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SEMANCO

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1 EXECUTIVE SUMMARY

This document presents the final version of the SEMANTCO integrated platform developed in Task 5.6 *Integrated platform*. This final version is the result of the development of the previous prototype reported in Deliverable 5.4 *Prototype of the integrated platform*

The work done in Task 5.6 encompasses the integration of the new tools developed since the creation of the prototype, the improvement of some of the prototype functionalities, and the enhancement of the interfaces. Specifically, the work done in the evolution of the prototype until the final platform included:

- Developing the infrastructure to support working with urban energy systems, urban energy models, plans, and projects.
- Integrating the tools developed in Task 5.3 *Energy simulation and optimization tool* and Task 5.5 *Interoperability of tools with the semantic framework*. In particular, these tools are the intervention assessment tools (to improve the energy consumption of buildings or urban areas), the multi-criteria decision analysis tool (to support users in decision-making processes by enabling the multi-dimensional comparison of multiple projects), and the integration of the URSOS calculation engine.
- Enhancing the existing functionalities of the Urban Energy Planning tool (enabling users to add more than one energy supply technology), a multi-scale aggregation feature (to visualize the energy performance indicators at urban scale), new filters (building use, year of construction, and the building floor area), and new indicator units (configuring the interface between to kind of units: annual and square meters per year).
- Improving the front-end interface which includes: redesign of the interface look (e.g. background and text colors, font styles), harmonization of pop-up layouts, creating a unique layout for all tools (common structure, layouts and styles), renaming interface components (visualization modes and indicators, among others), and adding a tooltip feature with explanations about the tools functionalities and the semantic data they use.

A usability test has been designed for final users to assess the performance of the platform in in the demonstration scenarios.

The work carried out in Task 5.6 is the starting point of the work to be done in Task 5.8 *Energy service platform web portal* whose goal is to create a web portal oriented to potential end-users of the platform. In this web portal, the functionalities of the tools will be explained to different target groups using a variety of written and visual material (documents, tutorials, videos).

2 INTRODUCTION

2.1 Purpose and target group

This report presents the work carried out in Task 5.6 *Integrated platform*. The purpose of this task has been to further develop the work presented in Deliverable 5.4 *Prototype of the integrated platform*. The target groups are project partners and final users involved in the application of the platform in demonstration scenarios.

2.2 Contribution of partners

FUNITEC has been responsible for the design and implementation of the platform, from the prototype until its final version. CIMNE, FORUM and RAMBOLL have collaborated in the design of the interfaces required to integrate the energy assessment and improvement tools used in Manresa and Copenhagen. POLITO has provided new labels for some elements of the interface which are aligned with the Energy Standard Tables conducted in WP3. Agency9 has provided the functionalities required to do spatial queries to identify the location of buildings within an urban area, and to make multiple selections of buildings. Besides, they have enhanced the 3d models of Manresa by encoding information about walls, and have improved the geometry of the Newcastle model.

2.3 Relations to other activities in the project

The final version of the platform integrates the tools developed in WP5 *Integrated Tools*. These tools access the semantically modelled data via the SEIF created in WP4 *Semantic Energy Information Framework*. The vocabulary provided by the Energy Standard Tables created in WP3 *Energy Data Modelling* has been instrumental in supporting the creation of the ontology used to integrate data from multiple domains and sources in each one of the three cases of study. The indicators used to assess the energy performance of urban areas have been provided by WP2 *Case Studies*. The implemented functionalities respond to the specifications provided WP6 *Enabling scenarios for stakeholders*. The integrated platform is the showcase of the overall project, and as such it has been presented in the various events organized within WP7 *Dissemination and Exploitation*. The platform will be applied in the third and final iteration of the demonstration scenarios to be carried out in WP 8 *Implementation*. Its functionality will be evaluated by means of a usability test included in this document. In sum, in the SEMANCO integrated platform converge the various strands of work carried out in the project.

The integrated platform is the starting point of Task 5.8 *Energy service platform web portal*, which will be dedicated to explain its functionalities to its potential users.

3 URBAN ENERGY SYSTEMS AND MODELS

The SEMANTCO integrated platform is the front-end for users to interact with the semantic data provided by the Semantic Energy Information Framework (Madrado et al., 2013). This semantically modelled data (i.e. specified as ontology) represents the combined knowledge of the different experts involved in the definition and solution of a problem concerning the improvement of the energy performance of an urban area. Ontologies also provide access to the multiple data sources from various domains and scales which are needed to formulate and solve a specific problem. The platform, therefore, facilitates access to the knowledge provided by experts – that is, to the methods and tools needed to define and solve a problem– and to the data associated to a specific problem.

As it was described in the the precedent report D5.4 *Prototype of the Integrated Platform*, the SEMNCO integrated platform enables the creation of models of urban energy systems which combine energy related data from multiple sources with various energy assessment and simulation tools. Urban energy systems have been defined as “The combined process of acquiring and using energy to satisfy the demands of a given urban area” (Keirstead & Shah, 2013, p.25) whereas an energy system model would be “a formal system that represents the combined processes of acquiring and using energy to satisfy the energy service demands of a given urban area” (Keirstead et al., 2012, p.6). This formal system stand for a model, that is, “a representation of a reality, in which the representation is made by the expression of certain relevant characteristics of the observed reality and where reality consists of the objects or systems that exist, have existed or may exist” (Echenique, 1972, p.164). A model of an urban energy system would fulfil two main purposes: to understand the current state of the system and to help to take decisions to influence its future evolution (Shah, 2013).

For a particular urban area –a city, a district, a neighbourhood– multiple energy models can be created combining data and tools in various ways (see Deliverable 5.4). Within a given urban model, users can use the tools to assess the energy performance of the urban area, and to carry out plans to improve it. The open structure of the platform enables an urban energy model to be enhanced when new tools and data –either from existing data sources or from the data generated by the different applications– become available.

For a given urban energy model created in the SEMANTCO platform, plans can be defined to improve the energy performance of an urban area. The baseline –that is, the current status of the analyzed area in terms of energy performance– is determined by using the energy assessment tools and the available data. For each plan, multiple projects can be proposed to improve the existing conditions applying different measures. The improvements obtained by applying the proposed measures are compared to the baseline in order to decide the best option. For example, a plan can be proposed to refurbish the old town of Manresa which would include the most deteriorated buildings in the city center. This can be achieved in different ways, each one represented by a project: renovating the facades, replacing the roof insulation, or changing the building equipments. The results of implementing these measures are determined using the same tools as those used to calculate the baseline. Then, a multi-criteria decision-making tool is used to rank the performance of the different projects.

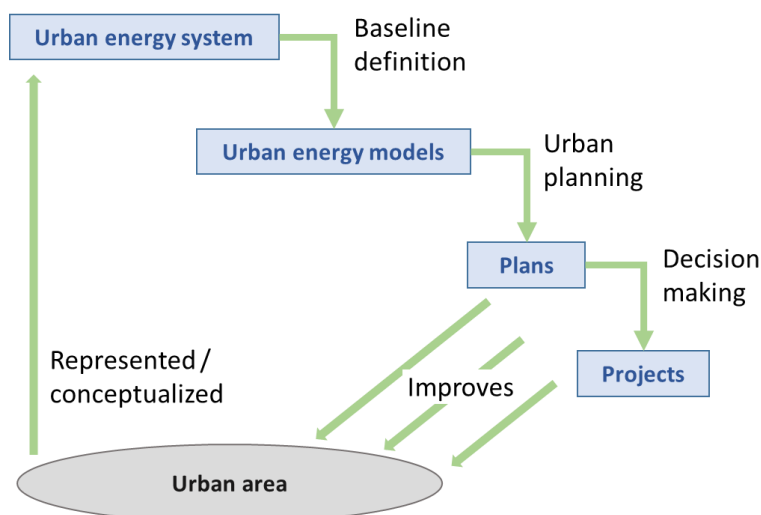


Figure 1. Workflow of the process to improve the energy performance of an urban energy system

Figure 1 synthesizes the process of assessing the urban energy performance and proposing projects to improve which is carried out in the SEMANTCO platform. The boundaries of the energy system can be determined from a “production” perspective –that is to say, considering fixed geographic limits based on established physical or administrative divisions, such as neighborhood– or from a “consumption” perspective –namely, establishing limits which take into account economic exchanges linked to energy use (Steinberg & Weisz, 2013). The baseline of the urban area considered, that is to say, the performance of the buildings within the selected, is set with the tools and data available within an urban energy model. Plans to improve the existing conditions are made. The goals set by the plan can be reached by different projects, this means, applying different measures. Decisions are made based on the results of the analysis of the different projects. Finally, the decisions adopted contribute to improve the performance of the urban energy system.

3.1 Creating Systems, models, plans and projects

Urban energy systems, urban energy models, plans and projects have been implemented in the platform for each one of the three cases of study (Manresa, Copenhagen and Newcastle). An urban energy system refers to a particular urban area delimited by the available data and by the goals and objectives to pursue applying specific tools to treat the data in order to understand the system’s performance. While an urban energy system generically represents the behaviour of an urban area in terms of energy use, an urban energy model is a conceptualization of the system which enables to assess its performance considering the available data and tools.

To define an urban energy system implies creating a 3d model and integrating the data sources needed by the tools. Both activities are carried outside the platform, since they are both complex processes which requires to be carried out as consultancy services. The creation of the 3d model for each case study has been reported in Deliverable 5.1 *Building Extraction and Classification Tools* and the integration of the data sources has been described in Deliverable 3.4 *Ontology repository with migrated data*.

For a given urban energy system, multiple urban energy models can be created in the platform by combining data, tools, and users (Figure 2). In a given urban energy model (top part of Figure 2), it is possible to create multiple plans (middle part of the Figure 2), each having various projects (bottom part of the Figure 2).



Figure 2. Interface panels related to the urban energy models, plans, and projects management

3.1.1 Creating an urban energy model

The form to create an urban energy model is shown in Figure 3. First, users introduce a name and a description to create a new urban energy model. Then, they assign to it one of the three tools integrated in the platform (i.e. simulating energy performance of urban areas, estimating building energy performance, and urban energy planning). The description of each tool can be found in Deliverable 5.1 *Building extraction and classification tools* and their initial integration in the platform is explained in Deliverable 5.4 *Prototype of the Integrated Platform*.

The description of the tool includes a description summary, the regulatory framework within which it can be applied, the methodology that is used to carry out the energy assessment, and the data required by the tool. It is important to notice that each tool needs specific data sources (Figure 3). This means that the data sources required by the tool are identified before, when the urban energy system is initialized.

Creating a new Urban Energy Model:

1. General data | **2. Tools** | 3. Data | 4. Users

conditions, urban grid, characteristics of enclosures, ventilation rates and volume. The calculation method is based on a monthly aggregation of daily average radiation and daily Tmax and Tmin according to the so called Method 5000, taking into account the internal gains and dynamic of solar radiation for cooling calculations, following the norm UNE - EN 832.

Data: Climatic parameters of the location, 3D geometry, thermal characteristics of enclosures, air renewable and characteristics of windows, and internal gains. Outputs from the tool are energy demand for heating and cooling of the buildings and the modelled urban area, as well as, detailed calculations of shadows and useful solar radiation for any closure and time during the year. Household income is used to estimate electricity consumption.

Urban energy planning Select this tool

Regulatory framework: The energy demand data is derived from expectations for future energy demand stated in the National building code. The supply data derives from the National Energy Agency.

Description: Assessment of energy demand based on building typologies (building use and year of construction) for net heat demand, hot water demand, cooling demand and electricity demand in kWh/m2. After the building net energy demand is estimated, supply data estimates the carbon emissions and the use of primary fuels.

Methodology: The tool uses building typologies and energy supply data to identify energy demand at building level based on conditioned floor space and energy intensities.

Data: Energy demands in terms of kWh/m2 for net heat demand, hot water demand, cooling demand and electricity demand. Supply data encompasses different means of energy supply to the building with values on efficiency and primary fuel sources.

Summary

Name: Name of the Urban Energy Model
Description: Description of the Urban Energy Model

Save Close

Figure 3. Form to create a new urban energy model. Selection of the tools selection

Once an urban energy model has been created, the selected tools can be used to assess the energy performance of the buildings included in the area encompassed by the model. By using these tools, an initial geometric model is enriched with energy related data. After the buildings have been assessed, the urban energy model becomes the energy performance baseline which will be used later as reference in the evaluation of the impact of the improvement plans.

3.1.2 Creating a plan

Within a given urban energy model, users (e.g. urban planners) can create plans (e.g. to build new buildings, to refurbish existing buildings) and propose projects to fulfil the objectives of a particular plan. The process to create a plan consists of two steps: firstly, to provide the name, description and realm (Figure 4); secondly, to select the buildings included in the plan that will be affected by the decisions to be made.

Creating a new plan for Default Urban Energy Model Newcastle

General properties

Name:

Description:

Public
 Private

Create Close

Figure 4. Input form to create a plan

The buildings to be included in the urban energy model are selected in the 3d model (Figure 5). When a building is picked up, a pop-up window shows its properties and performance

indicators. If the building is not yet in the plan, it can be added by clicking the button “Add building/s to plan”. The same procedure can be applied to a group of buildings after selecting them with drawing a box (mouse+shift key). A building that belongs to the plan is shown in green when the option “Show buildings plan” is enabled.

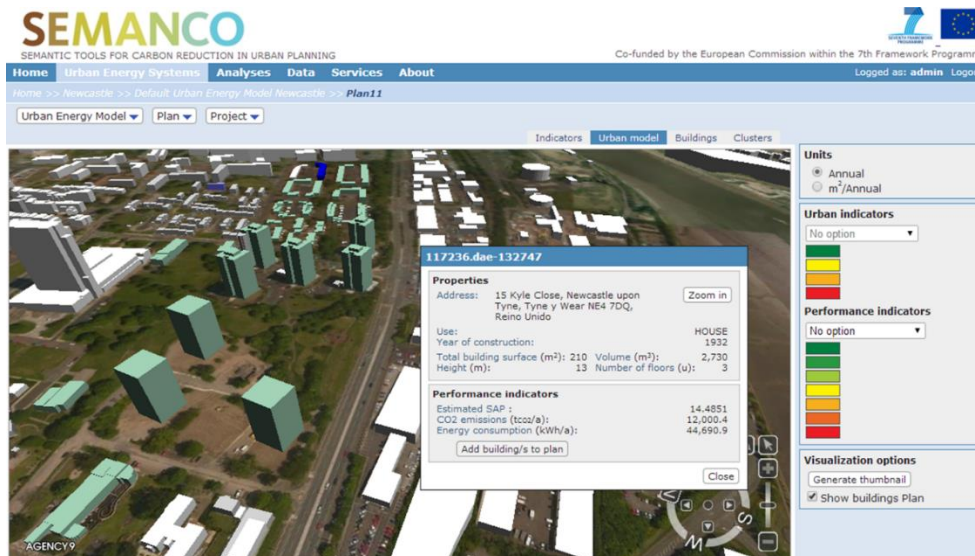


Figure 5. Selecting a building to include it in the plan

When the user selects an urban or performance indicator, the buildings of the model are coloured according to the scale (from green to red). The values are taken from the urban energy model since a plan is a part of it.

3.1.3 Creating a project

A project is a set of interventions on the buildings included in a plan done with the objective to improve the baseline conditions. A plan can have different projects which later can be compared using a multi-criteria decision analysis tool to find the most appropriate solution. Projects are created using the menu panel placed at the top side of the interface. The project creation process is made of two steps: firstly, providing the name, the description, and the customized data sources (Figure 6); secondly, applying modifications to the buildings using the intervention assessment tools which will be further described in section 4 of this document.

The screenshot shows the 'Creating a new project for Plan11' form. It has two tabs: '1. General data' and '2. Data'. The '1. General data' tab is active. Below the tabs, there is a blue instruction: 'Fill the form with the name and the description of the Urban Energy Model'. The form contains two input fields: 'Name' with the placeholder text 'Name of the project' and 'Description' with the placeholder text 'Description of the project'. At the bottom of the form, there are two buttons: 'Create' and 'Close'.

Figure 6. Input form to create a project

At the project level, the data sources, which have been previously associated to the tool at the

moment of creating the plan, need to be customized to adapt them to the specific purposes of the tools to be used in a project. For example, if the “Urban Energy Planning” tool is selected, then the user can modify the parameters of the building typologies and supply technologies. This customization is necessary since, for example, an intervention can imply the redefinition of the building typologies parameters.

4 TOOLS INTEGRATION

The platform integrates the various tools developed in Tasks 5.1 *Building stock energy modelling tool*, Task 5.2 *Energy analysis, and optimization and strategic decision tools* and Task 5.3 *Energy simulation and optimisation tool* as well as the semantic data explorer developed in Task 4.3 *User interfaces for knowledge representation*.

The analysis tools developed in Task 5.2 were already integrated in the platform prototype described in Deliverable 5.4. The development of the tools created in Tasks 5.3 and 5.5 has been carried out in parallel to their integration in the platform. This could not have been done otherwise since those tools cannot exist outside the platform. The thorough integration of these tools carried out in Task 5.6 has implied, basically: 1. to link the tools with the semantic data that is facilitated through the SEIF and 2. to implement the tools interfaces in the platform.

These tools developed in WP5 were integrated in the platform prototype already reported in Deliverable D5.4 *Prototype of the Integrated Platform*:

- Building stock energy modelling tools (Deliverable 5.1 *Building extraction and classification tools*)
- Energy analysis tools (Deliverable 5.2 *Tools for energy analysis*)
- Semantic data explorer (Deliverable 4.3 *User interfaces for domain experts interacting with SEIF*)

Besides, the following tools have been included in the final version of the platform:

- Intervention assessment tools (Deliverable 5.3 *Tools for energy analysis*)
- Multi-criteria decision analysis tool (Deliverable 5.3 *Tools for energy analysis*)

The building stock energy modelling tools are used to calculate the baseline of the current urban energy model. On the other hand, the intervention assessment tools are used to apply improvement measures to a particular project for a given plan.

4.1 Intervention assessment tools

The goal of the intervention assessment tools is to enable the application of measures aimed to improve the energy performance of buildings (single buildings or groups of buildings in an urban area) and for the quantitative calculation of the results of such interventions. The three assessments tools created in Task 5.3 *Energy simulation and optimisation tool* are an extension of the three tools developed in Task 5.1 *Building stock energy modelling tool*. The intervention assessment tools are used in the context of the decision making workflow reported in Deliverable 5.3 (Figure 7).

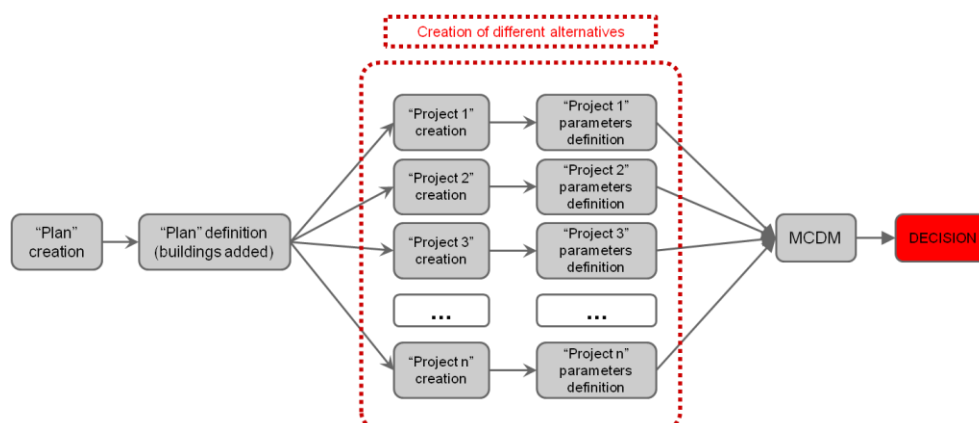


Figure 7. Workflow for decision making within the platform

These tools are invoked from a pop-up window which appears when a building or a set of buildings are selected in the 3d model or in the building list. This way, it is possible to run a tool for all the buildings of a project at once using the corresponding option in the menu panel.

4.1.1 USiT - Improvements tool (Manresa)

A building stock energy modelling tool for the Manresa case – henceforth named USiT, for Urban Simulation Tool – was presented in Deliverable 5.1 and an intervention assessment tool – from now on named USiT-Improvements tool – based on the preceding energy model tool was introduced in Deliverable 5.3. USiT is mainly used to calculate the baseline of an urban energy model, while USiT-Improvements is used to calculate the energy performance of the residential buildings after implementing some refits. However, USiT requires a high level of understanding of the parameters involved, a knowledge that is only available to energy experts. To mitigate these difficulties, the USiT – Improvements tool enables non-expert users to describe in their own language the measures to improve existing conditions in their own language (e.g. façade retrofits, window replacement). Internally, the tool translates the users' choices into parameters that are then provided to the calculation engine such as U values, alpha values, g-values, etc.

There are six possible measures which can be selected to upgrade the building fabric and/or building systems (Table 1):

Table 1. Improvement measures included in the USiT-Improvements tool

Improvement	Description	Affected parameter
Window improvement	Simulation of the results of replacing windows. There is the possibility to choose among seven frame types and nine glass types.	U value of the windows
Façade isolation improvement	Simulation of the results of adding new insulation materials to the building façade. There is the possibility to choose among four different types of insulation materials, with different thicknesses which can be applied either in the inner or outer faces of the wall.	U value of the wall
Roof isolation improvement	Simulation of the results of adding new insulation materials to the roof. It is possible to choose among four different types of insulation materials, with different thicknesses.	U value of the roof

Domestic hot water system improvement	Simulation of the results of replacing of the Domestic Hot Water (DHW) systems with more efficient ones. There is the possibility to choose among ten boilers.	Change of a DHW system
Heating system improvement	Simulation of the results after replacing the heating systems with more efficient ones. It is possible to choose among a list of a heating systems with different energy carriers and efficiency values.	Change of a heating system
Add renewable thermal energy supply	Simulation of the results of installing new renewable thermal energy supply systems. It is possible to indicate the percentage of the energy needs which will be supplied by the systems using renewal energy.	DHW covered with renewable value

Each of these potential improvements would bring about changes in some of the parameters of the buildings as described in Deliverable 5.3 *Tools for energy analysis*. Once the USiT – Improvements tool has translated the improvements selected by the user as URSOS parameters, an energy simulation for the building is performed with those inputs.

The interface of the USiT – Improvements tool let users select more than one improvement which will be applied to one or more buildings (Figure 8).

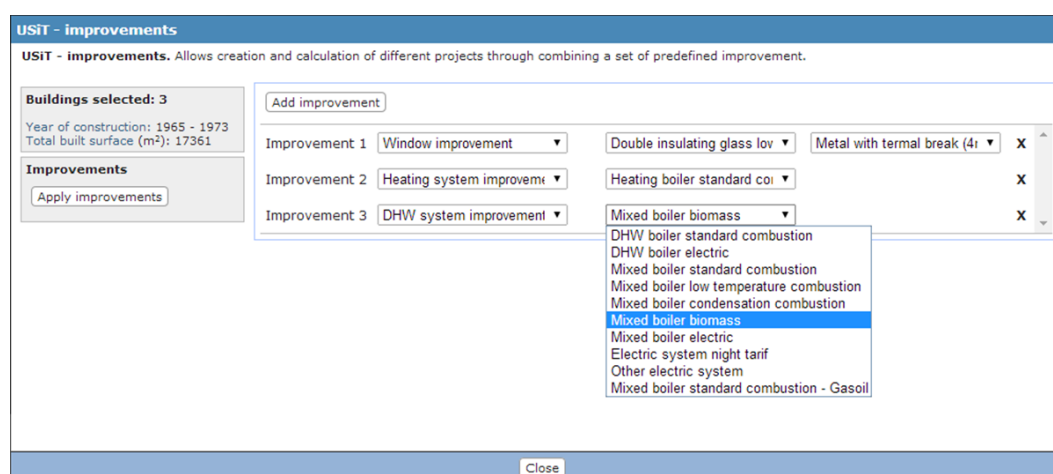


Figure 8. USiT – Improvements tool

4.1.2 SAP – Building improvement calculator tool (Newcastle)

This tool, which is based on the SAP calculation engine described in Deliverable 5.1 – henceforth named SAPMAP –, has been reported in Deliverable 5.3. It is used to calculate the energy performance of a dwelling after implementing some refits. Two types of refits can be performed: to the building fabric (e.g. adding more insulation) and to the capital (e.g. replacing the boiler used to generate heat). The user can select among six types of improvements that can be applied to the dwelling (Table 2):

Table 2. Improvement measures included in the SAP-Building improvement calculator tool

Improvement	Description
Adding solar PV panels to the house	Simulation of the results of adding solar PV panels with a specific orientation given by the user.
Adding solar thermal water heating to	Simulation of the results of adding solar thermal water heating

the house	system with a specific orientation given by the user.
Replacing the boiler currently in the property with a heat pump	Simulation of the results of replacing the boiler with a heat pump. The user specifies the heat source, fuel and convection method.
Replacing the boiler currently within the property with a micro CHP boiler	Simulation of the results of enhancing the boiler with a micro CHP boiler.
Replacing the boiler currently within the property with a combi boiler	Simulation of the results of replacing the boiler with a combi boiler.
Fitting additional insulation to the property	Simulation of the results of adding inner/outer wall insulation, filling in empty cavities in cavity walls, super-efficient windows, loft insulation, floor insulation and water cylinder insulation.
A social intervention	Changing the assumed internal temperature within the property.

The interface of the intervention assessment tool let users to apply more than one improvement at once (Figure 9). As in the USiT - Improvement tool, the selected improvement measures will give rise to an update of some of the building parameters. The updated parameters will be used in the energy efficiency calculation, while the parameters that are not affected by the interventions will be taken from the existing records stored in the urban energy model. The tool automatically calculates the following building performance indicators using the SAP calculation engine:

- SAP Rating
- Annual net CO₂ production
- Annual net CO₂ production per square meter of floor space
- Annual total energy use
- Annual cost

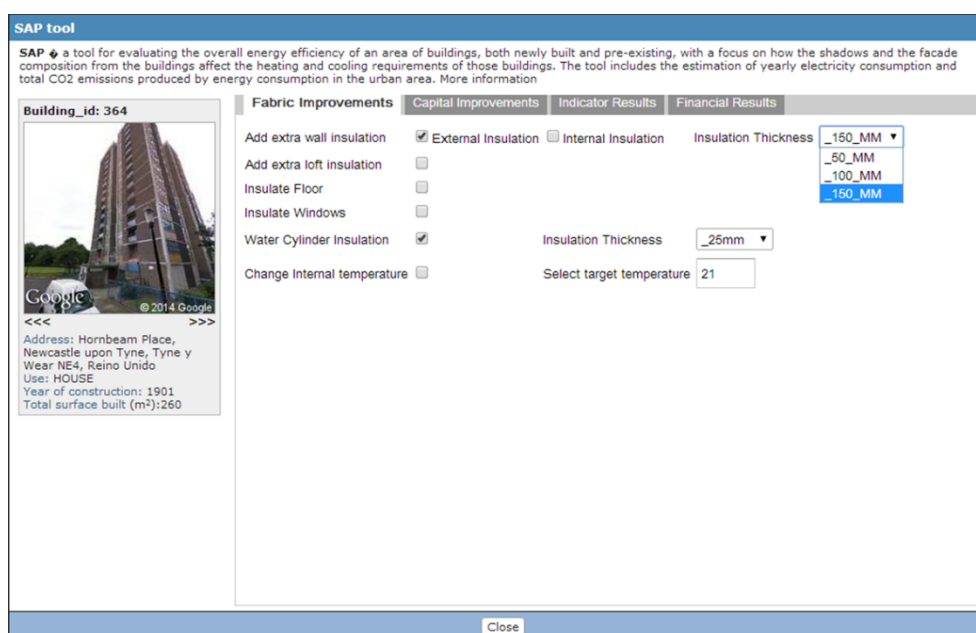


Figure 9. SAP – Building improvement calculator tool

4.1.3 Urban Energy Optimisation tool (Copenhagen)

The main objective of the Urban Energy Optimisation (UEO) tool created in Task 5.3 is to

determine the optimal combination of measures concerning sustainable energy supply and energy savings, in order to get the lowest possible costs, in a greenfield planning situation. While the Urban Energy Planning (UEP) tool developed in Task 5.1 is used in the context of urban energy models to determine the energy intensities for buildings and energy supply options, the UEO tool is used in plans and projects to optimize an urban area by applying one or more measures taking into account the energy reduction potentials and the related incremental cost.

The UEO tool considers three kinds of improvement according to the different degrees of insulation (Table 3):

Table 3. Improvement measures included in the Urban Energy Optimization tool

Improvement	Description	Parameters
Reference building	Based on minimum requirements in the Danish national building code (2010).	Insulation: 200 mm; window U-value: 2,0 W/m ² K
Insulation 1	Extra insulation of building envelope compared to reference building	Insulation: 100 mm (300 mm total); window U-value: 1,5 W/m ² K
Insulation 2	Extra insulation of building envelope compared to reference building	Insulation 200 mm (400 mm total); window U-value: 1,2 W/m ² K
Insulation 3	Extra insulation of building envelope compared to reference building	Insulation 300 mm (500 mm total); window U-value: 1,2 W/m ² K

The interface of UEO tool let users apply more than one improvement (Figure 10). The outputs of the tool are the reduction potential and the incremental cost resulting from the application of each one of the selected improvements.

Improvements	Reduction potential (kWh)	Incremental cost (€/kWh)
Improvement 1: Ground source cooling	6150.00	-17650.50
Improvement 2: Solar heating storage	192802.50	33579.00
Improvement 3: On shore wind turbines	65067.00	1537.50
Improvement 4: Solar pv	19557.00	85731.00

Figure 10. Urban Energy Optimisation tool

4.2 Multi-criteria decision analysis tool

The purpose of the multi-criteria decision analysis tool (MCDA) tool that has been integrated in the SEMANTCO platform is to support the decision making processes concerning the application of improvement measures by enabling the comparison of multiple differing projects for a given urban area using a multidimensional set of indicators. The MCDA tool was developed in Task 5.3 and comprehensively reported in Deliverable 5.3.

The MCDA tool is used to compare the various projects created within in a plan. The inputs to the tool is a list of projects and their performance indicators. The indicators of the overall project are calculated by aggregating the indicators of the buildings that belong to it. Both kinds of indicator depend on the tool selected for creating the urban energy model within which the plan had been created. Users can carry out more than one analysis on the same set of projects (Figure

11).

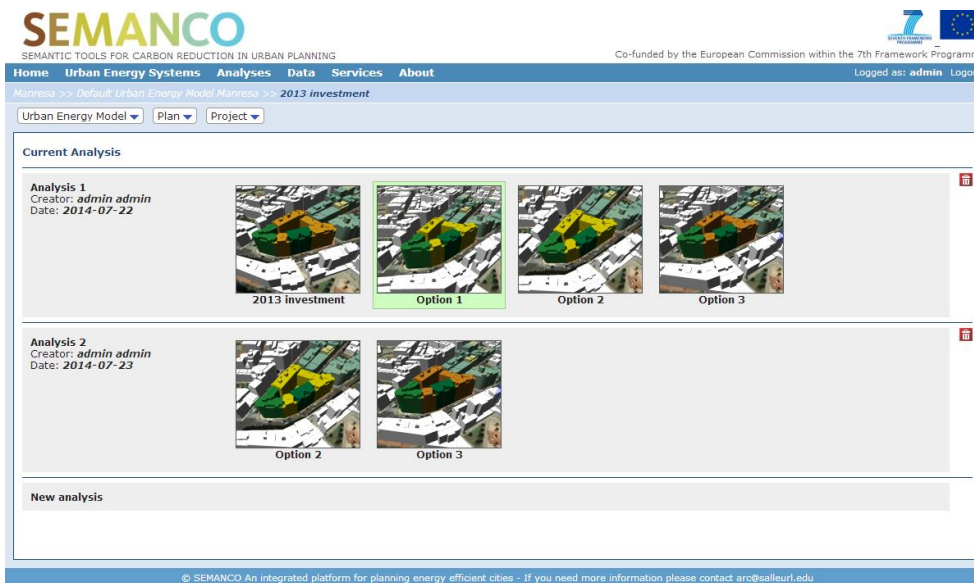


Figure 11. Multi-criteria decision analysis tool. Analysis selection

In order to perform an analysis, the user provides a name and the projects that are going to be compared. Only projects of the same plan can be included in the analysis. This way, the plan itself can be included as a baseline. Then, the user selects the indicators that will be used in the analysis. By default all the indicators are selected. For each indicator the user sets a weight between 1 and 5, where 1 is “not important” and 5 “very important”. The tool provides the values of the thresholds (i.e. the minimum value of an indicator that makes two projects different). The default values can be changed by the user. The user can add custom indicators to introduce some parameters that were not contemplated in the project, for instance, the social or political impacts (Figure 12).

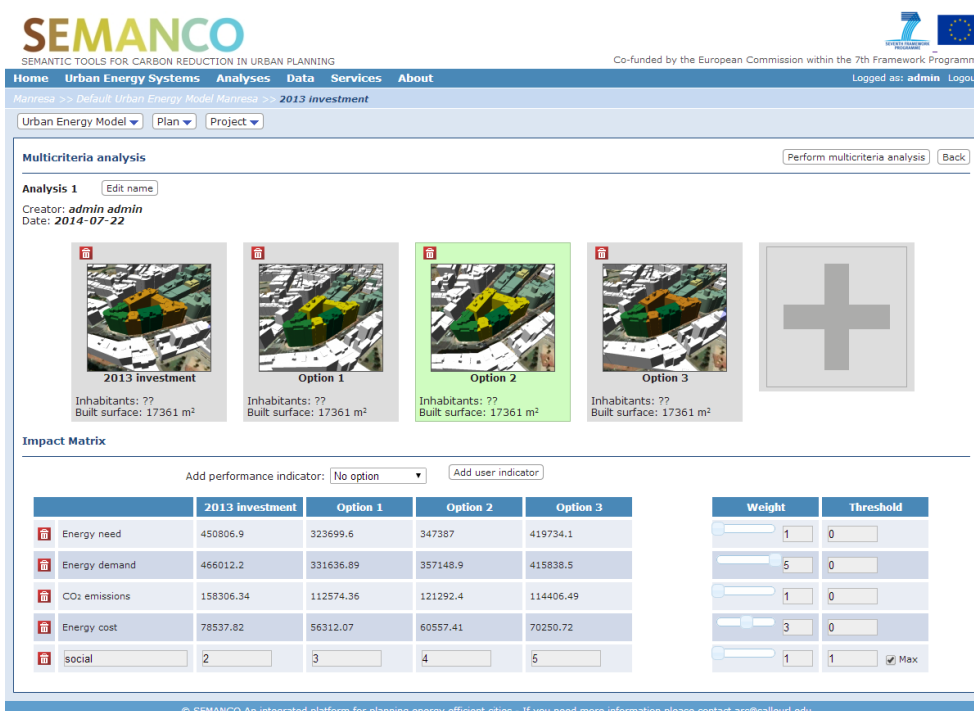


Figure 12. Multi-criteria decision analysis tool. Analysis configuration

The tool compares the projects among themselves in pairs using the weights and thresholds configured by the user. It calculates all possible pairwise rankings of the projects and then chooses the ‘most probable’ of these (Figure 13). The rankings are shown to the user ordered by a coefficient that represents the probability to be a valid ranking. The algorithm has been explained in detail in Deliverable 5.3. In each column, the projects are ordered from best (top) to worst (down). This way, the first project of the first ranking would be the best one. However, the user has the final decision to choose any other project as the “best”. By moving the mouse over the set of projects it is possible to compare one project to another.

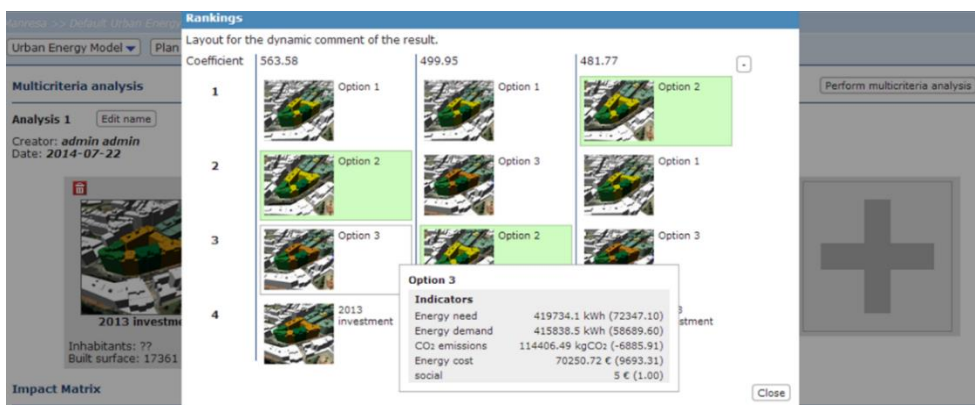


Figure 13. Multi-criteria decision analysis tool. Outputs of the analysis

5 INTERFACE ENHANCEMENTS

The interface of the platform has been enhanced since the prototype version. The main changes concern the overall layout and the integration of the different tools. Other minor changes have to do with the homogenization of the text font family, colors (background, text, links...), and padding between elements, among others.

The appearance of the pop-up windows which are displayed when a building is selected, have been standardized across the different environments and tools where they are displayed: labels, fonts, buttons, and content arrangement have now the same look in all cases. Figure 14 shows the pop-ups that are displayed in different contexts:

- An urban energy model that uses the Urban Simulation tool.
- An urban energy model that uses the SAPMAP tool.
- An urban energy model that uses the Urban Energy Planning tool.
- A project that uses the Urban Simulation tool.
- A project energy model that uses the SAPMAP tool.
- A project energy model that uses the Urban Energy Planning tool.

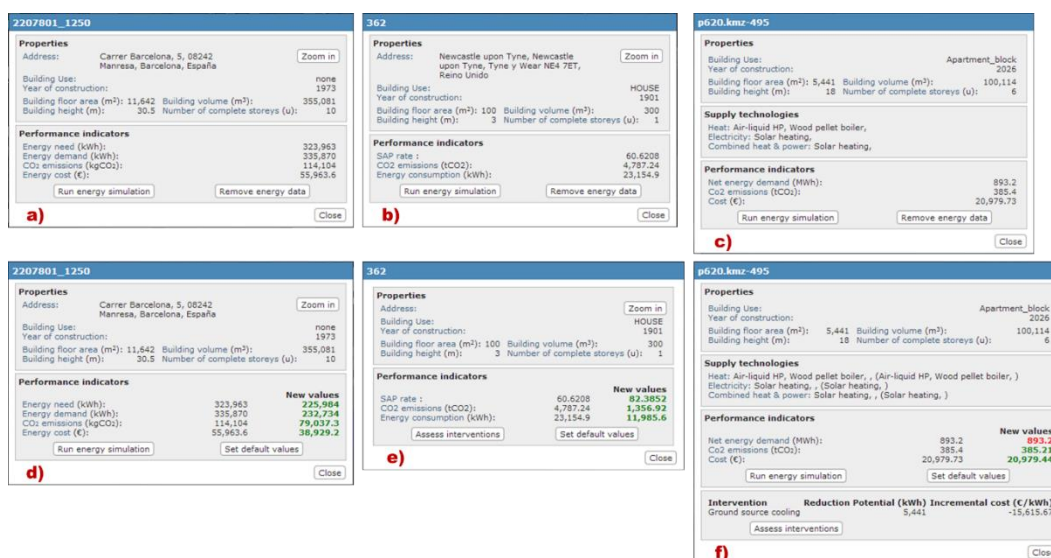


Figure 14. Standardization of the tool interfaces. A) USiT in UEM, b) SAP in UEM, c) UEP in UEM, d) USiT in projects, e) SAP in projects, f) UEO in projects

In the same line, the layout of the tools developed in Task 5.1 have been homogenized according to the same criteria (Figure 15). Besides, some new features have been introduced:

- The name of the tool and a brief description is placed at the top of the window.
- A panel summarizing the selected building/s is located on the right side, including a Google Streetview when this is available. The button to invoke the calculation engine is located below the summary panel which includes informative messages such as if the by default values are being used for the calculation.
- Placing the close button at the ending bar at the bottom.

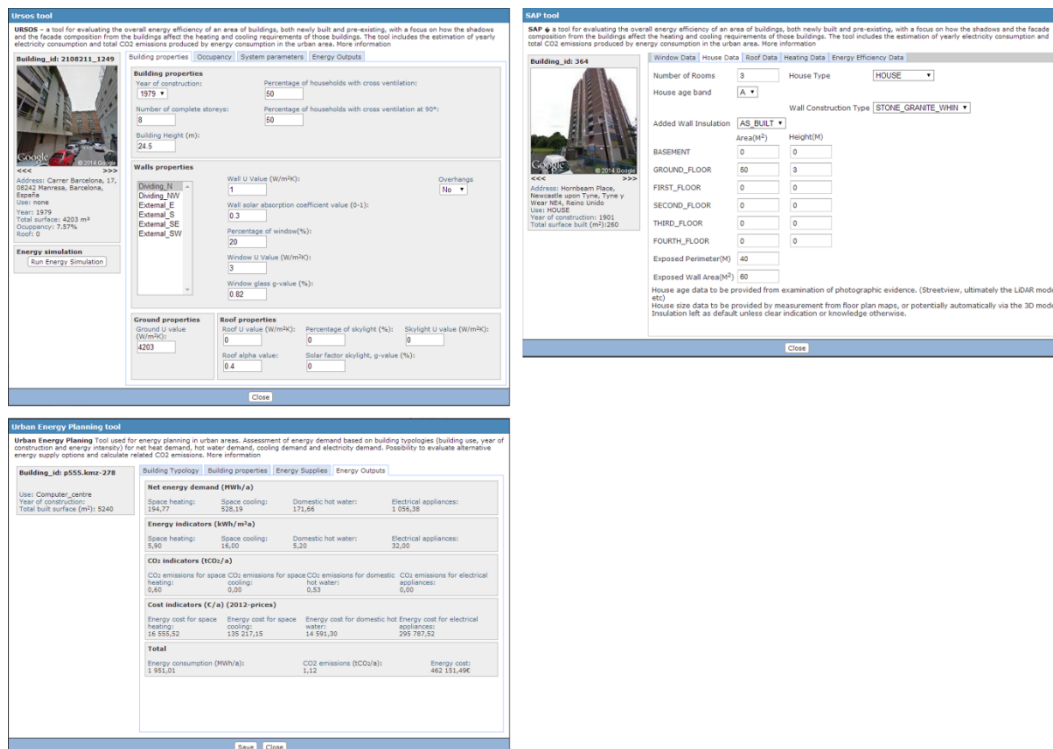


Figure 15. New design of the tools interfaces. Top-left, Urban Simulation Tool. Top-right, SAPMAP tool. Bottom, Urban Energy Planning tool

The information about indicators has been moved to the main window (Figure 16). This way, the main window displays these four types of information:

- **Indicators:** global indicators calculated by aggregating the indicators of the buildings of the urban energy model / project.
- **Urban model:** 3D visualization of the urban energy model / project.
- **Buildings:** A list of buildings which have been applied an energy assessment tool.
- **Clusters:** Diagram visualization for visually clustering the building by year of construction or use.

The user can switch between tabs to see the information about a given area in four different ways. For each type of information, the filters located at the bottom of the main window can be applied in the same way. The value given to the filters is maintained while changing tabs.

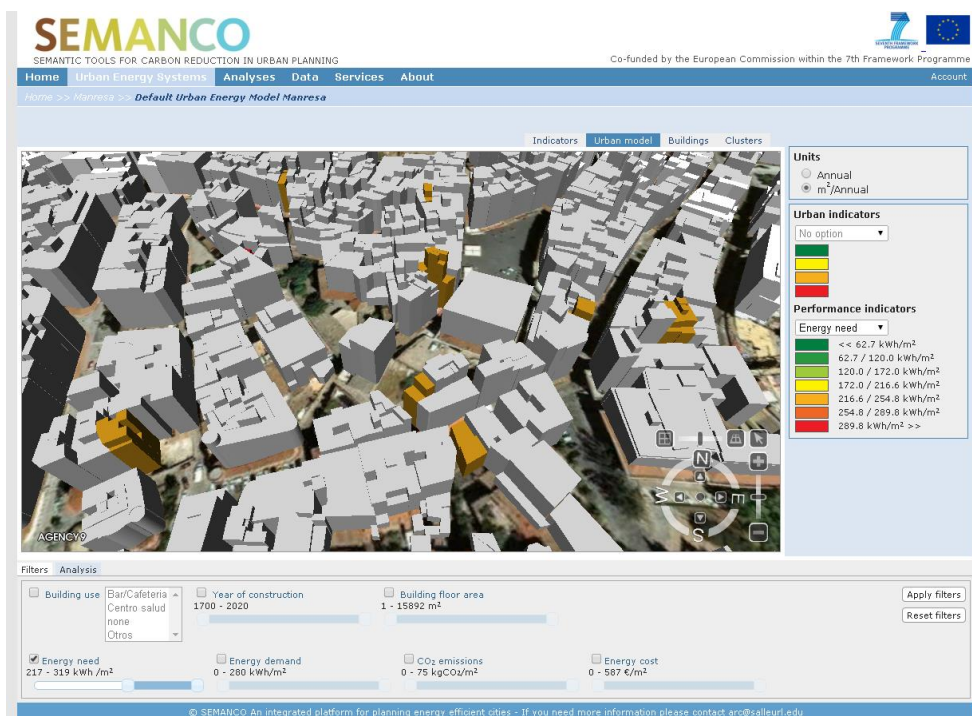


Figure 16. Update version of the main window with the four information visualization option: Indicators, 3d model, Buildings and Clusters

A tooltip feature has been implemented to let users know the meaning of the terms that appear in a form. This is particularly important in the case of the terms derived from the ontology, whose meaning has been agreed by users from different disciplines (Figure 17). Also, tooltips are used to explain the structure of the interface.

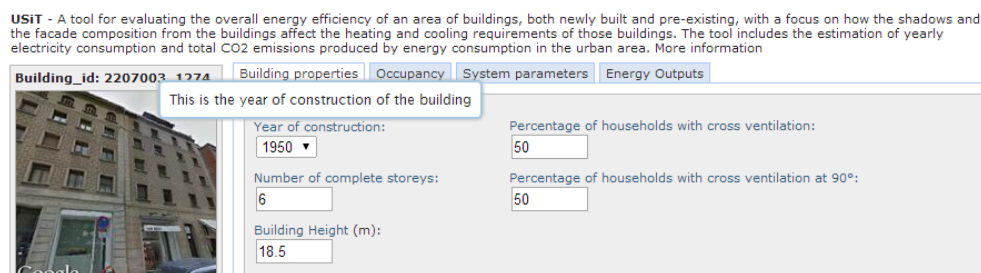


Figure 17. Tooltip feature in the USiT tool

6 ENHANCED FUNCTIONALITIES

Some new functionalities have been developed since the prototype version reported in Deliverable 5.4. They were proposed by the users participating in the demonstration scenarios, by energy experts in the consortium and by other stakeholders who participated in the dissemination events.

6.1 UEP tool

In the previous version of the Urban Energy Planning tool developed in Task 5.1, users could select only one supply technology for heating, cooling, and electricity. However, it is common in buildings to have more than one technology. A new version of the UEP tool overcomes this limitation (Figure 18). Thus, the users can specify the share of heat or electricity that a supply technology will provide. The calculation formulas have been updated in order to accept the new inputs.

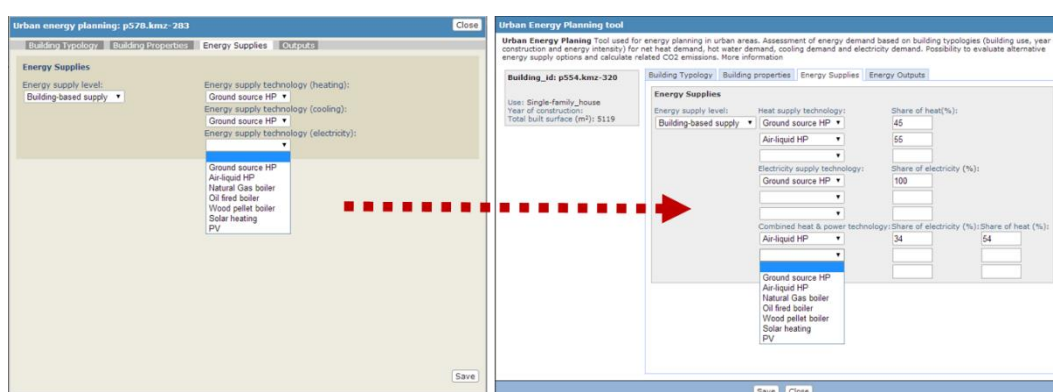


Figure 18. On the right, the old UEP interface; on the left, new UEP interface with the new energy supply technologies options.

6.2 Multi-scale aggregation

A multi-scale aggregation feature has been implemented to visualize the performance indicators at the urban scale, particularly at the neighbourhood scale. This feature can be seen in the urban energy system for Manresa for which data sources at the neighbourhood scale are available.

Since the information about the urban area (block, neighbourhood, district) to which a building belongs was not available, a generic method has been devised to find it out. It is based on a point-in-polygon algorithm that finds out whether a point representing a building lies inside, or outside of a polygon representing the boundary of the urban area. This means that an urban area is considered as a closed polygon having several edges and a building is represented as a single point. Such simplification can give rise to some few errors that can be assumed.

While navigating in the 3d map, the indicators change according to the scale that is visualized (Figure 19). The indicators of the upper scales (e.g. a block) are aggregated from the lower ones (e.g. buildings). For example, the energy need for a neighbourhood is calculated by adding all the energy need of the buildings that belong to that neighbourhood.



Figure 19. At the top, neighbourhood scale; at the bottom, building scale

6.3 Filters panel

Some new options have been added to the filters panel at the bottom part of the interface (Figure 20). They enable filtering buildings according to their properties, such as building use, year of construction, and the building floor area. In the case of the year of construction and building floor area the user has to select a range between two values. For the building use filter, the user can select among a fixed number of options. For example, building with an use of Single-family house and Stand-by duty.

The filters feature has been extended to all four tabs of the interface, when the filters are applied it will affect all tabs, so the figures shown in the Indicators tab will be those that affect the selection, and also the list of items that is shown in the Buildings tab are those also affected by the filters.

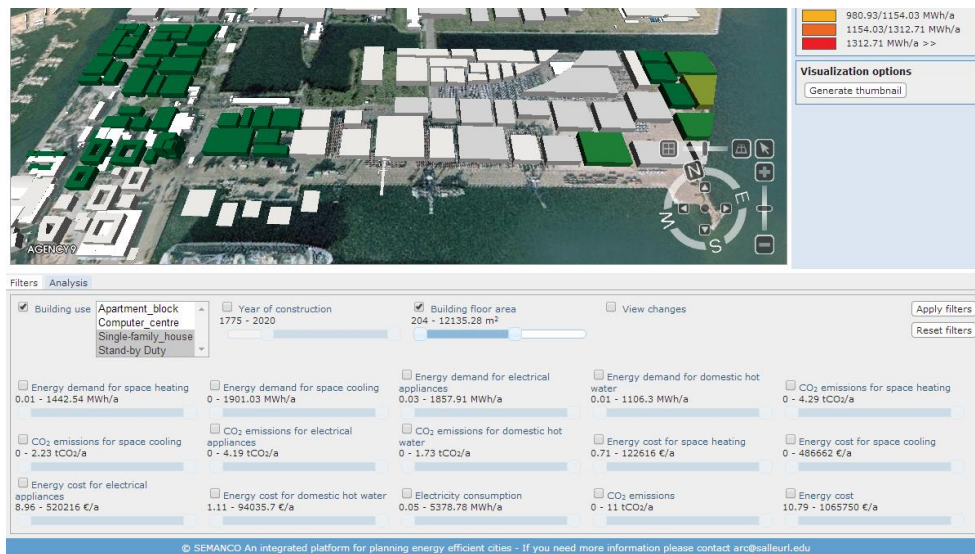


Figure 20. New filters available: Building use, year of construction, and building floor area

6.4 Indicators units

The units of the indicators can correspond to two kinds of aggregation: annual and square meters per year. The selections of the units' configuration parameter have an effect on all the interface panels: legend, pop-up windows, building list, clusters, indicators, filters (Figure 21). In the units are square meters per year (m^2/annual), the indicators are calculated by dividing the figure by the building floor area. For example, in Figure 21, the selected building has an energy need of 38507.9 kilowatts per year and a building floor area of 246 m^2 . If the square meters per year unit is selected (bottom part of the Figure 21) then the energy need becomes 156.5 kilowatts per square meter and year which is the result of dividing 38507.9 by 246.



Figure 21. Changing indicators units between annual and m^2/annual

7 USABILITY TEST

A usability test has been designed to assess the final implementation of the platform (Table 4). For that reason, the test will be carried out with during the last implementation cycle and the outputs will be reported in Deliverable 8.4 *Implementation effectiveness*.

The test includes five possible scenarios consisting of tasks to be performed by the user. Before starting the usability test, the facilitator (i.e. a consortium member) should give an overview of the platform: explaining the structure of the platform, the functionalities and the interaction with the interfaces by means of examples. Afterwards, a user carries out the tasks of a selected scenario.

The facilitator will be present during the execution of test to control the measuring of the time spent in the realization of the tasks, but he or she should not help the user to do the tasks. The facilitator should decide how many scenarios a user can do, considering the previous expertise of the user.

Once the tasks in a scenario have been completed, the user will evaluate the following features using a scale between 0 (worst) and 4 (best):

- **Navigation:** Could you navigate through the interfaces easily? For example, by changing from an Urban Energy Model view to Creating a Project and back,
- **Predictability:** Have the actions given the results you expected? For example, after applying a filter, selecting an item in a menu, running a tool,
- **Layout:** Is the layout of the different interfaces clear? For example, could you grasp the organization of information in the different areas, the position of menus,....
- **Graphics:** Is the content of the interfaces readable? Is the content of the menus readable? Are the contents of tables, charts, and maps understandable?

Table 4. Usability test

	Time spent	Task completed?	Navigation	Predictability	Layout	Graphics
Scenario 1: Creating an Urban Energy Model						
Task 1: Log in the platform						
Task 2: Load a “New Urban Energy Model”						
Task 3: Fill in the general data fields						
Task 4: Select the most proper tool to carry out the energy performance calculations						
Task 5: Customize the data related to the tool						
Task 6: Save the new Urban Energy Model						
Positive comments after completing the tasks:						

<p>Negative comments after completing the tasks:</p>						
<p>Scenario 2: Defining the baseline</p>						
<p>Task 1: Select a building</p>						
<p>Task 2: Load the tool</p>						
<p>Task 3: Fill in the tool form</p>						
<p>Task 4: Run the tool</p>						
<p>Task 5: Visualize the tool outputs</p>						
<p>Task 6: Do the same task for 10 buildings</p>						
<p>Task 7: Save the changes</p>						
<p>Task 8: Visualize the Urban Energy Model indicators</p>						
<p>Positive comments after completing the tasks:</p>						
<p>Negative comments after completing the tasks:</p>						
<p>Scenario 3: Analysing the baseline</p>						
<p>Task 1: Select an indicator to color buildings</p>						
<p>Task 2: Filter the buildings by adding some filters</p>						
<p>Task 3: In the Buildings tab, search for specific building use</p>						
<p>Task 4: In the Clusters tab, select the aggregation by year of construction</p>						
<p>Task 5: Modify the horizontal and vertical axis</p>						
<p>Task 6: Change the colors of the bubbles</p>						
<p>Positive comments after completing the tasks:</p>						
<p>Negative comments after completing the tasks:</p>						
<p>Scenario 4: Creating a new plan</p>						
<p>Task 1: Load “Creating a new plan for...”</p>						
<p>Task 2: Fill in the general data fields</p>						
<p>Task 3: Save the new Plan</p>						
<p>Task 4: Select some buildings and add them to the plan</p>						
<p>Task 5: Visualize all the selected buildings</p>						
<p>Positive comments after completing the tasks:</p>						

<p>Negative comments after completing the tasks:</p>						
<p>Scenario 5: Creating a new project</p>						
<p>Task 1: Load “Creating a new project for...”</p>						
<p>Task 2: Fill in the general data fields</p>						
<p>Task 3: Customize the data related to the tool</p>						
<p>Task 4: Save the new project</p>						
<p>Task 5: Visualize all the buildings that belong to the project</p>						
<p>Task 6: Select a building</p>						
<p>Task 7: Load the tool form</p>						
<p>Task 8: Fill in the tool form</p>						
<p>Task 9: Run the tool</p>						
<p>Task 10: Visualize the tool outputs and compare them to the baseline</p>						
<p>Task 11: Do the same task for 10 buildings</p>						
<p>Task 12: Save the changes</p>						
<p>Task 13: Visualize the project indicators</p>						
<p>Positive comments after completing the tasks:</p>						
<p>Negative comments after completing the tasks:</p>						
<p>Scenario 6: Comparing projects</p>						
<p>Task 1: Load a plan</p>						
<p>Task 2: Select the Compare option in Plan menu</p>						
<p>Task 3: Create a new analysis</p>						
<p>Task 4: Give a name for the analysis and save it</p>						
<p>Task 5: Select projects to be compared</p>						
<p>Task 6: Select indicators to be used in the analysis</p>						
<p>Task 7: Customize the weightand threshold parameters to be used in the analysis</p>						
<p>Task 8: Perform a multi-criteria analysis</p>						
<p>Task 9: Select the best project according to the outputs of the analysis.</p>						
<p>Task 10: Create a new analysis with an user indicator</p>						
<p>Positive comments after completing the tasks:</p>						
<p>Negative comments after completing the tasks:</p>						

8 CONCLUSIONS

8.1 Contribution to overall picture

The integrated platform presented in this report has contributed to bringing together the various components of the project: semantic data handled by the SEIF (WP4), multiple data sources (WP3), tools for energy assessment and analysis (WP5), requirements from stakeholders (WP6) and feedback from final users in demonstration scenarios (WP8). The platform has been the showcase of the project displayed in the various dissemination events (WP7). Impact on other WPs and Tasks.

8.2 Impact on other WPs and Tasks

The platform described in this report represents the final point of convergence of the different strands of work developed along the project. It will be the starting point of the work to be done in Task 5.8 *Energy service platform web portal* whose goal is to create a web portal oriented to future end-users of the platform. In this web portal, the functionalities of the tools will be explained to different target groups using a variety of written and visual material (documents, tutorials, videos).

8.3 Contribution to demonstration

The platform presented in this report will be the base of the third implementation of the demonstration scenarios to be carried out in the third year. The platform functionalities will be tested in real scenarios with users representing different decision-making domains in the three case studies. Also, at the moment it is being explored in which ways the platform could be implemented in other cities.

8.4 Other conclusions and lessons learned

One of the challenges in the development of the platform has been to create in parallel the tools that are integrated in it. This has required to work simultaneously at the platform level –structure of the platform interface (menus, environments, navigation); common interfaces for the tools; connections with the semantic data – and at the level of each tool – defining the functionalities, identifying required data, defining indicators –. This parallel development has facilitated the integration of all components. However, it has put more extra work on the design of the tool interfaces (styles, fonts, buttons) which underwent several reviews until they could be harmonized at the end of the process. The future enhancement of the platform – with the aggregation of new urban energy systems from the same cities participating in the project or from other cities – will require to apply the methodology described in Deliverable 1.8 *Project Methodology*, this means, defining use cases and activities, identifying data sources, using the terms of the existing ontology and adding new ones if they are needed. If the application of the platform to other cities continues in the future, it will be necessary to create a toolkit to facilitate its installation, a process which is now carried out manually by the developing team.

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