Deliverable D1.1:
European building and urban stock data collection

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1 Summary

The Task 1.1 Identification and collection of existing data devises a set of robust criteria for identifying data that will be taken into consideration during the research, such as buildings age, typology, social appropriation, geographical location, energy uses, demand and behaviour. The following aspects summarize the findings:

Criteria for identifying data
Nowadays there are multiple databases related to urban and energy information (National Urban Database Access Portal Tool (NUDAPT), Eurostat - City statistics - Urban Audit (Eurostat), Energy-Cities case studies (Energy-Cities), Global Urban Indicators (UN-Habitat)) that can be used to support the methodology of decision making for the assessment of energy interventions in historic districts. Nevertheless, it is necessary to establish criteria for identifying the databases that are useful and suitable for EFFESUS and that will ensure the exchange of data and the information workflow in the decision making process.

Identification and evaluation of existing statistical data sources
Statistical data on a national or regional level are anonymous. Therefore the use for certain historic district is limited, but they can provide valuable information about the total building stock. For the historic stock in European countries several building age classes are given (two or more). The age classes didn’t match, therefore the border range between historic and non-historic buildings covers the period 1945 to 1950.
In general the protected stock is only a small part of the historic stock, even if some conservation areas are taken into account. In consequence the data of the monument offices covers only a smaller part of the historic stock, which implies that for the major part no information about the cultural value or building structure is available in public data bases.
The measured energy consumption of buildings can be lower than the calculated energy demand, especially for historic buildings. The refurbishment of buildings before 1919 can be less effective compared to buildings in the period 1919 to 1948, because they show more architectural features on facades and details which results in more complex tasks for retrofitting.

State of the art summary and evaluation report of previous attempts to statistically represent and categorize the building stock
This state of the art summary of previous attempts to statistically represent and categorize the building stock shows that even though the projects use a variety of typologies and categorization schemes, they still define a common platform in terms of methodology and input data specifications.
The access to and quality of national building data varies greatly and will be a limiting factor. For the case studies, additional data will be actively collected. Existing typologies and categorization schemes are useful in the EFFESUS context, but they need to be modified to take into account cultural heritage values and vulnerability to change. Based on the previous studies, one can identify a minimum requirement of data that is needed for building categorization on a wider scale. For the case study districts, the level of detail will be much higher.
Collection of information on European building stock

In general the historic growth of a city is known, but several facts limit global information on buildings in districts. In World War II a lot of town centres were destroyed by bombing (e.g. major towns in Germany, UK, and Poland). Since the historic part of the building stock is more than 65 years old, at least one or more refurbishments were performed. Not all historic buildings are protected by law (listed buildings). Depending on the protective law, sometimes only façade elements or the appearing are protected. Other parts of a building could be changed or destroyed. Therefore the visual building typology could lead to miscalculations on energy efficiency measures, due to unknown refurbishments and changes at certain buildings.

Surveys in form of historic or archaeological analyses of towns or conservation areas could be a very valuable source of information, even though the listed building stock represents only a smaller part of the historic stock. Best practice examples like the “Raumbuch” concept of the 3ENCULT project (Exner et al. 2012) and the path for energy efficiency of the Swiss Society of Engineers and Architects (SIA 2040 2011) will be taken into account for the assessment and improving of energy efficiency in historic districts.

The collection of data in the different countries shows a great variability. In general up to Level of Detail 2 data (3d with roof forms) are available for most of the case studies. Even if not in all countries a proper set of climate data is available. The data from the Climate for Culture project will cover Europe with a grid 10 km by 10 km. Building specific data on energy consumption as well as data of building types, materials and construction are not in general available, besides the listed buildings and conservation areas. Therefore it is clear that the selection of a certain historic district needs additional efforts to gather not public available data. Information providers could by town administrations and energy providers as far as personal privacy aspects are not affected. Finally a personal survey of the chosen district will be necessary in all cases to set up the final data base for the Decision Support System.
2 Objectives

2.1 Task 1.1 Identification and collection of existing data

Objective of this task is to devise a set of robust criteria for identifying data that will be taken into consideration during the research, such as buildings age, typology, social appropriation, geographical location, energy uses, demand and behaviour. The first step will be to identify and evaluate existing statistical data sources on the European historic building and urban stock. European Housing statistics will be used as well as other national and regional statistical sources. This will be followed by a state of the art summary and evaluation report of previous attempts to statistically represent and categorize the building stock on national and regional levels. Special attentions will be paid to those investigations that have dealt with energy issues, indoor climate and material conditions. The results from the EU project 3ENCULT will be used along with the Swedish research database BETSI, The German database MASEA and a German Catalogue of typical regional building materials. All task participants and task leader will contribute to identify the European building stock by covering their own countries and neighbour countries.

As availability of information regarding all the aspects that need to be covered will be variable to one country to another, the acquisition and analysis of statistical data will be on a wide scale, in order to generalise some variables. Data that is not already available in existing studies or databases will be collected from primary sources.

The approach will be to collect climate and microclimate data for the chosen sites, and information about constructions, materials, use of space and organisation, energy sources, heating/cooling systems and other relevant data. An analysis of the collected material will reveal traditional sustainable practices which may be useful in predicting the consequences of alternative options for upgrading traditional buildings, as well as adapting passive energy efficiency principles. The study will focus both on single buildings and larger built contexts.

The output of this task will serve as a basis for the structured categorization at European level, by the use of existing data and statistical analysis and will serve for the data management model, which will be developed focusing on the case study of Santiago de Compostela, analysed in the project, by the use of gis, bim, citygml, and low cost data acquisition.

The data collection for the case studies will demonstrate the quality of the identified sources and the necessary Level of Detail to perform and assess the planned measures. Santiago de Compostela as focus case study will be collected with the most details. The other case studies will be analysed according to the planned measures, which impose different Level of Details. A measure at a single building will cover the building in detail, but for the surrounding district fewer details are necessary.
3 Achievements

3.1 Criteria for identifying data

Nowadays there are multiple databases related to urban and energy information (National Urban Database Access Portal Tool (NUDAPT), Eurostat - City statistics - Urban Audit (Eurostat), Energy-Cities case studies (Energy-Cities), Global Urban Indicators (UN-Habitat)) that can be used to support the methodology of decision making for the assessment of energy interventions in historic districts. Nevertheless, it is necessary to establish criteria for identifying the databases that are useful and suitable for EFFESUS and that will ensure the exchange of data and the information workflow in the decision making process.

The main goal of all the information gathered in this task will be to feed the Decision Support System (DSS). All the data have to be structured in order to be processed by a computer in an easy way and data operability will be a key factor to be taken into account. Data interoperability is the ability that data generated by any party can be properly interpreted by all other parties and it is the first step towards any system integration and collaboration (Shen et al. 2008).

Data should be accessible (free or of very low cost acquisition), accurate and reliable. Main criteria established for identifying the most suitable databases are the following:

- **Format**
  Data have to be readable and understandable by a computer and, in general terms, data sources need to have a structure that allows a semiautomatic process. For these reasons, text files, XML files, relational data bases, etc. are the most suitable. Many buildings related data don’t have a direct access: some of them are stored in paper and some are scanned documents whose information is not easily processable by a computer. These types of documents, such as images files, can be useful as attachments, but are not providing easy accessible data.

- **Accessibility**
  Availability of data sources is a key element for its further reutilization. Free or low cost data sources are preferable. It is necessary to know if the data is free, it has a cost and if it has a license and if exchange capabilities are provided for remote users (web access, ftp file exchange, XML…)

- **Quality**
  Representativeness, relevance and accuracy can be used as references for assessing the quality of the data source: these references have to be high in order to be taken in consideration. For example, the quality of data gathered using multiple sources of collection, such as volunteer campaigns and participatory methods needs to be checked with other sources to ensure the required accuracy.

- **Type of information**
  Geometric or semantic data: Current data bases are not only limited to the representation of the graphical appearance (geometric data), but they also give the possibility to store the semantic and thematic properties, taxonomies and aggregation among the different features.

- **Scale**
  The scale and scope of the data will be clearly defined (building, component, historic district, city, region, country, Europe…)


• **Thematic - Areas of knowledge**
  The domain and thematic of the information should be defined and categorised in order to facilitate the cross-thematic decision making.

• **Language**
  The language of the data source is important and has to be reflected for ensuring interoperability.

• **Updated data**
  It is important to check that the information is updated and the period of years that it covers, as there are databases that provide access only from/to specific years.

• **Geo-reference**
  Spatially referenced information is becoming crucial for urban planning and decision making. Considering that 80% of all public sector information is geo-referenced (Lemments 2001), the geo-referenced databases will be preferred.

### 3.2 Identification and Evaluation of Existing Statistical Data Sources

Statistical data on a national or regional level are anonymous. Therefore the use for certain historic district is limited, but they could provide valuable information about the total building stock. Two aspects are of interest for EFFESUS, one is information on the historic building stock and the other is on the energy consumption. EFFESUS focusses on historic districts, which were built before 1945. The aim is to develop and demonstrate, through case studies, a methodology for assessing and selecting energy efficiency interventions, based on existing and new technologies that are compatible with heritage values. Historic in that sense was defined in the Call-Topic as significant groupings of “old” houses built before 1945 and representative of the period of their construction or history, mostly not protected by legislation; they constitute in fact the vast majority of historic buildings in cities.

#### 3.2.1 Historic Building Stock

In Europe (EU 27, Croatia, Norway, Switzerland, and Turkey) the percentage of buildings older than 1945 vary between 6.1 % (Turkey) and 47.4 % (Luxembourg) with a mean value of 23.1 % (see Tab. 1, derived from (Dol, Haffner 2010) and other sources). The data provided by the national sources cover building types, heating systems, energy consumption, size, and sometimes information about structural system and building materials (e.g. Turkey (Turkish Statistical Institute 2000)). Not all countries match this data with the age classes, e.g. Norway does but Germany does not.

On European Level the Buildings Performance Institute Europe (BPIE) provides data on building stock for European countries (EU 27, Norway, Switzerland and Croatia). The database contains energy policy, energy usage, envelope, performance, district heating, climatic zones, and the existing stock across the EU (BPIE DATA HUB).

(Meijer et al. 2009) compare the European residential building stocks in eight European countries according to performance, renovation and policy opportunities. The German historic stock (< 1949) was in 2006 28 %, but newer data from 2010 show that the historic stock has decreased relative to 27.2 % (see Tab. 1, (Dol, Haffner 2010; DESTATIS 2010)). Additional the historic stock of the German states is listed as well (DESTATIS 2010). In Germany around 3 % of the total buildings are protected and roughly another 10 % are in conservation areas where special rules apply (personal
communication). Compared to 27.2% from the building statistic 2010, the protected stock is less than 50% of the historic stock. In Switzerland the relation is 1.5% protected and 15% in the inventory (Hassler 2009). Therefore the major part of historic buildings is non-protected, which implies that no information about the cultural value or building structure is available in public data bases.

3.2.2 Energy Consumption

With the establishment of the European energy certification standard (EN ISO 13790:2008) there is a tendency to use the measured consumption for the certification process, rather than standardized performance calculations based on the building structure (Kohler, Hassler 2012). If the age of a building and the state of retrofit is known a comparison is possible of retrofitted with non-retrofitted buildings of the same age on a large scale of examples. In (Michelsen, Müller-Michelsen 2010) an analysis based on a total of 156,866 multi-family buildings is given. The sample contains 19,456 buildings which were fully refurbished within the last 15 years and 26,057 buildings which were not refurbished (see Fig. 1). To remove outliers the median values were taken.

Fig. 1: Comparison of total heating energy consumption depending on the year of construction of domestic multi-family buildings (median values) in Germany. The upper curve indicates the median consumption of non-refurbished buildings; the lower curve of fully refurbished buildings; and the middle curve is the median consumption of the whole analysed stock. The total number of buildings is 156,866, fully refurbished is 19,456 and non-refurbished is 26,057 (Michelsen, Müller-Michelsen 2010; Data from ista company, Germany). The limit for historic buildings (< 1945) is shown.

The results show that the effect of refurbishment for buildings before 1918 is limited. The authors discuss that one reason are complex tasks of refurbishment of Wilhelminian style buildings. More potential in energy savings is visible for the period 1918-1945. Norwegian statistic data for 2009 show a similar trend for the average energy consumption (see Fig. 2, (Statistics Norway 2009)). The values are slightly higher, perhaps due to the higher amount of single family houses (farm houses) and the Nordic climate. Interesting is the increase for the youngest building class (> 1997).
# European building and urban stock data collection

Tab. 1: Age distribution of housing stock in the European Union (derived from Dol, Haffner 2010, and additional sources)

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<tr>
<td><strong>Average percentage</strong></td>
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<td></td>
<td></td>
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</table>

Dwellings classified by the period in which the construction of the building containing them was completed.

1 (Permanently) occupied dwellings
3 Estimate
4 From 1981 and onwards
5 Difference of percentage totals 100% due to unknown age of stock
6 < 1945 covers conventional dwellings
Dependent on the used methodology according to (EN ISO 13790:2008) a discrepancy occurs between calculated energy demand and measured energy consumption. A German study (Bigalke et al. 2012) based on 35,000 energy certificates shows that the measured energy consumption of buildings is in average around 30 % lower than the calculated energy demand, especially for historic buildings (< 1949). Mentioned reasons are uncertain U-values and different behaviour of users. A review on studies which showed this so-called 'prebound' effect is given in (Sunikka-Blank, Galvin 2012).

Fig. 2: Average specific energy consumption 2009 by year of construction (Norway StatBank 2009).

### 3.2.3 Databases

- National Statistical Institutes

  The following table list the links to national statistical institutes in Europe. The data provided are available in national languages and partly in English. Sometimes it is possible to export data in formats like pdf, excel, csv or other data formats.
## EFFESUS D1.1: European building and urban stock data collection

<table>
<thead>
<tr>
<th>Country</th>
<th>Name</th>
<th>Link</th>
</tr>
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<td>European Union</td>
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<td>Czech Statistical Office</td>
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<td><a href="http://www.nisra.gov.uk">www.nisra.gov.uk</a></td>
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• **BPIE Data Hub for the Energy Performance of Buildings**
  Provided by BPIE-Building Performance Institute Europe (http://www.bpie.eu/)
  A comprehensive open data portal for energy efficiency in European buildings (statistical data and policy information on Europe’s building stock).
  http://www.buildingsdata.eu/

• **BEEP (Building Energy Efficiency Policies) database**
  Provided by IEA Sustainable Buildings Centre (http://www.sustainablebuildingscentre.org/pages/home)
  Building Energy Efficiency Policies from all over the world.
  http://www.sustainablebuildingscentre.org/pages/beep

• **MUREII database**
  MURE (Mesures d’Utilisation Rationnelle de l’Energie) provides information on energy efficiency policies and measures that have been carried out in the Member States of the European Union and enables the simulation and comparison at a national level of the potential impact of such measures. The MURE database is therefore an important tool to show “demonstrable progress” as requested by the Kyoto Protocol. It has been designed and developed by a team of European experts, led and coordinated by ISIS (Institute of Studies for the Integration of Systems, Rome) and the Fraunhofer Institute for Systems and Innovation Research ISI (Germany).
  http://www.muredatabase.org/

• **Clean Energy Info Portal – reegle**
  Relevant clean energy information for countries (world-wide), including:
  - Country energy profiles including key statistics, policies and actors
  - Catalogue of relevant key actors and stakeholders
  - Map search of energy statistics and potentials
  - Statistics on energy, electricity and emissions
  - Overview of related policies and regulations
  - Catalogue of key stakeholders
  http://www.reegle.info/

• **ODYSSEE-Energy Efficiency Indicators in Europe**
  ODYSSEE on one hand contains detailed data on the energy consumption drivers by end-use and, on the other hand, energy efficiency and CO2 related indicators. Data is regularly updated by EU representatives, such as energy agencies, from all 27 EU member states as well as Norway and Croatia. Currently, energy efficiency data is available from the year 1990 to 2010.

• **Data Base on Energy Saving Potentials**
  This database provides harmonised energy savings potentials for each EU Member State, for Croatia, Norway, Iceland and Liechtenstein, for:
  - Potentials
  - Indicators
  - Technology Drivers
  - Socio-eco Drivers
The analysis of the potentials relies mainly on the MURE simulation tool (Mesures d'Utilisation Rationnelle de l'Énergie), which has a rich description of end-use technologies in order to describe the impact of the penetration of energy efficient technologies at a detailed level.
http://www.eepotential.eu/potentials.php

**TABULA**

The TABULA WebTool was created within the framework of the Intelligent Energy Project TABULA (www.building-typology.eu). The objective of the development was to disseminate the general idea of national building typologies to building experts from all European countries and to give them an understanding of the concrete implementation according to the TABULA agreements:

- The division of residential building stocks in size and age classes;
- Data of exemplary buildings: visual appearance, commonly found construction elements and their U-values;
- Data of exemplary systems: commonly found system types and their energy performance indicators;
- Typical values for the energy consumption by energy carriers;
- Energy saving measures on two quality levels and their impact on the energy consumption;
- Standard reference calculation procedure based on an agreed data format, user conditions and national climatic data;
- Calibration of the standard reference procedure to the typical level of measured.

http://webtool.building-typology.eu/

### 3.2.4 Assessment

- Statistical data for the historic stock in European countries are available. Several building age classes are given (two or more). The age classes didn't match, therefore the border range between historic and non-historic buildings covers the period 1945 to 1950.
- The data cover building types, heating systems, energy consumption, size, and sometimes information about structural system and building materials (e.g. Turkey). Not all countries match this data with the age classes, e.g. Norway does but Germany does not.
- In general the protected stock is only a small part of the historic stock, even if some conservation areas are taken into account. In consequence the data of the monument offices covers only a smaller part of the historic stock, which implies that for the major part no information about the cultural value or building structure is available in public data bases.
- Since statistical data need some time for evaluation, the information given dates back several years. For example the data of the Turkish Building census were collected in 2000; they didn't cover the very strong economic development within the last 10 years.
- The measured energy consumption of buildings can be lower than the calculated energy demand, especially for historic buildings (e.g. in average around 30 % in Germany for buildings older than 1949).
- The refurbishment of buildings before 1919 can be less effective compared to buildings in the period 1919 to 1948, because they show more architectural features on facades and details which results in more complex tasks for retrofitting.
3.3 State of the art summary and evaluation report of previous attempts to statistically represent and categorize the building stock

As the scope of the EFFESUS project is historic urban districts, it is necessary to find ways to analyse the potential for and consequences of energy retrofits not only at a building level but also at an area, or district, level. A common approach is to represent a larger stock of buildings by a limited number of typical or characteristic buildings.

In the EFFESUS project, it is the objective of Task 1.4 to develop a methodology for the categorization of historic districts. According to the DOW, Task 1.1 present a state of the art summary and evaluation report of previous attempts to statistically represent and categorize the building stock. In line with the overall mission of Task 1.1, this section will focus on the need for and availability of data in order to make a statistical representation.

3.3.1 TABULA project

The IEE project TABULA Typology Approach for Building Stock Energy Assessment (TABULA) gives an extensive overview on existing building typologies in Europe (Loga et al 2010). For the following EU countries, they present data sources and typologies:

- Germany
- Greece
- Slovenia
- Italy
- France
- Ireland
- Belgium
- Poland
- Austria
- Bulgaria
- Czech Republic
- Denmark
- Cyprus
- Estonia
- Finland
- Hungary
- Lithuania
- Luxembourg
- The Netherlands
- Portugal
- Romania
- Spain
- Switzerland
- United Kingdom
There is a great qualitative variety in terms of typologies and available data. In spite of this, the summary will be useful for the data collection strategy and method development in the EFFESUS project.

The TABULA project goes on to develop residential building typologies for the participating countries. (TABULA 2012) The typologies are based on size (single-family house, terraced house, multi-family house and apartment block) and age. Other parameters were used on national levels. Exemplary buildings were chosen to represent the different building types, and calculations on possible energy savings were made.

The methodology they have used is based on a system with national definitions – to be used for the needs of national applications – and common definitions – to make the data comparable between nations.

The parameters used for classification in TABULA are presented in the table below:

<table>
<thead>
<tr>
<th>Parameters for Classification</th>
<th>1 Country</th>
<th>country identification</th>
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<tbody>
<tr>
<td>2 Region</td>
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<td>{ region of the country, if necessary }</td>
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<tr>
<td>3 Construction Year Class</td>
<td>for each country definition of periods: from (year) to (year)</td>
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<tr>
<td>4 Building Size Class</td>
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<td></td>
<td>terraced house (single family)</td>
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<td></td>
<td>multi-family house</td>
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<td></td>
<td></td>
<td>apartment block</td>
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<td>5 Additional Parameter</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td>panel building</td>
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<tr>
<td></td>
<td></td>
<td>etc.</td>
</tr>
</tbody>
</table>

| Reference area               | floor area based on internal dimensions (see DATAMINE evaluation) |
| Calculation method building  | Calculation of energy need for space heating: |
|                              | seasonal method according to EN ISO 13790 |
|                              | one-zone model |

| Boundary conditions          | to be defined by partners for his country: |
|                              | external temperature |
|                              | solar radiation |
|                              | standard values: |
|                              | room temperature |
|                              | air exchange rate |
|                              | internal heat gains |
|                              | values for red. factors solar radiation (shading, …) |

| Thermal envelope             | external dimensions (DATAMINE convention) |
| U-values                     | table by each partner |
|                              | with explanations in national language and in English |

| Consideration of thermal bridging | categories (effect of constructional thermal bridges): |
|                                  | low |
|                                  | medium |
|                                  | high |

| Calculation method supply system | balance type: EN 15316, level B (tabled values) |
|                                  | tabled values for subsystems |
|                                  | determined by applying national procedures / standards: |
|                                  | heat generation: energy expenditure coefficients |
|                                  | heat storage: annual losses in kWh/(m²a) |
|                                  | heat distribution (including heat emission): annual losses in kWh/(m²a) |
|                                  | auxiliary energy: annual electric consumption in kWh/(m²a) |
|                                  | (each for space heating systems and dhw systems) |

| Delivered energy / fuel        | reference to gross calorific value |
3.3.2 EIPRO Study (Environmental Impact of Products)

In order to calculate the life cycle impact of EU residential buildings 72 building types were defined (Nemry et al. 2010). The categorization was conducted based on four parameters, analysed step by step:

1. Population and building stock data
2. Definition of buildings according to size
3. Material and building design
4. Definition of typology

Sources used for the population and building stock data were Eurostat, publications from the construction sector and statistics from financial institutions. The buildings were divided into the following groups according to size: Single-family house, multi-family house and high-rise building. Material and building design typologies were based on construction details for all climatic regions presented in the EPIQR project (EPIQR 1996). The typologies defined were aimed at representing 80% of the total EU-25 residential building stock.

3.3.3 Reference buildings

For calculations on energy performance in building stocks reference buildings can be used; different methods for selecting them and different applications are presented in a couple of articles (Ballarini et al. 2011, Corgnati et al. 2012). The aim of a set of reference or archetype buildings is to represent the typical and average building stock in terms of climatic conditions and functionality, but there is no standardized method to determine them. The data collected for selecting reference buildings can be categorised in four groups:

1. Form
2. Envelope
3. System
4. Operation

Other studies on the national level show a similar approach to data collection. Depending on the aim of the study and the size of the building stock the data needs to be more or less detailed.

Another type of reference buildings are generic buildings developed in the Climate for Culture project to assess the effect of climate change to different types of buildings. The following types are used: ‘sacred building’ (church), ‘museum’, ‘palace’ and ‘residential building’. For monuments that would not fit into the given categories the classification outstanding was introduced. These five categories reflect common associations with the use, building volume, construction as well as the technical equipment (Climate for Culture). See chapter 3.4.2.2 for a further description of the project.

3.3.4 ECCABS – Energy, Carbon and Cost Assessment for Building Stocks

A model called ECCABS – Energy, Carbon and Cost Assessment for Building Stocks has been developed (Mata et al. 2013). It is a bottom-up model to assess energy-saving measures and CO2 mitigation strategies in building stocks. The input parameters needed are data on building geometry and thermal properties of the construction materials as well as characteristics of the building service system and required indoor temperature. Each building is assigned a weighting coefficient, which represents the fraction of buildings in the entire stock that belong to that building category. This allows for the extrapolation of the results for the representative buildings to the entire stock. Either sample buildings or archetype buildings can be used. Sample buildings are
defined as representing actual building, with measured data. Archetype buildings are theoretically described buildings, based on data from statistics.

Further ECCABS studies have been made for different countries (Mata, Sasic Kalagasidis 2009, Medina Benejam et al. 2011) in order to demonstrate the application of the model. These studies show the applicability of the model, but also highlight the common problem of finding reliable data.

### 3.3.5 BETSI – Building’s Energy, Technical Status and Indoor Environment

In 2006 the Swedish National Board of Housing, Building and Planning, Boverket, was commissioned by the government to perform a larger study on the building stock. The objective was to describe the technical characteristics of the buildings by inspection, measurements, questionnaires, interviews, etc., with regard to energy use, indoor climate and the condition of materials and constructions of the buildings and the building services systems. Particular focus has been on producing data of damage to buildings and lack of maintenance, and data for development of environmental quality objective A Good Built Environment. The 50 surveyors underwent a two-day joint training in order to have the same starting points for surveys. A number of verification inspections have been conducted to assess the quality of survey records, instructions and how different surveyors had worked. A series of measurements were carried out in connection with inspections. These measurements included air circulation, radon, temperature, moisture and chemical substances in indoor air. Questionnaires were sent to residents in surveyed buildings, but also to a larger number of people living in private homes to get data from more dwellings. The first results were presented in 2009, and more extensive results in 2010.

Approximately 1800 buildings were chosen statistically to represent the entire building stock. The selection was made by Statistics Sweden. An advanced method for selection was used, due to the broad purposes of the BETSI-study. In the multi-step selection step I was to select 30 municipalities, step II taxation units, step III buildings and step IV apartments and individuals. The residential buildings belong to 5 different age categories:

<table>
<thead>
<tr>
<th>Building year</th>
<th>Single family buildings</th>
<th>Multi-family buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before 1960</td>
<td>168</td>
<td>112</td>
</tr>
<tr>
<td>1961-75</td>
<td>175</td>
<td>161</td>
</tr>
<tr>
<td>1976-85</td>
<td>166</td>
<td>98</td>
</tr>
<tr>
<td>1986-1995</td>
<td>155</td>
<td>99</td>
</tr>
<tr>
<td>1996-2005</td>
<td>162</td>
<td>90</td>
</tr>
</tbody>
</table>

### 3.3.6 DEMAKOalt

The German database DEMAKOalt describes in 7 different age classes (e.g. > 1918, 1919-1948 for historic buildings) the construction typology of 6 building elements: steep and flat roof, ceiling, basement ceiling, floor, and external wall. The data contain typical design and construction elements, and thermal transmittance (U-value), see Fig. 3. At the moment around 800 datasets for the zip code areas of Germany are available. The data are available for research purposes.

One reference (Böhmer et al. 2010) is a catalogue of building elements which lists the U-values of different historic construction types. It covers roofs, ceilings, basement ceilings, floors, and external walls. The data are based on standards (e.g. DIN 4108), data from the accompanying research project and structural-physical data.
The U-values are calculated with the software (DÄMMWERK 2008). They are not compared with real energy consumptions and give only estimations.

Fig. 3: Sketch of a dataset in the German database DEMAKO$^{\text{alt}}$.

3.3.7 MASEA

The German MASEA database was created during a research program and contains a publicly available material property. This database contains all the necessary hygrothermal characteristics for a wide range of typical building materials. The Fraunhofer-Institute for Building Physics leads the investigation in cooperation with the Institute of Building Climatology of the University Dresden and the Center for Environmentally Conscious Building (ZUB) in Kassel. Fig. 4 shows an example. Since Fraunhofer IBP is partner in EFFESUS the data will be available for the project.
3.3.8 Methods for categorization of smaller building stocks

A method called Statistical Distribution of Buildings according to primary Energy use for heating (E-SDOB) has been developed (Fracastoro 2011). E-SDOB is applicable to territories large enough to be covered by complete Census data and small enough to be quite homogeneous from climatic and building technology points of view. The idea is that E-SDOB should be a useful tool for a better knowledge of the regional building stock and for adapting energy regulations.

A case study was carried out, which resulted in the identification of 72 building geometries, based on three Census categories:

- Number of floors (1, 2, 3 and 4 or more);
- Number of dwellings per building (1, 2, 3 or 4, 5–8, 9–15, or more than 16);
- Three contiguity indices (no contiguity, one common boundary, two boundaries).

Each of these buildings belongs to:

- Four age categories (before WWII; 50s to 70s; 80s (after L 373/76); 90s (after L 10/91)), depending on which floor height, $S_w/S_f$, and U-values are defined.
- 11 Global heating system efficiencies (10 classes from 0.55 to 1 for boilers and one for the district heated buildings).
- A variable number of degree-days (DD) categories depending on the DD range width and the chosen “step” (100 DD in this study).
3.3.9 Surveying of districts

With direct relevance to the scope of the EFFESUS project, (Dall'O et al. 2012a, b) use a method but extensive surveying of the areas that were studied. The objective of this study is to define a tool that allows public institutions, particularly municipalities, to create a comprehensive database of the energy performance of buildings on an urban setting. Information on the building stock was gathered from already available material such as cartographic documentation, thematic maps, geometric data and others. When the method is used at a municipal scale a higher resolution of the results is required. The fact that a smaller area was studied allowed for actual surveying. The buildings were categorised mainly with the following variables:

- Climate (DD of the location);
- Geometric (S/V ratio, transparent surface/lateral surface area);
- Construction of the building envelope (class of $U$ for opaque surfaces, class of $U$ for transparent surfaces);
- Type of plant regulation (centralised, local, etc.); and
- User type (e.g., residential, commercial, etc.).

3.3.10 ECBCS Research Programme

The IEA (International Energy Agency) Energy Conservation in Buildings and Community Systems (ECBCS) Programme carries out research and development activities toward near-zero energy and carbon emissions in the built environment. The R&D activities focus on the integration of energy-efficient and sustainable technologies into healthy buildings and communities. ECBCS projects and activities have produced long-lasting decision-making tools and integrated systems technologies. Outcomes from the Programme are publicised through many seminars and conferences. ECBCS' mission is to develop and facilitate the integration of technologies and processes for energy efficiency.

The remit of the ECBCS Programme covers every aspect of energy conservation in buildings and community systems. Significantly, community wide energy systems are taking an increasing importance in providing energy services to buildings. For all building types, there are many issues relating to design, construction and performance in practice that need to be resolved. Therefore, the Programme carries out projects in the following areas:

- Community scale energy systems
- Performance benchmarking
- Integrated system design including renewable energy sources
- Renovation and retrofit
- Construction technologies
- Electric lighting and day lighting
- Energy measurement, management & auditing
- Environmental assessment
- Thermal simulation
- Ventilation
- Control of moisture in buildings
Specifically for non-residential buildings, they have carried out research to better understand how energy reduction may be achieved through improved design and operation of systems, including:

- Low energy cooling systems
- Fault detection and commissioning

Sometimes challenges posed by certain building types require special attention. Therefore, the ECBCS Programme has undertaken projects on the following end use sectors:

- Educational buildings
- Office buildings
- Hospitals
- Residential buildings

The primary rationale for ECBCS is its research programme. This is mainly undertaken through a series of research projects (so-called 'Annexes'). Typically each Annex has a life span of 3-4 years, although extensions are possible if a continuing need for the activity is identified. One example is Annex 50: Prefabricated Systems for Low Energy Renovation of Residential Buildings. Within this project studies were performed on the morphology and typology of buildings in two countries: Switzerland and France. The Swiss study includes historic buildings (Swiss Multi-family houses in the range 1919 – 1990) (Schwehr, Fischer 2010). The French studies cover the range 1949 – 1974 (Rout 2010a, b). The following list contains projects, which are eventually relevant for the purposes of EFFESUS:


3.3.11 BATAN project

BATAN is a research project in France (BATAN 2008) which deals with 14 historic buildings in rural regions. The project contains the following steps:

- Assessment of building typology
- Monitoring campaigns in each building
- Development of new models for energetic assessment
- Identification of adapted solutions for energetic improvement
3.3.12 Assessment

This state of the art summary of previous attempts to statistically represent and categorize the building stock shows that:

- Even though the projects use a variety of typologies and categorization schemes, they still define a common platform in terms of methodology and input data specifications.
- The access to and quality of national building data varies greatly and will be a limiting factor. For the case studies, additional data will be actively collected.
- Existing typologies and categorization schemes are useful in the EFFESUS context, but they need to be modified to take into account cultural heritage values and vulnerability to change.
- Based on the previous studies, one can identify a minimum requirement of data that is needed for building categorization on a wider scale. For the case study districts, the level of detail will be much higher. This will be addressed in Deliverable 1.4:

<table>
<thead>
<tr>
<th>Basic data needed for categorization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate zone</td>
</tr>
<tr>
<td>Type (residential or other types)</td>
</tr>
<tr>
<td>Size</td>
</tr>
<tr>
<td>Age of construction</td>
</tr>
<tr>
<td>Material</td>
</tr>
<tr>
<td>Use</td>
</tr>
<tr>
<td>Heating/cooling system</td>
</tr>
<tr>
<td>Heritage protection</td>
</tr>
</tbody>
</table>
3.4 Collection of information on European building stock

The aim of the EFFESUS project is to develop and demonstrate, through case studies, a methodology for assessing and selecting energy efficiency interventions, based on existing and new technologies that are compatible with heritage values in European historic districts. Existing data on the European building stock are the base to perform the methodology. All task participants and task leader have contributed to identify the European building stock by covering their own countries and neighbour countries. The exemplary collection of data will be performed on the different case studies, with the main focus on the case study in Santiago de Compostela. This chapter resume the information collected for the different countries.

3.4.1 Categorization

The identification of available data is based on the following categories, derived from the requirements of the multiscale model in Task 1.5:

- Geometric data
  - Districts, buildings: location, terrain, level of detail, space, volume, etc.
    The classification will use 5 Levels of Detail (LoD) derived from the OGC standard open data model CityGML (CityGML) for representing, storing and exchanging virtual 3D city models, which is an application schema of GML.

- Climate data
  - Climatic regions, microclimate, etc.

- Building data
  - Construction typology and materials, building age and usage, protection, retrofitting state, etc.

- Energy data
  - Provision, sources, heating/cooling systems, consumption, etc.

3.4.1.1 General remarks

The data above should be identified for the assessment of a historic district. Since EFFESUS focusses on historic districts in cities, the administration of a chosen city would be a first starting point to identify relevant districts. In general the historic growth of a city is known, but several facts limit global information on buildings in districts.
In World War II a lot of town centres were destroyed by bombing (e.g. major towns in Germany, UK, and Poland). An example of the centre of the German town Ulm is shown in Fig. 5 (Bräuning et al. 2000); only a small part of the buildings are historic.

Since the historic part of the building stock is more than 65 years old, at least one or more refurbishments were performed. Not all historic buildings are protected by law (listed buildings). Depending on the protective law, sometimes only façade elements or the appearing are protected. Other parts of a building could be changed or destroyed. Therefore the visual building typology could lead to miscalculations on energy efficiency measures, due to unknown refurbishments and changes at certain buildings.

During reconstruction and development after World War II historic buildings were destructed to generate car-friendly cities. The loss of buildings was higher than during the war.

The statistical analyses showed that listed cultural heritage buildings form only a small part of the historic building stock. Nevertheless surveys in form of historic or archaeological analyses of towns or conservation areas are a very valuable source of information. They list cultural heritage and historic buildings in their context within a town and provide a mapping of the historic parts of a town. One example from Bavaria is shown in Fig. 6 below. Other examples are the archaeological town cadastre in Baden-Württemberg (Bräuning et al. 2000, Archaeological town cadastre Baden-Württemberg), and the Scottish Burgh Surveys (Scottish Burgh Surveys).

Fig. 5: Historic buildings in city centre Ulm (Germany) for two periods: < 1850 and 1850 to 1920. Yellow marked are environments formed by historical buildings (Bräuning et al. 2000).
3.4.1.2 Concepts for retrofitting and energy efficiency

3ENCULT
The project 3ENCULT aims at the development of passive and active solutions for conservation and energy efficient retrofit for cultural heritage buildings, the definition of diagnosis and monitoring instruments, the long term monitoring (also for IEQ controlling) and the planning and evaluation tools and concepts supporting the implementation, the quality assurance and control of success of the energy retrofit measures (3ENCULT). As planning and evaluation tool the so-called “Raumbuch” (room book) will be extended to cover energetic aspects within a building acquisition (Exner et al. 2012). The “Raumbuch” concept covers a building by single rooms, which corresponds to a LoD 4 analysis. The data acquisition is based on a monument information system from (ProDenkmal), which could be combined with a GIS system. Within the project 8 case studies on buildings in Europe will be performed. The data analysis covers building details (plans, materials, and construction), cultural heritage values, and energy efficiency aspects. EURAC, the coordinator of 3ENCULT, is partner in EFFESUS. The experience of the extended Raumbuch concept on 8 case study buildings in Europe will be available to EFFESUS.

SIA path for energy efficiency
The 2000-watt society (2,000-Watt Society) is an environmental vision, first introduced in 1998 by the Swiss Federal Institute of Technology in Zürich, which pictures the average First World citizen reducing their overall average continuous energy usage to no more than 2,000 watts (48 kilowatt-hours per day) by the year 2050 - without lowering their standard of living (Wikipedia 2000-watt society). Based on this model the Swiss Society of Engineers and Architects (SIA) developed a path for energy efficiency (SIA 2040 2011) to reach the goal of the 2000 Watt society in the building sector. It covers grey energy (SIA 2032 2010), energy for mobility depended on the building location (SIA 2039 2011), energy consumption and the total life cycle of buildings.
Studies which use this path show that historic buildings in densely populated town centres and districts are comparable to energy efficient buildings in new districts further away from town centres (Bieli et al. 2011) and listed cultural heritage buildings could reach the 2000 Watt goal without destroying the cultural heritage value (Laube et al. 2010). The major effect is due to the fact that historic buildings are already built and need less energy for individual mobility.

3.4.2 Europe, Worldwide

3.4.2.1 Geometric data

INSPIRE

In Europe a major recent development has been the entering in force of the INSPIRE Directive in May 2007, establishing an infrastructure for spatial information in Europe to support Community environmental policies, and policies or activities which may have an impact on the environment.

INSPIRE is based on the infrastructures for spatial information established and operated by the 27 Member States of the European Union. The Directive addresses 34 spatial data themes needed for environmental applications, with key components specified through technical implementing rules (see table below). This makes INSPIRE a unique example of a legislative “regional” approach. The full implementation is foreseen until 2019. [http://inspire.jrc.ec.europa.eu/index.cfm](http://inspire.jrc.ec.europa.eu/index.cfm)

Data themes of INSPIRE

<table>
<thead>
<tr>
<th>Annex I</th>
<th>Annex III</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Coordinate reference systems</td>
<td>1 Statistical units</td>
</tr>
<tr>
<td>2 Geographical grid systems</td>
<td>2 Buildings</td>
</tr>
<tr>
<td>3 Geographical names</td>
<td>3 Soil</td>
</tr>
<tr>
<td>4 Administrative units</td>
<td>4 Land use</td>
</tr>
<tr>
<td>5 Addresses</td>
<td>5 Human health and safety</td>
</tr>
<tr>
<td>6 Cadastreal parcels</td>
<td>6 Utility and governemental services</td>
</tr>
<tr>
<td>7 Transport networks</td>
<td>7 Environmental monitoring Facilities</td>
</tr>
<tr>
<td>8 Hydrography</td>
<td>8 Production and industrial facilities</td>
</tr>
<tr>
<td>9 Protected sites</td>
<td>9 Agricultural and aquaculture facilities</td>
</tr>
<tr>
<td>Annex II</td>
<td>10 Population distribution and demography</td>
</tr>
<tr>
<td>1 Elevation</td>
<td>11 Area management / restriction / regulation zones &amp; reporting units</td>
</tr>
<tr>
<td>2 Land cover</td>
<td></td>
</tr>
<tr>
<td>3 Orthoimagery</td>
<td></td>
</tr>
<tr>
<td>4 Geology</td>
<td></td>
</tr>
</tbody>
</table>

LoD 0 (2d)

OpenStreetMap (OSM) is a collaborative project to create a free editable map of the world. Rather than the map itself, the data generated by the OpenStreetMap project is considered its primary output.

[http://wiki.openstreetmap.org/wiki/Main_Page](http://wiki.openstreetmap.org/wiki/Main_Page)
OpenStreetMap (OSM) example Istanbul Taksim place and Gezi-Park.

LoD 1

OSM2World

OSM2World creates 3D models from OpenStreetMap data. These models are rendered using OpenGL to create the map tiles. This map currently covers Germany and small regions elsewhere that were requested by mappers. The server usually checks for changes in the data at least once per week and updates any changed tiles as fast as possible. Rendering is usually finished in time for the next week’s updates. OSM2World comes from Tobias Knerr <osm@tobias-knerr.de>. [http://maps.osm2world.org](http://maps.osm2world.org)

The underlying data may be obtained on: [http://download.geofabrik.de](http://download.geofabrik.de), which provides country specific files from OSM. In principle new maps for other European countries are available on request.

Pseudo LoD 2: Street View services

Google Street View and other street view services as Norc Street View provide images of buildings and streets, which could be used to estimate building heights and typologies (only facades).

Google Street View via Google Maps or Google Earth. The availability for Europe is shown below.
Availability of Street View in Europe.

Norc Street View for regions and larger cities in Hungary, Austria, Czech Republic, and Poland.
http://www.norc.hu/street-view/

LoD 2
Google Earth (Google Maps) or Virtual Earth (Bing Maps 3D) provide 3d visualization with photorealistic LoD 2. As far as specific buildings are concerned, Google Earth shows many 3D computer building models in many cities, in these styles:

- Photorealistic: Shows many buildings in a realistic style, with more complex polygons and surface images.
- Gray: Low-detail models of city buildings designed for computers that may not have the capability of showing the photorealistic models.
Any real world building can be created for Google Earth via a number of avenues:

- Users can create their own 3D buildings with Building Maker. This browser based tool allows users to match “boxes” to aerial imagery of certain cities. Low learning curve resulting in lower quality 3D buildings.

- Users can download SketchUp a 3D modelling application that allows to create detailed digital representations of real world buildings. Provided the models meet Google's criteria, they can then be uploaded to the 3D warehouse and accepted to Google Earth.

- There are now several companies, certified by Google, that provide a service creating and maintaining 3D buildings for customers. These companies generally provide high detail models.

Some models (buildings) within Google earth are downloadable. The complexity of the models varies between simple, middle and complex. Possible file formats:

- .SKP (SketchUp file format)
  SketchUp is a 3D modelling program optimized for a broad range of applications such as architectural, civil, mechanical, film as well as video game design — and available in free as well as 'professional' versions. (Wikipedia.org)

- .KMZ (Google Earth Placemark File)
  Stores map locations viewable in Google Earth, provides a bird's eye view of locations throughout the U.S. and other areas of the world; placemarks may include a custom name and the latitudinal and longitudinal coordinates of the location. KMZ files may also include limited 3D model data exported from Google Sketchup (as an .SKP file) or from ArchiCAD. The model can be placed on the map at a specific location to provide an idea of what the building will look like in that area. (Fileinfo.com)

- .ZIP (Collada file in compressed format)
  COLLADA is a COllaborative Design Activity for establishing an interchange file format for interactive 3D applications. (Wikipedia.org)

Existing models which are not downloadable might be available on direct request from the provider; e.g. [http://www.3dlocationearth.com/](http://www.3dlocationearth.com/) produced a lot of 3d-models in Istanbul, but the models are not downloadable.

3.4.2.2 Climate data

**Climate for Culture**

To assess the damages to cultural heritage in the near and far future, the project considers two different scenarios from the Intergovernmental Panel on Climate Change (IPCC) using different estimates for future carbon dioxide emissions. These combine a range of assumptions about factors that can influence carbon dioxide emissions such as population growth and decline, future energy demands, new and more efficient technologies and strategies for reducing these emissions.

According to the World Meteorological Organisation, the term climate can be defined as ‘the statistical description in terms of the mean and variability of relevant weather quantities over a period of time’. Climate covers different weather elements such as temperature, air humidity, wind, clouding, precipitation, sun shine duration, air pressure, snow fall, radiation and evaporation. All these parameters, including their interactions
with the atmosphere, the hydrosphere, the cryosphere, the surface lithosphere, the biosphere and the resulting carbon cycles, are integrated into so-called general circulation models. Referred to as global climate models (GCM) they are the most complex computer models existing up to now. But global climate models must also take into account parameters which cannot be calculated and for which no fixed values from the past exist. CLIMATE FOR CULTURE includes such projections for high resolution climate simulations by investigating two scenarios: The first is the A1B scenario from IPCC’s 4th report predicting a greater CO₂ emission increase assumed until 2050 and a decrease afterwards. The second, known as RCP4.5, is a scenario which will be published as part of the forthcoming 5th report of the IPCC in 2014. RCP 4.5 stands for Representative Concentration Pathway (RCP) 4.5 and is a scenario of long-term, global emissions of greenhouse gases, short-lived species, and land-use-land-cover which stabilizes radiative forcing at 4.5 Watts per meter squared (approximately 650 ppm CO₂ equivalent) in the year 2100 without ever exceeding that value.

Regional climate model REMO

It has been shown in several EU-funded projects (e.g. (PRUDENCE 2001), (ENSEMBLES 2005), (NOAH’s ARK 2006)) that an ensemble of global and regional climate models can provide credible quantitative estimates of climate evolution over the whole of Europe. While coarse resolution global circulations models (GCM) successfully reproduce climate features on continental scale, only high-resolution regional climate models (RCM) with a resolution of less than 50 km are a reliable source of climate change information required for impact study on regional levels.

Against this background, CLIMATE FOR CULTURE uses the regional model (REMO) which for the first time allows obtaining data from a spatial resolution of up to 10x10 km grid size by dynamical downscaling of global models. REMO is coupled to hydrology and ocean models allowing to also simulate sea level changes under selected climate change scenarios and will be further developed for better prediction accuracy of the consequences of climate change for cultural heritage.

The project will produce climate models for the periods of 1960 – 1990, 2020 – 2050 and 2070 – 2100 with a resolution of 10 km to 10 km grid size for Europe and the Mediterranean. The first period will be validated by real measured data (see the grid distribution below (Erhardt, Antretter 2012)). The resolution is good enough to model buildings or districts in a hygrothermal simulation. The data covered are: air temperature (TA), relative humidity (HREL), wind speed (WS), wind direction (WD), global radiation (ISGH), atmospheric counter radiation (ILAH), rainfall (RN) and cloud index (CI) (Erhardt, Antretter 2012). The data will be available to EFFESUS, because Fraunhofer IPB is co-coordinator in Climate for Culture.

Climate for Culture grid distribution for the comparison with real measured data (red, pink, blue) and large scale models (points in green) for validation.

3.4.3 France

3.4.3.1 Geometric data

LoD 0, 1, 2
Central portal for geo information. 2D vector Data for buildings, parcels, roads, aerial photographs etc. available. 3D data of buildings available. The portal provides the addresses of responsible institutions. The language is French.


3.4.3.2 Climate data

Climate date at national and region level could be found at http://climat.meteofrance.com/ and meteofrance http://france.meteofrance.com/france/accueil/. The language is French.

France has 5 climate regions:
- Oceanic: e.g. Rennes or Brest
- Semi-continental: e.g. Strasbourg
- Oceanic degraded: e.g. Tours or Bourges
- Mountain: e.g. Albertville
- Mediterranean: e.g. Marseille, Nice
3.4.3.3 Building data

BATAN is a research project in France (BATAN 2008) which deals with 14 historic buildings in rural regions. The project contains the following steps:

- Assessment of building typology
- Monitoring campaigns in each building
- Development of new models for energetic assessment
- Identification of adapted solutions for energetic improvement

Interesting is the aim to improve models for energetic assessment and improvement.

3.4.4 Germany

3.4.4.1 Geometric data

LoD 0 (2d), partly LoD 1, 2

AdV
The Cadastral and Surveying Authorities of the Länder, which are responsible for the real estate cadastre and state survey (Official German Surveying and Mapping), cooperate within the Arbeitsgemeinschaft der Vermessungsverwaltungen der Länder der Bundesrepublik Deutschland (AdV) (Working Committee of the Surveying Authorities of the States of the Federal Republic of Germany) to discuss technical matters of fundamental and supraregional importance with a view to finding uniform regulations.

Central portal for cadastral information. In Germany the 16 federal states are responsible. The portal provides the addresses of the responsible offices. Cadastral 2D information (vector data of parcels and floor plans) is available in the ALKIS database. Most German states provide this tool. The rest will be finished in 2014.

http://www.adv-online.de

Link to the internet portals of the members:
https://upd.adv-online.de/icc/extdeu/broker.jsp?uMen=b4870061-7527-a8fe-ebc4-f19f08a07b51

National Geodata Base
The NGDB (National Geodata Base) is a core element of the geodata infrastructure in Germany. It consists of the geodata necessary for fulfilling legally required tasks, for supporting modern administrative actions, economic development and research. In 2007 the Inter-ministerial Committee for Geographic Information (IMAGI) has concluded NGDB Quality criteria, an NGDB Geodata product list and an NGDB implementation planning as seen from the point of view of the Federal Government. NGDB Geodata products of the Federal Government are visualized in the GeoPortal.Bund with a selected service (viewer) in the first implementation stage of the NGDB. The offer is continuously extended.

http://geoportal.bkg.bund.de/nn_161876/EN/Geoviewer/NGDB/NGDB.html [accessed June 2013, the viewer was down]

LoD 2
Several cities provide 3D data of different level of detail (up to photorealistic LoD2; e.g. Hamburg, Stuttgart, etc.). Bayern and Baden-Württemberg did an aerial laser-scanning of the whole terrain. At the moment LoD 1
data available, in future LoD 2. Several cities used the scanning data for 3D models. The data are available from the cities. Example Stuttgart: http://www.stuttgart.de/item/show/478258

3.4.4.2 Climate data

German Weather Service (Deutscher Wetterdienst DWD)
The German Weather Service is a public institution with partial legal capacity under the Federal Ministry of Transport, Building and Urban Development. DWD is the national meteorological service of the National Republic of Germany. It provides meteorological services (forecast) for the general public or individual users, such as shipping, agriculture or science, and also operates the Informationsverbund der Bundesverwaltung (IFMGA). http://www.dwd.de

DWD data can be obtained partly free of costs from the Internet. For research purposes, registered users could download long time measurements as hourly average as XML-files. More detailed information about costs for weather data at: http://www.dwd-shop.de/

Meteomedia

The weather service was founded in 1990 and is today one of the leading weather provider in Europe. With approximately 100 employees, operates Meteomedia subsidiaries in Germany, Switzerland, Canada and the USA. With about 830 stations, it is now one of the largest monitoring networks in Europe. Weather data are available at the link below. An overview of the availability of weather data is allocable on a general scale in the Internet.

Climate Data of Bamberg are also collected by Meteomedia via their local weather station. Available data are: outdoor temperature, relative humidity, wind speed, wind direction, deposition, possibly global solar radiation. Normally the data are available as an hourly average value. It is also possible to get a 10-minutes average value. Requests to get data free of charge for the EFFESUS-Project shall be made through partner Fraunhofer-IBP. www.meteomedia.de

3.4.4.3 Building data

Listed cultural heritage buildings

One part of historic buildings are listed cultural heritage buildings. A private website provides data on listed buildings in Germany which are available on Internet. Partly geo-databases are available (e.g. in Bavaria). http://www.denkmalliste.org/denkmallisten.html.

The contact data of the responsible offices are provided: http://www.denkmalliste.org/untere-denkmalbehoerden.html.

as well as the addresses of the main offices of the “Länder”: http://www.denkmalliste.org/denkmalbehoerden-landesamt-denkmalpflege-landesdenkmalamt.html

Example BAYERNVIEWER-DENKMAL (Bavarian viewer of cultural heritage)
The website offers a graphical presentation (floorplans, GIS-System) of the historical monuments and buildings in Bavaria, as well as the protected areas. It is possible to zoom into the map and to get more detailed information by double-click on a certain listed building. In certain towns a link to all listed buildings is provided on the additional information. The information is given in German. http://www.denkmal.bayern.de/ and http://geodaten.bayern.de/tomcat/viewerServlets/extCallDenkmal?
Concepts for energy efficiency of cultural heritage buildings

Since 1st April 2012 a new federal funding scheme for cultural heritage buildings exists: “Effizienzhaus Denkmal”:
https://www.kfw.de/inlandsfoerderung/Privatpersonen/Bestandsimmobilien/Energetische-Sanierung/KfW-Effizienzhaus-Denkmal/

The funding requires an assessment by an expert for energy efficiency on cultural heritage buildings (Energieberater für Baudenkmale). The necessary knowledge and training is described in a code of practice (Koordinierungsstelle Energieberater für Baudenkmale 2011).

3.4.4.4 Energy data

Energy Performance Certificates are not public available. The same is true for data from heating-, gas- or energy providers. Therefore only building owners can be asked directly.

3.4.4.5 Case study Germany: Bamberg

LoD 0, 1, in future LoD 2

Geoportal Bavaria (Geoportal Bayern)

On regional level Geoportal Bayern is a website of the Bavarian state government, which provides digital cadastral maps of the whole of Bavaria with buildings and boundaries. In addition, integration into GIS systems is possible. The cards are liable for costs. The roof forms are currently recognized. Therefore there is only a “block model” available at the moment. The accuracy of the measurement points is given in decimetres. A LoD 2 model with standardized roof forms is in preparation. Provider is the Bavarian state government.
http://geoportal.bayern.de/geoportalbayern/

Maps on internet are provided through the portal “Bayern Atlas” http://geoportal.bayern.de/bayernatlas/.
Additional functions like better resolution, use, cultural heritage, etc. are commercially available in the BayernAtlas plus solution. https://geoportal.bayern.de/geodatenonline/?x=*RA6In5zJ2TTgfr6NeDaVw.

Example for Bamberg with terrain and block models of buildings included.
LoD 2: 3D-City model

There are recently more than 1,000 3D models of different buildings of the World Heritage City of Bamberg available. It is possible to download the 1-KB KMZ file on a local server to get, depending on the computer and internet connection, stunning views of a detailed city model of Bamberg. Individual parts of the city are already mapped with fronts. The finished files have a large amount of data. The data continue to be completed.

https://www.stadt.bamberg.de/index.phtml?La=1&sNavID=1829.355.1&object=tx|1829.929.1&kat=&kuo=1&sub=0

The 3D-Data are available for the project EFFESUS through the town planning office Bamberg.

Town Planning Department Bamberg (Stadtplanungsamt Bamberg)

The Town Planning Department is preparing concepts for the city council and preparing the traffic planning. Their principles and concepts are implemented via generally binding land-use planning and transport policies. The City Planning Department of Bamberg has its own maps to the sewer-system and construction planning.

https://www.stadt.bamberg.de/index.phtml?mNavID=1829.355&sNavID=1829.355&La=1

Climate data Bamberg

See description above chapter 3.4.4.2 provided by Meteomedia.

Listed cultural Heritage Buildings

Example out of the BAYERNVIEWER-DENKMAL (Bavarian viewer of cultural heritage, see chapter 3.4.4.3 above) for the inner city of Bamberg. Light red marks the ensemble. Single listed buildings are marked in red.
Town descriptions Bamberg

It exist several cultural heritage descriptions about the town of Bamberg in German language from the office of cultural heritage in Bavaria. See (Gunzelmann 2012a, b), (Breuer et al. 2003a, b), (Breuer et al. 2008), (Breuer et al. 2009), (Breuer, Gutbier 1997a, b), (Breuer, Gutbier 1990a, b).

3.4.5 Greece

3.4.5.1 Geometric data

LoD 0 (2d)

Hellenic Cadaster Database


Open on-line database features (in Greek language only):

- Coverage: 347 Regions in Greece (including all cities and 90% of villages)
- Scale: 1:3000000 - 1:500
- Search options by: Region, Municipality, City, Postal Code, address
- Latest update on database: July 2012 for 107 Regions
- Only 2D animation in vector images
- Ability for on line measurements and coordinates information based on WGS84
- Geographical system with immediate conversion to the to the Hellenic Geodetic Reference System (EGSA '87)
- Data exportation on .*.pdf format sheets
Other data maintained by the Cadastral Office databases (on line demand option only) are the following:

- **The cadastral book**, which is comprised of the cadastral sheets (printed or digital) on which all cadastral registrations -initial and posterior ones- that are defined by law are entered. One cadastral sheet corresponds to each property; the cadastral sheet reads the Hellenic Cadastre Code Number (KAEK) of the property and contains its legal status (existing real property rights and general ones that need to be registered, e.g. ownership, easements, property assurances etc., beneficiaries and registrable deeds).

- **The journal**, in which all applications for the entry of deeds filed to the Cadastral Office are entered in chronological order of filing.

- **The alphabetical index**, which includes all beneficiaries that have been registered in the cadastral book.

- **The cadastral diagrams**, on which all properties encompassed in every surveyed area are depicted with their Hellenic Cadastre Code Number (KAEK).

- **The archive of titles**, diagrams and other supporting documents, which are attached to the applications filed for the registration of deeds in the cadastral book.

- **The cadastral survey archive**, which includes all documents collected during the cadastral survey or documents that were produced during the processing of declarations, objections etc., like declaration forms, titles, other supporting documents, objections, appeals, Committees’ decisions, interim cadastral tables and diagrams that were suspended, etc.

- **The cadastral tables**, which are records reading the interim real rights on the properties included in the cadastral diagrams. The content of the final reformed cadastral tables constitutes the content of the first registrations which are on the sheets of the cadastral book.

**Hellenic Organization of Cadastral and Cartography**

Official website of Hellenic Organization of Cadastral and Cartography:  
http://www.okxe.gr/el/ (English language declared as “Under Construction”)

Official database of Hellenic Organization of Cadastral and Cartography:  
Open on-line database features (Greek language only):

- Only 2D animation in vector images with printing utility
- Scale: 1:3000000 - 1:500
- Search options by (at different layers with the possibility to incorporate the desired number of layers to the interactive map)
  - Utility and governmental services
  - Protected sites (monuments – forests – NATURA – archaeological sites, etc.)
  - Transport networks
  - CORINE land cover 1990 -2000
  - Administrative units (regions – counties – municipalities – cities, villages)
  - Hydrography (coastal)
  - Historic districts
  - Geographical grid systems

Hellenic Military Geographical Service

Official website:
http://web.gys.gr/portal/page?_pageid=33,46034&_dad=portal&_schema=PORTAL

Official database (on demand – fees applying) with an online index and search tool:
http://web.gys.gr/GeoSearch_EN/

HMGS provides on demand by the on-line services the following:

- Study, management and execution of geodetic projects using conventional and satellite-based methods
- Processing and adjustment of terrestrial or satellite trigonometric networks
- Transformation of coordinates from one system to another
- Photographic coverage of Greek regions
- Development of coloured and panchromatic films
- Topographic survey of various areas and photogrammetric production of topographic diagrams in analogue or digital form
- Printing of cartographic projects
- Creation of digital terrain model using photogrammetric methods
- Transparency from photographic compilation of cartographic information
- Transparency from photographic processing with cartographic information
- Photo processing conversion, positive-negative-positive (1 - 4 levels and up)
- Photo processing conversion, positive-negative-positive & negative to positive, dimensions 1.0x0.8

Example orthophotos from 1951 (left) and 2012 (right)

**Public Open Data**

Open BETA database based on the data collection by the Hellenic Cadaster Database, Ministry of Culture, Ministry of Internal Affairs, Ministry of Citizens; Protection, Ministry of Education, Ministry of Environment and Climate Change and several Institutes such as Centre of Renewable Energy Sources, Info Society, Organization of Transportation etc.

There is an on-going update process with new data from all over Greece and the latest feature added is the selection of substrate map with the option to use the Hellenic Cadaster Maps, Google Maps and Microsoft Bing Maps.

- Official website:
- Official database (open – Greek language only):
Information included:

- All information included to the Hellenic Cadaster Database as described on the above (without the option of on-line measurements and coordinates exportation)
- Geophysical information (mountains, rivers, lakes, etc)
- Use of Land Orders (currently are available only for Athens)
- Preservation Areas
- National Parks
- Public Services Locations
- Building Authorities
- Stations for measurement air quality and water quality
- Blue flag awarded beaches
- Public Wi-Fi spots

**LoD 2, street view**

**Google Earth:**

- 3D imaging (angle 45°) fully available for Athens and partially to major cities.
- Street view available for Athens and major cities
• Archeological sites and listed buildings (by Law) are fully covered by the service.

Virtual Earth 3D (Bing Maps 3D)
• 3D imaging (angle 45° only) fully available for 90% of the country.
• Street view not available
Better imaging quality than Google Earth

3.4.5.2 Climate data

Hellenic National Meteorological service
Open on-line database for climate conditions:
http://www.hnms.gr/hnms/english/climatology/climatology.html?
Open on-line database for meteorological conditions:
http://www.hnms.gr/hnms/english/meteorology/meteorology_00.html?
On-line database (fees applying) for long and short term statistical data:
http://www.hnms.gr/hnms/greek/Paroxi/paroxi.html?

National Observatory of Athens (meteorological services)
Official website: http://www.meteo.gr/
Open on-line database for meteorological conditions:
http://www.meteo.gr/citySelection-En.asp
On-line database (fees applying) for long and short term statistical data:

Ministry of Environment and Climate Change
Official website: www.ypeka.gr
Open on-line database for climate conditions:
http://www.ypeka.gr/Default.aspx?tabid=226&language=el-GR (Greek language only)
A very brief presentation of the database will lead to the conclusion that the climatic zones of Greece are divided in four (4) different climatic zones, according to the number of heating degree-days. The degree-day is the sum, extended to all days in a conventional annual heating period, of positive differences between interior temperature (conventionally fixed at 20°C) and the mean daily external temperature:

• Zone A: municipalities presenting a number of heating degree-days between 601 and 1.100.
• Zone B: municipalities presenting a number of heating degree-days between 1.101 and 1.600.
• Zone C: municipalities presenting a number of heating degree-days between 1.601 and 2.200.
• Zone D: municipalities presenting a number of heating degree-days over 2.201
The table below shows the four climatic zones (A-D). In cases of areas with altitude higher than 500m, the climatic zone is considered to be the next. There is no any limitation about the usage of heating systems. For buildings constructed 2011 and later, the usage of power saving systems is necessary, e.g. inlet water temperature limitation, etc.

<table>
<thead>
<tr>
<th>Climatic zone</th>
<th>Prefectures</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Heraklion, Chania, Rethymno, Lasithi, Cyclades, Dodecanese, Samos, Messenia, Lakonia, Argolis, Zakynthos, Kefalonia, Ithaca</td>
</tr>
<tr>
<td>B</td>
<td>Corinthia, Elis, Achaea, Aetolia – Akarnania, Phthiotis, Phokis, Boeotia, Attica, Euboea, Magnesia, Sporades, Lesbos, Chios, Corfu (Kerkyra), Lefkada, Thesprotia, Preveza, Arta</td>
</tr>
<tr>
<td>C</td>
<td>Arcadia, Evrytania, Ioannina, Larissa, Karditsa, Trikala, Pieria, Imathia, Pella, Thessaloniki, Kilkis, Chalkidiki, Serres, Kavala, Drama, Evros, Rhodope, Xanthi</td>
</tr>
<tr>
<td>D</td>
<td>Grevena, Kozani, Kastoria, Florina</td>
</tr>
</tbody>
</table>

National Technological University of Greece

Official website: [www.ntua.gr](http://www.ntua.gr)

Open on-line database for climate conditions:

http://www.ntua.gr/weather/
http://openmeteo.org/db/
http://hoa.ntua.gr/

Charts and diagrams: [http://www.meteo.ntua.gr/e/charts/](http://www.meteo.ntua.gr/e/charts/)

Historical data: [http://openmeteo.org/db/stations/d/1334/](http://openmeteo.org/db/stations/d/1334/)

Other databases for climatic and meteorological conditions

- Official website: [www.metar.gr](http://www.metar.gr) (Greek language only)

  On demand (fees applying) on-line database for climate conditions:

  [http://www.metar.gr/signup/](http://www.metar.gr/signup/)
3.4.5.3 Building data

Listed cultural heritage buildings

List of Archaeological Sites and Monuments of Greece

The Enduring List of Archaeological Sites and Monuments of Greece is prepared and issued by the Department of National Monuments Record of the Ministry of Culture and Tourism and brings together declarations protecting immovable monuments, archaeological sites and historical places of Greece, dated from 1921. This list includes only monuments for which there was a need for a declaration in order to be qualified as protected (historical monuments) or to delineate protection zones (prehistoric, classical, Byzantine and post-Byzantine) or to solve any dispute over their inclusion in protective provisions of the law (especially in the case of post-Byzantine monuments). The List of Archaeological Sites and Monuments of Greece is enriched in regular basis with new declarations and additional data on protected monuments and sites.


Ministry of Environment and Climate Change


Open on-line database for historic buildings:
[http://estia.minenv.gr/](http://estia.minenv.gr/) (Greek language only)

The database of the Ministry of Environment and Climate Change covers 9,567 officially characterized as Historic Buildings and 824 officially characterized as Historic Districts and is maintained and updated since 2007.

(Note: in order a building or a district to be characterized as Historic an Official Audit is held by the National Archaeological Committee and the Central Architectural Council and their results needs to be approved by the Regional Commissioner and finally to be published to the Official Gazette)
Example of the open on-line database for historic buildings.

Technical Chamber of Greece

Official website: [http://www.tee.gr](http://www.tee.gr)

Provides libraries and databases related to buildings in English Language including publications, books, standards, materials etc.: [http://opac.tee.gr/cgi-bin-EN/egwcdi/egwirtcl/targets.egw](http://opac.tee.gr/cgi-bin-EN/egwcdi/egwirtcl/targets.egw)
3.4.5.4 Energy data

**Ministry of Environment and Climate Change**


Open on-line database for National Information System for Energy:


**IMPORTANT NOTE:** This database could be accessed only by clicking the link shown as it uses an internal proxy server of the Ministry of Environment and Climatic Change.

Link to the site below: [http://195.251.42.2/cgi-bin/nisehist.sh](http://195.251.42.2/cgi-bin/nisehist.sh)

**Regulatory Authority for Energy (RAE)**


- Open on-line databases:
  [http://www.rae.gr/geo/](http://www.rae.gr/geo/) (Greek language only)

**Centre for Renewable Energy Sources and Savings**


Open databases in English:

- Energy Indicators: [http://www.cres.gr/kape/datainfo/indicators_uk.htm](http://www.cres.gr/kape/datainfo/indicators_uk.htm) (.pdf only)
Open databases in Greek language only (more detailed than English version):

- Energy Indicators: [http://www.cres.gr/kape/datainfo/indicators.htm](http://www.cres.gr/kape/datainfo/indicators.htm) (.pdf only)

### 3.4.6 Hungary

#### 3.4.6.1 Geometric data

**Budapest**

Floor plan information is available via district/city municipality: Urban Planning and Building Regulation plan. In most cases floor plans are available as raster graphics (in some cases on request also as vector information). Most historic districts in Budapest are available as 3D models on Google Earth.

Example: plan for 8th district of Budapest, Józsefváros:

Available in Hungarian Language at: [http://www.jozsefvaros.hu/eugyintezes_epitesi_szabalyzat](http://www.jozsefvaros.hu/eugyintezes_epitesi_szabalyzat)
3.4.6.2 Climate data

- Climate information available for the whole country via homepage of Hungarian Meteorological Service (OMSZ)
  http://met.hu/en/idojaras/

- Detailed climate data and statistics
  http://owww.met.hu/eghajlat/eghajlati_adatsorok/
3.4.6.3 Building data

Historic building stock information

- via district/city municipality: list, map

Two significant sources could be used to gain building data:

EnergyCity project

The typology of the Hungarian residential building stock is developed during the ‘EnergyCity’ project with 7 main types according to the size of the buildings and it was further classified into sub-groups in function of age, layout and location taking into account the heating systems. The project made calculations of the energy performance of each type (based on real technical documentations).

It has to be emphasized that reliable statistics on the number of buildings are available only on the level of the three main building types: family houses, multi-residential buildings built with traditional technology and multi-residential buildings built with industrialized technology.

http://www.energycity2013.eu/

Database on national and scheduled monument buildings - Műemlékem

A database of monument buildings in Hungary and some of the border regions in surrounding countries. Contents: all national and scheduled monuments from the register of National Office of Cultural Heritage and those under local historical monument protection, registered by Hungarian Nonprofit Ltd. for Regional Development and Town Planning.

The database is constantly under construction, and therefore contains up-to-date information on the actual state of the buildings, as well as information of the development or retrofitting in approximately 5 years range. Search in the database is possible according to location, type of protection, use (function typology), type of protected object (archaeological site, building or area). Relevant data:

- type of monument protection
- use (current and original function of the building)
- location – address, coordinates, map
- age – date of construction
- current state of building and basic retrofitting information – photos and/or text

http://muemlekm.hu/
Possible data sources for the following features

**Age**
- Data from *Energycity project*
- Historic building stock information (see 1.3.2)
- Data from *Database on national and scheduled monument buildings*

**Use**
- Data from *Energycity project*
- Data from *Database on national and scheduled monument buildings*

**Material**
- Data from *Energycity project*
- Data from *Database on national and scheduled monument buildings*
- Data from Hungarian Central Statistical Office (KSH)

Building stock classification according to wall structure material

<table>
<thead>
<tr>
<th></th>
<th>Téglá</th>
<th>Vályog</th>
<th>Panel</th>
<th>Fa és egyéb</th>
<th>Öntött beton</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1944</td>
<td>499 711</td>
<td>316 652</td>
<td>0</td>
<td>2 025</td>
<td>0</td>
</tr>
<tr>
<td>1945-1959</td>
<td>499 711</td>
<td>316 652</td>
<td>0</td>
<td>2 025</td>
<td>0</td>
</tr>
<tr>
<td>1960-1969</td>
<td>420 166</td>
<td>97 935</td>
<td>46 995</td>
<td>2 007</td>
<td>33 111</td>
</tr>
<tr>
<td>1970-1979</td>
<td>530 172</td>
<td>39 279</td>
<td>277 822</td>
<td>4 252</td>
<td>61 310</td>
</tr>
<tr>
<td>1980-1989</td>
<td>434 456</td>
<td>6 027</td>
<td>208 848</td>
<td>8 502</td>
<td>40 626</td>
</tr>
<tr>
<td>1990-1999</td>
<td>268 631</td>
<td>5 970</td>
<td>16 009</td>
<td>6 820</td>
<td>10 840</td>
</tr>
<tr>
<td>2000-2005</td>
<td>117 339</td>
<td>1 911</td>
<td>973</td>
<td>7 419</td>
<td>2 136</td>
</tr>
<tr>
<td>2006-2010</td>
<td>148 157</td>
<td>318</td>
<td>92</td>
<td>7 950</td>
<td>398</td>
</tr>
</tbody>
</table>

Forrás: KSH Mikrocentrus és 2010. évi lakásstatisztikai évkönyv
Already retrofitted?
- Data from Database on national and scheduled monument buildings

3.4.6.4 Energy data

Consumption
- data from Hungarian BER classification data source
  
  From December 2012 a data base of so far completed energy classifications (BER) will be available on the internet.

Data base (left) and Hungarian BER classification template sheet (right).

- Data from literature:
  (Várfalvi, Zöld 1994) about Energy efficient retrofitting of building stock. Relevant data: the energetic features of housing in Hungary in 1992

@. táblázat: A hazai lakásállomány és energetikai minősége 1992-ben

<table>
<thead>
<tr>
<th>1992</th>
<th>Épülettípus</th>
<th>családi ház</th>
<th>hagyományos</th>
<th>zárt sorú</th>
<th>iparosított</th>
<th>összesen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lakásszám</td>
<td>2 365 000</td>
<td>577 700</td>
<td>201 600</td>
<td>794 300</td>
<td>3 938 600</td>
<td></td>
</tr>
<tr>
<td>Nem lakott lakások</td>
<td>109 400</td>
<td>40 000</td>
<td>9 900</td>
<td>6 000</td>
<td>165 300</td>
<td></td>
</tr>
<tr>
<td>Hőszigetelés mértéke</td>
<td>u &gt; 1,3 W/m²K</td>
<td>1 865 000</td>
<td>57 800</td>
<td>157 300</td>
<td>2 080 100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,3 &gt; u &gt; 0,7 W/m²K</td>
<td>350 000</td>
<td>433 300</td>
<td>40 300</td>
<td>635 400*</td>
<td>1 459 000</td>
</tr>
<tr>
<td></td>
<td>u &lt; 0,7 W/m²K</td>
<td>150 000</td>
<td>85 600</td>
<td>4 000</td>
<td>158 900</td>
<td>398 500</td>
</tr>
</tbody>
</table>

Megjegyzés: * az iparosított épületeken belül a paneles épületek tervezési értékeit jelentősen lerontják a gyártási, kivitelezési és szerkezeti hányosságok és hőhidak, ezért inkább a korai építésű panelek a „u > 1,3 W/m²K” kategóriába tartoznák.
Heating/cooling system

- Data from heating providers
  Source example: Budapest heating provider Főtáv Zrt.
  http://www.fotav.hu/hasznos-linkek/szolgaltatasi-terkep/

Map of Budapest districts with type of heating.

Energy performance

- Data from Energycity project (see link in chapter 3.4.6.3 above):
  Relevant data: the energy performance of specified building types.

3.4.6.1 Case study Hungary: University of Technology and Economics, Budapest

3D-data in Google earth as model available.
3.4.7 Ireland

3.4.7.1 Geometric data

LoD 0
Ordinance Survey Ireland
2D digital data are available through the Ordnance survey Ireland. www.osi.ie/
The GIS Geographical information system is described at: www.osi.ie/GIS/Benefits-of-GIS.aspx
Data formats are: Dwg, Dxf, Ntf, Shp, File gdb, Excel, Ascii, Tiff, URL links in both WMS and REST access via MapGenie supply.

3.4.7.2 Climate data
MET Eireann: www.met.ie/climate-ireland/climate-of-ireland.asp

3.4.7.3 Building data

National inventory of Architectural Heritage
The database provides floorplans of architectural heritage buildings (local (yellow), regional (blue) and national (green)). Mostly individual buildings – few in historic districts. By clicking on a building, a description of the heritage value is provided. http://www.buildingsofireland.ie

Dublin City Council
Dublin City Council provides plans outlining 11 areas of conservation in Dublin city (Architectural Conservation Area (ACA)). Detailed historic and architectural features are proved. http://www.dublincity.ie/Planning/HeritageConservation/Conservation/Pages/ArchitecturalConservartionAreas.aspx
The Architectural Conservation Area (ACA) aims to identify areas of special character and architectural interest and to preserve that special character. The goal is to provide a framework that will permit a degree of flexibility in terms of design consistent with the maintenance and improvement of the essential character of the ACA. To fulfil this objective all new development in the area of the ACA should be implemented and carried out in accordance with the outlined policies/objectives. There are currently 11 ACAs within Dublin City
1. O’Connell Street ACA, adopted 9th July 2001  O’Connell Street ACA Map
2. Grafton Street & Environs ACA  adopted 3rd July 2006
3. Prospect Square-De Courcy Square and Environ ACA  adopted 26th February 2007
4. South City Retail Quarter ACA  adopted 5th March 2007
5. Dartmouth Square and Environ ACA  adopted 4th February 2008
6. Capel Street and Environ ACA  adopted 5th January 2009
7. Marino Casino ACA  adopted 11th May 2009
8. Thomas Street and Environ ACA  adopted 7th September 2009
9. Chapelizod and Environ ACA  adopted 7th December 2009
10. Fitzwilliam Square and Environ ACA  adopted 7th December 2009
11. Mountjoy Square ACA  adopted 14th May 2012

List of protected structures in Dublin. 8691 buildings are on the record (Dublin City Council). No specification as to what you can or can’t ‘do’ with the buildings with regard to development. It is needed to apply for planning permission from Dublin City council, consul.
http://www.dublincity.ie/Planning/HeritageConservation/Conservation/ProtectedStructures/Pages/ProtectedStructures.aspx

Irish Georgian Society
http://www.igs.ie/

Irish Architectural Archive
www.iarc.ie/

An Taisce - The National Trust for Ireland
www.antaisce.org/

Department of Art Heritage and the Gaeltacht
Architectural Heritage Publications and Conservation Advice Series
Architectural Heritage Protection - Guidelines from Planning authorities (2011)

The Department of the Environment
List of local authorities and town councils
http://www.environ.ie/en/LocalGovernment/LocalGovernmentAdministration/LocalAuthorities/

Office of Public Works
http://www.opw.ie/en/
Heritage Ireland
http://www.heritageireland.ie/en/

3.4.7.4 Energy data

Building Energy Rating
BER certificates are now required for all new buildings and, in the case of existing buildings, for premises undergoing transaction, whether lease or sale. While buildings protected under the National Monuments Acts, protected structures and proposed protected structures are exempt from the requirements to have a BER, all other traditionally built buildings are required to have a BER certificate when let or sold. There is no requirement that a building achieve a particular rating.

3.4.8 Italy

3.4.8.1 Geometric data

LoD 0, terrain
National Geoportal
An important and wide database is the National Geoportal (NG), that contain all the available maps of the Italian territory concerning territorial and environmental themes.

The maps that form the Cartographic base of reference have sets of data that are homogeneous and easy to understand, compare and exchange the content, this information gives life to the National repertory of territorial data. At the moment amongst the strata of maps available all of which can be superimposed we will find:

- Black and white and colour photo;
- IGM cartography;
- Digital model of landscape;
- Toponyms;
- Administrative limits;
- Protected areas;
- Soil description;
- Plan of territory;
- Sea bathymetric;
- Coastal erosion risk;
- Physical map of coast;
- railways;
- Orthophoto dates;
- Geologic data;
- CORINE Land Cover.

http://www.pcn.minambiente.it
Planning sources

In Italy, the protection of the environment, of the ecosystem and cultural resources are under the exclusive competence of the central Government. In some other sectors as the land use planning, the State and the Regions have concurrent legislative powers.

The State provides the legal framework (Law n°1150/1942), and each Region (or autonomous province, as South Tyrol) defines its own land use law.

Municipalities are responsible for the local regulation (town planning plans - Piano Regolatore Generale - PRG and historic preservation plans) inside its administrative boundaries.

Most of planning plans are designed using the “Carta Tecnica Regionale - CTR” as cartographic base. The CTR uses the Gauss Boaga map projection. Usually the CTR is a vector file (dwg o dxf), that can provide only spatial information about the elements (e.g. area and perimeter of buildings).

LoD 1 and GIS-data

In some cases Italian Regions converted the vector file to a Geographical Information System –GIS. The so called shapefile (shp) associate to every vector element a data-record.

The database associate to the buildings can host several and various data (e.g. age, ground elevation, main use, if listed, raster images-pictures, history of authorized refurbishment and maintenance works).

Normally the building database filling is made by the municipalities during the planning process or its update, following the technical specification provided by the different Regional laws. For this reason the national overview is very different.
Often the Regions and province provide other GIS maps (and web-GIS) concerning e.g. environmental information, land degradation, water pollutions.

Besides the historic preservation plans for the old town centre use the cadastral map instead of the CTR as base (cadastre use the Cassini-Soldner map projection), and it gives some small overlay problems. Municipalities of main cities have often its own web-GIS, where several maps are available (or data-layer in order to self-create maps by users), concerning the building use, refurbishment and maintenance works allowed, rule and limitation for ancient buildings, volume.

Links to regional CTRs

- Abruzzo: [www.regione.abruzzo.it/cartografia](http://www.regione.abruzzo.it/cartografia)
- Basilicata [http://www.adb.basilicata.it/adb/cartografiah.asp](http://www.adb.basilicata.it/adb/cartografiah.asp)
- Campania
  - PROVINCIA DI NAPOLI [http://sit.regione.campania.it/ctr5k_2004/LINK_NA_1.htm](http://sit.regione.campania.it/ctr5k_2004/LINK_NA_1.htm)
  - PROVINCIA DI SALERNO [http://sit.regione.campania.it/ctr5k_2004/LINK_SA_1.htm](http://sit.regione.campania.it/ctr5k_2004/LINK_SA_1.htm)
  - PROVINCIA DI CASERTA [http://sit.regione.campania.it/ctr5k_2004/LINK_CE_1.htm](http://sit.regione.campania.it/ctr5k_2004/LINK_CE_1.htm)
  - PROVINCIA DI BENEVENTO [http://sit.regione.campania.it/ctr5k_2004/LINK_BN_1.htm](http://sit.regione.campania.it/ctr5k_2004/LINK_BN_1.htm)
  - PROVINCIA DI AVELLINO [http://sit.regione.campania.it/ctr5k_2004/LINK_AV_1.htm](http://sit.regione.campania.it/ctr5k_2004/LINK_AV_1.htm)
- Eemilia-romagna [http://territorio.regione.emilia-romagna.it/](http://territorio.regione.emilia-romagna.it/)
- Friuli-Venezia Giulia [http://irdat.regione.fvg.it/consultatore-dati-ambientali-territoriali/](http://irdat.regione.fvg.it/consultatore-dati-ambientali-territoriali/)
- Lazio
  - [www.regione.lazio.it/ptpr/ptpra/](http://www.regione.lazio.it/ptpr/ptpra/)
  - [www.urbanisticaecasa.regione.lazio.it/cartanet/](http://www.urbanisticaecasa.regione.lazio.it/cartanet/) (serve plug-in)
Liguria
  - www.cartografia.regione.liguria.it/
  - www.regione.liguria.it/territor/12_carto/frameset.htm

Lombardia www.cartografia.regione.lombardia.it/geoportale

Marche http://www.ambiente.marche.it/Territorio/Cartografieinformazioniterritoriali.aspx

Molise http://cartografia.regione.molise.it

Piemonte www.regione.piemonte.it/repertorio

Provincia di biella http://cartografia.provincia.biella.it/on-line/Home.html

Puglia
  - http://www.sit.puglia.it/
  - www.cartografico.puglia.it

Sardegna http://www.sardegnaegeoportale.it/

Sicilia http://www.sit.regione.sicilia.it/content/view/27/50/

Toscana http://www.rete.toscana.it/sett/territorio/cartocartopage/pagine/10000.htm

Trentino-Alto Adige www.regione.taare.it
  - Provincia autonoma di bolzano
  - Provincia autonoma di trento

Umbria http://umbriageo.regione.umbria.it/canale.asp

Valle d'aosta http://www.regione.vda.it/territorio/cartografia/default_i.asp

Veneto http://idt.regione.veneto.it/app/metacatalog/

3D public:
The entire Italian territory is covered by digital orthophoto maps (Google Earth, Microsoft Bing, ...). Main cities and surrounding have also birds-eye view. Most important buildings are provided as 3D models by Google Earth.

3.4.8.2 Building data

Information on historic buildings and districts in GIS:
The central Government provide a web-Gis with environmental and historical restriction concerning national law (D.Lgs. 42/2004). http://sitap.beniculturali.it/sitap/
Some Regions, like Lombardi and Liguria provide a specific web-GIS service for its own territory for environmental and historical restriction. [http://www.liguriavincoli.it](http://www.liguriavincoli.it)
Local databases

A local database of Venetian Villas (among 5,000 rural and urban buildings, heritage of Republic of Venice) protected as not by national laws.

http://irvv.regione.veneto.it/index.php?wp=INDEX

A local database of buildings protected by national laws is provided by “historical superintendence offices” (only some territories). It provides only static data (sometimes cadastre pictures) and not geographical searchable maps.

http://sbap-vr.beniculturali.it/vincoli/

Sometimes only address and legal framework, without map.

http://www.beniarchitettonicipiemonte.it
3.4.8.3 Energy data

Some regions, as Lombardy, started the creation of a “buildings energy cadastre”
http://www.cened.it/ceer

3.4.8.4 Case study Italy: Via Garibaldi, Genoa

Parts and some building-models of Genoa are available in 3d in Google, but nothing in the area of via Garibaldi.

3.4.9 The Netherlands

3.4.9.1 Geometric data

Geospatial Data Service Centre
http://gdsc.nlr.nl/gdsc/

3.4.9.2 Building data

Cultural Heritage Agency of the Netherlands
The Netherlands also has nine World Heritage sites and some 440 urban and village conservation areas.
http://www.cultureelerfgoed.nl/en

3.4.10 Norway

3.4.10.1 Geometric data

General
Norwegian authorities, mapping authorities, governmental institutions and research organizations collect, administate and distribute a wide range of geodata, some of which are capable of serving as sources for aggregated energy assessment of buildings. Most data sources are open and easily available through public channels on the www, while others might be partly restricted. State or municipal authorities have full access to collected information on buildings, the same goes for research institutions and universities. General mapping data (terrain, land use) which often play a role in modelling of energy consumption are available for the general public for free (research and other academic use, non-commercial use), or for a moderate fee (commercial use). Meteorological data and climate data are available for browsing/inspection free of charge, and can also be downloaded for use with GIS systems, for analytic purposes. High resolution, detailed map data, including topography, buildings and other built structures, infrastructure and natural environment, suitable for most purposes, are collected and maintained by the state mapping authorities. The digital version of these data are available for downloading or browsing/inspection under the name of FKB (“Felles Kart Base” – Common Map Base), through the joint organisation “Norge Digitalt” (Norgedigitalt.no). All geodata are distributed in a common structured exchange format (SOSI), and the mapping authorities are responsible for data maintenance, establishing and upkeep of unique IDs, categories, and classifications and so forth.
Included in the following data overview is data only from official sources (mapping authorities, property registrars etc.), while unofficial data sources available on the web (such as 3D building models on Google Earth) are omitted.

**LoD 0, 1, 2, GIS**

**Building information**

The Norwegian law on Property registration (Cadastral law) provides since the late 70ties the establishment of an integrated registry/data base for property, buildings and addresses. The registry was named GAB (“Grunneiendom Adresser Bygninger”) up until the law was revised in 2005. Since then the official name of the registry has been “Matrikelen” (“the Cadastre”).

The “Matrikkel” has three main parts:

- The property and land register (the official record of all land and building property)
  - Property tables
  - Property maps (digital)
- The address register (official record of addresses)
  - Mapped address points
- The building register
  - Tabled information of building details, which through a national building ID can be linked to geographic data:
    - Mapped building representation points
    - Digital outlines (on cm level) of roof

The building register contains information of all independent detached buildings (by definition: all building that can be removed/dismantled independently of other buildings), including also floor space information.

**FKB:** Most buildings are registered with footprint (2D) and with prominent details in 3D, at a 0.01 m precision level. The registry maintains a unique national Building ID (which ensures integrity/relations between all building and property data sources). Data available for download to GIS systems (vector data), or for browsing/inspection (WMS data).
3D roof data (left and compound model (right) based on FKB data alone, integrated with aerial photograph. Made using GIS tool ArcScene.

Similar 3D models based upon FKB data and aerial photographs are open for inspection/browsing on many different websites, for instance [www.norgei3D.no](http://www.norgei3D.no). Example from Bergen underneath:

**Building volume**

Calculated from *FKB 3D-data* (exact building heights) and *Matrikkel* (see below chapter 3.4.10.3) floor space or footprint information.

**Terrain**

*FKB*: Built-up areas, terrain contours with 1 m interval. Sparsely populated areas: 5 m contour interval. All built or natural terrain elements, such as roads, railways and water surfaces are available in 3D.

High accuracy Laser scanned terrain data (LIDAR) are available for a growing part of Norway, downloadable from the state mapping authorities.
Orthophotos

High resolution Aerial photographs covering all of Norway are available for inspection/browsing at (for example) www.norgeibilder.no. Also free downloading for academic and non-commercial use. The photographic database contains also historic pictures. The pixel resolution is 10 cm or better for most built-up areas, 20-50 cm for sparsely or non-populated areas.

1937 2012

3.4.10.2 Climate data

Climate data (long term) and weather data (short term), such as temperature, precipitation/runoff and wind, are available free at www.met.no, and www.eklima.no. Data are available for downloading, or as maps. Weather and climate maps for inspection/browsing are available at www.senorge.no. Some examples:

Wind rose, frequency distribution of wind

Wind rose for specified locations

Normal temperature diagrams
3.4.10.3 Building data

**Matrikkel (Cadastre):**
Footprint area, floor space and number of floors, building type classification (functional, for residential buildings also form classification), number of residential units, floor space for residential and other use. Year of construction.

<table>
<thead>
<tr>
<th>BYGNNING</th>
<th>Fylke</th>
<th>Kommune</th>
<th>Matrikkel</th>
<th>Tilf.</th>
<th>Eff.</th>
<th>Sannett</th>
<th>Yrke</th>
<th>Størrelse</th>
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<th>Funk</th>
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<td>1594613</td>
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<td>1591214 Tilk, eff, vnr</td>
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<tr>
<td>297250S</td>
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<td>1801</td>
<td>1595776</td>
<td>Store samm</td>
<td>1590101 Tilk, eff, vnr</td>
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<td>415</td>
<td>4</td>
<td>8</td>
<td></td>
<td></td>
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</tbody>
</table>

**Matrikkel – non mandatory part** (decided by the municipality whether this content is included in the registry):
Materials in fundamentals, horizontal and vertical supporting structure, roof. Heating system.

**Statistics, Norway:** General statistics for building data is found at StatBank Norway, 10: Industrial activities/10.09: Construction. Statistics on the dwelling stock and on the building stock in general are provided.

**Askeladden** is the national Norwegian database for built heritage. In this database all listed buildings are registered and the information is linked to maps and to a photo database for listed buildings.

**Kulturminnesøk** is the part of Askeladden which is open to the public. It shows selected information from Askeladden, and it is also open for the municipalities to enter data on non-listed building.
[http://www.kulturminnesok.no/](http://www.kulturminnesok.no/)

Both Askeladden and Kulturminnesøk are administered by Riksantikvaren (The Norwegian Directorate for Cultural Heritage).

**SEFRÅK registry:** SEFRÅK (SEKretariatet for Registrering av Faste Kulturminne I Noreg) is a nationwide register over monuments and sites in Norway. The mapping was made as field registrations in the years 1975-1995 and is covering all standing buildings in Norway pre-1900; and pre-1945 for the county of Finnmark in Northern Norway where most of the building stock was burnt during the WW2. Altogether more than 515 000
buildings are registered, about 480,000 are digitalized. Comprises building attributes like: construction, walls, façade and roof materials, roof form.

<table>
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<td>KRO_DAT_VID</td>
<td>180 3 191</td>
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</tbody>
</table>

3.4.10.4 Energy data

Statistics Norway (Statistisk sentralbyrå, SSB) provides statistics on the energy consumption of buildings, on energy sources and heating / cooling system.

The attached link shows one example on a table for average energy consumption for residential buildings. The energy sources are shown horizontally, and vertically the year of construction, region, and area (m2). The tables are available in English.


ENOVA is a governmental body under the Ministry of Petroleum and Energy with the responsibility to promote more efficient energy consumption and increased production of “new” renewable energy. ENOVA publishes annual building statistics on energy use in buildings, analysing different building types and variations in energy use dependent on type of heating/cooling system, area etc. It is only available in Norwegian.

http://www2.enova.no/publikasjonsoversikt/publicationdetails.aspx?publicationID=594
3.4.11 Portugal

3.4.11.1 Geometric data

In order to find geographic, the following assets were analysed:

- Portuguese Geographic Institute
- Database of the historical and cultural heritage of Portugal
- Google Earth

Portuguese Geographic Institute

The Portuguese Geographic Institute (IGP - Instituto Geográfico Português - www.igeo.pt) provides free consultation of Cadastral Sections relating to the municipalities that have Geometric Register Property Rustic effect.

In exercising its powers as Authority in the fields of Geodesy, Cartography and Cadastre, the IGP provides services within the regulation of the activities of cartography and cadastre:

- Circular guidance on mapping technique used for the drafting, revision or amendment of Planos Diretores Municipais (PDM) and Planos de Urbanização (PU);
- Year of Production Activities of Cartography
- Official Cartography and Cartography Approved (Visualization of 1:10 000 maps by county and municipal association);
- Cartographic Product Approval;
- Standards and Technical Regulations for Production of Cartography;
- Production of Large Scale Mapping other (1:1 000 and 1:5 000);

The Portuguese cadastre allows the visualisation of section covering 97% of the Country. The selection asks for the district, county, town and section or cadastral sheet that shall be extracted (Figure PT 1).

Figure PT 1: Selection page of cadastral information.
Depending on the age of the map, either a digitalized (scanned) copy or a raster vectorial version can be found. As an example, Figure PT 2 shows a scanned map, while Figure PT 3 shows a raster map.

Figure PT 2: Example of scanned cadastral map (Castro Verde county in Beja district).

Figure PT 3: Example of raster cadastral map (Mogadouro county in Bragança district).
Database of the historical and cultural heritage of Portugal

A database of the historical and cultural heritage of Portugal (with maps and classifications) can be found at the following address: [http://www.igespar.pt/pt/patrimonio/pesquisa/georeferenciada](http://www.igespar.pt/pt/patrimonio/pesquisa/georeferenciada)

There are different choices for searching legally protected heritage from mainland Portugal, either through “Pesquisa Geral” (general search form) or “Pesquisa Georreferenciada” (atlas based georeferenced search), as a result of implementation of the project “Inventorying and digitizing the Historical and Cultural Heritage”.

In the general search form, two groups of information are available: “Património Imóvel” (legally protected assets) and “Património Arqueológico” (archaeological heritage). The latter is based on the Endovélico Archaeological Information and Management System.

You may also access “Pesquisa Temática” (Theme Search) in order to find information about “Património Mundial” (World Heritage) and “Itinerários e Inventários Temáticos” (Thematic Routes and Inventories), as in the case of Cistercian Routes, Alentejo Historic Bridges, Modern Movement and others.

Registering legally protected assets is a nation-wide pioneer experience, as it includes the boundaries of the asset and those of its protection zones, a description of both, as well as georeferenced data, all of which are available on the Internet, through the ATLAS of Municipalities or Historic Centres.

The following Figure PT 4 shows which of the Portuguese regions are available for such kind of search.

![Figure PT 4: Available regions for database search.](image)

Once a region is selected, the map can be opened. As an example, Figure PT 5 shows a zoomed area of Lisbon. The legend allows recognizing classified and unclassified regions, as well as selecting different zones, such as: roads, monuments, protected zones, areas not for construction, etc. and a number of operations (zooming, printing, etc.).
3.4.11.2 Building and energy data

The last database that was analysed within T1.1 activities is the Information System for Architectural Heritage, which can be found at the following address [http://www.monumentos.pt](http://www.monumentos.pt).

The SIPA - Information System for Architectural Heritage is a system of information and documentation on architectural, urban and landscape Portuguese and Portuguese origin or matrix managed by the Institute for Housing and Urban Renewal, IP (IHRU).
The management and development of SIPA guided by the principle that the production and acquisition, retention, disclosure and dissemination of information and documentation authentic and quality related to the various values in territorial presence - namely the architectural, urban and landscaping - are essential activities aimed at identifying, recognizing and understanding, as well as the management, protection and enhancement of such cultural property.

The objectives of SIPA therefore constitute itself as an information tool to support the policies, strategies and actions of intervention in the built environment, in particular those governing spatial planning, regional development, qualification and urban rehabilitation and the protection and enhancement architectural heritage, urban and landscape.

Figure PT 7 shows the search tool to be used in order to find information on the building.

Figure PT 7: Search tool within the Architectural Heritage database.

Once the building is found, huge information can be downloaded from the website:

- Category
- Description
- Access
- Protection
- Storey
- Placement
- Complementary description
- Home Use
- Current Use
- Property
- Allocation
Depending on the sought information, this is probably the most powerful tool, especially as far as architectural (also regarding energy efficiency and materials) is concerned. The description, chronology and held intervention data are extremely complete and exhaustive.

3.4.11.3 Climate data

As for the climatic conditions, the site of the Portuguese Institute of Sea and Atmosphere was investigated. It is available at the following address: http://www.ipma.pt

The site provides climatic information, such as temperatures, rainfall, humidity, solar irradiance, etc. Data are available, region by region, in form of "navigable" graphs, i.e. where specific information can be found clicking in the area.

Figure 8 shows the average temperature during the year in the city of Lisbon.
3.4.12 Spain

3.4.12.1 Geometric data

LoD 0, 1, 2, GIS

Property registry. Web site.


Query of mapping and cadastral data.

- Floor Area
- Plot Area
- Uses
- Approximate construction data

It can be measured directly. 3D image and direct access to Google Earth, Bing, Google zoom is possible.
GALICIA URBAN PLANNING WEB.
All information about Galicia planning which can also be downloaded in pdf format.
http://www.planeamentourbanistico.xunta.es/

3.4.12.2 Climate data

METEOGALICIA
Galician database.
http://www.meteogalicia.es/web/index.action
Data from weather stations of Galicia.

Daily variables:
- Average air temperature
- Maximum air temperature
- Minimum air temperature
- Relative humidity average
- Relative humidity Maximum
- Relative humidity Minimum
- Temperature Dew
- Soil temperature
- Air temperature
- Hours of Cold (Base 7 º C)
- Hours Sun
- Hours Sun
- Global irradiation Daily
- Insolation
- Wind speed
- Gust
- Gust direction
- Direction of the prevailing wind
- Rain
- Balance water
- Reference evapotranspiration
- Barometric pressure
- Pressure reduced to sea level
- Ground Electric Field
- Hours of light

Graphics and summary tables of each weather station:
- Temperature and relative humidity
- Solar radiation
- Wind
- Precipitation
- Pressure
- Electric Field

AEMET
Spanish database.
http://www.aemet.es/es/portada
Data from weather stations of Spain.

- Average monthly temperature / year (° C)
- Monthly / annual maximum daily temperatures (° C)
- Monthly / annual minimum daily temperatures (° C)
- Precipitation Monthly / annual average (mm)
- Average relative humidity (%)
- Average monthly / yearly precipitation days than or equal to 1 mm
- Average monthly / annual snow days
- Average monthly / annual thunderstorm days
- Average monthly / annual foggy days
- Average monthly / yearly frost days
- Average monthly / annual clear days
- Average monthly / annual sunshine hours
3.4.12.3 Building data

Atlas of Housing

Digital Atlas of urban areas of Spain

http://atlas.vivienda.es

- Housing prices updated to the second quarter of 2012 at the municipal, provincial and autonomous community and urban area (fourth quarter 2011).
- Building type date (2011).
- Information Urban Urban Information System (SIU), with updated data from more than 1,800 municipalities.
- Data on nature of soil according to Land Registry (2011).
- Production structure according to the General Treasury of the Social Security (2011).
3.4.12.4 Case study Spain: Santiago de Compostela

**SIP. Heritage information system**

Santiago’s historic district database


- Information about monuments, description and pictures.
- Historical cartography in jpg format
- Cadastral Information
- Information about Special Protection Plan of the historic District. A catalog card for each listed building
Example of catalogue card _headquarters of the Consorcio

_ Restricted Area

- Information about archaeological interventions in the historic town between 1955 and 2002
- Update the information of all buildings and houses (floor area, number of plants, etc. and all elevations and plant drawings) Information in format dwg and pdf
- Documentation of all interventions carried out by the Consorcio.

A LoD 4 geometric model of the selected case study area will be provided to the EFFESUS project.

3.4.13  Sweden

3.4.13.1  Geometric data

LoD 0, 1, 2
Lantmäteriet – the Swedish mapping, cadastral and land registration authority has a lot of geographical data that they make available for research purposes. [http://www.lantmateriet.se/](http://www.lantmateriet.se/)
Some larger towns are available in 3D in Google Earth.

Floor area
We have statistics on floor areas of residential buildings (from Sweden Statistics) and that information could be used for estimating volumes. [http://www.scb.se/default.aspx](http://www.scb.se/default.aspx)
3.4.13.2 Climate data

Sweden has three climate zones when calculating for energy certificates and target energy use for buildings:

3.4.13.3 Building data

**Building information**

There is a registry of buildings at Lantmäteriet – the Swedish mapping, cadastral and land registration authority. Age, use and location are, for this project, the most important parameters that can be found there. Data can be made available on request. [http://www.lantmateriet.se/](http://www.lantmateriet.se/)

The most common construction types from before 1945 are quite well documented and described in, for example, the books “Så byggdes villan – Svensk villaarkitektur från 1890 till 2010” and “Så byggdes husen 1880-2000”. These books focus on typical constructions and materials from the late 1800’s and onward. Documentation on older building techniques and typical regional buildings is also available.

The Swedish registry of Energy Certificates holds information on the age, location, size, use and energy consumption of buildings. So far (October 2012) a little more than 210 000 buildings are registered, excluding one-family houses. But the information in it might not be a very reliable.

**Listed cultural heritage buildings**

There is a registry of listed buildings in Sweden:

[http://www.bebyggelseregistret.raa.se/bbr2/sok/search.raa](http://www.bebyggelseregistret.raa.se/bbr2/sok/search.raa)

The region Halland has a registry with about 10 000 buildings: [http://geoservices.lst.se/bebyggelseinventering/](http://geoservices.lst.se/bebyggelseinventering/) These buildings are registered because they hold some kind of cultural value, but they are not listed according to the national heritage laws. On each building there is information on age and a classification of the cultural value (A to C), on most buildings there is also a photo linked to the registry.
3.4.13.4  Energy data

Statistical data is available from Statistics Sweden and the Swedish Energy Agency in the yearly publication Yearbook of Housing and Building Statistics. There is data on energy sources, consumption, and consumption in relation to year of construction and energy efficiency measures made to one-family dwellings during the last years. There is data on residential and non-residential buildings. More data than the one found in this publication is available on request.

As mentioned above, the Swedish EC-registry could hold some useful information, but might be a bit unreliable.

**BETSI study** (see chapter 3.3.5)

The Swedish National Board of Housing, Building and Planning has carried out the BETSI study – Building’s Energy, Technical Status and Indoor Environment, a survey of 1800 statistically chosen Swedish buildings. The objective was to describe the technical characteristics of the buildings by inspection, measurements, questionnaires interviews, etc., with regard to energy use, indoor climate and the condition of materials and constructions of the buildings and the building services systems. The houses were surveyed by experts. There is a lot of information on the status of the houses and energy consumption that could be made available to EFFESUS in this study.
3.4.13.5 Case study Sweden: Visby

**Primary building data available for Visby, Sweden**

<table>
<thead>
<tr>
<th>Inventory/registry</th>
<th>Description</th>
<th>Year of establishment</th>
<th>Responsible authority</th>
<th>Topicality</th>
<th>Digital database</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire protection inventory</td>
<td>Includes 719 properties and mostly their main building.</td>
<td>2009 -2010</td>
<td>Rescue Services at Region Gotland</td>
<td>Not updated</td>
<td>Yes</td>
</tr>
<tr>
<td>Building registry</td>
<td>At the moment 1025 properties. Plot area.</td>
<td>Continuous</td>
<td>Lantmäteriet (Cadastral authority)</td>
<td>Updated</td>
<td>Yes</td>
</tr>
<tr>
<td>Older building inventories</td>
<td>Divided in areas.</td>
<td>1944 -</td>
<td>In the archives (Arkivcentrum)</td>
<td>Not updated</td>
<td>No</td>
</tr>
<tr>
<td>Listed building registry (Bebyggelseregistret BBR)</td>
<td>Mostly listed buildings</td>
<td>Continuous</td>
<td>Swedish National Heritage Board</td>
<td>Updated</td>
<td>Yes</td>
</tr>
<tr>
<td>Visby StadsGIS</td>
<td>Digital GIS-service containing mostly town archaeology. It will be finished in autumn 2013.</td>
<td>Archaeological investigations from 1960 – now</td>
<td>County Administrative Board</td>
<td>Will be updated</td>
<td>Yes</td>
</tr>
<tr>
<td>Primary map</td>
<td>Property division, physical infrastructure</td>
<td>Continuous</td>
<td>GI-unit, SBF Region Gotland</td>
<td>Partly updated</td>
<td>Yes</td>
</tr>
<tr>
<td>Real estate registry (fastighetstaxeringen)</td>
<td>Includes some information on building characteristics</td>
<td>Continuous</td>
<td>Swedish Tax Agency</td>
<td>Updated</td>
<td>Yes</td>
</tr>
</tbody>
</table>
3.4.14 Turkey

3.4.14.1 Geometric, statistical and building data

The following table provides sources for information on historic buildings in Turkey:

<table>
<thead>
<tr>
<th>LoD</th>
<th>Possible data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building</td>
<td></td>
</tr>
<tr>
<td>Load</td>
<td>Intelligent Cities</td>
</tr>
<tr>
<td>Island</td>
<td>Google map 3D</td>
</tr>
<tr>
<td>Parcel</td>
<td>Land Registry Cadastre</td>
</tr>
<tr>
<td>Base map</td>
<td>OpenStreetMap</td>
</tr>
<tr>
<td>Cadastral map</td>
<td>Metropolitan Municipality</td>
</tr>
<tr>
<td>Year of construction</td>
<td></td>
</tr>
<tr>
<td>Usage</td>
<td>Land Registry Cadastre</td>
</tr>
<tr>
<td>Number</td>
<td>Urban information system</td>
</tr>
<tr>
<td>Area</td>
<td></td>
</tr>
<tr>
<td>Basic construction materials</td>
<td></td>
</tr>
<tr>
<td>Structural type</td>
<td></td>
</tr>
<tr>
<td>District / sections census</td>
<td></td>
</tr>
<tr>
<td>Number of population</td>
<td>Turkish Statistical Institute</td>
</tr>
<tr>
<td>Number of male population</td>
<td></td>
</tr>
<tr>
<td>Number of female population</td>
<td></td>
</tr>
<tr>
<td>Number of population in age range</td>
<td></td>
</tr>
<tr>
<td>between 1 - 10 ...</td>
<td></td>
</tr>
<tr>
<td>Number of buildings</td>
<td></td>
</tr>
<tr>
<td>Number of pre-1945 buildings</td>
<td></td>
</tr>
<tr>
<td>Cultural Heritage</td>
<td></td>
</tr>
<tr>
<td>Listed buildings</td>
<td>Database of Ministry of Culture and Tourism</td>
</tr>
<tr>
<td>Legal regulation (status)</td>
<td></td>
</tr>
<tr>
<td>Protected areas</td>
<td></td>
</tr>
<tr>
<td>Archaeological sites</td>
<td></td>
</tr>
<tr>
<td>Safeguarding plans</td>
<td></td>
</tr>
</tbody>
</table>

Statistics Turkey

The Building Census 2000 contains the following data for whole Turkey and provinces:

- Type of buildings
- Age
- Heating system
- Condition
- Bearing structure
- Building materials

The rate of number of buildings within total number of buildings by use of materials in buildings

City of Bursa
The City of Bursa has a geoinformation system up to LoD 2: http://www.bursa.bel.tr/3-boyutlu-kent-rehberi/sayfa/1286
3.4.14.2 Case study Turkey: Istanbul

LoD 0 and orthophotos:
Floor plans are measurable. Historic photos from 1946, 1966, 1982, and actual ones are provided. 
http://sehirrehberi.ibb.gov.tr/map.aspx

LoD 2
Within Google Earth http://www.3dlocationearth.com/ produced a lot of 3d-models in Istanbul: The models are not downloadable directly, but might be available on request from the provider

3.4.15 United Kingdom
Changeworks in collaboration with Heriot-Watt University on behalf of partner Historic Scotland has produced a data survey on UK-data sources (Changeworks et al. 2013). The report will be downloadable from the EFFESUS website or published. A table of the most useful data sources is provided below. The following sections describe major findings of this survey and additional information by other partners.
Summary of the most useful data sources (Changeworks et al. 2013)

<table>
<thead>
<tr>
<th>Data source</th>
<th>Overview</th>
<th>Does it provide info on these categories?</th>
<th>Data it can provide</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>British Listed Buildings Online (or country lists)</td>
<td>Listed properties Searchable, but not exportable dataset</td>
<td>✓ ✓</td>
<td>Identify all listed buildings and some information on their architecture</td>
<td>Exact locations</td>
</tr>
<tr>
<td>Conservation areas</td>
<td>Boundary map, GIS file from Historic Scotland probably most use.</td>
<td>✓ ✓</td>
<td>Boundary map of conservation areas, may identify certain addresses.</td>
<td>Street level.</td>
</tr>
<tr>
<td>HEED</td>
<td>Large amount of data on energy efficiency</td>
<td>✓ ✓ ✓</td>
<td>Property details, energy efficiency measures installed.</td>
<td>Variety of levels</td>
</tr>
<tr>
<td>House Condition Surveys</td>
<td>Detailed surveys of housing in each UK country but limited sample size.</td>
<td>✓ ✓</td>
<td>Average NHERs and ages of housing stock.</td>
<td>Local authority</td>
</tr>
<tr>
<td>Home Analytics</td>
<td>A high proportion of the data is “probable”, so therefore should be used with caution.</td>
<td>✓ ✓</td>
<td>Property details e.g. age, wall type, heating system</td>
<td>Down to individual addresses but this level not recommended</td>
</tr>
<tr>
<td>Gazetteer</td>
<td>Property listings and addresses for UK.</td>
<td>✓ ✓</td>
<td>Addresses of property.</td>
<td>DoOnw to individual addresses.</td>
</tr>
<tr>
<td>Census data</td>
<td>Detailed profile of households across the UK. Limited info about buildings; most on occupants</td>
<td>✓ ✓</td>
<td>Basic housing type and heating system</td>
<td>Census output area</td>
</tr>
<tr>
<td>National Library of Scotland</td>
<td>Can be used to identify pre-1945 settlements</td>
<td>✓ ✓</td>
<td>Online maps of the UK from various historic dates. These show settlements.</td>
<td>1:50,000 scale and 1:25,000</td>
</tr>
<tr>
<td>MLOSA electricity and gas 2010</td>
<td>Estimates of energy consumption in properties</td>
<td>✓ ✓</td>
<td>Average consumption data per household</td>
<td>Middle layer super output area</td>
</tr>
<tr>
<td>Met Office, CIBSE or Weather Analytics</td>
<td>All provide weather data for UK locations on different scales.</td>
<td>✓ ✓</td>
<td>Climate data including temperatures, wind and rainfall</td>
<td>Varying levels.</td>
</tr>
<tr>
<td>UKCP09</td>
<td>Predictions of future climate conditions</td>
<td>✓ ✓ ✓</td>
<td>Future predictions of climate.</td>
<td>5km grid pattern at an hourly resolution.</td>
</tr>
</tbody>
</table>

3.4.15.1 Geometric data

LoD 0

Ordnance Survey UK

2D digital data (e.g. GML format), orthophotos are available through the Ordnance survey UK.

http://www.ordnancesurvey.co.uk/oswebsite/

Gazetteers

Gazetteers provide a comprehensive address list of properties across the UK and spatial information on properties. This should be relatively up-to-date as it will be updated by local authorities when, for example, new buildings are built. The database holds little information on each property but it could be used to cross-reference against other data. It is likely to be the most comprehensive data on all properties, although other data sources may contain just as relevant information on the pre-1945 stock.

One Scotland Gazetteer

http://www.onescotlandgazetteer.org.uk/
National Land and Property Gazetteer (England and Wales)
http://www.nlpog.org.uk/

National Library of Scotland
The National Library of Scotland holds online copies of maps covering much of the UK. These include many historic maps such as the 1:50,000 Ordinance Survey map from 1945-47 and a 1:25,000 map made between 1937-61. These maps can be used to show where settlements existed that would have buildings dating from before 1945. (i.e. if they are not mapped in 1945-47 they must have been later developments).
http://maps.nls.uk/

3.4.15.2 Climate data

CIBSE TRY & DSY Hourly Weather Datasets
The CIBSE (Chartered Institute for Building Surveyors) Test Reference Year (TRY) and Design Summer Year (DSY) weather data are used for building simulations to better understand energy requirements and overheating risk respectively. It provides data from 14 UK locations for 23 years. This is likely to be a useful source of climatic information in the UK.
http://www.cibse.org/index.cfm?go=page.view&item=1300

UK Met Office (UKMO)
The UK Met Office holds weather data for all the observation stations across the UK. This would provide the required information; however, a data request would incur a charge. Other sources, such as CIBSE and SAP, use data from the UKMO and present it in a different way. Data is available in tabled or mapped format.

Weather Analytics
This provides weather data for the past 30 years. It has information from across the globe and for the UK, provides data for 35km x 35km areas. It therefore provides a greater density of information than provided by CIBSE (beginning of this section); however, many of the files in this data source may have been derived from measurements taken elsewhere. Building simulations should ensure that any AMY (actual meteorological year) files used are as close to the site as possible.
http://www.weatheranalytics.com/

UK UKCP09 Climate Projections
Continuing on from the UKCP02 data, the Hadley Centre developed a probabilistic climate science model, which produced detailed data at a greater resolution. The UKCP09 data provides probabilistic climate change projections, relative to the same baseline period of 1961-1990, for a particular climate change variable, spatial location, time period, emission scenario and probability level. The information provides an indication of whether the change in a given climate variable will be more or less than a certain value.
UKCP09 outputs data for seven overlapping 30 year periods (2010-2039, 2020-2049, 2030-2059, 2040-2069, 2050-2079, 2060-2089, 2070-2099), which for simplicity are described by their middle decade (2020s to 2080s respectively), and for three emission scenarios (Low, Medium and High). The UKCP09 weather generator uses stochastic models to generate synthetic time series of weather variables, produced for a 5km grid pattern at an hourly resolution. For a given emission scenario and time period, up to 100 files can be produced by the weather generator, each featuring a 30 year time-series of climate data. For the given timeframe, the frequency analysis assumes stationarity, which means the data represents 30 possible annual climate files for that period, but not 30 climate years occurring subsequent to one another.

UK UKCP09 Climate Projections will provide useful data for predicted future weather patterns. However, care will have to be taken in requesting only essential information rather than large datasets. It will be important to consider data on likelihood of wind driven rain and overall rainfall when considering wall solutions. Data on temperature might also influence decision on insulation solutions and ventilation requirements. Integration with GIS should also be possible was data zones have been identified.

http://ukclimateprojections.defra.gov.uk/

3.4.15.3 Building data

Listed buildings

Data on listed buildings is held by each country within the UK:

- Historic Scotland Data Services
  Historic Scotland provides an online database of listed buildings and this can also be downloaded as a GIS dataset. Similarly much of the interesting data is in a free text making it awkward to interrogate and compare. http://data.historic-scotland.gov.uk/pls/htmldb/f?p=2000:10:0

- Listed Buildings in Wales GIS Point dataset – A web portal that should allow a dataset of Welsh listed buildings to be downloaded. Note it appears not to function correctly at the time of writing.
  http://jura.rcahms.gov.uk/NMW/start.jsp Downloadable datasets for Welsh listed buildings also exist at http://data.gov.uk/dataset/listed-buildings-in-wales-gis-point-dataset but again these either do not work properly or require a GIS specialist.

- National Heritage List for England
  The National Heritage List for England identifies every listed building in England and has a web based database with which to search for properties. Alongside the buildings it also identifies other listed items that include: monuments, parks and gardens, wreak sites and buildings with preservation notices. The data includes shapefiles indicating the location and/or extent of the designation and basic textual information, for example, heritage asset name and number and date of designation
  http://www.english-heritage.org.uk/professional/protection/process/spatial-data/

- Northern Ireland Listed Buildings Database
  The Northern Ireland Buildings Database holds information on over 9,000 historic buildings and each building is recorded individually. Most of these buildings have been listed for their special architectural or historic interest. Those that are not listed have been recorded as ‘record only’ on the database as part of the Second Survey of Northern Ireland’s buildings. Whilst these buildings did not meet listing criteria many nevertheless make a valuable contribution to the built heritage or record thereof.
  http://www.nidirect.gov.uk/finding-a-listed-building
British Listed Buildings Online.
This website combines listed building information from Wales, Scotland and England into a single portal. It has exactly the same data as held by Historic Scotland and English Heritage (see below) but in addition it includes online mapping so all the Scottish sites can be viewed ‘on the map’. Since the Welsh Listed Buildings site is inoperative, it is a particularly useful source of data on Welsh listed buildings. As with the official listed buildings sites, the database is searchable for specific records but the dataset is not exportable via the website. http://www.britishlistedbuildings.co.uk/

Conservation areas
Data on conservation areas is held by local authorities and Historic Scotland. This is essentially the same information and both are publicly available, but may be provided in different formats. This data is essential to the EFFESUS model. The data held by Historic Scotland is likely to be of most use as it is provided as a GIS shapefile.

- Local authorities
Local authorities designate conservation areas on account of their special character. This allows enhanced planning control. In most cases this is through designating a boundary or envelope within which controls apply. In most cases conservation areas will be of historic character with a high concentration of older buildings. Maps are held by individual local authorities and usually available online.
Depending on the local authority it should be possible to utilise this data to identify the most important groups of older buildings – although not all pre-1945 buildings are likely to be covered. In particular, common buildings dating from the 1920s and 1930s may not merit conservation status.
Available at websites of local authorities

- Historic Scotland
Historic Scotland also holds data on conservation areas. This will be the same information as held by local authorities.

Information on listed buildings and conservation areas in the UK
NOTE: An entry can sometimes include more than one building, such as a terrace. Thus, this does not represent the true total of Listed Buildings, for which the estimates vary between 750,000 and 1 million.

<table>
<thead>
<tr>
<th>Country</th>
<th>Listed Buildings Entries</th>
<th>Conservation areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>England</td>
<td>374,000</td>
<td>9,300</td>
</tr>
<tr>
<td>Scotland</td>
<td>47,600</td>
<td>645</td>
</tr>
<tr>
<td>Wales</td>
<td>30,000</td>
<td>500(+)</td>
</tr>
<tr>
<td>Northern Ireland</td>
<td>8,500</td>
<td>58</td>
</tr>
<tr>
<td>UK Sum</td>
<td>460,100</td>
<td>10,503(+)</td>
</tr>
</tbody>
</table>
Scottish Burgh Survey
The Scottish Burgh Survey offers guidance on the archaeological resource present in towns, and on the questions that may be answered by archaeology where development occurs. They began in the 1970s as rapidly-produced surveys that are not available in print. The format was altered in 1995 to make the second series more accessible, and these are available for purchase.

The main aim is to identify those parts of a burgh that may have archaeological interest and require sensitive treatment, but they also have more general historical use. Each volume describes:

- the geography and topography of the town,
- its known archaeology and history,
- its historic standing buildings and potential for further investigation

Burgh surveys could be of use for the identification of historic districts, because information on historic standing buildings in connection with geography and topography is given.

http://www.historic-scotland.gov.uk/index/heritage/archaeology/scottish-burgh-surveys.htm

Buildings at Risk Register
Historic buildings which are in a state of disrepair are defined as ‘buildings at risk’ in lists compiled by each nation. These buildings usually include listed buildings or those located in conservation areas.

These lists may be useful to the EFFESUS project to identify specific buildings or even types of buildings in an area. However, it will be of limited use as only buildings in poor condition are listed, and these buildings will not represent all types of buildings in an area. Aside from registers there are few other data sources for nondomestic properties.

Of all the lists, the Scottish website contains the most information about each building. Less information is available for buildings in Wales.

- Save Britain’s Heritage http://www.savebritainsheritage.org/buildings_at_risk/
- Register for Scotland http://www.buildingsatrisk.org.uk/
- Register for Wales http://cadw.wales.gov.uk/historicenvironment/recordsv1/buildingsatrisk/?lang=en

3.4.15.4 Energy data

EPC Register
This is a register compiled from completed EPCs (Energy Performance Certificates) in England and Wales. A similar database should be available soon in Scotland. EPCs show the energy efficiency rating for that properties and energy efficiency recommendations. Authorised users can access much of the input data to EPCs as well (e.g. construction type, level of insulation, etc.). This is useful data but the main limitation is that the sample of properties will be biased towards social housing (more energy efficient), private rented properties and properties which have been recently sold (as these will have required an EPC to be carried out). Fewer owner-occupied properties will be included.

- Free to access: EPC for any assessed home, searchable by postcode or EPC reference number.
• Authorised user: The EPC (energy use, cost and emissions), plus data behind the EPCs including construction information (including age, size, materials, construction type, level of insulation, heating systems, cooling systems, renewable energy generation and lighting).

https://www.epcregister.com/

MLSOAs, IGZ and LLSOA
The Middle Layer Super Output Area (MLSOA) data provide estimates of domestic and non-domestic gas consumption and electricity consumption across the England and Wales (similarly IGZs, Intermediate Geography Zone, are used in Scotland). This dataset provides an opportunity to geographically compare fuel consumption and highlight how fuel use varies across the country at a reasonably detailed level. Typically these MLSOAs cover between 2,000 and 4,000 households and a city like Edinburgh is broken down into 103 different output areas.
This is a very useful data source for energy consumption in data in different areas of the country. It could also be used to calculate CO2 emissions from properties using a CO2 factor for each fuel.


Home Energy Efficiency Database (HEED)
HEED has been developed by the Energy Saving Trust on behalf of the UK Government to register the uptake of sustainable energy measures and related survey data throughout the UK housing stock. HEED holds a vast amount of information about the energy efficiency of domestic properties which has been gathered on a property basis from a variety of sources. This means the data is highly relevant and up to date; however there will be gaps in the data as installers often only collect essential information. Reports are available from a national level down to a datazone level (c. 500 homes), but data will be less reliable at a lower level. Whilst it has limitations, this data source is likely to prove one of the most useful data sources on the characteristics and energy properties of dwellings.
Data includes:
• Property details: building type, full address building age band, insulation levels, building fabric and main heating system (this does not include any information on occupants).
• Recorded energy efficiency installations on a property-by-property basis e.g. those through fuel poverty energy efficiency schemes (Warm Deal, Central Heating Programme and Identification of UK Data Sources for the EFFESUS Project 22 Energy Assistance Package) or utility company schemes (EEC, CERT).

Data is sourced from a wide variety of sources including energy suppliers, government scheme managing agents, local authorities and other landlords, EST Home Energy Checks as well as other EST programmes. This includes data from Home Energy Checks (HECs), Energy Performance Certificates (EPCs), CIGA cavity wall installations data, Corgi works notifications, FENSA installed double glazing and data from Government microgeneration schemes such as Clear Skies, Low Carbon Buildings Programme and SCHRI. However, it is not possible to tell where the data from a report has come from – some available data would over-ride other data.
This is an online tool and three types of report can be generated: area-based schemes, installation summaries and status report. By special request, EPC reports can be provided that details both energy and carbon emissions based on properties that are in the EPC register.
It currently has data on 43% of properties in Scotland.

**Housing Energy Fact File**
This is a comprehensive overview of energy in the UK. On the whole it is nation or region wide and not available at a lower level. However, there are some very useful sections and tables, as shown below. It includes a whole range of topics such as energy end-use and insulation levels.

**Digest of UK Energy Statistics (DUKES)**
The Digest provides a highly comprehensive analysis of energy generation and consumption across the UK. It is much more focused on energy rather than housing so it provides very good background information, but would be unlikely to provide much spatial information concerning the energy performance of housing.

### 3.4.15.5 Case study United Kingdom: Glasgow

The case study in Glasgow will cover a district with listed cultural heritage buildings in the typical style of first half of 20th century. A lot of information about plans, materials, cultural value, etc. will be provided by partner Historic Scotland.
4 Conclusion and Recommendations

The historic building stock in Europe contains around 23.1% of all buildings. This is a huge part of the total stock mainly located near to town centres. The geographical identification can be performed by pre-1945 maps and orthophotos, as well as local information on town growth and development. One smaller part of the historic stock are listed buildings and conservation areas. Best practice examples provide public accessible GIS-based data bases on the listed stock (e.g. Ireland, UK, Bavaria). Nevertheless, information is available by contacting the responsible offices for cultural heritage preservation directly.

Most countries provide 2d up to 3d (Level of Detail 2) information on buildings (floor plans, terrain, boundaries, etc.). Another source could be tools like OpenStreetMap, Google Earth (Google Maps) or Street View, Virtual Earth (Bing Maps 3D) or others. Higher Levels of Details are not available in general. They might exist, but must be collected separately for any chosen district. Local authorities are a good contact point for such requests.

To identify the historic buildings in a chosen district will be not an easy task. Due to the age retrofit measures or major changes are most likely, as well as incidents like World War II or changes in town planning may have destroyed parts of the historic stock. Therefore visual appearance of buildings could lead to misinterpretations of the historic value. The same is related to calculations on energy efficiency measures, due to unknown refurbishments and changes at certain buildings. In case of listed buildings information might be available, but not for the historic stock in general. The contact to the town administration or a survey in a chosen district is recommended.

Data based on the European energy certification standard (EN ISO 13790:2008) can be used in several ways. When address data like in the UK are available, the performance of certified buildings in a chosen district could be assessed. If only anonymous data are available (e.g. Germany) the data can be used to assess the efficiency of retrofit measures (see Fig. 1 in chapter 3.2.2 according to (Michelsen, Müller-Michelsen 2010)). The data must be based on actual energy consumption for several years, corrected by the actual climate of the period (Michelsen 2010). Data based on calculated values are not reliable, because of incorrect covering of constructions and materials of historic buildings. It might be interesting to perform such analyses for different European countries or regions.

Effects of climate and climate change can be assessed by climate data from the Climate for Culture project, which will cover Europe with a grid 10 km by 10 km. Additional data sets are available for certain countries (e.g. UK).

The state of the art summary of previous attempts to statistically represent and categorize the building stock shows that even though the projects use a variety of typologies and categorization schemes, they still define a common platform in terms of methodology and input data specifications.

The access to and quality of national building data varies greatly and will be a limiting factor. For the case studies, additional data will be actively collected. Existing typologies and categorization schemes are useful in the EFFESUS context, but they need to be modified to take into account historic values and vulnerability to change. Based on the previous studies, one can identify a minimum requirement of data that is needed for building categorization on a wider scale. For the case study districts, the level of detail will be much higher. What is still needed is an estimation of the percentage of buildings belonging to a certain category. Additional interventions due to the age of historic buildings should be addressed.
Best practice examples like the “Raumbuch” concept of the 3ENCULT project (Exner et al. 2012) and the path for energy efficiency of the Swiss Society of Engineers and Architects (SIA 2040, 2011) could be used to define the methodology to assess and improve the energy efficiency in historic districts.
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