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SEMANCO Semantic Tools for Carbon Reduction in Urban Planning

SEMANCO

Deliverable 1.8
Project Methodology

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7	2012-09-21	Tracey Crosbie (UoT)	Final proof-reading

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1 EXECUTIVE SUMMARY

This document describes the methodology developed during the first year of the SEMANCO project. Its purpose is to explain how the work of the Tasks in different Work Packages (WPs) can be integrated. As such it introduces the tools and mechanisms used to ensure the integrated development of the different components of the project. As far as the working process is concerned, this document facilitates an understanding of the contents of the deliverables produced in the first year of the project, the relationships between them and their role in the next phases of the project.

The project methodology described in this document is an elaboration of the work plan proposed in the Annex I- *Description of the Work* (DoW). According to the proposed plan, Case Studies would be used to identify the scope and functionalities of the tools and methods to be developed in the project. A further refinement of the case study approach has led to the differentiation between Case Study, Use Case and Demonstration Scenario which are defined as follows:

- **Case Study**, is a delimitation of the research scope to some geographic boundaries (e.g. Manresa, Copenhagen, Newcastle)
- **Use Case** is a methodology to identify a strategic goal regarding carbon reduction in urban settings and the methods and tools to achieve it (e.g. identification of buildings below/above benchmarks of energy consumption and CO_2 emissions in suburban areas). A Use Case is made up of a series of **Activities**, these are, specific actions which have to be performed to fulfill a Task within a Use Case. A Use Case brings together the data, tools and users required to address a particular question posed by stakeholders.
- **Demonstration Scenario** is the verification in a particular setting of the components of one or several Use Cases. The results obtained through the implementation of a scenario will be used to inform the project's technical development.

The description of Use Cases in a systematic manner is a prerequisite for building ontologies. The ontology development encompasses three stages:

- **Capturing**: deriving specifications from Activities, standard documents and data sources to create an informal ontology
- **Coding**: translating the informal ontology specifications to OWL language
- **Evaluating**: assessment of each ontology in terms of completeness, intelligibility and computational integrity and efficiency

This document also describes the methodology behind the design and implementation of the three cycles of Demonstration Scenarios.

2 INTRODUCTION

2.1 Purpose and target group

The purpose of this deliverable is to present the methodology developed to integrate the Tasks carried out in the different WPs. The ultimate purpose of SEMANCO is to provide semantic-based tools to be applied by different stakeholders to reduce carbon emissions in urban environments. Devising, implementing and verifying such tools require simultaneous development at multiple levels, namely:

- **Case study**: In each of the three Case Studies it is necessary to identify the specific problems concerning carbon reduction, the available data sources, the methodologies to be applied, the stakeholders involved and the users of the tools.
- **Ontology design**: Involves creating an energy model which contains the problem domain (methods, concepts and relations) defined by the energy experts.
- **Tool requirements**: Capturing the requirements of different users and stakeholders to create tools relevant to their needs that interact with the semantically modelled data.
- **Data modelling**: It embraces identifying the relevant public and private data sources required by energy models at different geographic scales.
- **Tools and methods**: The design and implementation of tools and methods in specific realms to be used by different stakeholders (consultants, urban planners, policy makers etc.)

The Tasks involved in each level of development cannot always be carried out consecutively; rather development at each level, in many instances, must occur simultaneously. Therefore to ensure that Tasks are integrated it was necessary to design a working methodology which:

1. Sets each Task in relation to the others.
2. Enables consistent relationships between Tasks as the project develops.

This methodology was initiated in the first month of the project. It has been further developed as different Tasks came into play. It has contributed to the construction of a shared view of the project objectives and helped partners to place their work within the overall project development.

2.2 Contribution of partners

The design and planning of the project methodology is the key element in the SEMANCO project's technical coordination. All partners have contributed to its development and application lead by FUNITEC, the project coordinator.

2.3 Relations to other activities in the project

The content of this document supports an understanding of the work presented in the different deliverables produced in the first year of the project. To do so, it provides the basic vocabulary used in the deliverables. Importantly it also illustrates the relationships between the work conducted in different WPs and how the combined output of this research and technical development will achieve the ultimate objectives of the project: the creation of a Semantic Energy Information Framework (SEIF) and associated tools that can be applied in specific realms to improve energy efficiency at the urban level.

3 PROJECT METHODOLOGY

3.1 Work plan concept

The project methodology described in Section B1.3 of the Annex I- *Description of the Work* is represented in Figure 1 below. According to this structure, WP 2 *Case Studies* would provide the requirements for the design and application of the SEIF, and the methods and tools to be developed in the project. At the same time, the Case Studies would delimit the scope of the research by circumscribing to the known facts: data, tools and users, problems and stakeholders. In this structure WP2 would also provide the indicators required to evaluate the effectiveness of the implementations of the tools methods and strategies implemented in WP8 *Implementation*. According to the work plan, the implementation of the tools and systems will be carried out in three successive yearly cycles, enabling the research and technical development to benefit from feedback from the initial implementations.

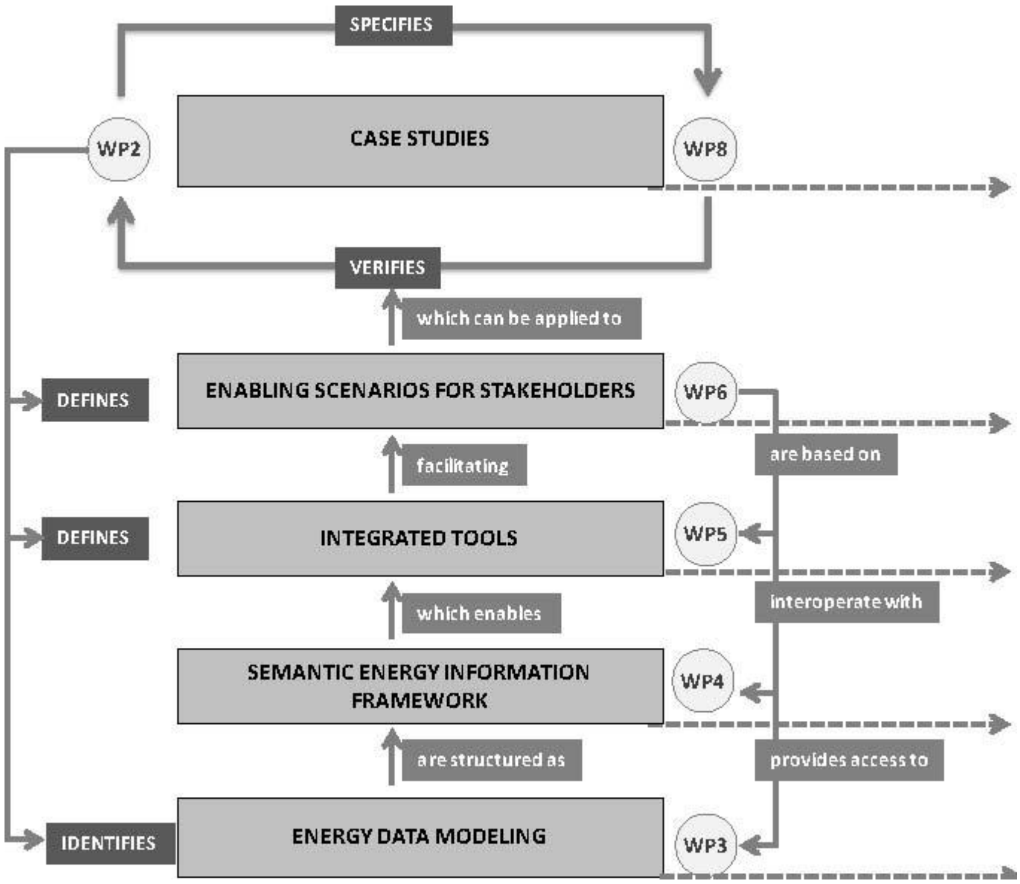

Figure 1. Structure of the relationship between WPs, as presented in the DoW

In the original formulation in the DoW, it was envisaged that the technological development of the project would follow a step-by-step process, in the following sequence:

1. The specification of the tools required in the Case Studies, at different geographical scales (WP2).
2. The modelling of the energy data required to develop CO_2 strategies in the Case Study Scenarios (WP 3).

3. The structuring of the energy data in the SEIF (WP4).
4. The development and integration of the tools required to access and analyse the data in the SEIF (WP5).
5. The development of appropriate methodologies to implement the tools at different geographical scales in the Case Study Scenarios (WP6).
6. The iterative implementations of the tools in the Demonstration Scenarios and the measurement of their impacts on CO_2 (WP8).

3.2 Work plan development

Even though the original work plan structure remains valid, it has undergone some refinements during its implementation in the first year of the project. Essentially, we have moved from a linear approach of the technological development to a networked approach which acknowledges the connections between the different project components. This approach is necessary due to the need for simultaneous development within the different WPs and Tasks.

Figure 2 represents the linear process described in the initial plan. The first iteration begins with the case study descriptions in WP 2 and ends up with the implementation in WP8. In between, the available data sources (WP3) are the precondition for the ontology design (WP 4), the semantic data is used by the tools (WP 5), and a methodology is provided to facilitate their use in the different application realms (WP 6). Figure 3 shows the approach adopted during the project. It combines the linear process with an approach which enables integration of the work in different WPs. This approach is further described in the following sections.

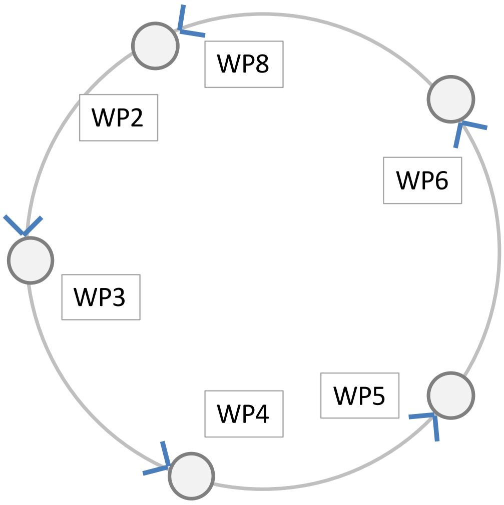

Figure 2. The linear development of the initial plan

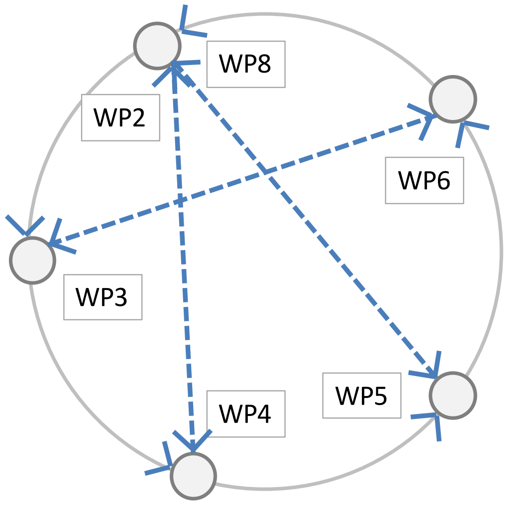

Figure 3. The linear/network development of the implemented plan

Ontologies are at the core of the SEMANCO project. Building ontologies requires the integration of the domains of data, tools, users and stakeholders etc. Therefore the process of building the ontology demands an approach which enables the different dimensions of project development to be viewed simultaneously to integrate the different components involved, as represented in Figure 3.

3.2.1 Work packages integration

To facilitate the integration of the different components of the project, a methodology based on Use Cases has been developed. A Use Case is the bond connecting the Tasks carried out in the different WPs. The Use Cases provide a bridge between the different elements of the RTD and a bridge between the Demonstration Scenarios and the RTD.

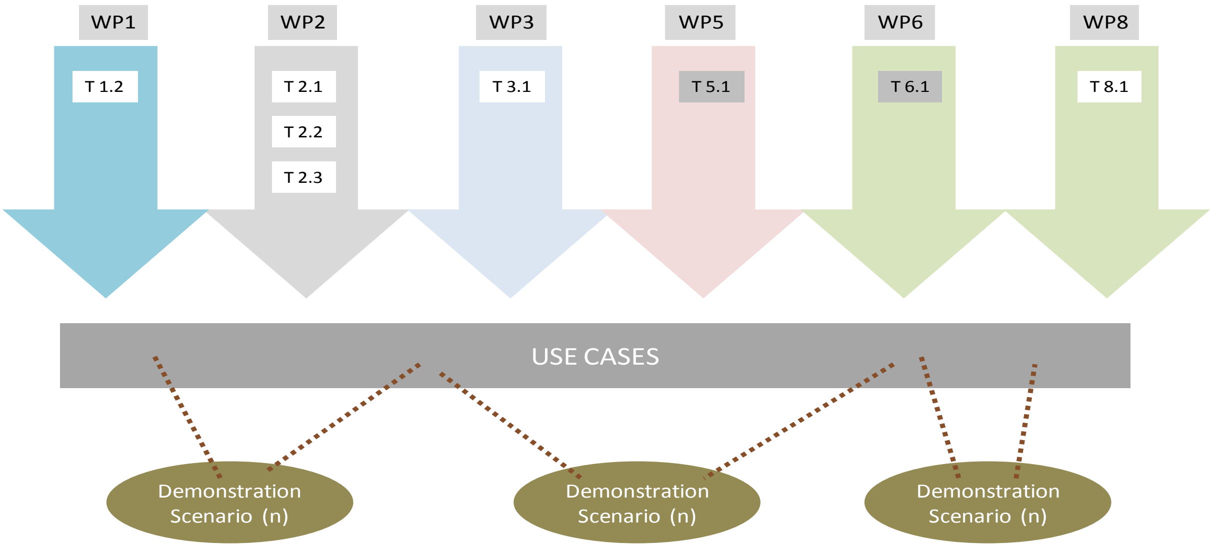

Figure 4. Integration of Tasks through Use Cases

Through Use Cases, the Tasks carried out in the different WPs are integrated (see Figure 4). This network of relationships – linking tools and users, data and tools, Case Studies and methods – provides the inputs required to build the ontologies in WP4 (see Figure 5).

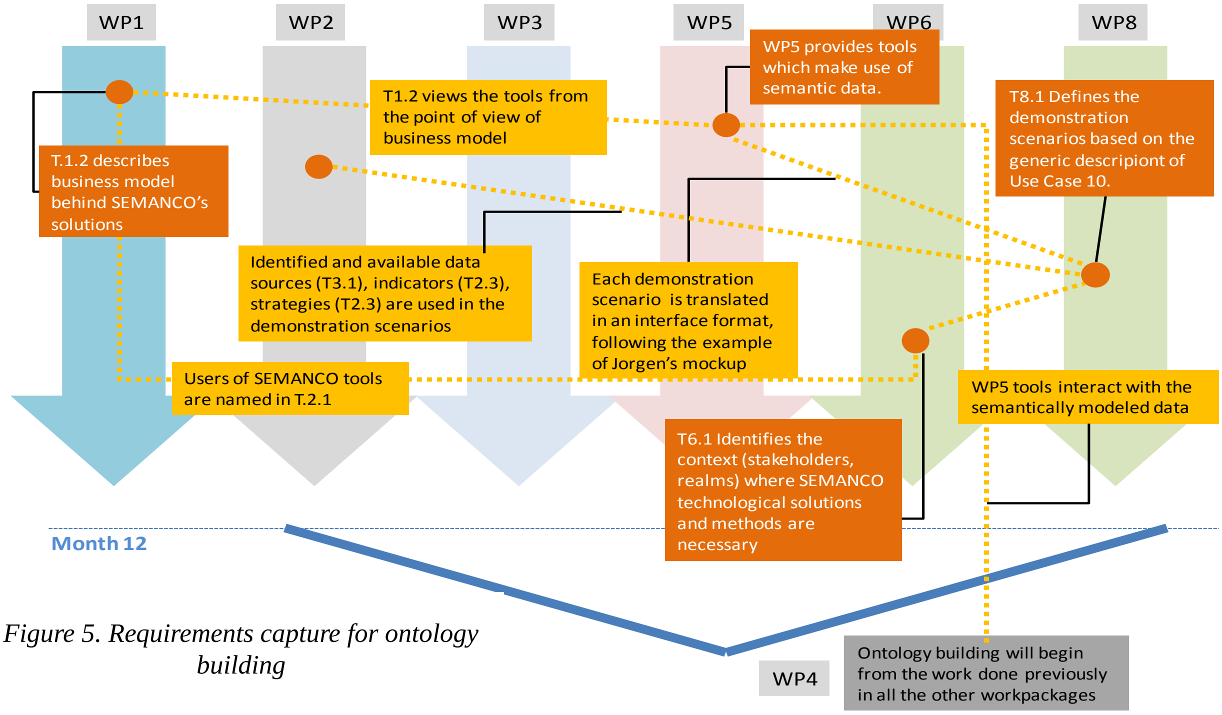

Figure 5. Requirements capture for ontology building

3.3 Case studies, Use Cases and Activities

During the project development it has been necessary to introduce a further distinction between Case Studies and Use Cases. This distinction was not foreseen in the initial work plan but it is essential for the ontology building process. In the context of the project, a Case

Study refers to the delimitation of the research scope to some geographic locations and the problem definition, stakeholders and methods etc. within those locations. A Use Case, on the other hand, delimits a specific research problem which can be applicable to one or several Case Studies. The Use Case is the frame which encapsulates data, service and actors, as well as their relationships to each other, in order to achieve a strategic goal concerning carbon reduction. Use Cases can be defined as single entities or as part of a network of Use Cases.

Each Use Case has a goal related to reducing CO_2 emissions in urban planning. It is composed of a network of Activities which need to be performed to fulfil the goal of the Use Case. Some Activities are shared by several Use Cases.

Figure 6 shows, the relationship between Use Cases and Case Studies and the role of the former as interface between the "ontology world" and the "real world"

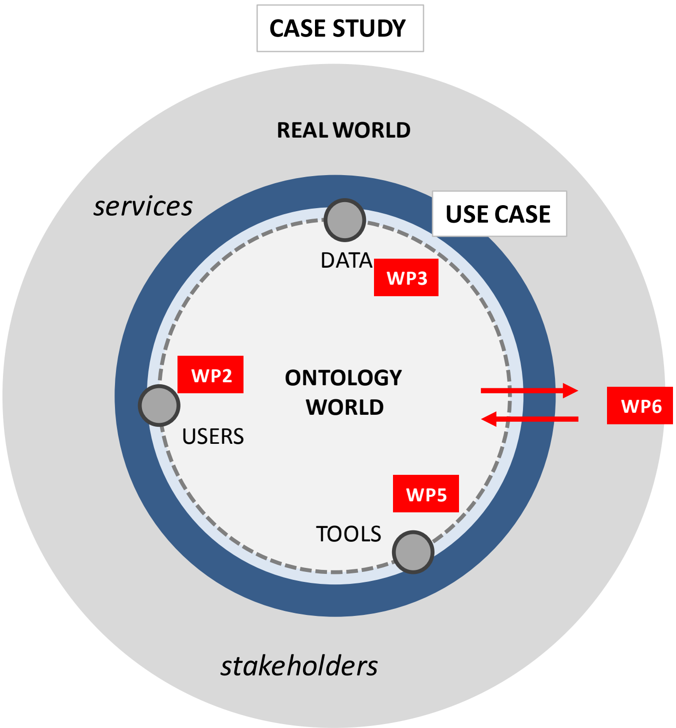

Figure 6. Relationship between Case Studies and Use Cases in the development of the ontology

Figure 7 illustrates the project development. It begins from the known facts (lower level, right side of Figure 7), that is, the data, methods and indicators, and moves to the final project output that is the creation of the SEIF and its associated tools (upper level, right side of Figure 7). The Use Case is the link which enables the technical development to move from what was previously known to what is new: the results of the project. The work produced by the different tasks informs the overall project development. Rather than being isolated pieces of work, Tasks are part of an integrated working strategy.

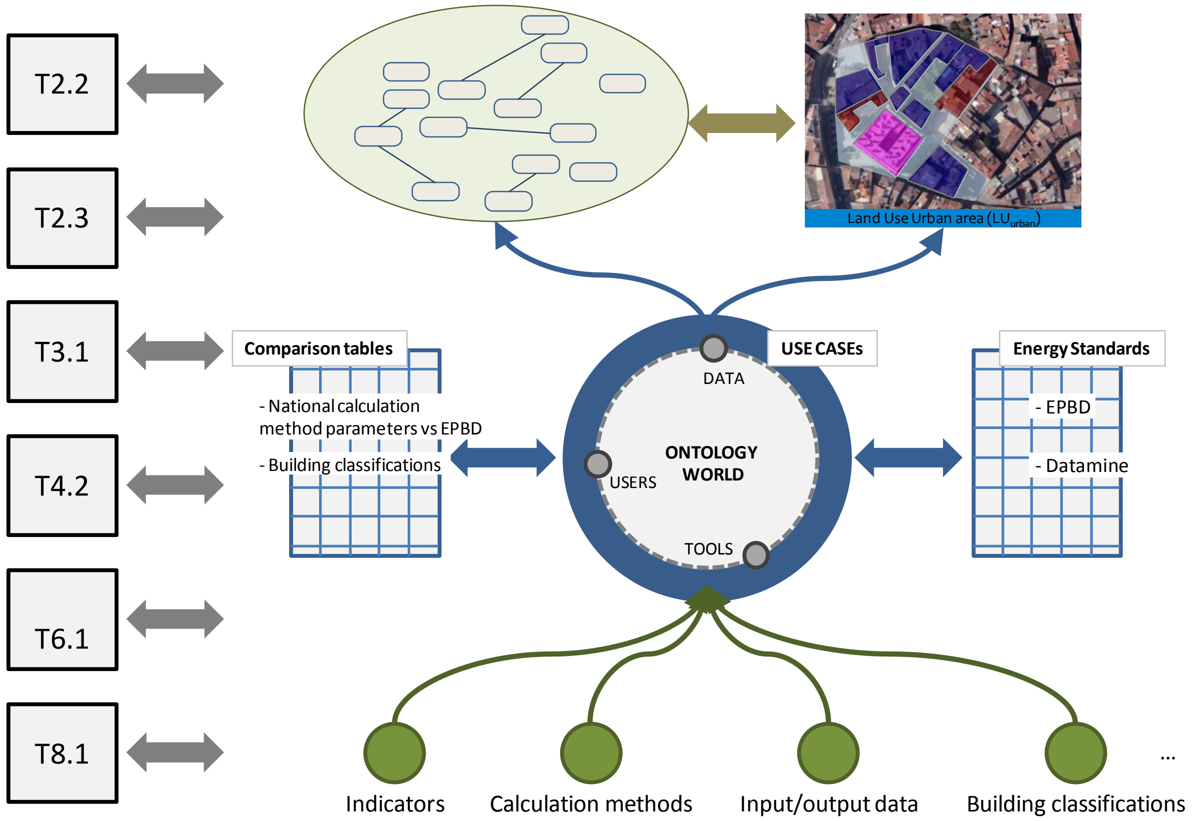

Figure 7. Integration of Tasks in overall project development

3.3.1 Describing Use Cases

A Use Case brings together information about actors, policies and Activities to fulfil a goal at a particular scale (micro, meso, and macro). The Use Case description is a generic statement of a complex problem dealing with carbon reduction in urban planning which require a series of discrete actions to be undertaken, these are Activities (see Figure 8).

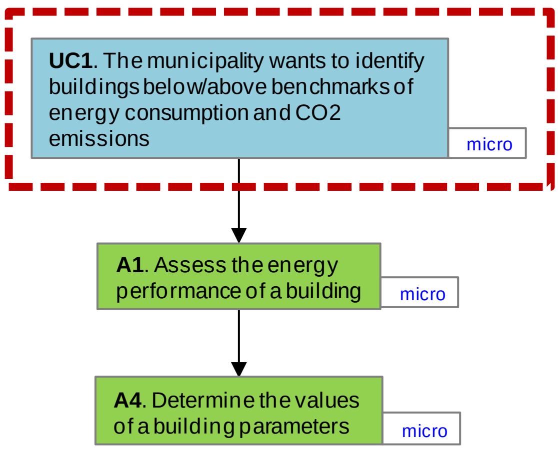

Figure 8. A Use Case and its Activities

Use Cases can make a network in the sense that the output of a Use Case can serve as input for another (see Figure 9). The arrows in the figure indicate that the output of one Use Case or Activity is the input of another one.

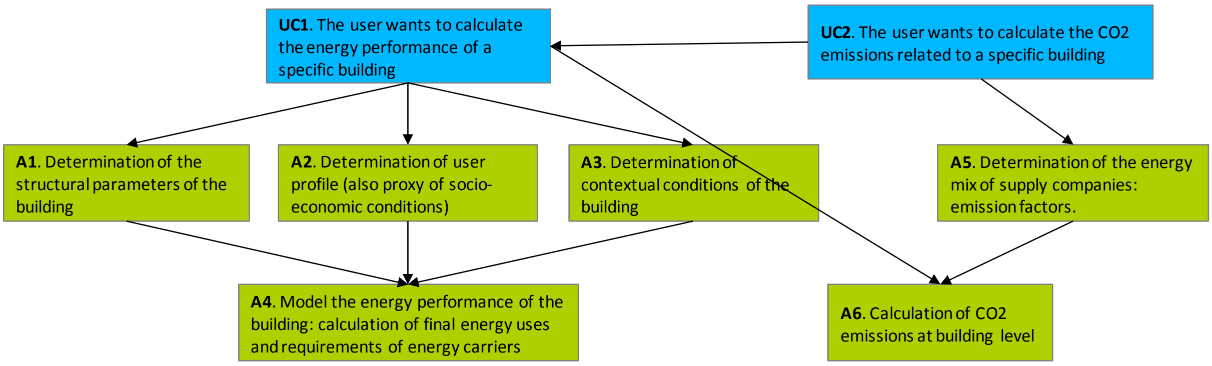

Figure 9. Networked Use Cases

Use Cases are defined by means of a template (see Figure 10)

Acronym	UCXXX
Goal	*EXPLAIN THE GOAL OF THE USE CASE*
Super-use case	*SPECIFY THE SUPER-USE CASES OF THIS ACTIVITY*
Sub-use case	*SPECIFY THE SUB-USE CASE*
Work Process	*THE USE CASE IS CARRY OUT IN A SPECIFIC WORK PROCESS, SELECT ONE ITEM OF THE FOLLOWING LIST:* – *PLANNING: it has to do with the city scale* – *DESIGN: it has to do with the building scale* – *PERFORMANCE: assessing existing buildings and urban plans*
Users	*THE USE CASE IS FIRST DEFINED THINKING OF THE USERS (SELECT ONE OR MORE USERS OF THE FOLLOWING LIST)* – *Planners* – *Architects* – *Citizens* – *Policy makers*
Actors	*IDENTIFY STAKEHOLDERS AND EXPLAIN WHY REACHING THIS GOAL IS IMPORTANT FOR THEM.* – *XXXX* – *XXXX*
Related national/local policy framework	*IDENTIFY NATIONAL/LOCAL POLICY FRAMEWORK RELATED TO THIS USE CASE* – *XXXX* – *XXXX*
Activities	*LIST OF THE ACTIVITIES INVOLVED IN THIS USE CASE* – *XXXX* – *XXXX*

Figure 10. Use Case template

As illustrated in Figure 10 the Use Case template is composed of the following fields:

- *Acronym*: UCnumber
- *Goal*: explain the goal of the Use Case

- *Super-Use case*: specify the super-Use Cases which contain this Use Case
- *Sub-Use Case* : specify the sub-Use Cases contained in this Use Case
- *Work Process*: select the domain in which the work process is carried out (planning, design, performance)
- *Users:* describe users involved in the Use Case (i.e. planners, architects, citizens, policy makers etc.)
- *Actors*: identify stakeholders and explain why reaching the goal is important for them
- *Related national/local policy framework*: identify national/local policy frameworks related to the Use Case
- *Activities*: list the Activities involved in the Use Case

Use Cases defined by means of these templates are a keystone in the ontology building process (see Figure 11). Furthermore, they bring together the different components of the project as described in the different WPs (data, tools, actors...)

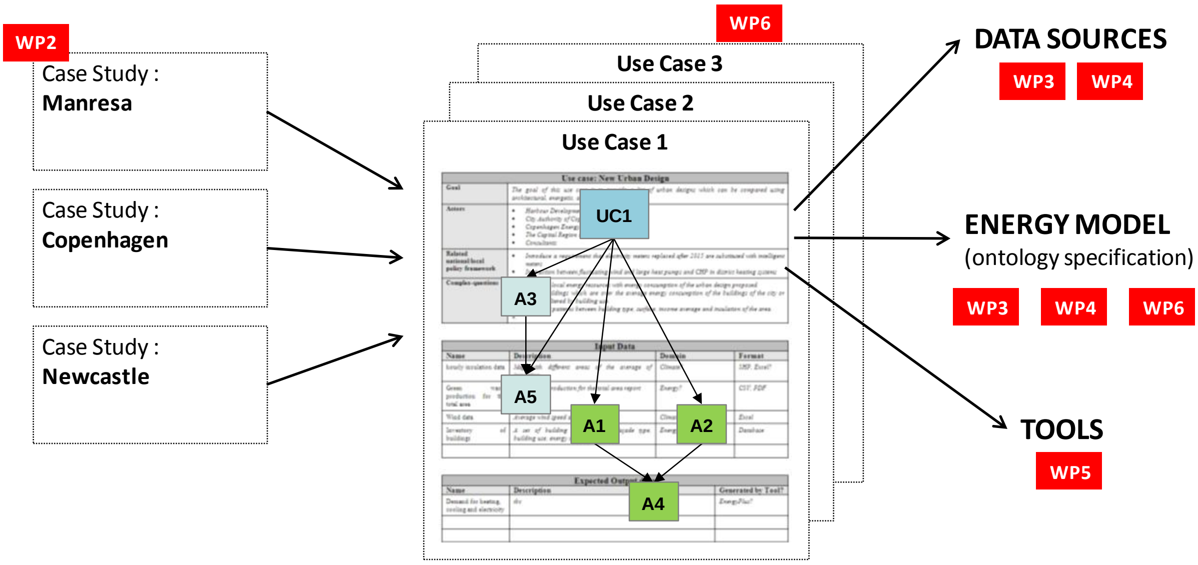

Figure 11. Use cases as links between WPs

Table 1 describes some of the Use Cases identified during the first year of the project.

Table 1. Identified Use Cases

ID	Name	Scale	Activities	Author	Date
UC1	Calculation of energy performance of new buildings (final energy uses and energy carriers), related CO_2 emissions, and calculation of different scenarios of energy efficiency measures	Micro	A1,A2,A3, A4	CIMNE	25/05/2012
UC2	The user wants to identify the different levels of energy efficiency in all neighbourhoods /areas of the city, in order to define priorities and mechanisms of action	Micro	A5,A6	CIMNE	25/05/2012
UC3	The user wants to evaluate the possibilities of energy supply from local renewable energy sources	Micro	A7,A8,A9, A10	CIMNE	25/05/2012
UC4	The user wants to compare different urban planning scenarios: at building level	Micro		CIMNE	25/05/2012
UC5	The user wants to calculate costs of production of energy (electricity, heating and cooling) for a variety of production technologies for both individual and district energy systems based on conventional as well as renewable energy sources.	Micro		CIMNE	25/05/2012
UC10	**To calculate the energy consumption, CO2 emissions, costs and /or socio-economic benefits of an urban plan for a new or existing development.**	**Meso**	**A15,A31,A 9,A32,A11, A7,A5,A12**	**CIMNE**	**25/05/2012**
UC11	Calculation of energy performance of an existing building (final energy uses and energy carriers), related CO_2 emissions, and calculation of different energy efficiency improvements scenarios	Micro		CIMNE	25/05/2012
UC12	The user wants to calculate the energy consumption and CO_2 emissions of different possibilities of refurbishment and regulations of urban planning in an existing area	Meso		CIMNE	25/05/2012
UC13	The user wants to calculate the costs of energy saving measures in neighbourhoods	Micro		CIMNE	25/05/2012
UC14	The user wants to compare different urban planning scenarios in new and/or existing areas	Micro		CIMNE	25/05/2012
UC15	Identify the CO_2 emissions of domestic dwelling stock in a neighbourhood and estimate its CO_2 emission reduction potential.	Meso	A11,A12,A 13	UoT	03/05/2012
UC16	The user wants to calculate costs of production of energy (electricity, heating and cooling) for a variety of production technologies for both individual and district energy systems based on conventional as well as renewable energy sources	Micro/Meso /Macro	A14, A15, A16, A17, A24 + UC6	Ramboll	25/05/2012
UC17	The user wants to map potentials of local energy sources (e.g. conventional and renewable energy sources).	Micro/Meso /Macro	A18, A25, A26	Ramboll	25/05/2012
UC18	The user wants to calculate the costs of energy saving measures in buildings (e.g. windows replacement, improved insulation, energy efficient electric	Micro/Meso /Macro	A1, A2, A3, A4, A20, A21, A27,	Ramboll	25/05/2012

	appliances and systems, smart grid etc.)		A28		
UC19	The user wants to calculate CO_2 emission impacts of energy production from the energy supply system and energy saving measures.	Micro/Meso /Macro	A19, A23	Ramboll	25/05/2012
UC20	The user wants to compare the cost effectiveness and related CO_2 reductions of a range of energy supply and energy demand options.	Micro/Meso /Macro	A29, A30 + UC5, UC7, UC8	Ramboll	25/05/2012
UC21	Optimise existing biomass district heating in terms of costs and CO_2 emissions.	Meso	-	UoT	27/05/2012
UC22	Optimise renovation plans for an existing building in terms of cost and CO_2 emissions.	Micro	-	UoT	27/05/2012
UC23	Calculate the built cost and CO_2 implications of different options for the redevelopment of urban land	Meso	-	UoT	27/05/2012
UC24	Identify the CO_2 emissions of domestic dwelling stock and estimate its CO_2 emission reduction potential.	Meso	-	UoT	27/05/2012
UC25	Identify low income (Fuel Poor) households living in energy intensive dwellings with a poor SAP (Domestic Energy Efficiency Rating).	Meso	A9, A10	UoT	27/05/2012

In the first year implementation, the demonstration scenarios (see Section 4) are derived from one of the Use Cases developed so far in the project, namely, Use Case 10 (UC10): “To calculate the energy consumption, CO_2 emissions, costs and /or socio-economic benefits of an urban plan for a new or existing development.”

3.3.2 Describing Activities

Activities are described by means of a template composed of the following fields (see Figure 12):

- *Acronym*: Anumber
- *Super-Activity/Use Case*: specify the super-Activities or Use Cases which contain this Activity
- *Sub-Activities*: specify the sub-Activities contained in this Activity
- *Goal*: explain the goal of the Activity. Add in the goal of the calculation method to be used (detailed, simplified, energy balance)
- *Urban scale*: select one or more scales (micro, meso or macro).
- *Users*: select one or more users from the related Use Case
- *Issues to be addressed*: describe the issues to be addressed to carry out the Activity.
- *Method*: explain the method applied to transform input data into output data. It is related to the data flow of the related Use Case.

Acronym	AXXX
Super-activity/use case	*SPECIFY THE SUPER-ACTIVITIES OR USE CASES OF THIS ACTIVITY*
Sub-activities	*SPECIFY THE SUB- ACTIVITIES OF THIS ACTIVITY*
Goal	*EXPLAIN THE GOAL OF THE ACTIVITY. ADD IN THE GOAL THE CALCULATION METHOD FROM THIS LIST: (Detailed, simplified, energy balanced -> check wording with WP3)*
Urban Scale	*SELECT ONE OR MORE URBAN SCALES OF THE FOLLOWING LIST* – *Micro (Building)* – *Meso (Neighbourhood)* – *Macro (City/Region)*
Users	*SELECT ONE OR MORE USERS OF ITS RELATED USE CASE* – *XXXX* – *XXXX*
Issues to be addressed	*DESCRIBE THE ISSUES TO BE ADDRESSED TO CARRY OUT THE ACTIVITY.*
Method	*EXPLAIN THE METHOD APPLIED TO TRANSFORM INPUT DATA INTO OUTPUT DATA. IT IS REALTED WITH THE DATA FLOW OF THE RELATED USE CASE.*

Figure 12. Activities template

The Activities template contains a section to describe the inputs/outputs which define their interrelations (see Figure 13). The parameters of each input/output are taken from existing standards (e.g. in the case of energy data, ISO TR 16344, CEN/TR 15615, EN 15603).

Input Data			
Name	**Description**	**Domain**	**Format**

Expected Output data		
Name	**Description**	**Generated by Tool?**

Figure 13. Inputs and outputs in the Activities template

Through the input/output relationship, a network of Activities is created which can be shared by different Use Cases (see Figure 14).

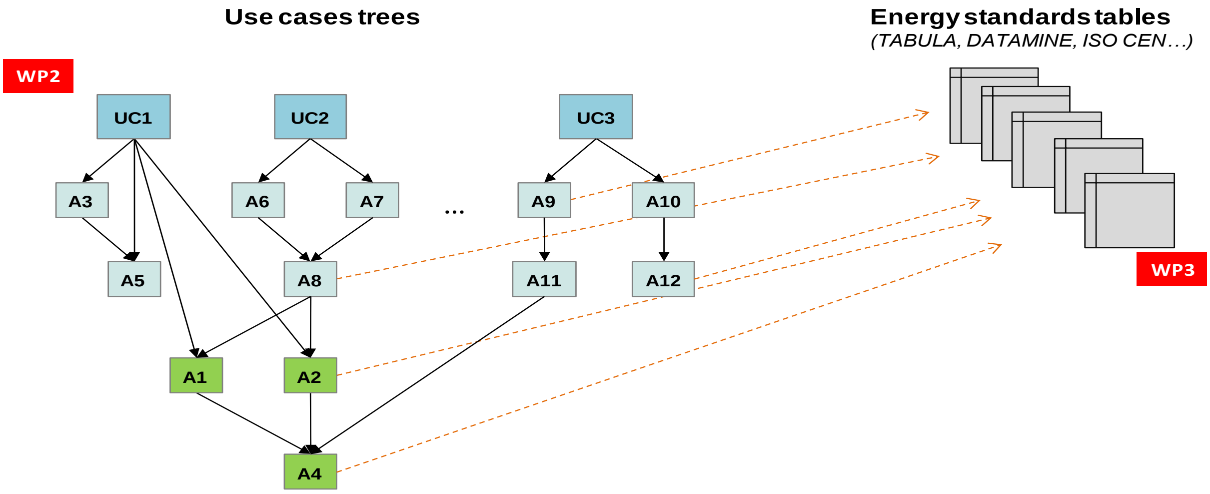

Figure 14. Network of Activities connected to different Use Cases

3.4 Building ontologies

This section describes the stages followed to build the ontologies from the specifications captured through the Use Case methodology.

3.4.1 Ontology Development

Ontology development is an iterative process and each iteration has three stages, namely capture, coding and evaluation (see Figure 15). Iterations are development phases equally structured but focusing on different aspects of the object to be developed, in the case of SEMANCO an ontology. After each iteration, the ontology grows quantitatively and/or is improved qualitatively. Each iteration gives rise to a new ontology release which is consistent and ready to be applied in specific tasks handled by the SEIF.

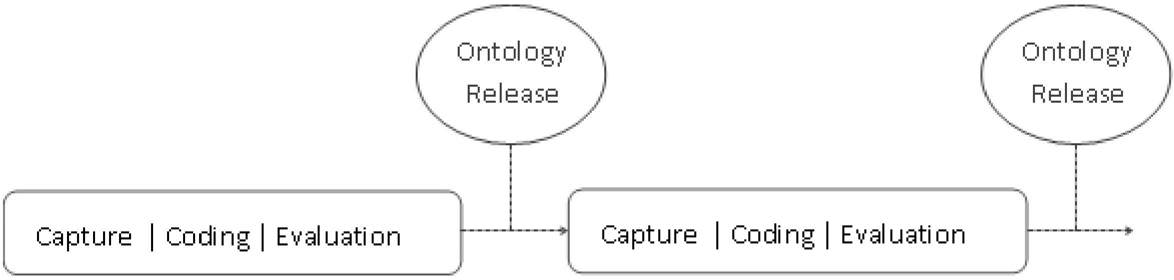

Figure 15. Ontology development process

3.4.1.1 Capture phase

In the capture phase information required for an ontology specification is extracted from three types of sources –Activity specifications, standardisation documents and data source specifications– and systematised in the form of Excel style sheets, enabling, domain experts to integrate concepts from the three types of sources (see Figure 16).

	Name	Description	Reference	Type of data (descriptive / numeric)	Unit	Reference to other sheets
	Building	**construction as a whole, including its envelope and all technical building systems, for which energy is used to condition the indoor climate, to provide domestic hot water and illumination and other services related to the use of the building**	EN 15603	descriptive	-	-
has	Space	enclosed space within a building	ANSI/ASHRAE 90.1	descriptive	-	-
has	**Use**			descriptive	-	"building_use"
has	**Occupancy**			descriptive	-	"building_occupancy"
has	**Profile of use**			descriptive	-	
has	**Building management**			descriptive	-	
has	…			descriptive	-	
has	…			descriptive	-	
Is	**Conditioned Space**	heated and/or cooled space	EN 15603 EN ISO 13790	descriptive	-	-
has	**Cs_geometry**			descriptive	-	"building_cs_geometry"
has	**Cs_envelope**	the exterior plus semi-exterior portions of a building (separating conditioned space from external environment or from unconditioned space)	ANSI/ASHRAE 90.1*	descriptive	-	"building_cs_envelope"
has	**Cs_building structure**			descriptive	-	"building_cs_buildingstructure"
has	**internal heat source**	occupants, appliances such as domestic appliances, office equipment, etc.	EN ISO 13790*	descriptive	-	"building_interalheatsource"
Is	**Unconditioned Space**	room or enclosure that is not part of a conditioned space	EN ISO 13790	descriptive	-	-
has	**Ucs_geometry**			descriptive	-	"building_ucs_geometry"
has	**Ucs_envelope**	the exterior plus semi-exterior portions of a building (separating unconditioned space from external environment or from another unconditioned space)	ANSI/ASHRAE 90.1*	descriptive	-	"building_ucs_envelope"
has	**Technical building system**	technical equipment for heating, cooling, ventilation, domestic hot water, lighting and electricity production, composed of different subsystems	EN 15603 EN 15316-1	descriptive	-	"building_system"

Figure 16. Excel sheet systemizing information collected in the capture phase of ontology development

The Activity specifications play the most important role in the capture phase. It is important that all the terms mentioned in the “issues to be addressed” field of the Activity specification are available in the resulting ontology as concepts. Otherwise, the SEMANCO’s tools that use this ontology for information representation will not be able to support the corresponding Activity or its Use Case.

During the capture phase, the terms collected from Activity specifications and those provided by energy standards are entered in the first left column of an Excel table. They are grouped according their relationship to each other and subdivided in different tables, e.g. “building geometry”, “building physics” or “building system”. In the next step each term is supplemented by a textual description (see Figure 16, column 2), a reference to standards (see Figure 16, column 3), a data type (see Figure 16, column 3), units of measure, e.g. m2, kWh or degrees (see Figure 16, column 5). Once this process is completed, relationships between terms, i.e. concepts, are identified and specified. Basically, there are two types of relationships that can be specified: “is” and “has”. The type of relationship denotes a specialisation or generalisation between concepts. On other hand, the “has” relation stands for an aggregation relationship where one concept contains the other one.

At the end of this phase a further segmentation of Excel tables can be carried out. This step improves reliability in the specification development. Tables resulting from such segmentation are connected by references in the first left column of each table.

3.4.1.2 Coding phase

The coding phase is carried out by translating the informal ontology specifications shown in Figure 16 to an OWL DL lite$_A$ ontology through an ontology editor developed in the project.

Conventional ontology editors, like Protégé or NeOn Toolkit, offer excellent environments for ontology experts, who are aware of particularities of Description Logic and formal ontology languages like OWL and RDF. Domain experts, in our case building engineers, however are missing this knowledge. Therefore they need an environment that will;

1) Hide complex formalisms like axioms,

   Carry out coding activities in interaction without obligating the user to enter code, and

2) Partition complex tasks into a sequence of simpler tasks.

The editor developed for this purposes is shown in Figure 17. The editor presents the ontology in two different perspectives:

1) As a taxonomy, i.e. a hierarchy of concepts subsuming each other (see Figure 17, left)
2) As a hierarchy of non-subsumption relationships (see Figure 17, left).

The first perspective is perfectly understandable for ontology experts, while the second is designed for domain experts. Therefore the ontology coding is partitioned in two sub-processes. Domain experts basically connect concepts by non-subsumption, i.e. *has*-relationships working in the right part of the window. New emerging concepts during this procedure are initially subsumed by the concept *Thing*. Later, in an independent sub-process, all sub-concepts of *Thing* are relocated to an appropriate position within the taxonomy. This sub-process is carried out as a mutual task by ontology and domain experts.

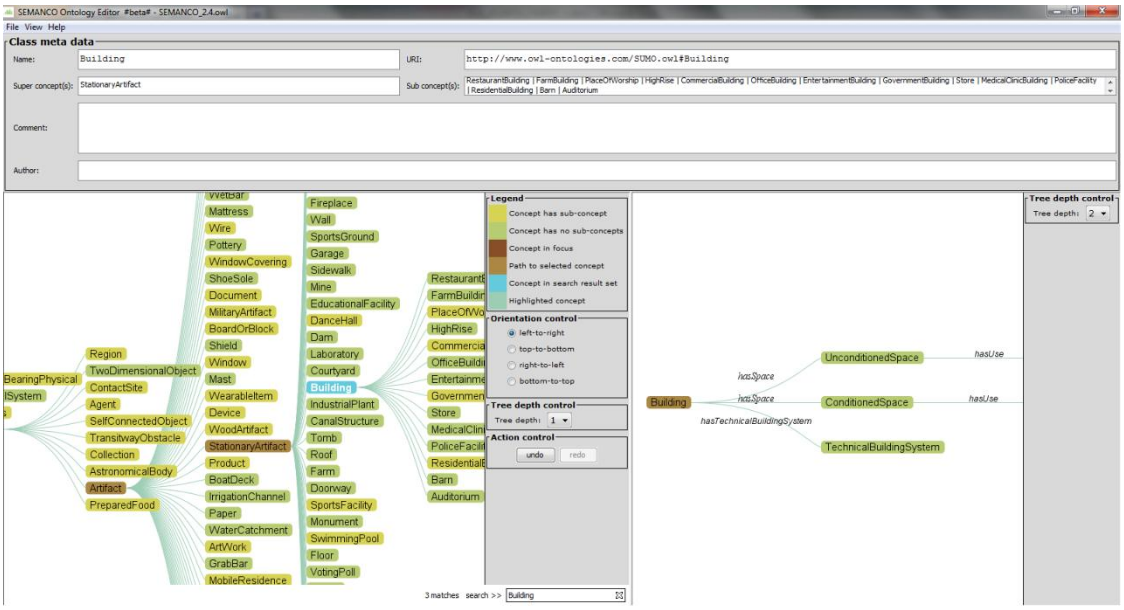

Figure 17. Ontology Editor

3.4.1.3 Evaluation phase

Evaluation, the concluding phase of each ontology design iteration, focuses on the assessment of each ontology release according to the following criteria:

- **Completeness**: in SEMANCO's context this means that all terms identified in the capture phase, using Activity specifications are explicitly specified in the ontology code or can be inferred through reasoning.
- **Intelligibility**: the ability of actors using the ontology and ontology-based applications in their decision making process to understand the ontology structure.
- **Computational integrity and efficiency**: the ability of the ontology to efficiently support reasoning tasks such as conjunctive querying so that they have a comparatively short response time.

3.4.2 Ontology integration

The ontology created through Use Case specifications and energy standards is further enriched through the semantic integration process. The purpose of this process is to integrate the different data sources, identified in Deliverable 2.1 and collected by the input data table of the Activities templates, with the global ontology.

The semantic integration process is carried out in Task 3.4 *Ontology Repository and Data migration to OWL format by domain experts* by means of the ontology mapping tools developed in Task 4.1 *Environments for collaborative ontology mapping*. These tools have been designed to allow data owners and domain experts to incorporate their databases into the SEIF, enabling users to relate the data source structure with the ontology by mapping tables and columns in a way which moves us towards global ontology concepts. If a data source cannot be related to a concept, then the user can create new concepts and relate them to an existing concept in the global ontology.

Once the mapping is completed, the data source can be queried using global ontology concepts which are the same for the other data sources and known by SEMANCO's tools.

Every time a data source is integrated in the SEIF, the global ontology grows accordingly.

The ontology mapping tools are designed to simplify the integration process and enable data owners and domain experts to collaborate in this integration process (see Figure 18).

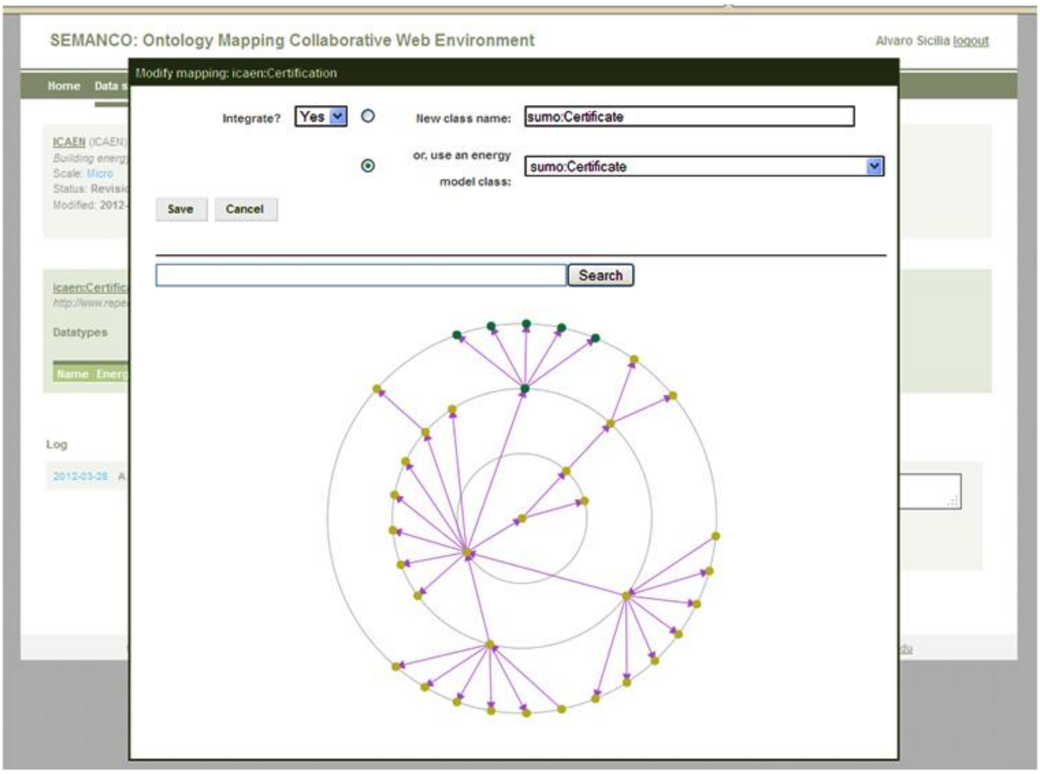

Figure 18. Ontology Mapping collaborative web environment

3.5 Stakeholders and users requirements

To describe the specifications of the tools to be developed in the project and to be used in the Use Cases, two lines of work have been initiated:

1. A process of the contextualising the Use Cases within each Case Study ;
2. Mock-ups of tools which translate the Activities described in the Use Cases into an interface.

3.5.1 Stakeholders requirements capture

The case study scoping work conducted in WP 2 *Report of the Case Studies and analysis* identified the goals and associated aims for each of the Use Cases under development. However, the contextualization of the Use Cases within each case study is the work of WP 6. To do so, it is necessary to unpack how the goals and the Activities of the Use Cases are applicable to the needs and requirements of the stakeholders, actors and users at each of the case study sites. To begin this process the following questions will be answered for each of the Use Cases to be demonstrated in each case study:

1. How is the goal of the Use Case relevant to the particular actors and users in each of the Case Studies to which it is applicable?
2. How are the Activities of the Use Case relevant to particular actors and users in each of the Case Studies to which the Use Case is applicable?
3. How is the goal of the Use Case related to the national /local policy frameworks

identified as relevant to it?

4. How the tools/methods identified in the Use Cases are related to the needs /requirements of actors and related national or local policy frameworks?

This work will be based on both, extensive literature reviews and interviews with the relevant stakeholders and users.

3.5.2 Mock-ups of tools

As part of the definition of the Activities, a mock-up of the tools to perform them in specific settings related to the Use Case objectives is created (see Figure 19). The purpose of the mock-up is:

- To use it as instrument to capture the user's requirements
- To validate the feasibility of the sequences of Activities
- To verify the need for the tools and methods provided by SEMANCO in the real settings

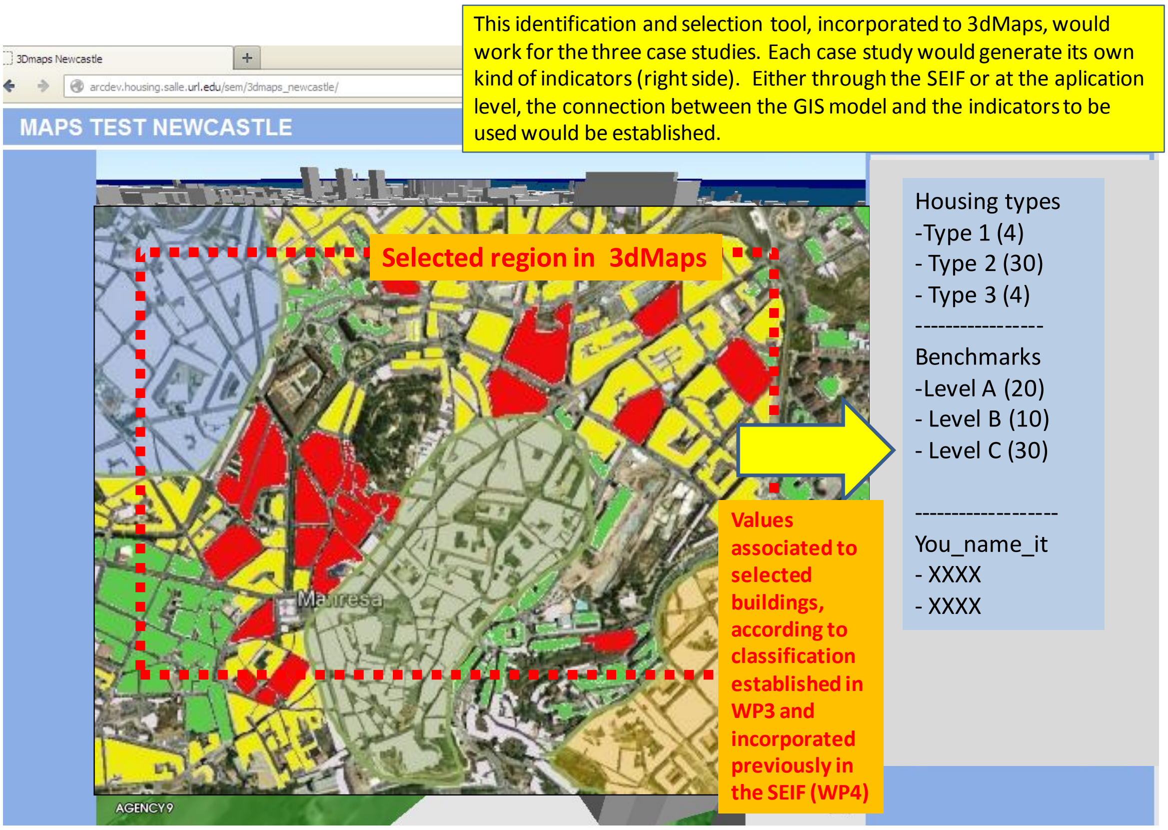

Figure 19. Tool mock-up

4 DEMONSTRATION SCENARIOS

A Demonstration Scenario is a subset of a Use Case which is implemented at a given time of the project's development for the purpose of:

- Applying the methods and tools identified in the Activities.
- Obtaining feed-back from users in different settings.
- Informing the technological development of the project.

Figure 20 shows the relationship between the Use Cases and the Demonstration Scenarios. A Use Case is a generic methodology to integrate the components of different WPs (data, tools, stakeholders, users). A Demonstration Scenario is an implementation of a Use Case at a reduced scale, implemented with the information and knowledge existing at a given time during the project's development.

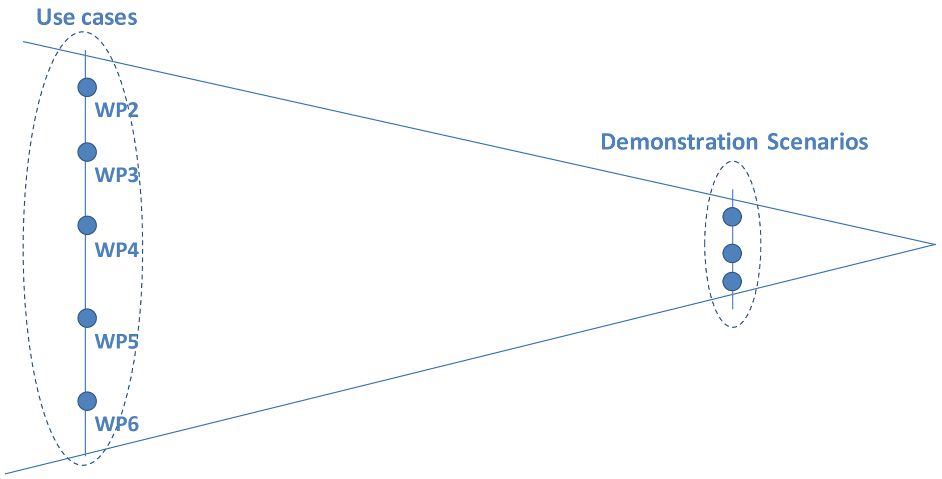

Figure 20. Relationship between Use Cases and Demonstration Scenarios

Figure 21 shows the role of the Demonstration Scenarios in the project's development. According to the DoW, Demonstration Scenarios are created and implemented three times in the project lifecycle. A Demonstration Scenario gives the opportunity to implement and verify what has been achieved in the project at a certain time. The feedback obtained through their implementation helps to move the project development forward.

In the first implementation, the Demonstration Scenarios are derived from one of the Use Cases developed so far in the project, namely, Use Case 10 (UC10). The goal of which is "To calculate the energy consumption, CO_2 emissions, costs and /or socio-economic benefits of an urban plan for a new or existing development."

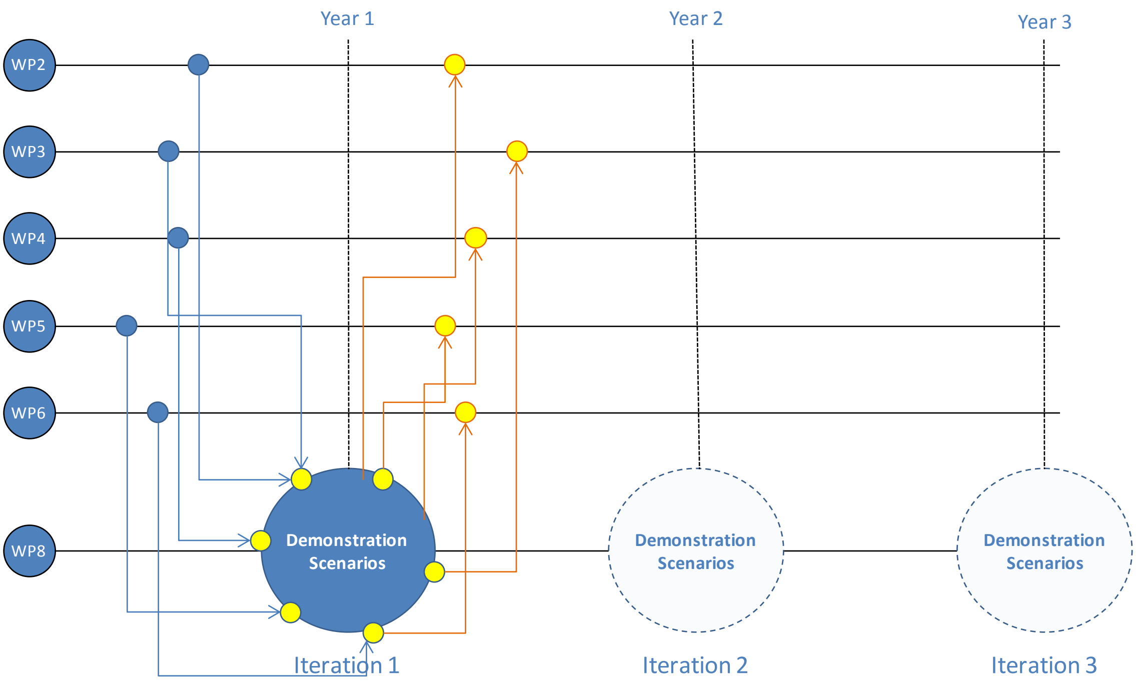

Figure 21. Implementation of Demonstration Scenarios in three cycles

4.1.1 Activities carried out in Demonstration Scenarios

The three Demonstration Scenarios to be carried out share the following Activities:

- Definition of alternative urban plans
- Integration of data from different sources and generation of input variables for calculation methods
    - Socio-economic and occupation parameters (it includes electric appliances, heating and cooling systems, number of inhabitants, among others)
    - Geometrical and climatic characteristic of the urban environment (e.g. in order to get shadows)
    - Architectonic (geometrical and structural) characteristics of the building(s) to be modelled
- Calculation of energy performance, CO_2 emissions and investment and maintenance costs

Each of the three partners in charge of Case Studies –NEA, FORUM, Ramboll– have proposed a Scenario Demonstration by adapting these Activities to their respective settings. In spite of their differences (e.g. specificities of each urban planning framework, the questions that have been raised by the users and the available tools and data), they have Use Case 10 as the common implementation framework from which each Demonstration Scenario is derived.

Each Demonstration Scenario has to define the relevant Activities to be implemented and to which extent those Activities are carried out. For instance, the Newcastle Demonstration Scenario aims at integrating socio-economic data (e.g. demography, income, energy poverty) of the city (*an Activity of the Use case*) in order to visualize it in 3D maps (*an ability of the* *system*) and identify deprived zones of the city (a *question from the user*). This would support the city council in its urban planning Tasks (objective of SEMANCO).

4.1.2 Comparisons across Demonstration Scenarios

The fact that the three Demonstration Scenarios derive from a single Use Case and from the same set of Activities enables a comparison between certain dimensions: users' responses, comparison of evaluation methods, results obtained from different tools, etc.

In practical terms, the implementation plan presented in D8.1considers the performance of the integrated tools after the first implementation round. To do so, we will first define the expected features of the integrated tools and the associated methodologies (i.e. the SEMANCO platform) from the practical and theoretical points of view (see Figure 22).

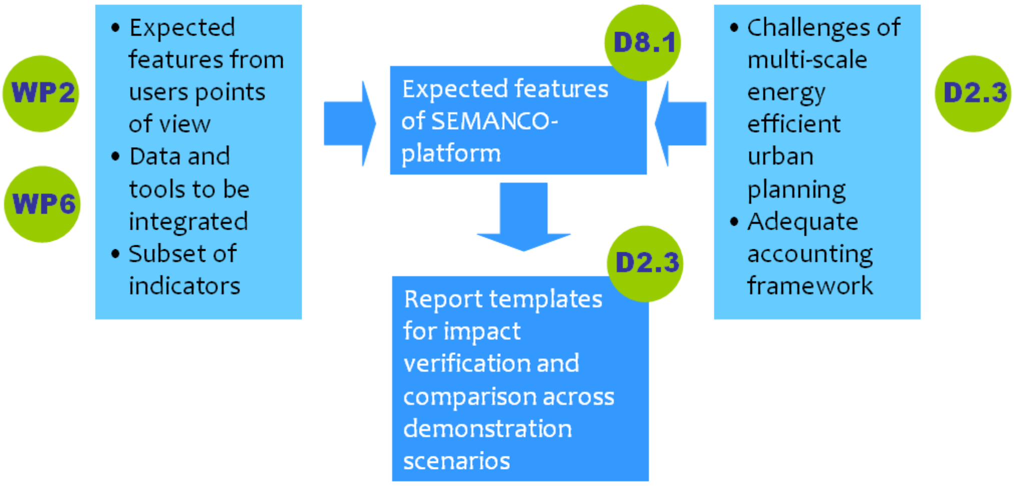

Figure 22. Process to verify the impact of the Demonstration Scenarios, to compare their outcomes and to feedback the technological development of the project

From a practical point of view we identify some expected features of the SEMANCO platform from the perspective of the potential users (Deliverable 2.1 and WP6). That is, we define what the integrated tools and associated methodologies will do in their respective scenarios. As mentioned previously, each partner in charge of the Demonstration Scenario will adapt the Activities of Use Case 10 to their respective settings. To do so, each partner defines the data and tools to be integrated in their respective Demonstration Scenario by filling in a table developed for that purpose (see Appendix A). In other words, each partner defines a preliminary set of indicators to be calculated for the first implementation from those identified in Deliverable 2.2. In this way, the Activities included in the first implementation cycle are in accordance with the current status of the project's technological achievements. As the technological development progresses, the Demonstration Scenario will be adapted accordingly (i.e. with new indicators, tools and data).

From a more theoretical point of view in Deliverable 2.3 we identify the challenges of dealing with multiple scales in the energy efficient urban planning domain. Then, we develop the strategies to deal with those challenges. This is basically about choosing an adequate accounting framework, which will lead, from a methodological point of view, to a set of expected features. Finally, we develop a set of report templates that will be used to assess the extent to which the integrated tools and associated methodologies meet those expected features. These report templates will also inform the technological development in the project.

5 Further Developments

In the second yearly report, there will be a second release of this deliverable which will describe the methodology applied in the technological development of the project: tools and SEIF.

6 Conclusions

6.1 Contribution to overall picture

The content of this document has been developed in parallel to the Tasks carried out during the first year of the project. It has helped to build a common view of the working process integrating the different research and demonstration components of the project. Building this integrated view of project development is a prerequisite to building ontologies to support energy efficient planning.

6.2 Impact on other WPs and Tasks

The methodology presented in this document enables the integration of the work conducted in different WPs their respective Tasks.

6.3 Contribution to demonstration

The methodology described in this document integrates the demonstration with the technological development of the project, in accordance with the three-stage cycle described in Annex I of the DoW.

6.4 Other conclusions and lessons learned

Initially, this deliverable was not included in the DoW. In future projects which demand a strongly integrated approach, it would be advisable to include a deliverable of this kind.

7 GLOSSARY

Case Study

A delimitation of the research scope to some geographic boundaries.

Use Case

A delimitation of a research problem to strategic goal, which describes the actors, tools and data required to fulfill that goal. A Use Case is described by means of a template.

Activity

Activities are actions that have to be performed to fulfill the specific goal of a Use Case. They can be shared by different Use Cases. Activities are described by means of a template. The description contains references to energy standard tables to ensure that all Activities are described in the same terms.

Demonstration Scenario

The verification in a delimited setting of components of one or several Use Cases, which provides feedback from users and stakeholders to inform the project development in an iterative manner.

8 APPENDICES

APPENDIX A. Implemented Activities

Table A1. Table used to describe the Activities from Use Case 10 to be implemented in each Demonstration Scenario

	Tools									Data		
	T5.1. Building stock energy modelling tool: integrating.	T5.2 Energy analysis, and optimization and strategic decision tools						T5.3 Energy simulation and optimisation tool	T. 5.4 Interactive urban design tool	T3.1. Providing access to distributed energy data repositories	T3.2 Structuring available data according to energy standards	Task 3.3 Structuring contextual data according to standards
Activities UseCase10	Integration of GIS with map digitisation and photogrammetry to develop a tool for identification and classification of buildings within a given geographic area. As far as it is feasible, an automated building identification tool will be developed	1.- Existing IT solutions and tools including underlying methodologies, calculation and simulation formulas, optimisation and visualization features will be analysed and evaluated to provide input for the technological solutions integrated through SEIF (e.g. LEAP)	2. Building and energy performance simulations approaches will be selected according to the qualitative analysis of the data retrieved in WP 3	3. Analysis tools which combine visual-based approach with complex data mining techniques will be developed.	4. Standard data mining algorithms will be selected and customized to infer knowledge out of available data.	5. Semantic reasoning processes aiming at automation of data selection and aggregation will be developed. This subTask will be carried out on the basis of semantic metadata retrieved from SEIF	6. Process design tools will be developed. Specification of collaborative processes to facilitate end users to carry out analysis and knowledge management Tasks from different perspectives, level of competence and abstraction	This Task will integrate energy simulation and optimisation tools with the tools developed in T5.1 using the 3DMaps GIS platform via applicable open standards A trade-off tool for optimisation Multi-criteria decision analysis	Interactive application developed as an add-on to 3DMaps which will enable planners to design alternative solutions of local interventions that will be dynamically evaluated	Identify characteristics of the data and define access mechanisms and protocols to access data stored in data repositories identified in T.2.1, for each case study	The energy data provided by T.3.1 will be modelled according to international standards	Modelling the data not recognised in the energy standards (e.g. building categories, pollution levels, socio-economical data, transportation flows, geodata, ...) using currently available standards such as CityGML and SensorGML
Creation of alternatives												
Integration of socio-economic data and occupation parameters												
Integration of geometrical and climatic data of urban environment												

Integration of architectonic characteristics of the building(s)												
Calculation of energy performance												
Calculation of CO_2 emissions												
Calculation of investment and maintenance costs												
Comparison of urban scenarios												