Support for setting up an observatory of the building stock and related policies

Service contract no. ENER/C3/2014-543

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Executive summary

Good governance and policy-making require monitoring and periodic evaluations of the impact of building policies and strategies. In 2016, most EU legislation on buildings, including the Energy Performance of Buildings Directive (EPBD), the Energy Efficiency Directive (EED) and the Renewable Energy Sources Directive (RED), are undergoing a review process. With this in mind, the European Commission decided to establish the European Union (EU) Building Stock Observatory to monitor buildings' energy performance improvement and its impact on the actual energy consumption of the sector in the EU Member States.

The EU Building Stock Observatory was developed (under the service contract *ENER/C3/2014-54)* by a consortium consisting of BPIE, ECN, Enerdata, Ecofys and SEVEn in cooperation with 20 national partners and a broad range of stakeholders. The key objective was to provide the European Commission with a comprehensive knowledge resource on Europe's building stock for policy-makers, investors, industry stakeholders, energy utilities, local and national authorities as well as researchers, in order to underpin decision-making, financial and long-term strategic support. The purpose of the project[1] was to:

- Establish a methodological framework for the monitoring of the EU-28 building stock in the context of building energy efficiency policies; including a set of quantitative indicators, guidance for data collection and analysis; as well as strategies to address data gaps;
- Collect buildings' statistics in EU-28 and provide a snapshot of the current status of the European building stock's energy performance;
- Disseminate the results through a dedicated publicly available portal;
- Set up a methodology for the continuous monitoring of the building stock and maintain the website as well as other communication tools.

The project methodology is presented in Figure 1, and includes the following actions.

A. Definition of the indicators' list

There are over 250 indicators included in the framework of the Observatory, grouped in 10 thematic areas: i.e. building stock characteristics, building renovation, nearly Zero-Energy Buildings, energy consumption, building shell performance, technical building systems, certification, financing, energy poverty and energy market. Besides quantitative data, the Observatory also monitors relevant qualitative information on national policies and regulation, including building codes, indoor air quality and thermal comfort. Defining the list of indicators for the EU Building Stock Observatory was achieved in consultation with a broad range of stakeholders, including industry associations, business, building owners associations and many others. In order to better understand existing strategies for data collection across Member States, the consortium performed an ex-ante data availability check. The results supported the work on the final indicators list[2].

B. Data collection and validation process

The data collection process for the EU Building Stock Observatory took into account the following steps:

- The first step was to collect information from international and European projects, reports and publications. Eurostat, the JRC and EU-funded projects were among the key sources for this so-called horizontal data collection.
- The second step of the data collection process was conducted by the consortium partners in collaboration with 20 national partners, to gather data available from national sources across Member States. The templates for national data collection were pre-filled with the horizontal data.
- In addition, the consortium contacted a number of stakeholders with a request to support the data collection process. Several industry associations supported the process and shared data on technical systems, etc.

Data was gathered in a standardised template with a basic function for data plausibility check. In addition, an exhaustive procedure for data verification and quality check was performed.

The list of data sources, including its quality assessment, is presented in Annex 2. Annex 3 presents the list of partners involved in the national data collection process.

[1] See also tenders specification of the service contract *ENER/C3/2014-54:* link
[2] Stakeholder consultations of the indicators' list and ex-ante data availability checks were performed in addition to the project specifications.

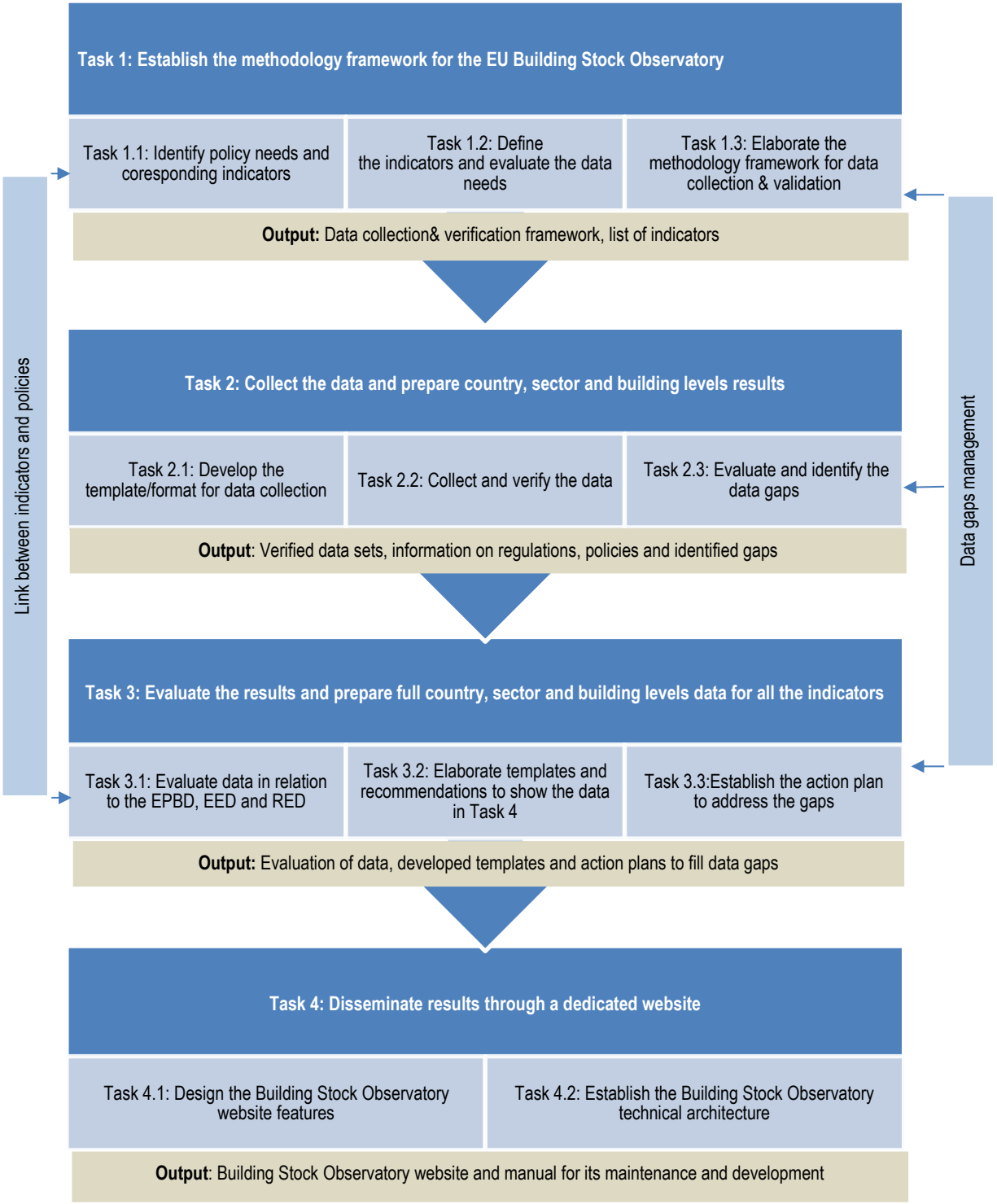

Figure 1 Building Stock Observatory – structure of the project

C. Data gap management strategies

After finalising the data collection and verification processes, the consortium launched the work on data gap management. First and foremost, the type of gap was determined, differentiating between informational, temporal or aggregation-level data gaps. As a next step, the consortium adopted the relevant actions to eliminate the gaps based on their type, with techniques such as correlation, data averages and extrapolations.

As a result of the actions taken, a significant number of additional data was derived within the project. **Error! Reference source not found.** In total, around 4500 data points for which data was not available before were derived within this data gap management process of the EU Building Observatory project. The input data and the formula are provided for the calculations within the Observatory database (as well as in Annex 2). Estimations are used where exact calculation rules were not settled but expert assumptions were based on available data from reports and literature.

D. Communication and dissemination of results

The target group of the Building Stock Observatory extends beyond policy-makers: the Observatory shall serve as a comprehensive source of public information and as a valuable tool in the hands of a wider range of stakeholders, including the industry, the financial community, researchers, etc. Therefore, the suggested display of results considers several tools, corresponding to different levels of data aggregation, to address the needs of these different stakeholder groups (see: Table 1).

Table 1 Tools for communication and dissemination of results

Tool	Target audience	Scope	Functionalities
Online database	Building experts, analysts, consultants and researchers	A comprehensive overview of building stock characteristics organised into 10 sub-categories: building stock, energy consumption, nZEB, renovation, building shell performance, technical systems, financing, certification, energy poverty and energy markets, with reference to the sources.	Data search organised per topic; country and year; Generation of tables and simple graphs for data visualisation; Download of data in raw data format; Reference to data sources and their quality.
Data Mapper	A wide range of stakeholders that search specific and comparable information	Selected indicators will be displayed in the Data Mapper; Country comparison (benchmark) will be provided in maps and graphs.	A visual representation of indicators in the map, with a short definition; Complementary indicators available through graphs below the map; Easy download of indicators and the graphical representation of the results.
Thematic factsheet	A wide range of stakeholders that search for data analysis, linked to the policy context (e.g.; national and EU legislation)	17 thematic factsheets that address the most relevant issues related to the implementation of the EU buildings legislation; Presentation of the key statistics, including analysis and the policy context.	Presentation of results in charts and tables, linking indicators and EU-related policies on buildings; Customised description of graphs and tables.
Country factsheets		28 country-specific factsheets that address the most relevant issues related to different aspects of the EU legislation; Presentation of key statistics with the national policy context provided.	Presentation of results in charts and tables, linking indicators and national policies on buildings.

The public version of the EU Building Stock Observatory will be included in the Directorate-General for Energy's website (https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings/)

1 Introduction

1.1 Rationale

European directives are legislative acts that set out the framework of common EU goals and predetermined end results that must be achieved in every Member State (MS). MS are obliged to adapt their national laws to meet these goals by means of measures fitting with their national legal, social and economic contexts.

The building sector is at the heart of EU policies and strategies aiming at increasing the efficient use of energy, further promoting renewable energy use and reaching a low-carbon society by 2050. Over the last years, several EU directives have entered into force introducing new and progressively more stringent requirements to enhance the energy performance of buildings. In this section, we look at the key directives that create the backbone of energy-related regulations throughout the European Union in terms of:

- Energy use in buildings: *Energy Performance of Buildings Directive* (2010/31/EU) (EPBD)
- Efficient use of energy: *Energy Efficiency Directive* (2012/27/EU) (EED)
- Exploitation of renewable energy resources: *Renewable Energy Sources Directive* (2009/28/EC) (RES)

Energy Performance of Buildings Directive

The building sector has been identified as one of the key sectors to achieve the 20/20/20 energy and climate targets of the EU. Beyond these targets, Europe also aims at bringing about drastic greenhouse gas emissions reduction in the building sector of 88 to 91% by 2050 compared to 1990 levels [COM (2011), 112][3].

To address the energy consumed in the building stock, in particular for heating and cooling purposes, the EU adopted a revised (recast) Energy Performance of Buildings Directive (EPBD) (2010/31/EU) in 2010, strengthening and expanding on the previous 2002 version. Besides the obligation for Member States to apply minimum energy performance requirements for new and existing buildings, the EPBD requires them to ensure that by 2021 (2 years earlier for buildings owned and occupied by public authorities) all new buildings are "nearly Zero-Energy Buildings" and to present their national approaches and plans to meet this requirement. Annex 1 of the EPBD sets out requirements on the general framework for calculating the overall energy performance of buildings.

Related to the ambition level of the energy performance requirements, the recast EPBD requires MS to: "*assure that minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels*". The cost-optimal level is defined as "*the energy performance level which leads to the lowest cost during the estimated economic lifecycle*".

The EPBD recast sets the responsibility on MS to transpose the following key aspects into national regulations and subsequently ensure compliance on the market:

- Minimum energy performance requirements for new buildings (in Art. 6 and 9);
- Minimum energy performance requirements for existing buildings that undergo a major renovation (in Art. 7, 1st);
- Minimum energy performance requirements for replaced or retrofitted building elements in existing buildings (both elements that are part of the shell and technical building systems) (in Art. 7, 3rd and Art. 8);
- Inspection of heating and air-conditioning systems (Art. 14 and 15).

The recast EPBD has also strengthened the role of Energy Performance Certificates within buildings, for example with the obligations:

- To have an Energy Performance Certificate for buildings that are constructed, sold or rented out as laid down by Art. 12(1)a of the EPBD recast;

[3] A roadmap for moving to a competitive low carbon economy in 2050

- To have an Energy Performance Certificate for buildings with a total floor area over 500m^2 occupied by a public authority and frequently visited by the public, as laid down by Art.12(1)b of the EPBD recast;
- To hand over the Energy Performance Certificate to buyers and new tenants under Art. 12(2) of the EPBD recast;
- To advertise the Energy Performance Certificates under Art. 11 (4) of the EPBD recast;
- To display Energy Performance Certificates in public buildings arising from Art. 13 of the EPBD recast;
- To implement an independent control system for the Energy Performance Certificates according to Annex III (Art. 18).

Energy Efficiency Directive

The Energy Efficiency Directive (EED) (2012/27/EU) is an important piece of the EU legislation to achieve 20% of primary energy savings in the period 2005-2020. It covers all sectors except transport. The EED requires MS to implement several measures addressing both the supply and demand-side energy efficiency, such as: the introduction of energy saving obligations for energy suppliers; support for ESCOs and highly efficient cogeneration; further implementation of smart meters; increasing the awareness of energy consumers; actions to overcome the split incentives dilemma in rental markets; improving energy efficiency financing; and establishing National Energy Efficiency Funds.

Specifically on buildings, Art. 4 of the EED asks EU MS to prepare and report long-term plans to stimulate investments in the deep renovation of buildings. Additionally, Art. 5 of the EED stipulates that all MS should undertake measures to stimulate the renovation of existing buildings owned and occupied by the central administration and to increase the renovation rate to 3% a year, or to provide equivalent energy savings.

Renewable Energy Directive

The Renewable Energy Directive (2009/28/EC) (RED) sets levels of renewable energy use within the European Union and was published on April 23, 2009. The Directive puts mandatory requirements on MS to produce an agreed proportion of their energy consumption from renewable sources, such that the EU as a whole shall obtain at least 20% of total final energy consumption from renewables by 2020.

By the end of 2014, EU MS had to set requirements for a minimum share of renewable energy to be used in buildings and take actions to stimulate the market uptake of renewable technology for heating and cooling. The targets of each individual Member State may vary depending on their renewable energy potential, the energy mix and their gross domestic product. MS should base their indicative trajectory to reach the RE target based on the 2005 levels as the Directive mentions that this is the latest year for which reliable data on national share of energy from renewable energy sources is available.

1.2 Objectives of the project

The ultimate aim of the EU Building Stock Observatory was to provide the European Commission with a tool showing a comprehensive snapshot of the building stock characteristics in the EU MS, together with a clearly defined methodology for a continuous monitoring of future progress.

The Building Stock Observatory is an “essential piece” of the EU building energy efficiency policies, as it aims to support monitoring of the EPBD implementation, as well as of relevant articles of the EED (i.e. Art. 4-5) and of the RED (i.e. Art.13-14) at national and regional levels. The Observatory will also contribute to future policy-making and support the review process of these EU Directives (such as the upcoming EPBD review).

The target groups of the Building Stock Observatory include more than policy-makers: the Observatory aims to serve as a comprehensive source of public information and a valuable tool in the hands of a wider range of stakeholders, including the industry, the financial community, researchers, etc. Therefore, the display of results takes into account different levels of data aggregation to address the needs of various stakeholder groups.

The list of indicators for the Observatory was set to give a comprehensive overview of different aspects of the building stock in Europe. It takes into account several kind of information: characteristics of the building stock (e.g. floor area, number of buildings per type, use, age, etc.); characterisation of buildings’ energy performance (e.g. end-use energy, technical building systems, nZEBs, etc.); certification (e.g. number of energy-certified buildings, other certification schemes, etc.); financing

(e.g. level of investment associated with deep retrofits and with major renovation, financial schemes targeting deep renovation, etc.); social aspects (e.g. energy poverty indicators).

The objectives of the service contract ref. ENER/C3/2014-543, was to:

- ✓ Establish a methodological framework for the EU-28 building stock monitoring in the context of building energy efficiency policies; this will consist of a set of well-defined quantitative indicators, guidance for data collection and analysis as well as strategies to address the data gaps;
- ✓ Conduct a data collection exercise across EU-28 based on a harmonised matrix template per country and sector, developed to summarise the relevant indicators previously agreed on;
- ✓ Provide a snapshot of the current status of the European building stock energy performance;
- ✓ Disseminate the results through a dedicated publicly-available portal and easy-to-use communication and policy tools;
- ✓ Set a methodology for the continuous monitoring of the building stock and maintain the website and other communication tools.

1.3 Scope of the report

The report sums up the work done in the scope of the Building Stock Observatory project from February 1, 2015 to June 31, 2016. It provides an overview on:

- In **chapter 2,** the methodological approach for establishing the indicators' list (2.1), data collection and verification framework (2.2), approach for data gap management (2.3) and data validation (2.4);
- In **chapter 3**, the tools for communication and dissemination of results on the Building Stock Observatory website, including the database, Data Mapper and thematic as well as country factsheets;
- In **chapter 4**, the consortium summarises the project deliverables and the added value of the Building Stock Observatory.

The following annexes are enclosed to this report:

- **Annex 1** – An updated list of the indicators (i.e. primary and secondary), with definitions;
- **Annex 2** – List of data sources for the project and their quality assessment;
- **Annex 3** – List of partners involved in the data collection process.

2 Methodology

2.1 Overview of all indicators in the EU Building Stock Observatory

2.1.1 Rationale behind the indicator selection in the Observatory

The objective of the EU Building Stock Observatory is to have a data set with necessary indicators to give a general overview of the building stock energy quality. The level of details of the indicators is enough to get an insight on what future policies should be based, so the indicators must cover the key obligations of the EPBD, EED and RED. However, additional indicators are included to allow for a general understanding of the EU building stock and the requirements set through legislation. Actions aimed at specific target groups, - for instance new and existing buildings and different types of non-residential buildings-, require a detailed subdivision of the indicators, e.g. when tracking the level of energy performance of buildings of different types versus the related thresholds.

The list of indicators for the EU Building Stock Observatory is based on the following selection criteria:

- The list of indicators must cover all relevant information to get a clear picture of the European building stock energy performance.
- The indicators should cover all key obligations derived from the EPBD, EED and RED: **Error! Reference source not found.**Table 2 gives an overview of the relevant articles of the European directives and the indicators in the database that are linked to these.
- The level of detail is enough to be able to make relevant subdivisions, but is not unnecessarily complicated.

The list of key indicators included in the Observatory is not limited by data availability, but based on the desired information. Data gaps in the Observatory could be filled in the coming years. To get a comprehensive overview of the European building stock, relevant for present and future policies, the Observatory contains information on 5 main themes. In the Observatory, there are in total 10 different topics to cover all indicators, as follows:

- **Building stock characteristics and energy consumption**
    1. Building stock characteristics
    2. Building renovation
    3. nearly Zero-Energy Buildings
    4. Energy consumption
- **Technical data on energy performance**
    5. Building shell performance
    6. Technical building systems
- **Certification**
    7. Certification
- **Financing**
    8. Financing
- **Energy poverty and energy market**
    9. Energy poverty
    10. Energy market

In addition, qualitative information on national policies and regulations were also collected in the scope of the project.
All topics will be discussed in the next paragraphs. The complete list of indicators can be found in Annex 1.

Table 2 Linking the Building Stock Observatory indicators and building relevant articles from the EPBD, EED and RED

Directive	Article(s)	Policy needs	Indicator	Covered in Topic
EPBD	Article 6	Minimum energy performance requirements	National minimum energy performance requirement	Topic 6 National requirements
			Achieved performance levels	Topic 1.1 Building stock
			Achieved performance levels for shell components (U-value for walls, windows, roof and floor)	Topic 2 Technical systems
	Article 7(3)	Building element requirements	National minimum energy performance requirement	Topic 6 National requirements
			Average energy performance after energy renovation	Topic 6 National requirements; Topic 1.1 Building stock (achieved)
			Airtightness	Topic 6 National requirements, Topic 2 Technical systems (achieved)
			Feedback system for smart meters	Topic 2 Technical systems
			Individual or collective metering	Topic 2 Technical systems
			New buildings with shading devices	Topic 6 National requirements, Topic 2 Technical systems
			U- value of building elements (floors, roofs, doors, windows, façades, walls)	Topic 6 National requirements
	Article 12 (1) a	Issuing EPC if building is built, sold or rented out	Number of buildings with EPC registered	Topic 3.1 Certification
			Production of EPC for new, sold, rented and existing buildings that undergo major renovation	Topic 3.1 Certification
			Share of EPC handed over to the new tenant / buyer	Topic 3.1 Certification
			Share of commercial advertisements where an energy label is presented	Topic 3.1 Certification
			Independent quality check of EPC	Topic 3.1 Certification
	Article 12(2)	Handing out EPC to buyer or tenant	Share of buildings rented out where EPCs were handed out	Topic 3.1 Certification
			Share of buildings sold where EPCs were handed out	Topic 3.1 Certification
	Article 11(4)	EPC indication to more detailed information	Does the EPC contain information on cost-effectiveness?	Topic 3.1 Certification
			Does the EPC indicate where more detailed information can be received?	Topic 3.1 Certification
	Article 13	Public display of EPC	Share of public buildings (floor area >500 m^2; >250 m^2) where EPC is displayed	Topic 3.1 Certification
	Article 9	nZEB	Number of new nZEBs by the end of 2020. Number of new public buildings nZEB by 2018.	Topic 1.1 Building Stock
EED	Article 5	3 % floor area public buildings >500m^2 should be renovated	Buildings related to the article 5 of EED.	Topic 1.1 Building Stock
			EED Article 5 buildings renovated	Topic 1.1 Building Stock
RED	Article 13(3)	Use of systems for the use of electricity from renewable sources	Buildings with PV panels	Topic 2 Technical systems
			Renewable electricity generation by PV panels	Topic 2 Technical systems
			Share of on-site renewable sources generation	Topic 2 Technical systems
	Article 13(6)	Use of renewable energy in heating and cooling systems	Buildings with PV panels	Topic 2 Technical systems
			Renewable electricity generation by PV panels	Topic 2 Technical systems
			Share of on-site renewable sources generation	Topic 2 Technical systems
		Use of renewable energy in heating and cooling systems	Renewable energy on-site Renewable heat generation by solar Renewable heat generation by heat pumps	Topic 2 Technical systems
		Biomass: a conversion efficiency of ≥ 85 % for residential	Renewable energy - biomass - conversion efficiency	Topic 2 Technical systems
			Renewable heat generation by biomass	Topic 2 Technical systems

Directive	Article(s)	Policy needs	Indicator	Covered in Topic
		and commercial applications	Space heating system - share of heating with biomass	Topic 2 Technical systems
		Heat pumps: minimum requirements of eco-labelling	Renewable energy - heat pumps - efficiency	Topic 2 Technical systems

2.1.2 Overview of indicators per topic

Building stock characteristics and energy consumption

Indicators within this topic are divided into the following thematic areas:

- **Building stock characteristics**
- **Building renovation**
- **nearly Zero-Energy Buildings**
- **Energy consumption**

Building stock characteristics

Building stock figures are very important since they form the foundation of many other indicators. In order to provide a good picture of the complete building stock in EU-28, the Observatory shows different subdivisions for building types, construction periods and size, ownership, location and occupancy levels.

Information on the building stock is available in different ways depending on the data, e.g. in absolute number of buildings, in useful floor are and in share of building stocks.

Policies differentiate measures for **new** and **renovated buildings**. Data for both categories is available in the database.

The number of newly constructed dwellings and non-residential buildings are presented per building type. Because specific targets exist for public buildings owned by the central government, these are specifically identified. The energy performance of new constructions is also included in the Observatory.

The number of transactions and **rented buildings/building units** was also collected (as the energy certification is linked to sales and renting of buildings).

Building renovation

Three indicators are defined for renovation: i.e. 'normal' renovation in which (part of) the building shell is insulated, 'major' renovation in which the full economic energy efficiency potential is reached and finally 'deep' renovation as defined in the EPBD. As for the number of dwellings renovated, there is no official definition. Little data is available and comparable among countries. The Observatory therefore only contains data on "**major equivalent renovation"** (e.g. share of annual building stock that undergoes a major renovation)**.** This information is taken from the project ZEBRA2020. The Observatory also includes data-sets on the average performance level reached after renovation and the average energy savings achieved by renovation, in final energy, primary energy or % depending on the data available.

nearly Zero-Energy Buildings

An indicator regarding the number of **nZEBs** (in the total existing stock and in new constructions) is available per building type (e.g. residential and non-residential).

Energy consumption

The database shows the different types of energy consumption (i.e. final, primary and climate-corrected) and is divided by end-use and by energy carrier (for total final energy consumption, space heating, domestic hot water, ventilation, cooling, cooking, lighting and other appliances).

As much as possible, these energy consumptions are made specific for different building types and age bands. Climatic corrections enable the user to measure energy consumption trends without climatic effects, i.e. regardless of yearly variations in the winter severity. The Observatory contains actual energy consumptions, e.g. with real climate conditions or climate-corrected.

Information on theoretical energy consumption is available, but only for a few countries. The theoretical energy consumption is given mainly for thermal end-uses, such as space heating. The theoretical consumption can be assessed from the

minimum theoretical energy consumption, set in the national building stocks, and based on information gathered in the Energy Performance Certificate or according to U-values.

Indicators cover the **fuel mix** used for electricity generation and for district heating, in particular renewable energy sources.

Technical data on energy performance

To link energy consumption and technical characteristics, the Observatory contains indicators on technical building components. The main categories can be distinguished as follows:

- **Building shell performance**
- **Technical systems**
  - **On-site renewable energy generation**
  - **Space heating**
  - **Space cooling**
  - **Domestic hot- water**
  - **Ventilation**
  - **Lighting**
  - **Appliances**
- **Embodied energy**

Building shell performance

For the building shell, the indicators are the U-values of external walls, floors, roofs and windows by construction period and a combined U-value for the total building shell.

In addition, data on window types (as for windows' frame and type of glazing) is available, which will show the most frequently applied types for each Member State.

Technical systems

For on-site renewable energy, energy production from biomass, PV-panels, solar thermal and heat pumps is presented in the Observatory.

Technical system indicators are included in the Observatory on heating devices, space cooling, domestic hot water, ventilation and lighting. When data is available at the Member State level, these indicators are available for existing and new, residential and non-residential buildings; the number of systems per type is presented in the Observatory. For conventional and condensing boilers, as well as for heat pumps and solar heating systems, the share in the total number of systems is presented.

To reflect the EPBD requirements on the inspection of heating and air conditioning systems, the Observatory contains information on the share of systems regarding the installations' capacity.

Embodied energy

Embodied energy is the total energy required for the extraction, processing, manufacture, delivery and disposal/reuse (not taken into account here due to uncertainties of the end-of-life phase) of building materials and does not include the energy use of the building during its service life. Dedicated synchronised data on embodied energy for the total building stock in all EU Member States is not available. Instead, the Observatory contains information on the energy content of building materials. A dedicated factsheet also provides information on this topic.

Certification

The Energy Performance Certificate (EPC) scheme is an important element within the EPBD. Indicators on this topic are to a great extent linked to policy obligations in this area.

The Observatory presents the number of buildings with EPCs, split by new and existing buildings. Further distribution is made for residential and non-residential buildings. It shows the absolute number of labels per category (A-G), together with the building stock data shares of labels. In addition, the distribution per energy label is collected in relation to the building size.

The Observatory shows how many EPCs were issued in the last year. This indicator can be linked to the number of transactions and dwellings rented out (for existing buildings) and sold (for new buildings), to see if in all these occasions EPCs were issued.

To follow the EPBD requirements, additional indicators were included, such as the share of EPCs displayed in those public buildings, the share of commercial advertisements where the energy label is presented, the share of EPCs handed over to the new tenant / buyer, etc. Finally, specific indicators demonstrate the quality control of EPCs.

Information on the EPC scope is available, in particular for EPC recommendations.

Next to EPBD-related EPCs, other voluntary certificates are available on the market. The Observatory contains information on these certificates, including: *Passive House, Minergie, LEED, BREEAM, DGNB and HQE*.

Financing

Financing of energy efficiency actions is an important subject to improve the European building stock.

To get a preview of the capital cost for owners willing to invest in energy-related renovations, the Observatory contains indicators on the characterisation of energy-efficient investments such as:

- Average investments for renovation, deep renovation and major renovation;
- Energy savings achieved per renovation type.

The two sets of indicators within the second subgroup display the energy prices per energy carrier (i.e. coal, gas, petroleum products and biomass) and the average energy-cost savings.

The indicators within the third subgroup are further divided into six sections referring to various financing sources used to finance energy-related renovation activities. The types of financing schemes covered here are:

- Private debt financing (loans);
- Public funding (dedicated credit lines);
- Grants;
- Fiscal incentives;
- Energy performance contracting and
- Energy efficiency supplier obligations.

Indicators in the Observatory show the average loan amount, the total volume of the investment, the average share of own contribution (equity), interest rates and the achieved savings.

Energy poverty

Energy poverty is an important topic for many Member States. Although the definition can vary from one MS to the other, in general, energy poverty refers to the situation when a household cannot afford to keep their home adequately warm. In order to get an overview of the scale of energy poverty in different MS, the Observatory includes indicators on:

- Population at risk of poverty or social exclusion;
- Arrears on utility bills;
- Proportion of inhabitants unable to keep their home adequately warm;
- Proportion of inhabitants living in a dwelling not comfortably cool in summer;
- Population living in a dwelling with leaking roof or damp wall, and more;
- Share of households' expenditures on housing (i.e. housing, water, electricity, gas and other fuels);
- Disposable household income before energy expenditure for adequate space heating;
- Disposable household income after energy expenditure for adequate space heating;
- Proportion of disposable household income spent on energy for adequate space heating;
- Share of households falling below the poverty line after covering the energy cost for adequate space heating;
- Excess winter mortality/deaths.

Energy market

To get a clear understanding of social issues and energy poverty, information on the energy market is crucial. The Observatory contains 10 indicators that offer background information to evaluate energy related social issues.

- Liberalisation of energy market;
- Concentration of supply in rental market;
- Ability of consumers to switch tariffs;
- Elder population (main tenant above 65);

- Average rent value;
- Is the rental housing market regulated?;
- Rules for district heating operation;
- Demographic division of tenants;
- Average floor area per person;
- Average number of rooms per person.

2.1.3 Policies and regulations

The Observatory aims at supporting the monitoring of building policies implementation in the EU Member States. In order to have a good overview and understanding of the different national approaches, links to information on national policies such as building codes for new and existing buildings are made available. This will take into account:

- Minimum overall energy performance targets - new buildings;
- Minimum overall energy performance targets - renovated buildings;
- Shell performance requirements, including the targeted U-values for shell components;
- Technical installation requirements;
- RES requirements (in new and existing buildings);
- Daylight requirements;
- Thermal comfort requirements;
- Indoor air quality requirements;
- Airtightness requirements.

To facilitate a good understanding of the national approaches, information on specific national definitions is collected. This takes into account, among others:

- Renovation and major renovation;
- nZEBs for existing and new buildings;
- Energy poverty.

Member State specific links to policy-related information can be found in the Observatory country factsheets.

2.2 Data collection

2.2.1 Methodology

The data collection process followed a stepwise approach, as presented in Figure 2.

- In the initial steps of data gathering, the consortium partners have pre-filled the horizontal data templates (Task 2.2), based on information available from international and European projects, reports and publications. Eurostat, JRC databases and EU-funded projects were among the key sources for horizontal data collection. In addition, the consortium contacted a number of relevant stakeholders with a request to support the data collection process.

- The next step was conducted in collaboration with 20 national subcontractors: the main objective was to access data available from the national data sources across Member States. Annex 3 presents the list of subcontractors who supported the consortium in data gathering in all EU-28. The templates for national data collection were pre-filled with the horizontal data. This allowed for the first step of data verification, as partners at national level were asked to provide feedback in case the quality of horizontal data was questionable.

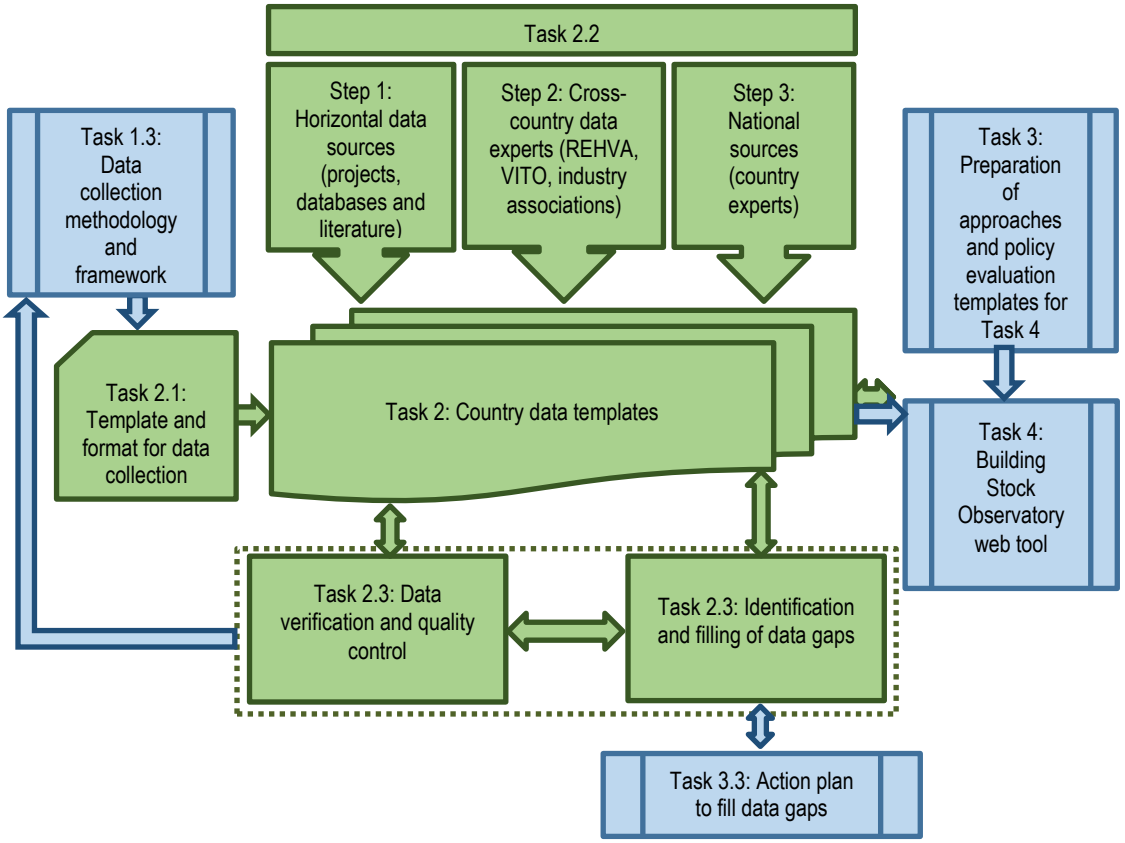

Figure 2 Methodology of data collection

There were two types of templates provided in the project; one for horizontal data collection (organised per topic) and another one for national data collection (organised per country). For Belgium and the United Kingdom, due to significant regional differences, the regional templates were developed separately.

2.2.2 Key data sources for the project

Topic 1: Building characteristic and energy needs

The main data sources for topic 1 are presented below. Most data is taken from Eurostat, national statistics, or directly collected in the frame of EU projects such as ODYSSEE-MURE[4], ZEBRA2020[5], INSPIRE[6], etc.

The first task consisted in gathering all the information from horizontal sources and EU projects. This step gives us a first overview of which data is available, where are the data gaps, what should be improved/harmonised, etc.

An extensive work was also done to show coherent data, comparable with Eurostat: for instance, data on the energy consumption by end-use for residential buildings is coherent with the total energy consumption data from Eurostat, even if the primary data sources are not the same. Assumptions were made, in particular for the non-residential sector where little data is available for most countries. Nearly 1/4 of data was added within the data gap management phase, including estimations and calculations; when no source was available, assumptions were made, based on ratio from neighbouring countries or available inputs from EU projects.

An overview of data sources and methodology for calculation and estimation of the results in topic 1 is provided in Annex 2.

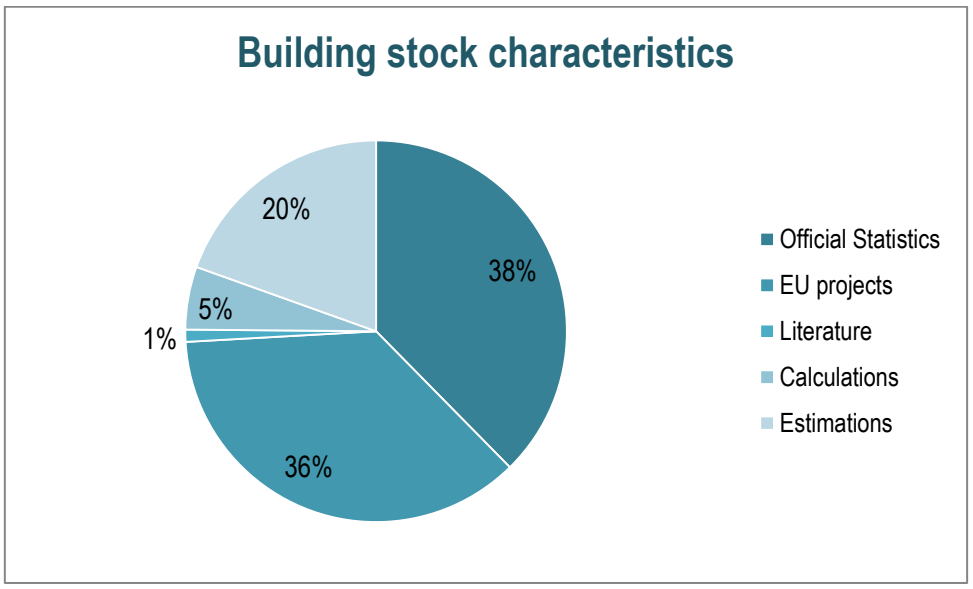

Figure 3 Overview of data sources for topic 1 on building stock characteristics

Topic 2: Shell performance and technical systems

European projects are the most important source for technical system data. The iNSPiRe[7], Entranze[8], Melissa[9] and Odyssee[10] projects are the primary sources. Eurostat, JRC-IDEES[11] and the results of service tender 2014/S 118-208553 on 'Mapping of the heating and cooling systems[12]' are also very important horizontal sources. Altogether, these sources were used for over 60% of all indicators. Commercial sources were also used to collect data, such as Rehva[13] and EHPA[14].

[4] http://www.odyssee-mure.eu/
[5] http://zebra-monitoring.enerdata.eu/
[6] http://www.inspirefp7.eu/
[7] http://www.inspirefp7.eu/
[8] http://www.entranze.eu/
[9] http://ecodesign-lightsources.eu/documents
[10] www.odyssee-indicators.org
[11] https://ec.europa.eu/jrc/sites/default/files/JRC-IDEES_20160301.pdf, http://ec.europa.eu/eurostat/web/energy/data
[12] https://ec.europa.eu/energy/sites/ener/files/documents/Report%20WP1.pdf
[13] Federation of European Heating, Ventilation and Air Conditioning Associations, www.rehva.eu
[14] European Heat Pump Association, www.ehpa.org

In total, 104 data sources were used to fill the database with information. Multiple sources were often used to provide up-to-date figures and to show historical trends. 17% of the collected data is based on own calculations.

We made calculations to combine different U-values of building elements into an overall envelope performance of residential and non-residential buildings. Weighted average U-values were also calculated for the whole EU region. The share of on-site renewable energy generation was calculated as a percentage of the total buildings energy consumption.

An overview of data sources and methodology for calculation and estimation of the results in topic 2 is provided in Annex 2.

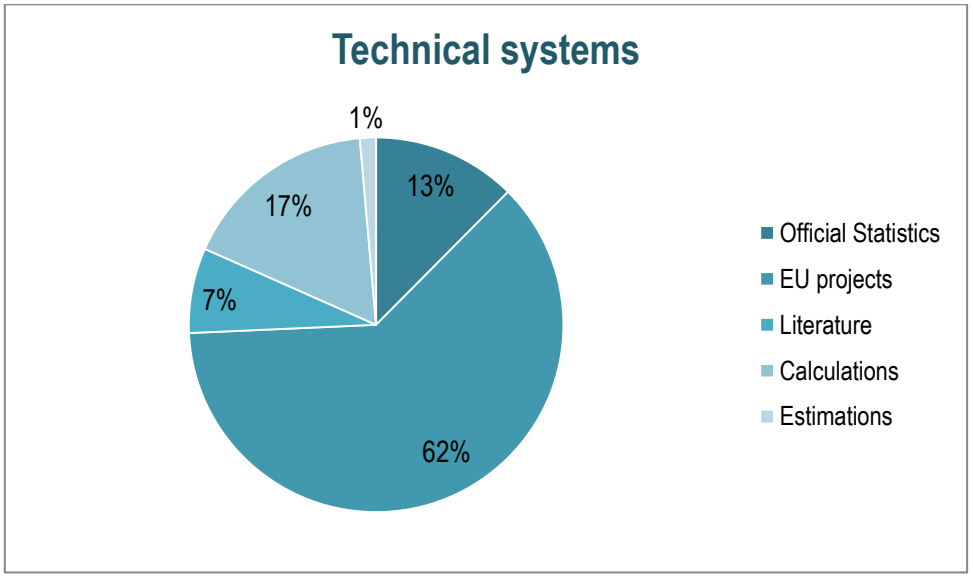

Figure 4 Overview of data sources for topic 2 on technical systems.

Topic 3: Certification

National and regional Energy Performance Certificates databases were the primary source of data in topic 3. One third of the data sets were provided by the project partners (i.e. national data providers), based on the statistical analysis of the EPC registries data.

For many countries, the information provided was based on the ZEBRA2020 project (IEE)[15], in which scope an analysis of EPC data in the central repositories was conducted. Other EU-funded projects that were valuable sources of data for topic 3 were: the Request2Action project (IEE)[16] for the share of EPC registered in databases, and the RenoValue (IEE)[17] project to measure the impact of the energy label on the property value. Results of the service tender N°. ENER/C3/2014-542/S12.701648 provided data on the EPC scheme compliance across EU Member States.

With the data gap management plan, calculations were made for the countries with continuous scale of the energy performance indicator. The consortium suggested a benchmark, to aggregate the results in the energy class categories, and enable cross-comparison.

An overview of data sources and methodology for calculation and estimation of the results in topic 3 is provided in Annex 2.

[15] http://zebra2020.eu/
[16] http://building-request.eu/
[17] http://renovalue.eu/

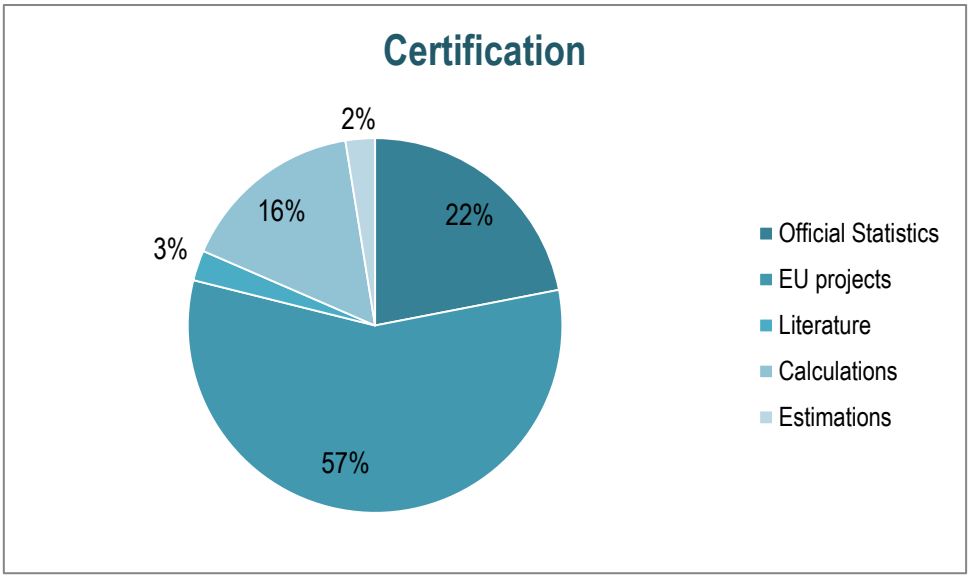

Figure 5 Overview of data sources for topic 3 on certification

Topic 4: Financing

The key sources where data for topic 4 were available are national statistics from MS, Eurostat (for energy prices) and EU projects such as the MURE database[18] and the project Entranze [19].

Within the data gap management, following actions were taken by calculations/estimations:

- Calculations from other available inputs were done, especially where national data was available but in a different format, e.g. average volume of grant, average loan amount were provided in Euro/dwelling whereas it was asked in Euro/m². This was calculated with available data from Topic1.1.
- Missing data was calculated according to known collected data series, e.g. level of support for grants and average share of own contribution of the dedicated credit lines in non-residential buildings.

An overview of data sources and methodology for calculation and estimation of the results in topic 4 is provided in Annex 2.

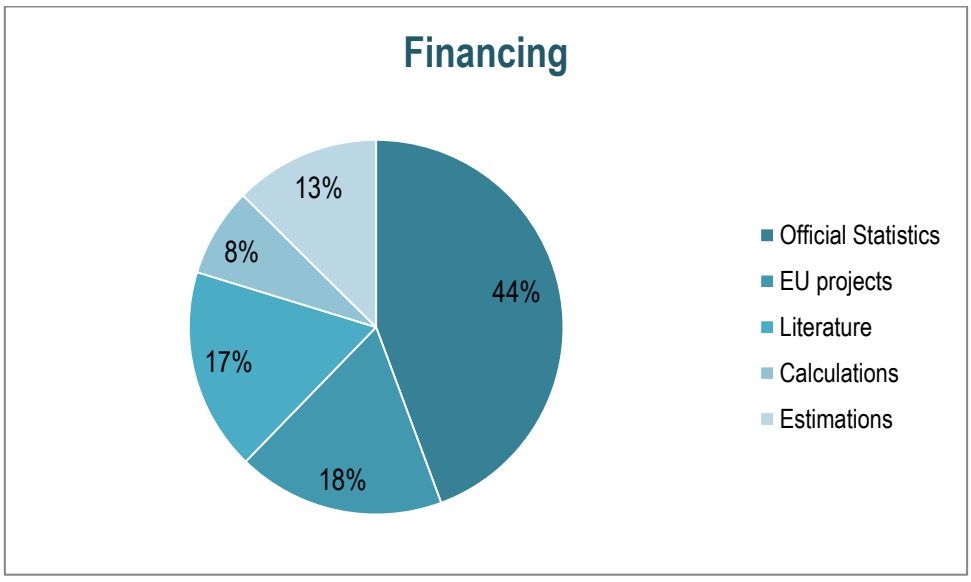

Figure 6 Overview of data sources for topic 4 on financing

[18] http://www.measures-odyssee-mure.eu/
[19] http://www.entranze.eu/

Topic 5: Energy poverty and social issues

Key data sources for most indicators were the official statistics from Eurostat, particularly data from EU SILC survey[20]. In spite of a relatively broad set of data and its public availability, the periodicity of data collection for the indicators differs a lot. Besides, many indicators of the topic were not available for the EU-28 in an aggregated form and are not available for each of the 28 Member States at the moment. The second largest source of data used was the ACER report[21]. Two indicators with quite low data availability – "Ability of consumers to switch tariffs" and "Disconnection rates" could also be collected within this report to cover the whole topic with data.

The data source with highest quality for the indicator "Breakdown of dwellings by ownership & tenure" is the Entranze project. Further data sources were national statistics and reports of energy agencies. For three indicators with no available data, model output (calculations) and assumptions were applied to obtain the values.

Four indicators within the topic were calculated for the EU-28 as a whole: "Elder population (main tenant above 65)", "Breakdown of dwellings by ownership & tenure", "Demographic division of the tenants" and "Average floor area per person".

The following indicators with missing data were estimated based on data collected in other topics, "Average rent value" and "Rent increase per year". The indicator "Average floor area per person" was calculated based on Entranze data.

An overview of data sources and methodology for calculation and estimation of the results in topic 5 is provided in Annex 2.

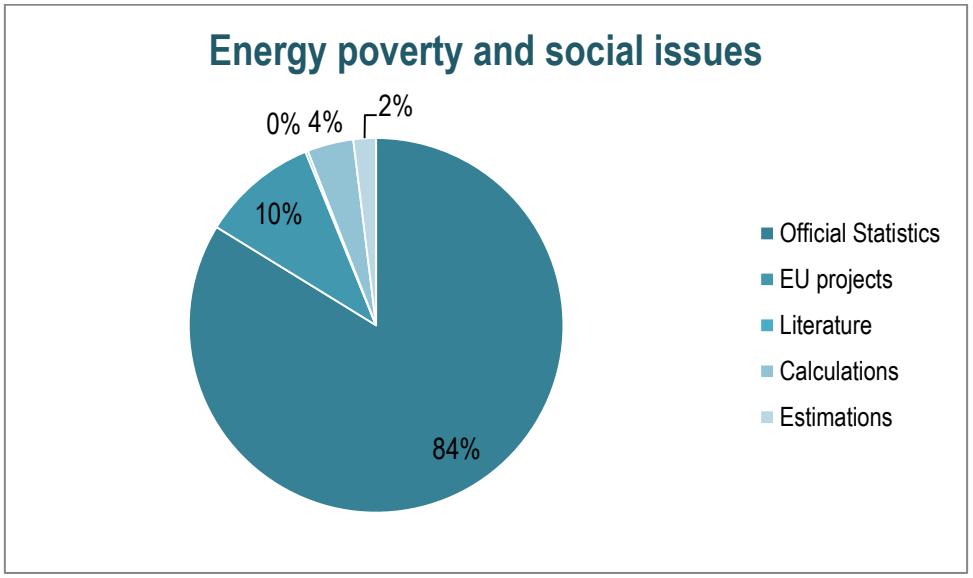

Figure 7 Overview of data sources for topic 5 on energy poverty and social issues.

[20] http://ec.europa.eu/eurostat/web/microdata/european-union-statistics-on-income-and-living-conditions
[21] http://www.acer.europa.eu/official_documents/acts_of_the_agency/publication/acer_market_monitoring_report_2015.pdf

2.3 Data gap management

The database of the EU Building Stock Observatory is designed to contain a wide variety of information in different formats (e.g. averages or totals), units (e.g. counts, shares or data-specific units) and aggregation levels (e.g. per building type, per energy source or per year) covering six main topic areas. This disaggregation forms a high level of details structured as indicators. Due to such details and variety of the information, each data field has some properties to consider for data gap management, unique to each indicator. The data gap management strategy delivered a thorough outline of these properties and actions, as well as a process to bridge the existing information gaps.

The Data Gap Management Strategy included two main phases. Phase I was based on the results achieved during the horizontal data collection. Phase II is based on the results achieved during national data collection.

The data gap management action plans that were part of Phase II included a detailed presentation of the actions per topic, to reduce the data gaps within the project timeline. Actions such as the calculation of data from available data and extending the data search to other data sources, as well as adding data received from the Commission were realised per country under each topic. Additionally, further recommendations were made for the potential actions beyond the Observatory project timeline that can be considered for improving the data availability.

Phase I

At this initial stage, the strategy focused on building an overall terminology for the gap management action plan; a typology to identify the gaps; a relevant approach to address each gap type and a common template to implement these within each topic. The components of Phase 1 are presented in Figure 8.

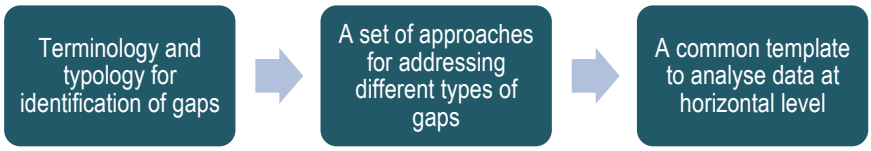

Figure 8 Components and results of the Data Management Strategy, Phase I

In Phase 1, the strategy in general and the challenges and expectations on reducing the data gaps within each topic were discussed on a regular basis with project partners, during meetings.

We have defined three data gap types based on the properties of the indicators in the EU Building Stock Observatory and the results of the data availability and horizontal data collection. An explanation of the main gap types is provided in this section. Specific data gaps, examples of indicators where these kinds of gaps can be observed and relevant methods to address them are presented in Table 3.

Informational data gaps:

Informational data gaps usually occur due to differences in the format of available data and the data that is asked for. Informational gaps also occur if there is no data addressing the indicators identified for the data collection within the EU Building Stock Observatory.

Several actions were already taken during the data collection phase to minimise the informational data gaps. The data collection template was prepared to get the maximum level of details for data collection in terms of data format. For example, within Topic 1, energy performance indicators are asked in two formats: primary and final energy; within Topic 4, the finance scheme indicators are asked for average and total loan amounts.

As it was not possible to foresee all possible formats of available data, the national experts were asked to provide information on available format of data if it was different from what was asked for in the Observatory.

Further actions, listed in This type of data gap is observed when the level of details in a set of data is not reaching the desired level, as defined in the EU Building Stock Observatory.

Several actions were already taken during the data collection phase to eliminate the data gaps related to the aggregation level. This was achieved by including data fields on several levels in the data collection template so that experts could fill in available data in the level it fit with. It is ensured that, where feasible, the highest aggregation level (e.g. all building types in addition to residential buildings and non-residential buildings; all types of energy renovation in addition to various depths of renovation) is provided as a data field in the template considering that this is generally the most available level.

If the data was available in a lower level of detail and input was provided for all sub-levels, information for high aggregation levels was calculated by summing the relevant fields where applicable in the second phase.

Table 3 3, were considered on an indicator-basis depending on the data provided by the national experts.

Temporal data gaps:

Temporal data gaps occur when existing data related to a certain indicator were not collected within, or specific to, the timeframe asked in the EU Building Stock Observatory. The data might have been collected in the timeframe prior to the desired years or have not been collected in the aggregated level of the timeframe.

In addition, there might only be a few data points historically available.

In the second phase of the data gap management, we analysed the content of the information to determine whether or not the available data might be indicative of the general trend for a specific indicator (in a specific MS). Data interpolation and extrapolation to eliminate temporal gaps were carried out carefully. The following issues were considered to determine the suitability of the available information for extrapolative and interpolative calculations:

- Is the available information providing sufficient data points in the timeline?
- Does the available information provide a trend?
- Are there significant external factors that would hamper the reliability of results applying extrapolation or interpolation of data?

Aggregation level data gaps:

This type of data gap is observed when the level of details in a set of data is not reaching the desired level, as defined in the EU Building Stock Observatory.

Several actions were already taken during the data collection phase to eliminate the data gaps related to the aggregation level. This was achieved by including data fields on several levels in the data collection template so that experts could fill in available data in the level it fit with. It is ensured that, where feasible, the highest aggregation level (e.g. all building types in addition to residential buildings and non-residential buildings; all types of energy renovation in addition to various depths of renovation) is provided as a data field in the template considering that this is generally the most available level.

If the data was available in a lower level of detail and input was provided for all sub-levels, information for high aggregation levels was calculated by summing the relevant fields where applicable in the second phase.

Table 3 Data gap management methodology

No.	Type	Data Gap	Definition and Example	Methodology for reducing the gap
1	Informational	Data is only available in different units	Energy consumption available in GWh and conversion to Mtoe	Calculation of value using conversion factors
2	Temporal	Data is only available for different times	Example (1) - Data is collected at different time spans rather than annually (e.g. collected every 5 years) Example (2) - Data is available for 2011, 2012, 2013 but not 2014	Calculation by inter- or extrapolation where steady development can be assumed
3	Aggregation level	Data is only available at higher/lower aggregation level	Example(1) - Data is available at building stock level but not at level of building types (residential and non-residential buildings) Example (2) - Data is available for certain specific building types (available for offices but not for non-residential buildings)	Apply (e.g. shares) to higher/lower level where justified
4	Informational	Data/indicator is not available but can be calculated from other available inputs	Example: calculation of total investment in renovation by multiplying available inputs on investments per m² with available inputs on m² renovated	Calculation from combination of available data

5	Informational, Temporal, Aggregation level	Data is available but requires payment	MS expert hints to payable data sources	Clarify price and publication rights
6	Informational, Temporal, Aggregation level	Data is not available and cannot be calculated	MS expert could not fill data and data cannot be calculated/derived	Different types of data gaps might require collecting additional information. Further data collection requirements need to be defined to fill data gaps in the future (e.g. via MSs statistics, research etc.)

Phase II

Following the insights achieved on the expected data gaps, based on the analysis carried out at the horizontal level and the identification of relevant approaches, the strategy was implemented at a detailed level after receiving all data from national experts. The data gaps were addressed following the structure of the national data collection matrix for indicators covering all aggregation levels and timelines for each MS. The methodologies used to reduce the amount of data gaps were:

Method 1: Reducing the gap by derived values:

1.1 Calculation of a data point by use of another data within the data matrix of the Observatory;
1.2 Calculation of a data point by using additional input (e.g. conversion factors);
1.3 Estimations based on expert judgements and relevant reports and literature.

Table 4 provides examples from the Observatory database where mentioned data gap management actions were taken for one of more MSs.

Table 4 Examples for data gap management actions

Method	Indicator name	Data gap management action
1.1	Share of district heating system	Calculations based on JRC-IDEES, Entranze and Topic 1.1. Based on formula: EWDI = [Number of buildings with system] / [Number of building units]
1.2	Average floor area per person	Calculations are based on Entranze data. Based on formula: average floor area per person = [Total floor area] / [Population]
1.3	Building floor area of private offices	Estimation with employment distribution between private and public offices
2	Average interest rate of the loan- residential buildings	Data provided with extended data search (after the official data collection period of the project) from the European Mortgage Federation Quarterly Review - Q4 2015. Data retrieved for all MSs for 5 years (the period 2010-2014), providing 140 data points.

The method of calculation or the basis of expert judgement for estimations is provided within the “Comments / Notes” section of the public database.

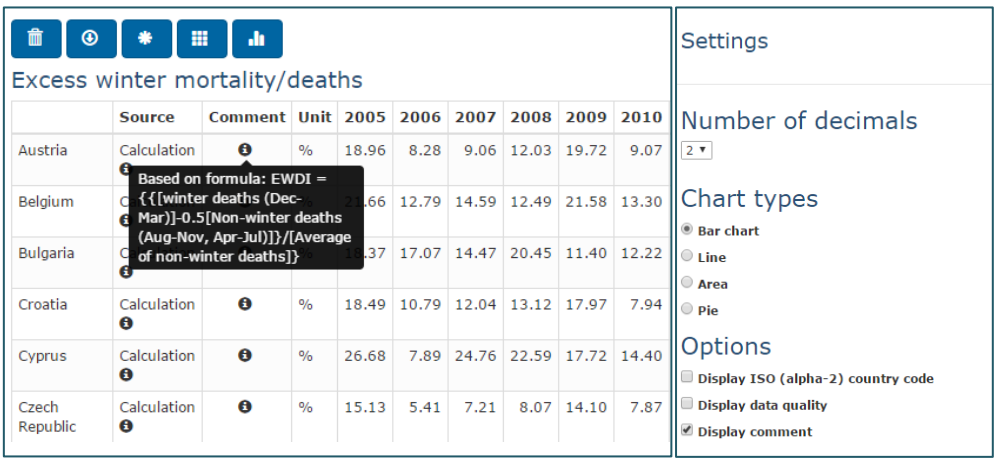

Figure 9 Screenshot form the Building Stock Observatory database

Method 2: Reducing the gap by further data collection from additional sources.

All sources are provided in the Observatory public database and data visualisation tools such as the factsheets.

Method 3: For the indicators where neither calculations nor use of additional data sources were available, actions that can be taken after the project timeline were recommended.

Recommendations on a future data collection was provided to the European Commission.

2.4 Data validation and quality check

Ensuring a high quality of the project results is considered a priority and therefore a consistent approach was developed for quality control. All project phases, tasks and deliverables were analysed to avoid potential delays or lower product quality. The data validation process and quality assessment were selected as key elements of the quality assurance.

2.4.1 Data validation process

The data validation process was conducted in Task 2 (see Figure 10). The process took into account 3 levels of validation:

The first validation level was performed during the data collection process, by the partners responsible for data gathering. In the horizontal and national data templates, the validation function was developed. Based on the validation tables, the data provider could check the data sets consistency.

The second level of validation was performed by topic leaders from the project consortium team and took into account:

- A check of data consistency: inner consistency and consistency among all EU Member States;
- A check of appropriate units (check if the data filled in the template is in line with units pre-defined in the template);
- A check of the values (fitting in expected value ranges);
- A check of the reliability of sources used.

The third level of validation was performed by the Steering Committee. The Committee discussed the most problematic cases, agreed on action points and approved the results of the verification process. The Steering Committee decided that further actions should be taken in order to evaluate the quality of the provided data after the full validation process was completed.

The data validation process was implemented as Task 2.3 “Data validation and Evaluation”. Figure 10 describes the key actions taken in this task. The data validation process was later followed with the evaluation of data quality.

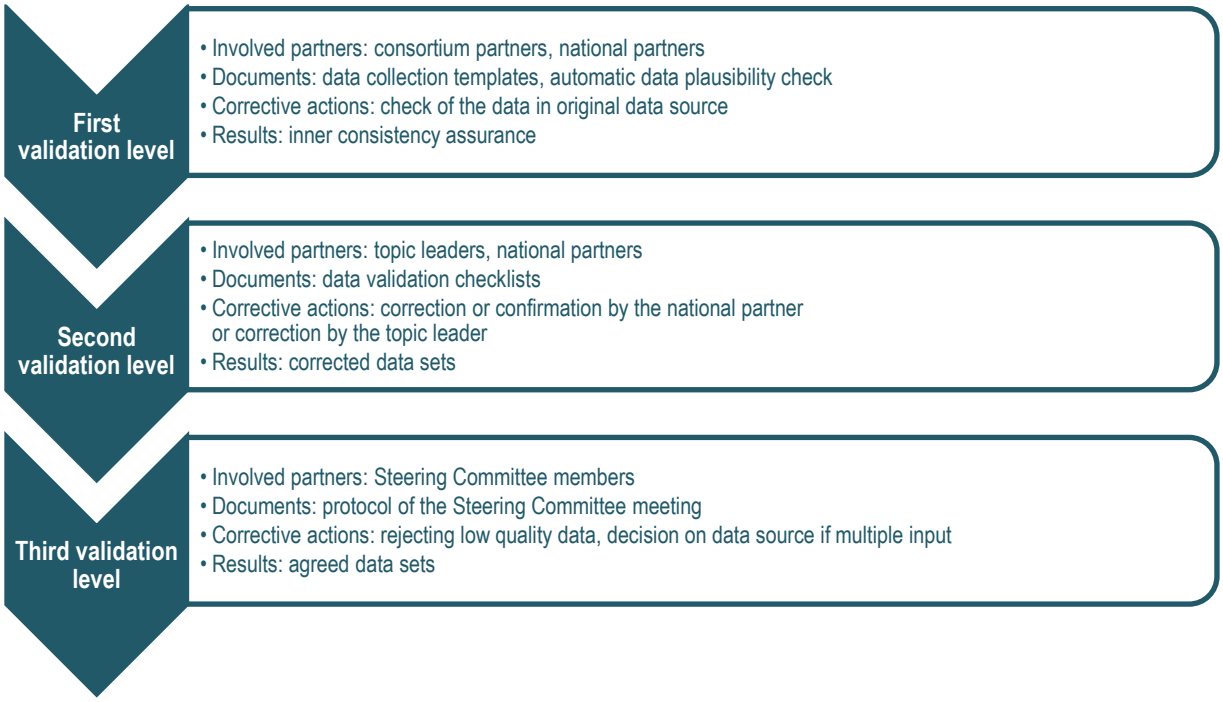

Figure 10 Data validation process

2.4.2 Quality assessment

On top of the data verification and validation processes, the consortium suggested an additional action on the quality assessment of the data sources. Quality of the data sources is critical for the results to be presented in the public domain of the EU Building Stock Observatory website.

The data sources were structured into 5 categories, from Official statistics (considered as the most reliable) to expert assumptions (considered as less reliable). It is worth mentioning that a lower quality score does not mean that the quality of the sources is necessarily low: it just means that the data was estimated within the Building Stock Observatory project.

Table 5 Scale for assessment of the data source quality.

Quality score	Quality score description	Comments
5	Official Statistics	Official European or national statistics considered more reliable than research from project results.
4	EU projects	Statistics developed in various research projects such as Odyssee-MURE, Entranze, EPISCOPE, iSERV; and many others.
3	Literature	Literature covering research aimed at specific topics. These reports often contain data, based on multiple sources and/or own analyses. In research reports, the quality of this data is already assessed and combined with the relevant context. Therefore, the below model output without context is preferred.
2	Model output/ Calculations	Results of modelling based on statistical data and experts' assumptions.
1	Assumption/ Estimations	Expert assumption; no analytical modelling involved.

Quality of the sources was then assessed, with the following steps:

Phase I: Quality assessment of the data sources

Based on the analysis of the sources and additional clarification with national data providers, classification of data quality was made according to the scale proposed in Table 5. The most used sources were the EU projects (around 40%) and official international or national statistics (around 39%) appeared to be the most important source of data on the European building stock. The expert assumptions and calculation provided by the national project partners and the consortium supported around 25% of the collected data.

Phase II: Presentation of the data quality assessment on the BLD Stock Observatory website

The data quality is represented with stars within the database when the users select the source to be displayed in the selection table. The number of stars shows the quality score presented in the table 5.

	Source	Data quality	Unit	2005	2006	2007	2008	2009	2010	2011	2012	2013
Austria	Calculation	★★☆☆☆	%	18.96	8.28	9.06	12.03	19.72	9.07	11.03	15.17	12.81
Belgium	Calculation	★★☆☆☆	%	21.66	12.79	14.59	12.49	21.58	13.30	-	-	17.01
Bulgaria	Calculation	★★☆☆☆	%	18.37	17.07	14.47	20.45	11.40	12.22	13.18	19.92	14.63
Croatia	Calculation	★★☆☆☆	%	18.49	10.79	12.04	13.12	17.97	7.94	11.83	13.72	10.37
Cyprus	Calculation	★★☆☆☆	%	26.68	7.89	24.76	22.59	17.72	14.40	12.40	25.86	13.08
Czech Republic	Calculation	★★☆☆☆	%	15.13	5.41	7.21	8.07	14.10	7.87	9.79	9.55	13.34

Figure 11 Screenshot form the Building Stock Observatory database; reference to the data quality scale

3 The Building Stock Observatory website

The main objective of the project was to present the results of Europe's building stock on the Building Stock Observatory portal, integrated in the DG ENER website. The target groups of the Building Stock Observatory include more than policy-makers: the Observatory shall serve as a comprehensive source of public information and a valuable tool in the hands of a wider range of stakeholders, including industry, the financial community, researchers, etc.

With this in mind, the development of the templates for communication and dissemination of results (in Task 3) took into account the following criteria:

- Display of the results should take into account different levels of data aggregation;
- Data display should address the needs of different stakeholder groups;
- Display shall include country profiles, sectorial (private, public and commercial) factsheets.

To address the above-mentioned criteria, the consortium suggested different features for the EU Building Stock Observatory website, including: a database (private and public), a Data Mapper and factsheets (See: Table 6). Each of the tools target different audiences and offer different approaches for the dissemination and communication of results.

Table 6 Communication and dissemination of the results on the Building Stock Observatory website.

Tool	Target audience	Scope	Functionalities
Online database	Building experts, analysts, consultants and researchers	A comprehensive overview of the building stock characteristics organised into 10 sub-categories: building stock, energy consumption, nZEBs, renovation, building shell, technical systems, certification, financing, energy poverty and energy markets, with reference to the sources.	Data search organised per topic; country and year; Generation of tables and simple graph for data visualisation; Download of data in raw data format; Reference to data sources and quality.
Data Mapper	A wide range of stakeholders looking for specific and comparable information	Selected indicators will be displayed in the Data Mapper; Country comparison (benchmark) will be provided in maps and graphs.	A visual representation of indicators in a map, with a short definition; Complementary indicators available through graphs below the map; Easy download of indicators and graphical representation of the results.
Thematic factsheet	A wide range of stakeholders looking for data analysis, linked to the policy context (e.g. national and EU legislation)	17 thematic factsheets that address the most relevant issues related to the implementation of the EU buildings legislation; Presentation of the key statistics, including analysis and the policy context.	Presentation of results in charts and tables, linking indicators and EU-related policies on buildings; Customised description of graphs and tables.
Country factsheets		28 country-specific factsheets addressing the most relevant issues related to different aspects of the EU legislation. Presentation of key statistics with the national policy context provided.	Presentation of results in charts and tables, linking indicators and national policies on buildings.

1.4 The website features

1.4.1 Online database

All the indicators collected and calculated are stored in a dedicated user-friendly online database, available at: http://building-obs.enerdata.net/eubuildings. The database offers an easy navigation to query raw data and indicators by type through different topics, for the EU-28 countries plus EU as a whole.

Indicators are organised by topic and available through a menu bar of topics according to the following 10 items: Building stock characteristics; Building shell performance, Technical system; nearly Zero-Energy Buildings; Building renovation; Energy consumption; Certification; Financing; Energy Poverty and Energy market.

The online database includes a topic menu in which users are invited to click to select one or several indicators to be displayed. The paragraph below summarises how to use the database for indicator query.

Once selected, indicators appear in a summary table in the main screen. By default, the database proposes to display results for all countries and last 5 years available.

Indicators query:

- Select **indicator** in the left menu:
  - Several indicators can be selected at the same time; (right) click on the chosen ones;
  - You can also use the search engine (below the indicators' list) to find an indicator.
- Select **country(ies)**:
  - User can choose one or several countries; to display aggregated data - for the whole Europe, select "EU28";
  - By default, all countries are selected.
- **Select a year**:
  - User can choose one or several years; by default, the last 5 years (>2000) are selected.

- Short data sources are provided by default in the result data tables. Detailed sources can be visualised through  . Links on data sources are available by hovering the mouse on the short titles.
- To display the results by indicator, click on the "eye" icon, next to the indicator name.
- To display data by country by indicator click on the "eye" icon, next to the country name.
- Users can unselect indicators, countries and/or years by clicking on  .

A search engine module was added to the database to allow users to search for information on a topic without entering the menu. Users should enter a keyword (e.g. nZEB); the system will then list all the indicators containing the typed word.

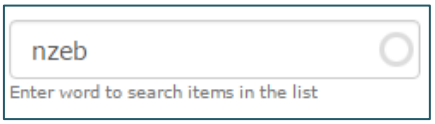

Figure 12 Search engine in the Building Stock Observatory database

Settings and options:

Figure 13 Settings and option menu in the Building Stock Observatory database

- Function to export results to Excel  :
  - Export data per indicator;

- Export data per country.

- Function to visualise the selection through graphs or tables .
- Options with the possibility to:
  - Change the number of decimals of the displayed data;
  - Change the type of graphs (bar chart, pie, line, area) - Downloadable in png/jpeg/pdf/svg vector image;
  - Display data quality (according to a 5-star system);
  - Display comments on datasets regarding the methodology of calculation for instance.

Once selected, indicators appear in a table or graph. Data can be downloadable in Excel to be used for reporting purposes. Indicators are clearly defined, by hovering the mouse over the icon , close to the title of the indicators (Figure 14).

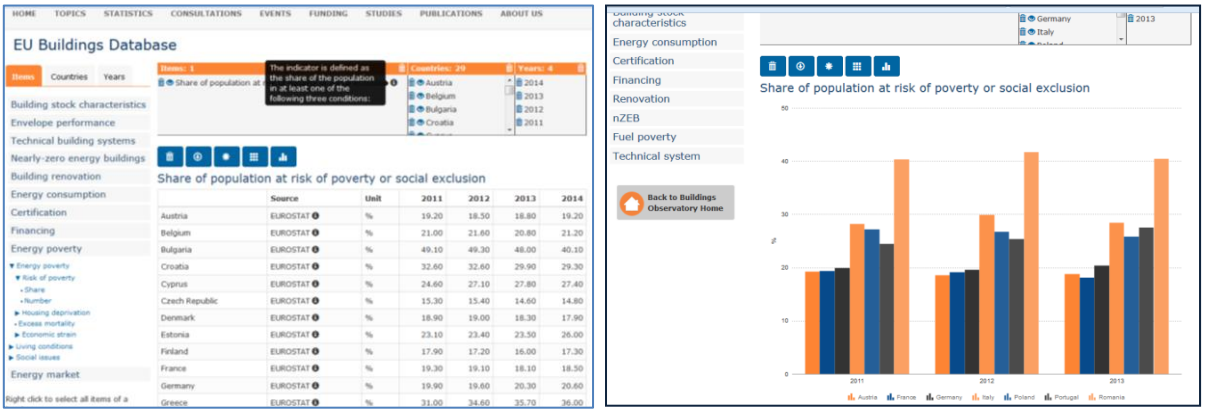

Figure 14 Display of the results in the online database, in table and through graph

1.4.2 Data Mapper

A selection of indicators presented within the different topics of the online database are displayed through a mapping application describing the countries' characteristics, the "Data Mapper".

Such a tool enables the display of comparable indicators in a map, through various colours to differentiate the countries according to the value of the indicator.

The Data Mapper is made of a selection of indicators calculated based on data collected within the project. Selected indicators should be available for almost all countries and comparable.

As for the database, the most representative indicators are presented per topic. Users can select pre-defined indicators in a short list. Indicators are then displayed in a map and an advanced or explanatory graph.

Indicators are displayed by default for the latest year available in most countries (e.g. 2013, 2014, or 2015 depending on the indicators). Users also have the possibility to change the year to select another one (from 2000 up to 2015).

Each indicator is clearly defined (by hovering the mouse over the icon close to the title). Sources, related link to the source, comments on the indicator (e.g. such methodology of calculation) are available within the box "Sources and Notes".

Figure 15 shows the ranking of the top 10 countries for the indicator represented in the map: 10 countries with the highest values for this indicator or 10 countries with the smallest values for this indicator.

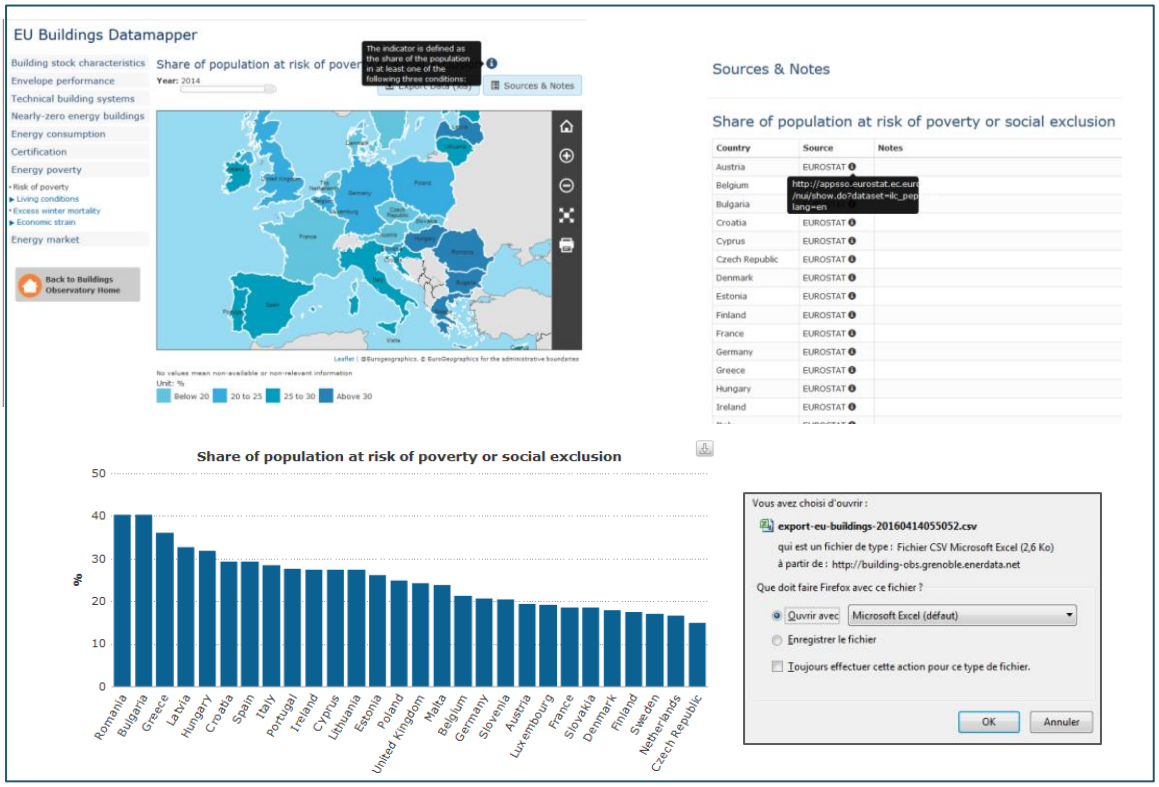

Figure 15 Screenshot of the Buildings Observatory Data Mapper

1.4.3 Factsheets

To promote and disseminate the results of the Building Stock Observatory database, factsheets related to the ten topics described previously as well as country-specific are also offered within the website.

The most important features (indicators and recommendations) are defined thanks to inputs stemming from the Building Stock Observatory database, in light of providing evidence and support for monitoring the implementation process of the different European Directives targeting the building sector.

Topic factsheets: presenting and gathering information on building characteristics in relation to EU policy requirements. Table 7 presents the list and scope of the thematic factsheets.

Table 7 List of indicators by topic to include in the topic factsheets

	Title	List of indicators included in the scope of the factsheet
Topic 1	Building stock characteristics	Building typology: residential with single/multifamily dwellings, non-residential with building types; Building characteristics: age, size, ownership and location; Building renewal: annual construction of new buildings.
	nZEB and energy performance	% of nZEBs in construction (residential, non –residential); Energy performance of nZEB (kWh/m^2 year); National definitions.
	Building renovation	Major renovation (equivalent).
	Energy use in buildings	Energy consumption by country and energy (for buildings, for residential, non-residential); Energy consumption by end-use per country (for residential, non-residential); Energy consumption per m^2 for residential and non-residential.
Topic 2	Building shell performance	U-value per building element (EU); U-value per dwelling age category (EU); U-value per element and country; U-value (building shell) per country and degree days.
	Technical systems (space heating, DHW, Ventilation)	European residential energy uses in 2013 split to functions; Division of space-heating types in Europe; Share of heating-device capacities in Europe in 2015;

	Title	List of indicators included in the scope of the factsheet
		% condensing boilers, conventional boilers; % of heat pumps and biomass; Trends in energy consumption for DHW production; % solar heaters; Number of cooling systems in Europe; Share of dwellings equipped with air-conditioning.
	On-site renewable energy	Development of share of on-site renewable energy generation in the EU-28*; On-site production of solar heat as share of total final energy consumption in buildings in 2013; On-site production of solar electricity as share of total final energy consumption in buildings in 2013 in different MS; On-site biomass consumption as share of total final energy consumption in buildings in 2013; On-site geothermal heat consumption as share of total final energy consumption in buildings.
	Appliances, cooking	Share of electrical appliance in total residential energy consumption at EU level; Development of appliance penetration rates in EU dwellings; Average number of appliances per dwelling in different MS in 2012; Average number of lamps in dwellings; EU average share of lamps in non-residential buildings; Topic on Eco-design standards; Share of cooking fuel in MS.
	Embodied energy [informative paper]	20 most energy-intensive materials (source: ICE database); Energy consumption per ton for cement, glass, steel (source ODYSSEE).
Topic 3	Energy Performance Certificates	EPC compliance rates reported by Member States - related to the production of EPCs; Share of dwellings and non-residential buildings with EPC registered (cumulative); Public EPC register; Distribution of EPCs in residential building stock; Distribution of EPCs in non-residential building stock; Distribution of EPCs in new buildings (Residential); Distribution of EPCs in new buildings (Non-residential); EPC monitoring.
	Impact of energy label on property value and rent price [informative paper]	Factsheet based on the national case studies for 6 countries, where data are available; Impact of the energy label on rent; Impact of energy label on property value.
	Voluntary certification scheme	Introduction to voluntary certification schemes; Total number of certificates per type.
Topic 4	Financial support schemes in the building sector [informative paper]	Definition of the schemes included in the Observatory and the methods of support for end-users.
Topic 5	Energy poverty	Inability to keep home adequately warm (per MS and EU-28 for 2014); Share of households' expenditure on electricity, gas and other housing fuels (per MS for 2010); Arrears on utility bills (per MS and EU-28 for 2014); Inability to keep home adequately warm, arrears on utility bills, population living in a dwelling with leaking roof (EU-28 from 2010 to 2014).
	Housing comfort	Thermal comfort, daylight requirements and internal air quality in the EU; Average floor area per person; Average number of rooms per person.
	Inadequate housing	Share of total population living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames; Share of population living in a dwelling not comfortably cool during summer time by income quintile and degree of urbanisation.
	Energy market	Date of liberalisation of the electricity market in 2014; Date of liberalisation of the gas market in 2014; Switching rates – electricity in 2008 and 2013; Switching rates – gas in 2008 and 2013.

Country factsheets: presenting results by country combining the main results from each topic presented above. Each country factsheet is structured in the same way and organised according to a selection of graphics stemming from the above-mentioned topics.

Figure 16 Screenshot from the Building Stock Observatory website; thematic factsheets

4 Summary

Establishing the EU Building Stock Observatory is an important step to support policy-making processes both at the European and Member State levels. The Observatory will support monitoring of the EU directives implementation at national and regional levels and will contribute to their review (such as the EPBD/EED/RED reviews in the coming months).

This public knowledge resource will be of use not only for decision-makers, but also for investors, industry stakeholders, energy utilities, local authorities and researchers to allow for, and underpin, decision-making, and for long-term strategic support. Better access to data will contribute to the improvement of the way the building sector is considered in economic modelling of energy efficiency policy options. Access to reliable information will also support effective decision-making in the financial sector, which is crucial specifically for buildings renovation.

The Observatory will also be an important support tool for the Member States reporting to the European Commission as required under the different articles of the EPBD and EED. For example, to update national renovation strategies in 2017 – as required under Art. 4 of the EED – Member States will be able to use the data provided in the Observatory to assess the status of their national building stock.,

The following added value of the project was identified:

- ✓ The Building Stock Observatory will serve as a centralised, official repository of information on Europe's buildings stock. It will provide information and link different aspects of the building stock characteristics, including typology, technical systems, energy performance, energy needs, as well as living conditions, comfort, indoor air quality, energy poverty and many others. There are over 250 main indicators included in the scope of the Observatory.

- ✓ The Observatory provides a harmonised structure for data collection and reporting across all EU Member States. This structure takes into account existing approaches for data collection at European, national and regional levels (such as: type of indicators collected, taxonomy). In addition, the consortium provided new approaches to tackle data collection e.g. for monitoring renovation activities.

- ✓ The Observatory allows for an easy search of information on Europe's buildings, until now only available in different sources (i.e. official statistics, research projects/reports, etc.), both at European and national levels. It also presents new data sets (i.e. never published) collected or estimated in the scope of the Building Stock Observatory project. This includes:

    - Calculations and estimations conducted by the project consortium. Around 4500 data points were derived as a result of data gap management actions;

    - Data from new sources, such as national EPC databases. For example, for Ireland, information on the technical system in the building stock was provided from analysis of statistically significant sample of the EPC certificates.

    - Data sets provided by industry associations, including REHVA, EHPA, Euroheat & Power, the German Window Association, EHI, Eurowindoor

    - The Observatory includes and promotes the results of EU-funded projects, including IEE, FP7 Framework Programme and H2020. Over 15% of data available in the Observatory comes from EU-funded projects, such as ODYSSEE-MURE, ZEBRA2020, EPISCOPE/TABULA, ENTRANZE, INSPIRE and many others.

- ✓ The Observatory targets different audiences and offers different approaches for the dissemination and communication of result. This includes:

    - A database that serves as a comprehensive overview of the building stock characteristics.

    - A Data Mapper, which allows for countries comparison (benchmark) of selected indicators in maps and graphs.

- Thematic and country factsheets that address the most relevant issues related to the implementation of the EU buildings legislation and include key statistics, analysis and the policy context.

✓ The Observatory uses the information and links the information provided by Concerted Action EPBD (CA EPBD), especially in the context of the implementation of building-related policies at national level (i.e. the Key Implementation Decision).

✓ Last, but not least, the Building Stock Observatory provides a comprehensive overview of building-data availability at the European and national levels. On the topic of data gap management (in the scope of the project), the consortium provided recommendations for data collection future approaches.

ANNEXES

Annex 1 – List of the indicators

Annex 2 – List of data sources for the project

Annex 3 – List of partners involved in data collection process

Annex 1 –List of the indicators (updated)

Topic 1: Building stock & energy needs

	Indicator name	Definition
T.1.1 Building stock statistics		
1	Number of buildings/building stock units	**This indicator will reflect the total number of buildings, building units and the floor area of the building stock in residential and non-residential sector.** A building is understood as a roofed construction having walls, for which energy is used to condition the indoor climate; and a 'building unit' means a section, floor or apartment within a building which is designed or altered to be used separately (EPBD definition). In the residential sector and in case of collective buildings, a building is made of several dwellings (or building units); while single-families include detached or semi-detached houses (see dwelling definition and building type definition below). As a result, in the residential sector we will speak about dwelling stock data, i.e. dwelling as structurally separate accommodation. Non-residential buildings refer to buildings in the service sector.
2	Number of dwellings	**This indicator will reflect the total number of dwellings.** The physical structure (a house, an apartment, a group of rooms or a single room) that is either occupied or intended for occupancy by the members of a household.
3	Building floor area (and average floor area)	**This indicator will reflect the total floor areas on the building stock in the residential and non-residential sectors.** The residential building floor areas correspond to the useful floor area; it is different from the gross floor area which includes common areas in multi-family buildings (e.g. corridors, etc.), attics, basement or verandas. It is expressed in million m². In non-residential buildings, the floor area represents the floor space that needs to be heated, cooled or illuminated; it is measured in m². The floor area that is heated during most of the winter months. Rooms that are unoccupied and/or unheated during the heating season, unheated garages or other unheated areas in the basement and/or the attic are not considered. The average dwelling size (m^2) or living area corresponds to the total useful floor area of residential buildings divided by the number of dwellings, available as such in household surveys and construction statistics.
4	Building stock decomposition by building or dwelling type	**This indicator will reflect the number of buildings/ building units and the floor areas on the building stock by building type[22].** In the residential sector, while an elaborate classification of dwellings may be used, a basic typology could be limited to 'single houses' and 'apartments'. • *Single house:* A dwelling, detached or attached, that provides living space for one household. • *Apartment:* A dwelling in a building that contains living quarters for more than one household and in which households live above, below or beside other households. But a more elaborated classification (detached, attached and semi-detached houses, low/high rising apartment buildings) is recommended, as all these factors affect the energy consumption. Non-residential buildings refer to buildings in the service sector and include several categories: o Wholesale and retail (i.e. total, shopping malls); o Hotels & restaurants (i.e. hotels, other short-stay accommodation, restaurants); o Health care facilities (i.e. hospitals, other institutional care buildings); o Educational buildings (i.e. kindergartens, schools, universities, others); o Sport facilities (i.e. with swimming pool, without swimming pool); o Offices; o Other non-residential buildings. The public buildings include the following categories (EPBD definition): o Central government buildings (frequently visited) >250 m^2

[22] According to data availability and relevance, it includes building stock or building floor areas' decomposition.

	Indicator name	Definition
		○ Central government buildings (frequently visited) >500 m^2 ○ Regional/local authorities' buildings
5	Building stock decomposition by construction period	**This indicator will reflect the number of buildings/ building units and the floor areas on the building stock by building type and by construction period.** The building stock will be given for both residential and non-residential sectors according to the following construction periods: • Buildings erected before 1945, of which: ○ Historical buildings located in conservation areas or with architectural and historical interests (world heritage), etc. that are protected from demolition or transformations. Historical building's definition is different across countries and will be defined at national level. ○ Officially protected buildings, protected for their special architectural or historical merit. • Built between 1945 and 1969; • Built between 1970 and 1979; • Built between 1980 and 1989; • Built between 1990 and 1999; • Built between 2000 and 2009 (effect of EPBD); • Built since 2010 (effect of EPBD recast).
6	Building stock decomposition by size	**This indicator will reflect the distribution of the household's size;** The distribution of the residential building stock is as follows: • 1-person dwelling • 2-person dwelling • 3-person dwelling • 4-person dwelling • 5+ persons dwelling
7	Building stock decomposition by location	**This indicator will reflect the number of buildings/ building units on the building stock by location for residential.** • *High-density cluster/urban centre:* contiguous grid cells of 1 km^2 with a density of at least 1 500 inhabitants per km^2 and a minimum population of 50 000; • *Urban cluster:* cluster of contiguous grid cells of 1 km^2 with a density of at least 300 inhabitants per km^2 and a minimum population of 5 000; • *Rural grid cell:* grid cell outside high-density clusters and urban clusters.
8	Building stock decomposition by climatic zone	**This indicator will reflect the number of buildings/ building units on the building stock by the climatic zones defined at national level.** Climatic zones are usually represented as homogenous zones in terms of climate, based on heating or cooling degree-days; climatic areas are defined in national thermal regulations. Climatic zones can be defined at the EU level.
9	Building stock decomposition by occupancy level	**This indicator will reflect the share of buildings/building units in the total stock by the occupancy levels.** There are three types of residence: - Primary residence: A dwelling which is the main residence of the householder; occupied for at least half of the year by the householder. Such dwelling is also understood as a permanently occupied dwelling. - Secondary residence: A dwelling occupied for less than six months of the year by the householder. (i.e. summer/ week-end houses). - Vacant building: non-occupied buildings/ building units. As for the non-residential sector, the occupancy rate will be given in particular for offices with daily occupancy hours per day.
10	Building stock decomposition by	**This indicator will reflect the share of buildings/building units in the total stock by the ownership status.**

	Indicator name	Definition
	ownership status	The different ownership status taken into account in the residential sector are assessed through the distribution of population by tenure status: • *Owner-occupied dwellings*; a dwelling is classified as 'owned' when the owner or co-owner is a household member. Dwellings bought on mortgage are included under this heading. The ownership refers to the structure itself (not to the land). • *Rented dwellings;* a dwelling is classified as 'rented' when it is occupied or used in return for regular payments (which can include free rent) by the tenant or a third person. Two categories of rented dwellings are presented: - Tenant, rent at market price - Tenant, rent at reduced price or free And in other hand: • Private dwellings (sum of owner-occupied dwellings and private-rented dwellings) • Social dwellings In non-residential: • Owned (public/private sector) • Commercial rent
11	New construction	**This indicator will reflect the number of buildings/building units and floor area of the new constructions** In residential buildings, the annual construction of dwellings represents the number of dwellings which are built every year. Such statistics are usually available from the national statistical office. In non-residential buildings, the annual construction of tertiary buildings represents the floor area of new buildings built every year. New construction can also be assessed through the building permits index (2010=100) for the number of residential and non-residential buildings, for the m^2 of useful floor area.
12	Average energy performance of new construction	**This indicator will reflect the average energy performance of new construction per building type.**
13	Renovation	**This indicator will reflect the number of buildings and floor area that undergo annually renovation,** including any type of renovation e.g. esthetical renovation (e.g. including only face lifting or any esthetical improvement) and thermal renovation with energy efficiency improvements. This indicator will take into account (after the EPISCOPE project) among others, buildings with: • Wall insulation improved from the original state, • Roof insulation improved from the original state, • Improvements to at least thermal-protection double glazing, etc.
14	Energy renovation	**This indicator will reflect the number of buildings and floor area that undergo annually thermal building renovation.** That is to say any renovation that will improve the energy efficiency or thermal energy performance of the building. We exclude renovation undergoing only face lifting or any esthetical improvement. Basic building elements renovated are wall, floor, façade, ceiling or windows. The different data we will consider include: • Renovation rates according to different level of retrofitting: ○ Deep energy renovation (see definition below) ○ Medium energy renovation ○ Light medium energy renovation
15	Deep energy renovation	**This indicator will reflect the share of the number of buildings and floor area that undergo deep renovation.** Deep renovation or deep energy renovation is a term for a building renovation that captures the full economic energy efficiency potential of improvements. This typically includes a focus on the building shell of existing buildings in order to achieve a very high-energy performance. Following the working document accompanying COM (2013) 225, deep renovation means at least 60% savings of the primary energy

	Indicator name	Definition
		compared to the status of the existing building before the renovation.
16	Major renovation (EPBD definition)	**This indicator will reflect the share of the number of buildings and floor area that undergo major renovation.** Major renovations are cases such as those where the total cost of the renovation related to the building shell and/or energy installations such as heating, hot water supply, air-conditioning, ventilation and lighting is higher than 25 % of the value of the building, excluding the value of the land upon which the building is located, or those where more than 25 % of the building shell undergoes renovation. Member States can also apply alternative approaches defined at national level.
17	Average performance level reached after renovation	**This indicator will reflect the average performance level achieved in the refurbished buildings by type of building and type of renovation (deep and major renovation, as defined above)**. Two coefficients are taken into account to fully consider the thermal building efficiency effect such as the rebound effect or behaviours: • Average energy performance level reached by the energy renovation: often calculated ex ante • Average energy performance level reached after the renovation: calculated ex post and taking into account the household composition rebound effect, etc. This indicator is expressed in kWh/m^2/year in final and/or primary energy, and/or %
18	Demolished buildings	**This indicator will reflect the share of the number of buildings and floor area demolished or otherwise removed from the stock.**
19	Rented out last year	**This indicator will reflect the number of buildings/building units rented every year**
20	Transactions last year	**This indicator will reflect the total number of dwellings sold per year in residential and floor area sold in non-residential buildings.**
21	Stock of nZEBs	**This indicator will reflect the total number of buildings that meet the nearly Zero-Energy Building (nZEB) standards defined at national level. Each country defines its nZEB standard according to:** • New construction • Building renovation
22	Average energy performance of nZEBs	**This indicator will reflect the average performance of nZEBs by building type.**
T.1.2 Energy needs		
1	Final energy consumption	**This indicator will reflect the total final energy for residential and non-residential buildings.** The annual energy consumption is the amount of energy commodities consumed by a dwelling/building during a twelve-month period. The final energy consumption of residential buildings includes the energy used by households in their dwellings. In non-residential, it includes the consumption in public and private buildings listed previously. Consumption can be observed (in Eurostat statistics) or measured at normal (standard) climate (i.e. climate corrected).
2	Energy consumption for space heating	**This indicator will reflect the total energy consumption for space heating in residential and non-residential sectors.** Space heating refers to the energy used to provide heat (i.e. thermal energy) in the interior area of a dwelling / building. This value is a real value of the energy consumption estimated on the basis of surveys and modelling and endorsed by national energy agencies or institutions.
3	Energy consumption for space cooling	**This indicator will reflect the total energy consumption for space cooling in residential and non-residential sectors.** Space cooling: refers to the energy used for cooling in a dwelling / building by a refrigeration system and/or unit. Fans, blowers and other appliances not connected to a refrigeration unit are excluded from this section, and should be covered in the lighting and electrical appliances section. Such information is estimated with surveys on the diffusion of space cooling appliances (i.e. air conditioners) and modelling, taking into account the intensity of use (number of hours) and their average

	Indicator name	Definition
		rated power.
4	Energy consumption for domestic hot water	**This indicator will reflect the total energy consumption for domestic hot water in residential and non-residential sectors.** Water heating: this energy service is referred to the use of energy to heat water for hot running water, bathing, cleaning and other non-cooking applications. Swimming pool heating is excluded and should be included in 'other uses'. This value is a real energy consumption value based on the estimations.
5	Water consumption	**This indicator will reflect the total water consumption for domestic hot water in residential and non-residential sectors.**
6	Energy consumption for lighting	**This indicator will reflect the total energy consumption for lighting in residential and non-residential sectors.** The electricity consumption for lighting is available for some countries from national estimations; it is not covered by usual energy statistics. It is usually estimated from modelling, taking into account the number of lighting points or the average lighting power and an average number of hours of lighting per year[23].
7	Energy consumption for appliances (including cooking)	**This indicator will reflect the total energy consumption for appliances in residential and non-residential sectors.** The consumption of electrical appliances can be calculated based on the difference between the total electricity consumption – electricity consumption for air conditioning - cooking – electricity water heating and lighting. Energy sources for cooking: the main energy sources used for cooking are natural gas, electricity, biomass, liquefied petroleum gas, kerosene and coal. Definitions are those of the ESR.
8	Energy consumption for ventilation	**This indicator will reflect the total energy consumption for ventilation in residential and non-residential sectors.** It represents the electricity consumption of households for ventilation.
9	Final energy consumption per end use per carrier (including for space heating and domestic hot water)	**This indicator will reflect the total final energy consumption by end use and energy carrier.** Household energy end use: the use of energy commodities by a household, in order to obtain some energy services (heating, cooling, hot water, etc.). The final energy consumption will be made specific for different building types. The energy will be divided in different energy carriers: natural gas, fuel oil, coal, electricity, biomass, on-site renewable energy and district heat. In addition, the disaggregation of the final energy consumption by carrier will be provided for **space heating** and **domestic hot water**.
10	Theoretical energy use	The theoretical energy use is defined as the amount of energy required in a dwelling with an average family using energy for space and water heating, lighting, cooking and for an appropriate level of warmth. The theoretical energy consumption tends to be much higher than the actual energy use due to occupant behaviour, especially for older buildings. This specific consumption is often given for existing dwellings by age bands.
T.1.3 Fuel mix		
1	Electricity production by carrier	**This indicator will reflect the mix of fuels used for electricity generation.**
2	District heating by carrier	**This indicator will reflect the mix of fuels used for district heating.**
3	Renewable energy generation by deep geothermic heat	**This indicator will reflect the value of the energy produced for district heating by geothermic heat.**
4	Renewable energy generated by waste heat	**This indicator will reflect the value of the energy produced for district heating by waste heat from e.g. incineration plants.**

[23] A default value can be 1000 hours per year.

	Indicator name	Definition
5	Renewable energy generated by hydro power	**This indicator will reflect the value of the energy produced for buildings (electricity) by hydro power.**
6	Renewable energy generated by other systems	**This indicator will reflect the value of energy generated by other systems than the ones listed above, often by new innovative technologies not well established yet on the market.**

Topic 2: Technical building systems

	Indicator name	Definition
T.2.1 Shell performance		
1	Air tightness	**This indicator will reflect the airtightness values provided by age band and per building type.** Airflow through the construction at a given building-to-outside reference pressure, typically at 50 pascal (Q50). The unit is $m^3/(m^2 \cdot h)$ or $dm^3/s/m^2$.
2	Average U-value for overall building shell	**This indicator will reflect the average U-values for overall shell, which will be provided per age band and building type.** A U-value is a measure of heat loss through a building shell element, also called a heat transfer coefficient. A low U-value indicates a high level of insulation. The unit is W/m^2K or $W/m^2°C$. It regards an average U-value of all doors, if possible weighed according to m^2 of doors having the same U-value.
3	Average U-value of doors	Ditto
4	Average U-value of external walls	Ditto
5	Average U-value of floors	Ditto
6	Average U-value of roofs	Ditto
7	Average U-value of skylight	Ditto
8	Average U-value of windows	Ditto. The U-value is calculated for window pane and frame together.
9	Disaggregation per type of glazing	**This indicator will reflect the number of buildings/building units by type of window/glazing.** The type of glazing can be: single, double, high performance double, triple and quadruple. The disaggregation will be done per age band and building type. This indicator is also displayed as share of total building units.
10	Disaggregation per type of window frame	**This indicator will reflect the number of buildings/building units by type of window frame.** Type of window frames can be: wooden, plastic, metal or other materials like composites. The disaggregation will be done per age band and building type. This indicator is also displayed as share of total building units.
T.2.2 On-site renewable energy generation		
1	On-site renewable energy sources generation	**This indicator will reflect the capacity of the on-site renewable energy by source.** On-site means installed in/on or near the building, also mentioned as "behind-the-meter". The generated energy can be directly fed into the grid or pipelines, but will mainly be consumed by the building itself. The value will be the energy produced in all buildings, the unit will be Mtoe. This indicator is also displayed as the share of buildings' total energy consumption.
2	Renewable electricity generation by PV panels	Ditto. The value will be energy produced in all buildings, the unit will be Mtoe. This indicator is also displayed as the share of buildings' total energy consumption.
3	Renewable heat generation by	Ditto. The value will be energy produced in all buildings, the unit will be Mtoe.

	Indicator name	Definition
	biomass	This indicator is also displayed as the share of buildings' total energy consumption.
4	Renewable heat generation by heat pumps	Ditto. The value will be energy produced in all buildings, the unit will be Mtoe. This indicator is also displayed as the share of buildings' total energy consumption.
5	Renewable heat generation by solar	Ditto. The value will be energy produced in all buildings, the unit will be Mtoe. Disaggregation for solar used for heating and domestic hot water. This indicator is also displayed as the share of buildings' total energy consumption.
6	Renewable electricity generation by wind (small size turbines)	Ditto. The value will be energy produced in all buildings, the unit will be Mtoe.
7	Conversion efficiency of the renewable energy technology used	Conversion efficiency is the ratio between energy input and output of renewable energy. This indicator will be provided for PV, biomass, heat pumps, solar thermal energy and small size wind turbines.
T.2.3 Technical systems		
A.	***Space heating*** refers to the use of energy to provide heat (i.e. thermal energy) in the interior area of a dwelling. (Eurostat)	
1	Disaggregation of buildings according to the heating device coverage (main and supplementary)	**This indicator will reflect the number of buildings/building units according to coverage.** According to the amount of heat provided to the dwelling and the frequency of use, the space heating systems can be separated into main and supplementary space heating systems. The main space-heating system provides most of the heat to the dwelling. The supplementary space-heating equipment is used less often than the main space-heating system. (Eurostat)
2	Disaggregation of buildings according to heating device capacity	**This indicator will reflect the number of buildings/building units according to the heating device capacity.** Following the EPBD provisions on inspections of heating systems, the heating devices will be disaggregated according to their capacity, in ranges as follows: <20kW; >100 kW. This indicator is displayed as absolute number and share of systems.
3	Disaggregation of buildings according to the heating system level	**This indicator will reflect the number of dwellings served by heating systems.** Collection of data on the heating system level as follows: individual and collective heating. This indicator will be expressed in %. The collective space heating system is serving more than one dwelling: multiple dwellings in one building (boiler room for the whole building), several buildings, community, district (local, community or district heating plants). An individual space heating system provides heat to a single dwelling. (Eurostat)
4	Average efficiency rate for space heating	**This indicator will reflect the average efficiency rate for space heating of all installed systems**.
5	Buildings/building units with central steam/hot water space heating system	**This indicator will reflect the number of buildings/building units with central steam/hot water space heating system.** Central steam/hot water space-heating system: it provides steam or hot water to radiators/convectors or pipes (including under-floor heating) in a dwelling. (Eurostat).
6	Buildings/building units with condensing boilers	**This indicator will reflect the number of buildings/building units with condensing boiler.** Condensing boilers are water heaters fuelled by gas, coal, oil or biomass. They achieve a high efficiency (typically greater than 90% on the higher heating value) by using waste heat in fuel gases to pre-heat cold water entering the boiler. This indicator is displayed as absolute number and share of buildings/ building units.
7	Average efficiency rate of condensing boilers	**This indicator will reflect the average efficiency of condensing boilers.** **Energy conversion efficiency (η)** is the ratio between the useful output of an energy conversion machine and the input, in energy terms. The useful output may be electric power, mechanical work, or heat.
8	Efficiency rate of the BAT condensing boilers	**This indicator will reflex the efficiency of the BAT condensing boilers.** Energy conversion efficiency (η) - ditto.

	Indicator name	Definition
9	Buildings/building units with conventional boilers	**This indicator will reflect the number of buildings/building units with conventional boilers.** Conventional boilers are water heaters fuelled by gas, coal, oil or biomass. This indicator is displayed as absolute number and share of buildings/ building units.
10	Average efficiency rate of conventional boilers	**This indicator will reflect the average efficiency of conventional boilers.** Energy conversion efficiency (η) - ditto.
11	Buildings/building units with combi boilers	**This indicator will reflect the number of buildings/building units with combi boilers.** A combi boiler provides heated water for both space heating and domestic hot water heating. This indicator is displayed as absolute number and share of buildings/ building units.
12	Average efficiency rate of combi boilers	**This indicator will reflect the average efficiency of combi boilers.** Energy conversion efficiency (η) - ditto.
13	Efficiency rate of the BAT combi boilers	**This indicator will reflect the efficiency of the BAT combi boilers.** Energy conversion efficiency (η) - ditto.
14	Buildings/building units with a built-in electric system	**This indicator will reflect the number of buildings/building units with a built-in electric system.** *Built- in electric system:* a system of electrical resistances (usually as under-floor heating) providing heat to individual rooms; the system is part of the building electrical installation (Eurostat).
15	Buildings/building units with central air space heating	**This indicator will reflect the number of buildings/building units with a central air space heating.** Central warm-air space-heating system: it provides warm air through ducts to the dwelling (Eurostat).
16	Buildings/building units with heat pumps	**This indicator will reflect the number of buildings/building units with heat pumps.** Devices that bring heat from the environment in the dwelling, using a compressor (mechanical work). Two main types of heat pumps are used in the residential sector and commercial applications: air-source heat pumps (by far the most common) and ground-source (or geothermal) heat pumps. A heat pump works like an air conditioner in the cooling cycle; in the heating cycle, it simply works reversely (i.e. cooling the outside, and venting heat to the inside). Ground-source heat pumps transfer heat through earth or water, whereas air-source heat pumps do so via air. Because heat pumps simply move heat around rather than creating heat, they can be a very efficient method of space conditioning, especially in moderate climates (Eurostat). This indicator is displayed as absolute number and share of buildings/ building units.
17	Buildings/building units with reversible heat pumps	**This indicator will reflect the number of buildings/building units with reversible heat pumps.** Reversible heat pumps are heat pumps that can be used in reverse mode to cool the air (Eurostat).
18	Average efficiency rate of heat pumps	**This indicator will reflect the average efficiency of heat pumps.** Energy conversion efficiency (η) - ditto.
19	Efficiency rate of the BAT heat pumps	**This indicator will reflect the efficiency of the BAT heat pump.** Energy conversion efficiency (η) - ditto.
20	Buildings/building units with solar heating system	**This indicator will reflect the number of buildings/building units with solar heating system.** It uses solar energy to heat a fluid and then transfer the solar heat directly to the interior space or to a storage system for later use. Flat-plate collectors are the most common, but evacuated tube and concentrating collectors are also in use. If the solar system cannot provide adequate space heating, an auxiliary or back-up system provides the additional heat. The collectors are the same as those used for domestic water heating systems. (Eurostat)
21	Buildings/building units with a stove	**This indicator will reflect the number of buildings/building units with a stove.** Stove: a non-portable apparatus that provides heat using solid or liquid fuels. (Eurostat)
22	Buildings/building units with a fireplace	**This indicator will reflect the number of buildings/building units with a stove.** Fireplace: usually built of bricks and as part of the house using fuel wood. (Eurostat)
23	Buildings/building units with an electric storage heater	**This indicator will reflect the number of buildings/building units with an electric storage heater.** Electric storage heater, portable electric heater: it stores heat in periods with cheaper electricity, usually overnight, and releases it during the day when required. (Eurostat)

	Indicator name	Definition
24	Buildings/building units with a portable kerosene / liquefied petroleum gas heater	**This indicator will reflect the number of buildings/building units with a portable kerosene / liquefied petroleum gas heater.** Portable kerosene / liquefied petroleum gas heater: portable kerosene heater is a device used to heat a room by using kerosene. A gas heater is a device used to heat a room by burning natural gas, liquefied petroleum gas, propane or butane. (Eurostat)
25	Buildings/building units with a cooking stove	**This indicator will reflect the number of buildings/building units with a cooking stove.** Cooking stove: equipment used normally for cooking purposes but serving also as a local space heating system. Regarding space heating, only the fuel consumption of this kind of equipment used for space heating is relevant and the shares of fuel used for cooking and space heating should be estimated. (Eurostat)
26	Disaggregation of space heating devices according to the energy source	**This indicator will reflect the number of buildings/building units using below-mentioned energy sources.** Heating systems can generate heat using different energy sources such as: electricity, natural gas, coal, fuel oil, liquefied petroleum gas, kerosene, biomass and solar thermal energy. (Eurostat)
27	Buildings/building units with heating on biomass – self produced	**This indicator will reflect the number of buildings/building units with biomass heating– self produced.** Boilers combusting biomass that is produced at home or within the area that belongs to the household or the building.
28	Buildings/building units with heating on biomass - purchased	**This indicator will reflect the number of buildings/building units with biomass heating– purchased.** Boilers combusting biomass that has been purchased.
29	Buildings/building units supplied with energy from heat and cold storage	**This indicator will reflect the number of buildings/building units supplied with energy from heat and cold storage.** Data on heat and cold storage technologies (compact heat storage, acquirer, etc.) will be collected.
30	Buildings/building units supplied with energy from on-site CHP	**This indicator will reflect the number of buildings/building units supplied with energy from on-site CHP.** Combined heat and storage technology can be at dwelling/building level (micro CHP) or at district level. The value will be the share of all buildings; the unit will be number of dwellings/buildings.
31	Buildings/building units supplied with energy generated by OTHER technologies	**This indicator will reflect the number of buildings/building units supplied with energy generated by OTHER technologies.** Other technologies than listed above will be included here.
32	Disaggregation of the heating system according to the age of the space heating equipment	**This indicator will reflect the number of buildings/building units according to the age (range).** Age of the main heating system of the household. (Eurostat)
B.	***Space cooling*** refers to the use of energy for cooling in a dwelling by a refrigeration system and/or unit. Fans, blowers and other appliances not connected to a refrigeration unit are excluded from this section, and should be covered in the lighting and electrical appliances section. (Eurostat)	
1	Disaggregation according to space cooling equipment coverage	**This indicator will reflect the number of buildings/building units supplied with air conditioning systems (central or local).** Central and local air conditioning systems equipment used for space cooling can be divided into two broad categories: central cooling systems or local (room-dedicated) cooling systems. Central air conditioning systems have ducts to bring cooled air in the individual rooms of the dwelling. Local air conditioning system: electrically-driven individual units that provide cooling to a single room of a dwelling (wall air conditioners, split systems). (Eurostat)
2	Buildings/building units with reversible heat pumps	**This indicator will reflect the number of buildings/building units with combi boilers.** A combi boiler provides heated water for both space heating and domestic hot water heating.
3	Average efficiency rate of space cooling	**This indicator will reflect the average efficiency of space cooling equipment.**

	Indicator name	Definition
	equipment	Energy conversion efficiency (η) - ditto.
4	Efficiency rate of the BAT space cooling equipment	**This indicator will reflect the efficiency of the BAT space cooling equipment.** Energy conversion efficiency (η) - ditto.
5	Age of the cooling system	**This indicator will reflect the age of the space cooling system.** Age of the cooling system: the age, in broad classes, of the cooling system or the oldest individual unit. (Eurostat)
C.	***Domestic hot water supply*** refers to the use of energy to heat water for hot running water, bathing, cleaning and other non-cooking applications. Swimming pool heating is excluded and should be included in other uses. A number of tank-based or tank-less systems can be used to heat the water. Domestic hot water can be produced alone or in combination with space heating systems. (Eurostat)	
1	Buildings/building units with a water heater/boiler	**This indicator will reflect the number of buildings/building units with a water heater/boiler.** Water heater/boiler: a thermally-insulated vessel designed for heating and storing hot water. (Eurostat)
2	Tank size	**This indicator will reflect the size of the water storage tank.** Tank size: volume (litres) of the water heater. Broad classes may be used for reporting tank size. (Eurostat)
3	Age of the tank	**This indicator will reflect the age of the water storage tank.** Age: age of the water heater. Broad classes may be used for reporting tank age. (Eurostat)
4	Buildings/building units with a combi boiler	**This indicator will reflect the number of buildings/building units with a combi boiler.** Combi boiler: a combi boiler is a high-efficiency water heater and a central space heating boiler, combined within one compact unit. It provides heat for radiators and domestic hot water. No separate hot water vessel is required. (Eurostat)
5	Disaggregation of the water heating devices according to the main energy source	**This indicator will reflect the energy used for water heating.** Energy sources for water heating: the main energy sources used for water heating include electricity, natural gas, coal, fuel oil, liquefied petroleum, gas, kerosene, biomass and solar thermal energy. (Eurostat)
6	Buildings/building units with electric boiler	**This indicator will reflect the number of buildings/building units with electric boiler.** Domestic hot water is heated up by a boiler using electricity. The boiler can be flow-through, heating water on demand or having a storage vessel.
7	Buildings/building units with electric heaters (not heat-pump)	**This indicator will reflect the number of buildings/building units with electric heaters (not heat pump).** Other electric water heaters than above, and heat pumps.
8	Buildings/building units with other water heaters	**This indicator will reflect the number of buildings/building units with other water heaters.** Domestic hot water is heated up by a system other than the systems mentioned above.
9	Average efficiency rate of water heating equipment	**This indicator will reflect the average efficiency of the water heating equipment.** Energy conversion efficiency (η) - ditto.
10	Efficiency rate of BAT water heating equipment	**This indicator will reflect the efficiency of the BAT water heating equipment.** Energy conversion efficiency (η) - ditto.
A.	***Ventilation***	
1	Buildings/building units with mechanical ventilation (no heat recovery)	**This indicator will reflect the number of buildings/building units with mechanical ventilation (no heat recovery).** A building ventilation system that uses driven fans or blowers to provide fresh air to and from rooms when the natural forces of air pressure and gravity are not enough to circulate air through the building. In many buildings, there is only a mechanical exhaust from rooms with moisture formation like in bathrooms or kitchens. The fresh air is supplied by means of natural ventilation and by under-pressure created indoors.

	Indicator name	Definition
2	Buildings/building units with mechanical ventilation (with heat recovery)	**This indicator will reflect the number of buildings/building units with mechanical ventilation (with heat recovery).** Partly ditto as above. This is always balanced ventilation; it means there are both mechanical supply and exhaust of ventilation and/or heating air. Part of the heat from the exhaust air is recovered in a heat exchanger.
3	Buildings/building units with natural ventilation	**This indicator will reflect the number of buildings/building units with natural ventilation.** There is no mechanical ventilation system. The air exchange happens through windows and ventilation grills and vents.
4	Average efficiency rate of ventilation equipment	**This indicator will reflect the average efficiency of the ventilation equipment.** Energy conversion efficiency (η) - ditto.
5	Efficiency rate of BAT ventilation equipment	**This indicator will reflect the efficiency of the BAT ventilation equipment.** Energy conversion efficiency (η) - ditto.
D.	***Lighting:*** This category includes the use of electricity for lighting. Interior or exterior lighting of dwellings is mainly powered by electricity. Incandescent lamps are slowly being replaced by more efficient fixtures, e.g. fluorescent tube lamps, compact fluorescent lamps (CFLs), halogen lamps, and LED (light emitting diodes). Households that do not have access to electricity still rely on traditional forms of lighting such as kerosene and liquefied petroleum gas lamps, and sometimes even candles and flash lights. (Eurostat)	
1	Share of incandescent lamps	**This indicator will reflect the share of incandescent lamps in buildings/building units.** This is the classical light bulbs old type, which has been phased out by the EU Eco-design Directive in 2012.
2	Number of incandescent lamps in a dwelling	**This indicator will reflect the average number of incandescent lamps in a dwelling.**
3	Share of TL	**This indicator will reflect the share of TL lamps in buildings/building units.** A TL-lamp (*Tube* Luminescent), a fluorescent lamp or a fluorescent tube use fluorescence to produce visible light. It is much more efficient than incandescent lamps.
4	Share of CFL	**This indicator will reflect the share of CLF lamps (%) in buildings/building units.** A compact fluorescent lamp, or light (CFL) and compact fluorescent tube, is a fluorescent lamp designed to replace an incandescent lamp. Some types fit into light fixtures formerly used for incandescent lamps.
5	Number of CFL lamps in a dwelling	**This indicator will reflect the average number of CFL lamps in a dwelling.**
6	Share of LED	**This indicator will reflect the share of LED lamps (%) in buildings/building units.** A LED lamp is a light-emitting diode product assembled into a lamp (or light bulb) for use in lighting fixtures. LED lamps have a lifespan and electrical efficiency that is several times better than incandescent lamps, and significantly better than most fluorescent lamps.
7	Number of LED lamps in a dwelling	**This indicator will reflect the average number of LED lamps in a dwelling.**
8	Share of halogen lamps	**This indicator will reflect the share of halogen lamps in buildings/building units.** A halogen lamp, also known as a tungsten halogen, quartz-halogen or quartz iodine lamp, is an incandescent lamp that has a small amount of halogen added such as iodine or bromine.
9	Number of halogen lamps in a dwelling	**This indicator will reflect the average number of halogen lamps in a dwelling.**
10	Share of others	**This indicator will reflect the share of other lamps in buildings/building units.** Lamps other than the above-mentioned types.
11	Number of other lamps in a dwelling	**This indicator will reflect the average number of other lamps in a dwelling.**

	Indicator name	Definition
E.	***Cooking:*** This energy service is the energy used to prepare meals (excluding appliances for auxiliary cooking -microwave ovens, kettles, coffee makers, etc.). (Eurostat)	
1	Disaggregation according to the cooking equipment	**This indicator will reflect the share of various cooking equipment.** Preparing meals can be achieved using a wide range of stoves, ovens, cookers, considered to be cooking equipment. Appliances like microwave ovens, kettles, coffee makers, toasters are, due to the difficulty in separating their respective consumption, classified as electrical appliances where possible. (Eurostat)
2	Disaggregation of the cooking devices according to the energy source	**This indicator will reflect the energy source used for cooking.** Energy sources for cooking: the main energy sources used for cooking are natural gas, electricity, biomass, liquefied petroleum gas, kerosene and coal. (Eurostat) This indicator is displayed as absolute number and share of systems.
F.	***Electrical appliances*** include: refrigerators, freezers, washing machines, dryers, dishwashers, televisions and personal computers. Appliances encompass two main categories: large (or major) appliances (sometimes called white appliances or white goods) and other (usually much smaller) appliances, also called brown appliances. Large appliances mainly include refrigerators, freezers, washing machines, dryers and dish-washers. Other appliances include a wide range of appliances from electronic equipment such as TV, computers, audio and video equipment to vacuum-cleaners, microwave-ovens as well as irons, fans and blowers. Almost all appliances are powered by electricity. Cookers, stoves, ovens and hobs should be included in 'Cooking' but other cooking appliances such as microwave ovens, kettles and coffee makers should be included here. (Eurostat)	
1	Number of refrigerators in a dwelling	**This indicator will reflect the average number of refrigerators in a dwelling.**
2	Number of freezers in a dwelling	**This indicator will reflect the average number of freezers in a dwelling.**
3	Number of washing-machines in a dwelling	**This indicator will reflect the average number of washing-machines in a dwelling.**
4	Number of dryers in a dwelling	**This indicator will reflect the average number of dryers in a dwelling.**
5	Number of dish-washers in a dwelling	**This indicator will reflect the average number of dishwashers in a dwelling.**
6	Number of televisions in a dwelling	**This indicator will reflect the average number of televisions in a dwelling.**
7	Number of computers in a dwelling	**This indicator will reflect the average number of personal computers in a dwelling.**
G.	***Metering***	
1	Individual or collective metering	**This indicator will reflect the share of individual metering in all buildings and share of collective metering in all buildings/building units**. Individual: metering of energy production (in case it is on-site) and production for one household or one end-user in a non-residential building. Collective: joint metering of more households or for the whole non-residential building. Cases with collective metering for a whole business or industry park are also possible.
2	Availability of a thermostat	**This indicator will reflect the number of thermostats.** Availability of thermostat: number of thermostats controlling the main heating and/or cooling system. (Eurostat) Thermostat: a device that turns on or off the heating and/or cooling system so that a desired temperature is reached in a space. (Eurostat)
3	Thermostat types	**This indicator will reflect the type of a thermostat (manual or programmable).** Thermostat types: manual on-off thermostat, allowing manual control of the heating and/or cooling period during the day. Programmable thermostat, designed to adjust automatically the temperature at different times of the day or night and days of the week. (Eurostat)

	Indicator name	Definition
4	Share of buildings with smart metering systems	**This indicator will reflect the share of smart metering systems in buildings/building units.** Smart metering systems can be installed for only one or several energy functions or integrated for all of them. Usually, there is a possibility to control the demand-response by energy function (like heating, ventilation, etc.) according to predefined requirements.
5	Feedback system for smart meters	**This indicator will reflect the share of feedback systems for smart metering in buildings/building units.** Smart metering systems with feedback in form of a display that shows the production of energy (in case it is generated on-site like by PV), consumption and possible energy flows. The feedback system can help influence the behaviour of the end-users as for energy consumption.
H.	***Others***	
1	Dwellings/buildings with shading devices	**This indicator will reflect the number of dwellings/buildings with shading devices.**
2	Dwellings/buildings with PV-panels	**This indicator will reflect the number of dwellings/buildings with PV panels.**
T.2.4 Embodied energy		
1	Estimated embodied energy of new construction	**This indicator will reflect the total energy required for the extraction, processing, manufacture and delivery of building materials to the building site**. Unlike the life-cycle assessment, which evaluates all of the impacts over the whole life of a material or element, embodied energy only considers the front-end aspect of the impact of a building material. It does not include the operation or disposal of materials. We provide data for dwellings and non-residential buildings.
2	Estimated embodied energy of deep retrofits	Ditto.
3	Estimated embodied energy of major renovations	Ditto.
4	Energy consumption per ton	This indicator reflects the energy intensity of the glass, steel and cement sector in a country.
5	Energy content	This indicator gives the energy content of the main construction materials: Aluminium (general & inch 33% recycled), Wool carpet, Polyurethane insulation (rigid foam), Paint - Solvent-borne, Expanded Polystyrene insulation, PVC (general), Vinyl flooring, Paint - Water-borne, Stainless steel, Bitumen (general), Copper (average incl. 37% recycled), Flax insulation, Mineral fibre roofing tile, Wallpaper, Ceramic sanitary ware, Glass fibre insulation (glass wool), Cork insulation, Lead (incl 61% recycled), Iron (general), Wool (recycled) insulation.

Topic 3: Certification

	Indicator name	Definition
T.3.1. EPC distribution		
1	Stock with EPC	**This indicator will reflect the total number of buildings for which the EPC has been registered and related floor area for residential and non-residential (and, if possible, by type of building).** Energy performance certificate: means a certificate which indicates the energy performance of a building or building unit. (Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings).
2	Distribution of EPC levels for existing buildings	**This indicator will reflect the distribution of the energy label (A-G) or energy level for existing (registered) residential and non-residential buildings.**
3	Distribution of EPC levels for new buildings	**This indicator will reflect the distribution of the energy label (A-G) or energy level for new (registered) residential and non-residential buildings.**

	Indicator name	Definition
4	Distribution of EPC level per building size	**This indicator will reflect the distribution of EPC per building size (i.e. number of apartments/units and floor area).**
5	Value of the buildings	**Average value of buildings per class and building type.**
6	Rent value	**Average rent value per energy class and building type.**
7	EPCs issued last year	**This indicator will reflect on the number of EPCs by energy label issued every year and related building floor area**. This indicator will help monitor movements between energy classes, etc.
8	EPCs displayed publicly	**This indicator will reflect the availability of the EPC displayed in the buildings occupied by public** authorities and frequently visited by the public with a total useful floor area over 500 m^2 (and from 9th July 2015, over 250m^2)
9	Energy label impact on property market	**This indicator will reflect a "one-letter" improvement in energy efficiency on prices and rents in the property market.**
10	Production of EPC	**This indicator will reflect on the compliance level (%) regarding the production of EPCs for new, sold, rented and public buildings.**
11	Energy label in commercial advertisements	**This indicator will reflect the availability of the energy labels commercial advertisement (%).**
12	EPC handed over to new tenant/owner	**This indicator will reflect on the compliance level (%) regarding the requirement for mandatory EPCs handed over to new tenant/building owner.**
13	Quality control of the EPCs	This indicator will reflect on the share of EPCs that were taken into account in the quality control process every year in the following options (Annex 2, EPBD): • **Option A:** validity check of the input data of the building used to issue the energy performance certificate and the results stated in the certificate; • **Option B:** check of the input data and verification of the results of the energy performance certificate, including the recommendations made; • **Option C:** full check of the input data of the building used to issue the energy performance certificate, full verification of the results stated in the certificate, including the recommendations made, and, if possible, on-site visit of the building to check the compliance between specifications given in the energy performance certificate and the building certified. • **Other check**: e.g. based on the client complains; etc.
13	Penalties for non-compliance	**This indicator will reflect the number and higher level of penalties resulting from the quality control of the EPCs.**
14	EPC registered to central register	**This indicator will reflect the share of certificates registered in the central EPC register (%).**
T.3.2 EPC content		
1	Does the EPC contain information on cost-effective improvement of the energy performance?	**This indicator refers to the EPC content related to the presence of recommendations for the cost-optimal or cost-effective improvement** of the energy performance of a building or building unit (Art. 11.3, EPBD).
2	Does the EPC indicate where more detailed information can be received?	**This indicator refers to the EPC content related to the presence of an indication for the owner or tenant to get more detailed information**, including the cost-effectiveness of the recommendations made in the energy performance certificate (Art 11.4, EPBD).
T.3.2. Voluntary certification scheme		
1	Residential buildings with voluntary certification schemes	**This indicator will reflect the number** of buildings/building units with a voluntary certification scheme including for residential and non-residential sectors: • **The Passive House** is not an energy standard but an integrated concept ensuring the highest level of comfort. A Passive House is a building for which thermal comfort (ISO 7730) can be achieved solely by post-heating or post-cooling of the fresh air mass, which is required to achieve sufficient indoor air quality conditions – without the need for additional recirculation of air.

	Indicator name	Definition
		• **Minergie** is a registered quality label for new and refurbished low-energy-consumption buildings. The Minergie standard is somewhat comparable to the German KfW40 (new buildings) and KfW60 (refurbishment) standards. • **LEED** is the green building rating system which takes into account the design, construction and operation phases, e.g. water savings, energy efficiency, indoor air quality, etc. • **BREEAM** is a green building rating system**,** which takes into account the building's specification, design, construction and use phases. It includes aspects related to energy and water use, the internal environment (health and well-being), pollution, transport, materials, waste, ecology and management processes. • **DGNB** is a green building rating system which takes into account the LCA of the building. The assessment consists of 50 sustainability criteria including ecology, economy, socio-cultural aspects, technology, process work flows, etc. • **HQE** is a green building rating system which assesses 13 sustainability criteria including construction, management of energy, water, waste, comfort, air quality, etc. • **Others**
2	Non-residential buildings with voluntary certification schemes	Ditto

Topic 4: Financing

	Indicator name	Definition
T.4.1. Average financial performance of renovation projects		
1	Total volume of investments in renovation (Mio EUR/a)	**This indicator will reflect the total volume of investments in renovation (e.g. in Mio EURO/a).**
2	Total volume of energy-related investments in renovation (Mio EUR/a)	**This indicator will reflect the total volume of investments in energy-related renovation (e.g. in Mio EURO/a).**
3	Average volume of total investments in renovation (EUR/m^2)	**This indicator will reflect the average size of investments in renovation (e.g. in EURO/m^2).**
4	Average volume of energy-related investments in renovation (EUR/m^2)	**This indicator will reflect the average size of investments in energy-related renovation (e.g. in EURO/m^2.**
5	Average volume of additional energy-related investments in renovation (EUR/m^2)	**This indicator will reflect the average size of investments in additional energy-related renovation (e.g. in EURO/m^2.**
6	Total energy savings achieved for renovation (Mtoe/a)	**This indicator will reflect the total energy savings achieved by energy-related renovation.**
7	Average simple payback period for renovation (years)	**This indicator will reflect the period in which the value of the benefits (energy cost savings) of the investment equals the initial investment (additional energy-related investments in case of major renovation). Energy price developments need to be taken into account.**
8	Average Internal rate of return (IRR) for renovation projects	**This indicator will reflect the internal rate of return (IRR) of a renovation project: the IRR defines the interest rate or discount rate that makes the present value of the investment costs (additional energy-related investment costs in case of major renovation) equal to the present value of the cost savings.** **Reflecting the regulation on cost-optimal building performance requirements under the EPBD, the calculation period should be set respectively at 30 years (residential buildings) and 20 years (non-residential buildings).** **Energy price developments need to be taken into account.**

	Indicator name	Definition
9	Average net present value (NPV) for renovation projects	**This indicator will reflect the net present value (NPV) of a renovation project: the NPV of the renovation investment is determined calculating the present value of the total benefits (cost savings) and investment costs (additional energy related investments), achieved by discounting the future value of each incoming and outgoing cash-flow over a period of time.** **Reflecting the regulation on cost-optimal building performance requirements under the EPBD, the calculation period should be set respectively at 30 years (residential buildings) and 20 years (non-residential buildings). The discount rate should be set at 3% for a macro-economic perspective (see cost-optimality regulation, Annex I, 4.4 (4)).** **Energy price developments need to be taken into account.**
10	Average energy cost savings per retrofit	**This indicator will reflect the average energy-costs savings, defined as amount of kWh saved on delivered energy, multiplied by the respective tariff.** **Energy price developments need to be taken into account.** **Reflecting the regulation on cost-optimal building performance requirements under the EPBD, energy prices development should reflect respectively a period of 30 years (residential buildings) and 20 years (non-residential buildings).**
T.4.2. Tariffs		
1	Energy tariffs (marginal costs, variable component average costs per kWh)	**This indicator will reflect the energy prices per energy carrier for households and industrial consumers. Split into fixed and variable components, where necessary.**
T.4.3. Sources of Energy Efficiency financing and their financial performance (e.g. loans schemes, grant and fiscal schemes) ***Note:*** *in this topic, all data should be ideally collected for each building type, depth of renovation and country*		
A. Debt financing / private debt financing for renovations (loans)		
1	Average loan amount (EUR/m^2)	**This indicator will reflect the average amount made available within the loan scheme.**
2	Total number of loans (No/a)	**This indicator will reflect how many loans have been provided within the scheme.**
3	Total volume of investment (Mio EUR/a)	**This indicator will reflect the total volume of investments in renovation under the financing scheme (e.g. in Mio EURO/a).**
4	Total savings achieved due to loan scheme for renovation (Mtoe/a)	**This indicator will reflect the total final energy-savings achieved within the financial scheme in the respective year (specific final energy-savings per m² and year multiplied with m² renovated within the scheme in the respective year).**
5	Average share own contribution (equity) /contribution (%)	**This indicator will reflect the average share of investment that the building owner/purchaser will provide within the total investment for the renovation.**
6	Average loan maturity (year)	**This indicator will reflect the duration in which the loan is due to be repaid.**
7	Total number of mortgages associated with renovations (No/a)	**This indicator will reflect the amount of mortgages linked to the renovation activities.**
8	Average interest rate of the loan (%)	**This indicator will reflect the interest rate offered to market actors within the programme.**
9	Loan default rates (%)	**This indicator will reflect the share of borrowers who default on loans.**
10	Average simple payback period (year)	**This indicator will reflect the duration in which the value of the benefits (energy cost savings) of the investment equals the initial investment (additional energy-related investments in case of major renovation). Energy price developments need to be taken into account.**
11	Average internal rate of return (IRR) for renovation projects	**This indicator will reflect the internal rate of return (IRR) of a renovation project: the IRR defines the interest rate or discount rate that makes the present value of the investment costs (additional energy-related investment costs in case of major renovation) equal to the present value of the cost savings.** **Reflecting the regulation on cost-optimal building performance requirements under the EPBD, the calculation period should be set at respectively 30 years (residential**

	Indicator name	Definition
		buildings) and 20 years (non-residential buildings). **Energy price developments need to be taken into account.**
12	Average net present value (NPV) for renovation projects (%)	**This indicator will reflect the net present value (NPV) of a renovation project: the NPV of the renovation investment is determined calculating the present value of the total benefits (cost savings) and investment costs (additional energy-related investments) achieved by discounting the future value of each incoming and outgoing cash-flow over a period of time.** **Reflecting the regulation on cost-optimal building performance requirements under the EPBD, the calculation period should be set at respectively 30 years (residential buildings) and 20 years (non-residential buildings). The discount rate should be set at 3% for a macro-economic perspective (see cost-optimality regulation, Annex I, 4.4 (4)).** **Energy price developments need to be taken into account.**
B.	***Debt financing- Dedicated credit lines (where public funding decreases the cost of energy efficiency building renovation loans***	
1	Average loan amount (EUR/m²)	**This indicator will reflect the average amount (in EURO/m² or EURO/a) that is made available within the loan scheme.**
2	Total number of loans (No/a)	**This indicator will reflect how many loans have been provided within the scheme.**
3	Total volume of investment (Mio EUR/a)	**This indicator will reflect the total volume of investments in renovation under the financing scheme (e.g. in Mio EURO/a).**
4	Total savings achieved thanks to loan scheme for renovation (Mtoe)	**This indicator will reflect the total final energy savings achieved within the financial scheme in a respective year (specific final energy savings per m² and year, multiplied with m² renovated within the scheme in the respective year).**
5	Average share of own contribution (equity)/ contribution (%)	**This indicator will reflect the average share of investment that the building owner/purchaser will provide within the total investment for the renovation.**
6	Average loan maturity (year)	**This indicator will reflect the duration in which the loan is due to be repaid.**
7	Average interest rate (%)	**This indicator will reflect an interest rate offered to market actors within the programme.**
8	Loan default rates (%)	**This indicator will reflect the share of borrowers who default on loans.**
9	Average simple payback period (year)	**This indicator will reflect the duration in which the value of the benefits (energy cost savings) of the investment equals the initial investment (additional energy-related investments in case of major renovation). Energy price developments need to be taken into account.**
10	Average Internal rate of return (IRR) for renovation projects (%)	**This indicator will reflect the internal rate of return (IRR) of a renovation project: the IRR defines the interest rate or discount rate that makes the present value of the investment costs (additional energy-related investment costs in case of major renovation) equal to the present value of the cost-savings.** **Reflecting the regulation on cost-optimal building performance requirements under the EPBD, the calculation period should be set respectively at 30 years (residential buildings) and 20 years (non-residential buildings).** **Energy price developments need to be taken into account.**
C.	***Grants***	
1	Number of final beneficiary (No)	**This indicator will reflect the number of people that have used the scheme.**
	Total volume of investment (EUR/a)	**This indicator will reflect the total volume of investments in renovation under the financing scheme (e.g. in Mio EURO/a).**
	Total amount of subsidies (EUR)	**This indicator will reflect the volume of issued grants (e.g. in Mio EURO/a).**

	Indicator name	Definition
2	Average volume of the grant (EUR/m²)	**This indicator will reflect the average amount (in EURO/m² or EURO/a) made available within the grant scheme.**
3	Total savings achieved due to grant scheme for renovation (Mtoe)	**This indicator will reflect the total energy savings achieved within the grant scheme.**
4	Level of support (%)	**This indicator will reflect the share of the grant within the total required investment.**
D.	***Fiscal Incentives***	
1	Number of final beneficiaries (No)	**This indicator will reflect the number of people who have used the scheme.**
2	Level of support (%)	**This indicator will reflect the share of the grant within the total required investment.**
3	Total tax exemption (EUR/a)	**This indicator will reflect the amount of tax deduction on the investment for renovation** (EUR/a).
4	Total volume of investment within the scheme (EUR/a)	**This indicator will reflect the total volume of investments in renovation under the financing scheme (e.g. in Mio EURO/a).**
5	Total savings achieved within the fiscal incentive for renovation (Mtoe)	**This indicator will reflect the total energy savings achieved within the grant scheme.**
E.	***Energy Performance Contracting (EPC)***	
1	Number of EPC projects in the area of building renovations (No)	**This indicator will reflect the total number of EPC projects coupled to building renovations.**
2	Volume of investments into building renovations implemented under EPC (EUR)	**This indicator will reflect the volume of investments into building renovations under EPC.**
3	Average simple payback period of EPC projects (year)	**This indicator will reflect the duration in which the value of the benefits (energy-cost savings) of the investment equals the initial investment (additional energy-related investments in case of major renovation). Energy price developments need to be taken into account.**
4	Average internal rate of return (IRR) of EPC projects (%)	**This indicator will reflect the internal rate of return (IRR) of a renovation project: the IRR defines the interest rate or discount rate that makes the present value of the investment costs (additional energy-related investment costs in case of major renovation) equal to the present value of the cost-savings.** **Reflecting the regulation on cost-optimal building performance requirements under the EPBD, the calculation period should be set respectively at 30 years (residential buildings) and 20 years (non-residential buildings).** **Energy price developments need to be taken into account.**
	Average net present value (NPV) of EPC projects (%)	**This indicator will reflect the net present value (NPV) of a renovation project: the NPV of the renovation investment is determined calculating the present value of the total benefits (cost savings) and investment costs (additional energy related investments), achieved by discounting the future value of each incoming and outgoing cash flow over a period of time.** **Reflecting the regulation on cost-optimal building performance requirements under the EPBD, the calculation period should be set respectively at 30 years (residential buildings) and 20 years (non-residential buildings). The discount rate should be set at 3% for a macro-economic perspective (see cost optimality regulation, Annex I, 4.4 (4)).** **Energy price developments need to be taken into account.**
	Average default rate of EPC projects (%)	**This indicator will reflect the share of borrowers who default on loans.**
F.	***Energy Efficiency Supplier Obligations***	
1	Volume of investments into building renovations	**This indicator will reflect the volume of investments into building renovations related to**

	Indicator name	Definition
	implemented (Mio EUR/a)	**Energy Efficiency Supplier Obligations.**
2	Size of the obligation in terms of cumulative end-use energy-saving (Mtoe/a)	**This indicator will reflect the total energy-savings obligation.**

Topic 5: Energy poverty & social aspects

ID	Indicator name	Definition
T.5.1. Energy poverty		
1	Population at risk of poverty or social exclusion	**The indicator is defined as the share of population in at least one of the following three conditions:** 1) At risk of poverty, meaning below the poverty threshold The at-risk-of-poverty rate is the share of people with an equivalised disposable income (after social transfer) below the at-risk-of-poverty threshold, which is set at 60 % of the national median equivalised disposable income after social transfers. 2) In a situation of severe material deprivation Material deprivation refers to a state of economic strain and durables, defined as the enforced inability (rather than the choice not to do so) to pay unexpected expenses, afford a one-week annual holiday away from home, a meal involving meat or fish every second day, the adequate heating of a dwelling, durable goods like a washing machine, colour television, telephone or car, being confronted with payment arrears (mortgage or rent, utility bills, hire purchase instalments or other loan payments). 3) Living in a household with very low work intensity The indicator *persons living in households with low work intensity* is defined as the number of persons living in a household having work intensity below a threshold set at 0.20. The work intensity of a household is the ratio of the total number of months that all working-age household members have worked during the income reference year and the total number of months the same household members theoretically could have worked in the same period.
2	Proportion of inhabitants unable to keep home adequately warm	**Refers to the share of the total population who are in the state of enforced inability to keep their home adequately warm.**
3	Proportion of inhabitants who are living in a dwelling not comfortably cool in summer	**Refers to the share of the total population who live in a dwelling not comfortably cool in summer.**
4	Share of household expenditures on housing (housing, water, electricity, gas and other fuels)	**This indicator describes the final consumption expenditure of households devoted to housing, water, electricity, gas and other housing fuels**. The final consumption expenditure is the expenditure by resident institutional units - including households and enterprises whose main economic centre of interest is in that economic territory - on goods or services that are used for the direct satisfaction of individual needs or wants or the collective needs of members of the community.
5	Share of household expenditures on housing (electricity, gas and other fuels)	**This indicator describes the final consumption expenditure of households devoted to electricity, gas and other housing fuels.**
6	Arrears on utility bills	**Refers to the percentage of households/persons out of the total population who are in the state of arrears on utility bills, expressing the enforced inability to pay their utility bills on time due to financial difficulties.**
7	Population living in a dwelling with a leaking roof or damp walls, etc.	**Refers to the percentage of households/persons in the total population living in a dwelling either with a leaking roof or damp walls/ floors/ foundation, or rot in window frames or floor.**

ID	Indicator name	Definition
8	Average energy spending for adequate space heating per household (theoretical energy demand)	**Refers to the average cost of energy consumption for space heating for residential buildings.**
9	Disposable household income before energy expenditure for adequate space heating (theoretical energy demand)	**Refers to the average income per household before energy expenditure for space heating** (calculated based on the median equivalised net (or disposable) income and the (equalised) household members).
10	Disposable household income after energy expenditure for adequate space heating (theoretical energy demand)	**Refers to the average income per household after energy expenditure for space heating.**
11	Proportion of disposable household income spent on adequate energy for space heating (theoretical energy demand)	**Refers to the share of energy expenditure for space heating out of the total household income.**
12	Share of households falling below the poverty line after covering the energy cost for adequate space heating (theoretical energy demand)	**Refers to the percentage of households that would be left with a disposable income below the poverty line after covering the cost for space heating.**
13	Excess winter mortality/ deaths	**Indicates if the expected deaths in winter are higher than the rest of the year (based on the formula: EWD = {[winter deaths (Dec-Mar)]-0.5[Non-winter deaths (Aug-Nov, Apr-Jul)]}/(Average of non-winter deaths).**
T.5.2. Social issues		
1	Liberalisation of the energy market	**This indicator refers to the liberalisation of the energy markets.** As energy supply (electricity, natural gas and central heating systems) is a natural monopoly, this entails complex and costly systems of regulation to enforce a competitive system. This indicator will describe the level of liberalisation of electricity, natural gas and heat from the central heating for final customers.
2	Date of market liberalization	**Number of years since market liberalization (electricity and gas).** Available in ACER's report 2013, table 29.
3	Switching rates	**Share of households who changed their supplier of electricity and gas.** Available in ACER's report 2013, tables 26 and 27.
4	Consumers with different supplier	**Proportion of electricity and gas consumers with a different supplier than their incumbent supplier.** Available in ACER's report 2013, table 28.
5	Concentration of supply in rental market	**This indicator explains the variability of the housing market**. It is the share of rented dwellings in the total number of dwellings (Data source: Census Hub).
6	Ability of consumers to switch tariffs	**This indicator explains the ability of consumers to switch tariffs as one of the indicators extending competition in the market.** The maximum frequency of switching the tariff and average duration of the switching is the key issue. The indicator is important, because the new tariff should be better for the customer than the old one.
7	Disconnection rates	**Number (share) of households experiencing disconnection of power/gas/district heat due to not paying the bills.** Average number of days/a with disconnection.
8	Elderly population (main tenant above 65)	**This indicator reflects the share of dwellings with predominant retired tenants.** The characteristic is described through the age of the tenant (above 65).

ID	Indicator name	Definition
9	Average rent value	**This indicator covers average prices for rental housing in specific regions**. Price average of the rent in € for m^2 for rental housing. It also includes the energy costs.
10	Rent growth	**Annual growth of rent in %, separately for social and private rents.**
11	Breakdown of rents	**Percentage of social and private rents.**
12	Existence of a market regulation of the rental housing	**There is a regulated price for housing by building type.** The regulated price aims to the specific social groups of tenants. This indicator describes the existence of the market regulation in the rental housing including its future expected development (e.g. year when the regulation will be/was terminated) and provides a short description of the target group.
13	Demographic division of the tenants	**This indicator includes the shares of tenants in given demographic categories.** The demographic categories are 0-4. 5-9, etc.
14	Average floor area per person	**This indicator of the living comfort is only dedicated to housing and describes average floor area per person (dweller) according to the type of building in division to family houses and apartment buildings.**
15	Average number of rooms per person	**This indicator includes average number of rooms per person (dweller) according to the type of building in division to family houses and apartment buildings.**

Topic 6 Policies and regulations

T.6.1 Building codes	
1	Minimum overall energy performance targets for new buildings
2	Minimum overall energy performance targets for renovated buildings
3	Shell performance requirements for new and existing buildings
4	Technical installation requirement for new and existing buildings
5	RES requirements for new and existing buildings
6	Daylight requirements for new and existing buildings
7	Thermal comfort requirements for new and existing buildings
8	Indoor air quality requirements for new and existing buildings
9	Airtightness requirements for new and existing buildings
T.6.2 National definitions	
1	National definition of useful floor area
2	National definition of building
3	National definition of (major) renovation
4	National definition of nZEBs for new and existing building
5	Energy poverty

Annex 2 – List of key data sources and their quality assessment

Building permits - m2 of useful floor area (index)

	Source	Data quality	Unit	2011	2012	2013	2014
Austria	EUROSTAT	★★★★★	index	116.13	101.09	112.75	115.24
Belgium	EUROSTAT	★★★★★	index	91.49	94.43	96.68	98.87
Bulgaria	EUROSTAT	★★★★★	index	95.12	84.86	95.02	121.36
Croatia	EUROSTAT	★★★★★	index	92.31	63.19	52.76	50.60
Cyprus	EUROSTAT	★★★★★	index	66.79	47.84	34.32	24.28
Czech Republic	EUROSTAT	★★★★★	index	97.42	81.54	76.62	82.16
Denmark	EUROSTAT	★★★★★	index	94.74	71.96	66.68	83.02
Estonia	EUROSTAT	★★★★★	index	114.57	113.59	124.20	144.05
Finland	EUROSTAT	★★★★★	index	100.61	92.75	74.59	75.32
France	EUROSTAT	★★★★★	index	107.48	99.80	86.98	75.05
Germany	EUROSTAT	★★★★★	index	121.46	124.71	135.29	138.84
Greece	EUROSTAT	★★★★★	index	57.02	31.34	18.09	14.38

Download xls here:: **LINK**

Annex 3 – List of partners involved in the data collection process

A. Consortium partners

	Description	Role in the project
BPIE	Buildings Performance Institute Europe is a not-for-profit policy research organisation with a focus on independent analysis and knowledge dissemination, supporting evidence-based policy making in the field of energy performance in buildings throughout Europe and beyond. In 2010-11, BPIE undertook an extensive survey of data related to the European building stock and associated policies and programmes to improve the energy performance of buildings, presenting the main results in a print report. In 2012, BPIE released the collected information in the first EU-wide buildings data hub (www.buildingsdata.eu) which provides an interactive and user friendly online repository, giving free access to state of the art information about Europe's buildings and related policies. BPIE therefore brings specific expertise in buildings data collection and evaluation, as well as in elaboration and online presentation of respective data sets and indicators. BPIE is also a partner in ENTRANZE and the EPISCOPE IEE projects mentioned as main sources of data within this service tender. In addition, BPIE has proven expertise in EU policy assessment and implementation at EU MS level and in modelling macro-economic impacts of policies and measures to improve the energy performance of EU buildings. Website: http://www.bpie.eu	✓ Project coordinator ✓ Coordinator of data collection process ✓ Coordination of topic on certification and energy poverty ✓ National data provider for Malta and Luxembourg
ENERDATA	ENERDATA has one of the longest track records in Europe on developing energy efficiency indicators and creation of online energy databases. Since 1990, ENERDATA is the technical coordinator of the ODYSSEE-MURE IEE project and has created and maintained the corresponding database for energy efficiency indicators (http://www.odyssee-mure.eu/). ENERDATA is also a partner of the ENTRANZE[24] and ZEBRA2020 projects[25]. For these projects, Enerdata has developed the ENTRANZE data tool and scenario results online tool, as well as an "nZEB tracker". Enerdata has specific expertise in energy statistics and energy information services; energy demand and energy efficiency evaluation and forecasting; in market analysis. Website: http://www.enerdata.net/	✓ Task leader on website development, including online tools presenting data ✓ Coordination of topic on building characteristics and energy needs ✓ National data provider for France

[24] http://www.entranze.eu/tools/interactive-data-tool
[25] http://zebra-monitoring.enerdata.eu/

	Description	Role in the project
ECOFYS	ECOFYS brings significant expertise in energy, environmental and buildings policy assessment and evaluation, preparing several important studies and reports on the topic over the years. ECOFYS undertook extensive work and coordination of consortia that provide external expertise to the European Commission, such as for the analysis of nearly Zero-Energy Buildings approaches within the EU and the elaboration of a comparative reporting framework, elaboration of the European Commission guidance document for cost-optimality and analysis of EU MS reports on cost-optimal methodology, for the evaluation of the macro-economic impact of buildings policies etc. Website: http://www.ecofys.com/	✓ Task leader on data gap management ✓ Coordination of topic on financing ✓ National data provider for Germany
ECN	ECN brings a consistent expertise on developing methodology for energy and buildings indicators as well as for buildings policy assessment. ECN contributed to the development of energy efficiency indicators and methodological aspects for data collection in the ODYSSEE-MURE IEE project. ECN has a long-lasting expertise and experience in providing policy evaluation and impact assessment of specific policies and measures. ECN will lead task 1 on defining the methodology and data collection framework. Website: https://www.ecn.nl/	✓ Task leader on elaboration of methodology for data collection and verification ✓ Coordination of topic on technical systems and shell performance ✓ National data provider for the Netherlands
SEVEn	SEVEn is a well-known centre of expertise particularly in Central and Eastern EU countries, having undertaken several projects and studies on energy efficiency and buildings over the years. SEVEn has an excellent knowledge about the CEE region, was a partner in the ENTRANZE project and contributed or coordinated many other national and EU projects on energy efficiency and energy services in buildings. Website: http://www.svn.cz/	✓ Task leader on data verification and quality control ✓ Coordination of topic on social issue and energy market ✓ National data provider for Czech Republic

B. Subcontractors

	Organisation	Country	Description
1	AEA	Austria	The **Austrian Energy Agency (AEA)** is a national centre of excellence for energy. New technologies, renewable energy and energy efficiency are the focal points of our scientific activities. The objectives of our work for the public and the private sector are the sustainable production and use of energy and energy supply security. We are an independent think tank that manages knowledge, provides the basis for well-founded decision making, and develops suggestions for the implementation of energy-related measures and projects.
2	REHVA	The Netherlands	Founded in 1963, **The Federation of European Heating, Ventilation and Air Conditioning Associations (REVHA)** represent a network of more than 100,000 engineers from 27 European countries. REHVA is the leading European professional organisation whose main activity is to develop and disseminate technology and information for mechanical services of buildings. REHVA has been participating in several European research and innovation projects promoting energy-efficient, smart and healthy buildings.
3	VITO	Belgium	**VITO** is an independent and customer-oriented research organisation that provides innovative technological solutions as well as scientifically based advice and support in order to stimulate sustainable development and reinforce the economic and social fabric of Flanders. VITO employs over 750 people.
4	SEDA	Bulgaria	**Sustainable Energy Development Agency (SEDA)** is a legal entity supported by the State budget with headquarters in Sofia and has the status of an executive agency within the Ministry of Economy and Energy.
5	Energy Institute Hrvoje Požar	Croatia	**Energy Institute Hrvoje Požar** has been founded as a non-profit institution. Part of its goals is to provide expert and scientific support to the strategic development of the Croatian energy system, the processes of legislative reform and development and the advancement of economic relations. The Institute's main tasks include among others, expert and scientific research in the field of energy for state, regional and local administration and energy companies; management of National Energy Programmes; periodicals and other forms of communication with experts, scientists and the general public. The Institute has 71 employees, including 17 doctorates and 10 with Master's degrees.
6	SBi	Denmark	The **Danish National Building Research Institute (SBi)** is affiliated with Aalborg University. SBi develops research-based knowledge to improve buildings and the built environment. SBi identifies subjects that are important for professionals and decision-makers involved with buildings and the built environment. Subsequently we communicate our knowledge to these groups. SBi has a staff of approximately 120 people.
7	Forecon Ltd	Finland; Sweden Estonia Lithuania	**Forecon Ltd** was established in 2013 on the basis of VTT Technical Research Centre of Finland's Build assets and business intelligence team's operation. The operations of the team moved from VTT to Forecon in December 2013. Forecon provides market information, expert analyses and information on the business cycles of the operational environment as well as forecasts for the construction and real-estate actors for decision making.
8	IENE	Greece; Cyprus	The **Institute of Energy for South East Europe (IENE)** is a non-profit organisation whose main activity is the study of energy matters and the provision of qualified information to professionals and to the public at large. IENE aspires to become the focus around which energy matters can be discussed, analysed, compiled and presented to the scientific-technical communities and to the representatives of social, business and economic life in Greece and SE Europe.
9	CEU	Hungary	The **Central European University** (CEU - founded in 1991) with approximately 1,400 students and 370 faculty members from more than 130 countries, is one of the most densely international universities in the world.
10	Energy Action Ltd	Ireland	**Energy Action Ltd** is a registered charity established in 1988. The key objective of the organisation is to alleviate fuel poverty in Dublin by providing insulation in the homes of older people and low income people free of charge. Additionally, for the past number of years Energy Action has been involved in many projects, ranging from involvement with European Community programmes, evaluations of housing condition, surveys on household condition, cross border initiatives, compilation of reports and assessments on housing standards from an energy consumption aspect.
11	EURAC	Italy	**EURAC** is an innovative centre for Research and Further Education comprised of four areas of research: Autonomies, Mountains, Health and Technologies. The research group for energy management in buildings is involved within the Energy Efficient Buildings international non-profit industrial association and within the European Construction Technology Platform. It is further involved in a leading role in several international energy agencies and European projects.
12	PAIC	Latvia	**Centre of Processes' Analysis and Research Ltd (PAIC)** is a private R&D company

	Organisation	Country	Description
			founded in June 1994 by the researchers of the Department of Physics and Mathematics, University of Latvia. Numerous projects related to energy performance of buildings are part of the Company's portfolio.
13	FEWE	Poland	The **Polish Foundation for Energy Efficiency (FEWE)** is an independent, non-profit, environmental non-governmental organisation created at the beginning of 1991.
14	ADENE	Portugal	**ADENE's** mission is to promote and carry out actions of public interest in the energy field, adding all entities in the sector and involving citizens. In 1984, ADENE started its activity and since then, it has been gaining new skills and responsibilities that reinforce its role as a mobilising agent for national energy sustainability. ADENE provides information, educates, shares, and implements new ideas and solutions in the energy efficiency sector. It is the ideal partner to help businesses and consumers to achieve a more sustainable way to ensure their energy independence.
15	URBAN-INCERC	Romania	The **National Institute for Research and Development in Constructions, Urbanism and Sustainable Spatial Development (URBAN-INCERC)** is a public owned institute, under the coordination of the Ministry of National Education and Research. URBAN-INCERC is currently responsible for the Central Database for Energy Performance Certificates in buildings (within the Centre for Energy Performance of Buildings) and for the technical secretariats for the examination and certification of energy auditors for buildings (within INCERC Bucharest). Furthermore, it provides training for specialists in the building sector.
16	TSUS	Slovakia	**Building Testing and Research Institute (TSUS)** is a non-profit organisation. The Institute focuses on research and development in the building construction area, including experimental on-site research and projecting in the field of thermal protection of buildings and building structures and elimination of system defects in older panel buildings. The Institute's activities cover evaluation of energy performance of buildings and energy certification, including standardisation, expertise, consulting and publishing attained know-how.
17	ZRMK	Slovenia	The **Building and Civil Engineering Institute (ZRMK)** was established in 2003, as a daughter company of ZRMK HOLDING. Its mission is to contribute to the research and development agenda and to acquire and communicate know-how and new findings in engineering and construction. Among others, ZRMK's activities include basic and applied research and development in structures and retrofitting and in indoor environment and efficient energy use in buildings. ZRMK employs more than 160 people (including 7 PhDs, 10 Master's degrees).
18	CENER	Spain	The **National Renewable Energy Centre (CENER)** is a technology centre, specialised in applied research and in the development and promotion of renewable energies. It has excellent qualifications and recognised national and international prestige. The CENER Department of Energy in Buildings (EDIF) is mainly involved in the study and application of energy in buildings.
19	ENERGY SAVING TRUST	United Kingdom	**Energy Saving Trust (EST)** is a non-profit organisation funded mostly by the British Government in order to help fight climate change by promoting the sustainable use of energy, energy conservation and to cut carbon dioxide emissions in the United Kingdom. EST is BPIE's UK partner for residential data.
20	BRE	United Kingdom	**BRE** is an independent and impartial, research-based consultancy, testing and training organisation, offering expertise in every aspect of the built environment and associated industries. BRE is BPIE's UK partner for non-residential countries.

The data collection for France, Germany, Czech Republic, the Netherlands, Malta and Luxembourg was covered by the project consortium.

C. Stakeholders

Partner	Type of data provided
Stakeholders	
REHVA	Data on technical systems
EHPA	Data on heat pumps
EuroHeat & Power	Data on district heating and cooling
German Window Associations	Information on glazing for Germany
EHI	Data on technical systems
Eurowindoor	Data on envelope components
EU projects	
ODYSSEE-MURE	Building stock characteristics, energy consumption, electrical appliances
ZEBRA2020	Data on new buildings; EPC
INSPIRE	Data on envelope performance
TABULA/EPISCOPE	Data on renovation rates; building energy performance, nZEB definition
Transparenze	ESCO data
Request2Action	Data on the EPC databases
RenoValue	Data on relation between energy label and property value
Melissa	Data on lighting in dwellings
EU Service tenders	
Consortium of the service tender 2014/S 118-208553	Data on the technical systems for heating and cooling
Consortium of the service tender No. MOVE/ENER/SRD.1/2012-409-Lot3/ENER/C3/2014-542/S12.701648	Data on the EPBD compliance regarding certification schemes