



## **Internal Report 1**

### **Analysis of the building stock and Guidelines for the Building Stock Surveys**

#### **(WP1. T1.2)**

- Guidelines for the analysis of the building stock and for conducting building energy surveys
- Building energy survey template – Annex I

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**Internal Report 1**

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<b>PP</b>	Restricted to other programme participants (including the Commission Services)			PP
<b>RE</b>	Restricted to a group specified by the consortium (including the Commission Services)			
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<b>Executive Summary:</b>	
Guidelines for the analysis of the building stock and for conducting building energy surveys and questionnaire for the survey.	
<b>Keywords</b>	Survey, data analysis, energy systems, transport & mobility, water & waste, cities, building energy survey, transport survey

## Introduction

This document is a supporting document for municipal partners in the InSMART project. It is a supplement to the document 'Data requirements on Building Stock for Work Package 2 (WP2)' prepared and distributed by UoN on the 27<sup>th</sup> January 2014.

The current document provides:

- Guidelines for the identification of building typologies and definitions of building types
- a set of criteria for the identification of basic building typologies in each city
- a summary of the process for the building stock analysis in each city
- guidelines for conducting building surveys
- a building energy survey template (Annex I)

## A. Identification of building typologies

According to the document 'Data requirements on Building Stock for Work Package 2 (WP2)', as described in page 2 of the document, in order to model each city's building stock, the basic sets of building typologies have to be defined (step 2).

More specifically, for the residential sector, buildings are categorized as:

- 1.** apartment buildings
- 2.** terraced houses
- 3.** semi-detached
- 4.** detached

For the non-domestic sector, buildings are categorized as:

- 5.** office buildings
- 6.** leisure centres
- 7.** school buildings (educational buildings)
- 8.** retail/commercial buildings
- 9.** Hospitals

Also, as discussed and agreed on the conference call of the 14<sup>th</sup> February, another category of building type has been added:

**10. mixed use buildings (\*)**

(\*) usually, buildings of 3 or more floors, where the ground floor is of commercial use and higher floors are used as offices or residential.

**Only** residential buildings and mixed use buildings (residential + retail) will be modeled using building analysis software in INSMART. So, typologies will be defined only for these kinds of buildings. Non-domestic buildings will be analysed using benchmark statistical modeling.

## **B. Identification of building types**

To identify the sets of building typologies, partners in each city have to define the building types of the city

### **B.1 Definition of building types**

To facilitate categorisation of buildings, building types are defined as follows:

#### **Terraced houses**

Terrace(d) houses or Row houses, is a style of medium-density housing (originated in Europe in the 16th century), where a row of identical or mirror-image houses share side walls.

Rowhouses (USA): 3 or more houses in a row sharing a "party" wall with its adjacent neighbour. Rowhouses are typically multiple stories (see 'Multi-Family' buildings(\*)).

Terraced houses: a style of housing where (generally) identical individual houses are conjoined into rows - a line of houses which abut directly on to each other built with shared party walls between dwellings whose uniform fronts and uniform height create an ensemble that was more stylish than a "rowhouse".

However this is also the UK term for a "rowhouse" regardless of whether the houses are identical or not.

#### **Multi-Family buildings (\*)**

Apartment building: Block of flats: a multi-unit dwelling made up of several (generally four or more) apartments.

Condominium: a form of ownership with individual apartments for everyone, and co-ownership (by percentages) of all of the common areas, such as corridors, hallways, stairways, lobbies, recreation rooms, porches, rooftops, and any outdoor areas of the grounds of the buildings.

**Detached House**

free-standing or Single-family house

**Semi-detached houses**

Semi-detached dwellings: two houses joined together,  
or Duplex house: two separate residences, attached side-by-side, but the term is sometimes used to mean stacked apartments on two different floors.

## **B.2 Building typology –Criteria**

To help partners identify representative buildings of each 'typology' a set of criteria that characterise the typology, are given:

1. Building type, as described in B.1
2. Building use, as described in A (relates to occupancy patterns, energy systems and energy demand)
3. Construction period (relates to the building practices of each period and materials used)
4. Building height / no of floors
5. Average ratio of glazing/envelope area
6. Roof type: flat, sloped (relevant for the identification of energy performance improvement scenarios)

## **C. Analysis of the building stock - Process step by step**

A 'step by step' guideline of the process for the analysis of the building stock is given below:

1. Identify city zones/districts (using e.g. census aggregation units, existing municipal boundaries and zoning) – Each Partner
2. Identify main building typologies, in each district (as described in B) – Each Partner
3. Estimate/define % of each typology in each district – Each Partner
4. Select adequate sample of buildings, representative of all typologies, and conduct surveys – Each Partner (questionnaires for the surveys will be prepared by – UoN & CRES. The sample size for each typology will have to be different, depending on the number of the typologies identified and the prevalence of each type within each city. Given the limited resources and time frame the sample size does not need to be significant to capture the main-large differences between residential sector buildings.
5. Elaborate survey data and identify representative buildings of each typology – Each Partner with the assistance of UoN & CRES
6. Simulate energy performance of each representative building – UoN & CRES

7. Extrapolation to all buildings of the same typology in each district / all city  
– **RESULT: Current Energy demand** – UoN & CRES
8. Identify energy performance improvement scenarios for each bldg typology – UoN & CRES
9. Simulate energy performance improvement for each typology – UoN & CRES
10. Extrapolate to all buildings of the same typology– **RESULT: Future Energy Demand** – UoN & CRES
11. Simulate further improvement of energy performance with RES installations (central systems, if feasible) – UoN & CRES

## **D. Guidelines for conducting building energy surveys**

Surveys will be conducted only in residential or mixed use buildings (as defined in section A). It is suggested that before conducting building surveys of selected buildings, surveyors contact the building manager in order to:

- gather information on general data for the building, data on central systems characteristics and consumption data of common use spaces,
- be informed on apartments' sizes
- arrange surveys of individual apartments

### **Basic Instructions for the selection of flats/apartments to be surveyed in each case:**

#### **D.1 Multi-family buildings**

##### 1. If the whole building is for residential use only:

Survey of representative flats using the following criteria:

- a) By floor: lower floor, upper floor, intermediate
- b) By position on the floor: at the corner of each floor
- c) By size: select flats that have an area equal to the average area (as defined by the national statistical service) of flats  $\pm 20\%$ .

Minimum number of flats/apartments to be surveyed in each building: 3.

Data from the building manager for central heating/cooling/lighting systems characteristics and consumption data for common areas.

##### 2. If the building is of mixed use:

- 1) Survey of ground floor, if it is of non-residential use.
- 2) Survey of representative flats according to the criteria presented in D.1.

Minimum number of surveys in each building: 4.

3) Data from building manager for central heating/cooling/lighting systems characteristics and consumption data for common areas.

#### **D.2 Detached - Single family houses**

Survey the whole building.

#### **D.3 Semi-detached - two residences**

Survey in all residences.

#### **D.4 Terraced houses – up to 3 floors**

Survey only the lower and upper floor.

# ANNEX I

## Building Energy Survey Template

1. General Data		
Building form	Terraced house <input type="checkbox"/> Detached <input type="checkbox"/> Semi-detached <input type="checkbox"/> Multi-family / apartment building <input type="checkbox"/>	
Building Use	Residential <input type="checkbox"/> Mixed <input type="checkbox"/>  If mixed use, please provide information of specific uses by floor ..... ..... ..... .....	
Address		
Total area (sq.m)		
Building height		
Number of Floors		
Area per floor (sq.m)	Basement ..... Ground Floor ..... 1 <sup>st</sup> ..... 2 <sup>nd</sup> ..... 3 <sup>rd</sup> ..... ..... .....	
Construction Year		
No of apartments		
Apartment number which is surveyed		
Floor at which apartment is located		
Apartment total area (sq.m)		
Refurbishment Year		
Type of Refurbishment	Replacement of windows: <input type="checkbox"/> Year: ..... Roof Insulation: <input type="checkbox"/> Year: ..... Wall insulation: <input type="checkbox"/> Year: ..... Boiler replacement: <input type="checkbox"/> Year: ..... Other: ..... .....	
No of residents:	Apartment .....	Whole building .....

2. Occupant / Contact person data	
	Owner-occupier <input type="checkbox"/> Tenant (private rented) <input type="checkbox"/> Tenant (public rented) <input type="checkbox"/> Leasehold <input type="checkbox"/> Shared ownership <input type="checkbox"/> Building manager <input type="checkbox"/>
Family name / First name	

Age of primary resident	
Vocation / Working status	Professional <input type="checkbox"/> Retired <input type="checkbox"/> Student <input type="checkbox"/> Other .....
Number of household members	
Age of each household member	
Relation of household members	Family <input type="checkbox"/> other Couple <input type="checkbox"/> room mates <input type="checkbox"/> Other .....
Income	High <input type="checkbox"/> Medium <input type="checkbox"/> Low <input type="checkbox"/>
Tel/ Fax	
e-mail	

### 3. Building Use data (for NON-residential building/NON-residential part of building)

Operation hours:	Monday – Friday: from .....- to..... Saturday – Sunday: from .....- to.....
Average number of occupants during:	
Working days (Mon – Fri)	
Saturday	
Sunday and Public holidays	

### 4. Building envelope data

Load bearing structure	Concrete <input type="checkbox"/> Wood <input type="checkbox"/> Timber <input type="checkbox"/> Steel frame <input type="checkbox"/> Other .....
External walls material	Brick wall <input type="checkbox"/> Single layer <input type="checkbox"/> Double layer <input type="checkbox"/> Masonry (brick and blockwork) cavity wall <input type="checkbox"/> Solid stone wall <input type="checkbox"/> Concrete panels <input type="checkbox"/> Other .....
External wall thickness (cm)	
Type of insulation	Expanded Polystyrene <input type="checkbox"/> Extruded Polystyrene <input type="checkbox"/> Polyurethane <input type="checkbox"/> Glass wool <input type="checkbox"/> Stone wool <input type="checkbox"/> Other .....
Insulation layer thickness (cm)	
Position of Insulation	Internal <input type="checkbox"/> External <input type="checkbox"/> Core <input type="checkbox"/>
<i>Roof:</i>	
Horizontal concrete roof	<input type="checkbox"/> thickness: ..... (cm)
Sloped concrete roof	<input type="checkbox"/>
Sloped Concrete roof with tiles	<input type="checkbox"/>
Horizontal concrete roof on which a wooden sloped with tiles is constructed	<input type="checkbox"/>
Sloped wooden roof with tiles	<input type="checkbox"/>
If sloped roof, please provide angle of slope (°):	.....
Roof space under the sloped roof occupied and heated?	Yes <input type="checkbox"/> No <input type="checkbox"/>
Roof insulation layer thickness	..... Expanded Polystyrene <input type="checkbox"/> Extruded Polystyrene <input type="checkbox"/>



## 5. Building layout

Please, provide a draft layout of the building, with spatial dimensions, orientation, street width height of adjacent and opposite buildings.

Please, provide photos of each façade and of the surrounding area.

A large, empty rectangular box with a thin black border, occupying the central portion of the page. It is intended for the user to provide a draft layout or photos as requested in the text above.

6. Heating system	
Type of heating system	Diesel boiler <input type="checkbox"/> Gas boiler <input type="checkbox"/> Heat pump <input type="checkbox"/> Micro - CHP <input type="checkbox"/> Electric based <input type="checkbox"/> Solid Fuel burners <input type="checkbox"/> Other .....
If multiple systems, estimate % of heating needs covered by each system	
Capacity (kW)	
Efficiency	
Type/Model	
Number of systems (if there are multiple systems of the same type e.g. two or more heat pumps)	
Installation year	
Operating hours per day	Winter Period: from .....- to.....
Operating hours per day	Spring/Autumn Period: from .....- to..... to get operation profile
Type of heating control	Thermostat <input type="checkbox"/> timer <input type="checkbox"/> thermostatic valve <input type="checkbox"/> other.....

7. Domestic Hot Water system	
Winter season please describe:	Type: electric resistance <input type="checkbox"/> solar <input type="checkbox"/> gas <input type="checkbox"/> diesel <input type="checkbox"/> biomass <input type="checkbox"/> heat pump <input type="checkbox"/> Other ..... Capacity kW): ..... Operating hours/day: .....
Summer season please describe:	Type: electric resistance <input type="checkbox"/> solar <input type="checkbox"/> gas <input type="checkbox"/> diesel <input type="checkbox"/> biomass <input type="checkbox"/> heat pump <input type="checkbox"/> Other ..... Capacity kW): ..... Operating hours/day: .....  For solar systems: Surface of solar panels ... m2
Is there a hot water storage vessel?	YES <input type="checkbox"/> NO <input type="checkbox"/>
If yes, what is the volume (lt)	

8. Space Cooling system	
Type	Central <input type="checkbox"/> split units <input type="checkbox"/> fan coil <input type="checkbox"/> Other .....
Installation year	
Number of units	
Electric capacity per unit (kW)	
Cooling capacity per unit (kW)	
Operating hours per day	
Is it used for space heating as well? If yes, please give %	YES <input type="checkbox"/> NO <input type="checkbox"/> .....%
Roof fans Number Power per fan	..... .....

9. Lighting system of individual apartments/households			
Type of light bulbs:	Number	Power (W)	Operating hours per day
Incandescent			
Fluorescent			
Fluorescent compact (CFL)			
Halogen			
Other			

10. Lighting system in common use areas of the building			
Type of light bulbs:	Number	Power (kW)	Operating hours per day
Incandescent			
Fluorescent			
Fluorescent compact (CFL)			
Halogen			
Other			
Is there an automation system? What type?	Time scheduling control <input type="checkbox"/> Occupancy sensors <input type="checkbox"/> 1. Other .....		

10.a Lighting system of non-residential part of building			
Type of light bulbs:	Number	Power (W)	Operating hours per day
Incandescent			
Fluorescent			
Fluorescent compact (CFL)			
Halogen			
Other			
Type of luminaires	ceiling mounted direct <input type="checkbox"/> ceiling mounted with diffuser <input type="checkbox"/> recessed downlighter <input type="checkbox"/> pendant direct <input type="checkbox"/> pendant indirect <input type="checkbox"/> chandelier <input type="checkbox"/> free standing <input type="checkbox"/> wall-washer <input type="checkbox"/>		
Is there an automation system; What type;	Time scheduling control <input type="checkbox"/> Occupancy sensors <input type="checkbox"/> Other .....		

11. Other Electric equipment			
	Number	Power (kW)	Operating hours per day
Computers - Desktop			
Laptops			
Copiers/Printers			
Refrigerator			
Electric cooker			
Microwave			
Washing machine			
Tumble dryers			
TV			
Other			

12. Energy consumption data of the last three years				
Year	Electricity (kWh)	Diesel (lt)	Natural Gas (Nm <sup>3</sup> )	Other fuel
2011				
2012				
2013				

<b>13. Energy cost data of the last three years</b>				
Year	Electricity (€) incl. tax	Diesel (€) incl. tax	Natural Gas (€) incl. tax	Other fuel (€) incl. tax
2011				
2012				
2013				

<b>14. Onsite energy generation</b>	
Is there a PV system on the building? If Yes please provide:	Installed Capacity .....KWp
Is there another micro-generation system? If yes please describe:	Type of system ..... Fuel Used..... Installed Capacity ..... kW