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SEMANCO Semantic Tools for Carbon Reduction in Urban Planning

SEMANCO

Deliverable 8.1
Implementation Plan

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Deliverable Administration & Summary					
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DoW	This task will provide a detailed implementation plan for each case study including measurement parameters, indicators of success, contingency plans and key control points in the process. This will include initial assessments of how the plans will be developed over the three years. At the international level there will be coordination between the plans to ensure comparable parallel development and sharing of know-how and experience. The plan will include details of: ▪ The geographical areas and precise buildings to be targeted for implementation initiatives and also those to be used as "controls" (areas of similar sizes and buildings of similar characteristics that will not be targeted but from which baseline data can be obtained as an additional means of measuring and quantifying the impacts of the project). ▪ The initiatives to be taken in terms of stakeholder awareness raising and involvement to ensure the outputs of the project are appropriate to their requirements and that they are fully exploited. Initial international collaboration will share know how and initiatives from each country and lead to a planned programme of targeted (at least annual) events in each case study area planned to coincide with "energy weeks" to focus attention and build interest in the project and in pro-active energy management				
Comments					

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EXECUTIVE SUMMARY

Introduction

In Annex I- Description of the Work, Deliverable 8.1 *Implementation Plan* is described in the following terms: “Description of measurement parameters, indicators of success, contingency plans and key control points in the process for each of the 3 case studies to enable subsequent control and evaluation of implementation, international comparability and know-how sharing.”

Deliverable 8.1 deals with the **demonstration scenarios** derived from the **use cases** described in Deliverables 1.8, 2.2 and 2.3. The objectives of the demonstration scenarios are threefold:

- to apply the methods and tools identified in the activities;
- to obtain feedback from users in different settings;
- to provide information to support the technological development of the project.

In this deliverable the processes of design, implementation and monitoring of the demonstration scenarios in the three cases of study are defined. The scenarios have been designed to ensure a comparable parallel development and to facilitate the exchange of experiences at the European level.

The network of use cases is defined in this report. The implementation process begins with the selection of a Use Case that is common to all the demonstration scenarios (Use Case 10).

In the description of the activities of the use case, and in the flow chart of the demonstration scenarios, input data is defined according to Task 3.1, whilst technical requirements and objectives are linked with those defined in Task 2.1 and will be further contextualised in Task 6.1. Output calculations from demonstration scenarios serve firstly as a basis for the calculation of indicators defined in Task 2.2 and secondly for validation of impact according to the methodology defined in Task 2.3. The outputs of the first and second iteration of the implementation process will serve in D2.4 as an updated version of impact defined in Task 2.3. In relation to WP5, technical requirements and software tools proposed in this document will be developed or integrated in the SEIF in Tasks 5.1 and 5.2.

Defining and selecting use cases

The process to define the preliminary set of use cases began with a series of meetings with relevant stakeholders. These stakeholders may become users of the tools and platforms developed by SEMANCO. These meetings focused on exploring and identifying the requirements of potential users and defining relevant use cases. After the definition of the use cases, it followed the difficult task of translating them into a sequence of activities and data flows which would be then applied in various contexts as described in the demonstration scenarios

Then, one use case was chosen to design the demonstration scenarios to be implemented in the three case studies. Use Case 10 provided a generic aim which could be assumed by all case studies: “To calculate the energy consumption, CO_2 emissions, costs and /or socio-economic benefits of an urban plan for a new or existing development”. This Use Case consists of the following activities (see Figure 1).

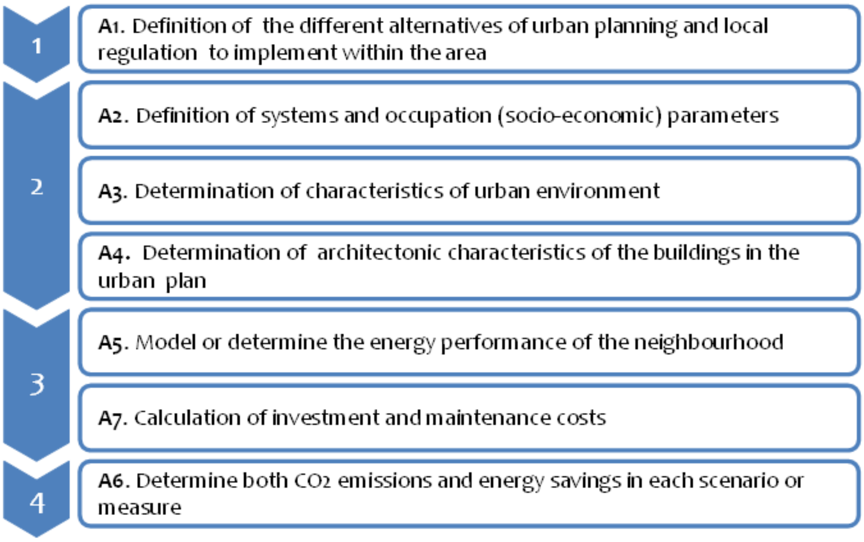

Figure 1. Main activities of Use Case 10

Designing demonstration scenarios

A demonstration scenario is the implementation of the use cases and the associated activities, and is the basis for project implementation. A detailed implementation plan for each demonstration scenario is provided, including: description, measurement parameters, indicators of success, contingency plans and key control points in the process. The scenarios have been designed to ensure a comparable parallel development and to facilitate the exchange of experiences at the European level. A detailed description of the first iteration is included and initial assessments of how the plans will be developed during the next three iterations are outlined.

The objectives of the demonstration scenario are threefold: to apply the methods and tools identified in the activities, to get feedback from users in different settings and to provide information to support the technological development of the project.

Implementation demonstration scenarios

The implementation of the demonstration scenarios are planned to run in parallel to the development of the semantic framework and its associated tools. This way, the implementation of the scenarios should provide feedback about the degree of fulfilment of the expected features of the SEMANCO tools from the point of view of both the users and domain experts.

The alignment of the implementation of the demonstration scenarios and the tool development is a essential for the success of their success. With this purpose, a timetable of the implementation of the demonstration scenarios is provided. There will be three implementations whose results will be reported on months 19, 15 and 33.

The results of each cycle of implementations will be reported using an evaluation template. This way, it will be possible to compare results from case studies in different countries.

Evaluation of the implementation

A common questionnaire for impact evaluation is provided to ensure comparable parallel development and sharing of know-how and experience among the three demonstration scenarios.
Task 8.2 will demonstrate and validate the value of the decision support tools in terms of their

cost effectiveness and capacity to support informed planning decisions that reduce CO_2 emissions in the built environment. This validation will be conducted within the **scenarios**, steps of implementation and **end-users** identified in the demonstration scenarios.

A key finding is that to implement a set of common tasks, subtasks and tools at the different scales, definition of categories appropriate to all circumstances defined by the users is not feasible. However, it is also true that an integrated assessment of the energy performance and CO_2 emissions of urban development is needed, in order to cover the three scales of analysis within an international and comparable framework. For this reason, the report defines a common use case (UC10) to implement, but opens the possibility of using complementary methodologies and different steps in each demonstration scenario. Three different iterations in each demonstration scenario are defined with the aim of finishing in each country with a demonstration of at least the whole implementation of UC10 in at least two of the three scales defined in Task 2.1 (building, district/neighbourhood, city/regional).

The fact that there are certain properties of the system that are not possessed by any of the individual scenarios making up the whole, and *vice versa*, entails important consequences in the processes of implementation. This issue is seriously considered in this task. An effort to converge the tools and methodologies, in a single demonstration scenario per country is presented. The aim of this is to produce coherent outcomes across geographical scales of analysis and case studies.

1 INTRODUCTION

1.1 Purpose and target group

In Annex I- Description of the Work, Deliverable 8.1 *Implementation Plan* is described in the following terms: “Description of measurement parameters, indicators of success, contingency plans and key control points in the process for each of the 3 case studies to enable subsequent control and evaluation of implementation, international comparability and know-how sharing”.

This description is related with the objectives of Task 8.1 which are described in the DoW as follows: “Implementation plan development (1 for each of the three case study scenarios). This task will provide a detailed implementation plan for each case study including measurement parameters, indicators of success, contingency plans and key control points in the process. This will include initial assessments of how the plans will be developed over the three years. At the international level there will be coordination between the plans to ensure comparable parallel development and sharing of know-how and experience. The plan will include details of:

- The geographical areas and precise buildings to be targeted for implementation initiatives and also those to be used as “controls” (areas of similar sizes and buildings of similar characteristics that will not be targeted but from which baseline data can be obtained as an additional means of measuring and quantifying the impacts of the project).
- The initiatives to be taken in terms of stakeholder awareness raising and involvement to ensure the outputs of the project are appropriate to their requirements and that they are fully exploited. Initial international collaboration will share know how and initiatives from each country and lead to a planned programme of targeted (at least annual) events in each case study area, planned to coincide with “energy weeks” to focus attention and build interest in the project and in pro-active energy management”.

Deliverable 8.1 has to do with the demonstration scenario, which will derive from the use cases defined previously and described in Deliverables 1.8, 2.2 and 2.3. A demonstration scenario is the implementation of the use cases and the associated activities, and is the basis for project implementation.

The report describes how a use case becomes a demonstration scenario, and does so taking an end point perspective, addressing the questions: What the users need from the data and tools that SEMANCO could provide?. In particular, which are the activities to be carried out by an end user with the provided tools? And how the impact of these tools to reduce CO_2 emissions will be evaluated?

In sum, this deliverable provides a detailed implementation plan for each demonstration scenario including: its description, measurement parameters, indicators of success, contingency plans and key control points in the process. The scenarios have been designed to ensure a comparable parallel development and to facilitate the exchange of experiences at the European level. A detailed description of the first iteration is included and initial assessments of how the plans will be developed during the next three iterations are outlined.

1.2 Contribution of partners

The participants Ramboll, UoT, Forum and NEA have each been responsible for the description of use case and demonstration scenarios in their respective case studies. CIMNE has been responsible for coordinating of this document and for aligning all the demonstration scenarios according with the selected Use Case.

1.3 Relation with the other activities in the project

In the description of activities of the chosen Use Case, and in the flow chart of the demonstration scenarios, input data is defined according to Task 3.1, whilst technical requirements and objectives are linked with those defined in Task 2.1 and will be contextualized in more depth in Task 6.1. Output calculations from demonstration scenarios serve firstly as a basis for the calculation of indicators defined in Task 2.2 and secondly for validation of impact according to the methodology defined in Task 2.3. The outputs of the first and second iteration of the implementation process will serve in Deliverable 2.4 as an updated version of impact defined in Task 2.3. In relation to WP5, technical requirements and software tools proposed in this document will be developed or integrated in the SEIF in Tasks 5.1 and 5.2. Figure 2 illustrates the relationships between the work packages and the demonstration scenarios:

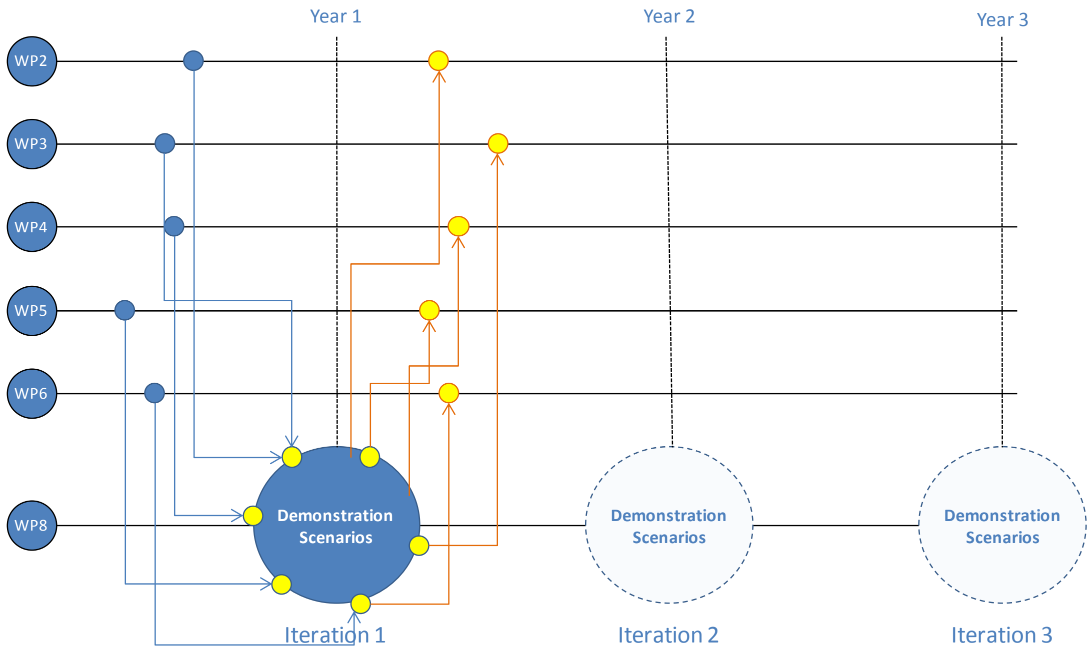

Figure 2. Relationships between WP8 and the others

2 CONCEPTS AND DEFINITIONS

Energy carrier

Correspond to the various forms of energy inputs required by the various sectors of society to perform their functions. Examples of energy carriers include liquid fuel in a furnace, gasoline in a pump, electricity in a factory or a house and hydrogen in a tank of a car (Giampietro & Mayumi 2009, Giampietro & Sorman 2011). They are also referred as *secondary energy*, which are all sources of energy that result from transformation of primary energy sources.

Energy end-uses

In the context of urban planning, energy end-uses refer to useful tasks and works performed in a built environment that convert energy carriers into applied power. Examples of energy end-uses are lighting, heating, cooling sanitary hot water and electric appliances.

Primary energy sources

Correspond to those sources that only involve extraction and capture. That is, the term refers to the energy forms required by the energy sector to generate the supply of energy carriers used by society. Examples of primary energy sources are below-ground fossil energy reserves (coal, gas, oil), blowing wind, falling water, solar radiation and biomass. It is extremely important to differentiate Primary Energy Sources from Energy Carriers. The concepts refer to energy forms of different quality and used at different hierarchical levels of the society. They cannot be aggregated since 1 MJ of an energy carrier is not the same than 1 MJ of primary energy source (Giampietro & Mayumi 2009; Giampietro & Sorman 2011).

Energy System.

In the context of the SEMANCO project, we understand an energy system as an interrelated network from energy sources to final energy uses, which are connected by transformation, transmission and distribution systems. There are numerous energy systems in nature, such as the food chain, the climate and ocean systems, and the cycles of materials such as water or carbon.

We can differentiate between endosomatic and exosomatic energy systems. The former encompasses the collection of solar radiation and the transformations to stores of energy in food and to work, and subsequent dissipation of energy. In SEMANCO we deal with the exosomatic energy system, which encompasses the collection and extraction of primary energy sources, the transformation to energy carriers and the transport and distribution to the society to perform the final energy uses.

Energy efficient urban planning

In the context of SEMANCO, we understand energy efficient urban planning as the development of urban plans and projects aimed at saving energy consumption and reducing CO_2 emissions. Therefore, we consider energy efficiency different than conventionally. That is, we consider increasing energy efficiency as an absolute reduction of energy consumption, and not as an increase in the ratio between output (e.g. service or final energy use) and input (e.g. supply of an energy carrier).

3 DEMONSTRATION SCENARIOS

This section deals with the urban areas and buildings to be targeted for implementation initiatives and also those to be used as "controls" (areas of similar sizes and buildings of similar characteristics that will not be targeted but from which baseline data can be obtained as an additional means of measuring and quantifying the impacts of the project).

3.1 From use case to demonstration scenario

As it has been explained in Deliverable D 1.8 *Project Methodology*, in the context of this project a use case is a cross-cutting methodology aimed at integrating the tasks and activities belonging to different work packages. As such, the use cases integrate data, methods and users in a detailed sequence of activities aimed at fulfilling a specific objective (i.e. the one expressed by the potential users).

The process to define the preliminary set of use cases started with a series of meetings with relevant stakeholders, who may become users of the tools and platforms developed by SEMANCO. The purpose of the meetings was to explore and identify the requirements of the potential users. This way we could identify several issues that can be framed within a specific scale of analysis and within an urban planning framework which would be later be defined in terms of sequences of activities to be carried out in the demonstration scenarios. Thus, a demonstration scenario is determined by a specific urban planning framework, the issues raised by the potential users and the available tools and data.

This part of the document is of key importance since it defines the boundary conditions the technological development of the project. It prioritizes the methods, tools and data that need to be integrated in the SEMANCO platform for the first round to be successful. The following sections present the use case to be implemented.

3.2 The use case to be implemented

The use case to be implemented in the demonstration scenarios was chosen from the set of use cases developed by the different partners (see Appendix B). The chosen use case had to fulfil several requirements. On the one hand, it should encompass the combined expectations of all countries involved, and therefore must include activities considered as important by different partners. On the other hand, it should find a balance between simplicity and complexity: The chosen use case should be as simple as required by the first implementation round. That is, it should contain activities and tasks that we can implement considering the current level of technological development of the project. At the same time, the use case should be as complex as possible to provide relevant feedback and boost important advances in terms of technological development in the next steps.

With these criteria in mind, Use Case 10 was chosen as the most appropriate case for the first round of implementations: "To calculate the energy consumption, CO_2 emissions, costs and /or socio-economic benefits of an urban plan for a new or existing development".

Use Case 10 is made up of the following activities[1] (see Figure 3):

1) Definition of alternative urban plans
2) Integration of data from different sources in order to generate 3D maps of indicators and socio-economic parameters, input variables for calculation methods, and potential of implementation of renewable energy systems (RES in advance).
    a) Socio-economic and occupation parameters (it includes electric appliances, heating and cooling systems, number of inhabitants, among others).
    b) Geometrical and climatic characteristic of the urban environment (e.g. in order to get shadows).
    c) Architectonic (geometrical and structural) characteristics of the building(s) to be modelled.
3) Evaluation of performance
    a) Energy performance.
    b) Investment and maintenance costs.
4) Calculation of energy savings and CO_2 emissions.

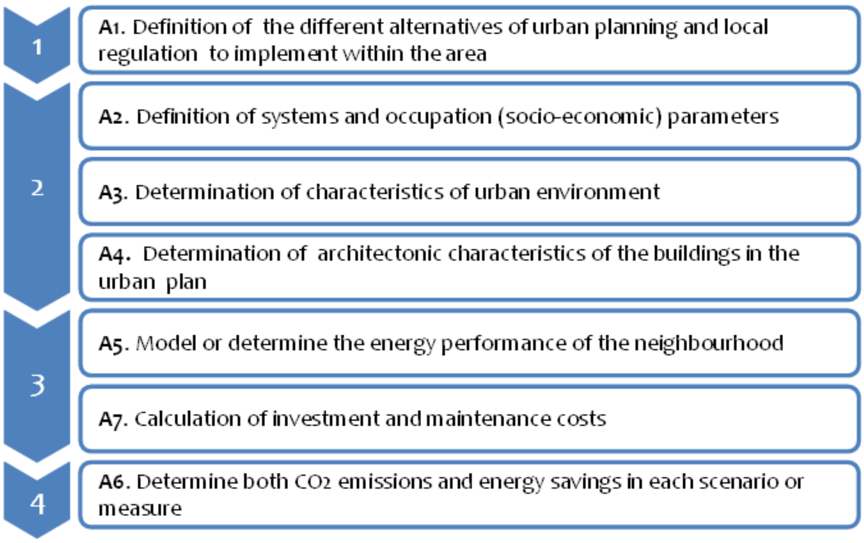

Figure 3. Main activities of Use Case 10

The next figure presents the activities, some of the required data needed to carry them out and the expected outcomes of the implementation process.

[1] More detailed information about the use case and related activities can be found in Appendix E

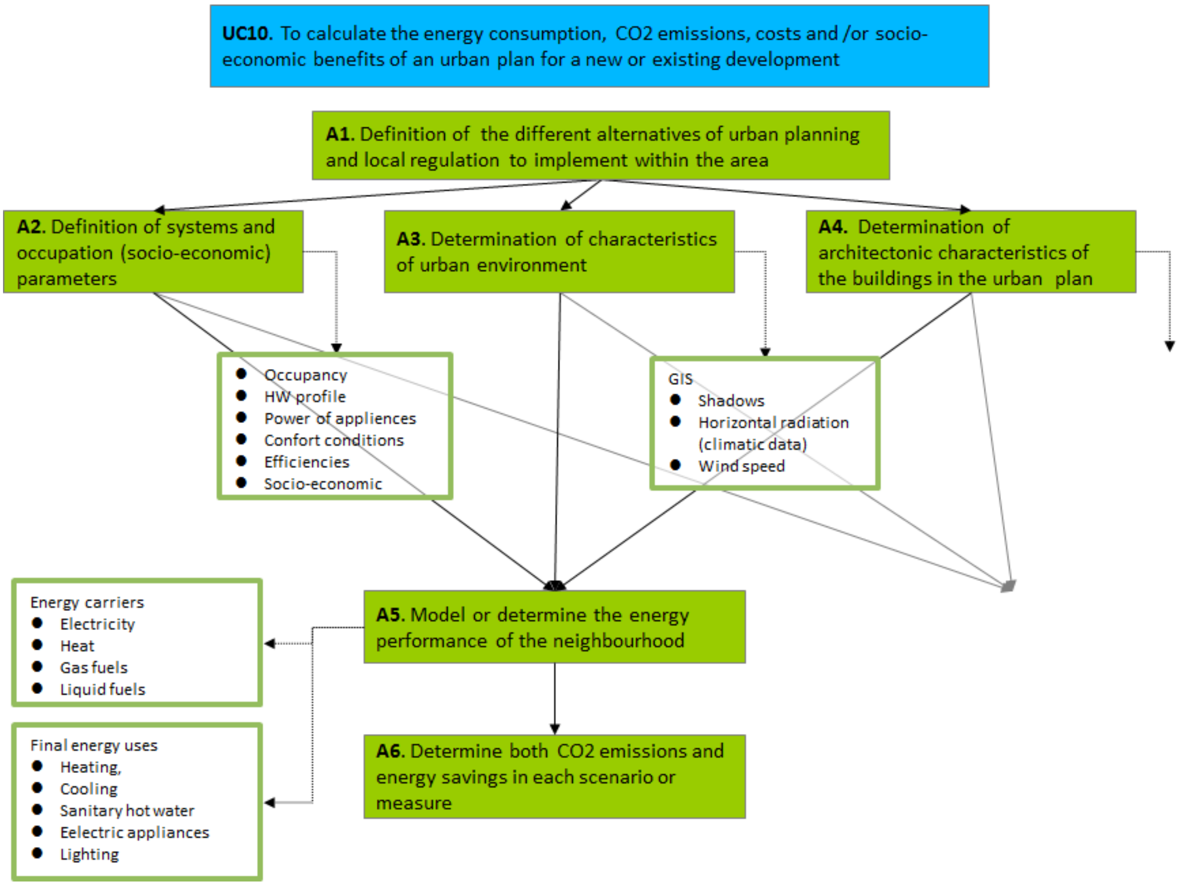

Figure 4. Use Case 10. Activities (in green boxes), data requirements and expected outputs

In Appendix E, the definition of the UC10, according with the templates presented in Deliverable 1.8 *Project Methodology* is showed.

3.3 Objectives of the demonstration scenarios

The objectives of the demonstration scenario are threefold: to apply the methods and tools identified in the activities, to get feedback from users in different settings and to provide information to support the technological development of the project.

The fact that the three demonstration scenarios derive from a single Use Case and refer to the same set of activities enable us to perform a comparison between the following dimensions:

- Users' responses. Regarding the degree of fulfilment of their expectations regarding the integrated tools and associated methodologies.
- Comparison of the degree of integration of the tools and methods used in each demonstration scenario.
- Appropriateness of the accounting framework proposed in D2.3 and its alignment with the methods and tools used in each scenario.

In order to do so, we first define the expected features of the integrated tools and associated methodologies (i.e. the SEMANCO-platform) from the practical and theoretical points of view (See Figure 5).

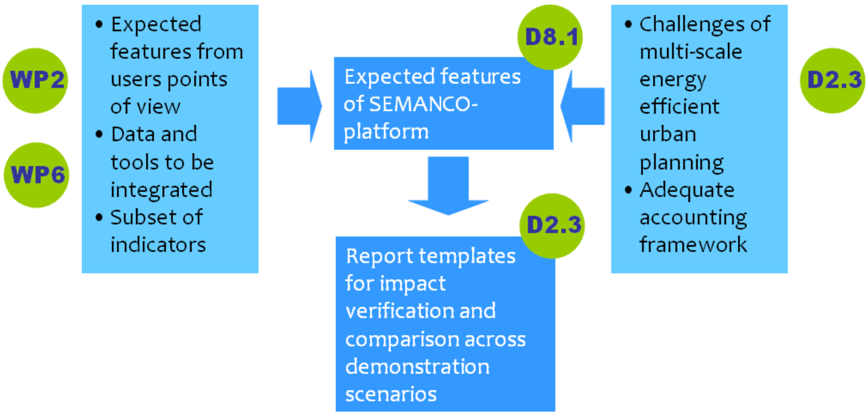

Figure 5. Relationships between expected features and multi-scale methodology

The demonstration scenarios will evolve along the three iterations in parallel to the project development. At the early implementation phase, each partner will select a preliminary subset of indicators and tools that they want to calculate in the third implementation rounds. Also, the activities included in the each implementation cycle will be in accordance with the current status of the project's technological achievements. Then, as the technological development progresses, the scenario will be adapted accordingly (i.e. more indicators, tools and data will be considered).

3.3.1 Feedback from users

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, flexibility of the SEMANCO's platform, comparison of evaluation methods, results obtained from different tools, among others.

This implementation plan considers assessing the performance of the integrated tools after the first implementation round with the users and stakeholders. In this way, we would be able to identify and analyse obstacles and also the potential uses of the integrated tools and corresponding methods.

In order to do so, at the same time than the first iteration will be carried out, a preliminary mock-up of the user interface will be showed to allow the users to visualise and interact with the integrated tools as currently envisioned. Also, we have developed questionnaires to be answered by the users (see section 6). One questionnaire will be applied with the preliminary mock-up in order to identify the requirements. The second questionnaire will be applied after the implementation round in order to assess to what extent we meet the expectations of the users. Both questionnaires aim at identifying drawbacks and proposing solutions.

3.4 Description of the demonstration scenarios

3.4.1 Newcastle demonstration scenario

3.4.1.1 Description of the urban area

The demonstration scenario will focus on the buildings at the heart of Elswick in the area of

Riverside Dene suitable for the retrofitting of energy efficient and reviewable energy technologies. In Appendix A detailed description of the urban area is described

3.4.1.2 The goal and objective(s) of the demonstration scenario

Currently, local planning officers lack methods to identify practicable and cost-effective measures likely to result in significant energy reduction in all residential accommodation in their area as demanded by the new Government frameworks and guidance. The demonstration scenario implemented in the UK is designed to overcome this by **providing planning officers and their local authorities with reliable calculations of the energy consumption, CO_2 emissions, costs and /or socio-economic benefits of an urban plan for a new or existing development**.

The Demonstration Scenario in the UK case will show how the SEIF and the tools developed in the SEMANCO project can be used **to support socio-economically and environmentally informed decisions in the development of urban plans as required by the 2012 National Planning Policy Framework**. The demonstration scenario in the UK case will show how the SEIF can be used to access databases held by the UK national office of statistics at the neighbourhood level about: Electricity consumption, gas consumption, fuel poverty numbers and percentages, tenure (household types) numbers and percentages, and multiple deprivation [Income, Health, Education]

The first iteration of the demonstration scenario will also show **how socio-economic and energy information at the neighbourhood level can be visualised on the GIS Platform 3D Maps**. While **later iterations** of the demonstration scenario **will illustrate how this process can be used to target interventions to reduce CO_2 emissions and fuel poverty at the municipal level**. This approach is in keeping with the 2012 guidance to local authorities advising them to prioritise and tackle areas with high levels of fuel poverty and poor quality housing with high CO_2 emissions and encourage uptake of the pending Government programme ‘Green Deal’ that seeks to encourage householders to invest in energy efficiency at no upfront cost, paying back the cost of the measures through savings on their domestic energy bills. The guidance advises that *“Authorities might therefore identify those areas that they would wish to target for early action e.g. those with high fuel poverty levels, those where little work has previously been carried out, those where local community organisations are active and able to help facilitate demand/take up. Authorities might also consider areas to target in the medium and longer term. If contained in their published further reports this could help local residents wishing to take up the Green Deal to gauge when potential offers might be available”* Par 3.34 , DECC 2012).

3.4.1.3 Implementing the demonstration scenario

The figures below illustrate the flow chart within the UK demonstration of elements of use case 10. As it is showed, in the first iteration (Step 01: baseline calculation), activities A2, A3 and A5 from use case 10 will be demonstrated, while later iterations of the UK demonstration scenario will demonstrate activity A6 and A7 (Steps 02-03: Advanced scenarios).

Figure 6 shows the overall approach of the Newcastle project within the framework of UC10.

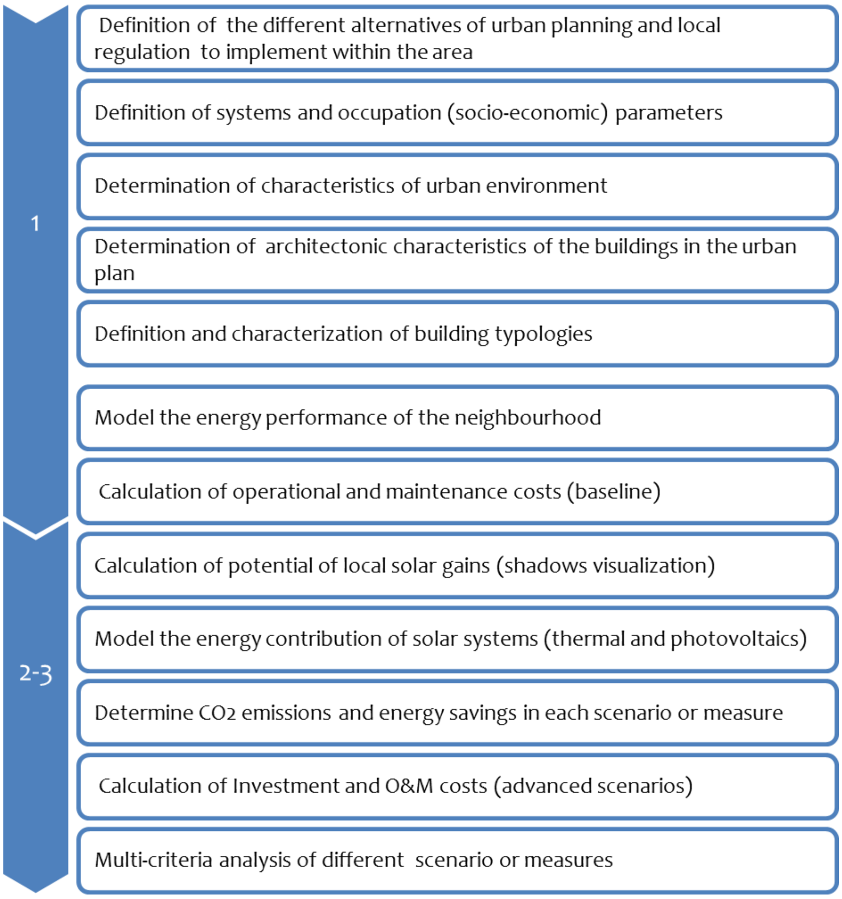

Figure 6. Overall analysis approach of the Newcastle project.

A2 Definition of systems and occupation (socio-economic) parameters: SEIF will provide access to databases containing LLSOA[2] boundary data, and socio-economic data which will be used to identify and visualise levels of fuel poverty at the neighbourhood level.

A3 Determination of the characteristics of the urban environment: In activity 3 the SAP estimation tool developed as part of WP5 task 5.1 will be used to classify the pre-existing housing stock in the demonstration area.

A5 Model or determine the energy performance of a neighbourhood: In activity 5 the SAP estimation tool developed as part of WP5 task 5.1 will be used to calculate the energy performance of domestic buildings in a neighbourhood

A6 determine both the CO_2 emissions and energy savings in each scenario: In activity 6 the SAP evaluation tool developed in T5.1 will be augmented in T5.3 to enable the estimation of the energy and CO_2 emissions reductions arising from different energy efficient and renewable energy interventions.

A7 determine costs of energy and multi-criteria analysis: In activity 7 the SAP evaluation tool will also be integrated with a Multi-Criteria Decision Analysis tool in T5.3. This will enable the optimisation of Energy Efficiency and renewable Energy insertions by supporting trade-offs between conflicting social economic political and environmental constraints.

[2] Lower layer Super Output Area [LLSOA]. England is divided into approximately 32,000 such areas, designed based on census results each to contain approximately 1500 residents.

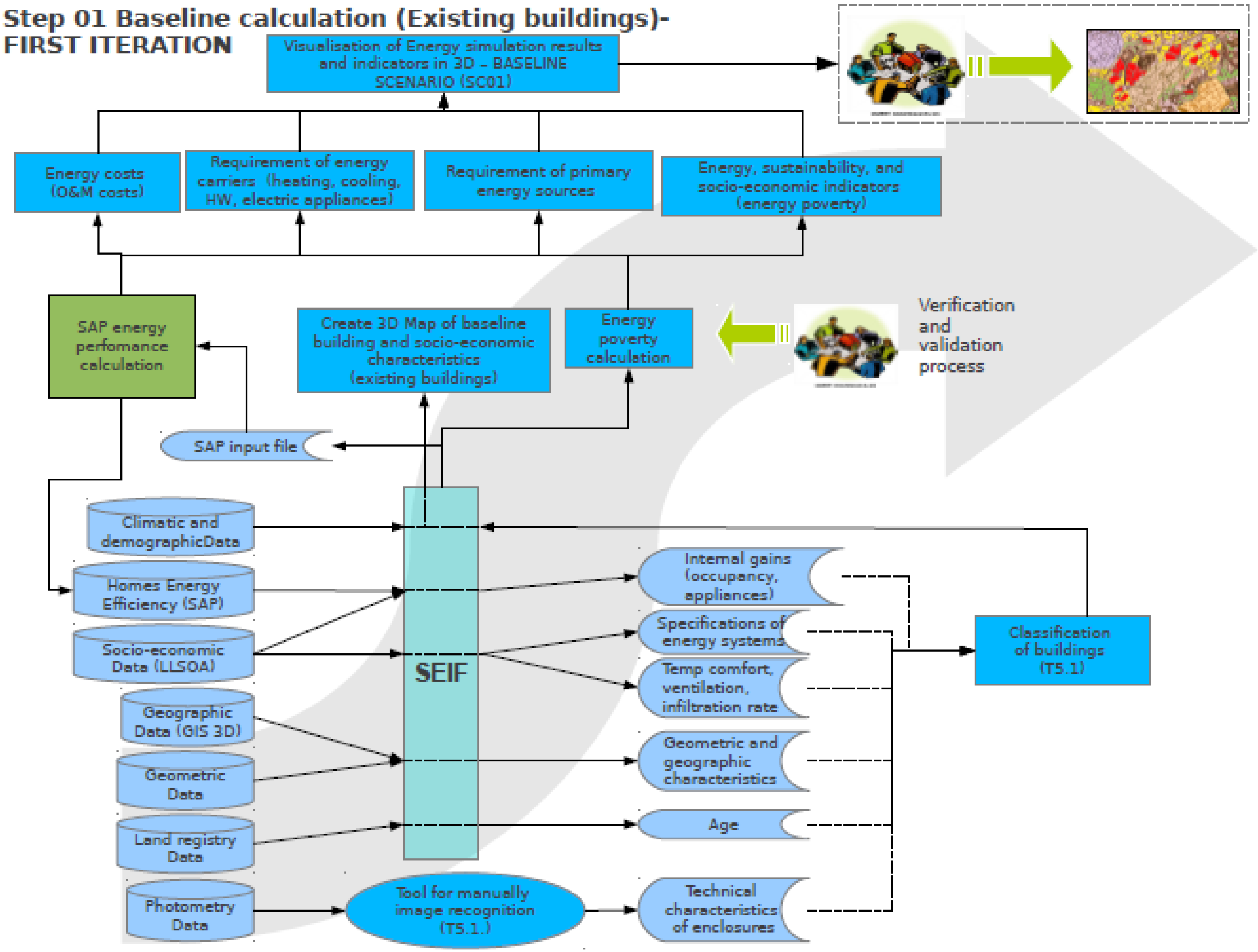

Figure 7. Flow chart for the first iteration in New Castle (Step01: baseline scenario)

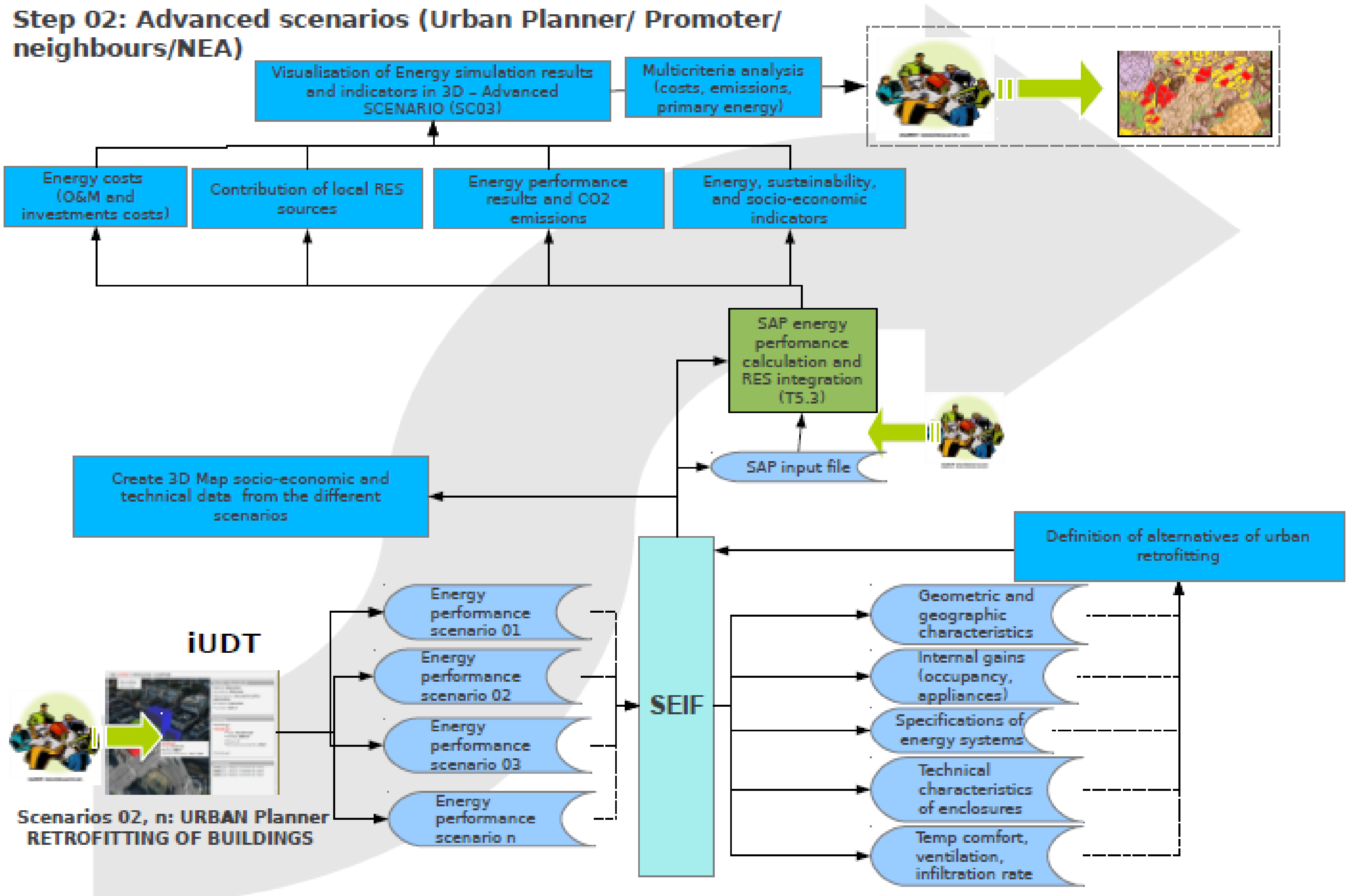

Figure 8. Flow chart for the second and third iteration in Newcastle (SC02: Advanced scenarios)

3.4.1.4 Control buildings and/or baselines

As mentioned earlier, the goal of Use Case 10 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". To do this it is necessary to have a baseline assessment of the socio-economic characteristics of the urban environment as well as the energy performance characteristics of the area. In the UK case study the UKs national calculation methodology, called the Standard Assessment Procedure (SAP), will be used to measure the energy performance of the domestic buildings as part of the demonstration scenario. The SAP assessment tool developed in task 5.1 will be used to provide SAP assessments of the current state of domestic properties. This tool will be further developed as part of task 5.3 and will be used to provide estimated SAP assessments for the domestic properties for various scenarios of energy efficiency and renewable energy interventions that could be undertaken on the properties.

The SAP is the UK Government, Department of Energy and Climate Change (DECC) methodology for assessing and comparing the energy and environmental performance of dwellings. SAP has been developed to provide reliable and accurate assessment of a dwellings energy performance (Anderson BR et al.)· It was developed to comply with the Energy Performance of Buildings Directive (EPBD) most EU member states have established a similar national energy calculation methodology to measure the energy performance of buildings (Andaloro et al. 2010).

SAP is applicable to self-contained dwellings of any size and any age. The SAP rating is expressed on a scale of 1 to 100, the higher the number the lower the running costs. Similarly, the EI rating is expressed on a scale of 1 to 100, the higher the number the better the standard.

3.4.2 North Harbour demonstration scenario

3.4.2.1 Description of the urban area

North Harbour is planned to be a mixed use district of about 50% residential buildings and 50% private enterprises and public institutions. Functions will intentionally be mixed in order to create optimum conditions for a vibrant urban life. In Appendix A detailed description of the urban area is described

3.4.2.2 The goal and objective(s) of the demonstration scenario

Considering the legal framework presented Appendix A and the characteristics of the urban project, the main objective of this demonstration scenario is **to determine the optimal combination of measures regarding sustainable energy supply and energy savings, with the lowest possible costs, in a greenfield planning situation.** The immediate goal of moving towards a CO_2 friendly urban development has been set by the CPH City and Port Development. **The longer term aim is a CO_2 neutral or negative neighbourhood**.

CO_2 neutrality is defined on the basis of a net principle, where the CO_2 offsets and emissions within the development area meet or exceed one another on a yearly basis. In other words, when an amount of CO_2 emissions from any energy use within the North Harbour area is emitted, a corresponding amount of additional CO_2-free energy must be exported through the district heating system or the power grid, and thus displacing CO_2 emissions elsewhere in the energy system.

The measures towards obtaining the defined goal can be divided into two general energy related categories; demand measures and supply measures. In order to create and demonstrate a CO_2 friendly/negative urban district, several energy demand measures and energy supply options have been benchmarked and analyzed, so that the optimal combination can be determined on the basis of socio-economic, financial and CO_2 emissions criteria.

Figure 9 shows the overall approach of the North Harbour project within the framework of UC10. In the following data flow diagram for each step is described.

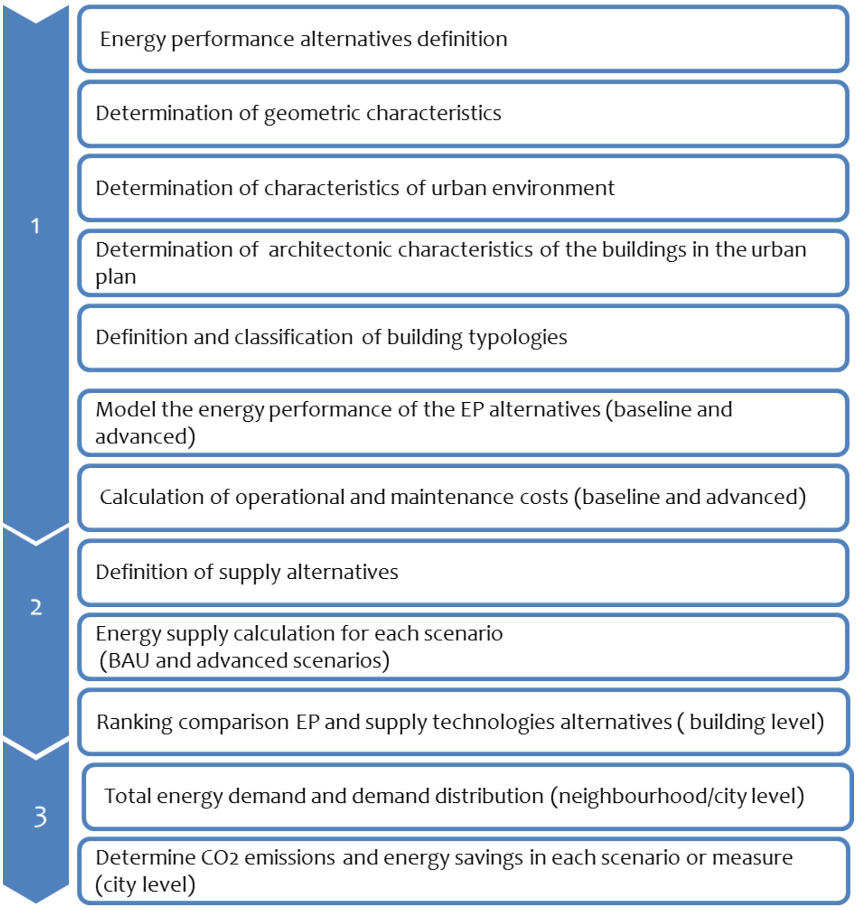

Figure 9. Overall analysis approach of the North Harbour project.

Step 1 is an implementation of Use Case 10 at building level. Step 2 is also an implementation of Use Case 10 at building level, but from the energy supply side. Step 3 acts as implementation of Use case 10 at urban and/or macro level.

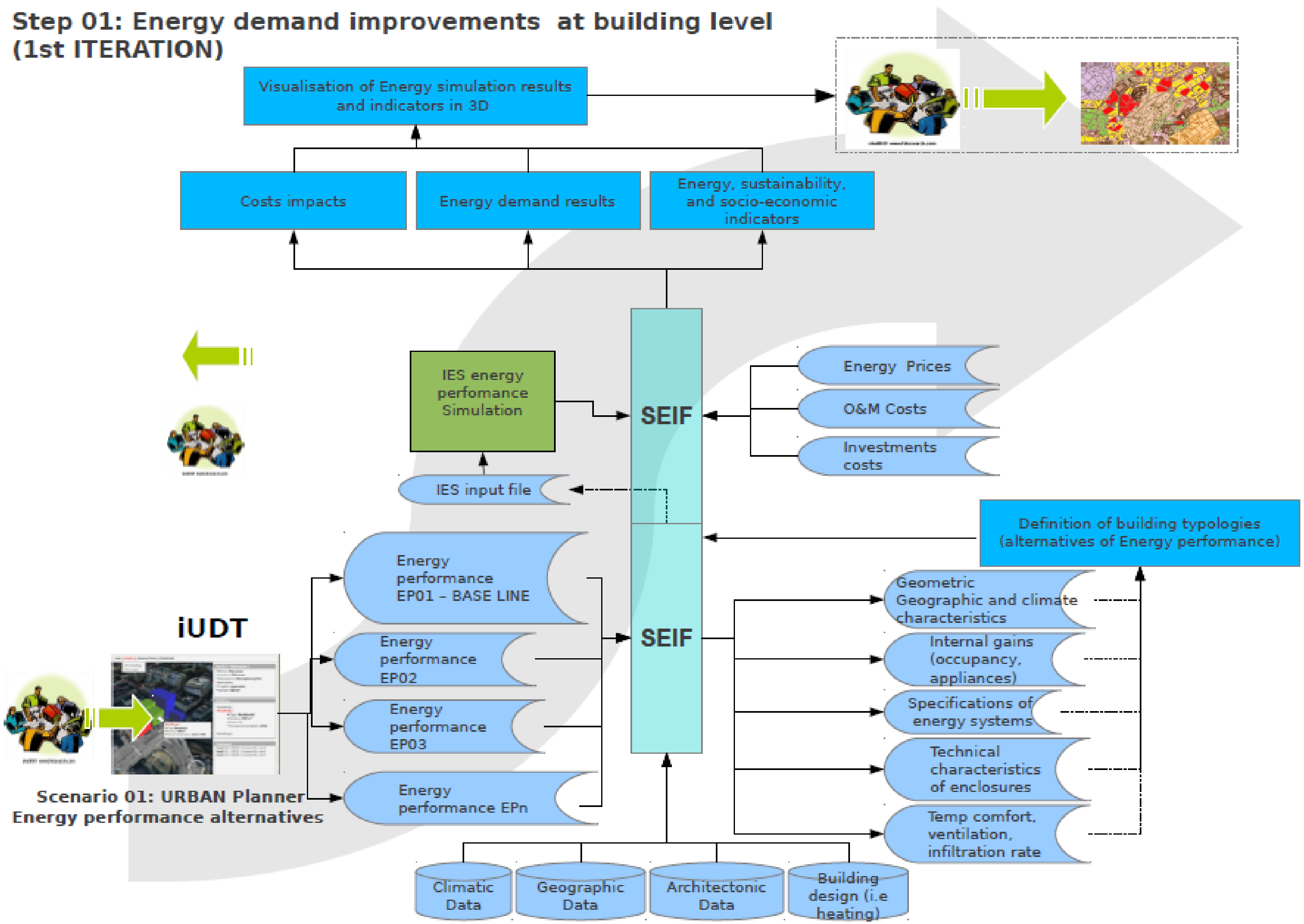

Figure 10. Flow chart for the first iteration in North Harbour (Step01: baseline scenario and energy performance measures at building level)

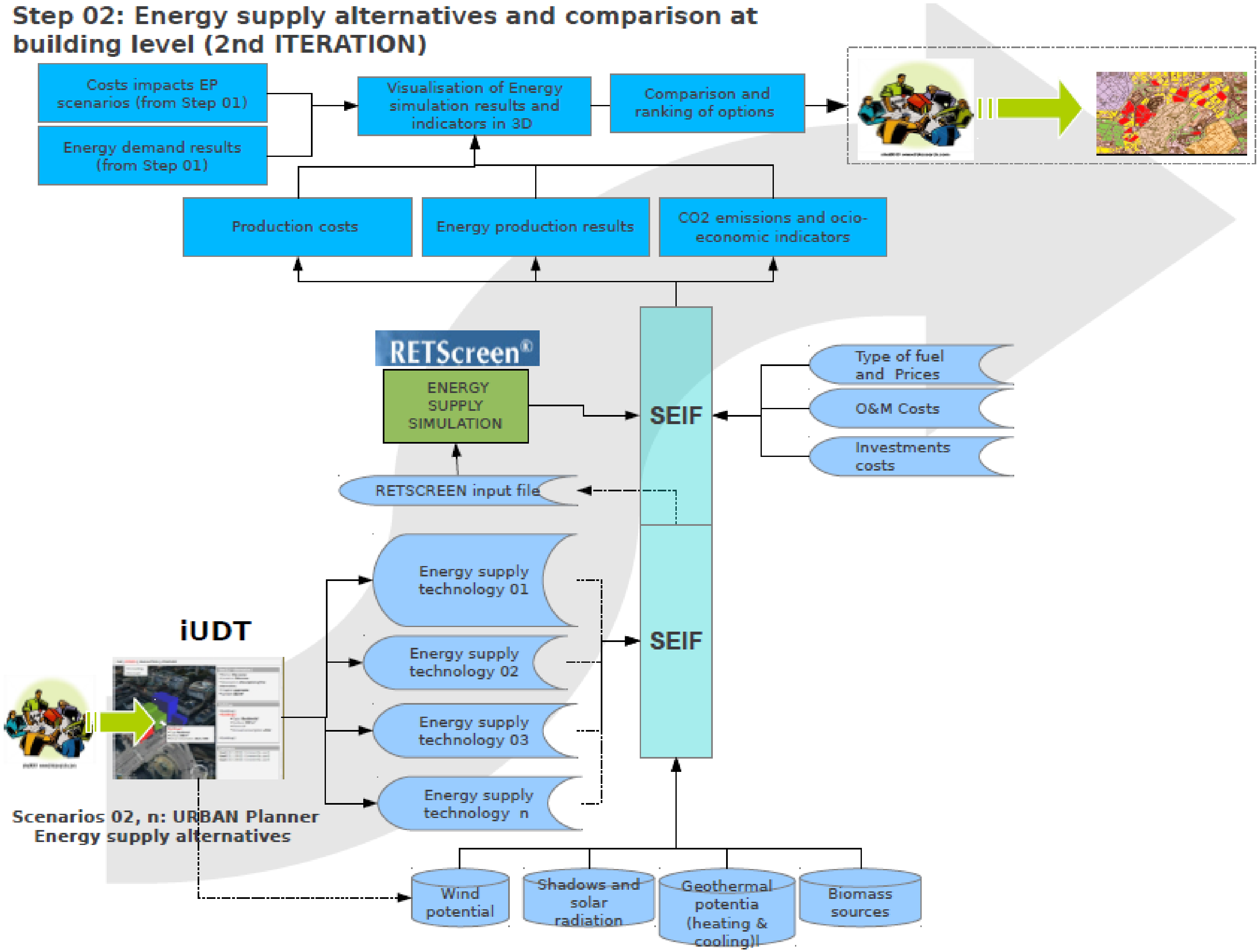

Figure 11. Data flow for the first iteration in North Harbour (Step2: energy supply alternatives at building level)

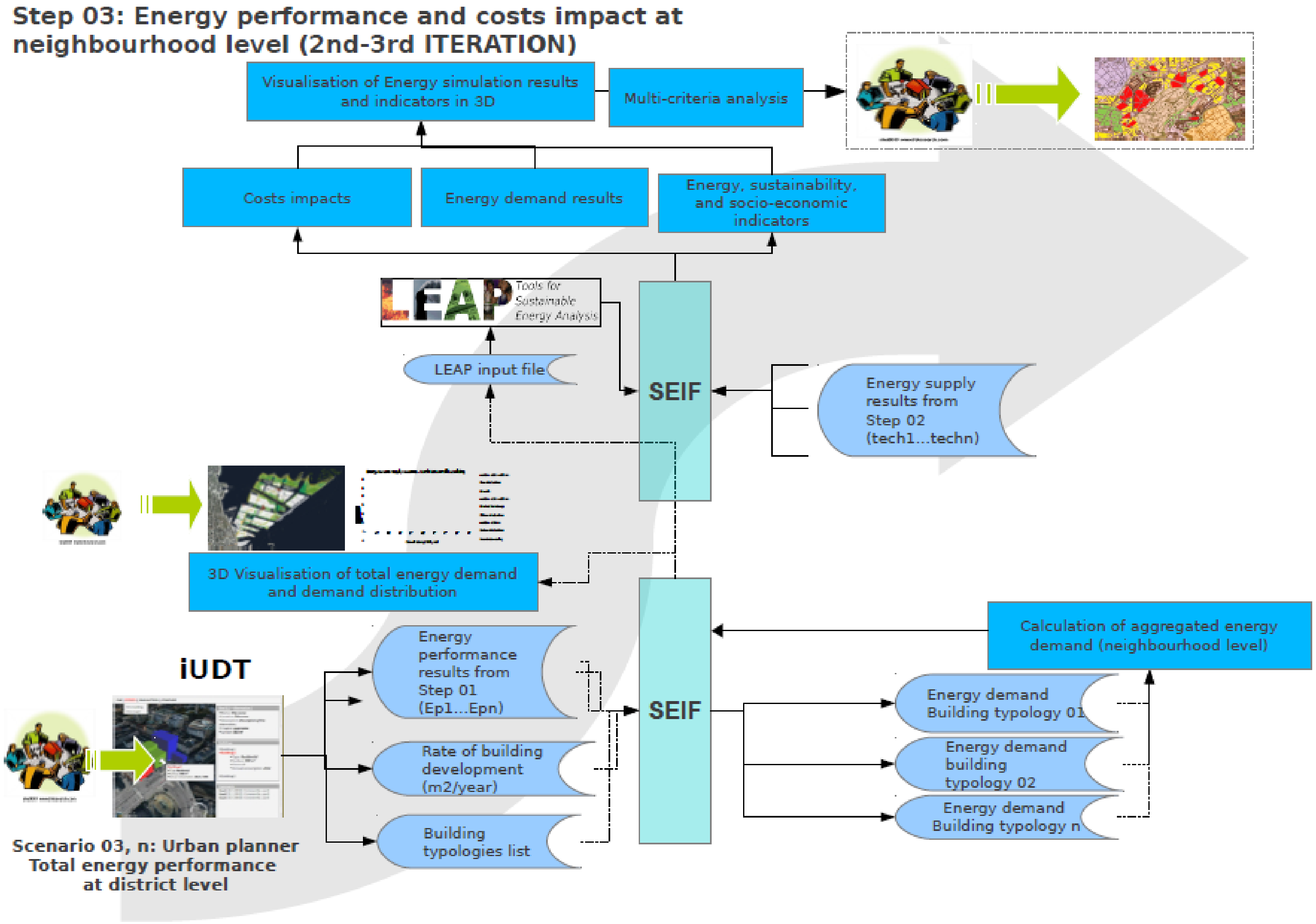

Figure 12. Flow chart for the second and third iteration in North Harbour (Step03: Energy performance and costs impact at neighbourhood level

3.4.2.2.1 Step 1: Energy demand and costs of various building performance levels

The aim of this part of the process is to determine the energy demand and cost impacts of a range of different levels of building energy performance. The output of this step serves as an input to step 2 (comparison of alternatives) as well as a baseline calculation (buildings designed according to Danish minimum standards of 2010). This step operates at two different levels.

As mentioned before, this step is a partial implementation of Use case 10, only considering the energy demand improvement measures. It considers carrying out the definition of alternative urban planning by means of defining alternative building performance levels (A1 of the UC10), collection and integration of socio-economic, building and urban environment data (A2, A4 and A3 respectively), and modelling the energy performance of buildings (A5).

Simulations of energy performance are carried out using the IES software. These simulations are based on parameters of building insulation, such as window U-value, thickness of insulation, building physics and climatic data. That information, specific to the area and context of North Harbour demonstration scenario, will be provided in tables for each building performance alternative in order to be introduced to SEIF.

The output from IES is systematized together with data on energy prices, investment and O&M cost in the Semantic Energy Information Framework (SEIF), and evaluation and 3D visualisation of the different energy performance levels is carried out. In first iteration, a first version of integration of this procedure with SEIF will be carried out.

3.4.2.2.2 Step 2. Primary energy efficiency, carbon emissions and costs of several energy supply technologies, and comparison of various supply and demand scenarios

This step is concerned with the analysis of production costs, carbon emissions and supply potential for different energy supply technologies in order to select the most suitable one. This evaluation would be carried out by using, for instance, the RetScreen software, which requires the availability of resources, efficiency, fuel cost among other input data. The outcomes from this step are used for comparison of various supply and demand scenarios.

Locally, the area is endowed with a range of energy resources to be potentially exploited, including: Solar energy, wind energy, geothermal energy, ground source cooling, and bioenergy. Regionally, the North Harbour could connect to the Copenhagen district heating system. When North Harbour has a demand from or supplies to the Copenhagen district heating system, it not only has an effect on the district heating production in the city, but also on the production of electricity in the various CHP plants. Therefore, the Copenhagen district heating system must be included in the study of impacts of heat supply and demand at North Harbour.

The North Harbour energy strategy is long term and extents well into this century. For this reason, the full effects of CO_2 reductions on the local electricity and CHP system have been included. In the North Harbour demonstration scenario, as it is showed in the flow chart of step 02, the assessment of local renewable energy potential is based on existing data of wind energy potential, solar radiation, geothermal characteristics of the area etc. The technology data are based on an official Danish Energy Technology catalogue, offering data of investment costs, O&M costs, efficiencies, among other information, of variety energy production technologies.

Output data from steps 1 and 2 is used at the end of step 02 to rank and to prioritize the combinations of energy performance levels and energy supply options, which will be further analysed. Implementation of the step 02 will be carried out in the second iteration.

3.4.2.2.3 Step 3. Total energy demand, demand distribution, and C02 and costs impacts of the scenarios

In this step, firstly we analyse the total energy demand as well as the distribution of the demand on buildings and neighbourhoods. The analysis is based on projections for the rate of building development over the project period as well as the building performance levels chosen in each scenario.

- Heat demand: Heat demand of each building typology, in kWh/m^2, is obtained from the calculations performed in Step 1 that showed the best overall performance in step 3. Then, the share of each building typology within the building stock is used to calculate the total heat demand of North Harbour.
- Cooling demand: It is assumed that office buildings in North Harbour are supplied with district cooling, while residential buildings are not supplied with cooling. There are very few statistics on energy consumption for space and IT-cooling in new offices and retail. For office buildings, cooling demand assumptions are based on data from four concrete office buildings, which Ramboll has designed. In addition, a simulation of a "North Harbour office", with respect to the orientation, shadow effects, etc. will be undertaken by using the IES software.
- Electricity demand: Electricity consumption is assumed to be 22 kWh/m^2 for residential buildings and 48 kWh/m^2 for office buildings, as an average over the entire construction period. This is based on extensive statistics of building electricity consumption.
- Total energy demand: The expected development in floor area (m^2) combined with the energy intensities (kWh/m^2), as described before, gives the total energy demand. This will be calculated per energy carrier and according to residential and non-residential buildings for the whole development period.

The different scenarios for energy demand and energy supply technology are finally analyzed using the LEAP software programme (Long-range Energy Alternatives Planning system). The results from the LEAP model are used to assess the environmental and economical impacts of the different demand and supply scenarios during the whole development period. Some of the expected results are the cumulative net contribution to reducing CO_2 emissions of a range of different supply systems. The outcome from LEAP will feed a multi-criteria model that will compare the different scenarios according to CO_2 emissions, primary energy consumption and costs. This procedure defined in step 03 will integrated in the SEIF at the end of the third iteration.

3.4.2.3 Control buildings and/or baselines

Due to the early planning stage, some simple conditions for the North Harbour project are assumed. 50 % of the building stock is residential and the remainder is non-residential buildings; offices, public institutions, retail etc. Furthermore it is assumed that all buildings meet the specifications with regards to heat and power consumption given here in the document.

As a point of reference, it is assumed that the buildings are designed according to Danish minimum standards of 2010. The analysis aims at identifying the level of building performance that is optimized for the lowest possible total costs of investment in building energy efficiency and energy supply costs. In other words, energy costs together with write-offs in energy savings measures in the building envelope. It is furthermore implied that the space heating is supplied from a district heating system.

3.4.3 Manresa demonstration scenario

Manresa is a medium-size city located in central Catalonia, whose old neighbourhood presents an irregular and tortuous street layout, inherited from the medieval times. This is the area where this demonstration scenario takes place.

3.4.3.1 Description of the urban area

In Manresa, the city council has started to draft the new POUM this year. Based on this diagnosis, the city council defined within the POUM some areas of the old neighbourhood to be renewed: new buildings, open spaces and a complete renovation of this part of the city was planned. The first Special plan of the old neighbourhood received the name of “Quatre Cantons”. It was the Unit 1 of the Special Plan named “Barreres”. The special plan had the following aims: to generate new dwellings in new buildings, to generate open spaces next to the old wall surrounding the old city, to create a big parking structure, to widen the street in the north side of the area and to generate commerce linked to the new public space. .

3.4.3.2 The goal and objective(s) of the demonstration scenario

The Manresa demonstration scenario is aimed at demonstrating the following abilities of the SEMANCO’s integrated tools:

- To create different alternative urban plans through a graphic interface, and based on the volume, location and orientation of the new buildings.
- To integrate data from different sources and generate the typologies of buildings to classify within a given geographic area according to their characteristics. Integration and classification of buildings aim at creating the inputs needed to calculate the energy performance of these buildings.
- To assess and compare different alternative urban plans under different performance indicators. That implies calculating the performance of the target building in socio-economic, energy and CO_2 emissions terms. The information will be organized in a multi-criteria impact matrix, which is the basis for performing a comparison between alternatives.
- To calculate potential of integrating solar energy systems (solar panels and/or thermal panels) and possibilities of natural ventilation in the area,

3.4.3.3 Implementing the demonstration scenario

As in previous cases, this demonstration scenario is based upon the UC10. In this case, we develop the following four urban planning scenarios:

- Baseline scenario, which is the energy performance of the old buildings according to assumptions (SC01).

- Business as Usual (BaU) and/or advanced scenarios (SC02). The first is the continuation of the current trends and is based on the application of the technical code to old buildings; the second is development of additional improvements towards an energy efficient urban plan.
- Extended scenarios to city level, which considers the possibility of extended the methodology of calculation to the whole city, in order to determine the total energy demand and the energy demand distribution (SC03).

Figure 13 shows the overall approach of the Manresa project within the framework of UC10.

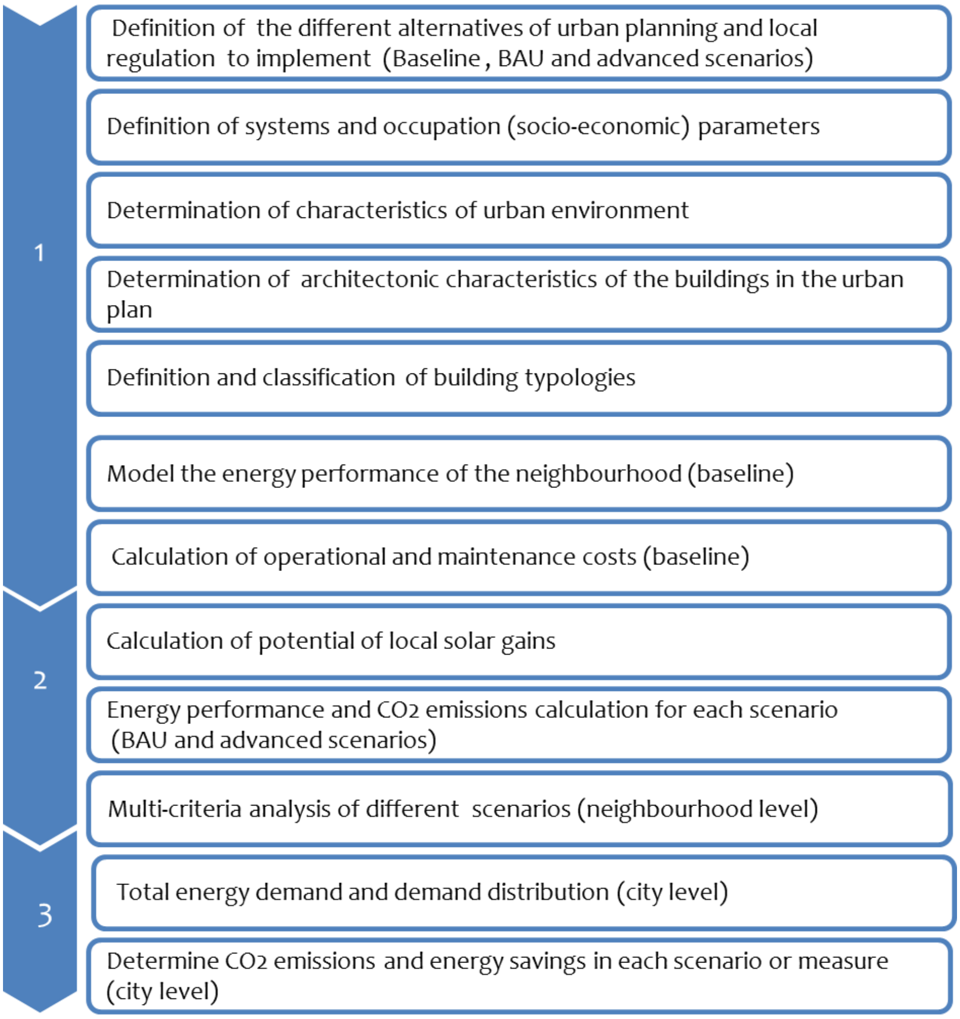

Figure 13. Overall analysis approach of the Manresa project.

Step 1 (first iteration) is an implementation of Use case 10 at building and neighbourhood level, and is equivalent to A1, A2, A3, A4 and partially to A5 (not considering RES implementation) of the UC10. Step 2 (second iteration) acts as the final calculation of primary energy, CO_2 emissions, costs and socio-economic indicators, and is equivalent to implementation of A6 AND A7.Step 2 finishes with the implementation of a methodology of multi-criteria analysis. Within the Step 3 (third iteration) there is an extension of the methodology of classification of buildings to the whole city, followed by a total energy demand and demand distribution over the whole city, and a 3D visualisation of these results, in order to allow the urban planners to identify hot spots and priority action areas.

The following figures present the flow chart of the calculation of the three scenarios; baseline scenario (SC01), BAU and advanced urban planner scenario (SC02), and city scenarios (SC03).

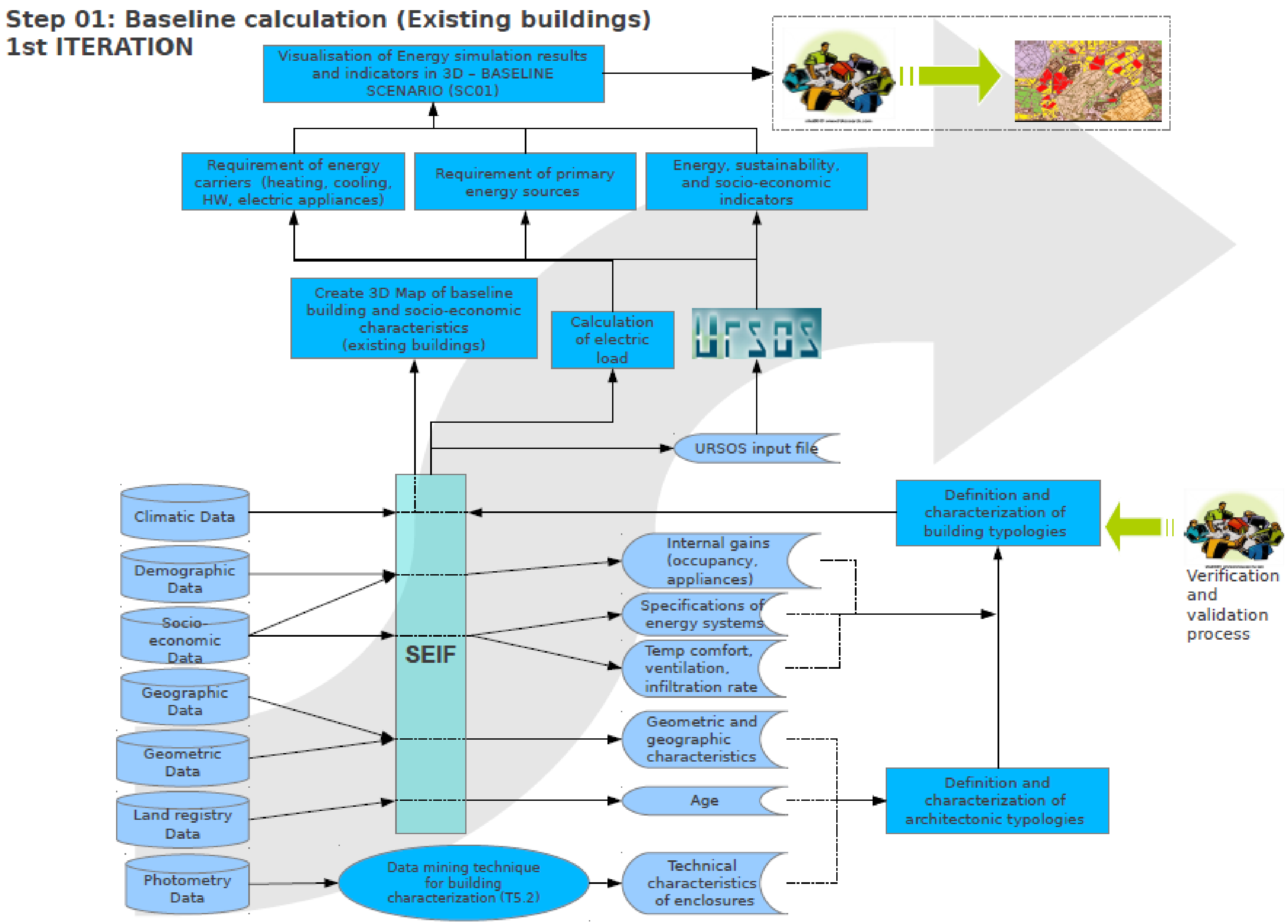

Figure 14. Flow chart for the first iteration in Manresa (Step01: baseline scenario (existing buildings)

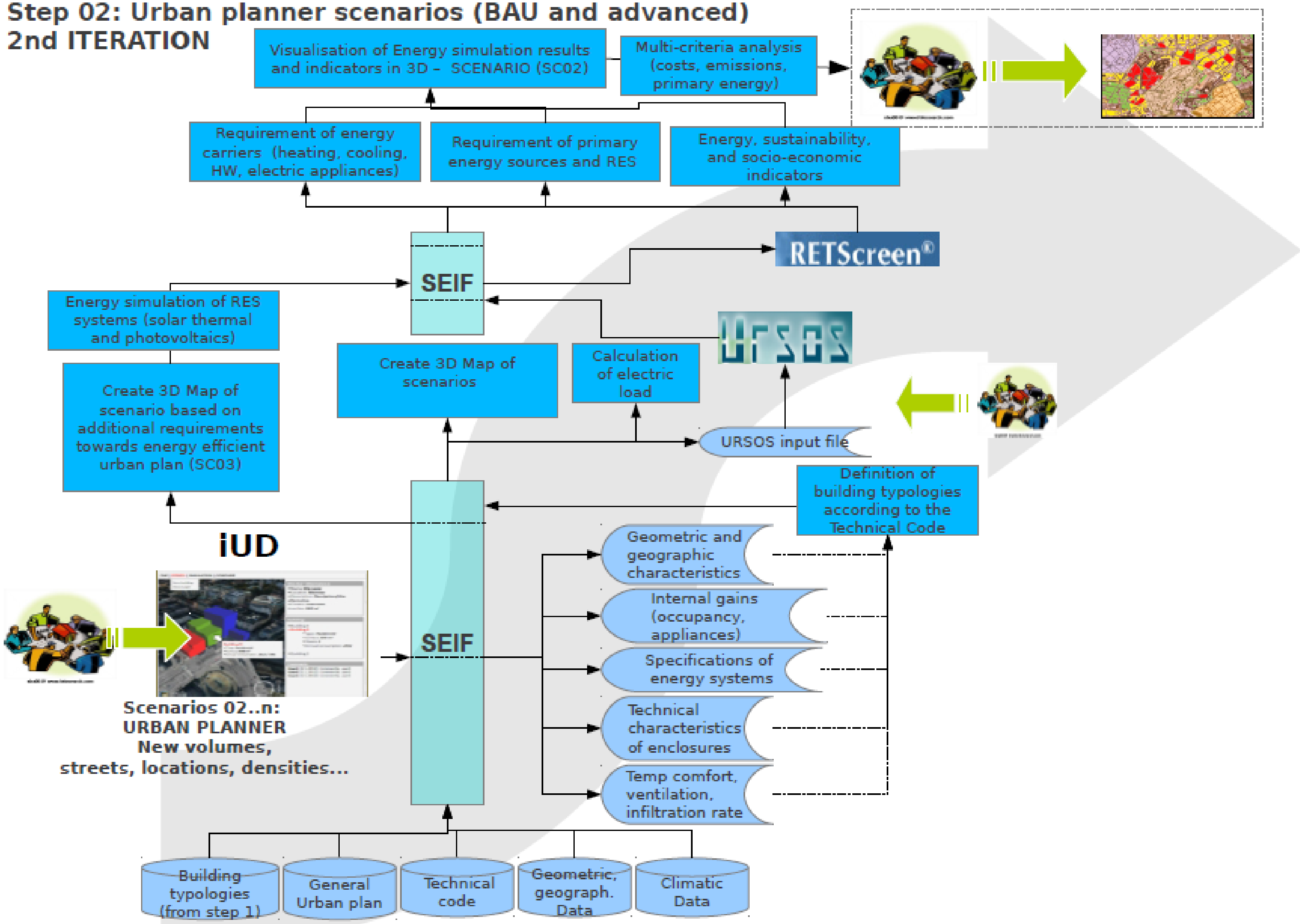

Figure 15. Flow chart for the second iteration in Manresa (Step02: Urban planner scenarios(BAU and advanced)

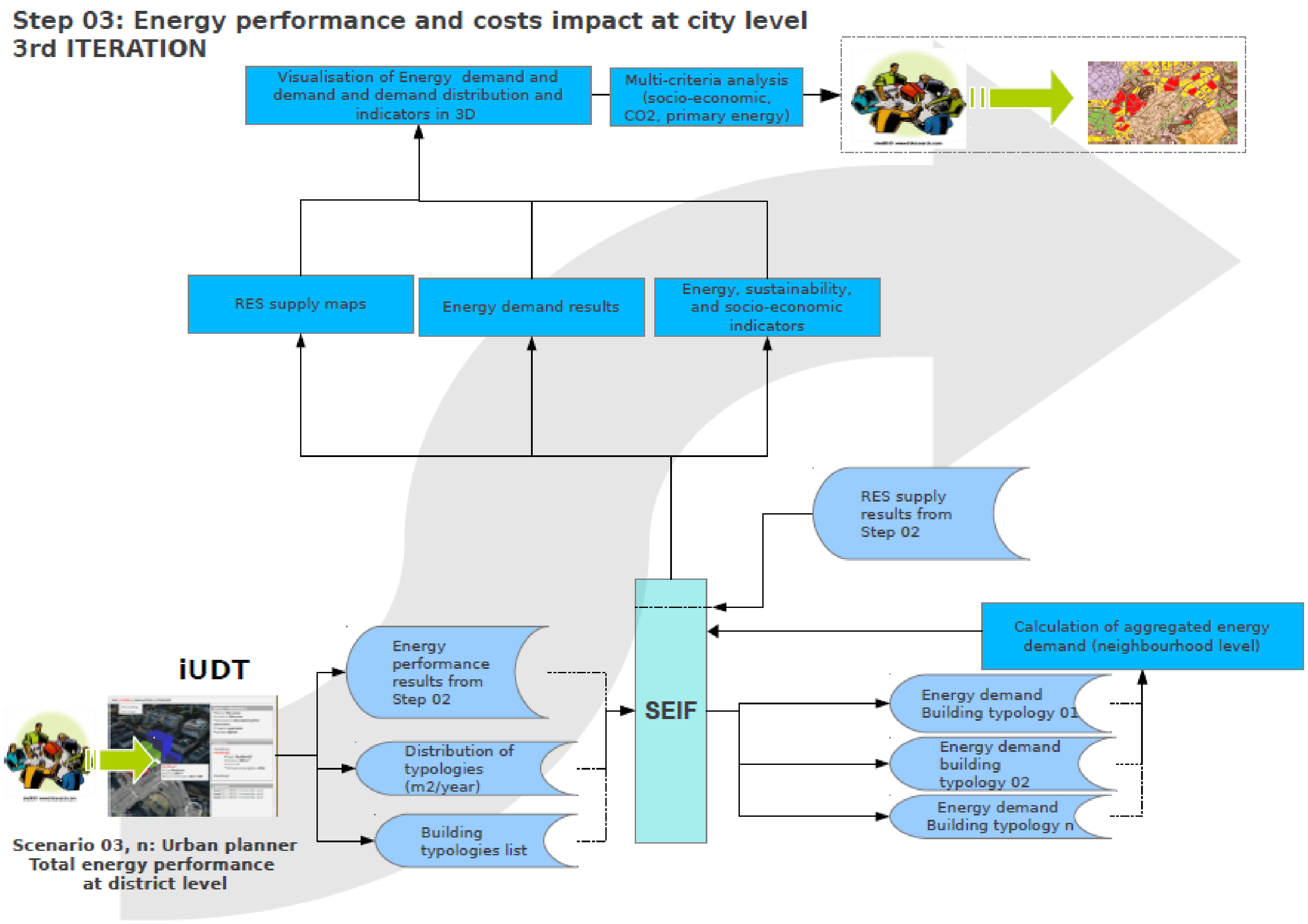

Figure 16. Flow chart for the second iteration in Manresa (Step02: Urban planner scenarios(BAU and advanced)

A1: Definition of different urban and building alternatives

The aim of this step is to carry out the definition of alternatives of urban planning actions by means of drawing in 2D and 3D the different alternatives of urban planning and combining it with information coming from local and national regulations. This is a common step for the three scenarios and involves the different users and stakeholder with the aim of defining the overall framework (at graphical and regulatory level) of the different urban actions that could be implemented. In the first iteration this step will be done with graphic interface of URSOS and a first version of integration of information with SEIF will be carried, final integration and development of a the graphical tool to define scenarios will be finished in second iteration.

In the baseline scenario the definition of urban environment will be obtained from the historical documents of the area and the information about the old buildings. In the other scenarios the urban and building alternatives will be defined by the users.

A2, A3, and A4: Building typologies characterisation

This step is defined to support access to the socio-economic, architectural, geometrical and environmental data required to characterise and classify the different typologies of buildings, and is also related to how this data can be visualised on the GIS Platform 3D Maps. In the base line scenario (SC01) collection and integration of socio-economic data with building and urban environment data (see D3.1 from task 3.1) will be carried out with the existing and old buildings. The final result of this step is to obtain a group of building typologies with their necessary parameters to model the energy performance of buildings.

In this way, this step in the Manresa case will show how the SEIF and the tools developed in the SEMANCO project can be used to create typologies to support the energy simulation of buildings in the development of urban plans as required by the derivative plans, or POUM or SEAP . In the first and second iteration the work will be limited to a group of buildings and/or neighbourhood, but in third iteration we will try to extend the creation of typologies and the calculation of energy performance to the whole city, in order to act as a support for decisions in energy performance within the development of the POUM.

In the **first iteration** a procedure of classification and characterisation of building typologies will be implemented manually. This methodology of classification is based on a combination of the age of the buildings and their characteristics according to the norms and the most common types of construction at that age, with data of number of occupants, type of buildings, geometry and volume coming from the cadastre (the property register).

While later iterations of the demonstration scenario will illustrate how this process can be improved with data mining techniques (task 5.2). That information, specific to the area and context de derivative plan, will be provided in tables for each building performance alternative in order to be introduced to SEIF and to send to URSOS software, as it is showed in flow chart of the step 01. In the other advanced scenarios (SC02) the differences of this step are that most of the technical characteristics of the buildings are defined by the requirements of the Technical Code or the advanced local regulations respectively. In this way, the procedure of classifying typologies of buildings will be adapted to reach these requirements.

A5: Model the energy performance of the neighbourhood

Simulations of energy performance are carried out using the URSOS software. These simulations are based on parameters of building insulation, such as windows U-value, thickness of insulation, building physics, urban environment and climatic data. That information, specific to the area of Quatre cantons derivative plan, will be provided in the first iteration, followed by an automated treatment and communication between SEIF and URSOS in subsequent iterations.

After simulation is done, the outputs obtained are:

- Heating demand of each building typology: According the different available combinations of primary energy sources, are obtained from the calculations performed with URSOS we will find the best overall performance of systems and architectural design. Then, the share of each building typology within the building stock is used to calculate the total heat demand of the area and/or the city.
- Cooling demand of each building typology: According the different combination able of primary energy, are obtained from the calculations performed in with URSOS. It is assumed that they could be supplied with a combination of centralized and decentralized systems, including RES in second iteration, while residential buildings should be supplied with no cooling systems, or with high efficiency cooling systems.
- Electricity consumption: Calculated taking into account combinations of typologies of families and their associated electric consumption. The consumption for the typologies of families will be defined from data of average consumption in Catalonia. In the case of public buildings and offices the calculation is based on extensive statistics of building electricity consumption obtained from the energy management system called SIE developed by CIMNE and implemented in around 350 municipalities.
- Total energy demand: In order to design an optimal energy supply system and a group of indicators for the whole area, it is essential to know the overall energy demand, by energy carrier. For the Cuatre Cantons project. URSOS supply the outputs of calculation of the total energy demand and the indicators for the whole area. This will be calculated per energy carrier and according to residential and non-residential buildings for the whole development period, and will be extended to the rest of the city in third iteration.
- Total energy supplied by solar energy: In the first iteration the solar energy available in the area and the potential yield of solar thermal or photovoltaic panels will not be calculated. In following iterations the visualization of shadows and their corresponding impact in solar radiation, and if it is possible, the automated exportation of these results as input files to the software called TRANSOL and PVSYST will be developed.

A6 and A7: Calculation of primary energy consumption, carbon emissions and costs of several energy efficiency and energy supply technologies.

This step considers the analysis of production costs, carbon emissions, and primary energy consumption for both energy efficiency measures and supply technologies in order to select the most suitable one. This evaluation would be carried out by using, for instance, the RETSCREEN software, which requires the availability of resources, efficiency, fuel cost among other input data. In the first iteration, the information needed for RETSCREEN to carry out this analysis will be manually obtained from URSOS and from databases, and in following iterations automated outcomes, to be exported from SEIF, will be developed.

The design of the Cuatre Cantons energy supply system takes into account only local features: Solar energy, and micro wind turbines. In the case of Manresa, the assessment of local renewable energy potential is based on existing data of wind energy potential, solar radiation, and geothermal characteristics of the area. This data is calculated by the government at regional and municipal level, while more detailed calculations of local solar energy within the urban area will be obtained through TRANSOL and/or PVSYST software. In the first iteration, within base the line, technical code and advanced scenarios, only energy efficiency improvements in combination with conventional heating and hot water systems (natural gas heaters and boilers) will be calculated. Supply scenarios based on RES will be added in subsequent iterations. Estimates of costs of energy efficiency investments are based on the building sector cost catalogue (ITEC catalogue).

Multi-criteria analysis

The different scenarios for energy demand and energy supply technology are analyzed using the URSOS, TRANSOL, PVSYST and RETSCREEN software Results from URSOS are the heating and cooling demand, and PVSYST and TRANSOL provide with percentage of solar energy for heat and electricity. These results will be combined with RETSCREEN in order to obtain the primary energy consumption, costs and carbon emissions calculation. The outcome from software will feed a multi-criteria model that will compare the different scenarios of CO_2 emissions, primary energy consumption and costs, according to requirements defined in D2.3. In first iteration this mix of software will be tested at the level of energy demand and costs and in a manually way, and in second iteration the integration of solar energy and the automation with SEIF will be implemented. The results will be used to assess the environmental and economical impacts of the different demand and supply scenarios during the whole development period. Some of the expected results are the cumulative net contribution to reducing CO_2 emissions of a range of different energy demand and supply systems.

4 HARMONIZATION OF DEMONSTRATION SCENARIOS

4.1 Joint implementation process (description of common activites)

The process of implementation of tools and methods developed in SEMANCO will take place stepwise in three cycles. The basis for the definition of the common implementation process is the table shown in Section 4.3, which links the activities of the UC10 with tools and data to be developed throughout the project. Each partner has made the exercise of identifying the task or subtask in which it is necessary to develop a new tool or to integrate an existing one.

This common implementation process is focused in description of the common activities and their implementation in the different demonstration scenario, and would enable us to perform cross-country comparisons and sharing of know-how and experience. The following sub-sections specify description, tools and required data of each activity to integrate in the SEIF in the different demonstration scenarios.

4.1.1 Activities A1, A2, A3, A4: Definition and classification of buildings

As can be seen in next table, the application along the three demonstration scenarios, of A1 (creation of alternatives), A2 (definition of socio-economic parameters), A3 (determine urban environment), and A4 (definition of architectonic parameters), involves common methodologies and tools to develop in these four activities. These very similar tools have the difficulty that different data requirements are defined; therefore an effort of integration of different databases in each country should be developed in WP4. .

Table 1. Table of implementation of A1, A2, A3, and A4 in the three demonstration scenarios

A1: Creation of alternatives			
	Manresa	*Newcastle*	*North Harbour*
Objective	To create alternatives of urban developments through the interface defined in URSOS (first iteration). Alternatives consider the baseline (previous buildings), Cuatre Cantons building and improved versions of that building, and overall scenarios at city level (second and third iteration)	To create alternatives of urban developments in 3D with GIS platform In the first iteration, alternatives consider baseline (energy performance of 5 tower being demolished and the remained and refurbished 5 towers). For next iterations, alternatives also consider a new mixed use site on the land freed up from the cleared tower blocks	To create alternatives of building performance levels, based on different insulation degrees (first iteration) different supply technologies (second iteration)
Required data to develop alternatives	- volume and geometry - type of building (office, residential, commercial, industry, school, hospital…) - building parameters (building technical data Table A18 D3.1)	- volume and geometry - type of building (office, residential, commercial, industry, school, hospital…) - building parameters (building technical data Table A11 D3.1)	- Degrees of insulation: U-value of enclosures and windows. - Climate conditions (solar radiation, wind speed) geothermal and biomass resources,
Tools to be developed	None for the first iteration. In next rounds we would need the 3D model editing tool and an interface to change building parameters	3D model editing tool	3D model editing tool that enables the user to change building parameters and to define supply technologies to calculate.
A2: Integrate socio-economic data			
Objective	To define occupation parameters depending on income	SEIF will provide access to databases containing LLSOA boundary data and socio-economic data which will be used to identify and visualise levels of fuel poverty at the neighbourhood level	Not apply

Required data	- Installed power capacity, and winter and summer comfort temperature will be defined according to the income level (See Table A18 D3.1) - Income, number of household members, household type (Table A23 D3.1)	LLSOA databases	Not apply
Tools to be developed	SEIF would do the work of integrating data	SEIF would do the work of integrating data	Not apply
A3: Integrate data urban environment			
Objective	To integrate data from different sources – climate, urban geometry and volumes and shadows – to be integrated in an URSOS input file and /or RES simulation software	To integrate data from different sources – climate, urban geometry and volumes, shadows – to be integrated in a SAP input file	To integrate data from different sources – climate, urban geometry and volumes, shadows – to be integrated in an IES input file
Required data	- climatic data: Monthly average solar radiation, maximum and minimum temperatures - % of shadows over building to be calculated	- climatic data: Monthly average solar radiation, maximum and minimum temperatures - % of shadows over building to be calculated	- climatic data: Monthly average solar radiation, maximum and minimum temperatures - % of shadows over building to be calculated
Tools to be developed	SEIF would do the work of integrating data	SEIF would do the work of integrating data	SEIF would do the work of integrating data
A4: Integrate architectonic parameters			
Objective	To integrate technical data of buildings from different sources – geometry and volumes, U-values, % of windows, among other – to be integrated in an URSOS input file	To integrate technical data of buildings from different sources – geometry and volumes, U-values, % of windows, among other – to be integrated in an SAP input file	To integrate technical data of buildings from different sources – geometry and volumes, U-values, % of windows, among other – to be integrated in an IES input file
Required data	Technical data of buildings. See Table A18 D3.1 In the first iteration, these data will be defined according to the age of the buildings.	Technical data of buildings. See Table A11 D3.1 In the first iteration, these data correspond to the 5 tower being demolished and the remained and refurbished 5 towers	Technical data of buildings.

Tools to be developed	SEIF would do the work of integrating data contained in tables describing building typologies and their corresponding architectonic variables	SEIF would do the work of integrating data	SEIF would do the work of integrating data

4.1.2 Activities A5, A6, A7: Calculate energy performance, CO_2 emissions, and costs, and multi-criteria analysis

As can be seen in next table, the application along the three demonstration scenarios, of A5 (energy performance calculation), A6 (calculation of costs), A7 (calculation of CO_2 emissions, energy savings, and multi-criteria analysis), and the common tools to be developed in the project are showed in next table.

In A5 there is the development of input files for the different calculation software (IES, URSOS, and SAP) as common activity, but particular developments in Manresa and North harbour should be carried out. The need of a methodology/module to extend the energy calculations to the whole city (Total energy demand and demand distribution) is detected both in Manresa and in North Harbour. A particular development of a module to export results from energy performance and energy supply to LEAP software is identified to be implemented in North Harbour.

In A6 a mix between an internal module of calculation of costs to develop within SEIF and external software (RETSCREEN) should be implemented. In A7 two common modules for CO_2 emissions calculation and multi-criteria analysis are defined in the three demonstration scenarios.

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Table 2. Table of implementation of A5, A6, and A7 in the three demonstration scenarios

A5: Calculate energy performance			
	Manresa	***Newcastle***	***North Harbour***
Objective	To calculate, with URSOS software, the baseline requirements of energy carriers (electricity, heat, gasoil and gas) according to final energy use (heating and cooling) (first iteration). To generate calculations of solar radiation to export as input file for RES simulation software (second iteration) To aggregate energy performance demand and demand distribution to the city level (third iteration)	SAP estimation tool developed as part of WP5 task 5.1 will be used to calculate the energy performance of the baseline (first iteration) and RES of a neighbourhood. Base line calculation will be calculated (second and third iteration)	To calculate the building performance level via the simulation software IES (first iteration). To integrate supply technologies and RES sources and to generate an input file to RETSCREEN software for energy supply calculations (second iteration) To integrate results of energy demand and energy supply technologies and generate an input file to LEAP software, in order predict new scenarios (third iteration)
Required data	- Technical data of buildings. See Table A18 D3.1 - Climatic data: Monthly average solar radiation, maximum and minimum temperatures - % of shadows over building to be calculated - Installed power capacity, and winter and summer comfort temperature defined according to income level (See Table A18 D3.1) - Income, number of household members, household type (Table A23 D3.1)	- Technical data of the 5 tower being demolished and the remained and refurbished 5 towers. See Table A11 D3.1 - climatic data: Monthly average solar radiation, maximum and minimum temperatures - % of shadows over building to be calculated - Occupation parameters (e.g. internal gains) See Table A11 D3.1	- Technical data of buildings. - Climatic data: Monthly average solar radiation, maximum and minimum temperatures - % of shadows over building to be calculated - Installed power capacity, and winter and summer comfort temperature defined according to income level - Income, number of household members, household type
Tools to be developed	SEIF should be able to export an input URSOS file. In the first iteration, calculation would be manual, so it would very useful to export at least a spreadsheet with the variables required by URSOS	SEIF would export the variables required by SAP to the corresponding Excel spreadsheet	SEIF should be able to export an input file for IES. In the first iteration, calculation would be manual, so it would very useful to export at least a spreadsheet with the variables required by IES
A6: Calculate costs			

Objective	To calculate energy related operation costs of the baseline in first iteration. It will be manually calculated with RETSCREEN software, and investment costs in next iterations. To integrate an automated tool between SEIF and RETSCREEN to calculate costs (second and third iteration)	To calculate energy related operation costs of the baseline in first iteration and investment costs in next iterations	To calculate investment and operation costs of the baseline in first iteration and investment costs in next iterations. To integrate an automated tool between SEIF and RETSCREEN to calculate costs (second and third iteration)
Required data	- cost of energy carriers - amount of energy carriers	- cost of energy carriers - amount of energy carriers	- cost of energy carriers - amount of energy carriers
Tools to be developed	SEIF module to calculate costs according to the outcomes of energy modeling tools (i.e. amount of energy carriers) and the corresponding prices and/or to export input files to RETSCREEN software	SEIF module to calculate costs according to the outcomes of energy modeling tools (i.e. amount of energy carriers) and the corresponding prices	SEIF module to calculate costs according to the outcomes of energy modeling tools (i.e. amount of energy carriers) and the corresponding prices
A7: Calculate energy savings, CO2 emissions, and Multi-criteria analysis			
Objective	To calculate CO2 emissions of the baseline in first iteration, followed by energy savings calculations and multi-criteria analysis.	To calculate CO2 emissions of the baseline in first iteration, followed by energy savings calculations and multi-criteria analysis.	To calculate CO2 emissions of the baseline in first iteration, followed by energy savings calculations and multi-criteria analysis.
Required data	Emission factors for each energy carrier (produced from a mix of primary energy sources) Amount of energy carriers	Emission factors for each energy carrier (produced from a mix of primary energy sources) Amount of energy carriers	Emission factors for each energy carrier (produced from a mix of primary energy sources) See Table A1 D3.1 Amount of energy carriers
Tools to be developed	SEIF module to calculate CO2 emissions according to consumption of energy carriers and emissions factors (second iteration). And a module of multi-criteria analysis (third iteration)	SEIF module to calculate CO2 emissions according to consumption of energy carriers and emissions factors (second iteration). And a module of multi-criteria analysis (third iteration)	SEIF module to calculate CO2 emissions according to consumption of energy carriers and emissions factors (second iteration). And a module of multi-criteria analysis (third iteration)

5 IMPLEMENTATION PROCESS

The implementation of the demonstration scenarios are planned to run in parallel to the development of the semantic framework and its associated tools. This way, the implementation of the scenarios should provide feedback about the degree of fulfilment of the expected features of the SEMANCO tools from the point of view of both the users and domain experts.

This section provides a summary of the tools to be developed within each demonstration scenario, based on the description of activities showed in Section 4. It also provides a timetable of the implementation process and sets up the milestones of implementation, evaluation and feedback.

5.1 Timetable of the implementation process

The implementation process will take place in three iteration cycles between months 13 and 32. At the end of each round, partners responsible of the demonstration scenario will deliver an implementation report according to the following calendar:

- First implementation report: month 19.
- Second implementation report: month 25.
- Third implementation report: month 33.

Figure 17 shows the moments during the implementation process and the corresponding deadlines to deliver these reports. Also, Figure 17 indicates the moments in which different activities of the first iteration will take place. It indicates the main activities of the second iteration and only the start and end of the third iteration. This is because most of the definition of second and third iteration will depend on the results and evaluation of the first one.

In general, the implementation reports will include an evaluation of the following issues:

- Ability integrate data from different sources,
- Ability of SEIF to communicate with external calculation tools (SAP, URSOS, IES)
- Reliability and usefulness of the outcomes of calculation and visualization procedures
- The degree of usability from the point of view of the user.

The use of this template would facilitate making comparisons of the results obtained in case studies at different countries.

The following section presents the technological requirements for each demonstration scenario.

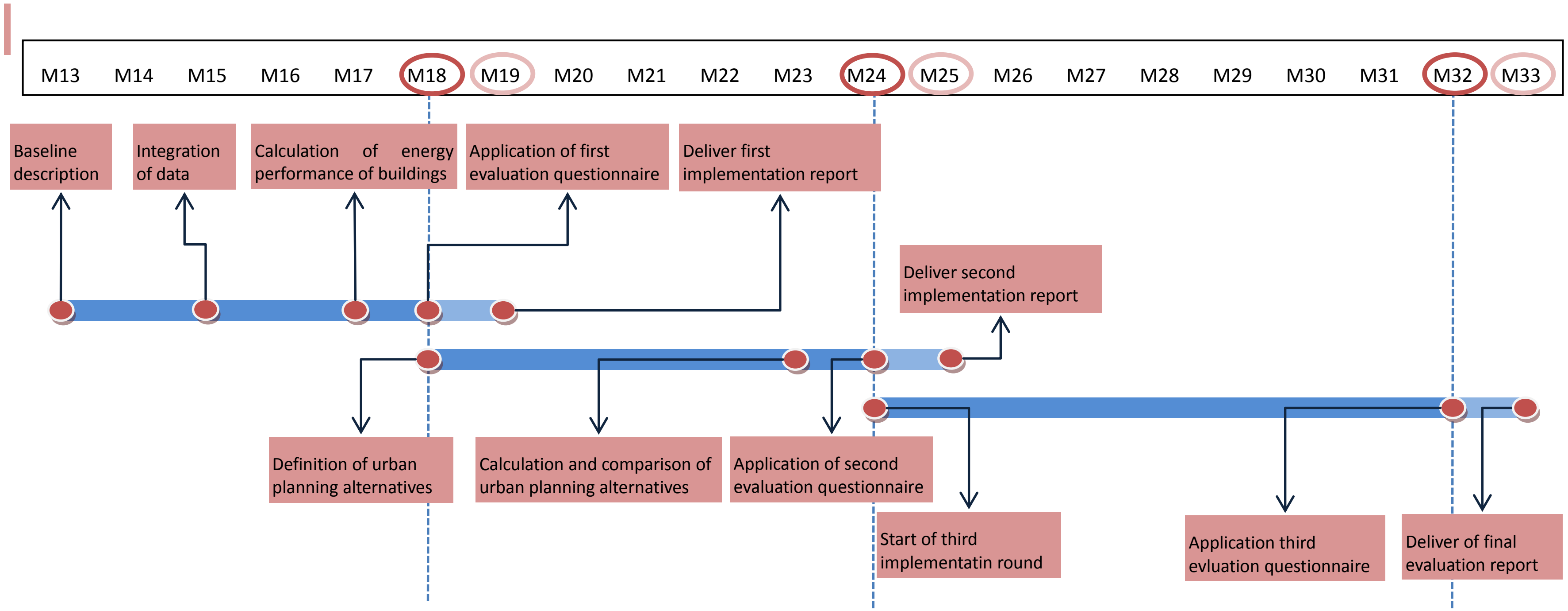

Figure 17. Timetable of the implementation of the demonstration scenarios

5.2 Technological requirements

The definition of each demonstration scenario entails a series of technological requirements to be developed within WP4 and WP5 of the project as presented in section. For instance, some demonstration scenarios require to perform a calculation of the energy performance of a building or urban area, which entails the need of connecting some calculation tools (e.g. energy simulation with URSOS) through the SEIF. These requirements are derived from the objectives and activities performed in each demonstration scenario.

For each scenario, and for each implementation cycle, the tools used to carry out the activities will be evaluated Table 4 summarizes the issues to be addressed and verified in the first implementation cycle. A proposal for the next two cycles can be found in Appendix C.

Table 3. Issues to be demonstrated across demonstration scenarios in first iteration and corresponding questions for impact verification

	Issues to be demonstrated in FIRST ITERATION			
Activities	*Manresa*	*Newcastle*	*North Harbour*	*Questions to verify the impact*
Creation of alternatives	To create alternatives through the interface defined in URSOS, in combination with 2D CAD maps	To create energy efficiency alternatives in 3D with GIS platform	To create a combination of energy performance in combination with 3D maps of the area	Has the system (or procedure) the ability to develop alternative scenarios of urban planning?
				In the case of Newcastle, has the user interface facilitated the development and definition of alternative scenarios of urban planning? In the other cases, which are the requirements of the interface (defined by stakeholders) to have the ability of creating alternatives?
Integration of socio-economic data and occupation parameters	To integrate data from different sources in a preliminary database of the area (i.e. climate, geometry, technical parameters, occupancy)	SEIF will provide access to databases containing LLSOA boundary data and socio-economic data which will be used to identify and visualise levels of fuel poverty at the neighbourhood level	To integrate data of energy demand (calculated with IES simulation software) and costs of various building performance alternatives	Has the system been able to integrated data from different sources?
			First version of procedure/module to assign building typologies, energy performances and year of construction for a given geographical area	Is the system able to generate input files for external energy simulation models? Is the system/procedure able to create building typologies

	To generate the building typologies of the area, based on their age , uses and technical parameters (from legislation at this age)	SAP estimation tool developed as part of WP5 task 5.1 will be used to classify the pre-existing housing stock in the demonstration area	☐	Is the system able to provide a spread sheet with the necessary information to feed an energy simulation model?
	To generate input variables for calculation methods (i.e. URSOS or energy plus)		☐	Is the system able to visualize socio-economic data through 3D maps?
			☐	Are the 3D maps containing socio-economic information ease to understand?
Integration of geometrical and climatic data of the urban environment	To generate 3D maps of Manresa and the urban area, with visualization of socio-economical and urban environment parameters		☐	Is the system able to classify buildings?
Integration of architectonic characteristics of the building(s) to be modelled.			☐	Is the system able to visualize shadows? Is this visualization useful for a preliminary urban planning?
Calculation of energy performance	To calculate requirements of energy carriers according to final energy uses, for the different alternatives (with URSOS software). Base line scenario, BAU scenario, and one advanced scenario will be calculated. Only Energy efficiency measures will be calculated	SAP estimation tool developed as part of WP5 task 5.1 will be used to calculate the energy performance of a neighbourhood. Base line calculation will be calculated	To calculate the building performance level via the simulation software IES.	Is the system able to calculate energy performance differentiating energy carriers and final energy uses?
				Is the system able to provide sound/reliable outcomes? Which are the outcomes of the base line scenario?
				Are you able to identify hot spots of energy performance based on those outcomes? Are you able to calculate alternative scenarios? Are you

				able to identify hot spots of energy performance based on those outcomes? Are you able to calculate alternative scenarios?
				Which are the comparable results (in form of indicators and parameters) from the different scenarios?
Calculation of CO_2 emissions	To calculate CO_2 emissions according to final energy uses (with URSOS and Spanish energy mix)	To calculate CO_2 emissions according to a preliminary method (First version of SAP calculation) of calculation, at least for the Base Line scenario.	To calculate CO_2 emissions according to final energy uses with IES and/or first version of module, for the different scenarios	Is the system able to calculate CO_2 emissions?
				Are the CO_2 emissions in accordance to the expected values?
				Are you able to redefine the energy mix used to calculate CO_2 emissions?
Calculation of investment and maintenance costs	To calculate energy costs of investment and maintenance of energy efficiency measures with RETSCREEN software. To calculate preliminary results of the multi-criteria and multi-dimension analysis to the calculated scenarios	To calculate Energy costs according to a preliminary method (First version of SAP calculation) of calculation, at least for the Base Line scenario.	First version of a cost benefit module to compare cost and energy savings for various energy performance levels, based on RETSCREEN software	Is the system able to calculate investment, operation and maintenance costs?
				Are those costs reliable?
				Are those values useful for urban planning?

5.3 Impact verification

As presented in D2.3 *Impact Verification*, the verification of the impact of the SEMANCO tools will be performed from two different points of view. On the one side, they will be evaluated from the perspective of the users: for instance, the urban planners and expert domains. On the other side, the SEMANCO tools should produce reliable outcomes from the methodological point of view.

Appendix D presents the evaluation questionnaire derived from the questions presented in Table 4. The responsible of each demonstration scenario will interview users and experts domain involved in the implementation process. The objective is to evaluate the degree of fulfilment of the expectations of these stakeholders. Appendix D also presents some additional questions for domain experts which are related to the methodological requirements specified in D2.3.

The responsible of each demonstration scenario will produce an evaluation report based on the questionnaires applied to end users and expert's domain. This report should include, at least, the following analysis:

- Analysis of issues (i.e. questions) with bad scores
- Identification of reasons of failure
- Definition of strategies to overcome obstacles and drawbacks
- Redefinition of expected features of SEMANCO tools

There are several aspects of the second and third iteration that rely on the success of the first round. Therefore, most of the issues to be defined in the second and third cycles will have to be defined following the first implementation.

6 CONCLUSIONS

6.1 Contribution to overall picture

The main objective of Task 8.1 *Implementation Plan Development* has been to delimit the scope of the research by means of the demonstration scenarios. The first definition of the case study conducted in Task 2.1 Report of the Case Studies and Analysis was the start point for the detailed definition of the demonstration scenarios presented in this deliverable.

In particular, the following objectives have been reached in Deliverable 8.1:

- Detailed implementation plan for each demonstration scenario including measurement parameters, indicators of success, contingency plans and key control points in the process;
- Coordination and impact verification methodology between the plans to ensure comparable parallel development and sharing of know-how and experience;
- Definition of the urban areas and buildings to be targeted in the implementation and also those to be used as baseline calculations;
- Interview meetings and technical workshops with users and/or stakeholders have been carried out to ensure the outputs of the project are appropriate to their requirements.

The report identifies several urban scenarios in three case studies comprised of different users, local urban planning schemes, and a variety of objectives to reach.

6.2 Impact on other WPs and Tasks

Task 8.1 and Deliverable 8.1 have the following impacts on the other work packages and tasks:

- Output calculations from demonstration scenarios serve firstly as a basis for the calculation of indicators defined in Task 2.2 and secondly for validation of impact according to the methodology defined in Task 2.3.
- Outputs of the first and second iteration of the implementation process will serve in D2.4 as an updated version of impact defined in Task 2.3.
- In relation to WP5, technical requirements and software tools proposed in this document will be developed or integrated in the SEIF in Tasks 5.1 and 5.2.
- All data identified (according to Task 3.1) tools, and technical requirements defined in D8.1 will be integrated in the ontology framework within WP4

6.3 Contribution to demonstration

At the end of the first year of the project, three demonstration scenarios have been defined and data and requirements of tools to implement these scenarios are outlined. The planning of implementation for the three iterations has also been defined. A common template for impact evaluation is provided in order to ensure comparable parallel development and sharing of know-how and experience among the three demonstration scenarios.

Within the demonstration and validation process, the Semantic Energy Information Framework (SEIF) is expected to support the following tasks (Table 4):

Table 4. Contribution of D8.1 to the demonstration phases.

Tasks in the demonstration phases	*Contribution of Deliverable 8.1*
The automated identification and classification of buildings for energy analysis within a geographic area	Description of existing databases, technical requirements, and objectives of an automated classification of buildings are defined for the different demonstration scenarios
The identification and visualisation of 'energy use hot spots' to support the effective targeting of urban energy efficiency and renewable energy interventions	Not applicable
Assessment of the potential of different technical and social interventions and strategies to reduce CO_2 emissions at different geographic scales;	Definition of the methodology of calculation and flow chart to define and calculate interventions and strategies to reduce CO_2 emissions considered within each demonstration scenario Recognition of the complexities entailed by the definition of the analytical scales and preliminary definition of micro, meso and macro scales, and by the definition of a common use case
Optimisation or trade-offs between conflicting social, economic, political and environmental constraints within planning and design practice to support stakeholder decision making;	Description of the international, national and local policy frameworks and local urban planning schemes, which frame (or constrain) the urban planning practices in demonstration scenario.
Extracting guidelines to apply to other areas and projects, providing planning authorities (local, national and European) with appropriate indicators for monitoring and reporting that can be used to establish future planning strategies;	Not applicable
Predicting future demand following demographic and economic changes by identifying patterns of growth and sustainable urban developments which reduce energy consumption	Definition of the methodology for baseline calculation of energy consumption and CO_2 emissions in each demonstration scenario. The performance of the final demonstration scenarios – developed with the support of the methods and tools developed in SEMANCO – will be compared against those baselines.

The actual implementation of the scenarios described in this document will take place as part of Task 8.2 *Implementation.*

6.4 Other conclusions and lessons learned

The different lines of work developed in the first year of the project converge in the demonstration scenarios. Their integration in a common framework has not been an easy task, at this point of the project. Further adaptations of the scenarios will be needed to tune the technological development with the implementation in actual working conditions. In this regard, the contribution of WP6 is expected to have an impact in the implementation and in the evaluation procedures proposed in this document.

7 REFERENCES

7.1 References

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8 APPENDICES

Appendix A. Demonstration scenarios

Newcastle demonstration scenario

The context of the demonstration scenario

In the UK, national and local government interventions to reduce CO_2 emissions from domestic housing stock have two aims: to reduce CO_2 emissions and to reduce fuel poverty. In the UK fuel poverty is defined as a situation in which households are required to spend more than 10% of their income to meet their energy needs, including sufficient warmth to maintain a healthy living environment (Department of Energy and Climate Change 2001). In other European countries the term energy poverty is more commonly used. In the UK context, people living in fuel poverty tend to live in poor quality housing stock which is expensive to heat. The policy approaches to ameliorating this problem seek to improve the quality of the properties in which the fuel poor live thereby reducing CO_2 emissions as well as reducing the numbers of people living in fuel poverty. This policy context frames local development frameworks for land development.

As outlined in deliverable 2.1, in the context of the UK case study the Local Planning Authority (LPA), in consultation with its community, is responsible for preparing local planning policies which take into account the unique needs and character of the local community and area, whilst adhering to policy and legislation (including energy) set at a national and regional level. At a local level, Local Planning Authorities (in this case Newcastle City Council) are responsible for preparing planning policy in the form of Local Development Frameworks (LDFs).

The Local Development Framework (LDF) is the means by which Newcastle City Council presents its proposals for the use and development of land; this framework also presents Newcastle City Council's spatial vision until the year 2030. The LDF consists of a number of different documents covering the full suite of planning policies (including energy) that will manage and influence future development in Newcastle. The Local work stream aims to address the impacts of new developments on climate change through the LDF by promoting a range of adaptation methods and identifying achievable policy targets. Currently LDFs are framed by new planning frameworks and guidance released in 2012.

The National Planning Policy Framework (DCLG 2012) sets out the UK Government's planning policies for England and how these are expected to be applied to achieve economic, social and environmental sustainability.

The National Planning Policy Framework states that to support the move to a low carbon future, local planning authorities should:

- plan for new development in locations and ways which reduce greenhouse gas emissions;
- actively support energy efficiency improvements to existing buildings;
- When setting any local requirement for a building's sustainability, do so in a way

consistent with the Government's zero carbon buildings policy and adopt nationally described standards.

In relation to actively supporting energy efficiency improvements to existing buildings there is also new guidance (DECC 2012) to help local authorities in England improve the energy efficiency of their residential housing published in July 2012. The guidance, issued under the Home Energy Conservation Act (HECA), asks local authorities to publish a report on their plans to achieve improved energy efficiency by 31 March 2013.

Local authorities will be required to identify practicable and cost-effective measures likely to result in significant energy reduction in all residential accommodation in their area.

The guidance also asks local authorities to consider the role key local partners, such as social housing providers and community organisations, can play in supporting their plans.

In the UK implementation of the demonstration scenario there are various parties that have a vested interest in the deployment of semantic modelling. For the purposes of this study we have defined these as actors and users.

Actors

- Neighbours' association or individual neighbours. It is important for them to know the environmental and socio-economic implications of the different possibilities in the district or environment, mainly in refurbishment projects. They can also use the information to ask additional questions to political figures such as local councillors or local officers.
- Mayor and municipal councillors: In order to evaluate CO_2 emissions impact of different local regulations and policies.

Users

These are organisations (public or private) or individuals with a vested interest in regenerating the area often for political or financial gain. Examples include:

- Municipal / local planning authorities technical planners
- Public companies providing social housing
- Policy Makers

Description of the urban area

The electoral ward of Elswick is highly visible on the western approach to Newcastle upon Tyne and has a diverse range of property types many of which are owned by social housing provider Your Homes Newcastle. The demonstration scenario will focus on the buildings at the heart of Elswick in the area of Riverside Dene suitable for the retrofitting of energy efficient and reviewable energy technologies. These include terraced domestic properties dating from the Victorian period, originally built to house workers during the industrial revolution. In the UK, high density terraced properties a dominant feature of most towns and cities and were a key part of the UK's building fabric right up until the Second-World-War. Consequently there are many of these properties within the current UK housing stock. Picture (2) below represents Victorian terraced properties surrounding Riverside Dene separated by a main road. These properties are typically three bedroom solid walled properties, some of which are heated by electricity and some gas. Most of the properties pictured are owned by social housing provider Your Homes Newcastle.

In addition, there are other properties (pictured below) built in the 1970s to house social housing tenants. They are brick cavity walled properties with clay-tile roofs and are fitted with high efficiency double glazing. Again these properties are owned by social housing provider Your Homes Newcastle.

In the UK, Standard Assessment Procedure (SAP) data is available for social housing, via housing providers. This covers about 19% of the total UK housing stock. The demonstration scenario in the UK case study will illustrate how the tool currently under development in T5.1 can be used to semi automate SAP assessments for the remaining 80% (approx.) of the UK housing stock for which we do not currently have these assessments. Later iterations of the demonstration scenario will illustrate how the SAP assessment tool developed in task 5.1 can be built upon in task 5.3 to provide a tool which enables the identification of practicable and cost-effective measures likely to result in significant energy reduction in all residential accommodation as demanded by the new Government frameworks and guidance

North Harbour demonstration scenario

The North Harbour area is situated north east of central Copenhagen, with sea connection to the strait of Øresund (The strait between Denmark and Sweden – a main sea traffic route that connects the Baltic Sea with the outside world). The area has evolved from a number of small harbours on the coastal line in the mid-1800s, to a large land area based on fillings that stretches about 2 km north-east into Øresund today. The North Harbour has hosted a free port and various port related industries during the time.

The North Harbour development project is the largest urban development project in Scandinavia in recent time – fully developed, it will cover 350 hectares of land. It is located on the coast of Øresund, only four kilometres from the centre of Copenhagen. Due to its location in Copenhagen and in the Øresund region, North harbour is expected to attract many residents, visitors and work places.

The context of the demonstration scenario

Since the municipal reform in 2007, the municipalities in Denmark have been given full authority over spatial planning within the framework of national regulation. Municipalities are obliged to perform a Municipal Planning Code every 4 years. The code must take into consideration – but is not bound by – the regional planning strategies developed by the regional authorities. In addition, the Code must comply with national planning directives, which are regularly being issued by the government.

With regards to energy supply, the Municipal Planning code should include a strategy for supply of heat to each of the districts of the municipality. This strategy must conform to the Heat Planning Act, which obliges all municipalities to develop and regularly update a plan for supply of heat. The act stipulates a set of criteria for the heat planning, of which the main principle is for the municipality to promote whichever type of heat supply is most efficient in socio-economic terms. In areas where a district heating system exists, municipalities can oblige building owners to connect to this system within a period of 9 years.

Municipal codes should also include a strategy for waste collection and treatment, including possible waste-to-energy strategies. In Denmark almost all residual municipal waste (the fraction of waste which is left after sorting of recyclable fractions) is incinerated for combined production of heat and power.

Municipalities are also obliged to undertake a plan of possible wind power production within their physical area. The plan must include an identification of areas which meet the national planning criteria for wind power utilisation. There is however no requirement for the municipalities to approve wind power projects even if they conform to national regulation.

A Local Planning Code is required ahead of any major development project or building construction or demolition project. The Local Planning Code specifies in detail which land plots will be supplied with district energy. The Code may also specify stricter regulation on building energy performance than the minimum requirements in the national building code.

In addition to the authority admitted in the planning legislation, municipalities are entitled to impose higher standards when selling their own land for property development (e.g. compulsory collection of rain water from roof tops). This entitlement is however, only used to a limited extent. Altogether, the Danish planning regulation is a key element in the national strategy of promoting energy efficiency and substituting fossil fuels with renewable energy sources.

The City of Copenhagen has about 500 000 inhabitants, a number which is expected to increase by 45 000 by 2025. The North Harbour project, which encompasses the above mentioned regulations and planning schemes, will be developed over the next 60 to 80 years and is intended to accommodate 40 000 residents as well as providing employment for another 40 000 people (CPH City and Port Development 2009).

The development project aims to create a CO_2 friendly city. This vision will become reality through a high energy performance of buildings, by providing a sustainable supply of energy to the North Harbour district; and by giving high priority to public transport and cycling. The North Harbour project can be seen as a step towards fulfilling the municipal goal of a CO_2 neutral Copenhagen in 2025. This is in line with the overall national ambition of a CO_2 free society in 2050.

Description of the urban area

North Harbour is planned to be a mixed use district of about 50% residential buildings and 50% private enterprises and public institutions. Functions will intentionally be mixed in order to create optimum conditions for a vibrant urban life.

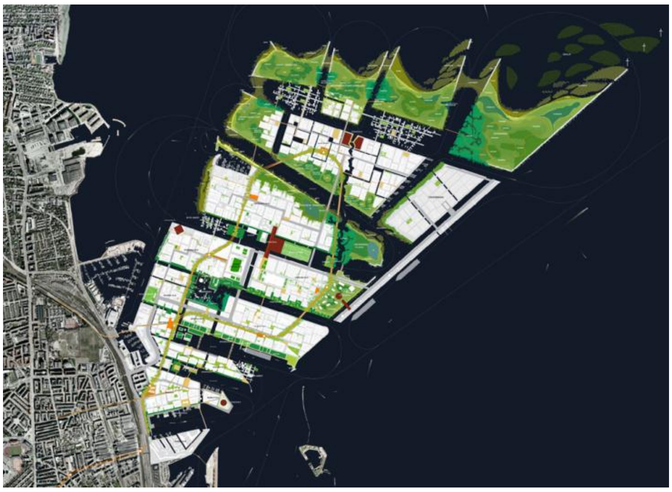


Figure 18. North Harbour project (City of Copenhagen 2011)

The so-called “intelligent grid” is an urban structure of building blocks allowing for maximum flexibility in terms of building dimensions and uses. The structure also supports the integration of landscape into the urban environment in the form of pocket parts, etc. Although flexibility is highly prioritised, a program has been made for a few large functions. For example:

- The existing cruise terminal will be expanded and moved further East to occupy most of the south-eastern coastline.
- The existing container terminal will be moved to a new land area, which is now under reclamation.
- Two large beach areas have been planned.

- A transport loop consisting of an elevated metro line and a high-class bicycle lane runs through the district.

Manresa demonstration scenario

Manresa is a medium-size city located in central Catalonia, whose old neighbourhood presents an irregular and tortuous street layout, inherited from the medieval times. This is the area where this demonstration scenario takes place.

The context of the demonstration scenario

As mentioned in Deliverable 2.1, urban development is a highly decentralised activity in Catalonia. At the territorial scale, the **Territorial plans** define the actions towards a defined vision of the territory and the **Urban Master Plans** frame the urban ordering process within a supra-municipal territory.

At municipal level, the city council, through the **Municipal Urban Ordering Plan (POUM),** designs the entire city within its boundaries, including the urban environment, as well as the rural or forest lands. The POUM categorizes the municipal territory into urban land (most of it already built), future/possible urban land (areas that are meant to be urban land in the future) and land protected from urban development. In practical terms, it determines the height and depth of buildings, the sections of the streets, the direction of the traffic, the use of the buildings, the population densities, the size of the balconies, the slope of the roof and the size of the public squares among other general definitions.

Sometimes, the directives of the POUM are not enough to achieve the expected vision of the city (i.e. what is envisaged in the POUM). So, in those cases the city council uses the legal figure of the **Derivative plans** (in its several forms: Partial plans, Special plans, detailed studies) in order to define certain areas where concrete rules are applied. The aim of the derivative plans can be to solve existing problems of the already built environment (e.g. lack of commerce in a neighbourhood) or to achieve a new development area with certain desired characteristics (e.g. build a new big park).

Derivative plans define a set of requirements and constrains for the development of the urban projects. Moreover, the plan could even force all the actors involved to achieve an agreement in order to develop what is defined there[3]. The urban planner can define a series of requirements according to the technical code or even stricter conditions within an urban area bound for derivative planning (See Table 5). Urban (public or private) promoters have to comply with those requirements when designing and implementing a concrete urban project[4].

Table 5. Parameters that delimit the option space for urban development.

[3] These plans use to search for an economic balance that encourages owners to force the development. This balance is always between costs (e.g. public spaces that promoters have to develop) and profit (buildings that at the end of the process will remain for the promoters).

[4] In some cases, the urban promoter is free to decide how to fulfil those requirements defined by the urban planner. For instance, if the urban planner defines a minimum share of electricity produced from renewables (let's say 25%) and reserves a space to construct a power plant using renewables, then the urban promoter is free to decide whether to construct a biomass plant or a photovoltaic field. Another example is the case when the urban planner requires a certain level of energy certification, and then the urban promoter decides the materials, the isolation and the extent to use renewables, among other possibilities in order to comply with that energy certification.

Family of parameters	Possible requirements from the urban planner
Parameters aimed at limiting the volume of the buildings	▪ To limit the minimum and maximum height of the building ▪ To establish the compulsory depth of the building ▪ To establish compulsory alignments ▪ To define the maximum or compulsory limits ▪ …
Parameters describing the activities of the zone under urban planning: Extensive urban area, commercial centre, buildings of social housing, industrial zones.	▪ Define the buildable area (maximum amount of squared meters to be constructed) ▪ Occupation rates (maximum surface that can be occupied) ▪ Density (maximum Lumber of houses that can be constructed) ▪ Delimit land uses ▪ …
Other parameters	▪ Set the qualification level of the building (a B on the national certification scheme) ▪ To require a percentage of electricity produced locally from renewables. At urban scale, the urban planner can also reserve space to construct a RES power plant (biomass, photovoltaic or whatever is decided by the urban promoter). ▪ To require a certain amount of domestic hot water generated locally (solar thermal panels) ▪ To bind the implementation of cross ventilation, and define related volumetric aspects

In the case of Manresa, the old neighbourhood of the city has a Special Plan of Integral Refurbishment (PERI): a set of derivative plans aimed at formalizing the vision of urban planners and politicians about what the city should (or shouldn't) be. The city is becoming old; with abandoned and empty buildings and plots, decreasing social and economic activity, decreasing salubrity and hygiene, and the need of improving old infrastructures. The PERI then promotes the modernization of the old neighbourhood.

Usually, urban planners have performed this task without much consideration of ecological criteria such as the reduction of greenhouse gas emissions. The dominant criteria encompass the urban dimension: e.g. the willingness to refurbish a degraded zone, to classify an urban zone for new developments (i.e. city expansion due to demographic growth) or to improve mobility issues by widening the streets.

In the first implementation round, we aim to demonstrate the usefulness of the SEMANCO integrated tools and associated methodologies for urban planners operating in the definition of the Derivative plans. Specifically, the demonstration scenario is based on the process where the urban planners define a set of additional requirements with respect to the technical code, for new or existing buildings (e.g. to meet the compromises under the Covenant of Mayors).

Despite the fact that an urban promoter is in charge of defining the details of the urban project (e.g. at building level), s/he can also take advantages of the calculation procedures developed here: The urban promoter might want to compare different alternatives for the urban project considering variation of general characteristic of the specific project, such as volume, location, orientation or shape of the building.[5]

[5] Once the urban promoter has chosen one or two options, s/he would like to export basic data to run more detailed simulations (e.g. in Energy Plus or Calener) and proceed to the certification procedure. In this process, the urban promoter can interact with the owners, other urban developers, neighbours or the city council in order to define general aspects of the project. Which can be considered for the next implementation rounds

Description of the urban area

In Manresa, the city council has started to draft the new POUM this year. The current POUM was reviewed in 1997 and the context has changed significantly. In those days, one of the concerns of the politicians was the status of some parts of the old city. It was becoming older, people and businesses were leaving the area and more and more buildings were empty. The reasons are diverse: buildings were all very old, a narrow street layout hindered solar gains and ventilation and new neighbourhoods were more attractive. Based on this diagnosis, the city council defined within the POUM some areas of the old neighbourhood to be renewed: new buildings, open spaces and a complete renovation of this part of the city was planned.

Due to the big extension of the area to be modified in the old neighbourhood (see **Error! Reference source not found.**b) and the diversity of problems and owners, the POUM fragmented the area in several urban planning. In this way, urban planners expected to be able to deal with the problem piece by piece.

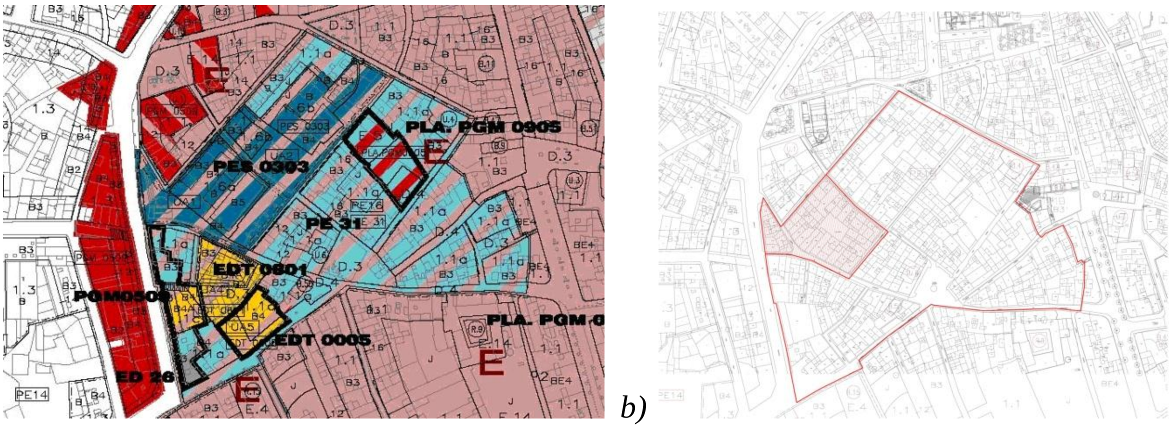


Figure 19. a) Several Special plans and detailed studies included within the Especial Plan for the refurbishment of the old city. B) Unit 1 of special plan "Barreres" within the special plan for the refurbishment of the old city.

The first Special plan of the old neighbourhood received the name of "Quatre Cantons". It was the Unit 1 of the Special Plan named "Barreres". The high level of degradation of the area motivated the involvement of a public promoter for implementing the plan: FORUM.

The special plan had the following aims: to generate new dwellings in new buildings, to generate open spaces next to the old wall surrounding the old city, to create a big parking structure, to widen the street in the north side of the area and to generate commerce linked to the new public space. Therefore, urban planners from the municipality developed the requirements and rules that might organise the new development, creating a map with the graphic rules like the one shown in figure 19. In this figure, urban planners proposed replacing all the existing buildings with one large new building with 4 facades, a small courtyard, dwellings of 16 meters depth and two heights. The design would allow widening the street on the east (to 18 meters), and would increase solar gains from the west.

a) b)

Figure 20. (a) Previous buildings and (b) graphic proposal of POUM for Unit 1

Within this legal framework, the public company FORUM started a long process of buying and demolishing old buildings. FORUM opened a call for urban development proposals for the design of the new buildings: the project presented in next figure**Error! Reference source not found.** was chosen.[6]

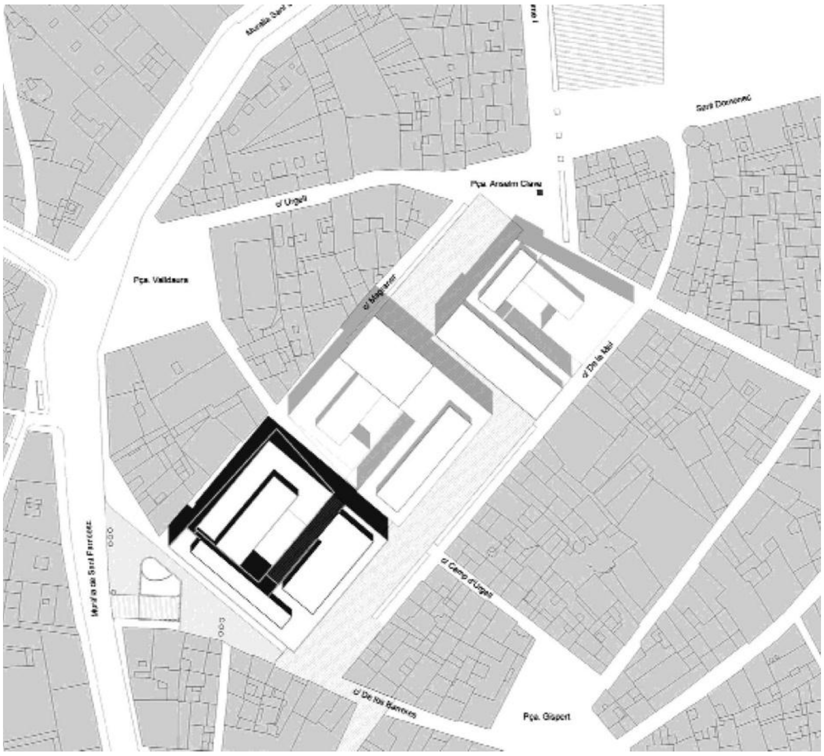


Figure 21. Urban project for the Unit 1

The constructed building can be seen in figure 22. Construction ended in 2007 and included 88 dwellings, 240 parking places and several new commercial areas at ground level.

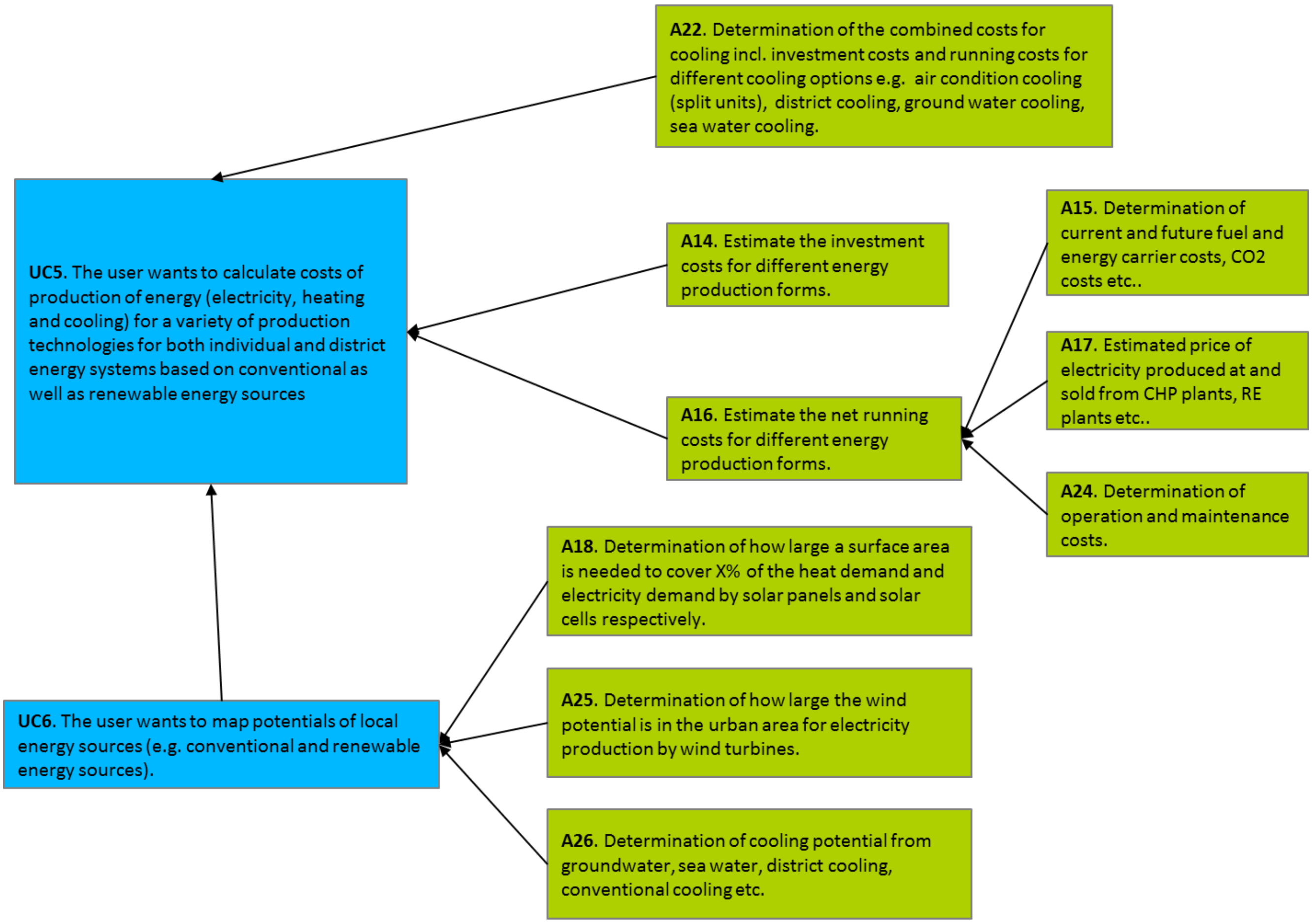
[6] The urban promoter proposed some modifications to the norms established by the POUM. The proposal respected the main parameters defined there (i.e. height, soil occupation, population density, depth of the building), therefore the City council accepted to modify the POUM in order to allow the construction of the building.

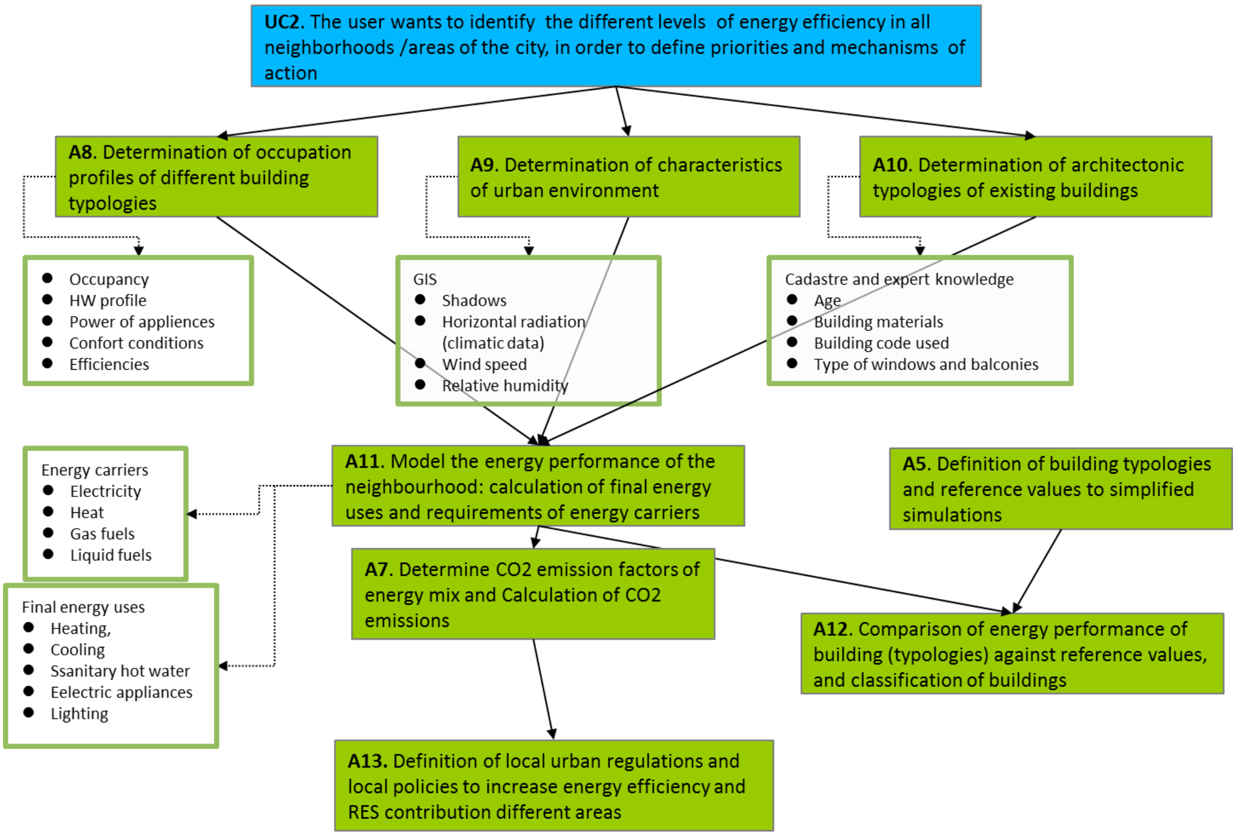
Figure 22. constructed building in Quatre Cantons.

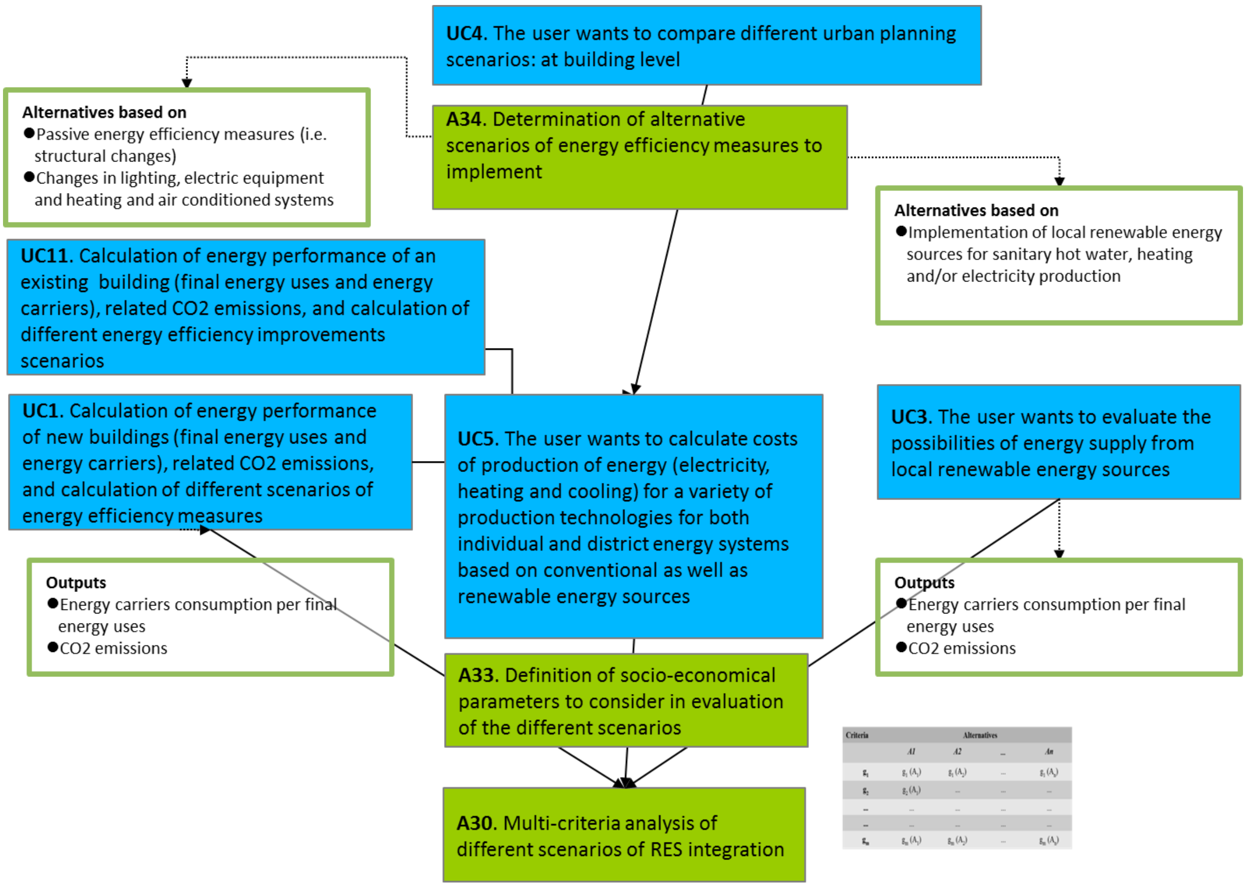
It is important to notice that all decisions taken during the process were justified by urban, economic and technical parameters. But, no parameters concerning energy performance neither CO_2 emissions were explicitly taken into consideration.

Appendix B. Previous Use cases

The figure shows examples of some of the identified use cases and their interrelationships, from which Use Case 10 was selected:




UC2. The user wants to identify the different levels of energy efficiency in all neighborhoods /areas of the city, in order to define priorities and mechanisms of action
A8. Determination of occupation profiles of different building typologies
A9. Determination of characteristics of urban environment
A10. Determination of architectonic typologies of existing buildings
Occupancy
HW profile
Power of appliences
Confort conditions
Efficiencies
GIS
Shadows
Horizontal radiation (climatic data)
Wind speed
Relative humidity
Cadastre and expert knowledge
Age
Building materials
Building code used
Type of windows and balconies
Energy carriers
Electricity
Heat
Gas fuels
Liquid fuels
A11. Model the energy performance of the neighbourhood: calculation of final energy uses and requirements of energy carriers
A5. Definition of building typologies and reference values to simplified simulations
Final energy uses
Heating,
Cooling
Ssanitary hot water
Eelectric appliances
Lighting
A7. Determine CO2 emission factors of energy mix and Calculation of CO2 emissions
A12. Comparison of energy performance of building (typologies) against reference values, and classification of buildings
A13. Definition of local urban regulations and local policies to increase energy efficiency and RES contribution different areas


UC4. The user wants to compare different urban planning scenarios: at building level
Alternatives based on
Passive energy efficiency measures (i.e. structural changes)
Changes in lighting, electric equipment and heating and air conditioned systems
A34. Determination of alternative scenarios of energy efficiency measures to implement
Alternatives based on
Implementation of local renewable energy sources for sanitary hot water, heating and/or electricity production
UC11. Calculation of energy performance of an existing building (final energy uses and energy carriers), related CO2 emissions, and calculation of different energy efficiency improvements scenarios
UC1. Calculation of energy performance of new buildings (final energy uses and energy carriers), related CO2 emissions, and calculation of different scenarios of energy efficiency measures
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
UC3. The user wants to evaluate the possibilities of energy supply from local renewable energy sources
Outputs
Energy carriers consumption per final energy uses
CO2 emissions
Outputs
Energy carriers consumption per final energy uses
CO2 emissions
A33. Definition of socio-economical parameters to consider in evaluation of the different scenarios
A30. Multi-criteria analysis of different scenarios of RES integration
Criteria
Alternatives

Appendix C. Issues to be addressed in second and third iteration

	Issues to be demonstrated in SECOND AND THIRD ITERATION			
Activities	*Manresa*	*Newcastle*	*North Harbour*	*Questions to verify the impact*
Creation of alternatives	To create alternatives through the interface developed in 3D GIS.	Demonstrate how this process of integration in 3D can be used to target interventions to reduce CO2 emissions and fuel poverty at the Municipal level.	To create a combination of supply technologies and energy performance in combination with 3D maps of the area	Has the system (or procedure) the ability to develop alternative scenarios of urban planning? Has the user interface facilitated the development and definition of alternative scenarios of urban planning?
Integration of socio-economic data and occupation parameters	New module based on results of data mining procedures, allowing us to integrate a classification of buildings according to their parameters	SEIF will provide access to databases containing LLSOA boundary data and socio-economic data which will be used to identify and visualize levels of fuel poverty at the neighbourhood level	To integrate data of energy demand (calculated with IES simulation software) and costs of various building performance alternatives	Has the systems been able to integrated data from different sources?
			A new /module to assign building typologies, energy performances and year of construction for a given geographical area	Is the system able to generate input files for external energy simulation models? Is the system/procedure able to create building typologies
	To generate 3D maps of shadows visualization as and input to solar energy systems simulation software (TRANSOL AND PVSYST), or to develop a new module of pre-estimation of potential of solar energy in the city	SAP estimation tool developed as part of WP5 task 5.1 will be used to classify the pre-existing housing stock in the demonstration area		Is the system able to provide a spreadsheet with the necessary information to feed an energy simulation model?

	To generate input variables for calculation methods (i.e. URSOS or energy plus). New module for automated generation of inputs to simulation software (URSOS)		□ □	Is the system able to visualize socio-economic data through 3D maps? Are the 3D maps containing socio-economic information ease to understand?
Integration of geometrical and climatic data of the urban environment	To generate 3D maps of Manresa and the urban area, with visualization of building parameters, results of calculations, and indicators		□	Is the system able to classify buildings?
Integration of architectonic characteristics of the building(s) to be modeled.	To perform data mining techniques to extrapolate building parameters to the Manresa building stock based on a significant sample of data. Visualization for the whole city, the socio-economical parameters and the building properties		□	Is the system able to visualize shadows? Is this visualization useful for a preliminary urban planning?
Calculation of energy performance	To integrate Energy performance calculation results (from URSOS), solar energy results (from TRANSOL and PVsyst) in 3D visualization. To defined a semi-automated procedure to connect the different software with SEIF	To find a simple approximation with data mining techniques for the energy efficiency simulation and (especially) and seeing with the LLSOA level data, in order to use to predict which areas are most likely to yield useful results of improvement when checked in detail	To integrate results of calculation at the building performance level via the simulation software IES with SEIF	Is the system able to calculate energy performance differentiating energy carriers and final energy uses? Is the system able to provide sound/reliable outcomes? Which are the outcomes of the base line scenario? Are you able to identify hot spots of energy performance based on those outcomes? Are you able to calculate alternative scenarios?

				Are you able to identify hot spots of energy performance based on those outcomes? Are you able to calculate alternative scenarios? Which are the comparable results (in form of indicators and parameters) from the different scenarios?
Calculation of CO_2 emissions	To integrate CO_2 emissions results from software in 3D maps	The SAP evaluation tool developed in T5.1 will be augmented in T5.3 to enable the estimation of the CO2 and energy impacts of different domestic energy efficiency and renewable energy interventions	To integrate inputs and outputs of LEAP, with SEIF, and visualize them in 3D maps	Is the system able to calculate CO_2 emissions? Are the CO_2 emissions in accordance to the expected values? Are you able to redefine the energy mix used to calculate CO_2 emissions?
Calculation of investment and maintenance costs	To integrate RETSCREEN results in a new module of cost-benefit module to compare cost and energy savings	The SAP evaluation tool developed of T5.1 will be augmented in T5.3 to enable the estimation of the cost of alternative domestic energy efficiency and renewable energy interventions	Last version of a cost benefit module to compare cost and energy savings for various energy performance levels, based on RETSCREEN software.	Is the system able to calculate investment, operation and maintenance costs? Are those costs reliable? Are those values useful for urban planning?
Comparison of urban scenarios	An MCDA approach will be developed to enable stakeholders to trade off CO2 emissions /costs and other factors identified as relevant in WP6 , based on CKYL algorithm	An MCDA approach will be developed to enable stakeholders to trade off CO2 emissions /costs and other factors identified as relevant in WP6 , based on CKYL algorithm	An MCDA approach will be developed to enable stakeholders to trade off CO2 emissions /costs and other factors identified as relevant in WP6 , based on CKYL algorithm	
	New module of Benchmarking of energy performance results (kwh/m2) of buildings with existing databases and visualization in 3D of rating			

Appendix D. Evaluation questionnaires

Questionnaires to users and expert domains

The following questionnaire will be applied, by the responsible of each demonstration scenario, to the users and expert domain that participate in the implementation process.

When the interview takes place, the interviewer should investigate the reasons of each response (e.g. whether the expectations of the user are met or not, and why) and ask for possible solutions.

The questionnaire would be also useful to refine the knowledge on the expectations of potential users and on the requirements for the tools.

EVALUATION QUESTIONNAIRE

Name: ____

Organization: ______________________________________

Date: ____

Interest: ____

____

____

The system (or procedure) has the ability to develop alternative scenarios of urban planning					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
The user interface (3D model editor) facilitates the development and definition of alternative scenarios of urban planning					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
The system is able to integrate socio-economic data from different sources					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):

Comments:					
The system is able to assign occupation parameters according to income					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
The system is able to visualize socio-economic data through 3D maps					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
The 3D maps containing socio-economic information are ease to understand					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
The system is able to visualize shadows					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
The visualization of shadows is useful for a preliminary urban planning (e.g. enables the identification of areas with high RES potential)					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
The system is able to generate input files for external energy simulation models					

Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
The system is able to provide a spread sheet with the necessary information to feed an energy simulation model					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
The selected modelling tools are able to calculate energy performance differentiating energy carriers and final energy uses					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
The system is able to provide sound/reliable outcomes at different scales					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
One can identify hot spots of energy performance based on those outcomes					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
The system is able to calculate investment, operation and maintenance costs					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					

The calculated costs are reliable					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
The calculated costs are useful for urban planning					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
The system is able to calculate CO_2 emissions					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
The calculated CO_2 emissions are in accordance with expected values					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
One is able to redefine the energy mix used to calculate CO_2 emissions					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
In general terms, the systems supports decision making and helps to reduce CO_2 emissions in the urban planning domain					

Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					

Additional questions for expert domains

The following questions are addressed for expert's domain, which are expected to be aware of the methodological requirements for the SEMANCO integrated tools.

The system is able to classify land uses according to relevant categories for up- and down-scaling indicators					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
The system is able to keep track of the series of energy transformations across scales. That is, it clearly differentiates energy carriers and primary energy sources across scales.					
Strong agree	Agree	Not apply	Disagree	Strong disagree	Other (specify):
Comments:					
The system provides a method to asses the feasibility and viability of urban planning alternatives.					

Appendix E. Description of Use Case 10 and associated activities

As example of tables of description of Use Case 10 and their corresponding activities, the tables for UC10, A1, and A2 are showed:

Use case 10

Acronym	UC10
Goal	To calculate the energy consumption, CO2 emissions, costs and /or socio-economic benefits of an urban plan for a new or existing development.
Super-use case	None
Sub-use caseUC9	
Work process	Planning
Users	▪ Municipal technical planners ▪ Public companies providing social housing providers ▪ Policy Makers
Actors	▪ Neighbour's association or individual neighbours: this goal is important for them to know the environmental and socio-economic implications of the different possibilities in the district or environment, mainly in refurbishment projects. They use to ask these questions to the municipality ▪ Mayor and municipal councillors: In order to evaluate CO2 emissions impact of different local regulations or taxes
Related national/local policy framework	▪ Sustainable energy action plan (Covenant of Mayors) ▪ Local urban regulations (PGOUM, PERI, PE in Spain) ▪ Technical code of edification and national energy code (CTE, Calener in Spain)
Activities	▪ A1.- Define different alternatives for urban planning and local regulations ▪ A2.- Define systems and occupation (socio-economic) parameters for each alternative ▪ A3. Determine the characteristics of the urban environment ▪ A4. Determine the architectural characteristics of the buildings in the urban plans ▪ A5. Model or measure the energy performance of the neighbourhood ▪ A6. Calculate CO2 emissions and energy savings for each proposed intervention ▪ A7. Calculate investment and maintenance costs for each proposed intervention

Activity A1

Acronym	A1
Super-activity/use case	UC10
Sub-activities	A2, A3, A4
Goal	Define different alternatives for urban planning and local regulations
Urban Scale	Micro-Meso
Users	• The municipality (councilors of urban planning, housing, environment and countryside, …) (stakeholder)

	• Urban planners • Public company of social housing • Owner/promoter of the building (stakeholder) • Neighbor's association (stakeholder) • Consultants and technicians from Engineering and consultancy companies • Supply companies (i.e. supply company of district heating)
Related national/local policy framework	1. Sustainable energy action plan (SEP from Covenant of Mayors) 2. Local regulations • National energy codes (Código Técnico and certificación energética in Spain, DECC 2012 and HECA in UK, and Heat Planning Act, and danish Planning regulation in Denmark)
Issues to be addressed	▪ To define the comparison of different CO2 emissions scenarios of urban planning, according to local energy requirements acts and/or Plans, in order to select the most efficient urban planning alternative in next steps. ▪ To select a set of technologies, and local regulation in order to evaluate their CO2 impact 3. To select different scenarios to evaluate the socio-economic impact of different measures 4. To define alternative building performance levels in order to calculate scenarios of improvement of energy efficiency

Input Data			
Name	**Description**	**Domain**	**Format**
Local regulations and requirements	Local regulations related to Energy Efficiency, RES, and CO2 emissions, as well as Local Urban regulation that can affect to de different proposals to implement	Energy efficiency Urban planning	Maps, and technical requirements
List of objectives from different users	List of scenarios of energy performance, energy supply, and/or urban planning measures, and their technical pre-proposed and socio-economical requirements	Energy efficiency Urban planning	Documents

Expected Output data		
Name	**Description**	**Generated by Tool?**
Geometry and architectural and context of the overall objectives and scenarios	3D maps, and context and objectives of the different scenarios to be evaluated	3D maps generation tool and SEIF
Indicators and calculations to generate	List of indicators and calculations to be carry out in the different scenarios	SEIF

Acronym	A2
Super-activity/use case	A1/UC10
Sub-activities	A5
Goal	Define systems and occupation (socio-economic) parameters for each alternative
Urban Scale	Micro-Messo
Users	5. The municipality (councilors of urban planning, housing, environment

	and countryside, …) 6. Urban planners and architects 7. Public company of social housing 8. Private urban promoter 9. Associations of neighbours
Related national/local policy framework	10. National energy codes 11. National electricity and or heating codes, and national statistics databases
Issues to be addressed	Integrate socio-economic and comfort information in order to achieve these different objectives: . ▪ To classify domestic buildings according to their SAP rating (UK) and to their parameters (Spain and Denmark) ▪ To visualize in 3D Maps ▪ To generate input to next calculations of energy performance and of buildings and supply systems ▪ To generate reference building typology and advanced building typology for the different scenarios (Denmark) The following parameters would be valued according to the socio-economic conditions of different building typologies ▪ Occupancy (time that inhabitants are in the building) ▪ HW profile ▪ Power capacity of appliances, utilization factor and efficiencies ▪ Comfort conditions (temperature set point) ▪ Efficiency of HW, AC and heating systems ▪ Fuel poverty (UK) ▪ Estimated Heating and cooling demand of typologies of buildings (Denmark)

Input Data			
Name	**Description**	**Domain**	**Format**
MANRESA DEMONSTRATION SCENARIOS			
Time uses	Profile of occupancy. Number of total hours spent in the household by the inhabitants or user in other type of buildings	Socio-economic data (time use survey)	.xls
HW profile	Profile of sanitary hot water use, according to typologies or socio-economic classification	Socio-economic data	.xls
Power capacity	Power capacity of appliances and their utilization factor, according to household typologies or socio-economic classification	Socio-economic data	.xls
Conform conditions	Temperature set point within the building. According to typologies or socio-economic classification. This would be a proxy variable of socio-economic conditions as well.	Socio-economic data	.xls
Efficiencies and costs	Efficiency of sanitary hot water, air conditioned and heating systems, and fuel	Socio-economic	.xls

	types and costs. According to typologies or socio-economic classification	data and building parameters	
NEWCASTLE DEMONSTRATION SCENARIO			
Fuel Poverty Statistics for LLSOA	Sub level fuel poverty statistics 2010	Gov. stats	.xls/dbf
LSOA Code	Lower Layer Super Output Area (LSOA) code	Gov. stats	.xls/dbf
LSOA Name	Name of LSOA	Gov. stats	.xls/dbf
LA Code	Local authority 4 digit code (consistent with ONS geography)	Gov. stats	.xls/dbf
LA Name	Name of local authority	Gov. stats	.xls/dbf
Parliamentary Constituency Code	3 digit code for 2010 parliamentary constituencies	Gov. stats	.xls/dbf
Parliamentary Constituency Name	Name of parliamentary constituency	Gov. stats	.xls/dbf
County	County name	Gov. stats	.xls/dbf
English Region	English Region	Gov. stats	.xls/dbf
Estimated number of households	The number of households in the corresponding geographical area (modeled)	Gov. stats	.xls/dbf
Estimated number of households in fuel poverty	The number of households in the corresponding geographical area that were in fuel poverty in 2010 (modeled)	Gov. stats	.xls/dbf
% of households fuel poor	The proportion of households in the corresponding geographical area that were fuel poor in 2010	Gov. stats	.xls/dbf
NORTH HARBOUR DEMONSTRATION SCENARIO			
RES AVAILABLE	Availability of RES in the Area	National Maps and climate data	.xls
HW profile	Profile of sanitary hot water use, according to typologies or socio-economic classification	Socio-economic data	.xls
Power capacity	Power capacity of appliances and their utilization factor, according to household typologies or socio-economic classification	Socio-economic data	.xls
O&M ,and fuel costs of supply technologies	O&M costs of different energy supply technologies according to national standards	Socio-economic data	.xls
Efficiencies	Efficiency of sanitary hot water, air conditioned and heating systems. According to typologies or socio-economic classification	Socio-economic data and building parameters	.xls

Expected Output data		
Name	**Description**	**Generated by Tool**
MANRESA		
Building model	Additional parameters of the typology model based on the information required by the chosen calculation methodology (Parameterization of profile of occupancy, profile of sanitary hot water consumption, power use of electrical appliances, profile of set point temperature, and efficiencies of AC/heating systems)	SEIF
NEWCASTLE		

LLSOA Fuel poverty map	Geo-referenced data showing the percentage of people in fuel poverty in each LLSOA in the relevant geographical area displayed on Agency 9 3D maps	An add on developed using for agency 9s 3D maps, developed as part of T5.1
NORTH HARBOUR		
Costs , savings and carbon emissions analysis of supply technologies	the analysis of production costs, carbon emissions and supply potential for different energy supply technologies in order to select the most suitable one	SEIF , followed by calculation with RETSCREEN