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SEMANCO

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DoW	This task will test and validate the tools developed in T5.1, T5.3 and T5.4 and link them to the semantic framework developed in WP4 whenever feasible. This task is going to effectively link the tools with the semantic framework so that data- from simulations, evaluations, visualisations, and analysis- for testing and validating the tools that are developed in this work package, will be exchanged with the semantic framework developed in WP 4. Existing IT solutions and tools; including underlying methodologies, calculation and simulation formulas, optimisation and visualization features; will be analysed and evaluated to provide input for the technological solutions, integrated through the Semantic Energy Information Framework. In particular, two external tools will be integrated in the platform: URSOS. The URSOS software –developed by the University of Zaragoza, UNIZAR, Spain– performs the calculation of the energy performance of an urban area with similar degree of detail than that used in the definition of the Derivative plans. Currently, URSOS is a stand-alone software with a user interface that enables users to introduce parameters for buildings in a given area. URSOS will be integrated to SEMANCO platform as a batch process. This work will be subcontracted to UNIZAR.				
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EXECUTIVE SUMMARY

This report is a summary of the work undertaken and the results achieved in Task 5.5 *Interoperability of tools with the semantic framework*. The goal of this task is the integration of external tools in the SEMANCO platform.

Integrating external tools within the SEMANCO platform implies access to distributed data sources. These are integrated by means of semantic technologies, involving interoperability issues which concern the communication among the data, and between the data and the tools that operate with them. Industry standards; such CityGML and IFC; address these interoperability issues by providing comprehensive data models that cover specific domains (e.g. city, building). Those tools which need to operate with data models based on these industry standards, need to adhere to them. These 'all-embracing standards' data models can include data from other domains by means of some extension mechanisms. However, these extensions are not always flexible enough. In some cases, data from multiple domains and applications will need to interact with a variety of tools in different contexts and over extended periods of time. This lack of flexibility can be overcome with an alternative approach based on Semantic Web technologies. In principle, these would provide the required flexibility to create and maintain open and distributed data models. They incorporate data from various domains and applications while assuring the interoperability of the data with a set of tools over time.

In the SEMANCO project, semantic web technologies have been applied to create open semantic data models. These consist of distributed data from multiple sources and domains which communicate with energy assessment tools. The data sources are interlinked by means of shared vocabularies (e.g. ontologies) and accessed through the Semantic Energy Information Framework which "knows" where the data is stored.

The purpose of the work carried out in this task has been to empirically demonstrate the feasibility of using semantic web technologies to facilitate the communication between semantically modelled data obtained from multiple sources and existing energy simulation tools. With this purpose, an urban energy simulation software application named URSOS – developed by the University of Zaragoza – has been integrated as a tool in the SEMANCO platform. The resulting integrated tool has been applied to the demonstration cases carried out for the city of Manresa.

URSOS has been transformed into a service which is invoked from the platform. The input parameters required by the simulation engine were obtained from the 3D model of the urban area visualised in the SEMANCO platform. This used parameters from the 3DMaps software together with queries against the distributed data sources handled by the Semantic Energy Information Framework (SEIF) previously developed in the project. The outputs produced by the URSOS calculation engine are stored in the platform as a new data layer. It is linked to other data through the SEIF.

One of the main challenges faced in the implementation of this tool has been the need to transform and simplify the 3D models of building representation to be understandable by the simulation engine. This task has raised questions concerning the feasibility of the distributed approach and the use of semantic technologies to solve the communication between an open set of data and the applications that could interact with it.

1 INTRODUCTION

1.1 Purpose and target group

This report presents the work carried out in Task 5.5 *Interoperability of tools with the semantic framework.* The purpose of this task has been to empirically demonstrate the feasibility of using semantic web technologies to address the interoperability between semantically modelled data, obtained from multiple sources, and ICT tools to assess the energy performance of urban areas. At the outset, interoperability needs to be distinguished from open standards such as IFC or CityGML. Even though the goal in both cases is to assure the effective communication between computers systems (data, applications), open standards (e.g. CityGML, IFC) aim at securing it right from the start – anticipating or even preventing communication problems. Interoperability solutions, on the other hand, can be developed ad hoc and a posteriori to solve a particular problem among specific systems.

Data models based on established open standards can be extended to embrace other domains which were not taken into account at the model creation. For example, IFC provides Model View Definitions (MVD) to create subsets of the IFC schema, and CityGML has developed Application Domain Extensions (ADE) to integrate data which was not considered in the standard. However, these extensions based on an all-embracing standard are not flexible enough in certain cases where data from multiple domains and applications needs to interact with a variety of tools over extended periods of time. An alternative approach based on Semantic Web technologies can provide the required flexibility to create and maintain models which incorporate data from various domains and applications in order to ensure the interoperability of the data with a set of tools over time. Such semantic-based data models combine the data-centred approach adopted by the open standards with the open demands of interoperability.

To verify the feasibility of this semantic-based solution to interoperability, URSOS – Urban Planning and Sustainability, an existing software to simulate the energy performance of urban areas – has been integrated in the SEMANCO platform. By means of semantic technologies (i.e. SPARQL queries), the URSOS calculation engine has been fed with data from different data sources (e.g. cadastre, census, building typologies) via the Semantic Energy Information Framework (SEIF) previously developed in the SEMANCO project.

The target groups for the work presented in this document are technical teams responsible for integrating new tools into the SEMANCO platform and developers of extensions for standardised data models.

1.2 Contribution of partners

The work carried out in Task 5.5 has been led by FUNITEC. The interface of the URSOS tool with the SEMANCO platform has been developed by FUNITEC. CIMNE and FORUM have collaborated in the identification of the input values gathered from the data sources and in the later processing of those inputs by the URSOS energy simulation software. An adaptation of URSOS to facilitate its integration in the SEMANCO platform has been commissioned with its developers, the University of Zaragoza.

This report has been jointly elaborated by FUNITEC, CIMNE, and FORUM. The internal review has been carried out by Nadeem Niwaz from Ramboll and Tomas Karlsson from Agency9. A final proof-reading has been carried out by Michael Crilly from Teesside University.

1.3 Relations to other activities in the project

The integration of URSOS in the SEMANCO platform enables users to carry out energy simulations using the data from distributed sources which are combined through the Semantic Energy Information Framework (SEIF). The work carried out is mostly related to the activities of WP5 *Integrated Tools*, and in particular to Task 5.4 *Prototype of the integrated platform* and Task 5.6 *Integrated platform* which are dedicated to the integration of the various tools in the SEMANCO integrated platform.

The specifications of the integration of URSOS have been derived from the activity forms which are part of the use case methodology introduced in Deliverable 1.8 *Project Methodology*.

The integration of URSOS is based on accessing the data sources using the SEIF interface which is described in detail in Deliverable 4.4. *Interfaces with external tools*. Through this interface, the URSOS tool is connected to the ontology repositories –and the data sources stored in them– which have been described in Deliverable 3.4 *Ontology repository with migrated data*.

The demonstration scenarios carried out in WP8 *Implementation* are closely related to the work reported in this document since the URSOS tool is used to perform energy simulations in the Manresa case study.

2 SEMANTIC-BASED INTEROPERABILITY

The Institute of Electrical and Electronics Engineers (IEEE) provides a definition of interoperability as "*(t)he ability of two or more systems or components to exchange information and to use the information that has been exchanged*" (IEEE 610.12-1990, 1990). On the other hand, the ISO/IEC 2382-01 describes interoperability as "*The capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units*" (ISO/IEC 2382-01, 1993). Accordingly, interoperability is a matter of facilitating the exchange of information across systems by means of protocols and exchange formats.

However over the last few decades, information technology has evolved from closed and stand-alone systems, to heterogeneous and loosely coupled systems distributed on the Web. At the same time, semantic web technologies have been developed with the purpose of adding meaning to the purely syntactic information. Both the increase of looseness of coupling and the need for semantic explicitness have been growing in parallel (Obrst, 2003). Semantic web technologies are applied to integrate rather than exchange data from multiple sources and domains. This integration of data via shared vocabularies (e.g. ontologies) has given rise to a "semantic interoperability" by which; in contrast with the previous "syntactic" interoperability; the data shared across systems is already endowed with meaning that facilitates the communication between them.

Semantic-based interoperable solutions can contribute in making the communication among systems, and between systems and data sources more effective. As stated by Salvatore & Fernandez-Llatas (2012), a semantic interoperability model improves the common interoperability models by facilitating the interpretation of the meaning of the data. Semantic interoperability models, with explicit semantics, can ensure that the meaning of data can be comprehended unambiguously by both humans and systems (Manafov et al., 2013). According to Barnickel (2011), semantic interoperability cannot rely on a common ontology that covers multiple domains but instead requires a mechanism of semantic mediation, based on domain ontologies and description logic rules, which would act as a nexus between independent domain information models and loose coupling systems.

There are precedents in different domains in which interoperability problems have been addressed using semantic technologies. In the public sector, for example, Barnickel et al. (2006) developed a tool to be used in eGovernment scenarios to support the design of data flows between semantic web services based on different ontologies. In the business sector, the interoperability across business information systems has been addressed by Zdravković and Trajanović (2011), who developed an architecture for implementation of the Semantic Interoperability Services Utilities formalized in the S-ISU ontology. In this way, companies might implement shared business functions which are described by the ontology and facilitated by the shared semantic applications. In the health domain, Mendes and Rodrigues (2012) proposed a semantically annotation method for automatic acquisition of computer-based patient records (CPR) from the medical history using ontologies.

2.1 Interoperability and standard data models

At the outset, interoperability needs to be distinguished from open standards such as CityGML and IFC. Even though the goal in both cases is to assure the effective communication between computers systems (data, applications), open standards try to guarantee it from the start, anticipating and preventing the communication problems. Interoperability, on the other hand, can be developed ad hoc and a posteriori to solve particular problems between specific systems.

2.1.1 CityGML

The City Geography Markup Language (CityGML) is a common information model for the representation of 3D urban objects. CityGML – an official standard of the Open Geospatial Consortium (OGC) since 2008 (Gröger et al., 2008) – has become a de facto standard widely accepted by the geospatial industry. Two of the main CityGML features, multi-resolution representation of virtual 3D city models and a rich semantic model with well-defined meanings of the geometric information, ensure the interoperability between tools and services. A CityGML-based 3D model can be used to exchange information between architects, urban planners, and construction companies (Gröger & Plümer, 2012).

The interoperability between tools and services is solved in the CityGML context by exchanging data structured with the agreed CityGML standard model. That is, a tool that needs to communicate with another tool or system. It does this by importing / exporting a CityGML model. Domains that are not covered by CityGML can be modelled by means of Application Domain Extensions (ADE). An ADE dedicated to energy which includes a set of indicators for modelling energy consumption of buildings, utility infrastructure distribution and capacities, and power stations is currently under development (Krüger & Kolbe, 2012).

2.1.2 Industry Foundation Classes (IFC)

In the Architecture, Engineering, and Construction (AEC) sector, the interoperability between professionals and tools is supported by BuildingSMART technologies: IFC, IDM and MVD.

Industry Foundation Classes (IFC) is a data model developed by the International Alliance for Interoperability (IAI) to support data exchange in the AEC sector. IFC provides a set of concepts (classes, attributes, relationships, property sets and quantity definitions) to represent a building and its components. It has been designed to exchange building information over the whole building life-cycle. The IAI is continuously improving the data model by releasing new versions which contain new classes and properties that enable enhanced interoperability among applications in the AEC industry. The last release of the IFC model is the version IFC4 (formerly IFC2x4) (BuildingSMART, 2013).

The Information Delivery Manual (IDM) defines what information must be in the data exchange between professionals and tools, thus the business rules applicable to that data are included.

Model View Definitions (MVD) express a subset of the IFC Schema providing implementation guidance for all IFC concepts (classes, attributes, relationships, property sets and quantity definitions among others) used within this subset. MVD describe the information exchanges defined in one or more related IDMs. Although IDM and MVD technologies can facilitate interoperability, loss of data has been reported as a problem (Carvalho & Scheer, 2012).

Similar to CityGML, IFC is an open standard which can help to solve a priori interoperability problems between tools, applications and services; and a posteriori through the extensions of the standards (ADE in the case of CityGML, MVD in the case of IFC).

2.2 Open semantic data models

Both standard data models – CityGML and IFC – overcome interoperability issues by assuming the existence of a “unique” and “virtual” data model (the one captured by the standard) which is shared and agreed by a community of users and reinforced by the industry. Afterwards, what is not captured in the original model is incorporated via extensions of the standards. An alternative approach comes from the Semantic Web and the Linked Open Data initiatives.

Previous research work has attempted to incorporate Semantic Web technologies into standard data models, CityGML and IFC. Métral et al. (2010) presented a set of case studies (air quality and cultural heritage) demonstrating how ontologies could go beyond the semantic limitation of the CityGML data models to improve interoperability. To demonstrate it, they generated some semantic links between the Ontology of Urban Planning Process – developed by the authors – and CityGML. Katranuschkov et al. (2003) created an ontological framework to access data in IFC format and retrieve product data from a repository using ISO STEP specification and ifcXML.

In the SEMANCO project, semantic web technologies have been applied to create open semantic data models consisting of data from multiple sources which communicate with energy assessment tools (Figure 1). Ontologies assure the interoperability in two ways:

- the interoperability among data from multiple domains, sources and applications. This data exchange is controlled by the Semantic Energy Information Framework (SEIF), which “knows” not only the meaning of the data but where the data is stored.

- the interoperability between the data semantically modeled and the tools that interact with them.

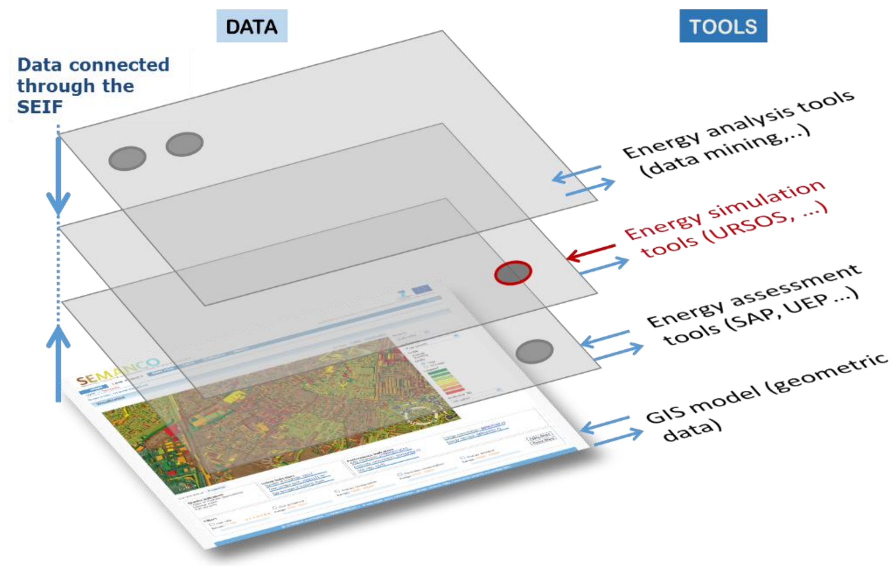

Figure 1. Interoperability data/tools controlled through the SEIF

In this open semantic model, the different layers of data obtained from multiple sources are interlinked to each other via the shared vocabulary (e.g. ontologies). Here, a polygon in a 3D model “knows”, for example, its relation to the information facilitated by the different data sources such as the cataster, census or climate data. This semantically modelled data also “knows” with which tools it can interact, for example, to perform an energy simulation. The access to the data and tools takes place within the SEMANCO integrated platform. This enables end-users to apply a variety of tools upon the semantic data is available for a given urban energy model.

The work reported in the following sections describes the implementation of this concept with the example of the URSOS software interacting with the multiple data sources used in the Manresa case study.

3 SOFTWARE TOOL INTEGRATION: URSOS

Urban Planning and Sustainability (URSOS) is a software tool for assessing and comparing the energy and environmental performance of buildings in an urban area. It has been developed by the Grupo de Energía y Edificación, from the University of Zaragoza (Spain). The program simulates the thermal behaviour of buildings or residential areas according to climate conditions, thermal characteristics of enclosures, ventilation rates and volume (see Deliverable 5.1 *Building Extraction and Classification Tools* for further detailed information). The aim of URSOS is to provide an energy analysis method that allows urban planners to optimise energy demands for a group of buildings. It provides results at different scales. It aggregates the individual performance of buildings and calculates the energy performance of the target urban area. This is germane as the assessment of the energy performance at different levels is also a key issue to be considered in the selection of the tool (See Deliverable 2.3 *Impact verification*).

URSOS has a user-friendly interface to introduce inputs needed for the calculations. However, as it was evident during the first demonstration scenario, introducing the required data can be a very time consuming task (See Deliverable 8.2 *Implementation Success Indicators*). Moreover, URSOS does not provide an interface to introduce inputs from 2D or 3D urban models. Therefore, to link this tool with the data facilitated by SEMANCO platform, the input parameters (e.g. geometry, urban conditions, climate, building energy properties and energy systems, among others) have to be provided in a proprietary file formatted in XML.

In the project of SEMANCO, we have used the calculation engine of URSOS to incorporate an energy assessment tool in the SEMANCO platform. The URSOS tool has been upgraded by the University of Zaragoza in order to let the calculation engine work as a "service". In this way, the input parameters do not have to be introduced manually but can be automated through an input XML file. To perform the energy simulations, URSOS requires different types of data inputs (geometric, structural and occupation) which need to be retrieved from different data sources such as the GIS model of the city, the cadastre, the census and the official statistics, among others. This link between the URSOS tool and the dispersed data is provided by the SEIF.

The guidelines to generate the XML input file have been compiled by the domain experts in the activity forms (see APPENDICES A, B, and C) in accordance to the specifications contained in the activity forms created for the use case for which an energy simulation of an urban area is required (see Deliverable 1.8 *Project Methodology*). The activity forms also contain precise instructions for the retrieval of data from the sources and its processing to create the file that URSOS will use as input to perform the calculations.

3.1 Adopted solution

The SEMANCO integrated platform is the environment in which the end users interact with the tools which, in turn, access the semantically modelled data. The semantic energy information framework (SEIF) connects the data required by the tools with the users and the tools. External tools can be integrated in the platform in different ways, depending on the characteristics of the tools' interface. In the case of URSOS, it has been possible to execute it as a batch process, using an XML file as input data. This contains all the data needed to carry out the energy simulation. The input file is filled with the data retrieved from the SEIF using SPARQL queries.

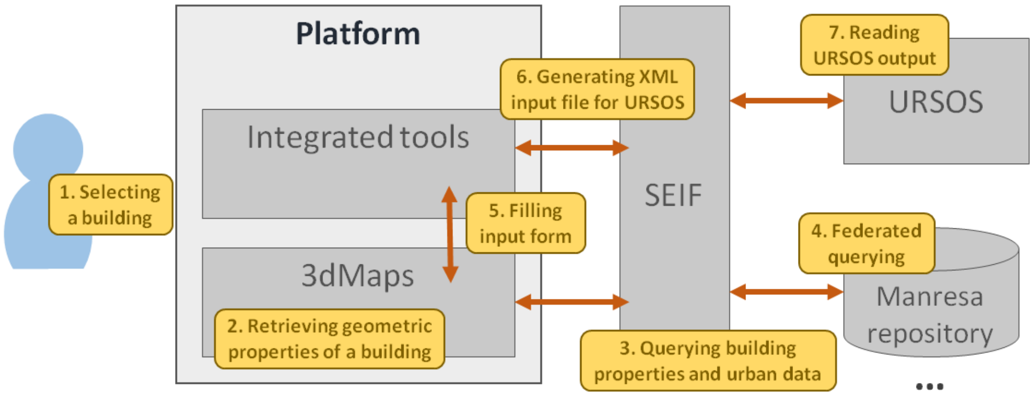

Figure 2. Workflow of the integration of URSOS

The energy simulations are carried out by the URSOS engine following a workflow (Figure 2). Steps 1 to 5 are the same in any other external tool integrated in the platform. Steps 6 and 7 are specific to URSOS since those steps generate the input file and read the output file produced by URSOS.

The description of each procedural step is as follows.

3.1.1 Step 1. Selecting a building

The building selection happens in the integrated platform interface. It can be achieved by selecting a model in the 3D representation (Figure 3) or by selecting the building from a list. Buildings can be identified by a specific ID provided by the cadaster data source and also by an identifier provided by the 3D model. In this manner, each building has a unique ID used in the 3D model and another one to query the urban data through the SEIF. Once a building is selected, a data entry form is shown to the user. This form is already completed with the data from the sources through the SEIF.

Figure 3. Building selection in the Platform interface

3.1.2 Step 2. Retrieving geometric properties of a building

The aim of the second step is to retrieve the geometric properties of a building from 3DMaps, the graphic engine responsible for representing the city in 3D. Each building has a unique identifier which is used to hold the geometric properties using the 3DMaps SDK API methods. These properties are introduced in the data entry form. The other fields of the form (i.e. wall-u value, occupancy and system parameters, among others) are filled in the steps 3, 4 and 5 of the workflow.

3.1.3 Step 3. Querying building properties and urban data

In the third step, SPARQL queries are executed to retrieve the specific data that URSOS requires. To do this, the parameters corresponding to the type of building selected, are obtained following the sequence below:

1. Obtain "year" of construction of the building;
2. Have "age class" of that year of construction;
3. Query for the specific parameter of the building typology.

The first two queries run one time only and the third one repeats itself for each parameter. The first step of this process is undertaken using the cadaster ID of the selected building to retrieve the year of construction (Figure 4). The cadaster ID value is in the variable of *$cadref* and the year of construction is obtained in the variable of *?year*.

```
PREFIX sumo: <http://www.ontologyportal.org/SUMO.owl#>
PREFIX semanco: <http://www.semanco-project.eu/2012/5/SEMANCO.owl#>

SELECT DISTINCT ?year
WHERE {
        ?b      a sumo:Building;
                semanco:hasAge [semanco:year_Of_ContructionValue ?year];
                semanco:hasBuilding_Cadastral_Data [
                        semanco:hasCadastral_Reference [
                                semanco:cadref1Value ".$cadref."]].
}
```

Figure 4. Query to retrieve the year of construction

With the year of construction (?year, in Figure 3) the age class can be queried with the SPARQL query shown in Figure 5. The age class of the building is in the *?age* variable, the variables *?to* and *?from* contain the starting and the ending year of the class (i.e. 1941-1960), and the year of construction is in the variable *$year_of_construction*. The filter clause is used to select the proper building typology of the Manresa source since other typologies in other cities may exist.

```
PREFIX sumo: <http://www.ontologyportal.org/SUMO.owl#>
PREFIX semanco: <http://www.semanco-project.eu/2012/5/SEMANCO.owl#>

SELECT DISTINCT ?age ?to ?from
WHERE {
        ?age    a semanco:Age_Class ;
                semanco:hasTo_Year [semanco:toYearValue ?to ].
                semanco:hasFrom_Year [semanco:fromYearValue ?from ].

        FILTER (?to >= '.$year_of_construction.' || ?to= "-" ) .
        FILTER (?from <= '.$year_of_construction.' || ?from = "-" ) .
        FILTER REGEX(?age, "manresa") .
}
```

Figure 5. Query to retrieve the age class of a building

In the Manresa data repository, building typologies are identified by year class or the income class. For example, it is possible to retrieve the typology properties using the age class. Figure 6 shows another example of a SPARQL query used to retrieve the u-value of the roof. The age class is in the variable *$age_uri* which is used as an URI to select a specific RDF triple. The u-value of the roof is obtained in the variable *?uvalue*. Other properties, such as the thermal comfort, can be obtained using the income class instead of the age class.

```
PREFIX sumo: <http://www.ontologyportal.org/SUMO.owl#>
PREFIX semanco: <http://www.semanco-project.eu/2012/5/SEMANCO.owl#>

SELECT DISTINCT ?uvalue
WHRE {
        ?b      semanco:hasSpace [
                        semanco:hasCS_Envelope [
                                semanco:hasHorizontal_Superior_Enclosure [
                                        semanco:hasRoof ?roof]]] ;
                semanco:hasAge <'.$age_uri.'>.
        ?roof   a sumo:Roof;
                semanco:hasRoof_U-value [
                        semanco:roof_U-valueValue ?uvalue] .
}
```

Figure 6. Query to retrieve the roof u-value

The other fields of the data entry form of URSOS are filled following the pattern described above.

3.1.4 Step 4. Federated querying

The SEIF receives the queries from the platform in SPARQL language. The core of the SEIF is the federation engine which analyses the input queries and send them to the corresponding data sources. The data sources are SPARQL endpoints which can response to queries which ask for data that they can understand. Thus, the federation engine processes the queries to adapt them to the target endpoint. If the data asked by the query is distributed in different sources, the federation engine will send a piece of the query to every data source that could provide a response. Once the federation engine has obtained all the data needed by the input query it sends them back to the platform. A technical explanation of the federation engine can be found in Deliverable 4.5 *Semantic Energy Information Framework*.

3.1.5 Step 5. Filling input form

The platform receives the data from the SEIF and the input form is filled with that data. Users can manually modify the input fields of the form, amending the values according to what they can see in a picture of the building (retrieved from Google Street View service) and informed by specific knowledge they have about the building. In this way, the user can amend or complement the automatic inputs obtained from the platform.

3.1.6 Step 6. Generating XML input file for URSOS

The input file required by URSOS – formatted in xml – is generated with the values obtained from the data input form. The input file contains the following information:

- **Urbanisation**: Description parameters of the file such as name, location, region of the city.
- **Climate**: Climate values for a typical year in the city. Temperature, radiation, and water temperature for each month.
- **Drawing area**: Dimensions (width and height) to fit all the elements to be simulated.

- **Horizon**: Horizon profile; the skyline made from distant geographic and urban elements, seen from the centre of the target urban area. This skyline is represented by a set of points indicating the azimuth and angle with respect to the south.
- **Indicators**: Urban indicators such as number of shops, pubs, hospitals, among others. These indicators are set to default values.
- **Plots**: Plots, this element is not taken into account.
- **Trees**: Trees, this element is not taken into account.
- **Streets**: Streets, this element is not taken into account.
- **Buildings**: Buildings which will be simulated, containing the footprint and the energy parameters for every surface.
- **Obstacles**: Other models (e.g. adjacent buildings) which can cast shadows on the selected buildings.
- **Bus stops**: Bus stops, this element is not taken into account.
- **Garbage containers**: Garbage containers, this element is not taken into account.

3.1.7 Step 7. Reading URSOS output

The URSOS engine performs the energy simulation and produces an output file (also in xml format). This output file contains the following information for every building that is considered in the target urban area:

- Monthly energy demand for heating and cooling.
- Monthly direct and indirect solar radiation on the building envelope.
- Other energy related information used for intermediate calculations (energy loses, solar heat gains, among others).

This information, together with additional information defined by default and / or by the user, is the baseline for calculating a set of energy performance indicators. The procedure is as follows:

- The monthly energy demand for heating is aggregated in order to obtain the yearly energy demand. This energy demand is supplied by primary and secondary heating systems, each one covering a defined surface of the building. Primary and secondary systems operate with specific energy carriers (i.e. electricity, natural gas or gasoil) and and provide different levels of efficiency. With this data, the platform calculates the energy demand according to the heating system and the energy carrier.
- With the information on energy demand and the CO_2 emissions factor of the corresponding energy carrier, the CO_2 emissions of the primary and secondary heating systems are calculated.
- A similar procedure to calculate the energy demand and CO_2 emissions for the cooling system is applied. In this case only a primary cooling system is considered.
- The energy demand is aggregated according to the different energy carriers. The result of this aggregation is used to calculate the cost of the energy bill for every building.
- The monthly solar radiation on the roofs is aggregated to obtain the yearly solar radiation. Afterwards, the potential electricity generation from solar PV panels is calculated by assuming a percentage of the roof surface to be covered by solar panels.
- Based on information about the occupation of the building, the energy demand for the

primary and secondary domestic hot water system is calculated. The CO_2 emissions and the cost of the energy bill are also calculated.

In this way, the following indicators on energy performance are calculated for every building within a target urban area:

- The demand of energy carriers (i.e. electricity, natural gas or gasoil) according to the final energy use (i.e. primary and secondary heating systems, cooling system and primary and secondary domestic hot water systems).
- Electricity consumption of domestic appliances. These values are derived from the household incomes provided by national statistics.
- The direct and indirect CO_2 emissions from the primary and secondary heating systems, from the cooling system and from the primary and secondary domestic hot water systems.
- The energy bill for every energy carrier.
- The potential electricity production from solar PV panels.

Indicators are calculated for every building and aggregated to obtain the energy performance of the target urban area, which are then presented on the integrated platform.

3.2 Simplification of the inputs

It has been necessary to make some simplifications to the geometric information extracted from the Manresa 3D model in order to facilitate the communication with the URSOS calculation engine.

3.2.1 Simplification of the geometric inputs

URSOS was originally conceived to be used for the energy assessment of new urban developments, especially in urban plans where the same buildings are repeated and spread through the development area. In addition, URSOS considers that buildings are simple volumes which can be the result of subtracting or adding other volumes (see Figure 7).

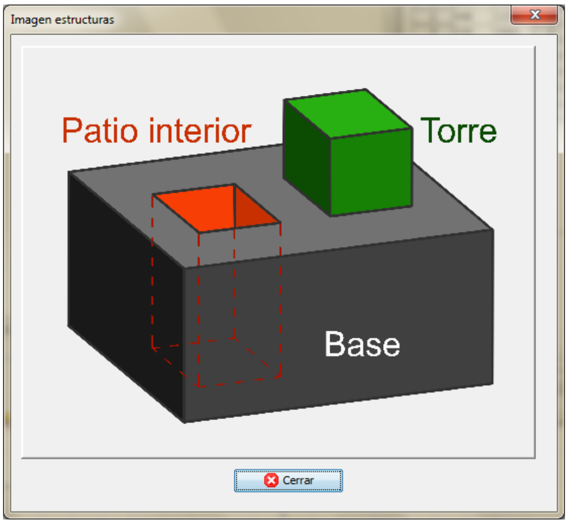

Figure 7. Possibilities for the creation of buildings within URSOS software

Therefore in order to carry out the required calculations, URSOS needs as input, a simplified geometry of a building. In the outset, this requirement of the tool has caused problems since the GIS model of Manresa – which was used to build the 3D model in 3DMaps – consisted of complex shapes which were extruded to create the model afterwards (see Figure 8).[1]

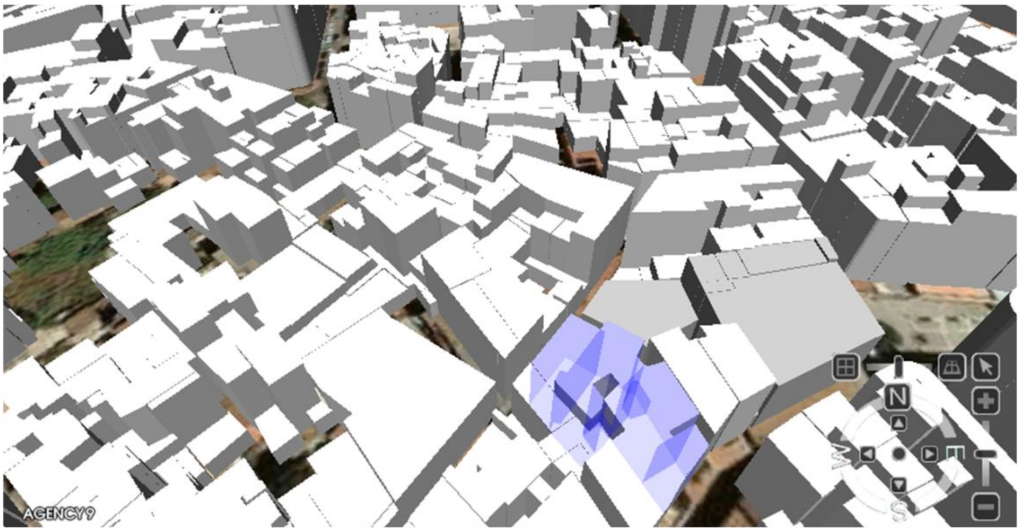

Figure 8. Buildings of the Manresa 3D model in the SEMANCO platform

Restoring the integration of the building volume

The 3D model of Manresa has been generated by extruding polygons; visualised using 3DMaps; to the height derived from the number of stories. In the Manresa GIS 2D model, which has been the base when generating the 3D model in the 3DMaps visualisation engine, a building is usually made of more than one polygon (due to changes in height in the different volumes that form a building). To restore the integrity of the building representation in the 3D model, polygons belonging to the same building have been assigned an identifier to group them. In this way, by selecting a polygon in the 3DMaps model, the user is able to choose all the polygons belonging to the same building.

Enclosing multiple volumes in a single envelope

In the first demonstration scenario, in which URSOS was used “manually” as a stand-alone application, it was proved that calculation of complex volumes (made of aggregated volumes with openings or courtyards) gave rise to slow calculations which often made the software crash. For instance, Figure 9 shows a building that URSOS is unable to model with the available modelling options of the software (creating courtyards and adding towers).

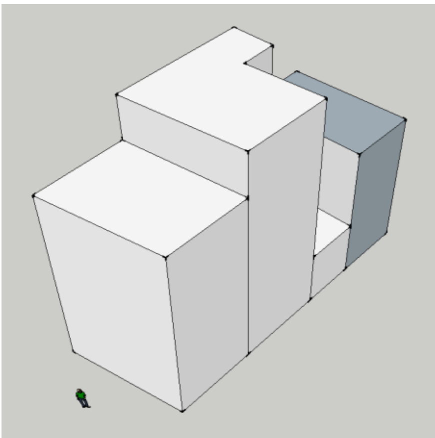

Figure 9. Building set to evaluate impact of geometric simplification in calculations

Three options were considered to simplify cases as the one shown in the previous example:

[1] It should be noticed that, despite this limitation of the URSOS software, we have prioritised its ability to consider mutual casting of shadows in the calculation of energy performance of buildings.

1. A "new simplified shape" which results from transforming the original building into a new one by changing the height so that the total constructed surface remains the same (Figure 10).

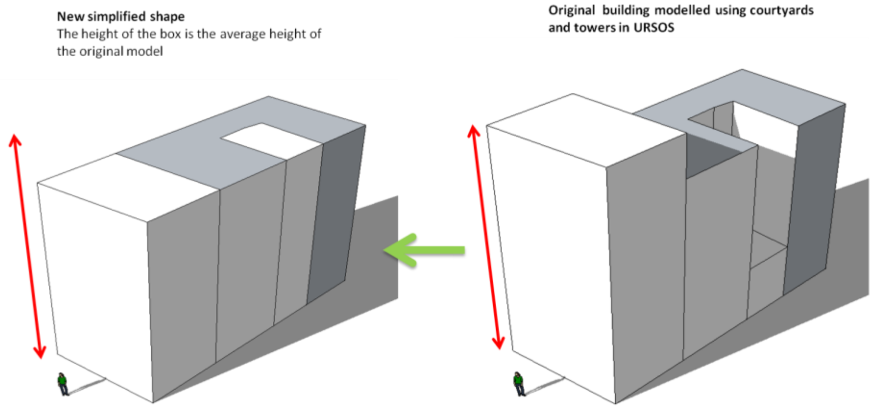

Figure 10. New simplified shape

2. A "bounding box" which encloses all the volumes of the building (Figure 11).

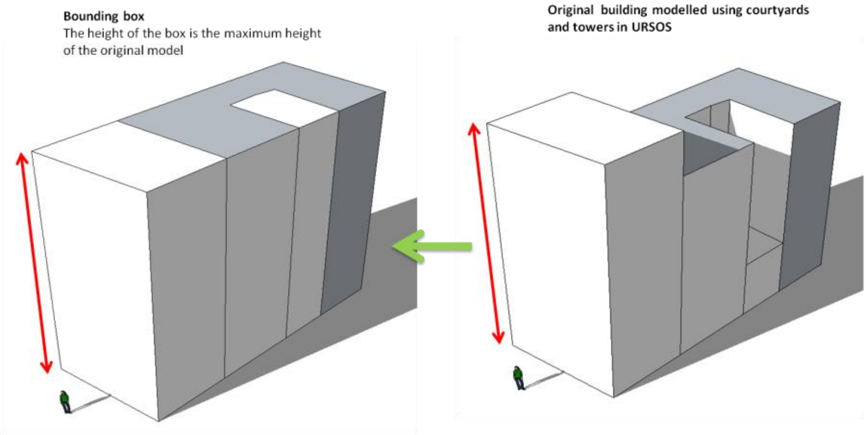

Figure 11. Bounding box shape

3. A "building broken down in pieces" so that every volume is calculated as a detached building and the outputs are aggregated after the calculation (Figure 12).

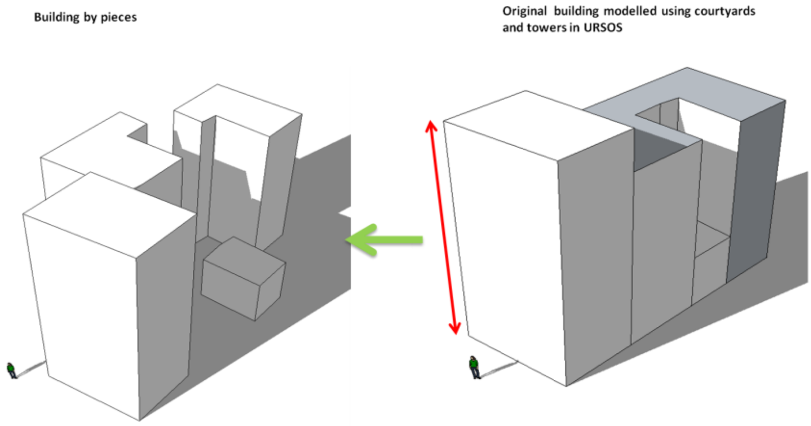

Figure 12. Building by pieces

The results of the tests were that the third option provided almost the same results as the reference model. However, this third option could not be applied since URSOS cannot understand cases in which a building is inside another building (i.e. an extruded polygon within an extruded polygon) (Figure 13). The number of occurrences of this kind in the Manresa urban morphology is large enough as to discard using this option.

Figure 13. Example of "building inside building"

In the evaluation of the other two options, the first one was selected. The "New simplified shape" provided results that were closer to the reference building outputs, as it better approximates the built volume of the original building. Therefore, the real energy needs for heating and cooling - collectively the most important energy consumption indicators- are closer to the original case.

3.2.2 Defining wall values

As it has been explained in previous sections, wall attribute values (transmittance, sun reflection, % of openings) are assigned according to already existing data (mainly year of construction), and type of wall. Two different types of walls have been considered: facades and dividing walls (described as a GIS shape file made of lines). Both wall types can be covered or uncovered by an adjacent building. All of these data is already in the 3D model or can be extracted from it and is related to external databases to determine the final values for every parameter (Figure 14).

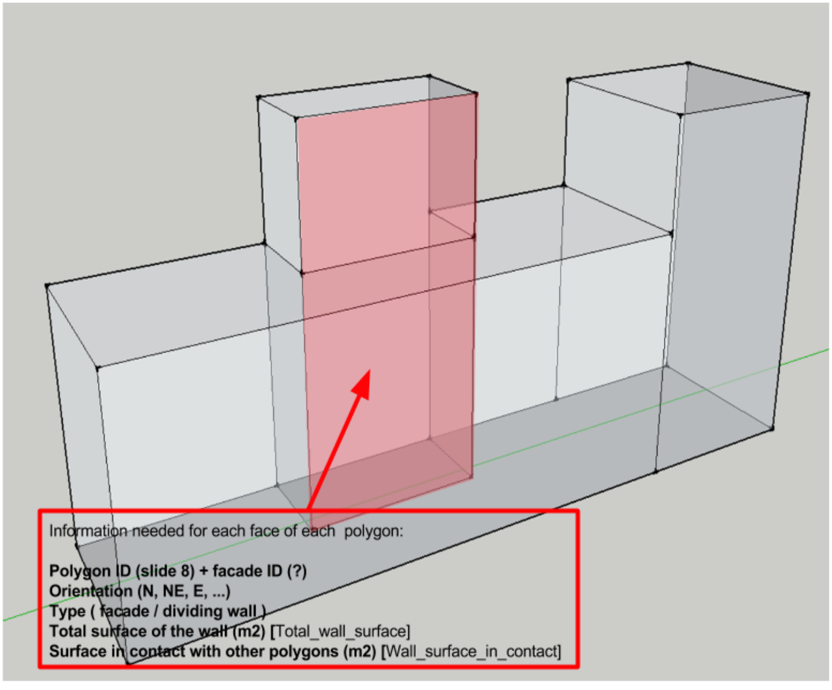

Figure 14. Information extracted from the 3D model regarding wall types

After having this information from the 3DMaps, the Activity Form (See Appendix C, Activity forms A.M4) describes the process to calculate the transmittance value which has to be assigned to each wall, taking into account the year of construction, the total surface, and the surfaces in contact with other buildings.

3.3 Technological challenge

The main technological challenge was to undock the calculation engine from the interface in order to integrate URSOS with the SEMANCO platform. The new development of URSOS was broken down into three issues carried out by software developers from the University of Zaragoza. The result of their work was a new version of URSOS which can be invoked as a "service". Thus, the input parameters include the new input data required by the SEMANCO platform.

3.3.1 Issue 1: Inputs file

A new input file has been designed – based on a previous one – that includes all the input parameters needed by the calculation engine. The input file includes a set of the parameters that a user can modify through the user interfaces and also parameters with a value fixed by the calculation engine. In this way, the calculation engine will be generic enough to include any European region. For example, the climate data could be provided as an input parameter.

3.3.2 Issue 2: Outputs file

In the previous version of the URSOS tool, the output could only be visualized in the graphic user interface. The goal was to generate a file with the outputs parameters generated by the calculation engine. Thus, new indicators were calculated and included in the output file. For example, the solar radiation (a solar energy potential value) for each surface –walls and roofs– was provided as an output. Some of the available indicators were provided in a disaggregated form letting the aggregation to the SEMANCO platform.

3.3.3 Issue 3: URSOS as a service

The goal of this task was to detach the URSOS calculation engine from the graphical user interface, which meant:

- Accepting input files with all the data needed for running calculations. Thus, the changes of the structure of the input file modified in task 1 were taken into account.
- Generating output files with the response of the calculation engine according to the work carried out in the task 2.
- Executing the URSOS calculation engine as a "service". The new version is a Java application which takes an input file to feed the calculation engine and generate an output file with the response of the calculation engine.

3.4 User Interface

The goal of the integration of URSOS within in the SEMANCO platform is to automatically assign values to the input parameters with the data retrieved through the SEIF. Despite the automated process, users can still modify the value of the parameters if they have precise data of the building based on local knowledge of the building or if they can see particular facade details highlighted by the Google Street View widget included in the interface (Figures 15, 16, and 17). The outputs of the URSOS engine are processed and aggregating on a yearly basis and by square meter (Figure 18).

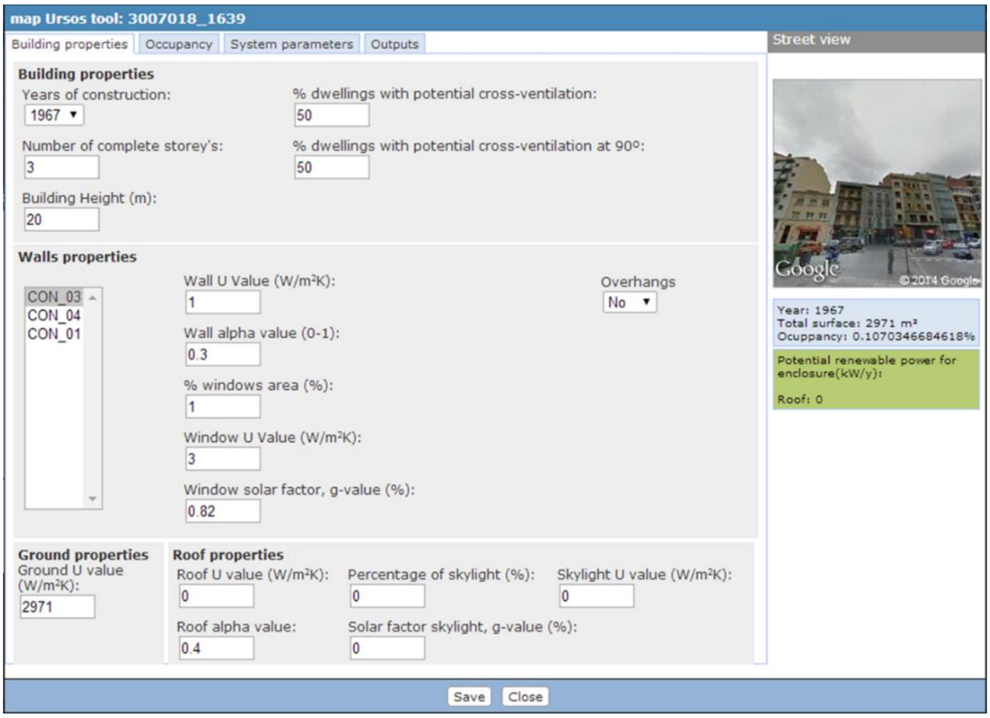

Figure 15. User interface to introduce the building properties

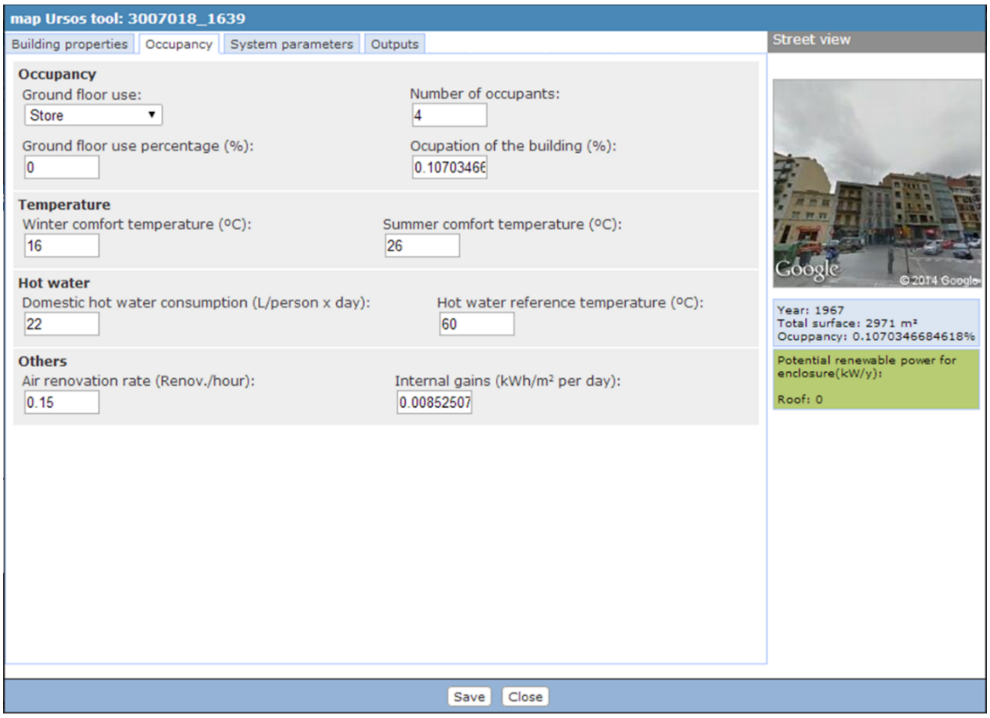

Figure 16. User interface to introduce the occupancy parameters

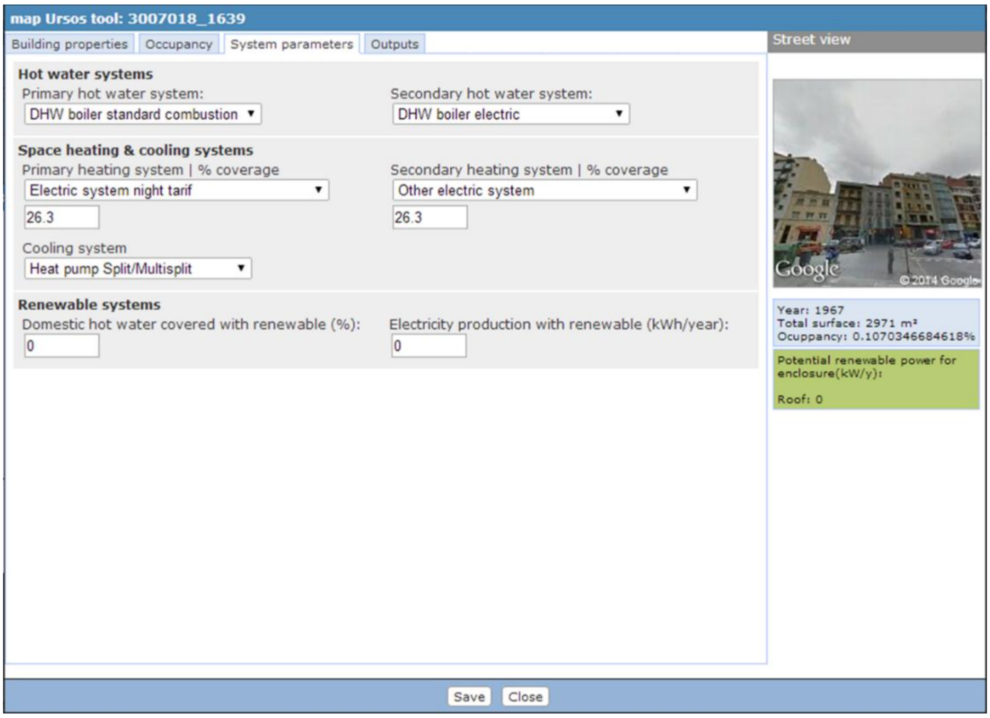

Figure 17. User interface to introduce the system parameters

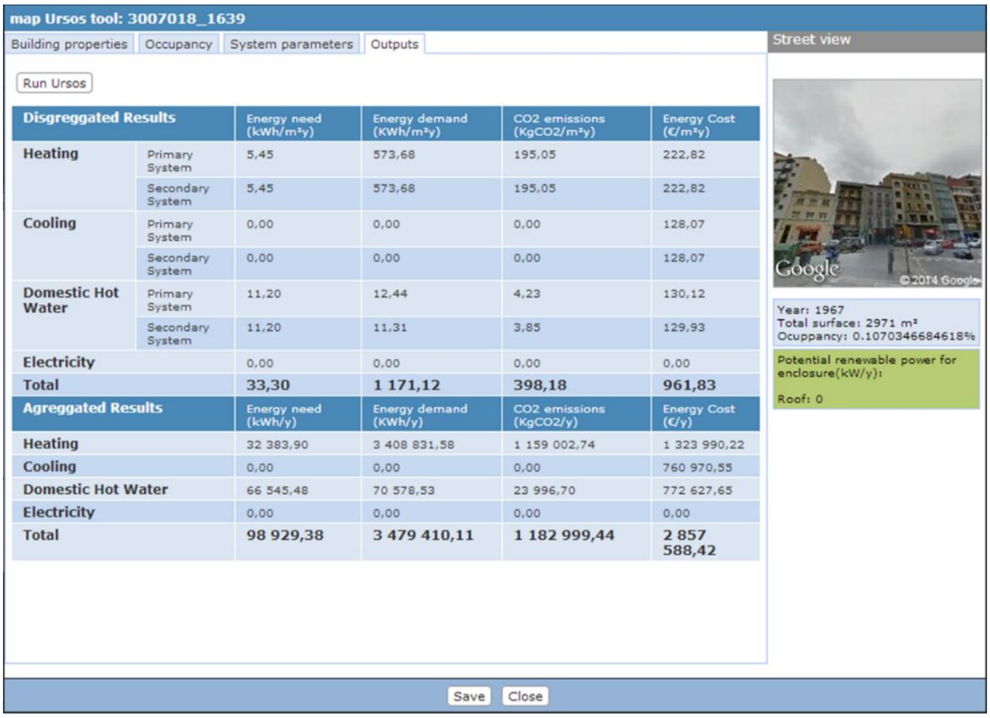

Figure 18. User interface for visualizing the outputs of the calculations provided by URSOS engine

4 Conclusions

4.1 Contribution to overall picture

The integration of the URSOS simulation engine in the SEMANCO platform carried out in Task 5.5 *Interoperability of tools with the semantic framework* has helped demonstrate the feasibility of the semantic interoperability to facilitate the communication between various data sources and multiple tools. The tools integrated in the platform previously were expressly created for it (see Deliverable 5.1 *Building extraction and classification tools* and Deliverable 5.2 *Tools for energy analysis*). The tool presented in this report is the first case of an external tool integrated in the platform by means of a dedicated interface which transforms the tool into a “service”.

4.2 Impact on other WPs and Tasks

The work carried out has continuity with some of the energy simulation and optimisation tools being developed in Task 5.3 *Energy simulation and trade-off visualisation tool*. In particular, an optimisation tool will be created using the calculations undertaken with the simulation tool, in order to evaluate multiple solutions in refurbishment projects for improving the energy efficiency of the exiting building stock. All of these tools will be integrated in the final version of the platform which will be the result of Task 5.6 *Integrated Platform*.

4.3 Contribution to demonstration

The work carried out in this task has a direct contribution to the demonstration scenarios. The calculations using the integrated tool will defined the baseline of the current state of the urban energy performance in the case study areas. The calculated baseline will be a reference to assess the effectiveness of the improvement plans developed for the third and last round of demonstration scenarios.

4.4 Other conclusions and lessons learned

The integration of URSOS in the SEMANCO platform has proved that semantic technologies can help to solve interoperability issues between data and tools.

One of the main difficulties which had to be solved has been the transformation of a complex geometric model into the simpler shapes that URSOS calculation engine could understand. These difficulties stem from the way in which the 3D model was built from the 2D data facilitated by a GIS. The application of a standard model such as IFC or CityGML would not have avoided the problem since URSOS is not supporting any of them, so an ad hoc transformation of the geometric representations would have been necessary too, in any case.

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6 APPENDICES

APPENDIX A. Activity forms A.M2

Activity 2 - Manresa

Acronym	A.M2
Super-activity/use case	A.M1/UC10
Sub-activities	A.M5
Goal	**Define systems and occupation parameters**
Urban Scale	Micro-Messo
Users	• The municipality (councilors of urban planning, housing, environment and countryside, …) • Urban planners and architects • Public company of social housing • Private urban promoter • Associations of neighbours
Related national/local policy framework	• National energy codes • 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 visualize socio-economic information in 3D Maps – To generate input to next calculations of energy performance and of buildings and supply systems

Building parameters <tipologia>

Example xml

```
<edificio id="22594860">
  <name>edificioL</name>
  <cotaViviendasMetros>0.0</cotaViviendasMetros>
  <plantasLocales>0</plantasLocales>
  <cotaLocalesMetros>0.0</cotaLocalesMetros>
  <listaLocales />
  <tipologia>
    <tIntConfortInvierno>20.0</tIntConfortInvierno>
    <tIntConfortVerano>25.0</tIntConfortVerano>
    <tasaRenovacion>1.0</tasaRenovacion>
    <gananciaInterna>0.15</gananciaInterna>
    <ocupacion>0.95</ocupacion>
    <resistenciaSuperiorExterna>0.06</resistenciaSuperiorExterna>
    <porcentVivPosibVentCruz>0.0</porcentVivPosibVentCruz>
    <porcentVivPos90Grados>0.0</porcentVivPos90Grados>
  </tipologia>
  <indicadores>
```

N.	Data name	File source	Description / Value
0	<tipologia>		
1	<tIntConfortInvierno>	<PLBARRI>	- Winter comfort temperature in °C

<table>
<tr><td>2</td><td><tIntConfortVerano></td><td><PLBARRI></td><td>- Summer comfort temperature in °C</td></tr>
<tr><td></td><td colspan="3">1- The extruded polygon FINREFCAD1+BLOCK_ID+POLYGON_ID is considered as a building for the Ursos calculations
2- Look for neighbourhood code in which the building is located
a. Neighbourhood code is indicated in [Barri] field in <PLBARRI.shp> shape file of the Manresa's GIS.
3- With the Neighbourhood code, enter to <TB_Neighbourhood_Income_Year.xlsx> file and look for the [Neighbourhood_Income_Coefficient] of the corresponding neighbourhood and the current year (or the last year)
4- Calculate the Household_Income in the corresponding Neighbourhood by multiplying the Neighbourhood_Income_Coefficient by the Household_Income of the current (or last) year in Tb_ManresaHouseholdIncome_Year.xls
5- Determine heating and cooling temperatures from table Tb_IndoorTemperature-Income.xls, according to the Household_Income.
6- [CS_Temperature_Heating_Mode] and [CS_Temperature_Cooling_Mode] correspond to <tIntConfortInvierno> and <tIntConfortVerano> respectively in Ursos</td></tr>
<tr><td>3</td><td><tasaRenovacion></td><td><Tb_AirRenovationRate_YearConstruction.xls></td><td>- Air exchange rate depending on construction year in rates/h</td></tr>
<tr><td></td><td colspan="3">1. With [FINREFCAD1] code, look for the Year_Of_Construction of the building in <DadesCadastre_2013_06_19.xls> file; in [STDDFICONS] field
2. Look for the corresponding [Air_Exchange_Rate] in file <Tb_AirRenovationRate_YearConstruction.xls>
3. [Air_Exchange_Rate] correspond to <tasaRenovacion> in Ursos
4. Apply the same value for all extruded polygons with [FINREFCAD1] in its code.</td></tr>
<tr><td>4</td><td><gananciaInterna></td><td><DadesCadastre_2013_06_19.xls>,
<ManresaCensus.xls>,
<PLBARRI>, <TB_Neighbourhood_Income_Year.xlsx>,
<Tb_ InternalGains_Exosomatic_Values.xls></td><td>- Internal gains in MWh/year
- Formula INTERNALGAINS</td></tr>
</table>

1- Internal gains (in kWh/m^2·day) are determined by adding up CS_Internal_Heat_Gains_By_Occupants and CS_Internal_Heat_Gains_By_Appliances

2- **CS_Internal_Heat_Gains_By_Occupants** depend on the number of occupants of the buildings and the time spent in it (we assume 16 hours/day). It is calculated with the following formula (in kWh/m^2·day)

$$\boldsymbol{CS\_Internal\_Heat\_Gains\_By\_Occupants} = \frac{1.88 \times \boldsymbol{Number\_of\_Occupants}}{\boldsymbol{Dwellings\_Net\_Floor\_Area}}$$

3- **The following calculation is done based on real buildings. The results are applied to all extruded polygons making up that building**

4- Where ***Number_of_Occupants*** is the number of people living in a same building

a. In <DadesCadastre_2013_06_19.xls >, filter by [FINREFCAD1] that correspond to selected building. Hold (record) all codes in [DOMCOD] field with the same [FINREFCAD1] code.

b. In <ManresaCensus.xls> file, filter the registers with [DOMCOD] value selected in previous step and **count** them. **The result is the number of people inhabiting the building.**

c. Hold the [DOMCOD] values for next steps

5- ***Dwellings_Net_Floor_Area***:

a. From <DadesCadastre_2013_06_19.xls>, select all registers with the [FINREFCAD1] code of the selected building.

b. Those registers correspond to the dwellings and locals of the building. Filter the registers with a "V" in column [CODDESTI] (that defines dwellings).

c. Once the records corresponding to dwellings are selected (step ii), sum all values of <SUPLOCAL> column in order to obtain the Building_Net_floor_Area of dwellings.

6- Calculate CS_Internal_Heat_Gains_By_Occupants and apply this value to all extruded polygons with [FINREFCAD1] in its ID

CS_Internal_Heat_Gains_By_Appliances are heat gains due to use of domestic equipment

a. Look for neighbourhood code in which the building is located. Neighbourhood code is indicated in [Barri] field in <PLBARRI.shp> shape file of the Manresa's GIS.

b. Determine the Neighbourhood_Income_Coefficient of the neighbourhood for the current year from <TB_Neighbourhood_Income_Year.xlsx> table

c. Obtain the average household income of Manresa ([Household_Income] field) for the current or last available year from table <Tb_ManresaHouseholdIncome_Year.xlsx>

d. Calculate the household income of the neighbourhood (Household_Income) by multiplying

$$\boldsymbol{Household\_Income} = \boldsymbol{Neighbourhood\_Income\_Coefficient} * \boldsymbol{Household\_Income}$$

e. In <Tb_InternalGainsExosomatic_Income.xls> it is indicated the CS_Internal_Heat_Gains_By_Appliances in kWh/m^2·day, according to Neighbourhood_Income

f. Calculate CS_Internal_Heat_Gains_By_Appliances according to the occupation of the building (See next point to calculate Percentage_Occupation_Surface of the building

$$\boldsymbol{CS\_Internal\_Heat\_Gains\_By\_Appliances} = \boldsymbol{CS\_Internal\_Heat\_Gains\_By\_Appliances} * \boldsymbol{Percentage\_Occupation\_Surface}$$

g. Calculate CS_Internal_Heat_Gains_By_Appliences and apply this value to all extruded polygons with [FINREFCAD1] in its ID

CS_Internal_Heat_Gains are calculated as the summation of heat gains by occupant and by appliances:

$$\boldsymbol{CS\_Internal\_Heat\_Gains} = < gananciaInterna > = CS\_Internal\_\_Heat\_Gains\_By\_Appliances + CS\_Internal\_Heat\_Gains\_By\_Occupants$$

<table>
<tr><td>5</td><td><ocupacion></td><td><DadesCadastre_2013_06_19.xls></td><td>- Building occupancy in percentage/100
- Formula OCCUPATION</td></tr>
<tr><td></td><td colspan="3">
1- Percentage_Occupation_Surface is calculated with the following formula (This calculation is based on real buildings. The results have to be applied to all extruded polygons making up that building)

$$< ocupacion > = Percentage\_Occupation\_Surface = \frac{\boldsymbol{Inhabited\_Building\_Net\_Floor\_Area}}{\boldsymbol{Building\_Net\_Floor\_Area}}$$
a. Inhabited_Building_Net_Floor_Area: Surface where people is living in the same building
a. From the previous step, you know which [DOMCOD] are inhabited. So you have to search these same values in <DadesCadastre_2013_06_19.xls>, [DOMCOD] column
i. Look for their surfaces in [SUPLOCAL] column and add them all, obtaining the Inhabited_Building_Net_Floor_Area
b. Dweelings_Net_Floor_Area: Total built surface of the building
i. From <DadesCadastre_2013_06_19.xls>, select all registers with the [FINREFCAD1] code of our selected building.
ii. Those registers correspond to the dwellings and locals of the building. Filter the registers with a “V” in column [CODDESTI] (that defines dwellings).
iii. Once select the rows that are dwellings, aggregate all values of <SUPLOCAL> column in order to obtain the whole constructed area of dwellings.
c. Calculate Percentage_Occupation_Surface and apply to all the extruded polygons with the same FINREFCAD1
</td></tr>
<tr><td>6</td><td><resistenciaSuperiorExterna></td><td></td><td>Percentage/100 of external top strength.
Default value = “0.06”</td></tr>
<tr><td>7</td><td><porcentVivPosibVentCruz></td><td>User input
Default value = “50”
Apply to all the extruded polygons with the same FINREFCAD1</td><td>Percentage of dwellings with possibility of cross ventilation.</td></tr>
<tr><td>8</td><td><porcentVivPos90Grados></td><td>User input
Default value = “50”
Apply to all the extruded polygons with the same FINREFCAD1</td><td>Percentage of dwellings with possibility ventilation at 90 degrees. Summed with cross ventilation value cannot add more than 100%.</td></tr>
</table>

XML example <indicadores> section

```
<edificio id="22594860">
  <name>edificioL</name>
  <cotaViviendasMetros>0.0</cotaViviendasMetros>
  <plantasLocales>0</plantasLocales>
  <cotaLocalesMetros>0.0</cotaLocalesMetros>
  <listaLocales />
  <tipologia>
    <tIntConfortInvierno>20.0</tIntConfortInvierno>
    <tIntConfortVerano>25.0</tIntConfortVerano>
    <tasaRenovacion>1.0</tasaRenovacion>
    <gananciaInterna>0.15</gananciaInterna>
    <ocupacion>0.95</ocupacion>
    <resistenciaSuperiorExterna>0.06</resistenciaSuperiorExterna>
    <porcentVivPosibVentCruz>0.0</porcentVivPosibVentCruz>
    <porcentVivPos90Grados>0.0</porcentVivPos90Grados>
  </tipologia>
  <indicadores>
    <coberturaACS>10.0</coberturaACS>
    <produccionERenovable>0.0</produccionERenovable>
    <tierrasExcedentes>15.0</tierrasExcedentes>
    <sistemasReductores>true</sistemasReductores>
    <wcDobleDescarga>false</wcDobleDescarga>
    <hayLavadora>true</hayLavadora>
    <hayCisternaWC>false</hayCisternaWC>
    <tipoSuelo>1</tipoSuelo>
    <porcentEcologicos>40</porcentEcologicos>
    <porcentReciclados>20</porcentReciclados>
    <tipoEdificio>0</tipoEdificio>
    <combustibleCalef>0</combustibleCalef>
    <combustibleRefrig>0</combustibleRefrig>
    <combustibleACS>0</combustibleACS>
    <rdtoCalefaccion>80.0</rdtoCalefaccion>
    <rdtoRefrigeracion>2.0</rdtoRefrigeracion>
  </indicadores>
  <geometria>
    <base>
      <estructura cotaRelativa="0.0" alturaMetros="13.0" isPatio="false"
numPlantas="3">
        <cerramientos>
          <cerramiento id="CERR.3" tipo="3" conAleros="false" laU="1.0"
uCristal="3.0" acristalamiento="10.0" transmitOptica="0.65" absortividad="0.4">
            <lado>
              <punto x="13684" y="5824" id="1" />
              <punto x="13529" y="6810" id="2" />
            </lado>
            <alerosValues altura="100.0" anchura="100.0" retranqueo="0.0"
das="0.0" aas="0.0" dad="0.0" aad="0.0" dai="0.0" aai="0.0" />
          </cerramiento>
          <cerramiento id="CERR.1" tipo="3" conAleros="true" laU="1.0"
uCristal="3.0" acristalamiento="20.0" transmitOptica="0.65" absortividad="0.4">
            <lado>
              <punto x="13529" y="6810" id="1" />
              <punto x="15481" y="7128" id="2" />
            </lado>
```

Predefined building indicators (<indicadores>).

N.	Data name	File source	Description / Value
0	<indicadores>		- Building indicators
1	<coberturaACS>	User input Default value = “0.0”	- Annual Coverage of ACS with solar thermal in percentage
2	<produccionERenovable>	User input Default value = “0.0”	- Electricity production from renewable sources in kWh/year
3	<tierrasExcedentes>	Not apply	- Exploited excavated land at the site in percentage - Default value = “0.0”
4	<sistemasReductores>	Not apply	- Systems are reducing potable-water flow - Default value = “true”
5	<wcDobleDescarga>	Not apply	- Dual flush toilet - Default value = “false”
6	<hayLavador	Not apply	- Washing machine using recycled water

<table>
<tr><td></td><td>a></td><td></td><td>- Default value = "true"</td></tr>
<tr><td>7</td><td><hayCisternaWC></td><td>Not apply</td><td>- WC tank using recycled water
- Default value = "false"</td></tr>
<tr><td>8</td><td><tipoSuelo></td><td>Not apply</td><td>- Land type (Values: 0 = degraded land; 1 = urban land in the centre; 2 = urban land in the periphery; 3 = developable land in the centre; 4 = developable land in the periphery)
- Default value = "1"</td></tr>
<tr><td>9</td><td><porcentEcologicos></td><td>Not apply</td><td>- Use of ecological materials in buildings in percentage
- Default value = "0"</td></tr>
<tr><td>10</td><td><porcentReciclados></td><td>Not apply</td><td>- Use of recycled materials in buildings in percentage
- Default value = "40"</td></tr>
<tr><td>11</td><td><tipoEdificio></td><td>Not apply</td><td>- Type of building
- Currently, it only admits "0"</td></tr>
<tr><td>12</td><td><combustibleCalef></td><td>Tb_SpaceHeatingSystems_EnergyCarrier_Buildings.xlsx
Tb_SpaceHeatingSystems_PercentageCoverage_Buildings.xls
Or
User input</td><td>- Space_Heating_Energy_Carrier
- (Values: 0 = Natural_Gas; 1 = Electricity; 2 = Biomass; 3 = Gasoil)
- Default value = "0"</td></tr>
<tr><td></td><td colspan="3">1- Despite the fact that URSOS considers only one heating system, URSOS form has the possibility of entering primary and secondary heating systems.
2- The default value of the heating systems to be entered in the URSOS form are the following:
a. Main_Space_Heating_System = Heating boiler standard combustion
b. Secondary_Space_Heating_System = Other electric system
3- Space_Heating_Energy_Carrier of main and secondary heating systems are defined from table <Tb_SpaceHeatingSystems_EnergyCarrier.xls> according to the Space_Heating_System, which was defined in step 2 or by the user.
4- The default percentage of the coverage of each heating system is defined from table <Tb_SpaceHeatingSystems_PercentageCoverage_Buildings.xls>, according to household income.
5- For Ursos calculation, define the <combustibleCalef> as the Space_Heating_Energy_Carrier of the Main_Space_Heating_System. The code is retrieved from column Space_Heating_Energy_Carrier_URSOS in table <Tb_SpaceHeatingSystems_EnergyCarrier.xls>
6- Apply this value to all extruded polygons with the same FINREFCAD1 in their ID

Obs. Space_Heating_Energy_Carrier_URSOS is not included in standard tables.</td></tr>
<tr><td>13</td><td><combustibleRefrig></td><td>Tb_SpaceCoolingSystems_EnergyCarrier.xls
Tb_SpaceCoolingSystems_PercentageCoverage_Buildings.xls
Or
User input</td><td>- Cooling fuel (Values: 0 = Natural Gas; 1 = Electricity; 2 = Biomass; 3 = Gasoil)
- Default value = "1"</td></tr>
<tr><td></td><td colspan="3">1- The default value of the Space_Cooling_System is the following:
a. Space_Cooling_System = Heat pump Split/Multisplit
2- The default value of the cooling system is the following:
a. Space_Cooling_Energy_Carrier = Electricity
3- The default percentage of coverage of Space_Cooling_System in the building is defined from table <Tb_SpaceCoolingSystems_PercentageCoverage_Buildings.xls>,</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">according to household income.

4- **For Ursos calculation,** define the **<combustibleRefrig>** from the column Space_Cooling_Energy_Carrier_URSOS in table < Tb_SpaceCoolingSystems_EnergyCarrier.xls>

5- **Apply this value to all extruded polygons with the same FINREFCAD1 in their ID**

Obs. **Space_Cooling_Energy_Carrier_URSOS** is not included in standard tables.</td></tr>
<tr><td>14</td><td><combustibleACS></td><td>Tb_DHW_EnergyCarrier.xls

Tb_DHW_PercentageCoverage_Buildings.xls

Or

User input</td><td>- ACS fuel (Values: 0 = Natural Gas; 1 = Electricity; 2 = Biomass; 3 = Diesel)

- Default value = "0"</td></tr>
<tr><td></td><td colspan="3">**1-** Despite the fact that URSOS considers only one domestic hot water system, URSOS form has the possibility of entering primary and secondary systems.

2- The default value of the Domestic Hot Water Systems to be entered in the URSOS form are the following:

a. Main_Domestic_Hot_Water_System = DHW boiler standard combustion

b. Secondary_Domestic_Hot_Water_System = DHW boiler electric

Obs. **Main_Domestic_Hot_Water_System** and **Secondary_Domestic_Hot_Water_System** are not defined in standard tables

3- Domestic_Hot_Water_Energy_Carrier of main and secondary DHW systems are defined from table <Tb_DHW_EnergyCarrier.xls> according to the Domestic_Hot_Water_System, which were defined in step 2 or by the user.

4- The default percentage of the coverage of each DHW system is defined from table <Tb_ Tb_DHW_PercentageCoverage_Buildings.xls>, according to household income.

5- **For Ursos calculation,** define the **<combustibleACS>** as the Domestic_Hot_Water_Energy_Carrier of the Main_Domestic_Hot_Water_System (defined in step 2 or by the user). The code is retrieved from column Domestic_Hot_Water_Energy_Carrier_URSOS in table < Tb_DHW_EnergyCarrier.xls>

6- **Apply this value to all extruded polygons with the same FINREFCAD1 in their ID**

7- Obs. **Domestic_Hot_Water_Energy_Carrier_URSOS** is not included in standard tables</td></tr>
<tr><td>15</td><td><rdtoCalefaccion></td><td>Tb_SpaceHeatingSystems_Efficiencies.xls

Or

User Input</td><td>- Heating system performance depending on system type

- Default value = "80%"</td></tr>
<tr><td></td><td colspan="3">**1-** Once the main and secondary space heating systems have been defined, go to table <Tb_SpaceHeatingSystems_Efficiencies.xls>, and look for the corresponding efficiency in column Space_Heating_System_Efficiency</td></tr>
<tr><td>16</td><td><rdtoRefrigeracion></td><td>Tb_SpaceCoolingSystems_Efficiencies.xls

Or

User input</td><td>- Coefficient Of Performance (COP) for cooling systems depending on system type Default value = 2</td></tr>
<tr><td></td><td colspan="3">**1-** Once the space cooling system has been defined, go to table <Tb_SpaceCoolingSystems_Efficiencies.xls>, and look for the corresponding efficiency in column Space_Cooling_System_Efficiency</td></tr>
</table>

APPENDIX B. Activity forms A.M3

Activity Form A.M3 - Manresa

Acronym	A.M3
Super-activity/use case	A1/UC10
Sub-activities	A.M5
Goal	Determination of **geometry of buildings and urban environment**
Urban Scale	Micro - Messo
Users	• The municipality (councilors of urban planning, housing, environment and countryside, …) • Urban planners and architects • Public company of social housing • Private urban promoter • Associations of neighbours
Related national/local policy framework	• Technical code • General urban plan
Issues to be addressed	• Determine geometric features of the buildings (footprint, height, volume) and of the urban area • With this information, the Ursos software is able to determine the interaction of the building with its surrounding environment. It basically means to determine shadows over the building to be calculated.
Observations	In the first iteration we will manually translate data input into a draw of the target urban area. This task will be done with the URSOS drawing tools. Second and third iteration considers to retrieve data from GIS databases and to input them directly to Ursos calculation engine (integrated in the platform)

3D 2D 3D**The following procedure applies to all buildings to be calculated**

```
      <edificio id="22594860">
        <name>edificioL</name>
        <cotaViviendasMetros>0.0</cotaViviendasMetros>
        <plantasLocales>0</plantasLocales>
        <cotaLocalesMetros>0.0</cotaLocalesMetros>
        <listaLocales />
        <tipologia>
          <tIntConfortInvierno>20.0</tIntConfortInvierno>
          <tIntConfortVerano>25.0</tIntConfortVerano>
          <tasaRenovacion>1.0</tasaRenovacion>
          <gananciaInterna>0.15</gananciaInterna>
          <ocupacion>0.95</ocupacion>
          <resistenciaSuperiorExterna>0.06</resistenciaSuperiorExterna>
          <porcentVivPosibVentCruz>0.0</porcentVivPosibVentCruz>
          <porcentVivPos90Grados>0.0</porcentVivPos90Grados>
        </tipologia>
        <indicadores>
          <coberturaACS>10.0</coberturaACS>
          <produccionERenovable>0.0</produccionERenovable>
          <tierrasExcedentes>15.0</tierrasExcedentes>
          <sistemasReductores>true</sistemasReductores>
          <wcDobleDescarga>false</wcDobleDescarga>
          <hayLavadora>true</hayLavadora>
          <hayCisternaWC>false</hayCisternaWC>
          <tipoSuelo>1</tipoSuelo>
          <porcentEcologicos>40</porcentEcologicos>
          <porcentReciclados>20</porcentReciclados>
          <tipoEdificio>0</tipoEdificio>
          <combustibleCalef>0</combustibleCalef>
          <combustibleRefrig>0</combustibleRefrig>
          <combustibleACS>0</combustibleACS>
          <rdtoCalefaccion>80.0</rdtoCalefaccion>
          <rdtoRefrigeracion>2.0</rdtoRefrigeracion>
        </indicadores>
        <geometria>
          <base>
            <estructura cotaRelativa="0.0" alturaMetros="13.0" isPatio="false"
numPlantas="3">
```


N.	Data name in xml code	File source	Description / Observations
0	<edificio>		Individual building This process is based on data about extruded polygons and the outputs are applicable to all extruded polygons making up a single building
1	<id>	3D map <20130722_PLCONSTR5C>	Building code (extruded polygon) For calculation purposes, in the ursos input file, each extruded polygon correspond to an individual <edificio> (i.e. building)
	7- The GIS database has the following fields for each extruded polygon a. FID b. POLYGON_ID c. HEIGHT d. FINREFCAD1 e. FINREFCAD2 f. BLOCK_ID g. AREA h. PERIMETER 8- All extruded polygons with the same FINREFCAD1, FINREFCAD2 and BLOCK_ID, belong to the same building 9- Each extruded polygon is assigned with a unique code, in the following form:		

<table>
<tr><th>N.</th><th>Data name in xml code</th><th>File source</th><th>Description / Observations</th></tr>
<tr><td></td><td colspan="3">a. FINREFCAD1+BLOCK_ID+POLYGON_ID

10- The process starts by selecting one building from the 3D map. It is important that, when the user selects one extruded polygon, the platform selects all the extruded polygons with the same FINREFCAD1+BLOCK_ID and apply the following procedure to all extruded polygons making up the building.

11- It can be also selected an urban area, and this process is performed for each building belonging to this urban area</td></tr>
<tr><td>2</td><td><name></td><td><20130722_PLCONSTR5C></td><td>- Building name
- This is for each extruded polygon</td></tr>
<tr><td></td><td colspan="3">1- The <name> of the extruded polygon (considered as one building in Ursos) also has the form FINREFCAD1+BLOCK_ID+POLYGON_ID</td></tr>
<tr><td>3</td><td><cotaViviendasMetros></td><td></td><td>- Height_Above_Sea_Level of the residences in the building (in meters)
- This is for each extruded polygon</td></tr>
<tr><td></td><td colspan="3">1- This value is obtained from the 3D model for each extruded polygon. The value depends on the existence of retail or commercial units in the ground floor. Therefore,

a. If <plantasLocales> ≠ 0, then <cotaViviendaMetros> = Height_Above_Sea_Level + <plantasLocales> · 3

b. If <plantasLocales> = 0, then <cotaViviendaMetros> = Height_Above_Sea_Level</td></tr>
<tr><td>4</td><td><plantasLocales></td><td>User input
Default value = “1”</td><td>- Number of floors for commercial use</td></tr>
<tr><td>5</td><td><cotaLocalesMetros></td><td>3D model</td><td>- Height_Above_Sea_Level of retail and commercial units (in groun dfloor)</td></tr>
<tr><td></td><td colspan="3">2- This value is obtained from the 3D model for each extruded polygon.

a. <cotaLocalesMetros> = Height_Above_Sea_Level</td></tr>
</table>

Building and Retail units

XML example <listaLocales> section

```
        <listaLocales>
          <local id="1" name="AlimentaciÃ³n" porcentaje="10.0" color="-65281" />
          <local id="2" name="Bar/CafeterÃa" porcentaje="12.0" color="-16776961"
/>
          <local id="3" name="Centro salud" porcentaje="15.0" color="-8355712" />
          <local id="4" name="Inst. deportivas" porcentaje="10.0" color="-
16711681" />
          <local id="5" name="Otros" porcentaje="15.0" color="-65536" />
        </listaLocales>
```

N.	Data name in xml code	File source	Description / Observations
6	<listaLocales>	<20130722_PLCONSTR5C> <DadesCadastre_2013_06_19.xls>	- List of retail unit types - This list (i.e. <listalocales>) in

			xml file has to be included in the description of each extruded polygon. This process is based on data about the entire building, but the **outputs are applicable to all extruded polygons making up that building.**
6.1	<local>		- Individual retail unit
	1) <local>: a) In the FINREFCAD1 column of <DadesCadastre_2013_06_19.xls>, filter all records with the same FINREFCAD1 of the building selected in the 3D map b) In the same file <DadesCadastre_2013_06_19.xls>, apply a second filter and select the entries containing "BX" in column [NCL_ADRECA_DOM_F(D.DOMCOD)]. The selected records correspond to a ground floor unit.		
6.1.1	<id>	<DadesCadastre_2013_06_19.xls>	- Retail unit code
	1) <id>: a) The ground floor may have one or more ground floor units, which are assigned with an <id>. The <id> is composed by the combination of values in columns [FINREFCAD1] + [LOCCOD], of <DadesCadastre_2013_06_19.xls> file		
6.1.2	<name>	<Tb_GroundfloorBuildingUses.xlsx> <DadesCadastre_2013_06_19.xls>	- Retail unit use
	1) <name>: **a)** In column [DESCDESTI] of <DadesCadastre_2013_06_19.xls> file, it appears the Land_Use for each ground floor unit. **b)** Filter the selected units disregarding those units whose use is defined as VIVENDA* (* is a wildcard character). The remaining ground floor units have a use different than residential. **c)** Then, the category of uses in the GIS data base indicated in [DESCDESTI] has to be translated to the corresponding Ursos category. In order to do so, follow the next steps: i) Go to <Tb_GroundfloorBuildingUses.xlsx>. In column [DESCDESTI_LandRegistry], look for the value of [DESCDESTI] obtained is step 1.a) ii) The corresponding Ursos category is under the field [Building_Groundfloor_Use_Ursos] of table <Tb_GroundfloorBuildingUses.xlsx> d) The Ursos category is used as the <name> of the retail unit		
6.1.3	<porcentaje>	<DadesCadastre_2013_06_19.xls> <20130722_PLCONSTR5C>	- Percentage of the retail unit with respect to the Building_Net_Floor_Area

	1) **<porcentaje>:** Percentage of building net floor area occupied with a retail unit, **obtained with the** following formula: $$< porcentaje >= \frac{[Local\_Floor\_Area]}{[Building\_Net\_Floor\_Area]} \times 100$$ a) ***Local_Floor_Area***: Retail unit area in m2. i) With [FINREFCAD1] + [LOCCOD], look for [SUPLOCAL] in <DadesCadastre_2013_06_19.xls> file. b) ***Building_Net_Floor_Area*** i) In the GIS database, look for all extruded polygons with similar FINREFCAD1+BLOCK_ID. They belong to the same building ii) Aggregate their [AREA] and obtain Building_Net_Floor_Area		
6.1.4	<color>		- Retail unit color - Value not used
	Apply the values obtained in this process to all extruded polygons making up the building selected in the 3D map.		

XML example <geometria> section


```
<edificio id="22594860">
  <name>edificioL</name>
  <cotaViviendasMetros>0.0</cotaViviendasMetros>
  <plantasLocales>0</plantasLocales>
  <cotaLocalesMetros>0.0</cotaLocalesMetros>
  <listaLocales />
  <tipologia>
    <tIntConfortInvierno>20.0</tIntConfortInvierno>
    <tIntConfortVerano>25.0</tIntConfortVerano>
    <tasaRenovacion>1.0</tasaRenovacion>
    <gananciaInterna>0.15</gananciaInterna>
    <ocupacion>0.95</ocupacion>
    <resistenciaSuperiorExterna>0.06</resistenciaSuperiorExterna>
    <porcentVivPosibVentCruz>0.0</porcentVivPosibVentCruz>
    <porcentVivPos90Grados>0.0</porcentVivPos90Grados>
  </tipologia>
  <indicadores>
    <coberturaACS>10.0</coberturaACS>
    <produccionERenovable>0.0</produccionERenovable>
    <tierrasExcedentes>15.0</tierrasExcedentes>
    <sistemasReductores>true</sistemasReductores>
    <wcDobleDescarga>false</wcDobleDescarga>
    <hayLavadora>true</hayLavadora>
    <hayCisternaWC>false</hayCisternaWC>
    <tipoSuelo>1</tipoSuelo>
    <porcentEcologicos>40</porcentEcologicos>
    <porcentReciclados>20</porcentReciclados>
    <tipoEdificio>0</tipoEdificio>
    <combustibleCalef>0</combustibleCalef>
    <combustibleRefrig>0</combustibleRefrig>
    <combustibleACS>0</combustibleACS>
    <rdtoCalefaccion>80.0</rdtoCalefaccion>
    <rdtoRefrigeracion>2.0</rdtoRefrigeracion>
  </indicadores>
  <geometria>
    <base>
      <estructura cotaRelativa="0.0" alturaMetros="13.0" isPatio="false"
numPlantas="3">
        <cerramientos>
          <cerramiento id="CERR.3" tipo="3" conAleros="false" laU="1.0"
uCristal="3.0" acristalamiento="10.0" transmitOptica="0.65" absortividad="0.4">
            <lado>
              <punto x="13684" y="5824" id="1" />
              <punto x="13529" y="6810" id="2" />
            </lado>
            <alerosValues altura="100.0" anchura="100.0" retranqueo="0.0"
das="0.0" aas="0.0" dad="0.0" aad="0.0" dai="0.0" aai="0.0" />
          </cerramiento>
          <cerramiento id="CERR.1" tipo="3" conAleros="true" laU="1.0"
uCristal="3.0" acristalamiento="20.0" transmitOptica="0.65" absortividad="0.4">
            <lado>
              <punto x="13529" y="6810" id="1" />
              <punto x="15481" y="7128" id="2" />
            </lado>
```


Building geometry (<geometria>): Building Box, without tower or courtyard.

N.	Data name	File source	Description / Value
0	<geometria>		- Building geometry
1	<base>		- Building Box
2	<estructura>		- Building structure
2.1	<cotaRelativa>	Default value = "0.0"	- Building elevation with respect to street elevation (If building is buried)
2.2	<isPatio>	Default value = "false"	- Presence of inner courtyard
2.3	<numPlantas>	<20130722_PLCONSTR5C> <Atributs.xlsx>	- Number_Of_Complete_Storeys

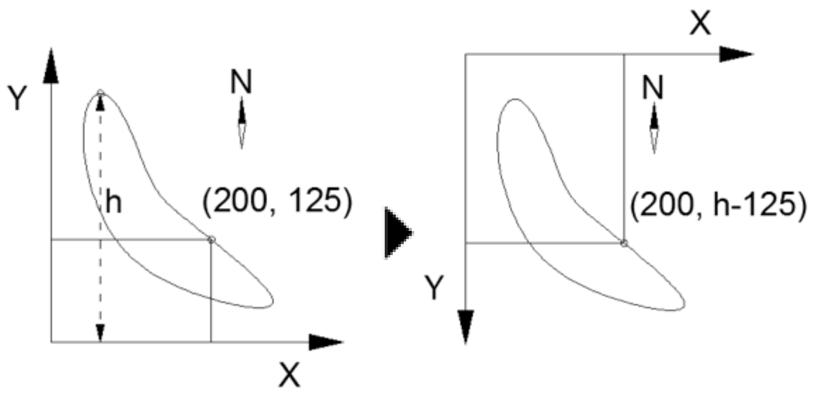
	1) <NumPlantas> a) In shape file <20130722_PLCONSTR5C>, look for [HEIGHT]] value of the extruded polygon. Example: S+V b) The equivalences of values obtained from [CNATRIBUT] is found in <Atributs.xlsx> file c) In principle, do not include basements in the total number of floors		
	XML example `<estructura cotaRelativa="0.0" alturaMetros="13.0" isPatio="false" numPlantas="3">`		
2.4	<alturaMetros>	<20130722_PLCONSTR5C>, <Atributs.xlsx>	- Building height in meters (from outdoor building elevation) - Calculated value
	- <alturaMetros> = <NumPlantas> · 3 - Another way to procedd is to retrieve the height of the building from the 3D map database		

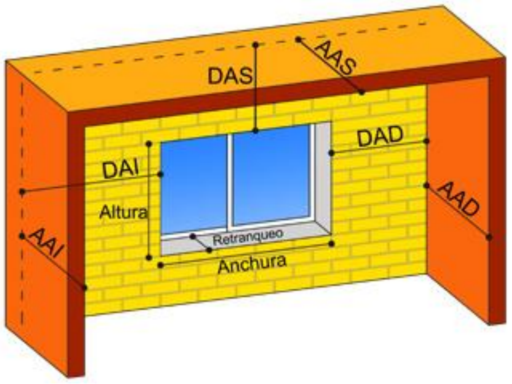
Enclosure (<cerramiento>): Walls (<cerramientos>).

N.	Data name	File source	Description / Value
0	<cerramientos>		- Wall enclosures
1	<cerramiento>		- Individual enclosure
1.1	<id>	<20130722_PLCONSTR5C>	- Enclosure code for a wall
	1) Obtain the code of the extruded polygon and add a code for each wall a) <id> = FINREFCAD1+BLOCK_ID+POLYGON_ID + AutomaticCodeforWall		
1.2	<tipo>	Automatic	- Enclosure type (Values: 1 = Roof; 2 = Ground; 3 = Wall) - Default value = "3"
1.3	<conAleros>	User input	- Whether the enclosure has overhangs - Default value = "false"
2	<lado>		- Enclosure side (line definition to locate an enclosure façade)

	`ucristal="3.0" acristalamiento="10.0" transmitOptica="0.65" absortividad="0.4">`
	`<lado>`
	`<punto x="13684" y="5824" id="1" />`
	`<punto x="13529" y="6810" id="2" />`
	`</lado>`		

2.1	<punto>		- Start point to locate an enclosure
2.1.1	<x>	<20130722_PLCONSTR5C> or Retrieved from 3D map coordinates	- X position of start point in URSOS - GIS reference of geometry value
2.1.2	<y>	<20130722_PLCONSTR5C> or Retrieved from 3D map coordinates	- Y position of start point in URSOS - GIS reference of geometry value
2.1.3	<id>	Automatic	- Enclosure start point name - Default value "1"

2.2	<punto>		- End point to locate an enclosure
2.2.1	<x>	<20130722_PLCONSTR5C> or Retrieved from 3D map coordinates	- X position of end point in URSOS - GIS reference of geometry value
2.2.2	<y>	<20130722_PLCONSTR5C> or Retrieved from 3D map coordinates	- Y position of end point in URSOS - GIS reference of geometry value
2.2.3	<id>	Automatic	- Enclosure end point name - Default value = "2"
	It is important to take into account the coordinates move into URSOS: **GIS coordinates → URSOS coordinates**  -		
3	<alerosValues>		- Oveharhangs definition - The following fields will be activated if the user sets <conAleros> = "true"
3.1	<altura>	User input	- Window height in percentage - Default value = "100.0"
3.2	<anchura>	User input	- Window width in percentage - Default value = "100.0"
3.3	<retranqueo>	User input	- Window to edge distance in meters - Default value = "0.0"
3.4	<das>	User input	- DAS in meters - Default value = "0.0"
3.5	<aas>	User input	- AAS in meters - Default value = "0.0"
3.6	<dad>	User input	- DAD in meters - Default value = "0.0"
3.7	<aad>	User input	- AAD in meters - Default value = "0.0"
3.8	<dai>	User input	- DAI in meters - Default value = "0.0"
3.9	<aai>	User input	- AAI in meters - Default value = "0.0"
PROCESS 1-3	**Recommended process for walls** Overhangs according to user input		



XML example

```xml
<cerramiento id="CERR.1" tipo="3" conAleros="false" laU="1.0" uCristal="3.0"
acristalamiento="20.0" transmitOptica="0.65" absortividad="0.4">
                  <lado>
                    <punto x="6118" y="13000" id="1" />
                    <punto x="7118" y="13000" id="2" />
                  </lado>
                  <alerosValues altura="100.0" anchura="100.0" retranqueo="0.0"
das="0.0" aas="0.0" dad="0.0" aad="0.0" dai="0.0" aai="0.0" />
                </cerramiento>
```

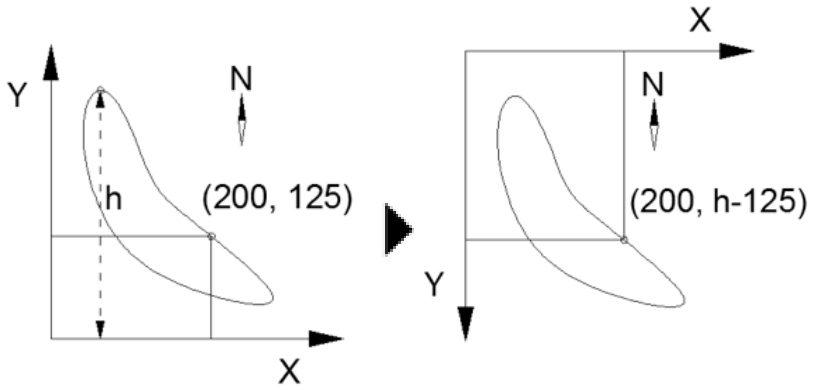
Enclosure (<cerramiento>): Ground (<suelo>).

0	<suelo>		- Ground enclosure
1	<cerramiento>		- Individual enclosure
1.1	<id>	<20130722_PLCONSTR5C>	- Enclosure code for ground
	1) Obtain code of the extruded polygon and add a code for the ground a) <id> = FINREFCAD1+BLOCK_ID+POLYGON_ID + AutomaticCodeforGround		
1.2	<tipo>	Automatic	- Enclosure type (Values: 1 = Roof; 2 = Ground; 3 = Wall) - Default value = "2"
1.3	<conAleros>	False	- Overhangs - Default value = "false"

The following procedure applies to Obstacle buildings

```
<listaEstorbos>
  <estorbo>
  <cotaMetros>0.0</cotaMetros>
  <alturaMetros>10.0</alturaMetros>
  <figura>
   <figuraPoligonal>
   <listaPuntos>
    <puntR id="0" x="26912" y="3824" />
    <puntR id="1" x="27912" y="3824" />
    <puntR id="2" x="27912" y="4824" />
    <puntR id="3" x="26912" y="4824" />
   </listaPuntos>
   </figuraPoligonal>
  </figura>
  </estorbo>
  <estorbo>
  …
  </estorbo>
  <estorbo>
  …
  </estorbo>
</listaEstorbos>
```

N.	Data name in xml code	File source	Description / Observations
0	<estorbo>		Buildings surrounding the buildings to be calculated. They are included to consider their shadows over other buildings. They are a polygon (<listaPuntos>) with a height (<alturaMetros>) and a height over the sea level (<cotaMetros>)
1	<cotaMetros>	Shape file PLCONSTR5C	-
	1- This value is obtained from the 3D model for each extruded polygon. It refers to the Height_Above_Sea_Level		
2	<alturaMetros>	Shape file PLCONSTR5C	-
	1) First, determine the Number_Of_Complete_Storeys of the building a) In shape file PLCONSTR5C, look for [HEIGHT]] value of the extruded polygon. Example: S+V b) The equivalence of the Number_Of_Complete_Storeys is found in <Atributs.xlsx> file. c) <alturaMetros> = Number_of_Complete_Storeys · 3		
3	<listaPuntos>		-
3.1	id	Automatic	- Enclosure end point name
3.2	<x>	Retrieved from shape file	- X position of end

<table>
<tr><td>N.</td><td>Data name in xml code</td><td>File source</td><td>Description / Observations</td></tr>
<tr><td></td><td></td><td><PLCONSTR5C> or
from 3D map coordinates</td><td>point in URSOS
- GIS reference of geometry value</td></tr>
<tr><td>3.3</td><td><y></td><td>Retrieved from shape file <PLCONSTR5C> or
from 3D map coordinates</td><td>- Y position of end point in URSOS
- GIS reference of geometry value</td></tr>
<tr><td></td><td colspan="3">It is important to take into account the change of coordinates from GIS to URSOS:
GIS coordinates → URSOS coordinates


-</td></tr>
</table>

APPENDIX C. Activity forms A.M4

Activity A.M4 - Manresa

Acronym	A.M4
Super-activity/use case	A1/UC10
Sub-activities	A5/A7
Goal	**Determination of technical parameters of buildings.**
Urban Scale	Micro/Messo
Users	• The municipality (councilors of urban planning, housing, environment and countryside, …) • Urban planners and architects • Public company of social housing • Private urban promoter • Associations of neighbours
Related national/local policy framework	• Technical code • Energy performance of buildings Directive • Sustainable Energy Action Plan
Issues to be addressed	• Determine the physical characteristics of the buildings (materials, transmittances, U-values) • Types of windows and balconies • Constructive thresholds defined in the technical code.
Observations	• To generate the building typologies of the area, based on their age , uses and technical parameters (from legislation at this age) • This activity considers to define the physical parameters of

	the building according to its age of construction. FORUM and CIMNE will provide the corresponding tables with the value of parameters for different building typologies (according to age and location)

Enclosure (<cerramiento>): Walls (<cerramientos>).

xml Example

```
<edificio id="22594860">
  <name>edificioL</name>
  <cotaViviendasMetros>0.0</cotaViviendasMetros>
  <plantasLocales>0</plantasLocales>
  <cotaLocalesMetros>0.0</cotaLocalesMetros>
  <listaLocales />
  <tipologia>
    <tIntConfortInvierno>20.0</tIntConfortInvierno>
    <tIntConfortVerano>25.0</tIntConfortVerano>
    <tasaRenovacion>1.0</tasaRenovacion>
    <gananciaInterna>0.15</gananciaInterna>
    <ocupacion>0.95</ocupacion>
    <resistenciaSuperiorExterna>0.06</resistenciaSuperiorExterna>
    <porcentVivPosibVentCruz>0.0</porcentVivPosibVentCruz>
    <porcentVivPos90Grados>0.0</porcentVivPos90Grados>
  </tipologia>
  <indicadores>
    <coberturaACS>10.0</coberturaACS>
    <produccionERenovable>0.0</produccionERenovable>
    <tierrasExcedentes>15.0</tierrasExcedentes>
    <sistemasReductores>true</sistemasReductores>
    <wcDobleDescarga>false</wcDobleDescarga>
    <hayLavadora>true</hayLavadora>
    <hayCisternaWC>false</hayCisternaWC>
    <tipoSuelo>1</tipoSuelo>
    <porcentEcologicos>40</porcentEcologicos>
    <porcentReciclados>20</porcentReciclados>
    <tipoEdificio>0</tipoEdificio>
    <combustibleCalef>0</combustibleCalef>
    <combustibleRefrig>0</combustibleRefrig>
    <combustibleACS>0</combustibleACS>
    <rdtoCalefaccion>80.0</rdtoCalefaccion>
    <rdtoRefrigeracion>2.0</rdtoRefrigeracion>
  </indicadores>
  <geometria>
    <base>
      <estructura cotaRelativa="0.0" alturaMetros="13.0" isPatio="false"
numPlantas="3">
        <cerramientos>
          <cerramiento id="CERR.3" tipo="3" conAleros="false" laU="1.0"
uCristal="3.0" acristalamiento="10.0" transmitOptica="0.65" absortividad="0.4">
            <lado>
              <punto x="13684" y="5824" id="1" />
              <punto x="13529" y="6810" id="2" />
            </lado>
            <alerosValues altura="100.0" anchura="100.0" retranqueo="0.0"
das="0.0" aas="0.0" dad="0.0" aad="0.0" dai="0.0" aai="0.0" />
          </cerramiento>
          <cerramiento id="CERR.1" tipo="3" conAleros="true" laU="1.0"
uCristal="3.0" acristalamiento="20.0" transmitOptica="0.65" absortividad="0.4">
            <lado>
              <punto x="13529" y="6810" id="1" />
              <punto x="15481" y="7128" id="2" />
            </lado>
```

N.	Data name	File source	Description / Value
0	<cerramientos>		- Enclosures
1	<cerramiento>		- Individual enclosure
1.1	<id>	<20130722_PLCONSTR5C>	- Enclosure code for a wall
	1) Obtain the code of the extruded polygon and add a code for each wall a) <id> = FINREFCAD1+BLOCK_ID+POLYGON_ID + AutomaticCodeforWall		
1.2	<tipo>	Automatic	- Enclosure type (Values: 1 = Roof; 2 = Ground; 3 = Wall) - Default value = "3"
1.3	<conAleros>	User input	- Overhangs - Default value = "false"
1.4	<laU>	<Tb_WallUvalue-YearConstruction.xlsx>	- U value of wall depending on construction year in W/m2K
	1. With [FINREFCAD1] code, look for the Year_Of_Construction in		

	<DadesCadastre_2013_06_19.xls> file; in [STDDFICONS] field 2. Look for the corresponding [Wall_U-value] in <Tb_WallUvalue-YearConstruction.xlsx> 3. Determine whether the wall is a diving wall or a façade a. In <LMCONSTR5C.shp> shape file, the [CODICC] field indicates the type of wall, as follows i. CON_01: Façade ii. CON_03: dividing wall iii. CON_04: change of height b. For **façades**, apply the [Wall_U-value] as it is in table <Tb_WallUvalue-YearConstruction.xlsx> c. For dividing walls and change-of-height walls, i. Determine the percentage of the wall in contact with the adjacent extruded polygon = [PercentageWallContact]. In order to do so: – Look for the height of the extruded polygon to which the wall belongs to – Look for the height of the adjacent extruded polygon – Calculate the percentage of the wall in contact with the adjacent building ii. Assign the U-Value of the dividing wall according to the following formula: $Wall\_U-value = (1-[PercentageWallContact]) * [Wall\_Uvalue]$		
1.5	<uCristal>	<Tb_WindowParameters-YearConstruction.xlsx>	- U value of glazing depending on construction year in W/m2K
	1. With [FINREFCAD1] code, look for its Year_Of_Construction in <DadesCadastre_2013_06_19.xls> file; in [STDDFICONS] field 2. Determine the [Window_Glass_U-Value] from <Tb_WindowParameters-YearConstruction.xlsx> according to Year_Of_Construction of the building		
1.6	<acristalamiento>	<Tb_Percentage_Windows-YearConstruction-Wall_Type.xlsx>	- Percentage of glazing depending on wall location and construction year
	1. With [FINREFCAD1] building code, look for building Year_Of_Construction in <DadesCadastre_2013_06_19.xls> file; in [STDDFICONS] field 2. If the wall is a façade [CON_01], then determine the Percentage_of_Window of the enclosure from <Tb_Percentage_Windows-YearConstruction.xlsx> according to Year_Of_Construction of the building. 3. For dividing or change-of-height walls <acristalamiento> = 0		
1.7	<transmitOptica>	<Tb_WindowParameters-YearConstruction.xlsx>	- Optical transmitancy
	1. With [FINREFCAD1] building code, look for building Year_Of_Construction in <DadesCadastre_2013_06_19.xls> file; in [STDDFICONS] field 2. Determine the Window_Glass_g-Value from <Tb_WindowParameters-YearConstruction.xlsx> according to Year_Of_Construction of the building		
1.8	<absortividad>	<Tb_Alphavalue-Colour.xlsx>	- Absortivity - Default value=0,4
	1. The user should have the possibility to access table <Tb_Alphavalue-Colour.xls> with different Alpha values according to wall colour.		

APPENDIX D. Activity forms A.M5

Activity A.M5 - Manresa

Acronym	A.M5
Super-activity/use case	A1/UC10
Sub-activities	A5/A7
Goal	**Determination of urban indicators.**
Urban Scale	Micro/Messo

Users	• The municipality (councilors of urban planning, housing, environment and countryside, …) • Urban planners and architects • Public company of social housing • Private urban promoter • Associations of neighbours
Related national/local policy framework	• Technical code • Energy performance of buildings Directive • Sustainable Energy Action Plan
Issues to be addressed	• Determine the physical characteristics of the buildings (materials, transmittances, U-values) • Types of windows and balconies • Constructive thresholds defined in the technical code.
Observations	• To generate the building typologies of the area, based on their age , uses and technical parameters (from legislation at this age) • This activity considers to define the physical parameters of the building according to its age of construction. FORUM and CIMNE will provide the corresponding tables with the value of parameters for different building typologies (according to age and location)

Energy_Need and Energy_Demand for Heating, Cooling and DHW


```
        </gananciaMuroOpaco>
      </cerramiento>
    </base>
    <torres />
    <patios />
  </sombras>
  <calefaccion>
    <mes num="1" val="26.629376016988438" />
    <mes num="2" val="19.447610597117663" />
    <mes num="3" val="14.094100058502338" />
    <mes num="4" val="7.285555592300713" />
    <mes num="5" val="0.0" />
    <mes num="6" val="0.0" />
    <mes num="7" val="0.0" />
    <mes num="8" val="0.0" />
    <mes num="9" val="0.0" />
    <mes num="10" val="3.0591846879576083" />
    <mes num="11" val="16.48795288968843" />
    <mes num="12" val="25.800466298330058" />
  </calefaccion>
  <refrigeracion>
    <mes num="1" val="0.0" />
    <mes num="2" val="0.0" />
    <mes num="3" val="0.0" />
    <mes num="4" val="0.0" />
    <mes num="5" val="0.0" />
    <mes num="6" val="4.973490356562201" />
    <mes num="7" val="13.419047868056932" />
    <mes num="8" val="10.789712317645412" />
    <mes num="9" val="1.4668105557729505" />
    <mes num="10" val="0.0" />
    <mes num="11" val="0.0" />
    <mes num="12" val="0.0" />
  </refrigeracion>
  <refrigeracionVentilacion>
    <mes num="1" val="0.0" />
    <mes num="2" val="0.0" />
    <mes num="3" val="0.0" />
    <mes num="4" val="0.0" />
    <mes num="5" val="0.0" />
    <mes num="6" val="4.973490356562201" />
    <mes num="7" val="13.419047868056932" />
    <mes num="8" val="10.789712317645412" />
    <mes num="9" val="1.4668105557729505" />
    <mes num="10" val="0.0" />
    <mes num="11" val="0.0" />
    <mes num="12" val="0.0" />
  </refrigeracionVentilacion>
  <gananciaInterna>
    <mes num="1" val="1395000.0" />
    <mes num="2" val="1260000.0" />
```


N.	**Indicator**	**URSOS Output Data Name**	**Description / Value**
0	Energy_Need and Energy_Demand	<name>	- Building level
1	Energy_Need for the Main_Space_Heating_System	<calefaccion>	- Energy_Need for the Main_Space_Heating_System (kWh/m2y)
	7- Select the building 8- In each case, aggregate the monthly values in kWh/m2 of **<calefaccion>**, and obtain the Energy_Need from the Space_Heating_System_of the building. 9- Calculate the Energy_Need from the Main_Space_Heating_System of the building by multiplying its **Space_Heating_Fraction_of_Heat/100** by the Energy_Need for the Space_Heating_System calculated previously.		
2	Energy_Need for the Secondary_Space_Heating System	<calefaccion>	- Energy_Need for the Main_Space_Heating_ System (kWh/m2y)
	1- Select the building 2- In each case, aggregate the monthly values in kWh/m2 of **<calefaccion>**, and obtain the Energy_Need from the Space_Heating_System_of the building. 3- Calculate the Energy_Need from the Secondary_Space_Heating_System of the building by multiplying its **Space_Heating_Fraction_of_Heat/100** by the Energy_Need for the Space_Heating_System calculated previously.		
3	Energy_Demand for the Main_Space_Heating_System	none	- Energy_Demand for the Main_ Space_Heating_ System (kWh/m2y)
	1- Calculate the Energy_Demand for the Main_Space_Heating_System by dividing Energy_Need for the Main_Space_Heating_System (see N.1) by its **Space_Heating_System_Efficiency**, retrieved from table 17-19.-		

	Tb_SpaceHeatingSystems_EnergyCarrier_Efficiencies.xls		
4	Energy_Demand for the Secondary_Space_Heating_System	none	- Energy_Demand for the Secondary_Space_Heating_ System (kWh/m2y)
	1- Calculate the Energy_Demand for the Secondary_Space_Heating_System by dividing Energy_Need for the Secondary_Space_Heating_System (see N.2) by its **Space_Heating_System_Efficiency**, retrieved from table 17-19.-Tb_SpaceHeatingSystems_EnergyCarrier_Efficiencies.xls.		
5	Energy_Need for the Space_Cooling_System	<refrigeracion>	- Energy_Need for the Space_Cooling_ System (kWh/m2y)
	6- Select the building 7- Aggregate the monthly values in kWh/m2 of **<refrigeracion>**, and obtain the Energy_Need from the Space_Cooling_System_of the building.		
6	Energy_Demand for the Space_Cooling_System	none	- Energy_Demand for the Space_Cooling_ System (kWh/m2y)
	1- Calculate the Energy_Demand for the Space_Cooling_System by dividing Energy_Need for the Space_Cooling_System (see N.5) by its **Space_Cooling_System_Efficiency**, retrieved from table 20-22.-Tb_SpaceCoolingSystems_EnergyCarrier_Efficiencies		
7	Energy_Need for the Main_Domestic_Hot_Water_System	none	- Energy_Need for the Main_Domestic_Hot_Water_ System (kWh/m2y)
	1- Select the building 2- Apply the next formula for the building: $Energy\_Need\ for\ the\ Domestic\_Hot\_Water\_System\ (kWh/m^2y) = Domestic\_Hot\_Water\_Consumption \left(\frac{L}{person \cdot day}\right) \times 365 \left(\frac{day}{y}\right) \times (Domestic\_Hot\_Water\_Reference\_Temperature - Water\_Temperature)(ºC) \times Number\_Of\_Occupants\ (person) \times 0{,}001162222\ (kWh/Kcal)/\ (Net\_Floor\_Area)$ Where Domestic_Hot_Water_Consumption = 22 l/person/day Domestic_Hot_Water_Reference_Temperature = 60 °C Number_of_occupants = (See Activity form A.M2) 3- Calculate the Energy_Need for the Main_Domestic_Hot_Water_System of the building by multiplying its **Domestic_Hot_Water_Fraction_of_Hot_Water/100** by the Energy_Need for the Domestic_Hot_Water_System calculated previously.		
8	Energy_Need for the Secondary_Domestic_Hot_Water_System	none	- Energy_Need for the Secondary_Domestic_Hot_Water_ System (kWh/m2y)
	1- Calculate the Energy_Need for the Secondary_Domestic_Hot_Water_System of the building by multiplying its **Domestic_Hot_Water_Fraction_of_Hot_Water/100** by the Energy_Need for the Domestic_Hot_Water_System calculated previously (see previous point).		
9	Energy_Demand for the Main_Domestic_Hot_Water_System	none	- Energy_Demand for the Main_Domestic_Hot_Water_ System (kWh/m2y)
	1- Calculate the Energy_Demand for the Main_Domestic_Hot_Water_System, by dividing its Energy_Need by its **Domestic_Hot_Water_System_Efficiency**.		
10	Energy_Demand for the Secondary_Domestic_Hot_Water_System	none	- Energy_Demand for the Secondary_Domestic_Hot_Water_ System (kWh/m2y)
	1- Calculate the Energy_Demand for the Secondary_Domestic_Hot_Water_System by dividing its Energy_Need by its **Domestic_Hot_Water_System_Efficiency**.		

CO2_Emissions

N.	**Indicator**	**URSOS Output Data Name**	**Description / Value**
0	CO2_Emissions	<name>	- Building level
1	CO2_Emissions for the Main_Space_Heating_System	none	- CO2_Emissions for the Main_Space_Heating_System (kgCO2/m2y)
	1- Select the building 2- If the Energy_Carrier of the Main_Space_Heating_System of the building is different than Electricity, assign the corresponding value of		

	CO2_Emission_Coefficient from table 26.-Tb_CO2EmissionCoefficient.xls. 3- Apply the next formula, and calculate **DIRECT** CO2_Emissions for the Main_Space_Heating_System: $CO2\_Emissions\ for\ the\ Main\_Space\_Heating\_System \left(\frac{kgCO_2}{m^2y}\right) = Energy\_Demand\ for\ the\ Main\_Space\_Heating\_System \left(\frac{kWh}{m^2y}\right) \times CO2\_Emission\_Coefficient(gCO_2/kWh) \times 0{,}001 \left(\frac{kg}{g}\right)$ 4- If Energy_Carrier is Electricity:, assign the CO2_Emission_Coefficient from table 28.-Tb_CO2EmissionCoefficient_Electricity.xls 5- Apply the previous formula, and calculate **INDIRECT** CO2_Emissions for the Main_Space_Heating_System		
2	CO2_Emissions for the Secondary_Space_Heating_System	None	- CO2_Emissions for the Secondary_Space_Heating_ System (kgCO2/m2y)
	1- Select the building 2- If the Energy_Carrier of the Secondary_Space_Heating_System of the building is different from Electricity, assign the corresponding value of CO2_Emission_Coefficient from table 26.-Tb_CO2EmissionCoefficient.xls. 3- Apply the next formula, and calculate **DIRECT** CO2_Emissions for the Secondary_Space_Heating_System: $CO2\_Emissions\ for\ the\ Secondary\_Space\_Heating\_System \left(\frac{kgCO_2}{m^2y}\right) = Energy\_Demand\ for\ the\ Secondary\_Space\_Heating\_System \left(\frac{kWh}{m^2y}\right) \times CO2\_Emission\_Coefficient(gCO_2/kWh) \times 0{,}001 \left(\frac{kg}{g}\right)$ 4- If Energy_Carrier is Electricity:, assign the CO2_Emission_Coefficient from table 28.-Tb_CO2EmissionCoefficient_Electricity.xls 5- Apply the previous formula, and calculate **INDIRECT** CO2_Emissions for the Secondary_Space_Heating_System		
3	CO2_Emissions for the Space_Cooling_System	none	- CO2_Emissions for the Space_Cooling_ System (kgCO2/m2y)
	1- Select the building 2- If the Energy_Carrier of the Space_Cooling_System of the building is different from electricity, assign the corresponding value of CO2_Emission_Coefficient from table 26.-Tb_CO2EmissionCoefficient.xls. 3- Apply the next formula, and calculate **DIRECT** CO2_Emissions for the Space_Coolong_System: $CO2\_Emissions\ for\ the\ Space\_Cooling\_System \left(\frac{kgCO_2}{m^2y}\right) = Energy\_Demand\ for\ the\ Space\_Cooling\_System \left(\frac{kWh}{m^2y}\right) \times CO2\_Emission\_Coefficient(gCO_2/kWh) \times 0{,}001 \left(\frac{kg}{g}\right)$ 4- If Energy_Carrier is Electricity, assign the CO2_Emission_Coefficient from table 28.-Tb_CO2EmissionCoefficient_Electricity.xls 5- Apply the previous formula, and calculate **INDIRECT** CO2_Emissions for the _Space_Cooling_System		
4	CO2_Emissions for the Main_Domestic_Hot_Water_System	none	- CO2_Emissions for the Main_Domestic_Hot_Water_ System (kgCO2/m2y)
	1- Select the building 2- If the Energy_Carrier of the Main_Domestic_Hot_Water_System of the building is different than Electicity, assign the corresponding value of CO2_Emission_Coefficient from table 26.-Tb_CO2EmissionCoefficient.xls. 3- Apply the next formula, and calculate **DIRECT** CO2_Emissions for the Main_Domestic_Hot_Water_System: $CO2\_Emissions\ for\ the\ Main\_Domestic\_Hot\_Water\_System \left(\frac{kgCO_2}{m^2y}\right) = Energy\_Demand\ for\ the\ Main\_Domestic\_Hot\_Water\_System \left(\frac{kWh}{m^2y}\right) \times CO2\_Emission\_Coefficient(gCO_2/kWh) \times 0{,}001 \left(\frac{kg}{g}\right)$ 4- If Energy_Carrier is Electricity, assign the CO2_Emission_Coefficient from table 28.-Tb_CO2EmissionCoefficient_Electricity.xls 5- Apply the previous formula, and calculate **INDIRECT** CO2_Emissions for the _ Main_Domestic_Hot_Water_System		
5	CO2_Emissions for the Secondary_Domestic_Hot _Water_System	None	- CO2_Emissions for the Secondary_Domestic_Hot_Water_ System (kgCO2/m2y)
	1- Select the building 2- If the Energy_Carrier of the Secondary_Domestic_Hot_Water_System of the building is different from Electricity, assign the corresponding value of CO2_Emission_Coefficient from table 26.-Tb_CO2EmissionCoefficient.xls.		

<table>
<tr><td></td><td colspan="3">

3- Apply the next formula, and calculate **DIRECT** CO2_Emissions for the Secondary_Domestic_Hot_Water_System:

$$CO2\_Emissions\ for\ the\ Secondary\_Domestic\_Hot\_Water\_System\left(\frac{kgCO_2}{m^2y}\right) = Energy\_Demand\ for\ the\ Secondary\_Domestic\_Hot\_Water\_System\left(\frac{kWh}{m^2y}\right) \times CO2\_Emission\_Coefficient(gCO_2/kWh) \times 0{,}001\left(\frac{kg}{g}\right)$$

4- If Energy_Carrier is Electricity, assign the CO2_Emission_Coefficient from table 28.-Tb_CO2EmissionCoefficient_Electricity.xls

5- Apply the previous formula, and calculate **INDIRECT** CO2_Emissions for the _ Secondary_Domestic_Hot_Water_System

</td></tr>
<tr><td>6</td><td>Direct and Indirect CO_2 emissions</td><td>None</td><td></td></tr>
<tr><td></td><td colspan="3">1- Aggregate all values of DIRECT CO2_Emissions and the values of INDIRECT CO2_Emissions as different indicators.</td></tr>
</table>

Energy_Cost

<table>
<tr><th>N.</th><th>Indicator</th><th>URSOS Output Data Name</th><th>Description / Value</th></tr>
<tr><td>0</td><td>Energy_Cost</td><td><name></td><td>- Building level</td></tr>
<tr><td>1</td><td>Energy_Cost for the Main_Space_Heating_System</td><td>None</td><td>- Energy_Cost for the Main_Space_Heating_System (€/y)</td></tr>
<tr><td></td><td colspan="3">

1- Select the building

2- Obtain the Building_Net_Floor_Area as indicated in activity form A.M3

3- Depending on the Energy_Carrier of the Main_Space_Heating_System, select one of the next formulas:

a) Electricity, considering a power contracted of 4Kw/dwelling:

$$Energy\_cost\left(\frac{\text{€}}{y}\right) = \left[Energy\_Demand\ for\ the\ Main\_Space\_Heating\_System\left(\frac{kWh}{m^2y}\right) \times Building\_Net\_Floor\_Area\,(m^2) \times 0{,}13\left(\frac{\text{€}}{kWh}\right) + 144\left(\frac{\text{€}}{dwelling\ y}\right) \times Number\_Of\_Appartments(dwelling) \times Percentage\_Of\_Apartments\_In\_Use\,(1/100\%)\right] \times 1{,}05\,(1/100\%\ Electric\ tax) \times 1{,}21\,(1/100\%\ IVA)$$

b) Natural_Gas, if considered a power contracted less than 5kw/dwelling:

$$Energy\_cost\left(\frac{\text{€}}{y}\right) = \left[Energy\_Demand\ for\ the\ Main\_Space\_Heating\_System\left(\frac{kWh}{m^2y}\right) \times Building\_Net\_Floor\_Area\,(m^2) \times 0{,}053\left(\frac{\text{€}}{kWh}\right) + 101{,}55\left(\frac{\text{€}}{dwelling\ y}\right) \times Number\_Of\_Appartments(dwelling) \times Percentage\_Of\_Apartments\_In\_Use\,(1/100\%)\right] \times 1{,}21\,(1/100\%\ IVA)$$

c) Gasoil, including home delivery service:

$$Energy\_cost\left(\frac{\text{€}}{y}\right) = \left[Energy\_Demand\ for\ the\ Main\_Space\_Heating\_System\left(\frac{kWh}{m^2y}\right) \times Building\_Net\_Floor\_Area\,(m^2) \times 0{,}3\left(\frac{\text{€}}{kg}\right) \times 0{,}2\left(\frac{kg}{kWh}\right)\right] \times 1{,}21\,(1/100\%\ IVA)$$

d) Biomass, including home delivery service:

$$Energy\_cost\left(\frac{\text{€}}{y}\right) = \left[Energy\_Demand\ for\ the\ Main\_Space\_Heating\_System\left(\frac{kWh}{m^2y}\right) \times Building\_Net\_Floor\_Area\,(m^2) \times 1{,}09\left(\frac{\text{€}}{l}\right) \times 0{,}1\left(\frac{l}{kWh}\right)\right] \times 1{,}21\,(1/100\%\ IVA)$$

4- Once the formula is selected, obtain the Energy_Cost for the Main_Space_Heating.

</td></tr>
<tr><td>2</td><td>Energy_Cost for the Secondary_Space_Heating_System</td><td>none</td><td>- Energy_Cost for the Secondary_Space_Heating_ System (€/y)</td></tr>
<tr><td></td><td colspan="3">Like in N.1</td></tr>
<tr><td>3</td><td>Energy_Cost for the Space_Cooling_System</td><td>none</td><td>- Energy_Cost for the Space_Cooling_ System (€/y)</td></tr>
<tr><td></td><td colspan="3">Like in N.1</td></tr>
</table>

4	Energy_Cost for the Main_Domestic_Hot_Water_System	none	- Energy_Cost for the Main_Domestic_Hot_Water_ System (€/y)
	Like in N.1		
5	Energy_Cost for the Secondary_Domestic_Hot_Water_System	none	- Energy_Cost for the Secondary_Domestic_Hot_Water_ System (€/y)
	Like in N.1		

PVSystem_Peak_Power for the Roof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  </cerramiento>
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<table>
<tr><th>N.</th><th>Indicator</th><th>URSOS Output Data Name</th><th>Description / Value</th></tr>
<tr><td>0</td><td>PVSystem_Peak_Power for the Roof</td><td><cerramiento> <tipo>Roof</tipo></td><td>- Building level</td></tr>
<tr><td>1</td><td>PVSystem_Peak_Power for the Roof</td><td><radiacionDirecta>, <radiacionDifusa>, <radiacionDirBloqueadaSombras></td><td>- PVSystem_Peak_Power for the Roof (kWp)</td></tr>
<tr><td></td><td colspan="3">1- Select the building
2- Calculate the Roof_Area, as the Ground_Floor_Area. This is equivalent to the value of PVSystem_Moduls_Area.
3- Calculate the Solar_Irradiance_On_Horizontal_Surface by adding the radiacionDirecta, radiacionDifusa and (minus) radiacionDirBloqueadaSombras of each extruded polygon making the building, according the next formula:
$$Solar\_Irradiance\_On\_Horizontal\_Surface\left(\frac{kWh}{m^2\cdot y}\right) = \sum\left[<radiacionDirecta>\left(\frac{Wh}{m^2\cdot day}\right)\times\left[1-\frac{<radiacionDirBloqueadaSombras>}{100}\right]\left(\frac{1}{100\%}\right)\times 30\left(\frac{day}{month}\right)\times 0{,}001\left(\frac{kWh}{Wh}\right)\right] + \sum\left[<radiacionDifusa>\left(\frac{Wh}{m^2\cdot day}\right)\times 30\left(\frac{day}{month}\right)\times 0{,}001\left(\frac{kWh}{Wh}\right)\right]$$
4- In the Ursos input form, we can include these two fields (power of PV panel and efficiency) with these default values.
5- If considering PV modules with maximum power of 100W, the PVSystem_Peak_Power</td></tr>
</table>

	for the Roof will be obtained through the next formula: $PVSystem\_Peak\_Power\ for\ the\ roof\ \left(\frac{kWh}{y}\right) = \frac{0{,}1\ \left(\frac{kW}{module}\right)}{1{,}5\ \left(\frac{m^2}{module}\right)} \times PVSystem\_Moduls\_Area\ (m^2) \times Solar\_Irradiance\_On\_Horizontal\_Surface\ \left(\frac{kWh}{m^2 \cdot y}\right) \times PVSystem\_Efficiency$