Project ICT 287534
Start: 2011-09-01
Duration: 36 months
Co-funded by the European Commission within the 7th Framework Programme

**SEMANCO Semantic Tools for Carbon Reduction in Urban Planning**

# Deliverable 5.4
# Prototype of the Integrated Platform

**Revision:** 8
**Due date:** 2013-08-31 (m24)
**Submission date:** 2013-10-29
**Lead contractor:** FUNITEC

| Dissemination level | | |
|---|---|---|
| PU | Public | X |
| PP | Restricted to other program participants (including the Commission Services) | |
| RE | Restricted to a group specified by the consortium (including the Commission Services) | |
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| Deliverable Administration & Summary | | | | | |
|---|---|---|---|---|---|
| **No & name** | **D5.4 Prototype of the integrated platform** | | | | |
| **Status** | Final | **Due** | M24 | **Date** | 2013-10-29 |
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| **Editor** | Leandro Madrazo (FUNITEC) | | | | |
| **DoW** | Prototype urban design tool: Prototype of an application developed on 3dMaps to enable planners to make design decisions based on the comparison of design alternatives. The application will interact with the SEIF. | | | | |
| **Comments** | | | | | |

**Document history**

| V | Date | Author | Description |
|---|---|---|---|
| 1 | 2013-07-15 | Leandro Madrazo (FUNITEC) | Structure of the document. |
| 2 | 2013-08-07 | Leandro Madrazo (FUNITEC) | Description of the development process. |
| 3 | 2013-10-04 | Leandro Madrazo (FUNITEC) | Describing the development process, describing the platform prototype. |
| 4 | 2013-10-07 | Leandro Madrazo, Álvaro Sicilia, David Ortiz (FUNITEC) | Completing chapters 4 and 5. |
| 5 | 2013-10-11 | Leandro Madrazo, Álvaro Sicilia (FUNITEC); German Nemirovski (HAS) | Completing description of integrated tools, platform structure and further work. |
| 6 | 2013-10-21 | Leandro Madrazo, Álvaro Sicilia (FUNITEC) | Reviewing descriptions of integrated tools; editing document. |
| 7 | 2013-10-25 | Pamela Hadida (FUNITEC) | Linguistic revision |
| 8 | 2013-10-28 | David Lynch (NEA) | Final proof-reading |

# Table of Contents

# 1 EXECUTIVE SUMMARY

This document presents the SEMANCO integrated platform at its current level of implementation, at the end of the second year of the project. The content of this report includes the development process undertaken in the last year of work -consisting of a sequence of cycles of design, development and testing of the platform prototype- as well as the structure and functionalities of the platform at its current stage of development.

The integrated platform is the front-end for users with different profiles to interact with the semantic data using tools that are associated to a model of an urban energy system.

This platform represents a crucial stage in the project as it implies putting together the different strands of work that are carried out in several work packages. At the core of the platform lies the Semantic Energy Information Framework (SEIF) which has been developed in work package 4. The SEIF provides access to the multiple data sources identified and categorized in work package 3. Building stock energy modelling and energy analysis tools developed in Task 5.1 and Task 5.2 have been integrated –to different extent– into the platform. This integration implies, basically: 1. linking the tools with the semantic data and 2. implementing interfaces which capture the work flow of users using the tools in the platform environment.

The platform enables users to define urban energy systems models for a given urban area. An urban energy model is thought of as the assembly of semantically modelled data, tools and users within a particular urban area. Urban energy models are characterized by the tools which can be applied to the urban area object of study, the input data that the tools need and the output data they generate as well as by the users profiles which use the tools within a particular decision making realm.

Within the platform, a variety of tools can interoperate through the exchange of data facilitated through the SEIF. Energy related data can be added to an urban energy model asynchronously over time, for example, by several users who use the tools to calculate baselines in an urban area. Scenario planning is carried out within a particular energy model, using the tools and data that characterize the model. Alternative plans can be evaluated against the baselines calculated for a particular model. Both, baselines and alternative plans use certain tools that are specific to the model. The multiuser platform fosters the participation of multiple users with different profiles: non-experts, domain experts, ontology engineers and platform developers.

Users can navigate through the information visualized in three different modes: 3d model, table, and diagram. They can interact with them to find out the information needed such as levels of fuel poverty, buildings with high energy consumption, hot spots where the $CO_2$ emissions are above certain level, among others.

The current prototype will be further developed in the third year. The ultimate objective is to create an open platform which can be expanded with additional data and tools for the current energy systems or for the newly created ones.

# 2 INTRODUCTION

## 2.1 Purpose and target group

This report presents the work carried out in Task 5.4 *Prototype of the integrated platform.* The purpose of this task has been to design and implement a platform prototype which facilitates access to the tools developed in Tasks 5.1 and 5.2 which interact with the semantically modelled data through the Semantic Energy Information Framework (SEIF). The prototype enables different types of user to visualize and analyze energy related data within a previously configured model of an urban energy system.

## 2.2 Contribution of partners

FUNITEC has been responsible for the design and conceptualization of the platform, as well as for its implementation. CIMNE and FORUM have collaborated in the design of the interfaces to integrate the energy assessment tools for the case study in Manresa. Ramboll has contributed to the design of the configuration of the urban energy systems model and to the integration of some components in the platform. NEA has carried out some testing of the functionalities of the platform during dissemination events and meetings and provided feed-backs regarding its design and functionalities. UoT was responsible for the refinement, and appropriate adaption of the tools related to the Newcastle use case.

## 2.3 Relations to other activities in the project

The creation of the integrated platform represents a crucial step in the project development as it brings together different project components –multiple data sources, semantic data, energy assessment tools– within a common operative environment. The starting point of its development has been the inputs received from the requirements capture process carried out in direct contact with stakeholders (WP6), and from those provided by the implementation of the use cases in the first iteration of demonstration scenarios (WP8).

The integrated platform has become the driver of the work carried out in the second year of the project. The need of integrating the tools created in Task 5.1 *Building stock energy modelling tool* and Task 5.2 *Energy analysis, and optimization and strategic decision tools* in the platform brought partners to build a common understanding of the platform and to understand the role that the tools play within it.

The platform described in this report will be used by end-users in the three cases studies – Newcastle, Manresa and Copenhagen– in the two demonstration scenarios to be implemented in the third year of the project (WP8). They will use the tools to feed the urban energy models with data, to visualize and analyze the information provided by the platform, to calculate baselines and to propose and evaluate alternative plans to improve existing conditions. The feedback provided by the demonstration scenarios carried out in the three case studies will contribute to refine and further develop the existing platform.

Furthermore, the platform prototype will play an important role in the dissemination work (WP7) in the third year of the project. A further public presentation is scheduled to happen in the context of the ICT 2013 exhibition in Vilnius, November 2013.

# 3 Development Process

## 3.1 The need of an integrated platform

At the outset, the technological platform foreseen in the original Description of the Work of the SEMANCO project included the data repositories of energy related information, a Semantic Energy Information Framework, and a set of tools to interoperate with the semantic modelled data (Figure 1).

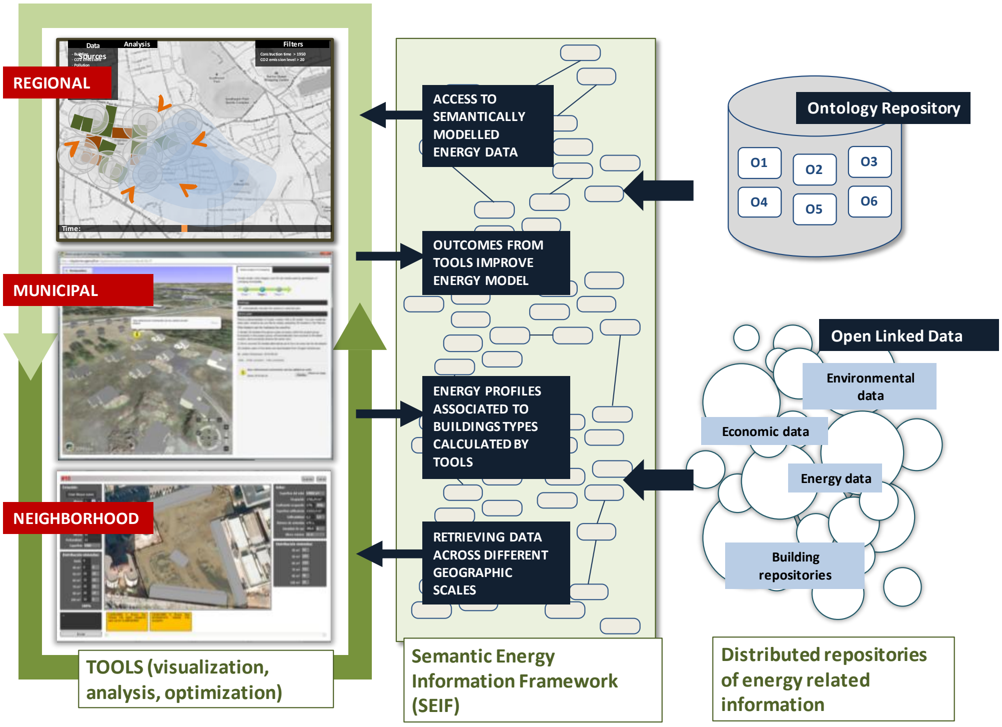



*Figure 1. SEMANCO technological platform as presented in the original DoW*

After the first year of work, it became clear that it was also necessary to count with a front-end which would facilitate different user's access to the tools and semantic data for a particular urban area. As it was stated in Deliverable 1.2 *IPR Management Plan*, "The purpose of SEMANCO is to develop an on-line integrated platform of tools and services that can be used by different stakeholders involved in the design and implementation of actions aimed at reducing carbon emissions at the urban scale".

Likewise, it became necessary to differentiate among the different tools available in the platform. As it was described in the amended version of the DoW (version 23.4.13, pp-13-14), there will be three types of tools in the platform (Figure 2):

- **Embedded**: intrinsic to the platform and developed specifically for the project;
- **Interfaced**: existing tools which interact with other tools and services from the platform via the interfaces built in the project; and
- **External**: existing tools which can be fed with data obtained from the platform and whose outputs can be stored in it.

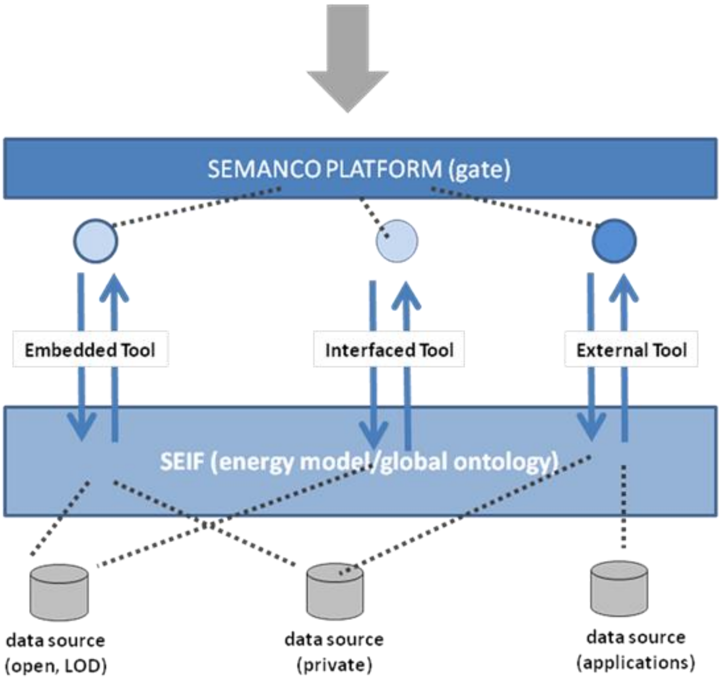



*Figure 2. The three types of tools integrated in the SEMANCO platform*

These tools are used to assess and visualize energy related data, and to create plans to improve existing baselines.

## 3.2 Development of the prototype

The design and development of the platform prototype has been a complex process which has required both, a top-down and bottom-up approach. Whereas an overall vision of the platform structure and its functionalities were being devised, the separate components that make the platform –the SEIF, the tools– were being developed in WP4 and WP5. The convergence of both approaches –top-down and bottom-up– required a strategy aimed to maintain the mutual interaction between the whole and the parts throughout the whole platform development.

The needs of the potential end-users have been taken into account in the design, development and evaluation stages. A process of requirements capture was conducted through meetings with stakeholders which helped to define the use cases for each case study (WP6); a verification of the platform functionalities was conducted within the consortium as the platform was being developed (WP5) and their application to the use cases and activities was tested by specific users (WP8). Considering the end-users from the start has been important to create a platform which responds to their actual needs, and which eventually would help them to improve their decision making processes in their actual working environments. By proceeding in this way, we wished to avoid ending up with a tool which is primarily a proof of concept rather than one which can potentially have a real impact after the end of the project.

### 3.2.1 Rapid prototyping

In order to facilitate the sequence design-development-evaluation during the platform development, a process of rapid prototyping has been carried out in cycles. By means of mock-ups depicting the platform structure, interfaces and workflow, the development team from FUNITEC has been able to communicate their vision of the platform to other partners and have their feed-back. In turn, partners have used the mock-ups for communication purposes, to have feedback from stakeholders and users in the three cases of study.

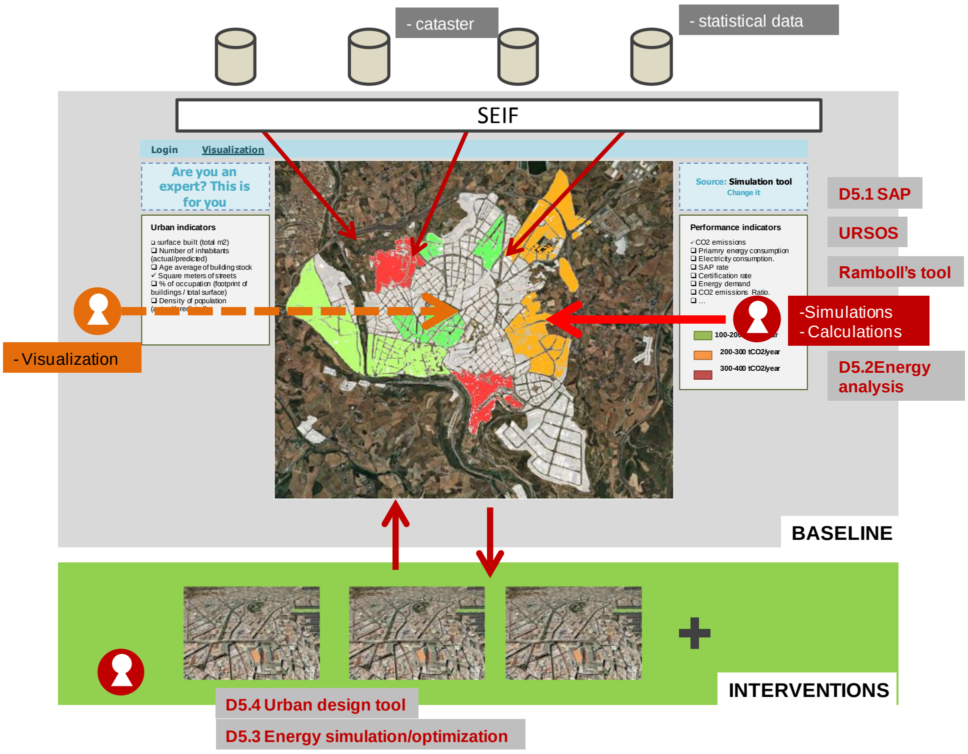



*Figure 3. An early structure of the platform environments*

### 3.2.2 Integration process

During a later stage of the development process, once a prototype version based on mock-ups was considered to be consolidated, a process started with the aim of converging different strands of work carried out in the different work packages in the platform. A procedure was designed to enable partners in charge of the case studies to integrate user and stakeholders feed-back into the platform development.

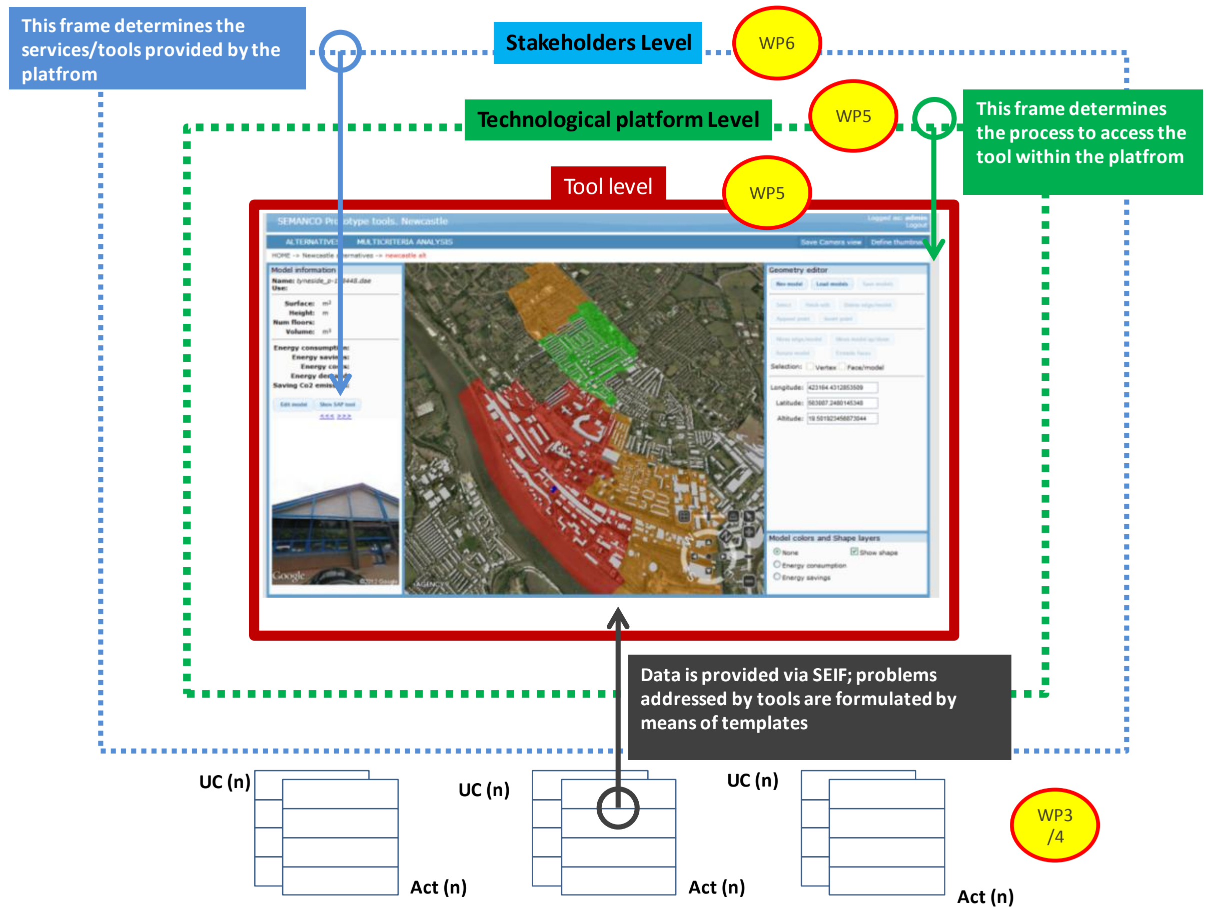



*Figure 4. An early structure of the platform environments*

The steps followed in this process are summarized in the next sections.

### 3.2.2.1 Integration process: Stage 1

The purpose of the first stage of the integration process was to align use cases and the platform development by identifying the data and data sources which needed to be semantically modelled and providing specifications for the tools which would interoperate with that data. To derive this information, a template was facilitated to partners (Table 1). For each activity to be carried out in a certain use case, the data input and output, the tools required and the task in charge of developing the tool were specified. The contents provided by partners as though this table is presented in appendix A.

At this stage of the integration process, the required tools were classified as:

- Data Generation Tools, which create new data and store it in the SEIF framework.

- Selection Tools, which support the user during the navigation in a 3Dmodel, helping to define an area and its scale.

- Task Management Tools, which facilitate the selection from a list of pre-defined tasks (calculation, estimation, prediction) of the one which best suits the selected area. For example, selecting alternative sub-tasks or the level of data aggregation.

- Calculation and Simulation Tools, which carry out calculations based on their built-in engines using the data obtained from the platform (e.g. URSOS, LEAP).

- Approximation/Extrapolation Tools, which exploit data mining technologies to estimate/approximate parameters of various objects related to a certain urban scale level.

- Prediction Tools, which use input data provided by the previous tools to predict the development of given parameters for urban objects on the given urban scale level (e.g. development of $CO_2$ emission)

- Data Visualization Tools, to visualize the results of data mining or to illustrate large data sets graphically, for their analysis by the end user using different graphic techniques (e.g. charts, scatter plot matrix or parallel coordinate matrix)

*Table 1. Template to align use cases and tools*

| **USE CASE 10: To calculate the energy consumption, carbon emissions costs and /or socioeconomic benefits of an urban plan for a new or existing development** | | | | |
|---|---|---|---|---|
| **Activity** | **Data input** | **Data output** | **Tool required*** | **Related Task**** |
| A1. Creation of alternatives | 3D models, type of building, building parameters… | A 3d model enriched with energy information | Data Generation | T5.4 |
| A2. Integration of socio-economic data and occupation parameters | | | Data Generation | T5.4 |
| … | | | | |
| A5. Calculation of energy performance | | | Calculation Tool | T5.1 |
| … | | | | |

Along with the table, a mock-up was created to represent the workflow of users describing their needs and the tools required to analyze the data (Figure 5).


*Figure 5. Mock-up of the first integration cycle*

Following the analysis of the inputs provided by the different partners, the next release of the prototype was created (Figure 6). This, in turn, gave rise to new questions to be answered in the next integration stage


*Figure 6. Evolution from the previous to the platform implementation*

### 3.2.2.2 Integration process: Stage 2

The goal of the second stage of the integration process was to bring together the domain experts with the developers of the integrated platform and component tools. Accordingly, partners were expected to meet with stakeholders in working sessions to have their requirements for the platform, using as communication tools mock-ups and interviews. This work is closely related with Task 6.1 *Defining the problem domain and scope of the tools within the case study scenarios*. On the other hand, partners responsible for the implementation of the tools in the three case studies provided more precise specifications of the interfaces (Figures 7-9).

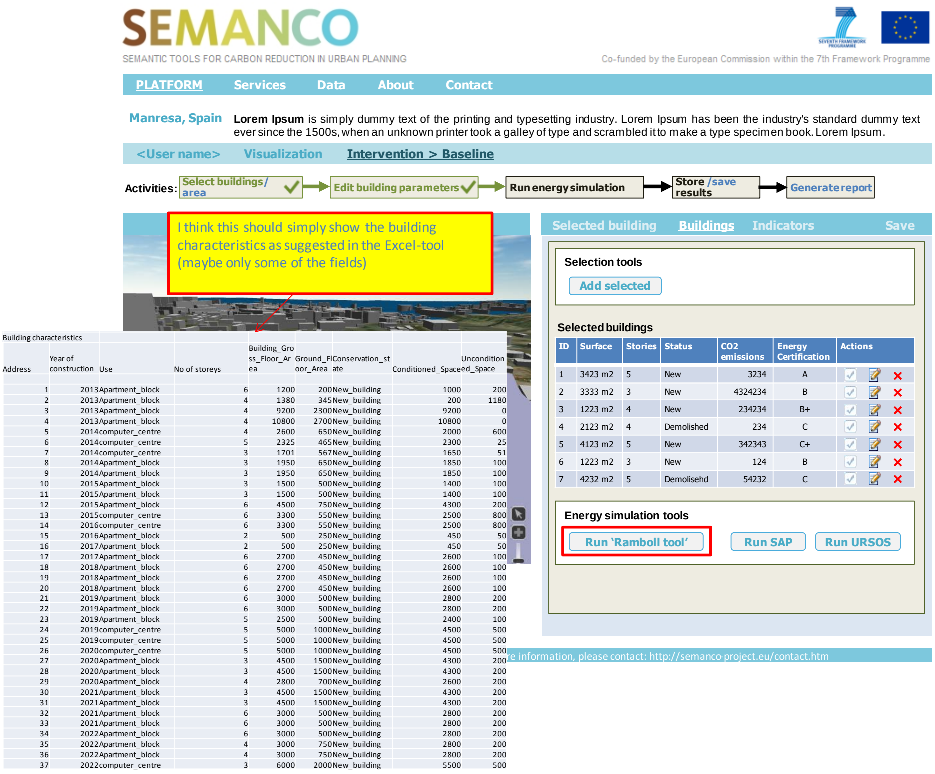



*Figure 7. Feed-back provided by Ramboll to FUNITEC*

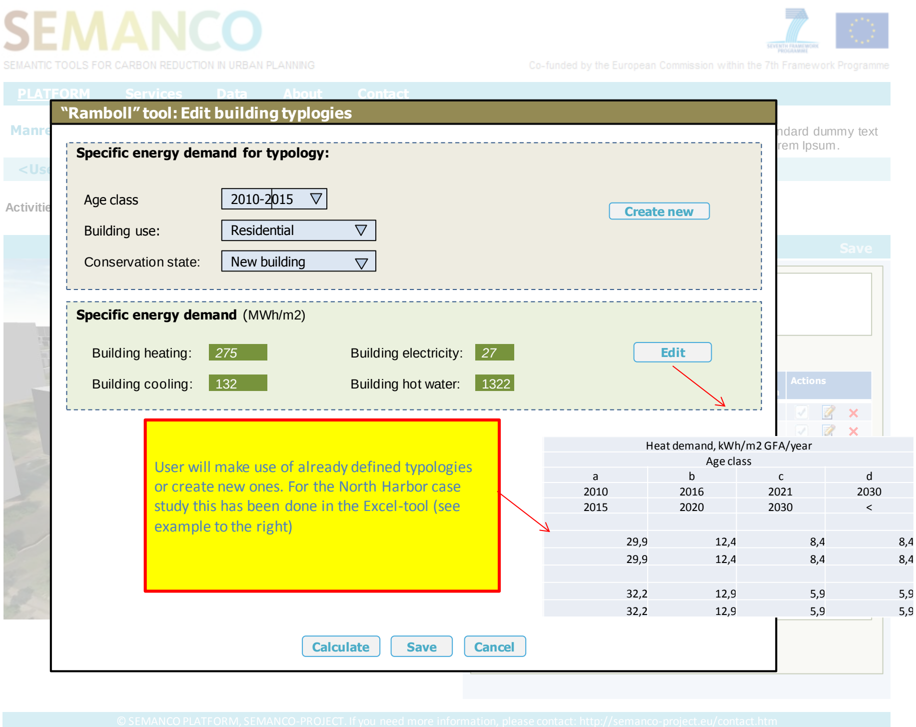



*Figure 8. Feed-back provided by Ramboll to FUNITEC*

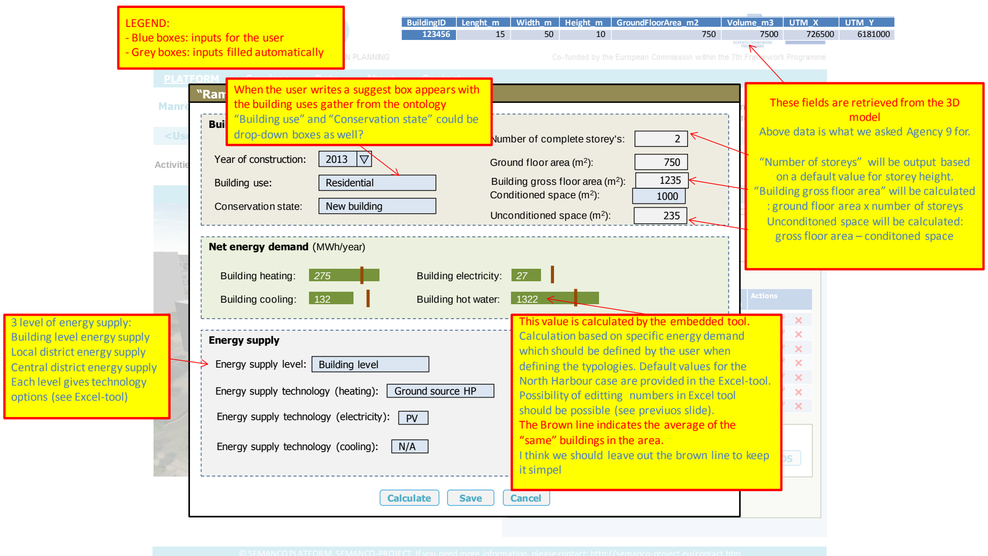



*Figure 9. Feed-back provided by Ramboll to FUNITEC*

### 3.2.2.3 Integration process: Stage 3

One of the goals of the third stage of the integration process was to assure the alignment of the platform and tools development with the work in other work packages, particularly with WP6 and WP8 (Figure 10). The feedback collected from stakeholders meetings and demonstration scenarios in the previous stage was confronted with the current state of the technological development.

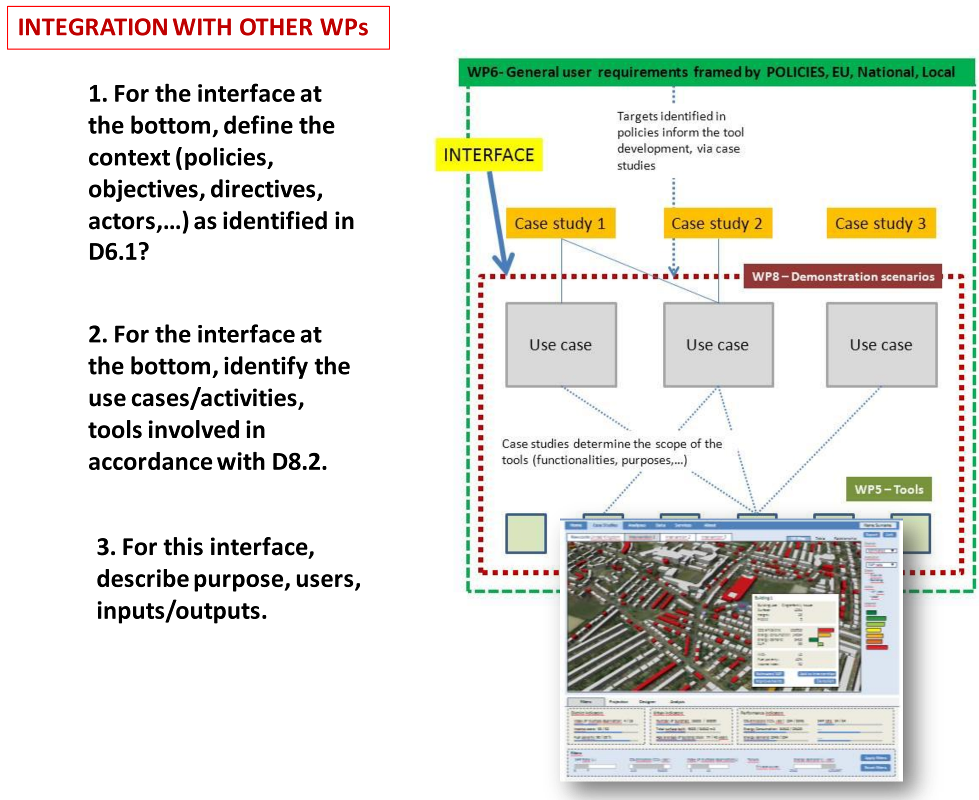



*Figure 10. Integration of platform development with other WP6 and WP8.*

At this stage of the integration process, the layout and structure of the platform underwent a thorough revision. More space was given to the graphic window by removing one of the two information columns in the previous layout. The information contained in those columns was placed at the bottom of the graphic window (Figure 11). In this way, it became easier to interact with the 3d model, applying the filters and selecting the indicators whereas there was more space dedicated to visualization.

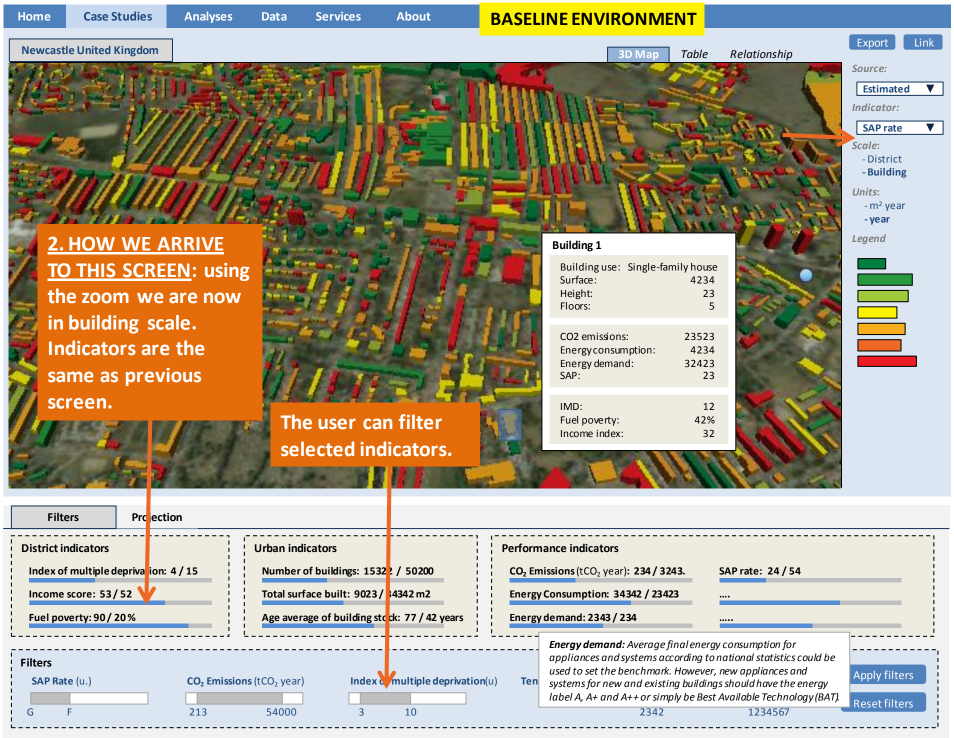



*Figure 11. New design of the layout providing more space for the graphic window*

Together with the 3d model, two more visualization modes were added which complement it while facilitating alternative ways to reach information: a table (Figure 12) and a diagram (Figure 13).


*Figure 12. Accessing information in a table.*

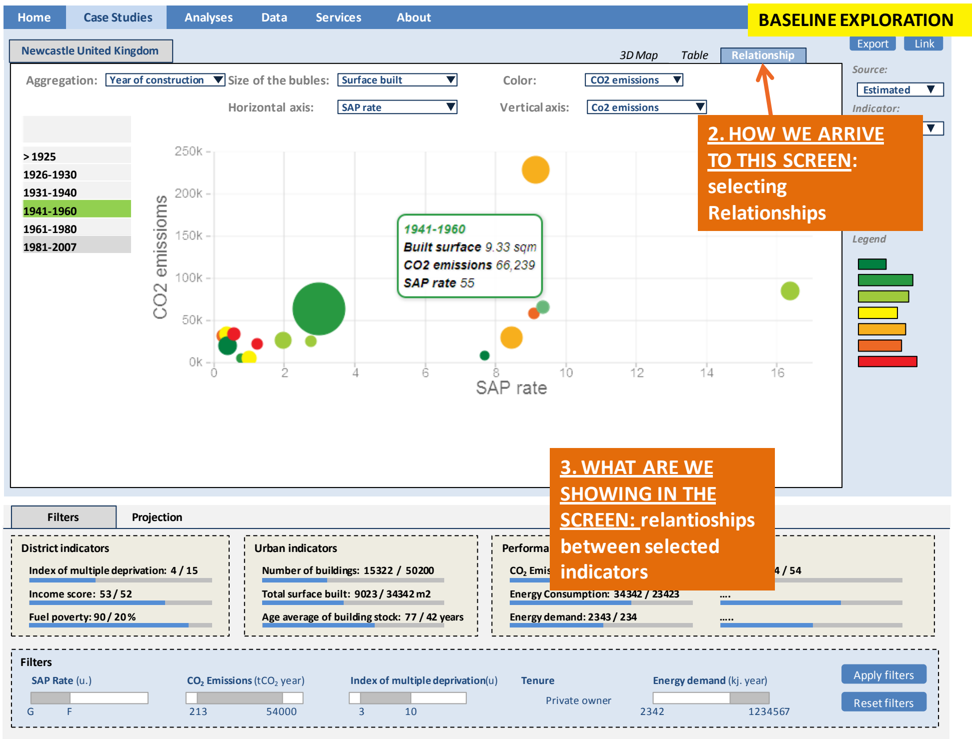



*Figure 13. Accessing information in a diagram.*

### 3.2.2.4 Integration process: Stage 4

By the fourth step of the integration process, it was possible to harmonize the development of the tools produced by separate tasks of WP5 with the development of the integrated platform (Figure 14). The functionalities of the tools within the platform were defined.

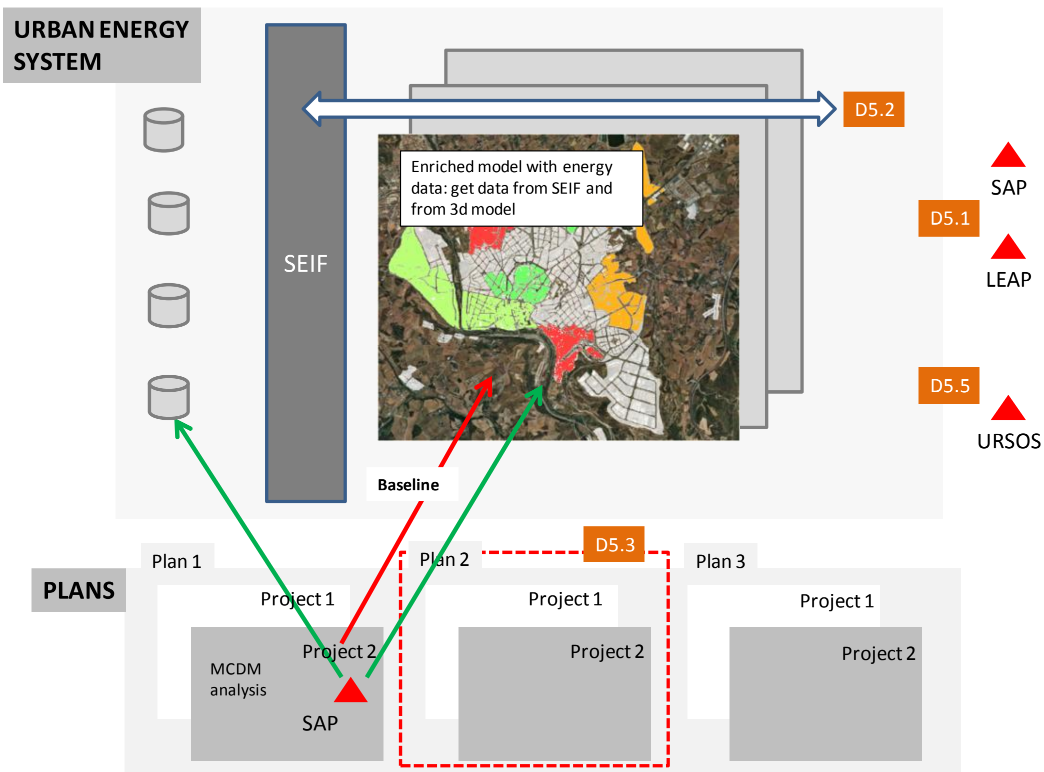



*Figure 14. Coordinated development of tools and platform*

### 3.2.2.5 Integration process: Stage 5

At a later stage, the platform has been conceptualized as an environment which provides users with the possibility to create multiple models of an urban energy system.[1] Each model is created with the data and tools available through the platform. Within a particular model, expert users can create plan and evaluate alternatives. The concept of urban energy model helps to encapsulate tools, data and users in a coherent framework (Figure 15).

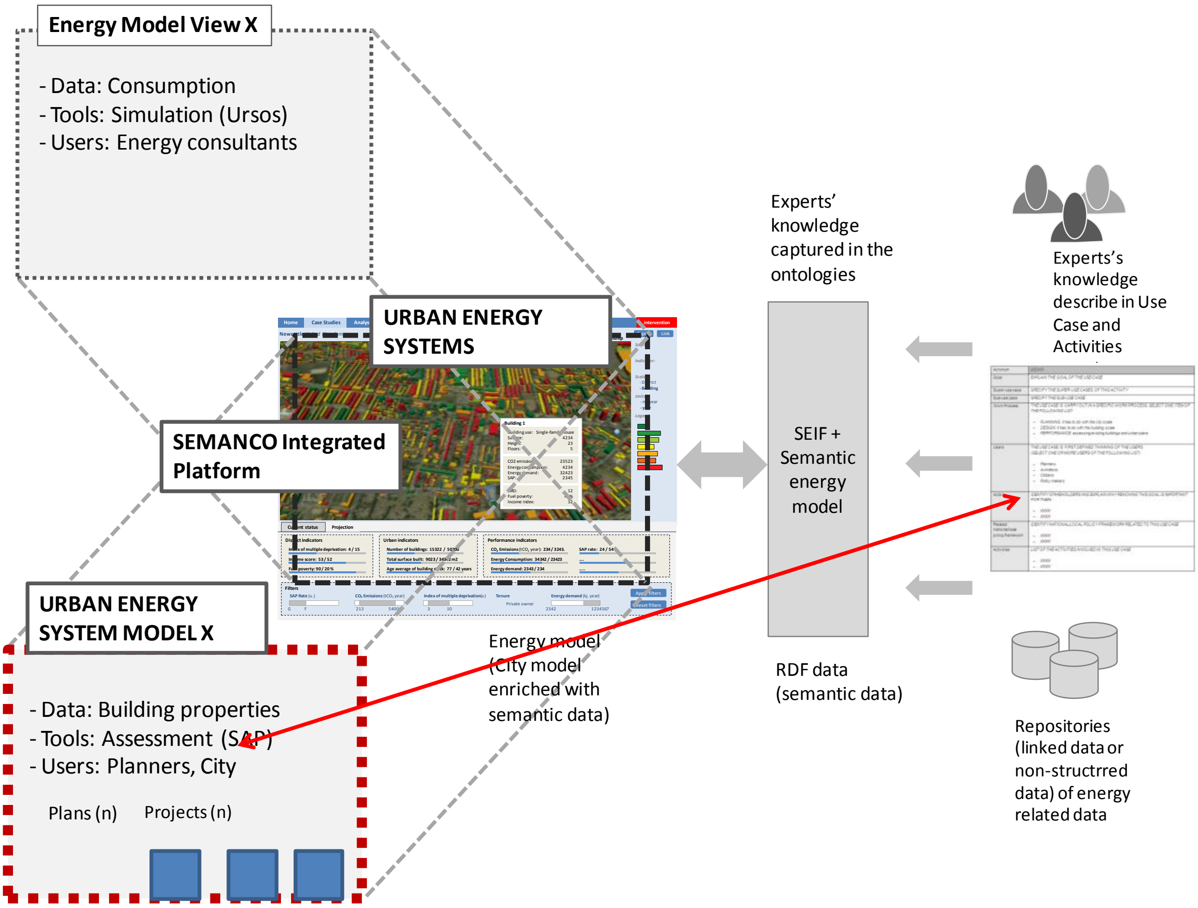



*Figure 15. Urban energy models and systems*

Within a particular energy model, domain experts can represent the existing conditions of an urban system (descriptive model), analyse its future evolution (predictive model), explore different scenarios for future development (exploratory model) and propose plans and evaluate measures to improve the performance of the system (planning model)[2] using

[1] 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, 2013b) 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). 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). An urban energy model is expected to provide answers to questions formulated by actors involved in the improvement of the urban energy system's efficiency as, for example, how much energy an urban area is consuming and what for, how consumption could be reduced, what are the connections between urban density and energy demand.

[2] These four types of models are identified in Echenique (1972).

multicriteria decision analyses tools[3].

For each energy model, the platform provides a stack of data layers which interact with the available set of tools. Data layers and tools are closely related. Additional data layers can be created as new tools are available or existing tools enhanced. Through the SEIF, the different data layers become interlinked. This way, it is possible to provide tools with the input data assembled from different data layers. This exchange of data through the SEIF facilitates the interoperability in three different ways: between data, between data and tools and between tools (Figure 16).

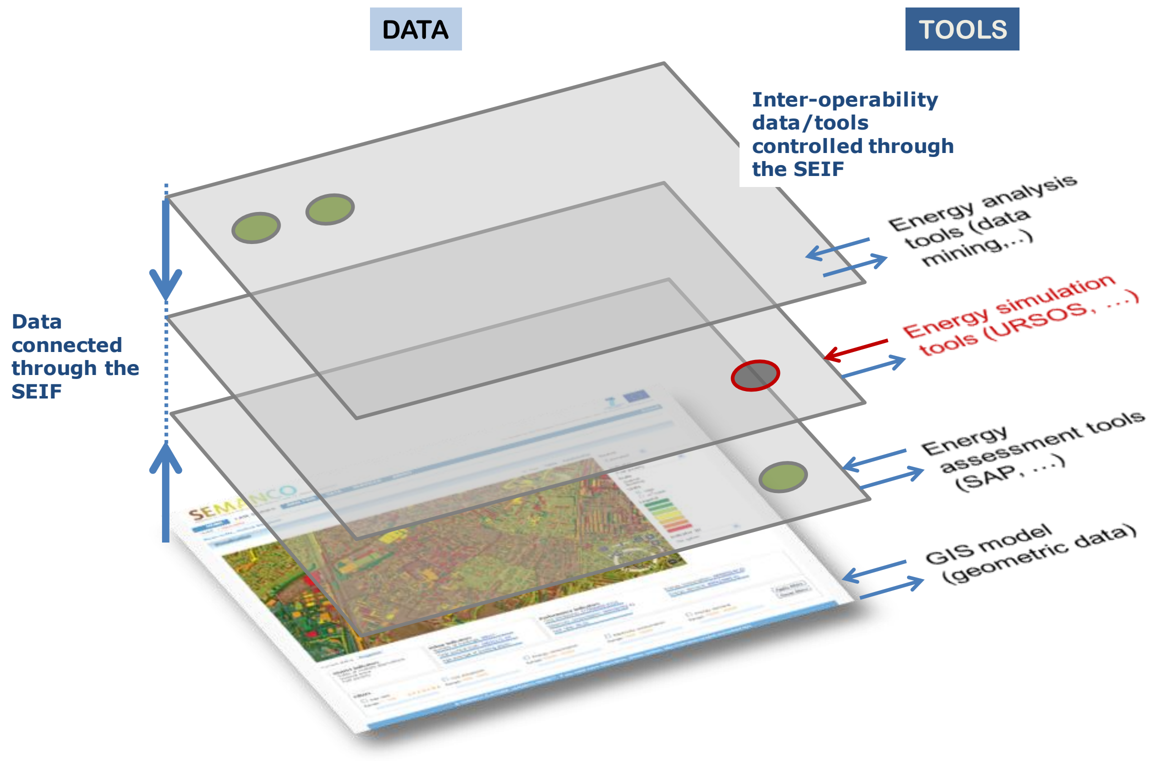



*Figure 16. Interoperability between data and tools through the platform*

## 3.3 Conclusions from the development process

The process of development of the integrated platform has been carried out simultaneously in two directions: top-down and bottom-up. We started with a rough draft of the platform which has progressively evolved while at the same time the requirements for the tools were being defined and the tools implemented. This process has required a reciprocal approach from both directions –top and bottom– which has been carried out step-by-step through the successive stages described above. Along with this process, the level of complexity of the platform –with regard to its structure, functionalities, interface design– has increased while the initial prototype has become steadily upgraded.

In parallel to the purely technological development, there has been another process whose purpose has been to capture the stakeholders and user requirements which helped to define the functionalities and purpose of the platform. Again, as in the technological development, we are confronted with the “chicken-and-egg” problem: stakeholders and users could not provide feed-back unless they have a certain idea –an image– of the benefits that a platform which

[3] Yamaguchi and Shimoda (2010) provide an example of the application of a set of tools to analyse alternatives to improve energy performance in a district within a given energy model.

facilitates access to multiple sources of data and tools to visualize this data and analyze it, could provide to them. To break the circle, mock-ups of the platform were presented to users and stakeholders in order to have them involved in the process of defining the platform requirements.

# 4 PLATFORM PROTOTYPE

In the previous section, we have described the process that was followed to arrive to the current prototype of the platform which is now described in this section.

## 4.1 Platform scope

The SEMANCO platform enables different types of users to participate in the creation, maintenance and operation of models of urban energy systems with the purpose of assessing the current energy performance of an urban area and to undertake planning actions to improve it. It is meant to be a decision support system for planning energy efficient urban areas, what is known in the literature as a Planning and Design Decision Support System (PDDSS).

Systems to support decision making of the various stakeholders involved in planning have been already created, even without the help of computer technology. McHarg (1969), for example, proposed a procedure to based on the following sequence of actions (see Kwartler & Longo, 2008, p7):

- formulate a question or query;
- assemble the data needed to respond to the question;
- determine the variables and formulate criteria to be used to screen the data;
- establish the sequence of analysis most critical to the least critical variables;
- select the appropriate display format or formats.

This procedure, which begins with the formulation of a question or query by a group of stakeholders, is comparable to the use case methodology which lies at the core of the development of the SEMANCO platform (see D1.8 *Project Methodology*). What the integrated platform enables is to carry out the subsequent processes to access the data, formulate the criteria to screen the data, carry out the analysis of the data and display it in multiple formats.

Most recent PDSS operates in conjunction with GIS data. Such systems enable users to create and evaluate scenarios. Some examples of such system are PLACE (Planning for Community Energy, Economic, and Environmental Sustainability), CommunityViz and INDEX (Kwartler & Longo, 2008) and SynCity (Keirstead & Shah, 2013a). Like these systems, SEMANCO's platform facilitates design scenario construction and evaluation within a particular urban model and applies multicriteria decision analysis tools to come up with the optimal solution.

## 4.2 Platform specifications

The integrated platform is the nexus between the multiple data sources and the tools that can interact with it (Figure 17). Within the platform, Urban Energy Models (UEM) are created as a result of combining data, users and tools which interact to each other through the SEIF, the semantic framework. Accordingly, a tool integrated in the platform knows –through the SEIF– which data is needed and where to find it. Conversely, the data generated by a tool is properly stored through the SEIF.

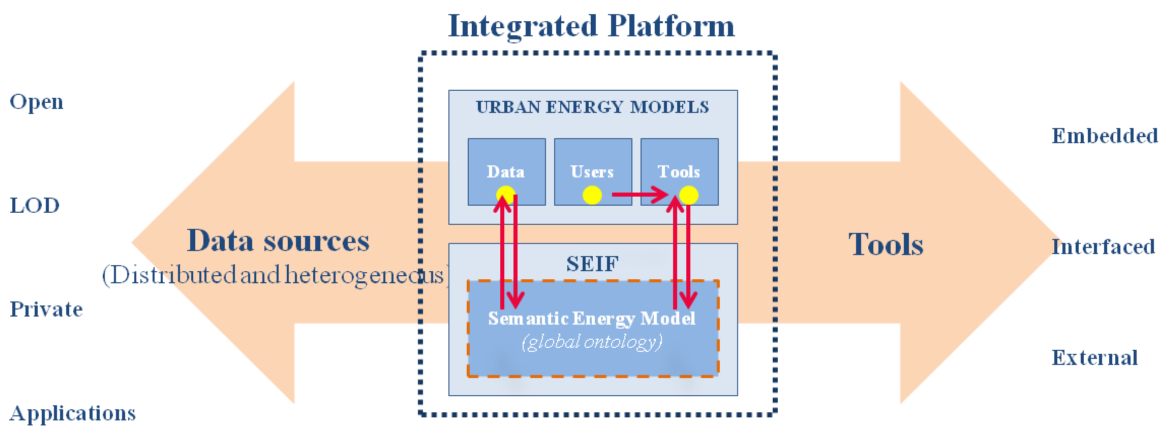



*Figure 17. The platform as nexus between distributed data and different applications*

Within a given Urban Energy Model (UEM), the same tools and data are used both to create the baseline of the urban energy system at a particular time and to develop projects to full the objectives set by a particular plan (Figure 18).

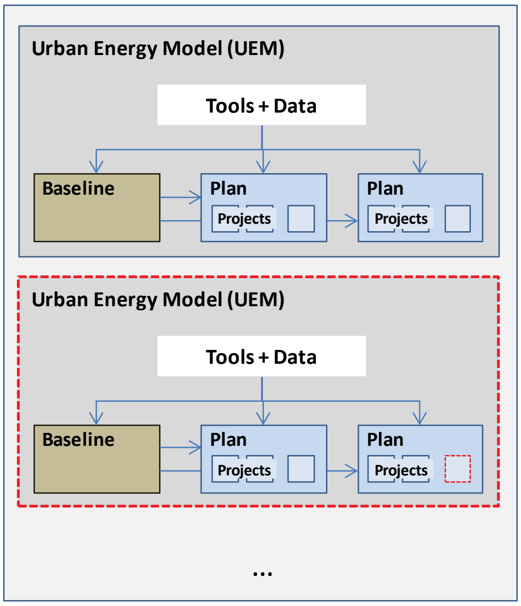



*Figure 18.The same set of tools and data are applied to calculate the baseline and to develop improvement plans*

## 4.3 Platform users

The platform has been designed to be used by four groups of users:

- Domain experts. They collaborate in the construction of an energy model (e.g. describing use cases and activities, defining terms of the ontology), and/or they interact with the model (e.g. extracting reports, enriching the energy model with new data). They elaborate and evaluate alternative plans to improve the performance of the urban energy system, and they provide advanced data analyses services to other experts.
- Ontology engineers. They collaborate with domain experts in the maintenance and enhancement of the system's ontology. With this purpose, they use the tools developed for the project to create the energy model as a global ontology (Ontology Editor), to

carry out the semantic integration process (Ontology mapping environments), and to verify the outputs of the process (Semantic data explorer).

- Platform developers. They assist experts in the integration of new tools and data in the platform.
- Non-experts. They interact with the platform –either by themselves or assisted by a domain expert– to visualize the energy data using different tools provided by the platform (3Dmodels, tables and diagrams), to extract the information they need and derive conclusions from it.

The users and roles identified are summarized in the following table. They have been characterized from the feed-back obtained in the demonstration scenarios and in the stakeholders meetings.

*Table 2. Characterization of the platform users*

| Group | Role | Description | Rights | Registration |
|---|---|---|---|---|
| Non-expert | Guest | Architect, urban planners, citizen, politician, urban developer who are not experts in urban energy efficiency. | - Visualizing data in the Urban Energy System (3DMaps, Table, Bubbles.)<br>- Using filters to navigate though the energy data<br>- Visualizing Plans and Projects | No |
| Domain expert | Energy Expert | An energy expert with expertise to run building energy assessment tools (SAP, URSOS,….) | - Same as a Guest.<br>- Creating Plans and Projects by:<br>o Adding new buildings / Demolishing existing ones.<br>o Changing parameters of buildings<br>o Changing energy supply options<br>o Running assessment tools (SAP, URSOS, Urban Energy Planning,…)<br>o Applying building improvements (T5.3).<br>- Comparing projects of the same plan (MCDM). | yes |
| Domain expert | Urban Energy Expert (working for private developer, municipality) | An energy expert in charge of managing an Urban Energy System of an Area / Case Study. | - Same as Energy Expert<br>- Can modify the baseline of the Urban Energy System by.<br>o Adding new buildings / Demolishing existing ones.<br>o Changing parameters of buildings<br>o Running assessment tools (SAP, URSOS,…) | yes |
| Domain expert | Urban Planner (working for private developer, municipality) | A planner in charge of an urban development, who might work together with the energy experts. | - Same as Energy Expert<br>- Can modify the baseline of the Urban Energy System by.<br>o Adding new buildings / Demolishing existing ones.<br>o Changing parameters of | yes |

| | | | | |
|---|---|---|---|---|
| | | | buildings<br>- Running assessment tools (SAP, URSOS,…) | |
| Non-expert | Decision maker | A politician or developer who runs analysis services to assess alternative options on an Area / Case Study. | - Formulate request for a Data mining processes.<br>- Visualize the results of the Data mining processes<br>- Comparing projects of the same plan (MCDM). | yes |
| Domain expert | Data mining expert | A data mining expert in the user side who can prepare the outputs of the data mining processes and facilitate them to non-experts. | - Customizes the Data mining processes.<br>- Prepares the visualizations for the Decision maker users. | yes |
| Ontology engineer | Ontology Expert | An expert who knows about the SEMANCO ontology and the available data. | - Generates the SPARQL query needed by the Data mining processes | yes |
| Domain expert | Data mining expert | An expert in the consultant side which has the expertise of creating RapidMiner processes. | - Creates/Modifies RapidMiner processes.<br>- Generate Data Request to an Ontology Expert | yes |
| Platform developer | Admin | | - Can do everything. | yes |

## 4.4 Platform structure

The integrated platform structure includes two major components: a front-end consisting of interfaces to manage the information and the integrated tools. Both components are connected to the SEIF to have the data it needs as it has been explained in the Deliverable 3.4 *Ontology repository with migrated dat*a (Figure 19).

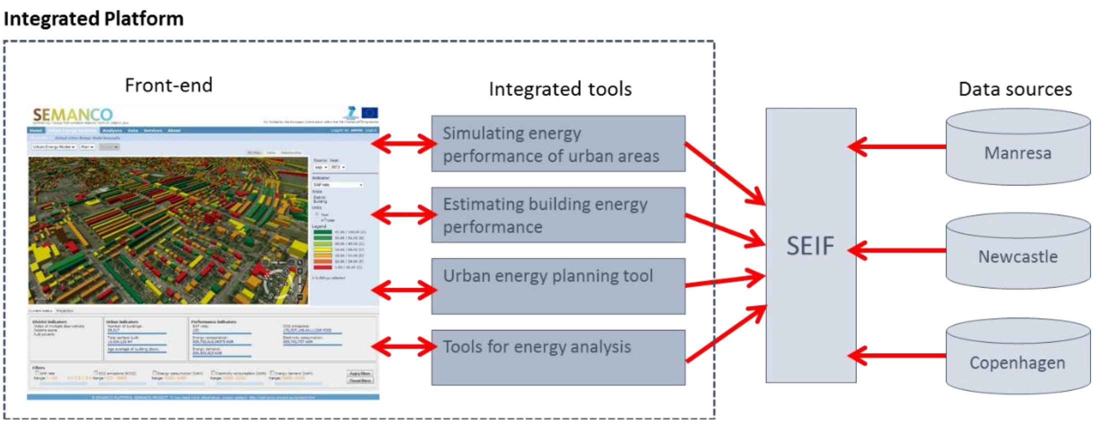



*Figure 19. Structure of the platform*

The front-end includes the environments to create and manage urban energy systems, urban energy models, plans and projects, as well as the visualization modes (3d model, table, and diagrams). A user can create and work within urban energy models, plans and projects using the interfaces of the integrated platform. The front-end includes the 3DMaps applet from

Agency9 to visualize an urban energy system in a three-dimensional environment.

There are four tools –from those previously developed in Tasks 5.1 *Building stock energy modelling tools* and Task 5.2 *Energy analysis, and optimization and strategic decision tools*– which interact with the SEIF to obtain the data from the sources using the semantic energy model provided by the SEIF. These tools combine data from a 3d model (surfaces, heights, walls, among others), data from the multiple data sources (census, cadastre, building typologies, energy supply technologies, among others) with the inputs of the user in order to enrich the urban energy model with energy related data.

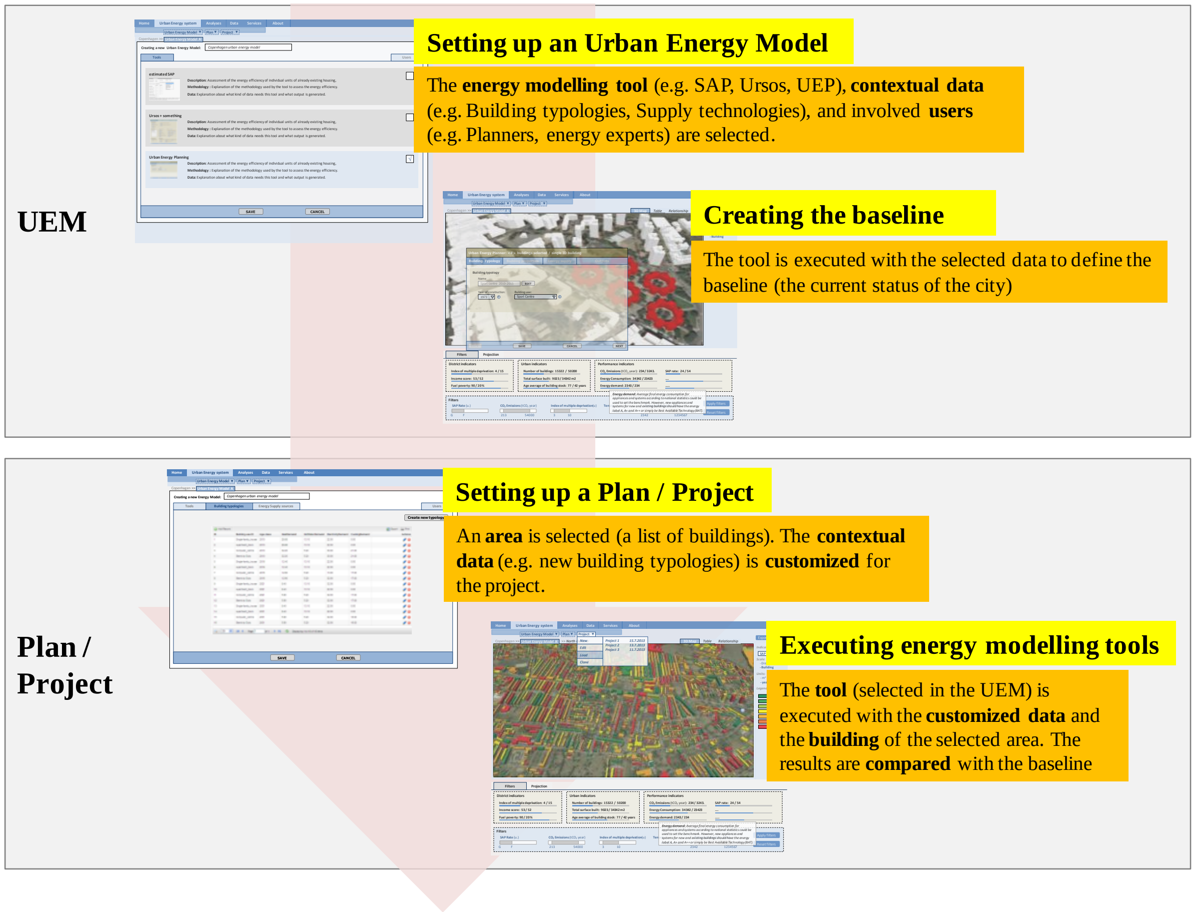



*Figure 20. Activity areas*

Within a particular urban energy system, there are two major areas of activity: one dedicated to create Urban Energy Models, and a second one to create projects for a given plan (Figure 20). Once an UEM has been configured selecting data, tools and users, it is possible for other users to use the available tools which enrich the model with energy related data. Then, within a given UEM, other users (e.g. urban planners) can propose plans (e.g. new urban areas, renovation of existing buildings) and develop projects to fulfil the objectives of a particular plan.

By accessing the platform, the user selects one of the available urban energy systems which, in the current prototype, correspond to each one of the three case studies (Figure 21).

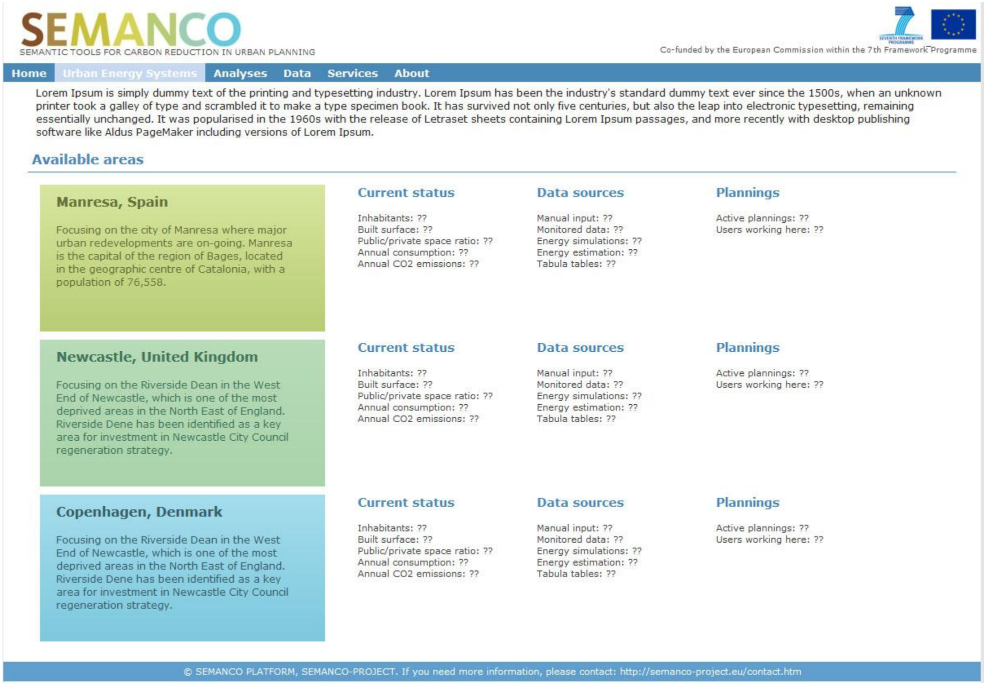



*Figure 21. Home page of the platform*

## 4.5 Platform visualization modes

In the platform, users can navigate through the information which can be visualized in three different modes: 3d model, table, and diagram. They can use these visualization modes, for example, to find out the information needed such as fuel poverty areas, buildings with high energy consumption and hot spots where $CO_2$ emissions are above certain level.

### 4.5.1 3D model

This model is composed of a satellite images plus the 3d geometry of the built areas of the city. When the user selects an indicator, the buildings of the model are coloured based on the indicator selected (Figure 22). For example, buildings with an energy demand for heating above of 4509 MWh per year will be coloured in red. Users can zoom the model in and out. When the zoom reaches a certain level, the layers containing information at the regional level are shown. In the case of Manresa, this applies to the neighbourhoods and in the case of Newcastle to the Lower Layer Super Output Areas (LLSOA).

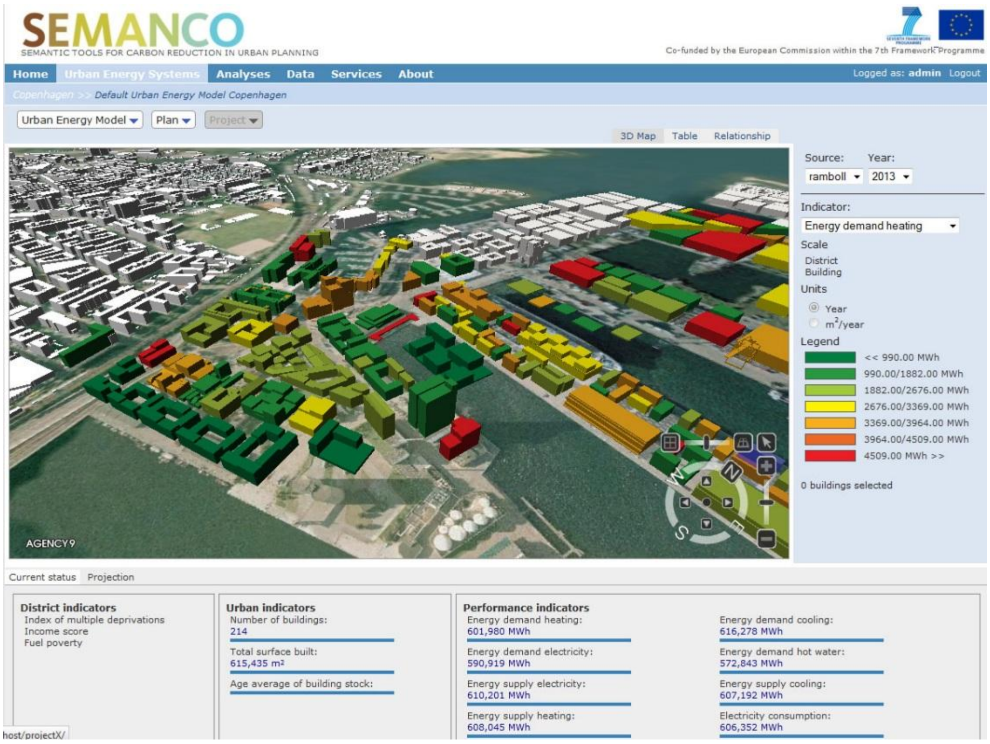



*Figure 22. 3dMaps visualization of an urban area*

### 4.5.2 Table

The alternative visualization to the 3d model is a table which shows the same data as the model. The table shows a few building records with the main indicators at once, the other buildings are accessible through pagination. If the baseline has been modified by running some of the integrated tools, changes are illustrated in this table as well. The user can search the table content using keywords, for example, or by filtering buildings according to their use (Figure 23).

*Figure 23. Table visualization mode*

### 4.5.3 Diagram

The diagram mode enables users to find relations within the data (Figure 24). The diagram uses different dimensions which are related to an indicator, and shows the data clusters as bubbles with different sizes and colours.

The user can customize the diagram in different ways:

- Aggregation: it includes building use and year of construction. Each bubble will be a value of the aggregated data selected. For example, if a building use is selected, each value will be a use such as Residential or Office.
- Size of the bubble: the indicator selected will be related to the size of the bubbles. For example, if the surface built is selected, the building uses which have more surface built will be the largest bubbles.
- Colour: The indicator selected in this option will change the colour of the bubbles based on the range of the indicator selected.
- Horizontal/Vertical Axis: the indicators selected in these options would change the position of the bubbles. For example, in Figure 24 the horizontal axis is the energy consumption, that means that the building uses with less consumption will be in the left side of the diagrams and the buildings uses with a high value of consumption will be placed on the right side.


*Figure 24. Interactive diagrams to display relations between multiple dimensions*

## 4.6 Platform tools

This platform prototype integrates the various tools developed in Task 5.1 and 5.3, as well as the semantic data explorer developed in Task 4.3. The integration of these tools in the platform conveys, basically two things: 1. to link the tools with the semantic data that is facilitated through the SEIF and 2. to implement interfaces to use the tool in the platform.

The following tools developed in WP5 have been integrated in the platform, so far:

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

### 4.6.1 Building stock energy modelling tools

The purpose of these tools is to enhance the base geometric information of a city with energy related data, accessible through the SEIF. They are used to create a baseline of the current status of the urban energy system at different scales: building, district, and city. The tools are not specific to a particular urban energy system. They can be applied to different cities providing that they comply with the local regulatory frameworks. The current limitation, from the point of view of the functioning of the platform, is the compatibility between data and tools.

The tools that have been integrated in the current prototype, detailed in D 5.1 *Building extraction and classification tools*, are the following:

- **Simulating energy performance of urban areas.**

This tool adds energy related information obtained from the SEIF to the selected buildings. The combined data becomes the input to the simulation engine provided by URSOS, a software tool for assessing and comparing the energy and the environmental performance of buildings in an urban area.

The inputs that URSOS need are:

- Building geometry (footprint and height, dwellings with cross ventilation, year of construction)

- Characteristics of enclosures (U-values, glazing, solar factor, α-value)

- Occupation parameters (ground floor, % of occupation of building, comfort temperatures, internal gains, water consumption)

- System parameters (space and cooling systems and efficiencies, water heating system and efficiency, coverage of renewable energies)

These inputs are obtained from the SEIF.

The outputs provided by URSOS to the platform are:

- Energy demand for heating and cooling in the buildings in the modelled urban area.

- Total energy demand of the urban development, for heating and cooling.

- Information on built areas surfaces and buildable plots.

- Detailed calculations of shadows for any closure and time during the year.

These outputs are combined with other data obtained through the SEIF, such as electricity consumption in order to calculate additional indicators. The combined outputs are displayed in the platform.

The connection between the platform and the simulation engine will be performed automatically. This work is being carried out in Task 5.5 *Interoperability of tools with the semantic framework.*

*Purpose of using the tool within the platform*

With this tool, it is possible to use the URSOS simulation engine to enrich parts of the urban model with additional data (energy consumption, $CO_2$ emissions, solar gain potential and other outputs). Having this additional information easily available in the urban model provided by the platform can be helpful to make decisions in the urban planning process. Furthermore, having access to this information would help to increase the awareness of relevant stakeholders involved in the decision making process.

This additional information can also be useful in the context of urban planning decisions. Energy performance of buildings is not considered at urban scale, partially because the available tools have been created mostly to be used at the building level. Furthermore, the data that this tool provides to the platform (energy consumption, $CO_2$ emissions, solar gain potential and other outputs) could be considered together with other more common parameters such as economic, social, land morphology and land property. Altogether, the combined information would influence relevant stakeholders in the decision making process in urban planning and increase the general awareness about energy use in the cities.

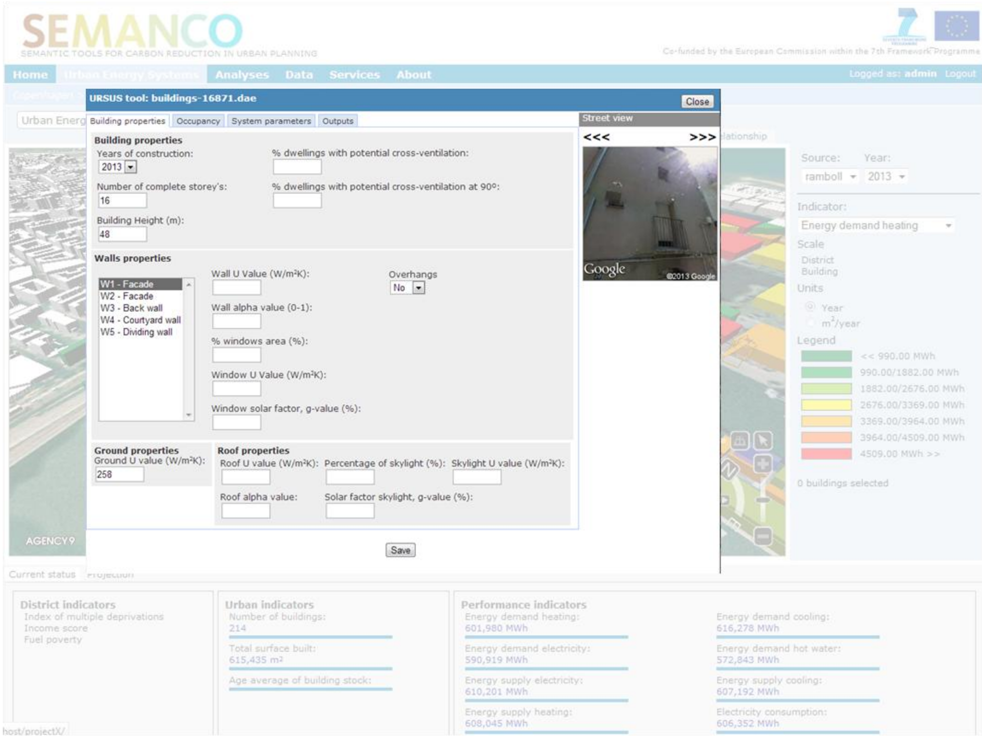



*Figure 25. Input form to add energy data to selected buildings using URSOS software*

- **Estimating building energy performance**.

This tool is used to calculate a SAP rating of an existing property. It is a simplified version of the SAP procedure which is embedded in the platform. It gives results that closely match with the SAP rating that would be produced by an engineer visiting the building in question. The tool can be applied on single buildings selected individually.

At the current level stage of development of the platform, this tool can operate on the buildings selected on the 3dmodel although does not receive inputs via the SEIF. In the third year of the project, some of the inputs needed (e.g. height of buildings) will be retrieved via SEIF.

The outputs generated by the use of the tool are:

- SAP rating;

- Net $CO_2$ consumption;

- Normalized $CO_2$ consumption;

- A detailed list of estimated structural parameters of the house concerned.

These outputs are added to the building information in the urban model of the platform and – through the SEIF- they can be used as input by other tools. A prominent example of this is the tool to propose improvements of the existing building stock being developed in Task 5.3 *Energy simulation and optimisation tool*, which uses this data to evaluate the potential effects of differing proposed refits to dwellings that have been previously rated using this tool been developed.

The outcome of using the tool to rate an area of housing in the platform is firstly that some basic energy efficiency measures – SAP rating and $CO_2$ consumption – are attached to each building. These figures can be visualised on the platform through the colouring of houses.

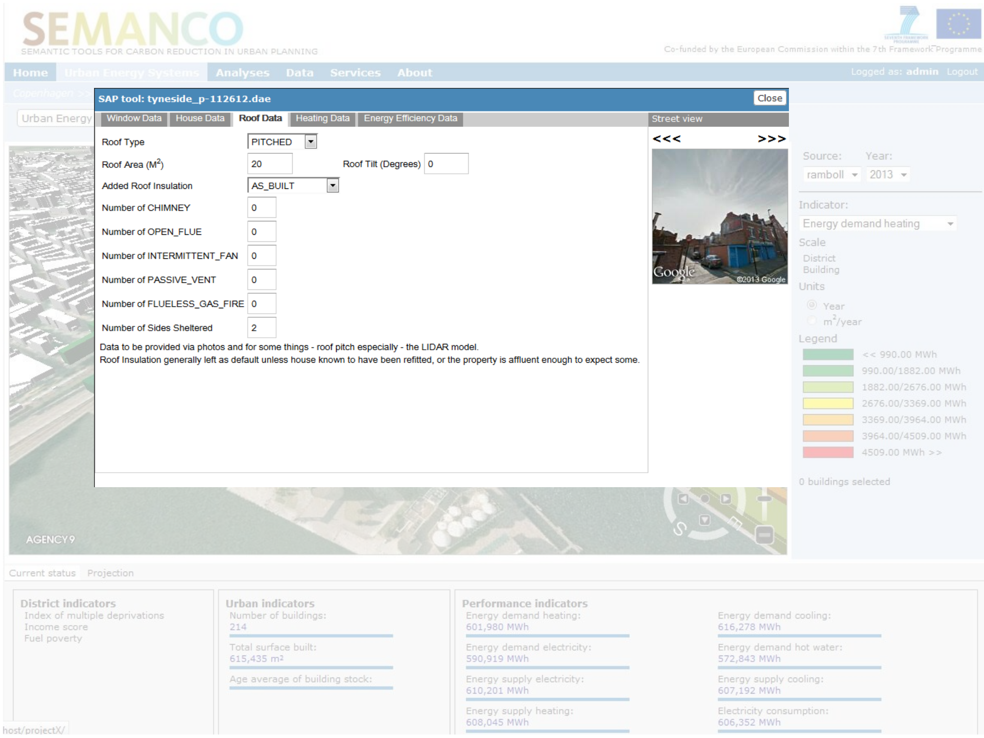



*Figure 26. Interface of the SAP tool*

*Purpose of applying the tool in the platform*

A major problem facing the United Kingdom, and other European countries, is the need to refit the large quantities of existing housing stock. In order to do this efficiently and intelligently there is a primary requirement that we are able to correctly evaluate the energy efficiency of that housing stock. Currently this requires the visit of accredited engineers to each of the properties concerned, a process which consumes substantial time and effort. In consequence many houses remain unrated. In this instance, the application of this tool could offer the opportunity to aid the refitting of housing stock.

- **Urban energy planning tool**.

This tool is used to make a simplified energy assessment of buildings included within an urban area. It uses specific data, methods and calculations for determining the energy demand for a new urban area based on certain building characteristics, building typologies and specific energy intensities.

The inputs required by the tool are:

- Geometrical information such as: height and surface are obtained from the buildings selected.

- Building use and age of construction are entered by the user based on the building typologies provided by the SEIF.

- Supply energy sources obtained via SEIF.

The combined inputs are processed by the tool to produce as output a “baseline” measurement of the current state of the urban energy model. This “baseline” is defined as the quantification of $CO_2$ emissions based on energy consumption within the city’s defined geographical area for a given year. $CO_2$ emissions are mapped from energy fuel sources and the respective reduction potentials.

The outputs provided by this tool are:

- Net energy demand for heating, cooling, electricity, and hot water.

- Energy supply for heating, cooling and electricity.

- Electricity consumption and $CO_2$ emissions

These outputs are added to the building information in the urban model of the platform and – through the SEIF– they can be used as input to other tools.

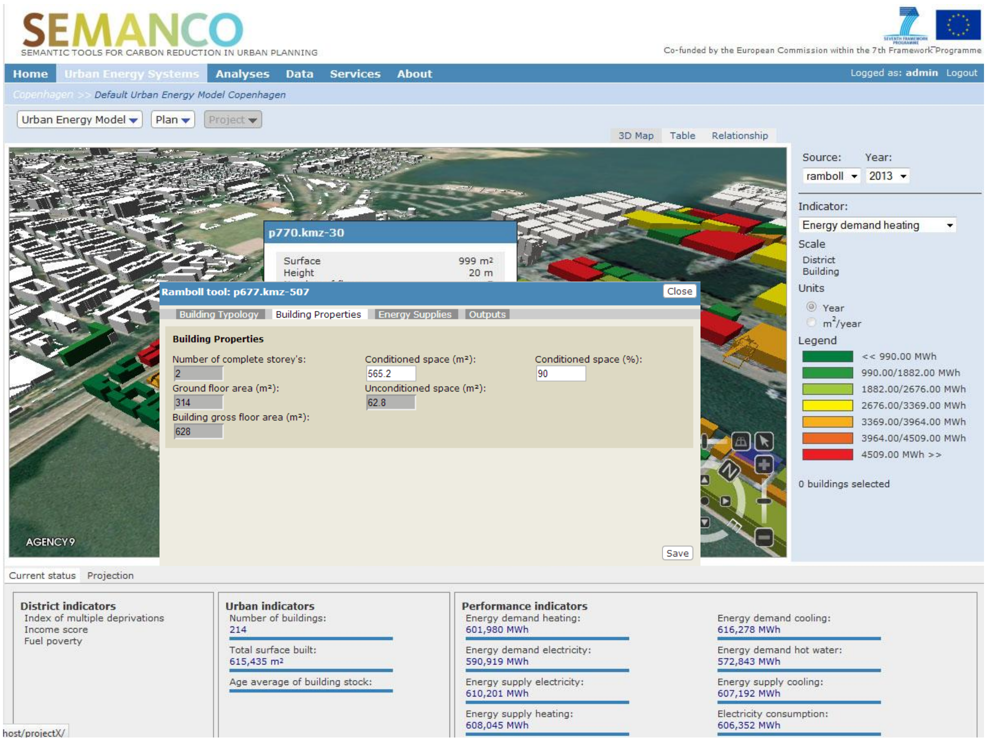



*Figure 27. Urban energy planning tool interface*

*Purpose of applying the tool in the platform*

This tool can help to identify energy planning strategies for the development of newly built urban areas.

Once the baseline has been calculated for a given urban area (e.g. North Harbour), the energy intensities of the buildings selected in the 3d model accessible through the platform can be edited and changed to create alternative scenarios and evaluate the effect on energy consumption and $CO_2$ emissions. The potential users are energy experts and decision makers who would like to analyse the effect of choosing different energy standard for buildings (requirements in existing and new building codes, nearly energy zero buildings, among others).

On the energy supply side, users can use the tool to explore different energy supply options (heat pumps, PV-systems, and district heating; among others) for the different levels (building based supply, local district heating and central district heating; among others). The tool gives the option of calculating the reductions in $CO_2$ emissions by choosing one energy supply technology over another, depending on the share of renewable energy in the energy supply option.

### 4.6.2 Tools for energy analysis

Energy data analysis using advanced data mining techniques is a complex task which needs to be done by an expert. In this case, the platform acts as a bridge between a user with no skills in data analysis and data mining experts (Figure 28). To make this dialogue possible, a dedicated workflow has been developed which is described in detail in Deliverable 5.2 *Tools for Energy Analysis.*

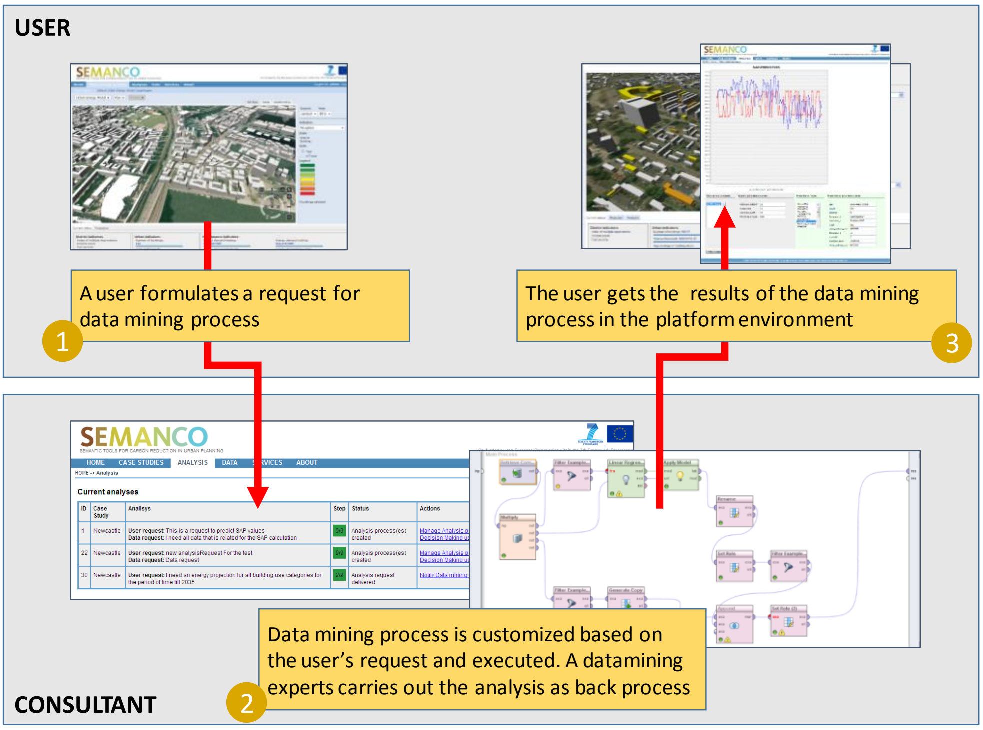



*Figure 28. Simplified view of the workflow between users and consultants through the platform*

The integration of this workflow in the platform enables the dialogue between a user side represented by a decision maker and a data mining specialist and a consultant side represented by an ontology expert and a data mining expert. This dialogue takes place in the following form:

1. A decision maker initiates the workflow on the user side by formulating a data analysis request. The request is submitted to the platform to be processed by experts on the consultant side (Figure 29).

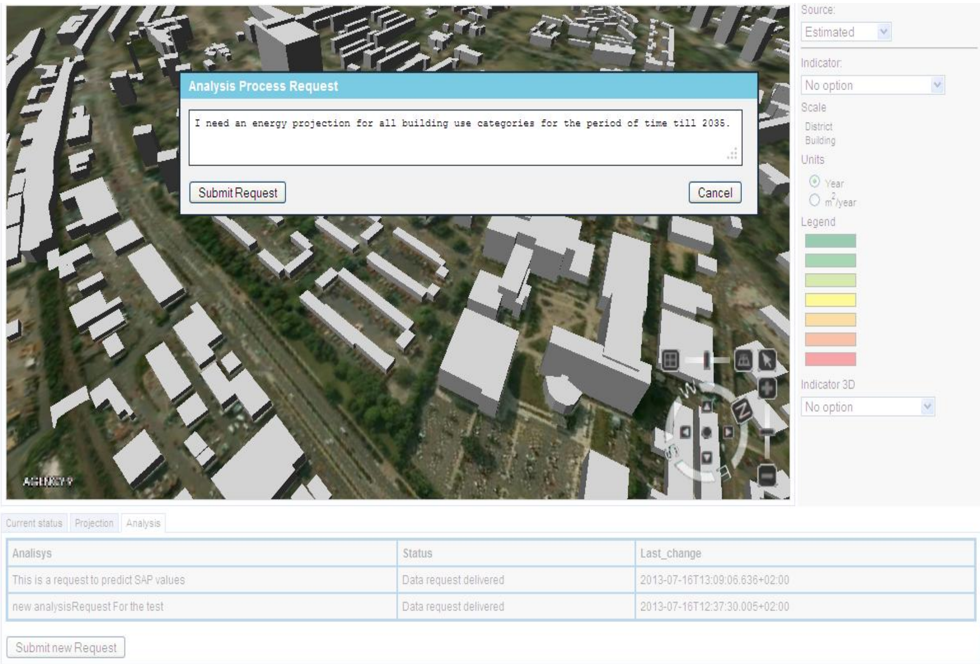
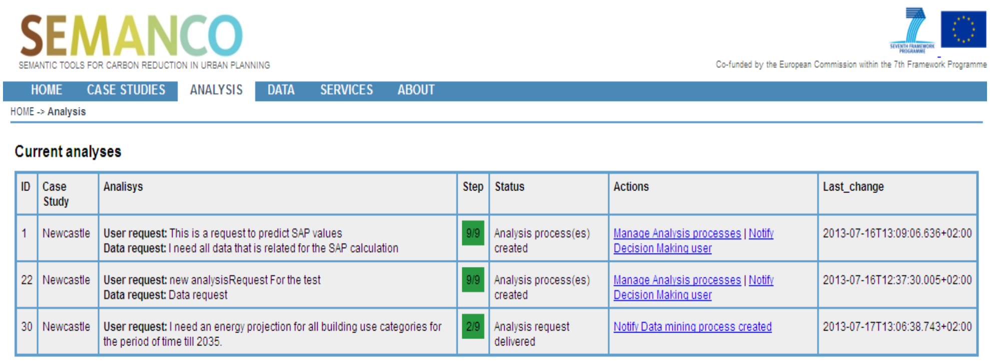



*Figure 29 . Submitting an analysis request from the user side*

The request is posted in a bulletin board (Figure 30). Besides, all users are able to check the status of the submitted request using the same facility. Here, changes in the status request are described in terms of case study, analysis type, workflow stage, undertaken actions and the time stamp. For the description of all nine stages of the data analysis workflow see Deliverable 5.2 (Nemirovski et. al. 2013).




| ID | Case Study | Analisys | Step | Status | Actions | Last_change |
|---|---|---|---|---|---|---|
| 1 | Newcastle | **User request:** This is a request to predict SAP values<br>**Data request:** I need all data that is related for the SAP calculation | 9/9 | Analysis process(es) created | Manage Analysis processes \| Notify Decision Making user | 2013-07-16T13:09:06.636+02:00 |
| 22 | Newcastle | **User request:** new analysisRequest For the test<br>**Data request:** Data request | 9/9 | Analysis process(es) created | Manage Analysis processes \| Notify Decision Making user | 2013-07-16T12:37:30.005+02:00 |
| 30 | Newcastle | **User request:** I need an energy projection for all building use categories for the period of time till 2035. | 2/9 | Analysis request delivered | Notify Data mining process created | 2013-07-17T13:06:38.743+02:00 |

*Figure 30. The status of the analysis request as posted in the bulletin board*

2. After a data analysis request has been processed by the data mining expert at the consultant side, the outcomes are available as a web service in the platform (last row in table of Figure 31). On the user side, users who have requested the analysis are informed. In this example, the status says that the corresponding analysis process has been published from the consultant side as a service and, therefore, it is available from the user side.

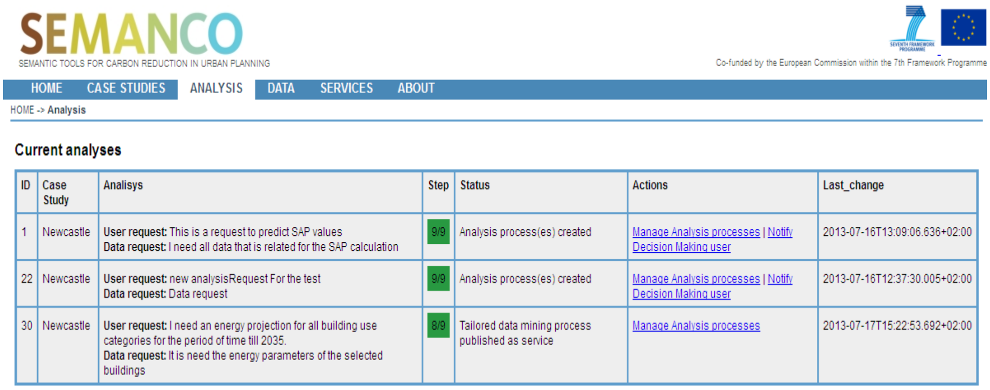



*Figure 31. Notification introduced from the consultant side to inform about the ending of a request*

3. At this stage, the data mining specialist at the user side takes over the process control. This specialist uses the GUI integrated into the platform (Figure 32) to set the parameters to run the analysis process which has been previously published on the consultant side. Using the web interface, the data mining specialist is able to adjust the visualization of the results and undertake some changes in the settings of the data mining algorithms.

4. The user who initiated the request uses the same integrated GUI as the data mining specialist. However, in this case the interface is used only to visualize the analysis results (Figure 32).

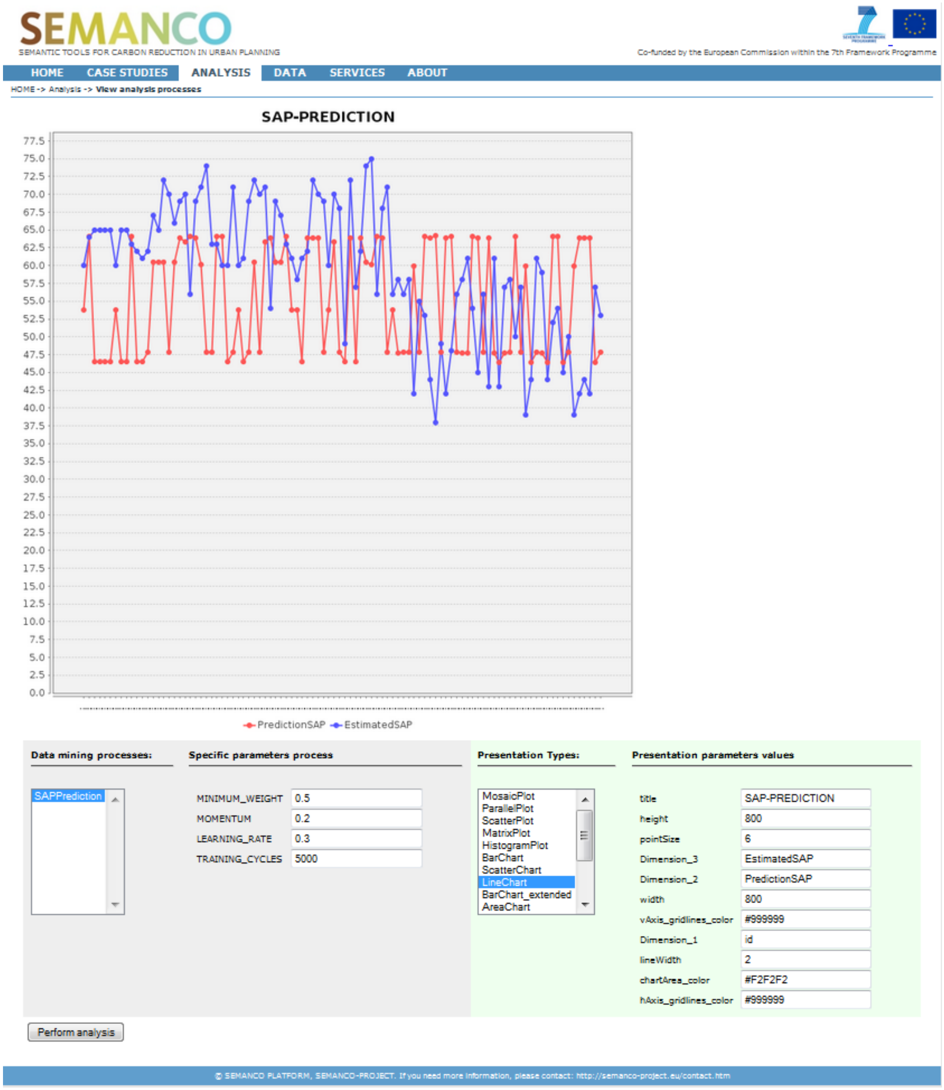


*Figure 32. Interface to set the values of parameters to run a web-service and to visualize results*

The analysis tools integrated in the platform facilitate the advanced analysis on energy related data at different scales (neighbourhood, municipality, region or building). Data analysis provides stakeholders with missing information such as figures, classifications, hidden dependencies or rules. They have been applied in the three case studies of the project:

- In Newcastle, data analysis has been performed to replace SAP calculations by predictions

- In Copenhagen (North Harbour), energy analysis has been carried out to forecast future energy consumption of different types of buildings

- In Manresa, different categories of buildings have been identified based on their energy consumption and $CO_2$ emissions

The data analysis process for the case study Newcastle is fully integrated into the platform. The integration for the processes related to the case study Manresa and Copenhagen will be carried out in the third year of the project.

### 4.6.3 Ontology-based services

The platform integrates SEIF services such as the semantic data explorer environment presented in Deliverable 4.3 *User interfaces for domain experts interacting with SEIF* which enables domain experts to explore the data and its relations without directly using the energy analysis tools. This environment makes use of the ontology to support the users in the query formulation. For example, to enable energy domain experts to query using concepts such as Energy_Generator, Energy_Service, Thermal_Envelope_Area and Space_Heating_System. It also facilitates the exploration of the data provided by the SEIF. It encompasses a glossary of all concepts –including their descriptions and references– which includes associated data showing the number of instances of each concept.

The semantic data explorer uses the semantics of the data to navigate through data sources and their relations. In this way, it is possible to use the terms of the SEMANCO ontology and their properties to create queries to retrieve data. It provides a user friendly interface enabling users with no knowledge about ontologies to explore the data sources using natural language (Figure 33).

Users can explore data through a query tool which supports a syntactic search which guides the user through the ontology structure. In this case, the input is a phrase composed of two elements: concepts which are ontology classes (in terms of OWL) and relations which are properties that connect the classes. The tool returns a list of sequences of instances which follows the same structure of the input phrase.

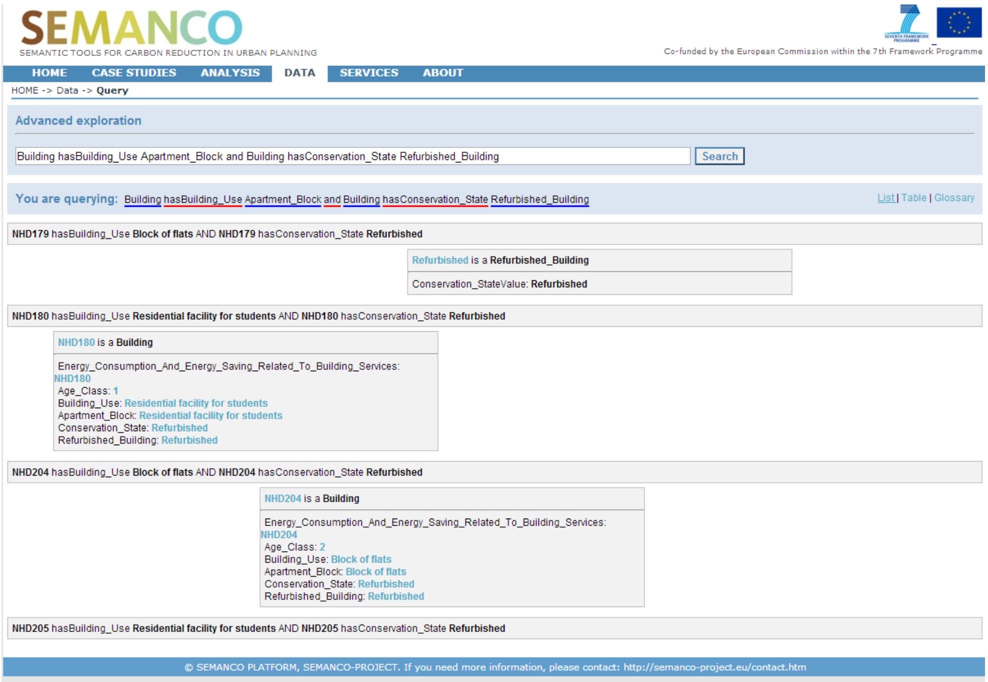



*Figure 33. Semantic Data Explorer*

To integrate the Semantic Data Explorer in the platform some changes have been made to the work done in Task 4.3 *User interfaces for knowledge representation*. The main improvement has been the creation of a glossary to help the user to search for data. Furthermore, following feedback from project partners some visualization tweaks have been implemented to homogenize the interface between the platform and the explorer.

# 5 Platform Architecture

## 5.1 Database structure

In this section, we describe the main features of the database of the integrated platform. An excerpt of the structure of the database is illustrated in Figure 34.

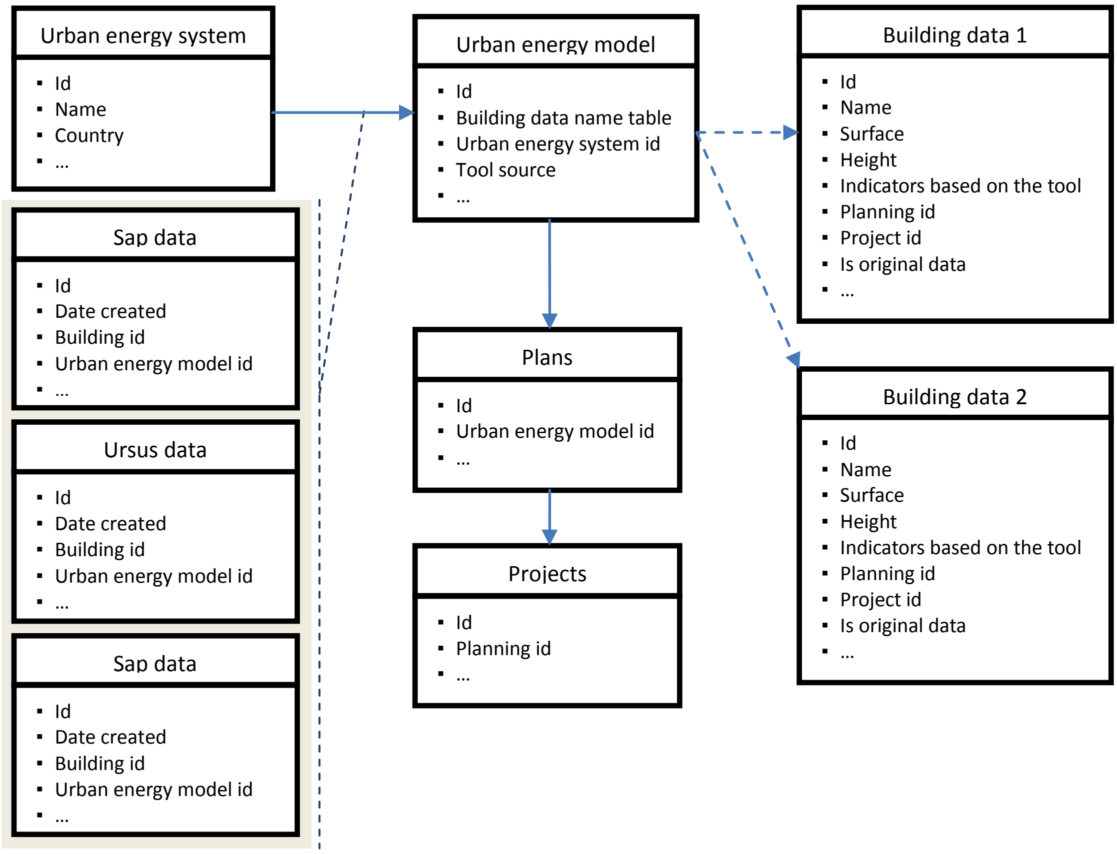



*Figure 34. An excerpt of the database structure*

The “urban energy system” table contains the urban energy system of the project which corresponds to the three urban areas currently included in the platform: Manresa, Newcastle and Copenhagen. Each system may have different urban energy models which are stored into the “urban energy model” table. That table is related with another one (i.e. building data 1 and building data 2 in Figure 34) containing the main building data. These are the name, the surface, the height and the indicators. The list of indicators depends on the tool that has been selected in the creation of the urban energy model. For example, in the case of an urban energy model which includes the tool “Estimating building energy performance”, the indicators would be SAP rating or $CO_2$ emissions. On other hand, for an urban energy model which uses the tool “urban energy planning”, the indicators would be energy demand, electricity or energy consumption; among others.

In addition, there are tables which store extra building data depending on the tool selected. Each register in these tables is related to a building from the building data table. SAP data is the main table of the “estimating building energy performance” tool. Tables such as “sap economy data”, “sap energy efficiency data”, “sap heating data”, “sap house data”, “sap roof data” and “sap window data”; are related to the “sap data” table. Tables such as“ramboll data” and “ramboll form data” correspond to the building data used by the “urban energy planning” tool. Finally, “ursus data” is the main table of the “simulating energy performance of urban areas” tool. Other tables such as “ursus building properties” and “ursus wall properties” are related to the “ursus data” table.

Each urban energy model may have different plans and each plan may have different projects. Therefore, as it is illustrated in the database structure (Figure 34, above), there are relations between the “urban energy model” table and the “plans” and “projects” tables.

## 5.2 Implementation process

In this section we describe the implementation of the main processes carried out by a user of the platform.

### 5.2.1 Creating a new urban energy model

The process of creating a new urban energy model is started by the user when he or she enters the name of the model, the available data to be used, and the tools that interact with the data. The system first checks whether the name of the model is valid. When it is validated, a new register is added into the table “urban energy model”. Afterwards, a new building data table is created using a name which is based on the primary key of the urban energy model being created. The fields of this new table are created based on the selected tool.

### 5.2.2 Invoking a tool

A user selects one or multiple buildings to assess their energy performance. Once a building – or group of buildings– is selected, the system collects the data from the building data table and visualizes it in a pop-up window. The building data table selected depends on the urban active energy model. If it is the first time that the building has been selected, then the data to fill its properties are retrieved from the data sources through the SEIF, for example, from the building typologies of that urban energy system. If the building has already been assessed, then the properties are filled with the data stored in its table. For example, while running the “estimating building energy performance” tool, the data is gathered from the “sap data” table.

Once the tool is invoked, the output is stored into the tool’s table adding a new register or updating it, if already exists. In addition, a new register of the building data is added into the buildings data table, with the same building name and the new indicator values. When the window of the tool is closed, the report of the building shows the comparison between the original data and the new values generated by the tool. If the new indicator data is greater than the original data, it is showed in green colour. Otherwise it is showed in red colour (Figure 35).

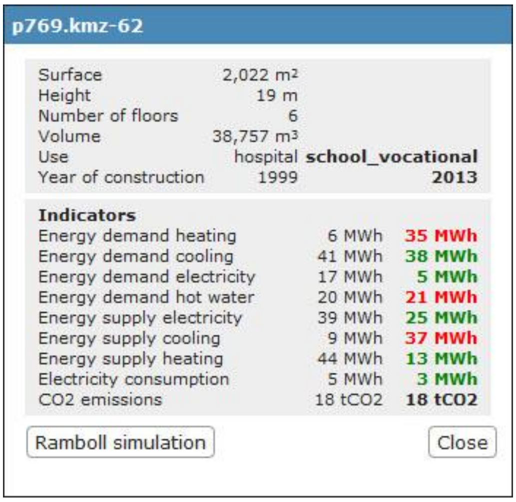



*Figure 35. Report window of a building*

### 5.2.3 Visualizing data

As described in section 4.5, the platform provides three kinds of visualization methods: 3d model, table and diagrams. If an indicator is selected, the buildings in the 3d model have a colour based on its indicator value. The ranges are calculated using the values of all buildings of the urban energy model.

When the table visualization is enabled, the system collects all data from the building data table and shows it in a table layout. In addition, if a building's energy performance has been updated by a tool, the system obtains the modified data from the database and shows it also in green or red colour depending if the indicator value is greater (or not) than the original value. In order to have a better visualization, the system pages all the content. This means that only fifteen buildings are showed at the same time and that it is necessary to browse pages.

Finally, when the diagram visualization is enabled the system obtains the data from the building data table, grouped by the building use and processed depending on what parameters are selected in order to have the maximum and minimum, or the average. This data is illustrated in a bubble chart where each bubble represents a type of building use.

### 5.2.4 Applying filters

The user can apply filters to each indicator, for example to select all buildings whose SAP rate is between G and H. When the user applies the filters, the system obtains the data from the building data table based on the parameters of the filters. This data is used to have the ranges (minimum and maximum values) of each indicator and to show the buildings that are between those ranges. The selected buildings are illustrated in the 3d model in blue colour as they are also displayed in the table and diagram visualization modes. In addition, if an indicator is selected too, the filtered buildings have a colour based on the selected indicator selected and its range.

### 5.2.5 Planning and projecting

Plans and projects belong to a specific urban energy model. A user introduces the name and parameters of a new plan. The system checks if the parameters introduced are valid. Once the parameters are accepted, a new register is added to the "plan" table. This new plan is related to the urban energy model selected previously. Like in the plans case, a project is first created and validated. Once the parameters are accepted, a new register is added to the "projects" table which is related to the urban energy model and to the plan previously selected.

## 5.3 Technical implementation

The platform has been developed with different technologies. The programming languages HTML and Javascript have been used for the views, and the programming language PHP 5.3 has been used to connect the platform with and MySQL database.

The PHP framework Codeigniter has been used because it provides a better organization of the functionalities request/response and facilitates the connection with the database. Codeigniter uses a Model View Controller design pattern: the model has the methods to handle the database, the controller contains the business logic of the application, and the view generates the output representation to the user.

The interface has been built using the jQuery[4] library, specifically to generate the table layout in the table visualization mode. The open-source Canvajs[5] JavaScript library has been used to implement the diagram interface to visualize the relations between data.

[4] http://jquery.com/
[5] http://canvasjs.com/

# 6 Further Developments

The prototype version of the platform described in this document has been produced along the first two years of the project. In the third and last year, the platform development will continue in Task 5.6 *Integrated platform*. The final operative version of the platform is expected to be delivered in month 33 of the project.

The further development of the platform from its current stage described in this report will encompass the following tasks:

- adding new functionalities, such as a modelling tool integrated in the 3d model.

- integrating new tools developed in Task 5.3 *Energy simulation and optimisation tool* and Task 5.5 *Interoperability of tools with the semantic framework*.

- enhancing the interfaces of the existing platform (refinement of interfaces, assuring cross-platform compatibility)

- user support tools, such as on-line assistance and tutorials.

## 6.1 Adding new functionalities

In the first year of the project, a modelling prototype tool was developed to provide very basic functionalities to model simple 3d models of newly planned urban developments. During the second year, the development of this tool had to be interrupted until the overall platform structure would be completed. In the third year, this tool will be completed. The modelling tool will incorporate 3d files from external sources like Google SketchUp. It will be used to do alternative projects for a given plan.

The level of integration of some of the tools included in this prototype will be further developed.

## 6.2 Integrating new tools

Some tools, which will be delivered in different tasks of WP5, will be integrated during the third year:

- Task 5.5 *Interoperability of tools with the semantic framework*, will deliver the integration of the URSOS calculation engine and the embedded tools to calculate the performance indicators such as global $CO_2$ emissions and energy carriers' demand.

- Task 5.3 *Energy simulation and optimisation tool* will provide multi-criteria decision making (MCDM) tools and building improvement tools. A basic MCDM tool was already created in the first year of the project. During the second year, the development of this tool had to be interrupted until the overall platform structure would be completed. In the third year, the inclusion of all the indicators generated by the platform tools, will be emphasized. Furthermore, new interfaces will be included guiding the user in the decision making.

## 6.3 Enhancing interfaces

The feed-back obtained from users in the second and third implementation cycles to be carried out within WP8 will help to improve the interfaces and the platform functionalities in general. Usability tests will be carried out to assess the cross-platform compatibility as well as to measure the efficiency –time or steps to conclude the tasks– and accuracy –number of mistakes of users.

## 6.4 User support tools

Tutorials will be elaborated to explain the platform functionalities. On-line assistance will be offered and implemented to explain to the platform's users the whereabouts of methods, data, and regulatory frameworks related to the tools and data provided by the platform.

# 7 Conclusions

## 7.1 Contribution to overall picture

The current development of the integrated platform presented in this report has contributed to bring 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). The integration of the tools and the development of the platform has been also present in the meetings with stakeholders involved in the planning of efficient urban areas (WP6) and in the first implementation of the demonstration scenarios (WP8).

## 7.2 Impact on other WPs and Tasks

The prototype described in this report will facilitate the dialogue and communication with stakeholders (WP6) and users (WP8) in the third year of the project. As new data becomes available, it is going to be necessary to facilitate their access via SEIF applying the methods already devised in WP3 and WP4. The next development stage will take place within Task 5.6 *Integrated platform* which will bring the prototype to its full implementation stage.

## 7.3 Contribution to demonstration

The prototype platform presented in this report will be the base of the second and 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. The feedback provided by this demonstration will be fundamental for the further development of the platform.

## 7.4 Other conclusions and lessons learned

Carrying out several parallel processes of development along the project has become a highly demanding challenge: requirements capture from stakeholders and users before and during the platform development, designing and implementing the semantic framework while the platform structure was being envisioned, and developing the integrated platform at the same time that the component tools were created.

# 8 References

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# 9 APPENDICES

## APPENDIX A. Procedures to integrate domain experts and technological developers

### STAGE 1: INTEGRATION PROCESS

At the current state of the project, we need to align the use cases and activities to the technological development to be carried out in WP4 (semantic data) and WP5 (tools).

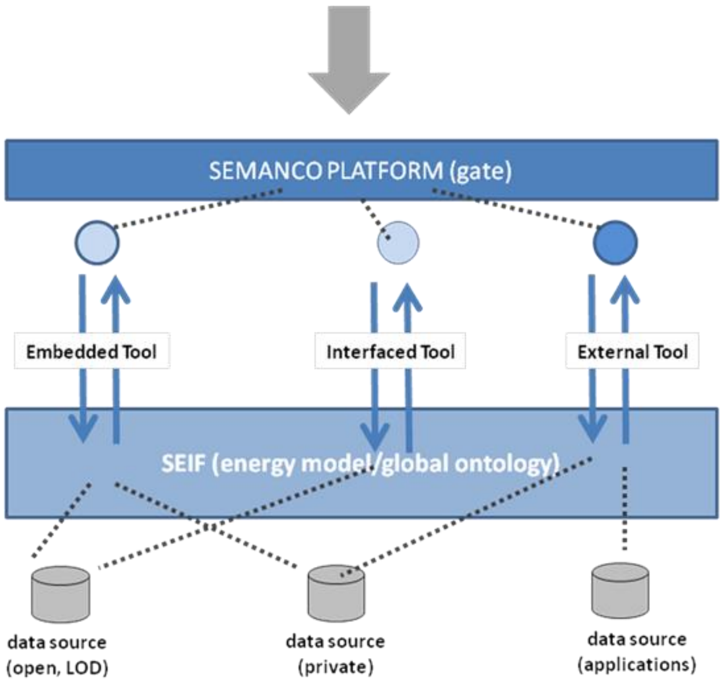
The use cases and activities description should fulfil a double purpose of:

- identifying the data and data sources which need to be semantically modelled

- providing specifications for the tools which will interact with the semantically modelled data.

The ultimate purpose of the SEMANCO tools is to facilitate novel ways to work with data which would not be accessible without the SEIF. For instance, a tool/environment which: enables to work together with different data sources (e.g. energy, economic,...); facilitates processing data and extract benchmarks at different scales –from local to European….

IMPORTANT TO REMIND: the purpose of the SEMANCO platform is not to reproduce existing tools. We can provide access to existing tools such as SAP, LEAP or URSOS because we are interested in storing and grasping the data they generate to carry out some novel processes with it which are the result of combining that data with other data sources through the SEIF.




The mock-up that goes along with this document (semanco_platform_20121107.ppt) describes the top level of the diagram, from the point of view of users. The tools included in the platform could be of three types: embedded (the example of the multi-criteria analysis in the urban design tool, and the simplified SAP); interfaced (presumably URSOS and LEAP), and external (Energy Plus, Rapidminer).

**SEMANCO Tools**

These are examples of data generation tools which can be incorporated in the SEMANCO platform, in any of the three categories: embedded (or owned), interfaced and external.

**Data Generation Tools**

These tools aim at generating NEW DATA and STORING them in the SEIF framework.
A good sample of such a tool is the SAP based calculation engine has been developed by Martin and Amit in T5.1. This tool in interaction with the user generates parameters of a building needed for calculation of its energy consumption.
Another example is the tool (presented by Alvaro and Tomas). This tool generates and stores GEO-Data, e.g. urban project alternatives.

**GEO Selection Tools**

Tools that support the user in geographic navigation, scale level definition and selection of an interesting area or an object, e.g. an urban project alternative such as a city, a district, a house, or just an area supposed to be used as a ground for a set of alternative urban projects.

**Task Management Tools**

Tools that facilitate the user to SELECT (from a list of pre-defined tasks) and CUSTOMIZE a task to be fulfilled for the object in focus. For example selecting alternative sub-tasks or the level of data aggregation.

**Calculation Tools**

e.g. Ursus, LEAP

**Simulation Tools**

Energy Plus

**Approximation / Extrapolation Tools**

These tools exploit data mining technologies to estimate/approximate parameters of various objects related to a certain urban scale level. As a rule the approximation will use a limited set of data generated by Data Generation tools or Selected by GEO Selection tools or calculated/simulated by Calculation/Simulation Tools as a training set to determine unknown parameters of a larger set or urban objects on a given urban scale level.

**Prediction Tool**

These tools will use as input data provided by Data Generation, Calculation, Simulation, GEO-Selection or Approximation tools to predict the development of given parameters for urban objects on the given urban scale level, e.g. development of $CO_2$ emission.

**Data/Results Visualization Tools**

To visualize the results of data mining or to illustrate large data sets graphically for their analysis by the end user. Charts, Scatter plot matrix or Parallel Coordinate Matrix.

**ALIGNING USE CASES AND TOOLS**

The purpose of this table is to align the use cases with the tool specifications and the requirements for ontology building. Additional columns could be added to align the use cases with the activities of WP6. The demonstration scenarios would focus on very well defined ensembles of elements appearing in this table.

The content of the table will be translated in the mock-up of the SEMANCO platform (semanco_platform_20121107.ppt). The "solutions" that appear in the entry page of the platform would be the use cases defined in these tables. Keeping both representations in parallel –this table, and the graphic mock-up– will help to visualize the end tools and environments which we need to create.

The content of the table is not circumscribed to a particular iteration of the demonstration scenarios but to the project as a whole.

For the purpose of the technological development, we need more than one use case.

| **USE CASE 10: To calculate the energy consumption, carbon emissions costs and /or socioeconomic benefits of an urban plan for a new or existing development** | | | | |
|---|---|---|---|---|
| **Activity** | **Data input** | **Data output** | **Tool required*** | **Related Task**** |
| A1. Creation of alternatives | 3D models, type of building, building parameters… | A 3d model enriched with energy information | Data Generation | T5.4 |
| A2. Integration of socio-economic data and occupation parameters | | | Data Generation | T5.4 |
| … | | | | |
| A5. Calculation of energy performance | | | Calculation Tool | T5.1 |
| … | | | | |

*describe whether the tool is EM/I/EX; describe what it should do in a few lines
** describe the Task which corresponds to the tool to be developed, according to DoW

| **USE CASE 10: To calculate the energy consumption, carbon emissions costs and /or socioeconomic benefits of an urban plan for a new or existing development (CIMNE)** | | | | |
|---|---|---|---|---|
| **Activity** | **Data input** | **Data output** | **Tool required*** | **Related Task**** |
| A1. Creation of alternatives | 3D models (building geometry, building coordinates), building use, | Geometry of the building, socio-economic characteristics according to location (income, inhabitants, demographic structure, profile of time use) | Data Generation | T5.4 |
| A2. Integration of socio-economic data and occupation parameters | Income, size of households, type of households, time use profiles | Occupation, comfort temperatures, internal heat gains, energy carriers for heating, cooling & sanitary hot water, prices of energy carriers | EM. The tools will calculate output parameters according to a set of predefined formulas and technical coefficients. | T5.2.5. Semantic reasoning processes aiming at automation of data selection and aggregation |
| A3. Determination of characteristics of urban environment | Orography, Centroids construction polygons, Limits of construction | Buildings coordinates, Height, Number of floors, Orientation of the building, Maximum | 3D model / SEIF. SEIF will retrieve the geometry of urban environment (including the target | T5.2.5. |

| | | | | |
|---|---|---|---|---|
| | conforming polygons, Constructions and structures of public roads, Constructed polygons, Communication routes | air temperature, Minimum air temperature, Global solar radiation, Radiation by insulation, Horizon profile, Latitude | building) and the climatic information from the corresponding data bases. | |
| A4. Determination of the architectonic characteristics of the buildings in the target urban area | Building age, building conservation state | Building use, Air exchange rate, Name of the enclosure, Wall U-value, Wall α-value, Window percentage, Windows U-value, Windows g-value, Roof U-value, Skylight percentage, Skylight U-value, Skylight g-value, Roof α –value, Ground α –value, U-value ground, Land quality, Non-drinkable water in washing machine, Percentage of household with night cross ventilation, Percentage households with cross ventilation at 90º, Water flow reduction | SEIF. SEIF will retrieve building information (values of building parameters) from building typologies tables. In principle, most parameters will be valued according to building age and neighbourhood. | T5.2.5. |
| A5. Calculation of energy performance | Buildings coordinates , Height, Number of floors, Orientation of the building, Occupation, Building use, Air exchange rate, Name of the enclosure, Wall U-value, Wall α-value, Window percentage, Windows U-value, Windows g-value, Roof U-value, Skylight percentage, Skylight U-value, Skylight g-value, Roof α –value, Ground α –value, U-value ground, Land quality, Non-drinkable water in washing machine, Percentage of household with night cross ventilation, | Demand for domestic hot water, Demand for space heating, Cooling demand with or without natural ventilation, Electricity consumption, Solar heat gains for each enclosure, Heat Losses, Technical code compliance | Interfaced tool (URSOS) | T5.2.1. |

| | | | | |
|---|---|---|---|---|
| | Percentage households with cross ventilation at 90º, Water flow reduction, Solar coverage for sanitary hot water, Renewable electricity, Excavated soil, Land quality, energy carriers for heating, cooling & sanitary hot water, efficiencies of heating, cooling & sanitary hot water systems, Internal heat gains, Non-drinkable water in washing machine, Non-drinkable water in WC, % of ecological materials, % of recycled materials, Horizon profile, City, Latitude, Global solar radiation, Indoor air temperature (space heating), Indoor air temperature (cooling), Maximum air temperature, Minimum air temperature. | | | |
| A6. Calculate $CO_2$ emissions and energy savings for each proposed intervention | Emission factor electricity, Emission factor natural gas, Emission factor of liquid fuels, Energy Demand sanitary hot water, Energy carrier – sanitary hot water, Demand for space heating, Energy carriers for space heating, cooling and sanitary hot water, Electricity consumption from electric appliances | Total electricity consumption, Total natural gas consumption, Total liquid fuels consumption, $CO_2$ emissions | EM. The tools will aggregate consumption of different energy carriers and the corresponding $CO_2$ emissions. | T5.2.5. Semantic reasoning processes aiming at automation of data selection and aggregation |
| A7. Calculation of investment and maintenance costs | Energy price (electricity, natural gas, liquid fuels), Total consumption of electricity, natural gas and liquid fuels, maintenance cost rates, buit area, | Energy cost of electricity, natural gas, liquid fuels, naintenance costs, payback rate (internal return rate) | EM. The tools will calculate costs of energy consumption and maintenance costs. Also, embedded tools will calculate payback rates | T5.2.5. Semantic reasoning processes aiming at automation of data selection and aggregation |

| | | | | |
|---|---|---|---|---|
| | energy carriers space heating, cooling, sanitary hot water. | | | |

| **USE CASE 10: To calculate the energy consumption, carbon emissions costs and /or socioeconomic benefits of an urban plan for a new or existing development (RAMBOLL)** | | | | |
|---|---|---|---|---|
| **Activity** | **Data input** | **Data output** | **Tool required*** | **Related Task**** |
| A3. Determine the characteristics of the urban environment | • 3D architectural master plan model of North Harbour project.<br>• Ortophoto of the area.<br>• Energy demand (A5)<br>• $CO_2$ emissions (A6) | 3D GIS model of the North Harbour area | GIS based platform, e.g. Agency9's CityPlanner. Embedded tool. | T5.1, T5.3 |
| A5. Model or measure the energy performance of the neighbourhood | • Gross floor area<br>• Structural parameters<br>• Insulation<br>• Building design<br>• National Building Code requirements | Energy performance | IES or other building simulation tool. External tool | T5.1, T5.2, T5.3 |
| A6. Calculate the $CO_2$ emissions and energy savings for each proposed intervention. | • Energy performance indicators (A5)<br>• $CO_2$ emission from energy suppliers<br>• Projection of $CO_2$ emissions on district heating and electricity | $CO_2$ emission per measure on a temporal scale.<br>Energy savings per measure | MS Excel and LEAP.<br>Interfaced tool. | T4.4, T5.2, T5.3 |
| A7. Calculate investment and maintenance costs for each proposed intervention | • The Danish Energy Outlook (Energy cost)<br>• Insulation cost<br>• Technology data for individual heating plants and energy transport.<br>• Technology data for individual heating plants and energy transport.<br>• Ramboll in-house | Financial and socio-economic parameters | MS Excel and LEAP.<br>Interfaced tool. | T4.4, T5.2, T5.3. |

| | | | | |
|---|---|---|---|---|
| | knowledge | | | |

**STAGE 2: INTEGRATION PROCESS**

The second stage of the integration process is made of the following steps:

**STEP 1**. CASE STUDY PARTNER meets with stakeholders in working sessions to obtain requirements from them. They can use different instruments for this purpose (mock-up, interviews). The work done in these sessions are directly related to D6.1.

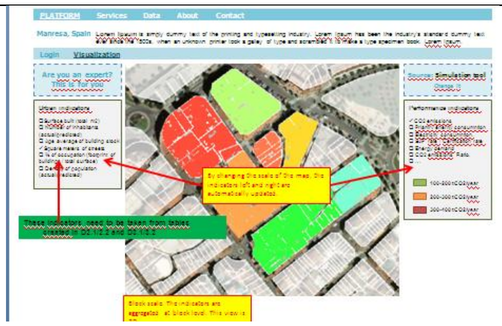
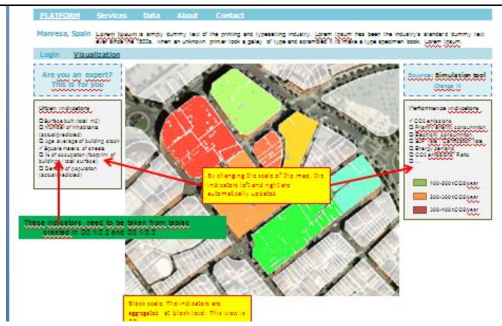
**STEP 2**. CASE STUDY PARTNER meets with WP5 developers to work on the mock-up, via Skype sessions. The goal of this step is to integrate the stakeholders/users requirements obtained in 1 into the project. This means to check the following topics:

- **Topic 1**. The proposed functionality does not reproduce existing functionalities carried out by other tools. Justify this.
- **Topic 2.** The functionality includes data semantically modelled. Explain which data, precisely. (Mapping table).
- **Topic 3**. The functionality takes advantage of the access to various data sources (repositories, tools). Explain how.
- **Topic 4**. The functionality uses the indicators defined in WP2. Explain which ones, precisely
- **Topic 5.** The user of the functionality has been identified (need for the functionality, context of use,….). This can be elaborated in D6.1
- **Topic 6.** The functionality can be carried out through the activities described in Use case and Activities templates. Identify which activities, and if there is none, create the ones you need using templates.
- **Topic 7.** Explain how the functionality is integrated in the demonstration scenarios, in any of the iterations.
- **Topic 8**. Exploitation plan: services related to the activities

The sessions will take place during the month of February. Calendar will be set with a Doodle poll.

**STEP 3**. REPEAT STEPS 1-2 until a stable solution is found.

**STEP 4**. Once some specifications for the tools –as integrated in the SEMANCO platform- have been created in all three cases, WP developers can carry out the programming (5.1, 5.3 Martin; 5.2 German, 5.4, 5.5, David; 5.6 URSUS interface developed by UNIZAR with the support of FUNITEC)

| Mock-up | Description |
|---|---|
|  | Description of the interface. Explain in a few words the purpose, stakeholders, integration in the platform, …. This description is the result of STEP 1 |
|  | Add more interfaces images if you need to explain a flow of actions. |

| Topic | Description |
|---|---|
| T1 | Answer to the topic described in the list above. The descriptions in this list will be verified and completed during the Skype sessions between domain experts and WP5 developers (STEP 2) |
| T2 | Same as above |