to build up energy-technology models at different spatial scales (Pan-EU, National, Local scale) to build up to conduct in-depth energy and environmental analyses, assess policy measures and define energy-technology roadmaps. In particular energy externalities and LCA impact coefficients were included in the input databases of some models. The TIMES can assist in the design of least-cost pathways for sustainable energy systems, and is ideally suited for the preparation of Low-Emissions Development Strategies (LEDS) and Intended Nationally Determined Contributions (INDC) and Nationally Determined Contributions (NDC) roadmaps and is used by the EU Commission for policy evaluation (**https://iea-etsap.org/)**

  Pros: Powerful tool widespread used at international level that combines two different, but complementary, systematic approaches to modelling energy: a technical engineering approach and an economic approach. TIMES is a technology rich, bottom-up model generator, which uses linear-programming to produce a least-cost energy system, optimized according to a number of user constraints, over medium to long-term time horizons. It offers elegant solutions for compilation of long term energy scenarios and in-depth national, multi-country, and global energy and environmental analyses

  Cons: Very complex, it should be utilised by expert modellers to set up the energy model structure, define the scenarios and analyse the solutions and therefore is not suited as an easy-to-use Decision Support Tool in the short-term planning. The modelling of a local scale system requires the acquisition of a lot of data on energy consumption and infrastructures.

2. How do you establish the contents and organization of this kind of tool (e.g. PrioritEE toolbox: database, DST, guides & repository of good practices)? Do you perform any kind of requirement analysis?

- The set of tools was defined taking into account the main objective of the project, the needs of public authorities, the views of key stakeholders and experiences in other projects.
- A careful review of the existing models and tools was carried out to define the basic features to be enhanced in the design of an easy-to-use support tool. The conclusion of this preliminary analysis was that the tool developed by REGEA was respondent to the main characteristics and was a good starting example to be further implemented according to the users' needs
- A first technical workshop was then organized with key stakeholders to carry out a requirement analysis in order to define users' needs and expectations. This analysis was based on a questionnaire sent before the meeting to the participants and on a guided discussion. The "world café" method was used in Italy in this first technical workshop to allow for a broad and informal debate.

3. What were the major issues you encountered while developing the tool/s?
   - The goal was to develop a varied set of tools that are really useful in different situations and for different users, providing verified and easy to use information.
   - The DSTool tool was further developed by REGEA on an original model already tested in the definition of the priorities for the renovation of public buildings.
   - The main problems encountered in customizing the DSTool to local characteristics were related to the involvement of the personnel of the Public Authorities for data mining, training and testing. However, the possibility of utilising basic input data and the involvement of regional agencies that provided the data on consumption allowed to partly overcome the difficulties.
   - The other tools were defined capitalizing on the partners' experience and were aimed at improving the knowledge and skills of technical staff.

4. For PrioritEE DST What were the main challenges in moving from an Excel tool to a web-based tool? Which aspects do you consider that were improved or worsened?
   - The Excel version, initially available was improved and adapted to the local features. The online version was addressed to promote a wider use of the DSTool from PPAA
   - Worsened aspects: lack of information of the calculation process and less flexibility and adaptation

5. Which feedback (positive and negative) have you received from users after using the tool/s?
   - The PrioritEE toolbox was presented to PPAA and key stakeholders in a technical workshop in which the methodological framework was presented and the participants were involved in an operational evaluation of the functionality and potentialities of the PrioritEE DST with reference to the real situation of the public buildings of the Potenza municipality.
   - Responses from the participants highlighted their interest in the potential of the toolbox, and above all for the DST that can be used for a preliminary analysis and comparison of different energy saving options, emphasizing the important role of engineers and technical professionals in the adoption of this tool to promote the efficiency of the existing building stock.
   - In particular, the municipal officers have agreed on the great potential of the instrument also to catalogue the energy characteristics of the MPBs and to evaluate in a transparent way all the interventions made to increase energy efficiency in public buildings.
   - Many participants in the training session also found the tool not very easy to use and public administration staff expressed considerable reluctance to use it as a planning support tool due to the difficulty of finding technical and consumption data.

6. If you had to remake the tool/s, what would you do differently?
   An upgrade of the DSTool has been planned in the PrioritEE PLUS project, based on the feedbacks and in order to facilitate a wider use among the public administrations and end-user engagement. To this issue, the main improvements will concern:
   - Technical improvements

- Database
- Calculation methodology
- Change of calculation options
- Additional input
   - User-interface and visualisation

- General front-end design improvement
- Visual improvements
- Translations
- Data export
   - Capacity building materials

7. For PrioritEE DST, the predefined data is calibrated for Mediterranean regions, what problems do you expect to encounter during the process of increasing spatial reach?

- The main problems concern the update of the default data at national and local level, specific data to customise local scale applications, technology features and use, translation of the items.

Interview with Sergi Pérez, expert technician in sustainable building and energy projects at the AMB

1. What topics related to Energy Efficiency are you interested in?

Topics	Interest (1-5)
Which sectors provide more return for EE action?	4
Which policies should be applied to tertiary sector and retails?	3
Which policies should be applied to housing?	5
Which neighbourhoods are more suitable for housing renovation?	5
Which policies should be applied to public equipment?	5
Which are the benefits of active mobility?	2
What is the impact of promoting circular economy initiatives in industrial areas?	1
What likely impacts of vehicle electrification?	5
What is the impact of increasing EE of public lightning?	5
What impacts derived from district heating policies?	4

- It is necessary to implement remote management or consumption monitoring tools in public buildings, today it is not contemplated in any current regulations.
- My department does not address active mobility directly, but other departments in the AMB may be interested in quantifying EE impacts in this area.
- Space optimization linked to teleworking
- The EE in public lighting still has a long way to go, being conservative there is a potential saving of around 60%.

2. Which kind of plans/studies/tasks are you usually involved with?
   - Official bodies such as the ICAEN and the IDAE perform impact analyses of EE measures by energy sectors and sources, but the data they work on is 2-3 years apart. The AMB

works with this data, it would be very useful to be able to work with current data but it seems complicated to be able to obtain this type of data from other sources.

- My department is in charge of public equipment and lighting projects, other departments of the AMB are in charge of waste treatment and transport projects, quantification of impacts on these areas would be useful.
- Roof plans. They consist of the selection of public facilities with the greatest potential for photovoltaic power generation.
- 100% renewable municipalities, pilot test of energy savings of public facilities with the aim of achieving electricity consumption from renewable sources. It is intended to be achieved through self-generation actions (solar panels) and with energy efficiency measures.
- POEM Municipal Energy Efficiency Optimization Plan, the project covers the planning of energy saving measures of municipalities, control audits, and monitoring of the plan after its implementation.
- We are involved in "electric charging stations" planning projects, stations points with photovoltaic installations. There is a clear trend in the electrification of vehicles and buildings,

3. What time horizons do you usually cover? Short (5 years), medium (10-15 years) and/or long (20-30 years) term?
   - Annual targets are generally set with an average time horizon, a 50% reduction in energy consumption by 2030.

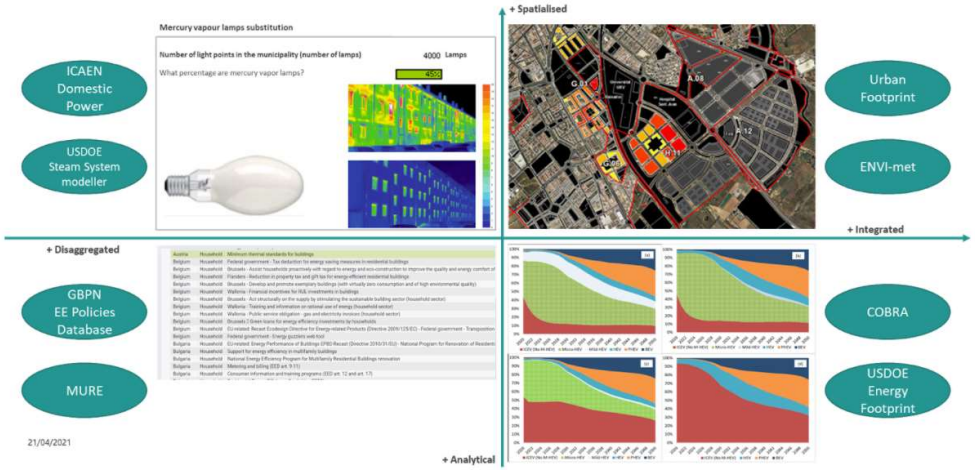
4. What tools do you usually use to elaborate them? Do those tool properly cover your needs to elaborate those plans systematically?
   - In the year 2020, a regulation of energy efficiency requirements for newly built and rehabilitated buildings has come out, much more restrictive than the current one. We have our own tool (xls) for the analysis of the most suitable neighbourhoods to implement energy efficiency measures. A more user-friendly tool would be really useful to carry out this analysis and to prioritize the actions to be carried out, it is important that this tool takes into account the subsidies given by the administration.
   - Energy accounting tool, optimize power and compare consumption from previous years.
   - We have a viewfinder where you can find the monthly consumption of all the AMB municipalities (water, gas and electricity) from 2019.

- We have developed a tool for monitoring the measures of the POEs, each measure has impacts on associated energy and monetary units.

5. Which EE impacts would you find useful to be quantified for your work activities?

Impact	AMB PoV (1-5)	Personal PoV (1-5)
Pollution and air emissions	5	-
Mortality and morbidity, public health expenditure (humidity, indoor thermal quality, pollution ...)	5	-
Impact of high temperatures	1	5
Productivity and industrial competitiveness (more efficient workers, lower energy costs)	1	5
Wealth generation and GDP	4	-
Employment (jobs)	5	-
Energy prices	3	-
Real estate value	4	-
Consumption of natural resources (water, soil ...)	2	-
Material consumption (fossil energy resources, metals, non-metallic minerals ...)	2	5

6. Which kind of tool would you find more useful?
   1) Specific calculators for buildings, services or industrial facilities
   2) Tools based on GIS data (e.g. urban planning)
   3) Reference database and knowledge repository
   4) Analytical model for aggregate medium / long-term forecasting (key indicators at national level)



- The first three groups are interesting and not exclusive. Tools with GIS information can determine areas of energy poverty and pollution, among others.
- Analytical data at more macro levels would not be of much interest to the work he is currently doing
- Powerful tools that require the input of large amounts of data by the user may not be very operational depending on the difficulty of obtaining such data.
- Depending on the user's profile (political, technical, private ...) the functionality of the tool should be different.

Interview with Núria Parpal, expert technician in environmental projects at the DIBA

7. What topics related to Energy Efficiency are you interested in?

Topics	Interest (1-5)
Which sectors provide more return for EE action?	1
Which policies should be applied to tertiary sector and retails?	2
Which policies should be applied to housing?	2
Which neighbourhoods are more suitable for housing renovation?	2
Which policies should be applied to public equipment?	5
Which are the benefits of active mobility?	5
What is the impact of promoting circular economy initiatives in industrial areas?	3
What likely impacts of vehicle electrification?	2
What is the impact of increasing EE of public lightning?	5
What impacts derived from district heating policies?	3

- DIBA is giving support to self-production energy project, particularly in photovoltaic energy ones. We focus on projects in public buildings but also on energy communities in residential buildings. In other departments they also deal with issues of energy poverty. Energy saving projects have been carried out in public facilities adopting the 50/50 methodology, where 50% of the energy savings from energy efficiency measures are returned to the facility through a financial payment and the other 50% represents savings for the administration responsible for paying energy bills.
- There is a department that does work on issues in the industrial sector but in my department we do not directly touch on the issue.
- Topics of circular economies are interesting for us but not specifically in industrial areas.
- We have participated in projects related to the electrification of bicycles, at first we also addressed the electrification of motorized vehicles (cars, motorcycles ...). We also participate in projects to promote electric charging points.
- Lighting is an issue that is very worked on, both public lighting and lighting in public facilities. At the services and commercial level I have the feeling that it is has not been addressed that much. It would be interesting to be able to include health issues, such as the impact that certain lights have on people during large periods of time.

- Centralized heating is a very interesting topic for use, still has a long way to go in our context and can be an interesting solution that replaces and / or complement biomass boilers like it is already doing in northern Europe countries.

8. Which kind of plans/studies/tasks are you usually involved with?
   - We have worked in many SECAPs, specifically in local and regional (group of municipalities) adaptation plans.
   - We also work on European projects related to issues of adaptation to climate change, looking for nature-based solutions such as cleaning forests with grazing and promoting green spaces to promote water retention.
   - We have also carried out mobility projects such as the Business Displacement Plans (known in Spain as PDE). In this projects we evaluate the demand for mobility of workers and the mobility offer available to give recommendations where the use of Public Transport, active mobility (bicycles and on foot) and shared use of private vehicles are promoted.
   - We also carry out a project of "Climate Shelters" where the vicinity of public facilities (temperature, green spaces, open spaces...) is evaluated to define vulnerable spaces where action should or could be taken.

9. What time horizons do you usually cover? Short (5 years), medium (10-15 years) and/or long (20-30 years) term?
   - Depending on the project we generally work in short and medium-term. SECAPs have a horizon of 2030, mobility projects have a horizon of 5 years and some European projects usually have a long-term vision.

10. What tools do you usually use to elaborate them? Do those tool properly cover your needs to elaborate those plans systematically?
    - To elaborate the SECAP' we have our own tool in an excel format, we now have allocate resources to be able to modify the tool so that it will be powered by an external database to be more operational. The Excel tool already contained too much data. The new system will automate the collection and processing of the required data. The tool includes mitigation data and is trying to include adaptation data to have more information on vulnerability issues.
    - In PDE projects a series of indicators are usually defined, these indicators often come or are made from databases that do not always have continuity, the information collected periodically may change, the data collected is less exhaustive or it can be different. So

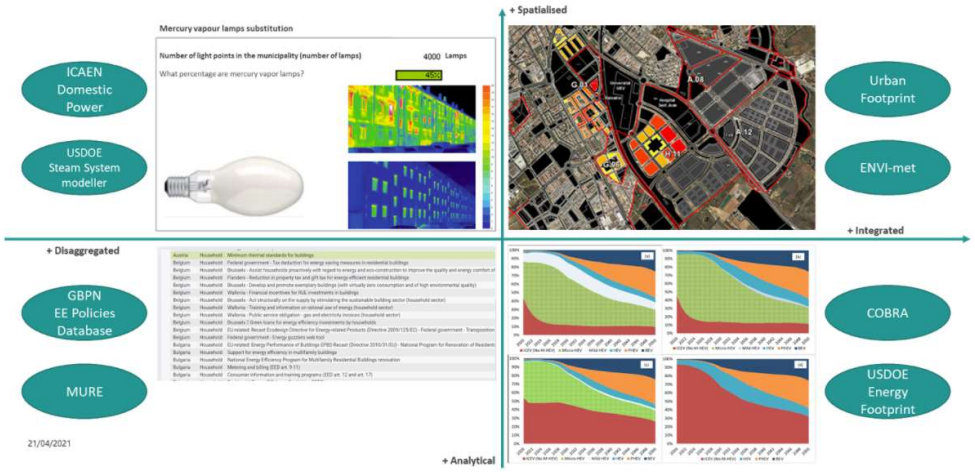
the defined indicators can no longer be calculated with the methodology established, making the indicator system obsolete or requiring more resources to update the methodology to define once again the indicators. It is ideal that the tool has default data but also that it adapts well the particular context of users to have data accurate enough to be useful.

11. Which EE impacts would you find useful to be quantified for your work activities?

Impact	AMB PoV (1-5)
Pollution and air emissions	5
Mortality and morbidity, public health expenditure (humidity, indoor thermal quality, pollution ...)	5
Impact of high temperatures	2
Productivity and industrial competitiveness (more efficient workers, lower energy costs)	3
Wealth generation and GDP	5
Employment (jobs)	1
Energy prices	1
Real estate value	5
Consumption of natural resources (water, soil ...)	5
Material consumption (fossil energy resources, metals, non-metallic minerals ...)	5

12. Which kind of tool would you find more useful?

5) Specific calculators for buildings, services or industrial facilities
6) Tools based on GIS data (e.g. urban planning)
7) Reference database and knowledge repository
8) Analytical model for aggregate medium / long-term forecasting (key indicators at national level)



- Simple calculators are really useful but they are also the ones that have been more studied and developed, there are many online, such as energy consumption calculators for buildings.
- Tools that work with GIS data are interesting but require a certain expert knowledge which makes them not always useful for everyone. It is important that they are user-friendly.
- At the DIBA we work with simple (Excel based) databases, which are used as a repository of actions for climate change measures, but we also are trying try to relate vulnerabilities to these actions.
- Aggregated predictions from key indicators are widely extended in more macro levels, but I find that this same type of prediction is missing in a more micro context that can be useful to local administrations.

Annex 3 – Environmental policy packages

European sustainability policies, in their beginnings, were mainly based on those areas most related to climate change, and mitigation and adaptation strategies. Progressively, European policy has increased its interest in topics based on efficiency in the consumption of resources and energy, recycling and currently in the promotion of models based on the circular economy.

In 2011, the *Low Carbon Economy Roadmap* opted for an integrated strategy that would in-force sustainability throughout the European Union and contribute to mitigating the progress of climate change. This strategy was outlined in 4 sectorial roadmaps based on: 1) energy efficiency and consumption (Energy*Efficiency Roadmap),* 2) the production and renewal of energy sources (Energy*Roadmap),* 3) a more integrated and sustainable European transport (RoadmapTowards a Single Transport*Market),*and 4) efficiency in resource consumption (Roadmapto a Resource Efficient*Europe),* antecedent of the current European circular economy strategy.

Based on the roadmap that is committed to a more efficient Europe in the use of resources (Roadmap to a Resource Efficient Europe *COM (2011)/571)* other instruments are deployed that have defined the European framework on recycling and the current circular economy. In 2015, the European Commission published a European Action Plan for the Circular *Economy* (COM/2015/614 final). This document develops, in particular, the European circular economy strategy, defines its objectives in Horizon 2030, identifies key sectors of opportunity and proposes monitoring and monitoring indicators. The Action Plan is part of the so called *Circular Economy Package*.

In 2018, new specific work packages are developed for those key sectors in the development of an economic model based on circularity, such as:

- The European PlasticsStrategyin a Circular Economy (COM/2018/028final),
- Communicationon key actions for Chemicals (COM/2018/032 final),
- El Report on 27 Critical Raw Materials (SWD(2018)/36), and
- The Communication on the Monitoring System (COM/2018/029 final).

In 2019, the European Commission presented the Progress Report on the deployment of the Circular Economy *Package.* This report states that there is not yet a harmonized methodology for the analysis and evaluation of "circularity" that fully analyses the situation and evolution of the cycles that make up the circular economy, and that the proposed circularity indicators do not yet lack sufficient robustness to be applied across the board. However, since 2018 EUROSTAT has been calculating a circularity indicator: circular material use rate (CUM) that assesses the share of material recovered and reintroduced back into production processes in relation to the use of new raw materials. A higher value of the circularity rate indicates that

more secondary materials replace the raw materials thus reducing the environmental impacts of primary material extraction.

In 2020, the *European Green Deal* is approved. This European strategy that aims to "transform the EU economy with a view to a more sustainable future", and responds to the challenges posed by the fight against climate change based on six major fields of action: energy efficiency through a transformation of the industry sector and sources towards more sustainable ones, transformation towards a circular economy based on processes of recycling and reuse of both products and their packaging, efficiency in the construction sector with respect to construction processes, use of materials and energy efficiency of buildings, a mobility that aims at a90% reduction in emissions , sustainability in the food sector and a framework for the protection of biodiversity. With the approval of the European Green Deal, the process for updating the 2015 European Circular Economy Action Plan begins.

The figure below shows a comprehensive map of the environmental policy packages from 2011 to 2021.

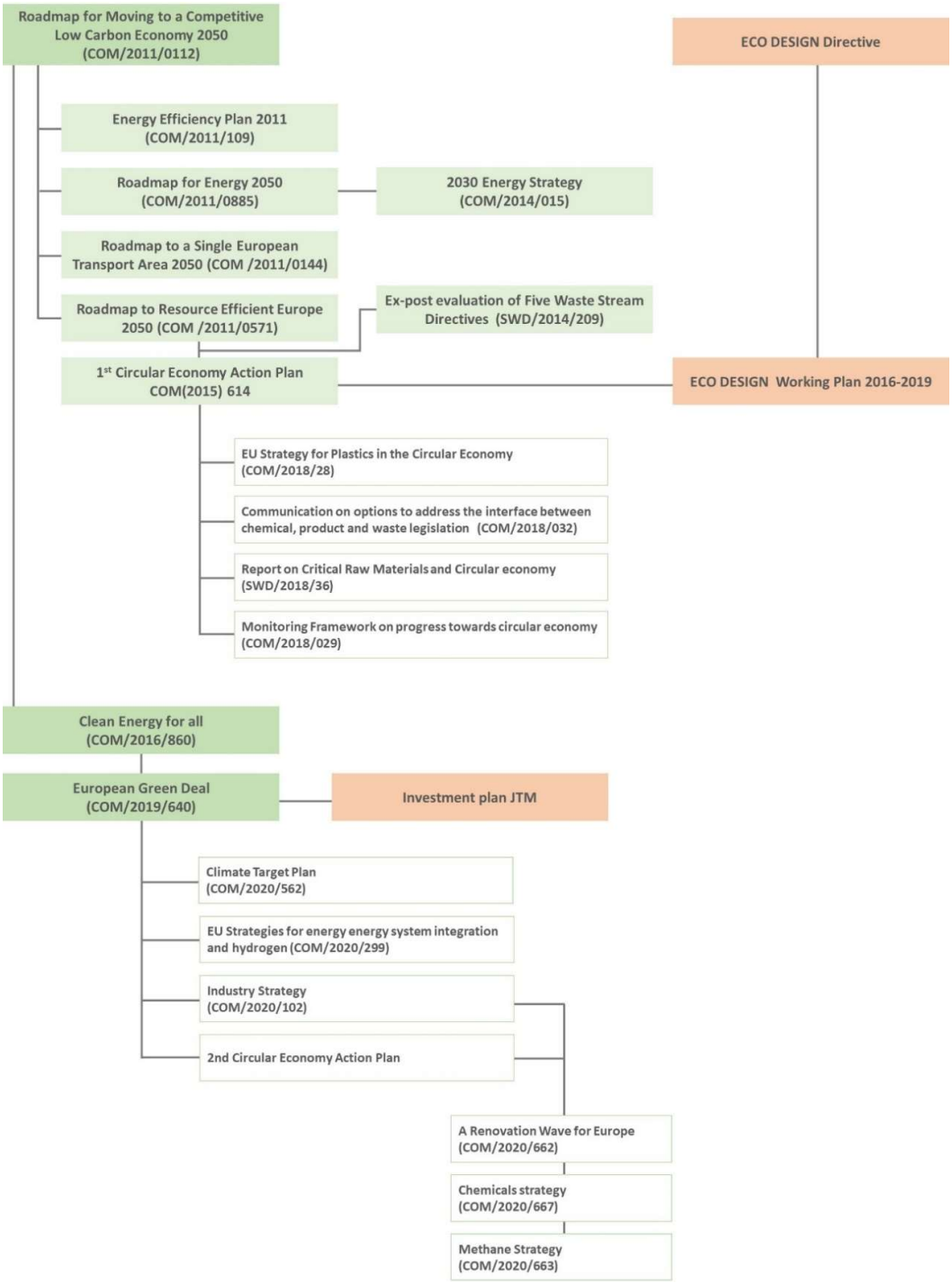


Figure 21 Environmental policy packages 2011-2021. Comprehensive map. Source: MCRIT (2021).

The EU-wide targets and policy objectives for the period from 2021 to 2030 are according to "2030 climate and energy framework":

- At least 40% cuts in greenhouse gas emissions (from 1990 levels)
- At least 32% share for renewable energy
- At least 32.5% improvement in energy efficiency.
- Increase in resource productivity by 30% by the end of 2030
- Reduction of waste generation by 10% by 2030
- Increase in the recycling rate of municipal waste by 55% by 2025, by 50% by 2030 and by 65% by 2030
- Increase in the recycling rate of packaging to 70% by 2030: in the case of paper and cardboard up to 85%,
- Limit of the landfill of municipal residents to 10% of the total by 2035

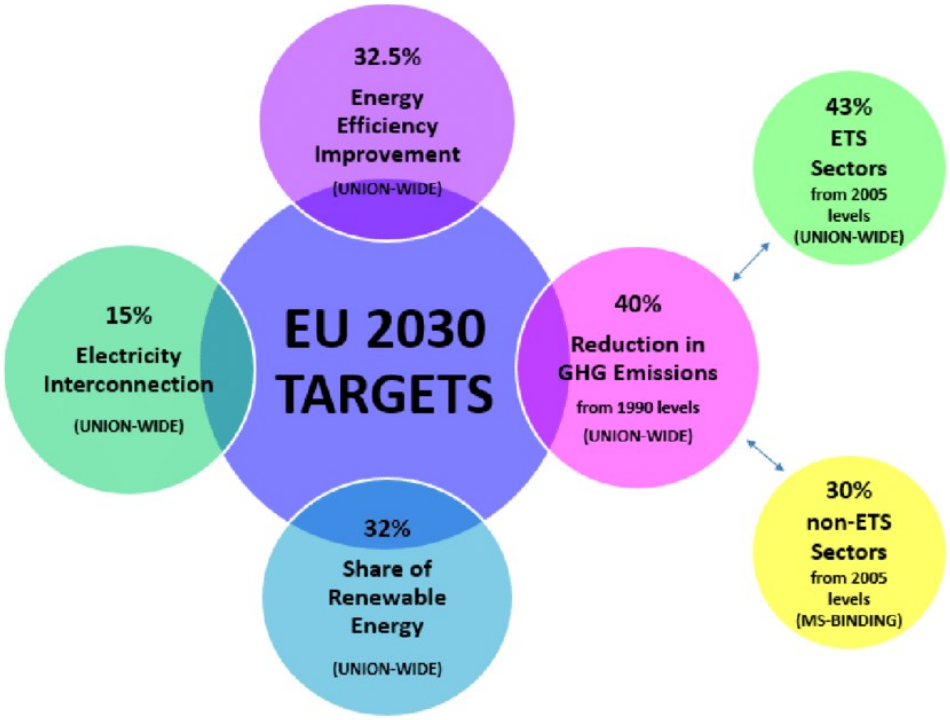


Figure 22 Current EU 2030 Targets. Source: The EU Clean Energy Package (FSR Energy Union Law Area, 2020).

As part of the European Green Deal, the Commission proposed in September 2020 to raise the 2030 greenhouse gas emission reduction target, including emissions and removals, to at least 55% compared to 1990. All three pieces of climate legislation will be updated with a view to

implement the proposed at least 55% net greenhouse gas emissions reduction target. The Commission is expected to come forward with the proposals by July 2021.

Former policy targets in the 2011 and 2015 policy packages include others like the ones shown next:

Table 3 Former targets. Source: MCRIT (2015)

Sector	Year	Targets	Source
Mortality	2015	Reduce by two thirds, between 1990 and 2015, the under-five mortality rate in the World	Millennium Development Goals Target 4A
Mortality	2015	Reduce by three quarters, between 1990 and 2015, the maternal deaths per 100.000 live births in the World	Millennium Development Goals Target 5A
Health	2020	Increase healthy life for everyone in Europe by an average of two years	European Innovation Partner-ship on Active and Healthy Ageing
Education	2020	Reducing school drop-out rates below 10% by 2020	EU2020
Education	2020	At least 40% of 30-34 year old completed tertiary education	EU2020
Poverty / Social exclusion	2020	At least 20 million fewer people in or at risk of poverty and social exclusion by 2020	EU2020
Employment	2020	75% of the 20-64 year-olds to be employed	EU2020
R&D / innovation	2020	From 1.8% in 2005 to 3% of the EU's GDP (public and private combined) to be invested in R&D	EU2020
Inflation (Eurozone)	always	Maximum 2%	ECB
Inflation (Member States in the eurozone)	always	Maximum 1.5% above that of, at most, the three best performing MS in terms of price stability	Convergence criteria
Government deficit (Member States in the eurozone)	always	Maximum 3.0% of GDP	Convergence criteria
Government debt (Member States in the eurozone)	always	Maximum 60% of GDP	Convergence criteria
Interest rate (Member States in the eurozone)	always	Maximum 2.0% above that of, at most, the three best performing MS in terms of price stability	Convergence criteria

Sector	Year	Targets	Source
Total GHG emissions	2020	Total greenhouse gas emissions 20% in 2020 (or even 30%, if a satisfactory international agreement can be achieved to follow Kyoto) lower than 1990	EU2020
	2050	Total greenhouse gas emissions 80% - 95% in 2050 lower than 1990	A Roadmap for moving to a competitive low carbon economy in 2050
Energy sources	2020	20% of total energy from renewables in 2020	EUROPE 2020
	2020	10% of transport energy from renewables in 2020	Renewable Energy Roadmap Communication by the EC, 2007
	2020	10% of transport energy from biofuels in 2020	(European Council, 2007)
Energy consumption	2020	20% increase in energy efficiency by 2020	EUROPE 2020
	2030	50% increase in energy efficiency by 2030	EUROPE 2030 report by the Reflection. Group on the Future (F.González)
	2020	20% decrease in primary energy consumption by 2020	20-20-20 targets
	2050	30% decrease in primary energy consumption by 2050 respect to 2005.	Roadmap for moving to a low-carbon economy in 2050
Transport emissions and energy consumption	2020	10% of transport energy from renewables in 2020	Renewable Energy Roadmap Communication by the EC, 2007
	2020	fuel suppliers reduce greenhouse gas emissions from fuel across its life-cycle by 10% by 2020	Energy Policy, 2007
	2020	10% of transport energy from biofuels in 2020	Energy Policy, 2007
	2030	Transport emissions (including CO2 aviation, excl. maritime), 20% lower in 2030 in relation 2008	Transport White Paper 2011
	2050	Transport emissions (including CO2 aviation, excl. maritime), 60% lower in 2050 in relation 1990's	Transport White Paper 2011
Air pollution	2020	47% reduction in loss of life expectancy as a result of exposure to particulate matter	Thematic Strategy on Air Pollution
	2020	10 % reduction in acute mortalities from exposure to ozone	Thematic Strategy on Air Pollution
	2020	reduction in excess acid deposition of 74% and 39% in forest areas and surface freshwater areas respectively	Thematic Strategy on Air Pollution
	2020	43% reduction in areas or ecosystems exposed to eutrophication	Thematic Strategy on Air Pollution
	2020	Reduction of air emissions: SO2 by 82%, NOx by 60%, volatile organic compounds by 51%, ammonia by 27%, and primary PM2.5 (particles emitted directly into the air) by 59%	Thematic Strategy on Air Pollution
Water	2015	Restore degraded surface and ground waters to "good status"	Water Framework Directive
	2020	By 2020, good environmental status of all EU marine waters is achieved	Roadmap to a Resource Efficient Europe (EC, 2011)

Sector	Year	Targets	Source
Biodiversity	2020	100% more habitat assessments and 50% more species assessments under the Habitats Directive show an improved conservation status; and 50% more species assessments under the Birds Directive show a secure or improved status.	EU Biodiversity to 2020
	2020	ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15 % of degraded ecosystems	EU Biodiversity to 2020
	2020	maximise areas under agriculture across grasslands, arable land and permanent crops that are covered by biodiversity-related measures under the CAP	EU Biodiversity to 2020
	2020	Forest Management Plans are in place for all forests that are publicly owned and for forest above a certain size	EU Biodiversity to 2020
	2015	Achieve Maximum Sustainable Yield	EU Biodiversity to 2020
	2020	Invasive Alien Species and their pathways are identified and prioritised, priority species are controlled or eradicated, and pathways are managed to prevent the introduction of new ones.	EU Biodiversity to 2020
	2020	the EU has stepped up its contribution to averting global biodiversity loss	EU Biodiversity to 2020