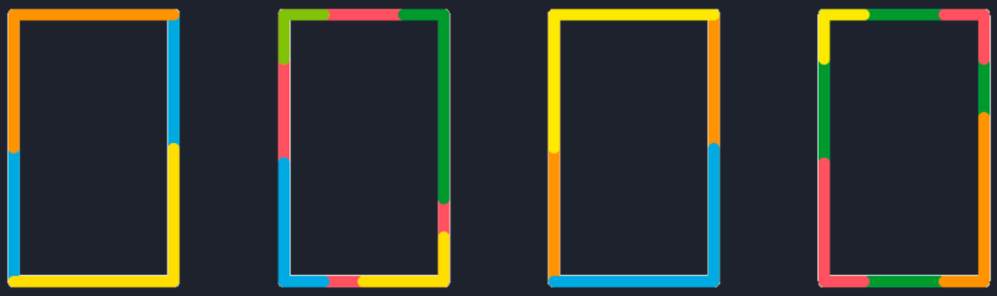
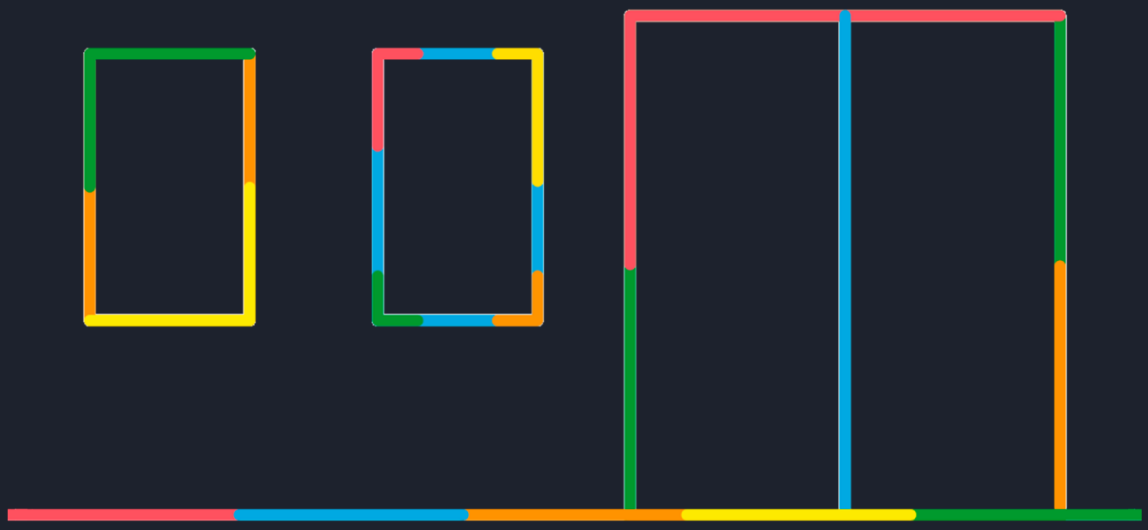


D2.6 – ALDREN Methodology note on rendering of the collected data and results in a building renovation passport



ALDREN ALliance for Deep RENovation in buildings

Implementing the European Common Voluntary Certification Scheme, as back-bone along the whole deep renovation process

Disclaimer:

Attention: The present versions are still working documents

*The aim of these **draft** ALDREN Methodology notes is to provide information on how to apply the different ALDREN protocols during the pilot phase, to test, consolidate and validate the work done on the different tasks, to collect feedback from stakeholders on their utility and applicability.*

Therefore, they are made public.

These drafts will be finalized and updated for roll-out before the end of the ALDREN project.

Project resume:

Start: 1 November 2017
End: 30 Avril 2020

The ALDREN objectives are to achieve higher renovation rates and better renovation quality by overcoming market barriers and preparing the ground for investment.

The excellence of the ALDREN solutions offered are:

1. a harmonized Energy performance rating based on the European Voluntary Certification Scheme (EVCS) verified by measurements to increase comparability, confidence and market uptake by standardized solutions (CEN / ISO);
2. associating low energy renovation with high quality indoor environments to trigger renovation and to promote health and comfort;
3. aligning market recognition of high quality with enhanced building value by financial tools and capacity building. Establishing business case for deep renovation to motivate private investment.

These solutions will be integrated in a consistent, common way in a building passport to ensure the results and effective financing also in case of step by step renovation.

The ALDREN coordinate and support actions bring together in ALDREN Alliance the main stakeholders involved in building renovation to specify the needs of the non-residential building sector and to organize the pilot use of the ALDREN procedure.

The ALDREN actions are sound and credible. They answer a market request for common reliable tools by using the EVCS policy instrument (EPBD Art. 11(9)) and by completing it to reach the needed holistic approach for deep renovation.

The implementation and dissemination of the ALDREN procedure will use existing channels of environmental scheme operators for the pilot phase, but also for further dissemination.

The ALDREN overarching outcome will be the infrastructure to enable market transformation by deep renovation driven by the business case and able to directly support the EU policies (EED, EPBD).

Coordinator:

- **CENTRE SCIENTIFIQUE ET TECHNIQUE DU BATIMENT** — **France**

Participants:

- ENBEE SRO — Slovakia
- INSTITUTO VALENCIANO DE LA EDIFICACION — Spain
- CERTIVEA — France
- REHVA — Netherlands
- VERCO ADVISORY SERVICES LIMITED — United Kingdom
- DANMARKS TEKNISKE UNIVERSITET — Denmark
- POLITECNICO DI MILANO — Italy

Project duration: 2017.11.01 – 2020.04.30

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Revision History

Date	Version	Author/Revision by	Comments
18 April 2019	Version 1.0	POLIMI / Marta Maria Sesana, Graziano Salvalai CSTB / Simon Ligier	First provided version
25 April 2019		CSTB / Olivier Greslou, Mathieu Rivallain, Johann Zirngibl	Review
29 April 2019	Version 2.0	POLIMI / Marta Maria Sesana, Graziano Salvalai	Second provided version. Ammendments included

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EXECUTIVE SUMMARY

T.S. Eliot, The Rock:
Where is the wisdom we have lost in knowledge?
Where is the knowledge we have lost in information?

The ALDREN concept

According to the Paris agreement, Europe needs to reach net-zero by 2050 at latest in all sectors, and with buildings as a cornerstone to any realistic plan. To stay on track, a net-zero scenario with efforts shared across sectors requires ramping up the renovation rate to at least 3%/year with an average energy efficiency improvement of 75%, both reached at latest by 2030 [1]. The stock of buildings in the EU is relatively old, with more than 40% of it built before 1960 and 90% before 1990. Older buildings typically use more energy than new buildings. The current rate at which new buildings either replace this old stock, or expand the total stock, is low with only about 1-2% of the building stock renovated each year, although it is estimated that renovation accounts for 57% of all construction activity. Most of these renovations do not utilize the full potential energy savings that could be achieved. In this context, the ALDREN (Alliance for Deep Renovation in Buildings) project has the goal to motivate the construction sector value chain stakeholders to undertake deep renovation projects on their properties. Non-residential buildings in EU countries account approximately for 25% of the floor area distribution and can be drivers of the energy transition that Europe is looking for.

To match the ambitious EU commitments several complementary actions have been made at the same time with different actors: the development of tools (CEN standards), capacity building (CEN-CE), provided a consultancy support (EPB Center). The revised EPBD provide the chance to contribute at EU level and the ALDREN approach – presented in this deliverable – would like to facilitate on one hand the transposition of the revised EPBD and on the other to be in line with the suggested European harmonization. The ALDREN approach and the outcomes presented in particular in this document reflect the structure of the activities carried out during Task 2.6 (Figure 1).

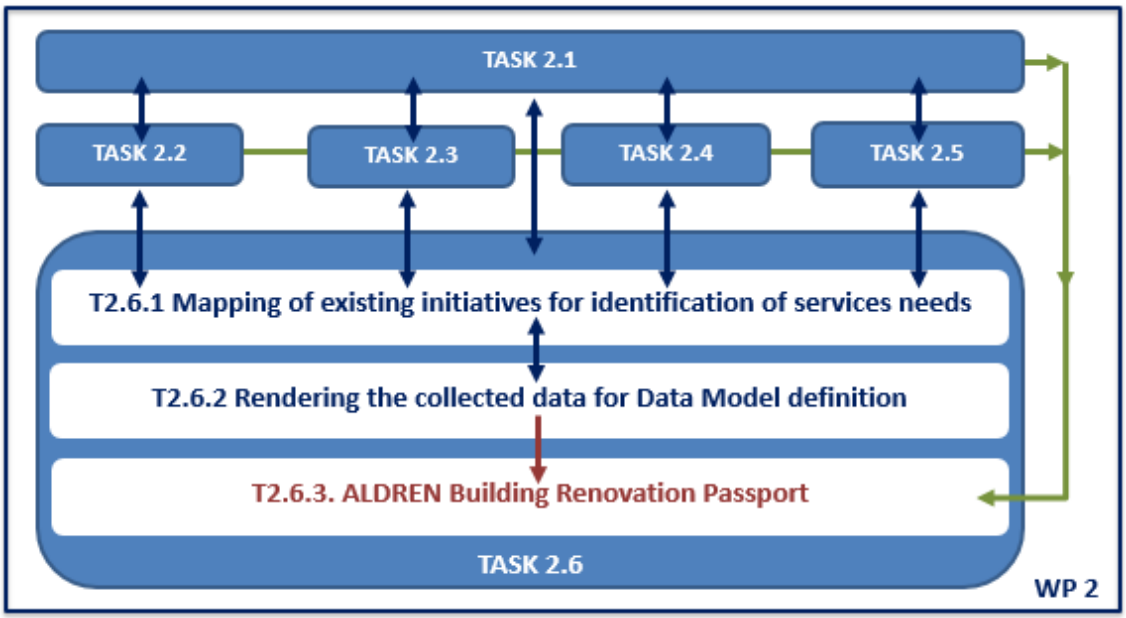


Figure 1 – Overall structure of the WP2

WP2 is the technical workpackage of the ALDREN project composed by 6 tasks: four vertical (sectorial) tasks (T2.2 Energy rating & target, T2.3 Addressing the gap between calculated and actual EP; T2.4 Addressing health & well-being, T2.5 Linking EVCS to the financial valuation), harmonized by a common language defined in the first horizontal task (T2.1) and integrated by an overall approach - second horizontal one (T2.6) - into a Building Renovation Passport (BRP).

Task 2.6 is then substructured in 3 respective subtasks:

Task 2.6.1 Overview on the available knowledge and information;

Task 2.6.2 Rendering and Structuring of all the collected data and Knowledge;

Task 2.6.3 Building Passport form definition.

This deliverable has the main aim to present the ALDREN approach and the ALDREN Building Renovation Passport, giving an overview of the connections and data links with other existing databases, certification schemes and the potentialities that this service could have on the market.

This protocol document is structured in sections to guide the reader through the whole contents and objectives:

- presentation of the preliminary studies and analysis conducted on the available knowledge to take into consideration the lessons learned from previous initiatives (Section 1 + Annex a) and to guide the Data Model structure definition of the ALDREN Buidling Renovation Passport (BRP) (Section 2-3 + Annex b);
- description of the overall instructions and reccomandations for the use of the ALDREN BRP (Section 4 + Annex c).

In details, Section 00 presents task 2.6 goals and proposes a recall of its activities description from the Grant Agreement with the response of the results already achieved and the remaing goals and integrations to be done before the end of the project.

The following sections 01 – 02 – 03 reflect the activities performed during T2.6, coupled with the section 04 which presents the ALDREN approach and how to use the ALDREN Building Renovation Passport.

Section 05 listed all the references used and considered for the development of the study and section 06 provides the Annexes realized in support to the core contents of the deliverable.

00 – RECALL OF GRANT AGREEMENT: TASK 2.6

The contents of the Grant Agreement are presented below. POLIMI's response to how each of the three subtasks has been delivered to date, and any remaining activities to complete by the close of the project, have been set out following and enlarged results have been included and presented in the related following sections 01-02-03 of this document.

The main goal of task 2.6 is to provide the assembling combination of respective data collected in the previous tasks 2.2, 2.3 and 2.4 by all the partners with the financial evaluation of the task 2.5. The rendering of all these collected data has been structured into a robust definition of a Building Passport form for Existing Buildings (presented in section 04 Protocol steps: how to use the ALDREN BRP).

Task 2.6.1 Overview on the available knowledge and information

The first activity of task 2.6 will be focused on the analysis of existing database on the European Building Stock and EPC data previously collected over the EU. The purpose will be to identify the main data layers such as the technology developed/used, standards, incentives, energy efficiency policy and all those information necessary for the definition of the Building Passport. Moreover this subtask will study the compatibility with emerging databases at national and European levels (e.g. Building stock observatory, Product databases based on Ecodesign Directive and other building components).

Key GA task	Work completed	Comments
Analysis of existing database	Section 01 set up a complete overview on the available knowledge and information starting from an introduction on terminology and definitios to support the data comprehension. Existing databases have been investigated and a more focus analysis has been also included within Annex a.	Data and structure analysis have been conducted not only on existing databases in general, but also on certification scheme (section 1.5) and ongoing Building Passport initiatives (section 1.6) to provide a more comprehensive overview on the state of the art on the information knowledge available.
Study on the compatibility with emerging databases at national and European levels	This special focus has been presented in Annex a subdivided in (a1) on EPC register databases and (a2) on BSO for Non-Residentil buildings.	The Annex is mostly completed, only (a1) due to difficulties to collect informations by partners is still ongoing and will be implemented soon.

Task 2.6.2 Rendering and Structuring of all the collected data and Knowledge

After the identification of the dataset available and its consistence, links and compatibility, it will be defined a data model to structure and capitalize all these building information (from the EVCS information needs and collection), so as to support deep energy retrofitting operations. An important attention will be paid to the inclusion in the data model of information relating to building control strategies, the Building Management System, the sub-meter configuration and energy monitoring and targeting plan. The data structure will be suitable to collect information at the four critical stages of the deep renovation: design, as-constructed, post commissioning and in operation

according to the protocol defined in the subtask 2.3.2. In this subtask 2.6.2 the integration of BIM for the structuring knowledge will be considered and grounded on the experience of the ALDREN core members on information needs in the perspective of building energy retrofit.

Key GA task	Work completed	Comments
Definiton of data model structure	Section 02 presents in details inputs, outputs and data flow for the ALDREN data model structure.	Complete.
The data structure will be suitable to collect information at the four critical stages of the deep renovation.	The data structure has been defined in collaboration with all the other partners and in particular with Task 3.1.	Complete and validate within the Task 3.1 with pilots application.
Integration of BIM for the structuring knowledge	Annex b provides an overview of existing dataset and evaluation of BIM integration within the ALDREN approach.	Complete.

Task 2.6.3 Building Passport form definition

The final phase of task 2.6 will lead to the results formalization from all the previous modules, in a tool offering a dynamic step-by-step vision of the pathway to deep renovation, specifying EP targets and renovation actions to be undertaken. In particular all the collected data will be presented and presented in the form of a building passport. Partners involved in the pilot studies (Task 3.1) will test the Building Passport form to track their progress.

Key GA task	Work completed	Comments
Formalization from all the previous modules in the form of a building passport.	Section 03 presents in details the ALDREN Building Renovation Passport: elements and functinalities.	Complete.
Testing the Building Passport form.	Section 04 in parallel with Annex c provide protocol information on how to use the ALDREN BRP.	Complete and validate within the Task 3.1 with pilots application.

01 – OVERVIEW ON THE AVAILABLE KNOWLEDGE AND INFORMATION (Task 2.6.1)

1.1. Introduction

Vale of data is continuosuly increasing. Indeed, data has proven to be the most important commodity in the digital economy. Data's actual value continues to grow, and the limits of its prospective value are pushed every day. Data is the new oil for digital economy.

Nowadays there are multiple databases related to building characteristics and stocks. The buildings data are collected by different institutions (i.e. statistics offices, energy agencies, consultancy companies, research organisation, others) mainly on the Member States (MS) level; its quality, availability and completeness varies significantly between the different countries [1].

The main collectors of these data considered relevant for ALDREN approach at European level are a) Eurostat, b) Energy Perfomance Certificate (EPC) register, c) Building Stock Observatory, d) databases from European reserches. An overview on the above listed databases has been conducted with the aim to individuate the main characteristics of the existing databases and to individuate which of them can be used to support the ALDREN methodology of decision making for the BRP definition and the assessment of energy interventions in existing Non-Residential buildings.

Following a brief presentation to set the scene of this section and then a more comprehensive analsys has been presented in each respective paragraph.

a) Eurostat [2], the official Directorate-General of the European Commission with the main responsibility to provide statistical information to the institutions of the European Union (EU) and to promote the harmonisation of statistical methods across its MS through the European Statistics System (ESS). Eurostat statistics are open data available on its website, they are hierarchically ordered in a navigation tree with tables distinguished from multi-dimensional datasets from which the statistics are extracted via an interactive tool.

b) Energy Performance Certificates (EPCs): established in 2002 with the EPBD [3] implementation process and remarked in 2010 with the EPBD recast [4], this initiative stimulate the creation of indipendet register – often at local level - Databases collecting data from EPCs are the central source of information on the energy performance of the EU building stock. Unfortunately, some European countries do not have central databases, and where they do, these are not usually publically accessible [5].

c) Building Stock Observatory (BSO): at European level it is the official and centralized database on the European buildings stock. The Observatory was developed for the European Commission by Buildings Performance Institute Europe (BPIE) in collaboration with ECN, Ecofys, Enerdata and SEVEn, as well as national project partners [6]. BSO contains a database, a datamapper and factsheets. BPIE began collecting facts and figures on the European building stock in 2010 in the context of preparing its major study Europe's Buildings under the Microscope [7].

In 2012 [7], the information gathered was made available on BPIE's open data portal, the Data Hub, including technical data on building performance never before collected EU-wide. The platform offered country statistics on buildings, information about policies and access to information sources provided by partner organisations and fed into research and legislation [8]. The Data Hub's wealth of information and model were used as a basis to design the BSO. Currently the Observatory is managed by RICS and it has been investigated in detail in the paraghaph 1.2.3 of the present report.

d) An important part of the building's statistics is energy performance data and in the latest years many specific databases have been realized, often as outcomes of European Reseaches (mainly belonging to the 7th Framework Programme funded European Research and Technological Development (FP7) and Horizon 2020 Framework Programme for Research and Innovation), that at the end they also become a valiable sources fot the BSO. The most related to the ALDREN project has been investigated in detail in paragraph 1.3.

1.2. Terminology and definitions

Data needs to be curated, coddled, and cared for. It needs to be stored and processed, so that it may be transformed into information, and further refined into knowledge.

Considering the building sector, evaluation is highly dependent on good, reliable, and accessible data. This is equally true for the evaluation of energy programs and policies. Evaluators typically will try to leverage as much available data, databases, and studies to support their evaluations.

This paragraph presents some key database concepts and their corresponding concise, straightforward definitions, considering the basic structure of the Data, Information, Knowledge, Wisdom (DIKW) Pyramid in Figure 1.

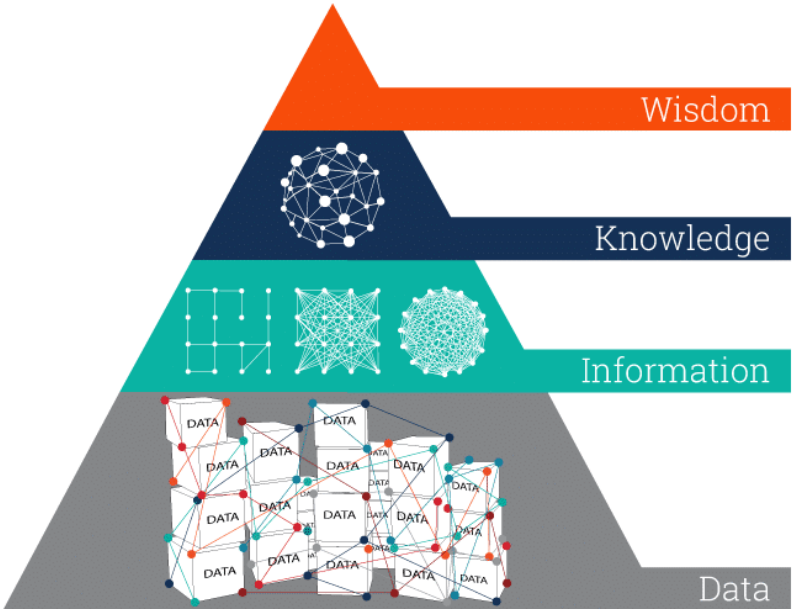


Figure 2. Data, Information, Knowledge hierarchy (Source: www.ontotex.com)

Like other hierarchy models, the Knowledge Pyramid has rigidly set building blocks – data comes first, information is next, then knowledge follows and finally wisdom is on the top. Each step up the pyramid answers questions about the initial data and adds value to it.

The selection and the description of the terms have been studied and individuated from the literature for this topic [9][10].

This selection was performed featuring two objectives: i) provide a jumping off point for those interested in learning more about databases, and their design and management and; ii) focusing on the concept that affected the definition of the ALDREN Building passport Database.

Table 1 - Main criteria and parameters used for database analysis

Code	Criteria	Description
A	**Organization of the data**	*Data collected can be stored and organized indifferent ways.* *Typical choices for data organization are:* • ***Relational Database**: a relational database is one which employs the relational model, in which the raw data is organized into sets of tuples, and the tuples organized into relations. This relational model imposes structure on its contents, in contrast to unstructured or semi-structured data of the various NoSQL architectures* • ***NoSQL Database**: NoSQL is an umbrella term, one which encompasses a number of different technologies that are not relational in nature. This lack of relational structure results in unstructured or semi-structured data in storage; there may be structure, but it is loose in nature.* *Main NoSQL architecture are:* *o Key-value stores: are simple paradigms at a high-level: assign values to keys to facilitate the access and storage of these values, which are always found via their keys. Data values are added to the database with a identifying keys; the same data values are later accessed with the same key.* *o Document Store: use JSON-like "documents" to store data. The document is akin to a record, housing fields and values. MongoDB is a free and open source exemplar.* *o Column-oriented Database: rows actually contain what we most usually think of as vertical data, or what is traditionally held in relational columns. The advantage of column-oriented database design is that some types of data lookups can become very fast, given that the desired data could be stored consecutively in a single row Cassandra is a popular example of a column-oriented database.* • ***No specific organization**: data are stored without a specific machine readable organization criteria.*
B	**Organization of the database**	*Database for data collection can be stored in different ways. Considering the EPC register as an example to describe, the most common and possible organization can be:* *• National database: a national building database exists and all the EPCs are collected in this unique DB.* *• Regional databases: a regional building database exists and all the EPCs are collected in this unique DB.* *• Multiple databases: multiple databases exists (both at national or regional level)for each specific EPC.* *• No collection in database: EPCs are not collected in a database.*

C	***Organization responsible for the database***	*To get easy access to information in the database it is important to know the organization responsible for the database. This is mainly connected with the organization of the database (see previous point).* *• National authority: one or more national public authorities collect data and maintain the database.* *• Regional authority: one or more regional public authorities collect data and maintain the database.* *• Private company: one or more private companies collect data and maintain the database.* *• Semi – public company: one or more semi-public companies collect data and maintain the database.*
D	***Data collection***	*Data collection methods can give important information about data quality.* *• Automatic filling: data are automatically reported in the database by a certification/calculation tool that can be managed by consultants/experts.* *• Centralized reporting: a central secretary is reporting the data from the collection to the database.* *• Simple Reporting: data are reported in the database by consultants/experts.*
E	***Data quality***	*One of the most important issues when dealing with database is the quality of data in the database. If an high number of independent check exist the quality of the data is supposed to be verified.* *• Statistical check: generation of statistical information and cleaning of data and identification of out-of-range data after input.* *• Probability check on entry: e.g. acceptable value range for different parameters.* *• Crucial data check: data from a certificate is rejected if crucial data are missing.* *• Syntactical check: e.g. no text in numerical fields.* *• Other.*
F	***Data query***	*One of the most important aspect of database is the possibility to perform queries on the data.* *• Database supports query: all fields of the database can be queried.* *• Database partially supports query: only a limited number of fields of the database can be queried.* *• Database does not support query: database doesn't allow third part query.*

G	***Connection with other databases and other uses of the data in the database***	*The database is connected to ther source of information, e.g., spatial data infrastructure:* *Yes* *No*

1.3. Overview on existing databases

As anticipated in the introduction, many databases on buildings data are nowadays available. In the following subparagraphs, the databases considered relevant for the ALDREN project development, have been analyses considering the criteria described in Table 1.

1.3.1. Eurostat

Eurostat was established in 1953 to meet the requirements of the Coal and Steel Community. Over the years, its task has broadened and when the European Community was founded in 1958, it became a Directorate-General (DG) of the European Commission. Eurostat is the agency within the European Union (EU) charged with providing statistical information for the continent and ensuring that member countries are using acceptable methods to track and report statistics within their borders. Eurostat consolidates, processes and standardizes all statistical data from member countries so that they cross-comparable conceptually and in term of units of measurement.

Table 2. Eurostat analysis by criteria defined in Table 1

Code	*Criteria*	*Description*
A	***Organization of the data***	*Eurostat covers all areas of European society with over 4600 datasets containing more than 1.2 billion statistical data values.* *The data are available for consultancy by a navigation tree and all data are presented in simple two or three-dimensional tables.*
B	***Organization of the database***	*The Eurostat statistical work is structured into Themes and Sub-themes. Nine are the main statistical themes: general and regional statistics; economy and finance; population and social conditions, industry, trade and services; agriculture and fisheries; international trade; transport; environment and energy; science, technology, digital society.* *There are then some cross-cutting topics intercorrelated on subthemes.* *Database contains the full range of data publically available at Eurostat. They are presented in multi-dimensional tables with various selection features and export formats.*
C	***Organization responsible for the database***	*Eurostat is part of the portfolio of Marianne Thyssen, the Commissioner for Employment, Social Affairs, Skills and Labour mobility. Eurostat's key role is to supply statistics to other DGs and supply the Commission and other European Institutions with data so they can define, implement and analyse Community policies.* *Eurostat offers a whole range of important and interesting data that governments, businesses, the education sector, journalists and the public can use for their work and daily life.*

D	***Data collection***	*Eurostat data contains many indicators (short-term, structural, theme-specific and others) on the EU-28 and the Eurozone, the Member States and their partners.* *The database of Eurostat contains always the latest version of the datasets meaning that there is no versioning on the data. Datasets are updated twice a day, at 11:00 and at 23:00, in case new data is available or because of structural change. It is possible to access the datasets through:* *- SDMX Web Services, as well as* *- Json and Unicode Web Services* *For each of the 9 themes a dedicated manual for data collection are available on Methodological manuals relating to statistics on the RAMON - Reference And Management Of Nomenclatures web page of the eurostat website.* *At the following link for example it is available the Manual titled: Getting messages across using indicators – A handbook based on experiences from assessing Sustainable Development Indicators: (https://ec.europa.eu/eurostat/documents/3859598/5936409/KS-GQ-12-001-EN.PDF/c47039bd-c026-4d99-a819-135b5e4c1da4?version=1.0).*
E	***Data quality***	*Eurostat performs data validation by verifying whether data are in accordance with certain basic criteria that serve to assess the plausibility of the given data. In the target business process, validation rules are jointly designed and agreed upon at the level of each statistical domain's Working Group.* *The resulting validation rules are documented using common cross-domain standards, with clear validation responsibilities assigned to the different groups participating in the production process of European statistics. The European Statistical System (ESS) is in charge of the data validation workflow.*
F	***Data query***	*Eurostat Database supports query: all fields of the database can be queried.*
G	***Connection with other databases and other uses of the data in the database***	*YES.* *The European Statistical System (ESS) is the partnership between the Community statistical authority, which is the Commission (Eurostat), and the national statistical institutes (NSIs) and other national authorities responsible in each Member State for the development, production and dissemination of European statistics.* *This Partnership also includes the EEA and EFTA countries. Member States collect data and compile statistics for national and EU purposes.*

1.3.2. The Building Stock Observatory (BSO) database

The EU BSO is a European Commission initiative to monitor the energy performance of buildings across Europe.The purpose of the EU BSO is to:

- provide a snapshot of the energy performance of the EU building stock, by providing high-quality data from all Member States in a consistent and comparable manner;
- set a framework/methodology for the continuous monitoring of the building stock.

Through the energy efficiency indicators in the BSO and associated topics, the data presented gives an overarching view of energy consumption patterns within each building typology across the EU. Thus, the primary driver of the BSO is to provide a clear understanding of the effectiveness of EU policy measures and of market support mechanisms, which will steer an improvement in the depth and rate of building renovations to enhance energy efficiency across the EU.

Table 3. BSO analysis by criteria defined in Table 1

Code	*Criteria*	*Description*
A	***Organization of the data***	*The BSO includes more than 250 indicators 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, and energy poverty and energy market.*
B	***Organization of the database***	*The BSO includes more than 250 indicators grouped in the following thematic areas:* *Topic 1.1 BUILDING STOCK – NZEB & NEW CONSTRUCTION* *Topic 1.2 ENERGY NEEDS* *Topic 1.3 FUEL SUPPLY MIX* *Topic 2 TECHNICAL SYSTEM* *Topic 3 CERTIFICATION* *Topic 4 FINANCING* *Topic 5 FUEL POVERTY & SOCIAL ASPECTS* *Topic 6 BUILDING CODES* *Future implementation for COMFORT* *The BSO 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.*
C	***Organization responsible for the database***	*The first phase of the project launched in November 2016, was developed by a consortium led by BPIE. The second phase is for the continuation of the EU BSO lead by RICS.*

D	***Data collection***	*The data collection for the BSO has been conducted using data from 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 several stakeholders with a request to support the data collection process. Several industry associations supported the process and shared data on technical systems, etc.* *In the original iteration of the EU BSO numerous EU Projects were employed to populate approximately 4% of the entire EU BSO database. There is a long list of projects that are cited in the database. However, these projects have now reached completion, which effects the future data position of the EU BSO. As these projects are no longer collecting data on energy efficiency indicators across the EU built stock, which consequently means that the indicators within the EU BSO that were originally populated through these projects will not be updated with the latest data.*
E	***Data quality***	*The most used sources were the EU projects (around 40%) and official international or national statistics (around 39%), followed by expert assumptions and calculation provided by the national project partners and the consortium supported around 25% of the collected data.* *The EU BSO faces a serious amount of persistent data gaps. Meaning, some energy efficiency indicators present in the EU BSO have no data whatsoever. One of the main tasks of the current phase of the EU BSO is to populate as much of the database as possible. Currently, the EU BSO has 13% of its indicators populated with data. Of this 13%, 8.4% of the populated data are sourced regularly from high quality and reliable sources, i.e. Eurostat, Odyssee-Mure, and various National Statistical databases.*
F	***Data query***	*BSO supports query: all fields of the database can be queried but many datasets are still unavailable. Often there are lacks of years for some countries.* *All sources are provided in the Observatory public database and data visualisation tools such as the factsheets.*
G	***Connection with other databases and other uses of the data in the database***	*YES.* *Many data come from previous Databases or databases developed within EU project researches. Explicit references and links are available directly on BSO browser during its navigation.*

1.3.3. EPC registers

Issuing the EPC is the last step of a comprehensive process. Thus, several factors determine the quality of results, which are the EPC and the presentation of its energy indicators. Geissler and Altmann [5] in a publication belonging to the EPBD Concerted Action individuated and listed them as following.

- Qualification of energy experts calculating EPCs.
- Methodology used in data collection.
- Quality of the software used for EPC calculations.
- Quality control procedure to detect mistakes in calculations and in production of EPCs in general.
- Commitment of real estate agents to using energy indicators for informing clients in a useful manner:

Morevoer in this framework, many MS have recognised the necessity or the advantages of establishing a database for collection of data from the energy performance certification (EPC) schemes. Data have started to enter into the databases, difficulties have been identified and solutions to overcoming them found. Most MS have however been very busy taking care of the implementation of the EPC schemes and have thus not had time or resources to investigate the possibilities for exploiting the information in the database for other purposes than meeting the requirements in the EPBD.

A user-friendly database with integrated control mechanisms (e.g., automatic check by the calculation tool during EPC upload into the database) could support the assessors and the owners in issuing EPCs with fewer mistakes. Furthermore, it could serve as a source of information (both qualitative and quantitative) for policy development, monitoring and evaluation. It could also help governments to design funding and other schemes for building refurbishment and to define the baseline of building performance for the further development of regulations. Opportunities for utilisation depend on how access to the EPC-database is regulated and whether EPC information can be linked to other data, e.g., statistical data on income, employment and specific data related to the building sector.

There are MSs which provide open access to selected EPC information, while in other countries access is limited to the authorities and granted upon approval for selected organisations, e.g., research entities. The EU project REQUEST2ACTION (01/04/2014 *to* 31/03/2017 http://building-request.eu/) has explored several options of how to make use of EPC-databases analizing selected EPC-database in selected countries (Italy Regione Lombardia, Austria, Portugal, Netherlands, Slovakia, UK).

Table 4 provides the results of the analysis conducted as an overview on the EPC-database developed at European level by the different MS using the criteria defined in Table 1.

Table 4. EPC register analysis by criteria defined in Table 1

Code	*Criteria*	*Description*
A	***Organization of the data***	*The majority of the MS (18) collect EPC data in a central register managed by an official authority.*

		There are however MS that do not have a central register and some MS employ a private company to manage the register. *Almost all MS collecting EPC data in a register have arranged that data flows directly from the experts or assessors into the database and in most cases by using an accredited EPC tool.*
B	***Organization of the database***	*Databases can be organised physically in different ways ranging from one country-wide database holding all information from the certification schemes to no collection of information in a database.* *Currently the most diffuse organization is at regional level being in charge at this scale even the energy regulations.*
C	***Organization responsible for the database***	*In most of the MS there is an official authority responsible for the database, either at a national level or at a regional level.* *In Austria, Slovenia, and Switzerland a private company managed the energy certification database (calculated and/or metered). Slovenia will have both a national database and require that the experts store the information gathered during the energy certification audits. Austria has several regional databases and one voluntary central database run by the Austrian Energy Agency. Simliarly in Italy, there are different EPC registers at regional level.*
D	***Data collection***	*In many cases data are entered directly by the assessor or expert into the database or data comes directly from accredited certification tools. Then usually, all information collected during the certification process and audit in the buildings are stored in the database. In some cases different methodology for data collections are followed including calculation and / or measured energy perfomance. (i.e. in Germany ther is no one official, central database.* *Within DENA´s private database, all data of the mandatory certificate are collected in an anonymous way (postal code of the building is captured only). Data cannot be related to a certain building or issuer (only to the postal code).* *The data of certificates issued according to the standards of the voluntary seal of quality are fully captured including U-values, areas, efficiency etc. These data are anonymous as well, but the data can be related to the issuer in charge*
E	***Data quality***	*The introduction of the EPC system in the first EPBD, was not sufficiently supported by quality assurance requirements. In order to ensure high quality of energy performance certifications, an independent control system was introduced in the EPBD recast Art.18.* *Most of the MS do perform some kind of quality checks on data. In some cases, before data are entered into the database, but in most cases as a retrospective exercise with selected (randomly or after complaints) certificates being investigated.*
F - G	***Data query and connection with other databases***	*EPC register was born to facilitate the use of the data collected in databases for different purposes.* *Anyway, the possibility to download or filter or select specific dataset is not always possible and it depends on the database characteristics of each national/regional/local*

1.4. EU project databases outcomes

An important part of the building's statistics is energy performance data and in the latest years many specific databases have been realized, often as outcomes of European Reseaches (mainly belonging to the 7th Framework Programme funded European Research and Technological Development (FP7) and Horizon 2020 Framework Programme for Research and Innovation), that at the end they also become a valiable sources fot the BSO. The most related to the ALDREN project has been investigated and summarized in this paragraph.

1.4.1. DATAMINE

Title Project	Acronym	Duration	Data base name & link
Collecting Data from Energy Certification to Monitor Performance Indicators for New and Existing buildings	DATAMINE	01/01/2006 - 31/12/2008	http://www.meteo.noa.gr/datamine/

The goal of the DATAMINE project was to set up a structure to collect data from EPC like procedures to be able to facilitate cross country comparison of building energy performance. To be able to do that, development of a harmonised data structure was essential holding all necessary information yet not restricting input in such a way that only a limited number of datasets could enter the database. The starting point was thus identification of where data can be used and which data to collect to be able to facilitate achieving the goals. First a harmonised data structure was developed for establishment of a model for data collection. Then carrying out national model projects to verify and fill the database and finally performing a cross country comparison over the steps in DATAMINE.

Table 5. DATAMINE analysis by criteria defined in Table 1

Code	*Criteria*	*Description*
A	***Organization of the data***	*The DATAMINE Data Structure provided a framework for the data to be collected during the monitoring process. A total of 255 parameters were defined of which a suitable sample could be selected to describe the building's energy performance, depending on the concrete case and the type of energy certificate. During the projects more than 19,000 datasets were collected in the 12 different countries*.
B	***Organization of the database***	*The data of each model project was collected in a database, which is an EXCEL worksheet The following groups of quantities were considered in the Data Structure: Energy Certificate Data, General data of the building, Building envelope data, System Data, Calc. Energy Demand, Basic Parameter of Operational Rating, Summery of Energy Consumption and Energy Generation, Primary Energy, Co_2 emissions and benchmarks.*

C	***Organization responsible for the database***	*Each project partner could use his own data structure (for example specified by the applied software) and carry out his analysis on an individual basis according to the objectives and conditions of the individual Model Project. At the end the national data base was translated to the harmonised data structure that was then delivered to the project coordinator IWU who collected all data in a common evaluation data base.*
D	***Data collection***	*The DATAMINE project is characterised by its bottom-up approach: In the 12 Model Projects a large variety of experiences was made with data collection and analysis. Different types of buildings (residential and non-residential) were analysed using different types of energy certificates and energy audits (asset rating as well as operational rating). Different methods of data collection were applied: existing databases were used but there was also data transfer from single energy certificates or building energy audit reports – carried out by hand or by a new developed interface for energy certificate software. Also data collection via internet was realised.*
E	***Data quality***	*The Data Structure accounts for different types of energy certificates in the EU countries and in the project partners' Model Projects, as well as the different monitoring aims. In general the cross-country comparison was performed in a straight forward way. The harmonised definition of the data fields proved to be an immense advantage. Already during the runtime of the Model Projects each partner had processed a transformation from the systematic used in his coun-try or provided by his software to the DATAMINE structure. Therefore the databases delivered from the different countries were transparent for the evaluator. A manual pre-check was performed to find inconsistencies or deviations from the DATAMINE standard. Most of the data were of good quality. Only a small number of corrections had to be made.*
F	***Data query***	*DATAMINE Database supports query: all fields of the database can be queried.*
G	***Connection with other databases and other uses of the data in the database***	*NO*

1.4.2. EPISCOPE - TABULA

Title Project	Acronym	Duration	Data base name & link
Energy Performance Indicator Tracking Schemes for the Continuous Optimisation of Refurbishment Processes in European Housing Stocks	EPISCOPE	04/2013 - 03/2016	http://www.meteo.noa.gr/datamine/
Typology Approach for Building Stock Energy Assessment	TABULA	2009 - 2012	http://webtool.building-typology.eu/#bm

The overall strategic objective of the EPISCOPE project was to make the energy refurbishment processes in the European housing sector transparent and effective. This will help to ensure that the climate protection targets will actually be attained, and that corrective or enhancement actions can be taken in due time, if necessary. A main outcome is a concerted set of energy performance indicators which shall enable key actors and stakeholders on different levels to ensure a high quality of energy refurbishments, the compliance with regulations, to track and steer the refurbishment processes in a cost-efficient way and to evaluate the actually achieved energy savings.

Table 6. EPISCOPE analysis by criteria defined in Table 1

Code	*Criteria*	*Description*
A	***Organization of the data***	*In the framework of the IEE project TABULA, residential building typologies were developed in 13 European countries following a common methodological structure. Each typology consists of a classification scheme grouping buildings according to their size, age and further energy-relevant parameters as well as a set of exemplary buildings representing the respective building types. In the course of the EPISCOPE project, 10 of these typologies were further developed and new typologies for 6 more countries were elaborated.*
B	***Organization of the database***	*It was developed an excel file which consists of two tables with constant and variable input data. In parallel to the Excel workbook a webtool was developed which enables an online calculation according to the TABULA method (TABULA WebTool).* *Each partner has its own division of Building Typology according to the needs of the national experts in the different application fields. The TABULA Data Structure is divided in: Parameters for Classification (country, region, costruction year class, Building Size Class, Additional Parameter), Reference area, Calculation method building, Boundary conditions, Thermal envelope, U-values, Consideration of thermal bridging, Calculation method supply system and Delivered energy/fuel.*
C	***Organization responsible for the database***	*All TABULA partners are responsible for the consistent transformation between their national building typology and the common definition.*

D	***Data collection***	*Data collection have been performed by distinct TABULA partners in according to national needs.*
E	***Data quality***	*Data acquisition and transformation is prone to errors. Especially the determination of the thermal envelope area and the conditioned floor aerea of a bulding is problematic: double counting or omission of area, copy-past errors, uncertainties as regards the correct position of the thermal envelope.*
F	***Data query***	*TABULA WebTool supports query: all fields of the database can be queried.*
G	***Connection with other databases and other uses of the data in the database***	*It follows up on the previous EU projects DATAMINE (2006 - 2008).*

1.4.3. REQUEST2ACTION

Title Project	Acronym	Duration	Data base name & link
Removing barriers to low carbon retrofit by improving access to data and insight of the benefits to key market actors	REQUEST2ACTION	04/2014 - 08/2017	• **Belgium's Retrofit Action Hub** http://genk.zetjewoningopdekaart.be/ • **Greece's Retrofit Action Hub** http://www.energyhubforall.eu/ • **Italy's Retrofit Action Hub** http://www.portale4e.it/ • **Portugal's Retrofit Action Hub** Portal CasA+ • **Scotland's (UK) Retrofit Action Hub** https://localhomesportal.est.org.uk/

Request2Action addressed information and trust barriers to maximising the impact of EPC recommendations. The project helped stimulate uptake and investment in retrofit by ensuring easy access to accurate, trustworthy data about EPCs, bringing together market actors –-householders, suppliers and policy makers -through a one-stop shop model. Trusted, impartial national and regional energy agencies, usually with unique access and expertise in EPC data, are best placed to set up these one-stop shops - “Retrofit Action Hubs”.

Within this framework five Hubs have been developed within the topic of energy renovation for residential housing in the following five countries:

1. BELGIUM
2. GREECE
3. ITALY
4. PORTUGAL
5. SCOTLAND - UK

The hubs were to drive action on EPCs and they present useful, aggregated data on EPCs, market tracking data, and guidance that has been developed as part of the REQUEST project. They act as trusted meeting platforms, bringing together demand and supply in the market for retrofit products and services.

Table 7. REQUEST2ACTION analysis by criteria defined in Table 1

Code	Criteria	Description
A	***Organization of the data***	*There are very different sorts of data that could be collected and presented, its availability and confidentiality level depend per country. There are e.g. data information on the status of the building stock, real energy consumption, financing mechanisms for renovation measures, lists of supply chain companies, etc. EPC databases can be a good starting point to support the Hub.*
B	***Organization of the database***	*The HUBS structure have been outlined in function of the type of information available and organized in a funnel way. When various target audiences will use the Hub, it should be decided whether the information will be separated per section or everything will all be found at the same location.*
C	***Organization responsible for the database***	*Hub manager defined in each country by project partner.*
D	***Data collection***	*Data collection have been performed by distinct REQUEST2ACTION partners in according to national and regional entities and authorities.*
E	***Data quality***	*Data acquisition and transformation is prone to errors. Especially the determination of the thermal envelope area and the conditioned floor aerea of a bulding is problematic: double counting or omission of area, copy-past errors, uncertainties as regards the correct position of the thermal envelope.*
F	***Data query***	*All the Hubs are basically online tool based on GIS and in some cases they allow users to filter the data visualization.* *For example the Italian Hub foresees three typology of analysis:* - *GIS DIPENDE (Standard web-GIS)* - *Mapping tool* - *Excel DIPENDE_table/Queries for focus analysis*
G	***Connection with other databases and other uses of the data in the database***	*YES with country regional and national register of EPC or system plant.* *For example the Italian hub is planning a full connection with the regional registers for the EPC and also the SIAPE the online system for the HVAC inspections.*

1.4.4. ENTRANZE

Title Project	Acronym	Duration	Data base name & link
Policies to Enforce the Transition to nearly Zero-Energy Buildings in the EU-28	ENTRANZE	04/2012 - 09/2014	http://www.entranze.enerdata.eu/

The objective of the ENTRANZE project is to actively support policy making by providing the required data, analysis and guidelines to achieve a fast and strong penetration of nZEB and RES-H/C within the existing national building stocks. The core part of the project was the dialogue with policy makers and experts and focused on nine countries. Data, scenarios and recommendations were also provided for EU-27 (+ Croatia and Serbia).

The project allowed for evidence-based policy making by providing:

- an online data mapping tool allowing user friendly access to building data, energy demand indicators and scenario results;
- analyses regarding cost-optimal levels of NZEB;
- an overview of principle integrated policy sets that aim at the NZEB standard;
- model-based scenarios up to 2030 (for different policy settings built on the discussions with policy makers);
- international comparative policy analyses.

Table 8. ENTRANZE analysis by criteria defined in Table 1

Code	*Criteria*	*Description*
A	***Organization of the data***	*In Entranze project, residential building typologies were analysed in EU-28 states and Serbia and it contains an in-depth description of the characteristics of buildings and related energy systems. It provides data on the thermal quality, size, age, type, ownership structure of buildings, on the heating and cooling systems and on the energy consumption by end-use.*
B	***Organization of the database***	*During the project several databases and tools were developed in order to facilitate a quick, easy and tailor-made access to national and comparative international indicators. The databases and modelling tools can also act as a comprehensive basis for decision-making processes both for policy makers and other stakeholders. As such three tools were developed: The Data Tool, The Cost Tool, The Online Scenario Tool.*
C	***Organization responsible for the database***	*All ENTRANZE partners are responsible for their own data.*
D	***Data collection***	*The policy sets chosen by the ENTRANZE target countries differ widely according to the country-specific needs and their current political framework.*

E	***Data quality***	*The level and quality of data related to non-residential buildings is significantly lower than the data on the residential stock. Non-residential buildings still represent on average 25% of the stock making them a crucial part of the equation. However, basic data, such as the breakdown of stock according to the age of construction or to branches and their corresponding U-values, are missing in several countries.*
F	***Data query***	*ENTRANZE supports query: all fields of the database can be queried.*
G	***Connection with other databases and other uses of the data in the database***	*It is a sort of follow up on the previous TABULA-EPISCOPE project (2009-2016).*

1.4.5. EXCEED

Title Project	Acronym	Duration	Data base name & link
Policies to Enforce the Transition to nearly Zero-Energy Buildings in the EU-28	EXCEED	09/2016 - 05/2019	http://www.entranze.enerdata.eu/

The project answers the need for transparency and comparability of energy performance calculations. The scope of ExcEED is to create a European database for measured and qualitative data on beyond the state-of-the-art buildings and districts. Key performance indicators (KPIs) will be developed to quantify and benchmark the energy efficiency and the environmental quality at building and district level. Advanced tools and KPIs will be associated to the database to analyse real energy performance and environmental quality at the level of single building/district, geo-cluster of buildings, and European new or renovated building stock.

The objectives of the project are:

- orchestrate seamless integration of heterogeneous data to create the European energy efficient buildings & district database and platform;
- deliver information which provides immediate value to the user;
- determine performance benchmarks;
- realise an indoor quality survey;
- set up a return of experience process.

ALDREN consortium is in contact with the EXCEED coordinator and being at the time of the ALDREN deliverable first release submission (April 2019) not yet published more information on the EXCEED database, a detailed analysis will be integrated in the latest version of D2.6 in the next months.

1.5. Mandatory and voluntary certification scheme: an overview

1.5.1. Energy Performaance Certification (EPC)

The Energy Performance Certificates (EPC) was introduced at European level in the EPBD 2002 [3] as an important instrument that should contribute to the enhancement of the energy performance of buildings. EPCs play a central role in the context of the Article 20 (2) EPBD, which asks Member States to provide information: on the energy performance certificates and the inspection reports, on the cost-effective ways and, where appropriate, on the available financial instruments to improve the energy performance of the building to the owners or tenants of the buildings.

The main aim of the EPC is to serve as an information tool for building owners, occupiers and real estate actors and, as remarked by Arcipowska et al. [11], EPCs can be a powerful market tool to create demand for energy efficiency in buildings by targeting such improvements as a decision-making criterion in real-estate transactions, and by providing recommendations for the upgrading of the energy performance.

As stated on the EPBD Directive, an EPC is needed whenever a building is constructed, or in the case of existing buildings, before it is marketed for sale or rent. The certificate includes the overall energy performance of the building and reference values such as the minimum energy performance requirements, allowing the comparison with another building of the same type. With the EPBD recast 2010/31/EU the certification scheme for existing buildings was strengthened by including a mandatory recommendation report, listing measures to improve the energy performance of the building, known as list Recommendations Measures (RMs) for the cost-optimal or cost-effective improvements of the energy performance of a building or building unit. This element on the EPC, to provide energy recommendations for retrofitting building in mass, represents an attractive solution to improve the existing residential building stock, which is the main source of CO_2 emissions in the building sector [12]. To date, however, renovation rates in the EU are low and renovating the existing building stock to make it more energy efficient remains a challenge, even more so when considering the ambitious levels set by the EPBD which includes aims for nearly zero-energy buildings (nZEBs). Increasing the renovation rate is not an easy task, many barriers have been individuated by the study for the ITRE Committee on 2016 [12]. In Annex C the key barriers to renovate the existing building stock are outlined and grouped into 5 main families: financial, technical, process, regulatory and awareness.

In this context [14], EPC has been considered as a reaction to the “information deficit” that belongs to the framework of the barriers to renovation in the EU summarized in figure 1 and referring to building owners’ lack of awareness and knowledge of actions to take in order to enhance the energy performance of their building [13].

Moreover, it has been demonstrated by different researches, that the EPC is become a valuable instrument to support market transformation providing energy related building information (i.e. publication of energy performance indicator in commercial media advertisements) [15][16][17] and in parallel affecting the price of buildings and/or the time of sale [18][19].

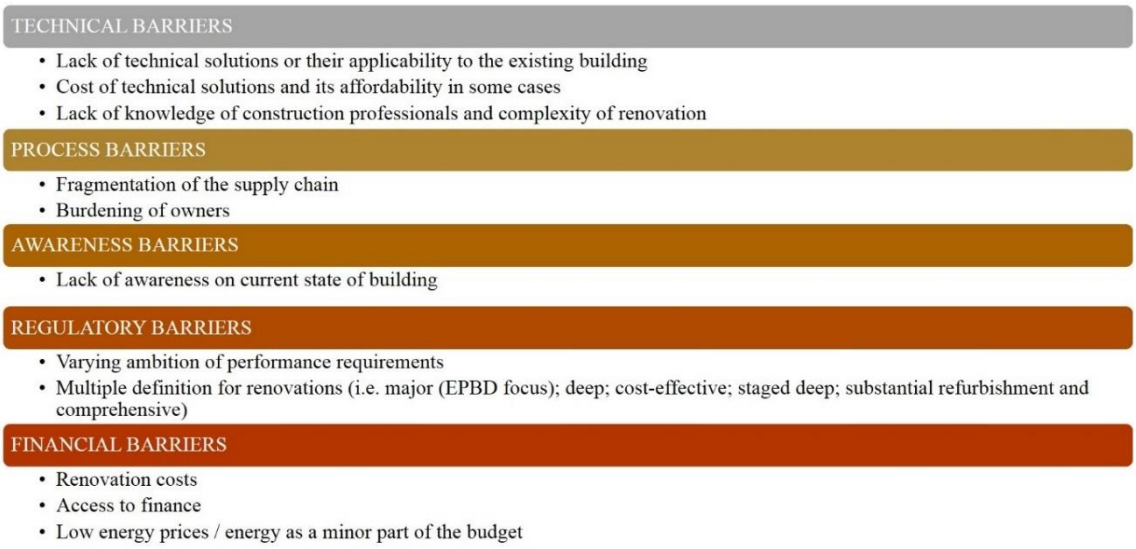


Figure 3. Key barriers to renovation in the EU (Source: Artola et al. [13])

Despite the EPC potentialities, González Caceres [20] in his work underlined that the different implementation process across the Europe and the weakness of LRs, limited their influence and impact on the renovation process, suggesting changes to improve the quality and impact of this EPC feature.

More in depth, Geissler and Altmann [21] pointed out constraints on the role of the RMs within the EPC specifying advantages and disadvantages of the RMs and they proposed to include into the EPC two categories of recommendations: standard and tailor-made.

The standard recommendations should show the improvement potential of the renovation measures such as providing the minimum U-value of the building elements, the upgrading or the possible change of heating, AC and domestic hot water systems into more energy efficient alternatives according to the building type and age. These recommendations are cheaper and are kept general providing a basic potential overview of the building components, but in this case, the building owner might not be motivated enough to carry out improvements.

The tailor-made EPC recommendations should not only demonstrate the energy efficiency potential of the building, but also propose detailed renovation measures, such as the thickness and quality of the insulation according to the calculated needed U-value, the quality of the windows, the appropriate heating and domestic hot water system or variations according to the condition and situation of the building. In order to obtain a reliable EPC and tailor-made recommendations. Those other recommendations would significantly increase the price of the EPC but provide more specific information. The detailed or tailor-made EPC recommendations give the building owner a proper support in what needs to be done in relation to the energy efficiency of the building [21].

This fact is moreover confirmed in the latest update of the EPBD, since the current directive 2018/844/EU [22] has not modified the articles related to issuing and displaying of the energy performance certificate (Articles 11, 12 and 13). Basically, the Directive requires the Member States to lay down the necessary measures to establish a system of certification of the energy performance of buildings, including a methodology for the calculation of the energy performance of buildings which shall be transparent and open to innovation.

Several studies have addressed the EU implementation of energy labeling buildings empirically. Eichholtz et al. [23] investigating the commercial office segment, found that US office buildings with a “green rating” are sold for about 16% higher prices. Brounen and Kok [24] performed a hedonic regression analysis on housing sector and they provided a first evidence of the economic impact of EPC implementation for residential dwellings confirming that there is a price premium for houses labeled as more energy efficient. Similarly, the Bio Intelligence Service [25] report - prepared for the European Commission - stated that EPCs have a significant impact on transaction prices and rents in selected EU countries thanks to a literature review on 22 studies to examine whether the EPCs affect property values.

The main recommendations suggested within the conclusion of this study were: (i) to strength the role of EPCs; (ii) to implement them faster, (iii) to anticipate the publishing phase within the transaction process (e.g., at the time of advertising) and (iv) to make them more visible and comprehensible (e.g., with a more eye-catching front page or by improving the layout and using common language).

Coupled with those recommendations, Arcipowska et al. [26] in their study, based on the EPC implementation across Europe, underlined also the following needs: introduction of further quality assurance measures especially during the early stages of the certification process; guidance in development of the centralized EPCs databases and digitalization of the EPC process and promotion of the effective use of the EPC data.

1.5.2. Voluntary certification scheme

The field of building voluntary environmental assessment and labelling has matured remarkably quickly over the past decade and many countries currently have systems in place. The push toward sustainable design increased in the 1990s with the creation of Building Research Establishment's Environmental Assessment Method (BREEAM), the first green building rating system in the U.K. In 2000, the U.S. Green Building Council (USGBC) followed suit and developed and released criteria also aimed at improving the environmental performance of buildings through its Leadership in Energy and Environmental Design (LEED) rating system for new construction. Since that first release, LEED has continued to grow in prominence and to include rating systems for existing buildings and entire neighborhoods. Additional rating systems have been developed that were influenced by these early programs but are tailored to their own national priorities and requirements or seek to go beyond the limits of current policy and building practices to address broader issues of sustainability or evolving concepts such as net zero energy and living and restorative building concepts that improve the natural environment. In the 21st century, when growing concerns over global warming and resource depletion became more prominent and supported by research, the number and type of green products and a proliferation of standards, rating, and certification programs in the marketplace to help guide, demonstrate, and document efforts to deliver sustainable, high-performance buildings. Many green building rating programs in fact are in use around the world and they vary in their approach with some outlining prerequisites and optional credits, while others take a prescriptive approach, and still others suggest performance-based requirements that can be met in different ways for different building types. As a result, it can be challenging and time consuming determining which standards, certifications, and rating programs are most credible and applicable to a project.

Across Europe for example over 20 schemes for voluntary building certification are currently in use and they are also well-established [28].

Table 9. Comparison of Voluntary Certification labelling and certification schemes

Name	Country of origin	Year of creation	Type	Rating system
BREAM	United Kingdom	1990	Whole Environmental Impact	Comparative label
CasaClima	Italy (South Tyrol)	2002	Energy Efficiency	Energy class
CasaClima Nature	Italy (South Tyrol)	2008	Whole Environmental Impact	Comparative label
DGNB	Germany	2007	Whole Environmental Impact	Comparative label
Energy Star	United States of America	1992	Energy Efficiency	Energy class
FEBY12	Sweden	2007	Energy Efficiency	Energy class
GPR Gebouw	Netherlands	1995	Whole Environmental Impact	Comparative label
GreenBuilding Programme	European Commission	2004	Energy Efficiency	Energy class
GreenCalc+	Netherlands	1996	Whole Environmental Impact	Comparative label
HQE	France	1992	Whole Environmental Impact	Comparative label
LEED	United States of America	1998	Whole Environmental Impact	Comparative label
Miljöbyggnad	Sweden	2005	Whole Environmental Impact	Comparative label
Minergie	Switzerland	1994	Energy Efficiency	Energy class
OGNI	Austria	2009	Whole Environmental Impact	Comparative label
Passive house certification	Germany	1990	Energy Efficiency	Energy class
SBTool ICZ	Czech Republic	2010	Whole Environmental Impact	Endorsement label
VERDE	Spain	2002	Whole Environmental Impact	Comparative label

Table 9 provides an overview of the most diffuse certification scheme for selected criteria. These assessment methods can be used on different types of buildings (new or existing; residential or non-residential; etc.); cover different stages (design, construction, upon completion or operation); and address different criteria (energy only vs. sustainability schemes).

The main differences belong to the environmental and energy issues included or not in the assessment method, making the benchmarking or comparisons between the schemes difficult as their baselines, scopes and indicators differ.

The market for voluntary building certification schemes is mainly developed and used for commercial buildings: public and private users rely primarily on the mandatory EPCs. In the absence of financial incentives, the take up of a voluntary building certification scheme depends on the benefits perceived by the client in terms of marketing advantage and/or enhancements to building performance with a label demonstrating the sustainability of the building and the credibility of the energy assessment.

Based on the current available data on the number of certifications for commercial buildings by several leading schemes in 8 European countries (Table 10), BREEAM is the European market leader. According to the RICS survey Going for Green [29][30] and the Green Building Information Gateway and other database [31] (which appears to be the most up to date and comprehensive source) BREEAM accounts for 85% of all sustainable building certifications. BREEAM has issued 12.107 certificates in the 8 EU analysed countries (for new/refurbished as well as existing commercial buildings) out of a total of 14.210 sustainable certificates in under the four leading schemes (BREEAM, DGNB, LEED and HQE).

Table 10. No. of Voluntary Certification certifications in selected EU countries. (Source: RICS [29][30], Triple [28] and Green Building Information Gateway [31]

	BREEAM	LEED [32]	DGNB	HQE
Country	*Existing Retrofit and New Build*	*Existing Retrofit and New Build*	*Existing Retrofit and New Build*	*Existing Retrofit and New Build*
Italy	159	66	1	1
France	134	11	-	1080
Germany	330	316	504	1
UK	10689	45	1	-
Slovakia	87	17	-	-
Denmark	23	17	23	-
Spain	27	39	-	-
Belgium	685	15	-	5
Total certification	12107	487	528	1087
% share of schemes	85%	3,4%	3,7%	7,6%

In December 2014, the European Commission received a market study on the voluntary common EU certification scheme for non-residential buildings, in accordance with EPBD Article 11(9). The report gives an overview of existing voluntary schemes, analyzing the demand for a European wide voluntary scheme. Rademaekers [28] stated that the voluntary EU scheme should build on CEN standards, take a modular approach for energy performance only, and be applied both for public & private buildings, as well as new & existing buildings. The key findings of this study were: (i) the market for voluntary building certification schemes in the EU is young, and there are differences between Member States in their uptake of such schemes; (ii) key factors when choosing a certification scheme include reliability, cost and international acceptance; (iii) the most significant added value of a voluntary common EU scheme is that it allows for a consistent comparison between buildings across Member States, while simultaneously offering high-quality assessment and international acceptance; (iv) a majority of interviewed scheme users were in favor of integrating the EU common voluntary scheme within existing mandatory or voluntary schemes.

1.5.3. Level(s)

Level(s) [33] is the voluntary reporting framework, developed by the European Commission in close co-operation with industry stakeholders, to improve the sustainability of buildings. Buildings sector is a key target in the EU Commission's policy for circular economy; a regenerative economic system in which resource and energy consumption are minimized: Level(s) is the answer to this need being a sustainability framework of the circular economy and offers a tiered approach to life cycle assessment.

Developed as a common EU framework of core indicators for the sustainability of office and residential buildings, Level(s) provides a set of indicators and common metrics for measuring the performance of buildings along their life cycle defining in this way a general language of sustainability for buildings.

In addition, the Level(s) framework aims to promote life cycle thinking guiding users from an initial focus on individual aspects of building performance towards a more holistic perspective, with the aim of wider European use of Life Cycle Assessment (LCA) and Life Cycle Cost Assessment (LCCA).

Using existing standards, Level(s) provides a common EU approach to the assessment of environmental performance in the built environment, with a common language (structured in Figure 4) that can make a clear contribution to broader European environmental policy objectives enabling actions to be taken at building level.

Within the framework, each indicator is designed to link the individual building's impact with the following priorities for sustainability at the European level: greenhouse gas emissions throughout the building's life cycle; resource efficient and circular material life cycles, efficient use of water resources, healthy and comfortable spaces. adaptation and resilience to climate change and life cycle cost and value. Each indicator within Level(s) can be used for different types of performance assessment, from a basic level through to a full Life Cycle Assessment (LCA).

The entry point to Level(s) is through the common performance metrics: the simplest and most accessible use of each indicator. Level(s) sets out common units of measurement and basic calculation methodologies, which can be used by building professionals, building assessment schemes, investor reporting tools and public sector initiatives.

For each indicator, a 'graduated' approach is possible, enabling users to move from simple through to more complex and precise calculation methods and extended reporting.

Level(s) shows how to reduce environmental impact and can prepare users for more challenging performance assessment schemes and tools.

Level(s) can be used at defined project stages – design, construction, post-completion, occupation – and defined life cycle stages – production, construction, use, end of life. It is recommended to use Level(s) as early as possible in the conception of a project in order to model and identify possibilities for improvements in performance. If a project is quite well advanced, then there could be value in comparing the performance predicted at earlier project stages with the completed and occupied stages.

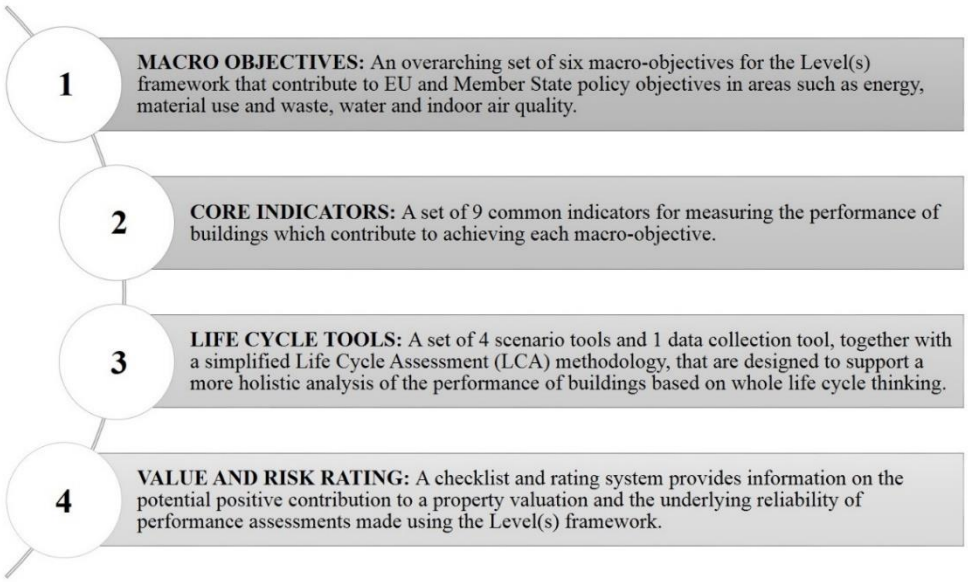


Figure 4. Scheme of the four main elements that structured the framework

Level(s) is the world's first regional framework to address sustainability in buildings and its ambitious focus on circularity will present some challenges. Therefore, the following issues will need to be addressed during the testing and implementation phase that is currently ongoing.

- How to bring Level(s) from theory to practice.
- How to generate and sustain support for Level(s).
- How to address the skills gap and educate the workforce.
- How to access the necessary data.
- The cost implications of performing an assessment.

The testing phase offers the opportunity for stakeholders from the private sector, public sector and civil society to mobilise their efforts to address these issues and demonstrate their commitment to sustainable buildings.

Those participating in the testing of Level(s) will be marking themselves as frontrunners with a key role in shaping and informing the development of Europe's first pan-regional policy that considers the whole life cycle of a buildings environmental performance.

Moreover, testers of Level(s) can be assured that the buildings they are designing, and building are helping to deliver on global and regional priorities in areas including climate change, resource efficiency, water efficiency, resilience and health.

Level(s) offers a simple entry point for users to develop their knowledge and skills in emerging policy areas such as Life-Cycle Assessment (LCA) and Life Cycle Costing (LCC). This will assist in improving business development acumen and further their understanding of green building tools.

1.6. Overview on Building Renovation Passport Initiatives

According to the EU Commission's impact assessment, to reach the objectives of transforming the existing building sector by 2050, the rate of renovation of existing buildings needs to increase dramatically, from the recent rate of around 1% of floor area renovated annually, to a rate of around 3% per annum by 2050 [34].The European policies are aimed toward significantly increasing both the rate of renovation, and the depth of energy savings in the renovated buildings. More renovation of existing buildings has the potential to lead to significant energy savings – potentially reducing the EU's total energy consumption by 5-6% and lowering CO_2 emissions by about 5%. With the directive 2002/91/EC [3] of the European Parliament and Council the EU introduce as compulsory the Energy Performance Certificates (EPC) concerning the evaluation of the energy performance of buildings. Its primary aim was energy saving, due to the amount of energy being wasted resulting from using inappropriate technologies, improper materials or building design errors. EPCs usually assign energy classes to individual buildings, which inform a potential purchaser or tenant about the energy quality and consumption.

The current Energy Performance Certificates (EPCs) provide a mere snapshot of a building's performance at a given time, lacking coherent recommendations about planned steps to bring the building to Nearly Zero Energy Building standard in the future. Building owners need infact easily available and reliable information to drive investment decisions. The revised Energy Performance of Buildings Directive 2018/844 [22] among other measure that aims to accelerate the rate of building renovation towards more energy efficient systems and strengthen the energy performance of new buildings, making them smarter, introduce an optional document called Building Renovation Passport (BRP) that is complementary to the Energy Performance Certificates (EPC), in order to provide a long-term, step-by-step renovation roadmap for a specific building based on quality criteria, following an energy audit, and outlining relevant measures and renovations that could improve the energy performance.

The introduction of Building Passport has been discussed for decades with the objective to provide information to a potential purchaser, investors, renter or user of the building. The term Building Passport is currently being used with differing meanings and there is no a single definition. According to BPIE definition [36][37] it can denote a certificate displaying the most important performance characteristics and technological data of a building - comparable with motor vehicle documents – as well as a comprehensive collection of various building-related documents (plans, calculations, lists and declarations of materials and products used, operating and maintenance guidelines, etc.).

The ALDREN project aims to explore the existing concept and initiatives, by including a detailed analysis of data accessibility and availability. This section contributes to the body of knowledge in three ways:

1. it provides an overview on BP definition from first initiatives in EU;
2. it presents an updated evaluation and comparison of some BRP experiences developed in some European Member states (Belgium, France, Germany and Denmark, selected for their advanced phase of development;
3. it points the main known barriers and the lesson learned within the review initiatives in order to provide suggestions for the standardization of BRP across EU.

The aim of the present paragraph is to analyze the current European initiative regarding the study and application of the Building Renovation Passport (BRP) for the construction sector. All the collected initiatives are related to the residential sector but can be use as reference and basis for the tertiary sector with focus to hotels and offices.

The analysis has been conducted analyzing (a) the general description of the building passport and (b) the graphical representation and structure.

1.6.1. Passeport Efficacité Energétique (P2E) - France

a) General description

In France, Building Renovation Passport are being developed in the form of the so-called "Passeperot éfficacité énergétique introduce by The Shift Project [39] and later developped and experimented by the association Expérience P2E [40]. The project targets about 16 million private houses in France and aims at the massification of depp energy renovation. Identical to other examples, the BP has a set long term vision targeting in this case at transforming the whole French building stock to Low Energy Building standards by 2050, under the law promoting energy transition for a green growth [41]. Hovorka [42] claims that the thermal renovation of buildings has been intended as a primordial step towards de-carbonizing the economy in France and the objectives for 2025 are to have all F and G class (according to EPC) buildings renovated, and by 2050 having the whole building stock listed as A or B class. The P2E is based on a pragmatic approach, in which an energy reflex is established amongst the owners and building professionals who engage themselves into optimizing the overall energy efficiency with every work (also maintenance) done to a building. Contrary to other examples of BRPs, the French version aims to standardize the measures to be taken, based on the building's current technological status. The goal is then to combine these standard solutions together and to make adaptations based on the specific case in order to get a customized solution for each specific building. This can help offering the policymakers a nationwide overview and gives the industry a set of benchmarks. The goal is then to combine these standard solutions together and to make adaptations based on the specific case in order to get a customized solution for each specific building. The Energy Efficiency Passports are placed on an open-source (free) web-based platform that is shared between the owners, the governmental instances and all involved professionals [43]. It all starts with a certified audit, leading eventually to a complete renovation scenario in concordance with the owners' needs and possibilities.

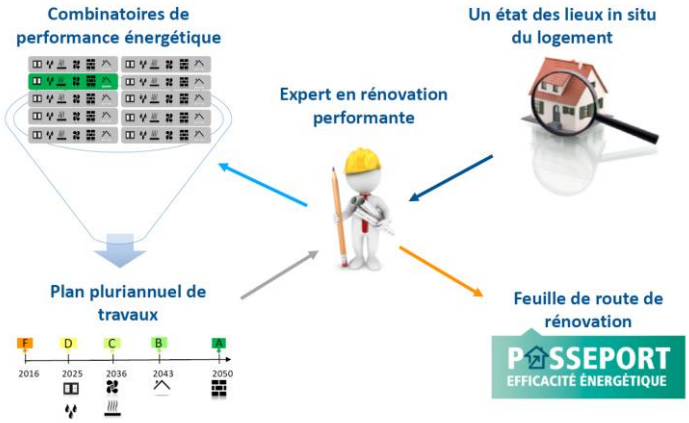


Figure 5. P2E – Graphical view of the web tool (Source: Expérience P2E [40])

The final report includes a clear graphical layout to visualize the results for each step clearly to individuals not familiar with the construction industry. Later, all files related to the building's maintenance, equipment replacements and renovation can be stored in an online digital logbook. Although the Energy Efficiency Passport is not planned to become a full logbook itself, it does contribute to energetical aspect of the French digital logbook ("carnet numérique de suivi et d'entretien du logement") that is obligatory for all new buildings from 2017 onwards.

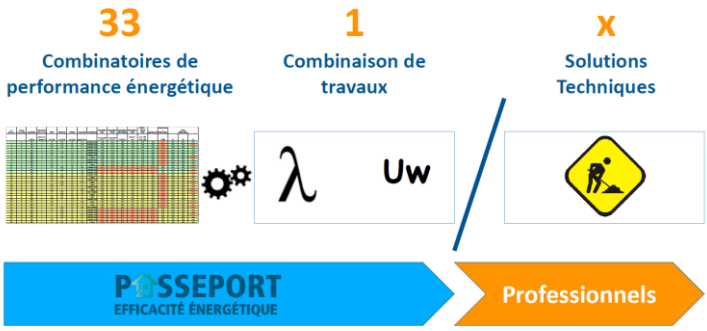


Figure 6. P2E – Process for the analysis of the solution techiques to be applied in the building renovation roadmap (Source: Expérience P2E [40])

b) Graphical representation and structure

The building passport is designed for three specific users: 1) owners, 2) auditors and craftsmen, and 3) renovation professionals with different type of log in levels.

Figure 7. P2E – Graphical view of the web tool Passeport Effacicité Energétique BETA Version (Source: Expérience P2E)

The main function of the Passeport Efficacité Energetique is to collect and store information related to: energy, comfort, detailed features, valuation, financial aspects and files storage.

An integrated dashboard shows the level of renovation for different building element (e.g. to be planned, planned, ongoing, and completed). Different sections show also architectural and technical characteristic of the building component. The renovation actions that compose the renovaton roadmap are selected according to 36 possible action selected by a large simulation study (more than 10.000 case study). The roadmaps are chosen by the owner among different (2-3) options.

1.6.2. Sanierungsfahrplan - Germany

a) General description

The concept of the “individual renovation roadmap” (Individueller Sanieringsfahrplan in German with the acronimous iSFP) was initially developed and tested on the scale of region of Baden – Wuerttemberg and launched on 2015. The iSPF is part of the National Energy Efficiency Programme (NEEAP) [44].

In 2017 the Federal Government launched the Tailored Renovation Roadmap for buildings in order to provide building owners with harmonised cost-effective renovation concepts. These concepts will be reliable multi-stage and multi-year strategies which owners can follow in order to improve the energy efficiency of their buildings, and which take into consideration not only purely energy-related issues but also age of the owners, social context etc.

The iSFP has been devolopped as user friendly and reliable tool considering long and short-term actions for single-family house and smaller multy family-house. The method is based on two site visits and on proper dialogue between the owner of the building and the energy auditor, of which the whole process is described in the handbook dedicated to the energy auditors. It provides, through a face-to-face approach, individualized information and measures, starting from a standardized format. Furthermore, it works with the “best possible principle” (bestmöglich Prinzip), taking into account the opinion, needs and possibilities of the owners to achieve a reasonable result avoiding excessive costs. The primary objective towards the owners is an increase in comfort and health conditions to provide a good environment to live in but not the energy efficiency on itself. These future improvements are explained in a qualitative way to the owner, in order to be clear and to encourage the actual implementation.

The iSPF additionally includes a chapter on how to save energy in the use-phase by changing the users’ behavior.

The energy auditors’ handbook [45] clarifies that two documents are included for the owner: 1) an overview page of all measures to be taken along the road and 2) a well-explained technical report containing the more detailed documentation on the renovation works, their costs, effects and impact. These documents have a self-explanatory graphical layout to guide the user towards the final renovated stage.

At the current level of development, the german building renovation, roadmap does not foresee the introduction of a digital logbook associated with the renovation roadmap. The owners of buildings receive the iSFP as a printed document and in .pdf format. As in Flanders, the opinion of many stakeholders played a major role in the BRP’s development. The iSFP aims at the privately-owned houses, as already seen for Flanders and France, with the idea ti include multiple family buildings in the future.

The renovation programm provides financial subsidies: 60 percent of the eligible consultancy costs, with a maximum of 800 euros for detached or semi-detached houses and 1,100 euros for residential buildings with three or more residential units. For

condominium owners' associations there is an additional one-off subsidy of up to 500 euros if the energy advice report is explained at condominium owners' meetings.

The training of the auditors is an important task of the process considering that the knowledge of the building components is a crucial part for the roadmap definition. To support the auditor in theire work an extensive checklist is provided to them for costructing the vision for the future building.

Figure 8. Example of the checklist for the auditor on-site visit. The audit is based on 3-4 h on-site visit to the property and individual calculation (Source: Ministerium für Umwelt und Verkehr Baden-Württemberg)

b) Graphical representation and structure

The Sanierungsfahrplan tool is compesed by several sheet with condensed information. The first two sections describe the motivation of the building energy revovation and the actual status of the building showing varius critical point of the currente status of the building. Informations regarding the quality of the walls, roof, windows, floors are reported togheter with the geometrical characteristic of each one. The quality of the component is shown by means of a colour scale (with green good quality and red poor quality).

Motivation **Actual status** **Road map** **Detail description of the actions**

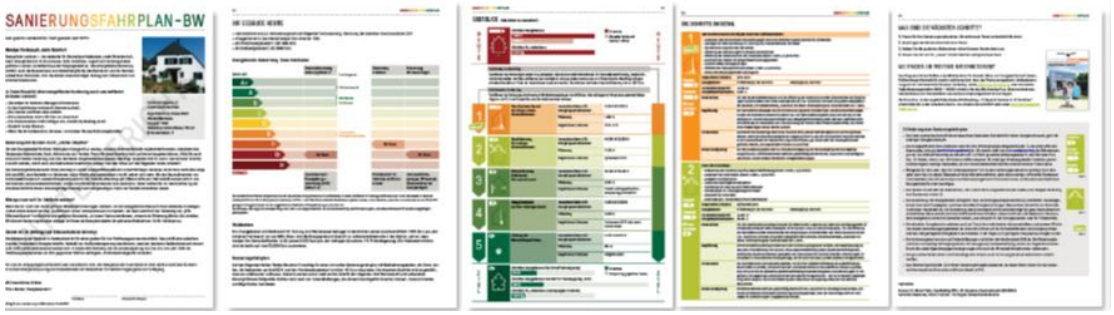


Figure 9. Scheme of the main section of the Sanierungsfahrplan BW. 1) motivation 2) actual building status 3) renovation road map 4) detailed explaination of the actions (Source: Ministerium für Umwelt und Verkehr Baden-Württemberg and Martin Pehnt).

The section contains also information regarding the thermal bridges and the tipology of the heating system, the year of construction. The roadmap, third section, is composed by a page overview collecting all the action planned and a detailed documentation with the presentation of different actions, with focus on energy saving and costs, guidelin for technical implementaton, and materials for the auditors (handbook and checklists). A web platform in beta version is available at: https://drucktool.sanierungsfahrplan-bw.de.

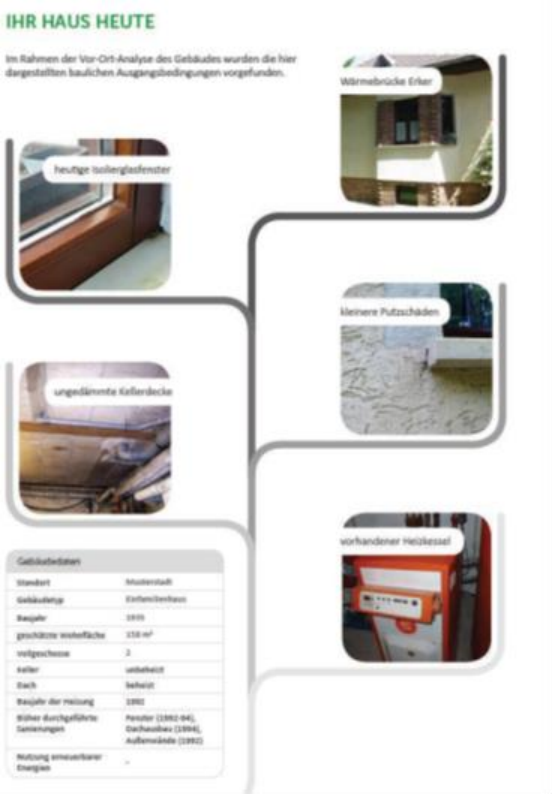
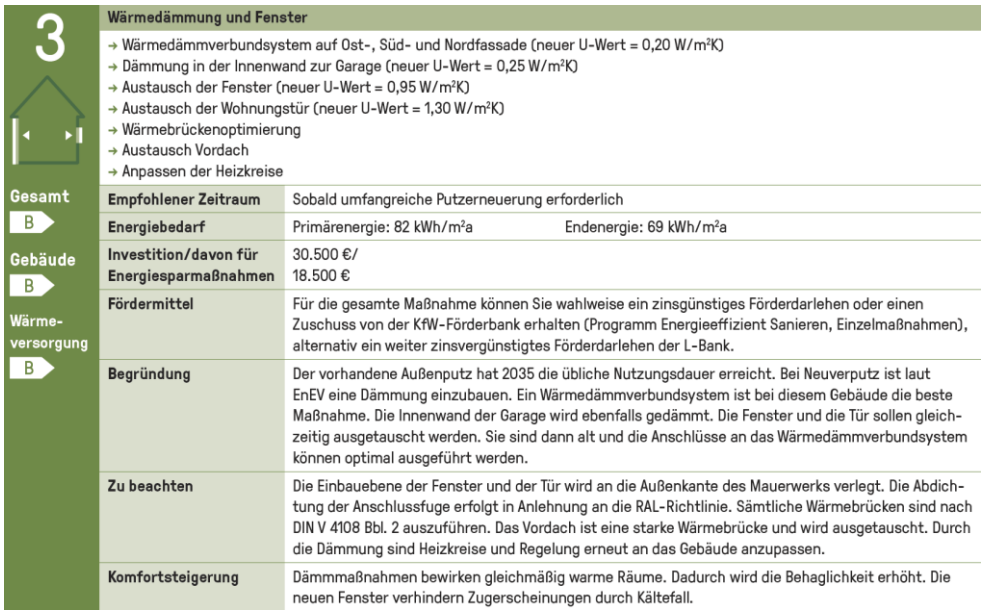


Figure 10. Graphical view of the Sanierungsfahrplan (section 1). The picture shows the key-issue for the description of the status of the building. (Source: Ministerium für Umwelt und Verkehr Baden-Württemberg).

Figure 11. Graphical view of the long-term renovation roadmap (section 2). (Source: Ministerium für Umwelt und Verkehr Baden-Württemberg)



3	Wärmedämmung und Fenster	
	→ Wärmedämmverbundsystem auf Ost-, Süd- und Nordfassade (neuer U-Wert = 0,20 W/m²K) → Dämmung in der Innenwand zur Garage (neuer U-Wert = 0,25 W/m²K) → Austausch der Fenster (neuer U-Wert = 0,95 W/m²K) → Austausch der Wohnungstür (neuer U-Wert = 1,30 W/m²K) → Wärmebrückenoptimierung → Austausch Vordach → Anpassen der Heizkreise	
Gesamt B	**Empfohlener Zeitraum**	Sobald umfangreiche Putzerneuerung erforderlich
	Energiebedarf	Primärenergie: 82 kWh/m²a Endenergie: 69 kWh/m²a
Gebäude B	**Investition/davon für Energiesparmaßnahmen**	30.500 €/ 18.500 €
	Fördermittel	Für die gesamte Maßnahme können Sie wahlweise ein zinsgünstiges Förderdarlehen oder einen Zuschuss von der KfW-Förderbank erhalten (Programm Energieeffizient Sanieren, Einzelmaßnahmen), alternativ ein weiter zinsvergünstigtes Förderdarlehen der L-Bank.
Wärme-versorgung B	**Begründung**	Der vorhandene Außenputz hat 2035 die übliche Nutzungsdauer erreicht. Bei Neuverputz ist laut EnEV eine Dämmung einzubauen. Ein Wärmedämmverbundsystem ist bei diesem Gebäude die beste Maßnahme. Die Innenwand der Garage wird ebenfalls gedämmt. Die Fenster und die Tür sollen gleichzeitig ausgetauscht werden. Sie sind dann alt und die Anschlüsse an das Wärmedämmverbundsystem können optimal ausgeführt werden.
	Zu beachten	Die Einbauebene der Fenster und der Tür wird an die Außenkante des Mauerwerks verlegt. Die Abdichtung der Anschlussfuge erfolgt in Anlehnung an die RAL-Richtlinie. Sämtliche Wärmebrücken sind nach DIN V 4108 Bbl. 2 auszuführen. Das Vordach ist eine starke Wärmebrücke und wird ausgetauscht. Durch die Dämmung sind Heizkreise und Regelung erneut an das Gebäude anzupassen.
	Komfortsteigerung	Dämmmaßnahmen bewirken gleichmäßig warme Räume. Dadurch wird die Behaglichkeit erhöht. Die neuen Fenster verhindern Zugerscheinungen durch Kältefall.

Figure 12. Detailed description of the actions. The picture describes the action "thermal insulation and windows" indicating the motivation, costs, energy savings and comfort increses expectation (section 4). (Source: Ministerium für Umwelt und Verkehr Baden-Württemberg availlable at www.um.baden-wuerttemberg.de)

1.6.3. Woningpas - Belgium Flemish Region

a) General description

The building renovation passport in Flanders (Belgium) hass been developped with the name 'Woningpas' or Dwelling ID. The focus of this project lies mainly on single family house. However, over time, the goal would be to extend the concept to a 'Gebouwenpas' or building ID, to be used also for non-residential buildings The Flemish Energy agency (VEA) government, in cooperation with a network of stakeholders, is developing the so-called "Renovation Pact, with the aim to improve the energy efficiency of the existing housing stock (towards E60) for 2050 that means a mean primary energy consumption of 100 kWh/m^{2}a [46].

The "light version" of the Dwelling ID will be release around April 2018 in a static version and it will focus mainly into renovation purposes with the goal to digitalize all information related to each building over its entire lifespan. To accomplish this, the Dwelling ID involves the cooperation between house owners, several government bodies, such as the departments of urban planning, energy, environment and waste management and, professionals such as architects, engineers, contractors and service providers. Thus, the passport goes way beyond the notion of energy consumption or the EPC. It contains all information about the building in a logbook, ranging from on-site collected data and measurements, restauration or improvement works done with their respective invoices, up to building permits and subsidies. Furthermore, it is meant to provide a tailored renovation advice for the building owner and an expanded energy certification for tenants and potential buyers, called EPC [47]. These new tools will support energy experts and renovation advisors to draft a step-by-step renovation plan and indicate households the expected benefits of each step and the renovation as a whole.

Aside from improving the long-term energy efficiency of the current building stock, also the dynamism of the renovation market and, providing the average private house owner with an easy-to-use tool to keep track of his property, it is found to be crucial aspects of a well-designed passport by VEA. They stated furthermore very clearly that the graphic design is of major importance: an appealing and clear layout with adequate visualizations etc. can be very stimulating for the normal private owner to be engaged in renovation works. Charts, schemes, colors and icons as used in the mock-up by BPIE make a non-trained eye notice the elements of major importance much more easily. Finally, an important concept in the Dwelling ID is the one of a step-based approach: a single household cannot account for a full deep-renovation as is needed to meet future standards in one single project. By planning measures well, a lock-in at any point can be avoided too. The idea is to guide the proprietors to a better preforming building over time by taking the most important measures first, in an economical viable way. This, whilst taking care of investment/output rates, property value and comfort improvement. The implementation is foreseen to start gradually from 2018 onwards.

b) Graphical representation and structure

The Woningpass is intended as a digital file containing information of singular building accessible to owners or third parties after authorization. The first version is already available, and it is composed by different sections.

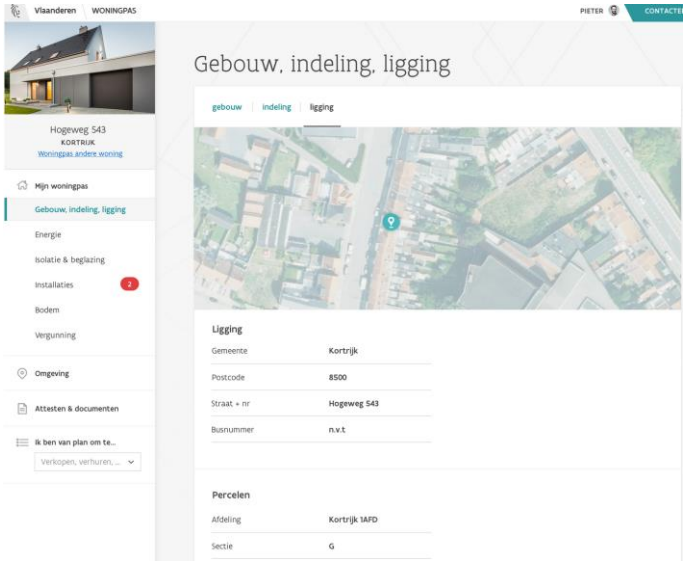


Figure 13. Structure of the Woningpass online tool. (Source: Flemish Energy Agency)

The logbook is divided in twelve sections featurig energy performance, renovation advice, the housing quality and building permit and it is useful to track the changes accours in the lifespam of the building. The energy module contains informations regarding energy performances and the potential of the renovation actions.

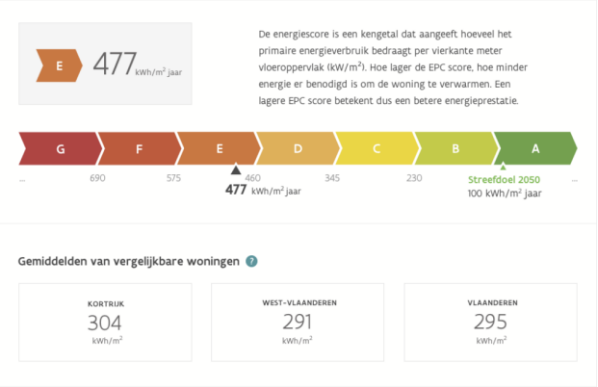


Figure 14. Representation of the energy rating (Source: Flemish Energy Agency)

Other modules contain specific information not directly related to energy efficiency as: stability of the building, quality of the soil, accessibility, spatial planning, aesthetics, and quality of the natural light.

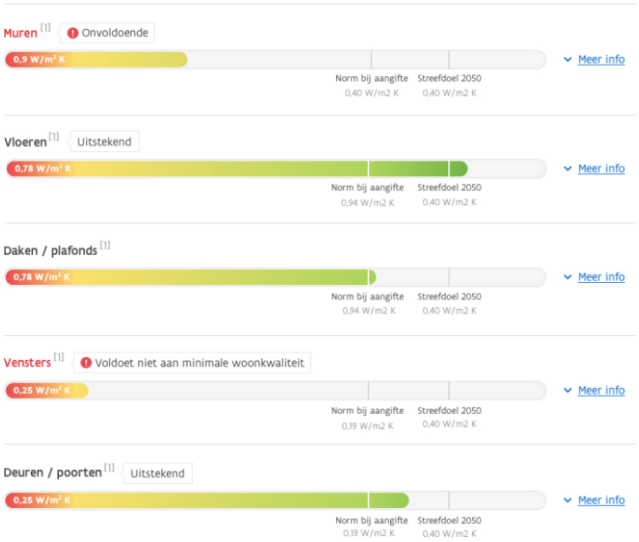


Figure 15. Status of the building envelope with the future target. (Source: Flemish E. Agency)

The renovation roadmap is shown in detail in a dedicated section of the online tool and contain detailed information regarding the singular action with a general description, the cost and the energy reduction. Several icons are used to describe the path towards high-energy efficiency. A bar ranging from Class F to A+ shows the energy rating and the icons shows how each action reduce the energy of the building.

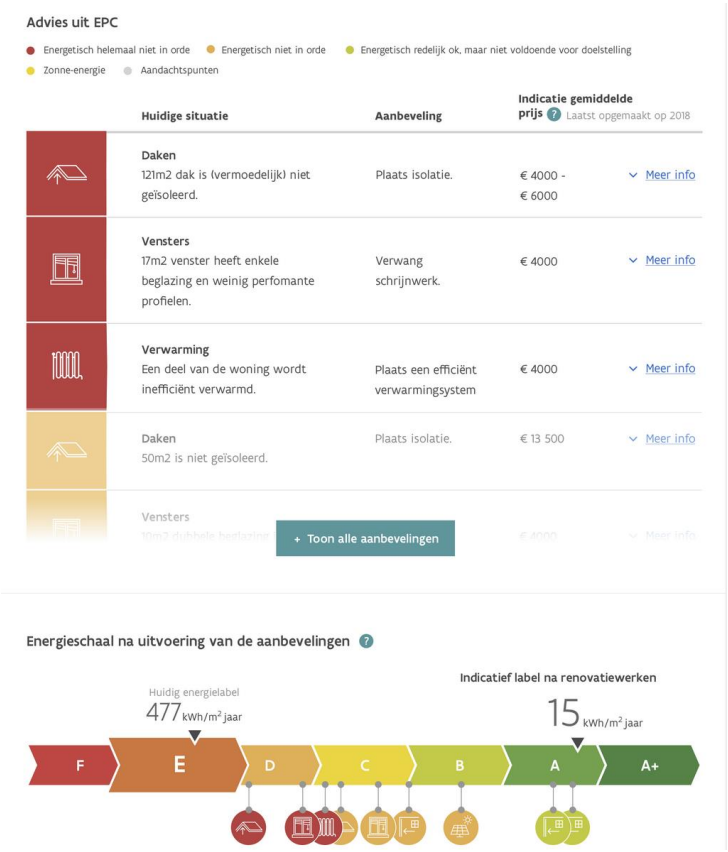


Figure 16. Graphical view of the renovation roadmap. (Source: Flemish Energy Agency)

1.6.4. Better Home - Denmark

a) General description

BetterHome [48] is a Danish initiative initiated in 2014 by four main Danish private building component manufacturers (Danfoss, Grundfos, Rockwool and Velux). The initiative reached a great success in 2016 with more than 200 buildings renovation. The process has been developed for residential building renovation but can be extended to apartment and commercial buildings. The success is due to the owner centric business model and the relation instaured by user and the installers that is the “frontman” of the project. The installers are trained by Better Home and a supportive digital tool can guide trought the renovation process. The overall model contains 5 main phases: 1- contact the expert, 2- describe your ideas of renovation discussing target and budget available, 3- check of the building, 4- formulation of the renovation proposals. 5- Proposal of development.

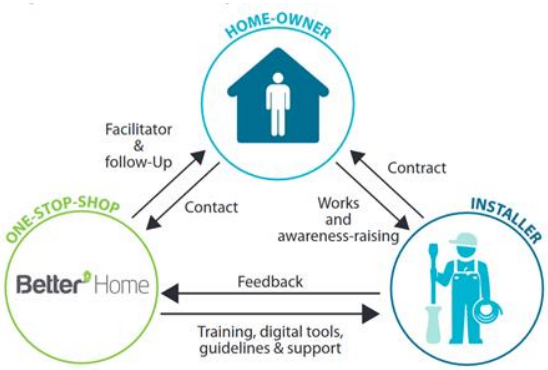


Figure 17. BetterHome project. Process maps. (Source: BetterHome and BPIE)

b) Graphical representation and structure

The on-site visit as well as the owner-renovation target arepresents a crucial part of the process. During the on site vist the expert inspects the quality of the building and and interview the owner regarding missing information, target ambition and economic or technical constrains. The approach does not offer a long-term roadmap but a series of tailored main renovations actions. BetterHome throught a digital platform minimizes the extra work of the audithors (often installers) with a clear step between the first contact with the owner and the finalization of the work. The auditor using a check list to have an overview of the building fill in the online simplified pplicaton to calculate the energy saving potentialand extract the renovation proposal analysing owner benefit and expectation.

Figure 18. BetterHome building data. According to the address, the system collects the main available info (i.e. numbers of floor, year of construction, HVAC systems. (Source: BetterHome)

1.6.5. Finnish Building Passport

a) General description

The Finnish Green Building Council [49] was established in 2010 and 'functions as a platform for dialogue and the sharing of information and know-how. FIGBC's Building Passport, for pre-design and occupancy phases, aims to be:

- an accessible, visual tool that presents the key indicators in environmental efficiency, along with images and the basic facts of the property;
- a convenient information package that can be used to support decision-making in sustainable development projects" (owners, investors, users, builders, developers).

b) Graphical representation and structure

At the design phase, the focus is on expected carbon footprint, life cycle cost, imported energy and indoor air quality. In the operation phase, key building information reported (per year) includes imported energy, carbon emissions, baseload power and percentage of satisfied users (in terms of thermal conditions for summer and winter; quality of indoor air, lighting conditions and acoustic conditions).

The Passport is an accessible, visual tool that presents the key indicators in environmental efficiency, along with images and the basic facts of the property. This convenient information package can be used to support decision-making in sustainable development projects.

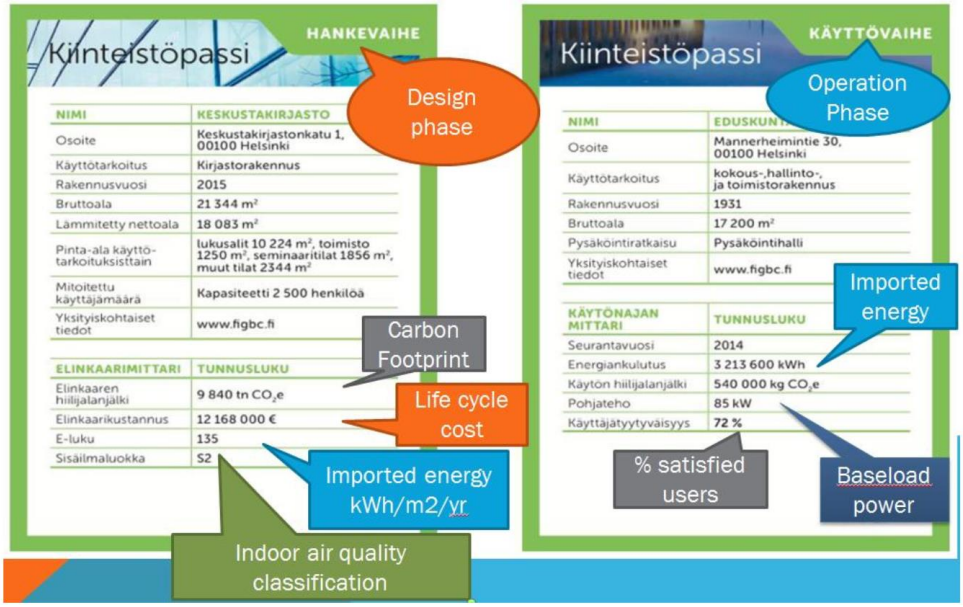
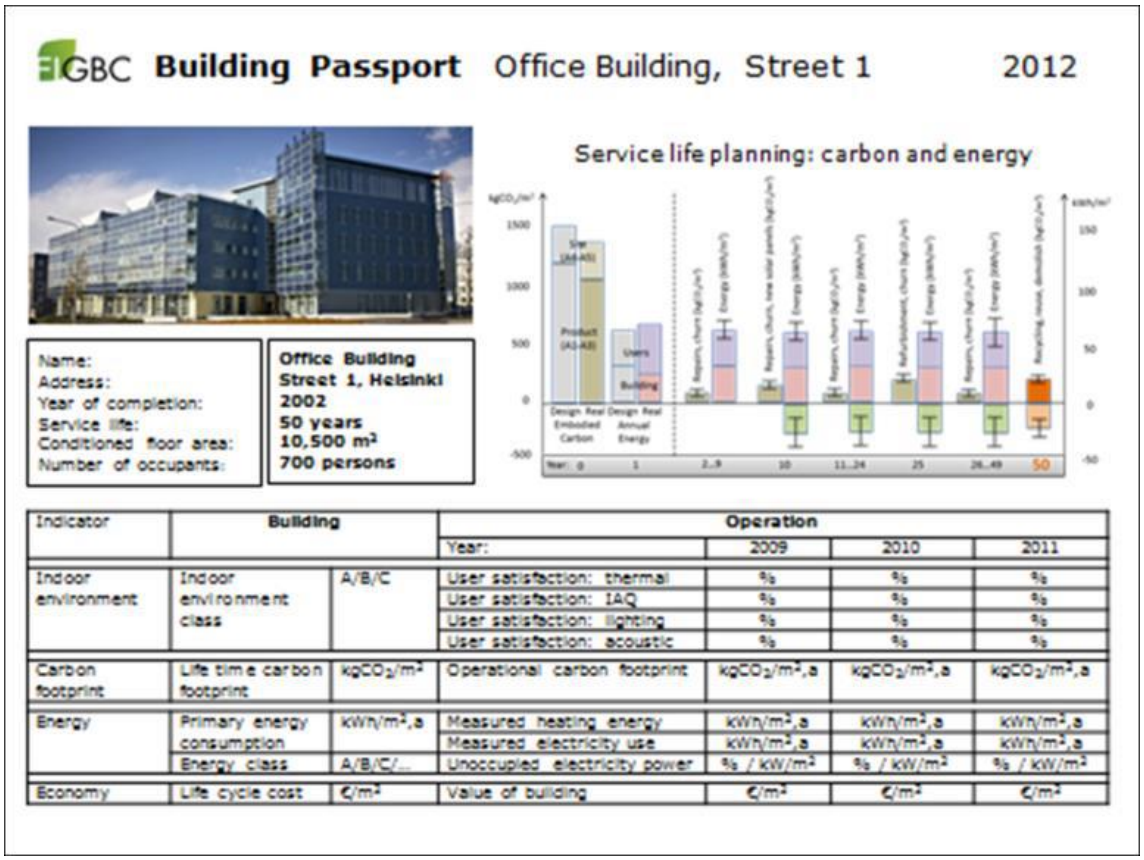


Figure 19. P2E – Graphical view of the finnish Building Passport: (left) design phase (right) occupation phase (Source: Finnish Green Building Council)

Finnish Building Passport [50] contains both the “birth certificate” and “health certificate” of a building. Building passport can be printed in various formats. The simplest one only describes the selected indicators of building either in project phase or during the operational phase. The more comprehensive version can also describe the service life planning in terms of energy and carbon.

The “birth certificate” presents the life cycle planning ad key performance indicators specified during the design process or after a first year of operation. This part remains unchanged over the years until the building is refurbished. It describes the ability of building to be operated in a sustainable manner. Investors and owners can use the “birth certificate” to compare different buildings in different locations.

The “health certificate” is updated annually based on the real performance of a building. It compares the operation of building to the operation of previous years. “Health certificate” helps maintenance people to operate building more efficiently and it also tells users if they should change their behavior in the building. Annual indicators are also used to plan the short and long term repairs and retrofitting.



FIGBC **Building Passport** Office Building, Street 1 2012

Service life planning: carbon and energy

Name:	**Office Building**
Address:	**Street 1, Helsinki**
Year of completion:	**2002**
Service life:	**50 years**
Conditioned floor area:	**10,500 m²**
Number of occupants:	**700 persons**

Indicator	Building		Operation			
			Year:	2009	2010	2011
Indoor environment	Indoor environment class	A/B/C	User satisfaction: thermal	%	%	%
			User satisfaction: IAQ	%	%	%
			User satisfaction: lighting	%	%	%
			User satisfaction: acoustic	%	%	%
Carbon footprint	Life time carbon footprint	$kgCO_2/m^2$	Operational carbon footprint	$kgCO_2/m^2,a$	$kgCO_2/m^2,a$	$kgCO_2/m^2,a$
Energy	Primary energy consumption	$kWh/m^2,a$	Measured heating energy	$kWh/m^2,a$	$kWh/m^2,a$	$kWh/m^2,a$
			Measured electricity use	$kWh/m^2,a$	$kWh/m^2,a$	$kWh/m^2,a$
	Energy class	A/B/C/...	Unoccupied electricity power	% / kW/m^2	% / kW/m^2	% / kW/m^2
Economy	Life cycle cost	€/m²	Value of building	€/m²	€/m²	€/m²

Figure 20. Example of a FIGBC Building Passport format with included both indicators for uidilng and operation (Source Virta et al. [50])

1.7. BRP common features and benefits as a lesson learned

This review on Building Passport for Residential buildings has shown that different types and levels of BP are used by countries or the free market to improve the information flow. Anyway, some common features have been individuated within the systems compared:

- flexible structure of the BP to be able to adapt and suit to the local context;
- strong bias towards existing information;
- importance of the data information flow and communication along the path (from construction company, investors, to the owner or renter);
- involvement of multiple stakeholders.

In conclusion, comparing the above summarized initiative concerning the BP, the following lessons learned can be derived.

- All the initiatives are at the moment framed as voluntary actions. Some member states are planned to use it as complementary tool to the actual EPC scheme.
- In three out of five cases there is a long-term vision of the building 20-30 years (German, France and Flamish initiatives). Between the actual status and the future picture of the building a renovation roadmap shows the step-by-step energy renovation actions.
- The renovation process is intended as “deep”. There is not, at the moment, a common definition on the analyzed scheme. The EU define deep renovation with a primary energy reduction of 60%. The target of woningpass is 100 kWh/m^{2}a P2E process set to 80 kWh/m^{2}a the primary energy limit for 2050. The Geman initiative propose the “best-possible-principle” meaning that the roadamp shold be abitious as possible.
- The German and Flamish initiative are supported by national funding while the France, the Danish and the Finnish initiative has been developed by private actors and organizations.
- In all the initiatives the knowledge of the actual status of the building is a foundamental task and represent the basis for a good and reliable renovation roadmap. In Germany and Denmark, the work of the auditors is supported by manual and checklist to be used to define the tailor-made renovation roadmaps.
- The owner is the driver of the process, decide the typology, time and the economic effort.
- The audit is a foundamental part of the overall process and the auditors have to be able to deliver the results of analysis in easy and automated way.
- The renovation roadmap for both long- and short-term vision require skills and competences able to have a clear vision of the building in 20-30 years. They can be able to explain (with good communicaiton qualities) and support the renovation action and this can be supporte even by online tools, check list and online platform.
- The comfort and wellbeing are intended as the driver for the renovation. The idea to renovate to save energy is supported by the idea renovate to feel better.

To conclude the comparison developed within this section, the 5 European initiatives on BRP have been summarized in Table 11.

Table 11. Main features of the European BRP initiatives analyzed

		Flanders Woningpas	France Passeport Efficacité Energétique (P2E)	Germany Individueller sanierungsfahrplan (iSPF)	Denmark Better home	Finnish Building Passport
MAIN FEATURES	Energy audit/on site technical visit	*yes*	*yes*	*yes*	*yes*	*Yes*
	Building target typology	*Single family house*	*Single-multy family house*	*Single-multi family house*	*Single family house*	*Residential and non residential*
	Loogbook database	*yes*	*yes*	*no*	*no*	*yes*
	Automated advice	*yes*	-	-	-	-
	Deep renovation target (primary energy)	*100 kwh/m^{2}y*	*80 kWh/m^2 y*	*Best possible principle*	-	-
	Comfort indicator	*qualitative*	*yes*	*qualitative*	*no*	*yes*
	Roadmap	*yes*	*yes*	*yes*	*no*	
	Integrated financial support	*no*	*no*	*yes*	*no*	*Yes (LCC EN 15643-4)*
	Training for auditors	*important*	*important*	*important*	*important*	*important*
	Web platform	*yes*	*yes*	*yes*	*yes*	-

1.8. Conclusions for the overview on available knowledge

As anticipated in Section 00 – GA recall – the state of the art on the available knowledge has been conducted not only on existing databases but also to certification scheme and Building Passport initiatives in order to have a more complete overview on DM structure, data points and flow limits and needs in order to be aware of weakenss and strength to be considered for the development of the ALDREN Data Model and the BRP. The main milestones, key take away and lessons learned from the overview on the available knowledge are following summarized.

Regarding the existing databases, the analyses conducted on the emerging ones - at national and European levels – permits to identify the main characteristics to take into consideration for the ALDREN DM structuring in order to be in compliancy with them and to become in a further step their data provider. Considering then the focus done on EPC registers across EU, another important issue has been highlighted by the overview: open data initiatives and management are increasingly being used by governments to allow access to official datasets or to process energy consumption information to improve energy efficiency not only for academic /research purposes, but also for commercial stakeholders to increase confidence in the investors on how, when and where renovate.

The review on the outcomes (i.e. databases, tools or platform), from previous or ongoing EU projects, remarked the importance of the open data and also to the quality of the source: from one hand to have more transparency and possibility to share data, from the other to guarantee the implementation trough the time of new and updated data set in order to maintain the instruments alive and useful even after the end of the project. Automation and dynamism of the process instead of static tool are consequently the key take away of this part of the analysis.

The state of the art conducted on the certification schemes, both mandatory and voluntary, highlighted the need to harmonize the existing frameworks to give the possibility to make a feasible comparison and to increase the comprehension of the rating system referring to a common energy efficiency labelling and standards.

The study on the BRP initiatives, on residential buildings in selected EU countries, reveals interesting and innovative approaches, considered as a valuable source for the development the ALDREN BRP concept and to understand better the market needs of building renovation across Europe.

Despite the BP is not a new concept, the major shortcoming revealed by this review is the absence, in most cases, of a common idea and definition of BRP definition even because the EPC implementation within Europe has been implemented in different way. In order to not set up a “new” BRP tool, since many other are already available, the ALDREN approach is based on the milestone to formalize the ALDREN BRP concept starting from the data set selection of the available and already existing databases (i.e. BSO or others from European H2020 projects outcomes) in a modular way.

The final, but not for importance, key take away derived by this overview is the importance to define a clear renovation roadmap with long-term perspective, which could cover the design phase but also the renovation strategies implementation, with the engagement of various stakeholders (i.e. government, local and regional authorities, agencies, industry and the wider public). Coupled with timing and sequencing of renovation actions to increase attractiveness and motivation within the users/investors and to be updated through the time.

02 – RENDERING AND STRUCTURING OF ALL THE COLLECTED DATA AND KNOWLEDGE (Task 2.6.2)

ALDREN ALliance for Deep RENovation in buildings

2.1. Data Model structure: inputs, outputs and data flow

After the identification of dataset available on: existing building stock for non-residential typology (more info available also in Annex a), EPC and other voluntary certification scheme available on the market and products and building components, the activities of the task 2.6.2 focus on the definition of a data model to capitalize all those building information.

The data–information–knowledge–wisdom hierarchy (DIKW), referred to variously as the the “Information Hierarchy” or the “Knowledge Pyramid” is one of the fundamental, widely recognized and taken-for-granted models in the information and knowl edge literatures. The hierarchy is used to contextualize data, information, knowledge, and sometimes wisdom, with respect to one another and to identify and describe the processes involved in the transformation of an entity at a lower level in the hierarchy (e.g. data) to an entity at a higher level in the hierarchy (e.g. information).

The DIKW model or DIKW pyramid (see also Figure 2) is an often-used method, with roots in knowledge management, to explain the ways we move from data (the D) to information (I), knowledge (K) and wisdom (W) with a component of actions and decisions. It’s a model to look at various ways of extracting insights and value from all sorts of data: big data, small data, smart data, etc.

In literature, one the most know DIKW hierarchy definition is the Ackoff’s one [53], which clearly explains that each of the higher types in the hierarchy includes the categories that fall below it. The DIKW model is quite linear and expresses a logical consequence of steps and stages with information being a contextualized ‘progression’ of data as it gets more meaning. In Figure 21 the traditional DIKW model has been interpreted and adapted to describe the ALDREN approach.

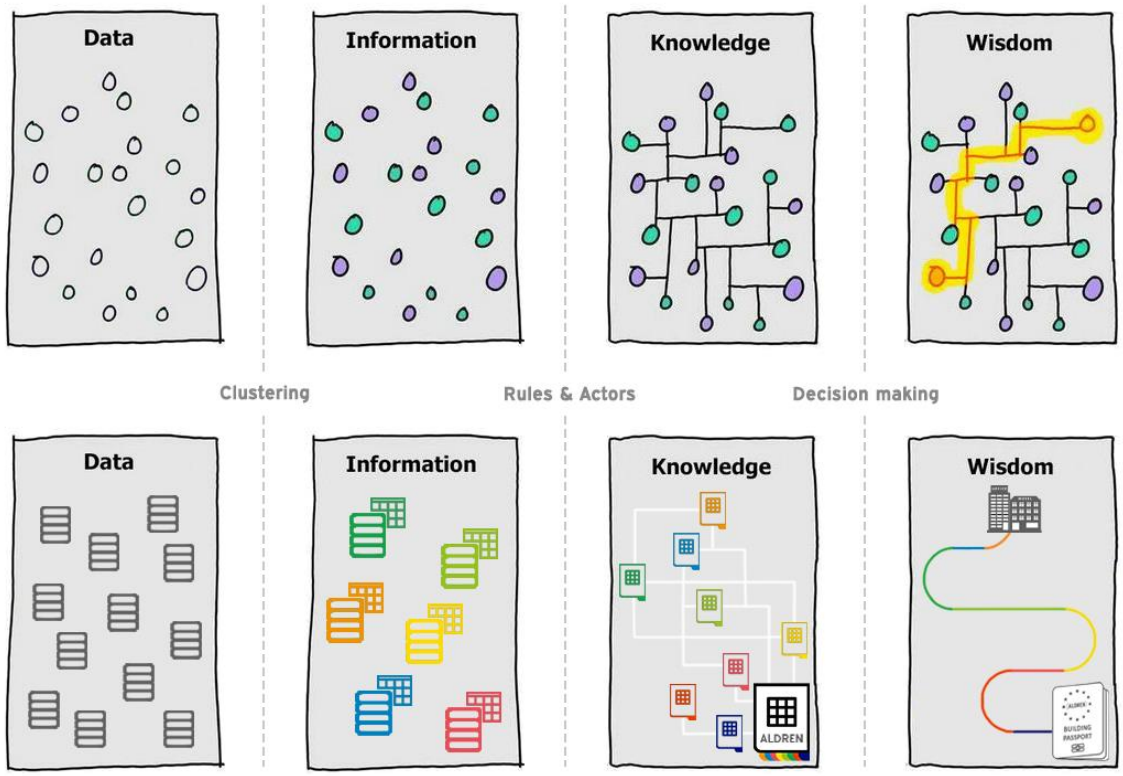


Figure 21. the DKIW model adopted for the ALDREN approach data model

The D-step foreseen the data collection within existing database (i.e. Euroepan Building Stock, Product databases, European projects outcomes databases,...see section 1 of the present deliverable) with the purpose to identify the main data layers (such as technologies, standards, policies, buildings compoments, market trends, etc.) necessary for the definition of the ALDREN Building Renovation Passport.

The action to reach the following I-step is the data clustering: information is defined as data that is given a context or data that have been organized into a structure [54]. The fundamental principle is that a refining process has been applied to the data, which now evolves to information that possesses a meaningful purpose or value and within the ALDREN approach the clustering action has been conducted referring to the 6 tasks pf the WP2 for the consolidation and adaptation of an European Voluntary Certification Scheme based on a common language.

The K-step is reached adopting rules and actors into the all information clustered in the previous step. For the ALDREN approach, this corresponds to a selection of overall indicators per topic from the raw data of each respective database. The ALDREN methodology, within this step, comprehend also an additional added value, all the overall indicators per topic are collected and linked into a unique storage: the digital version of the ALDREN BRP.

The fourth step is arguably the most elusive of all these four elements and concepts. Wisdom is the highest level of abstraction, with vision foresight and the ability to see beyond the horizon. The Wisdom definition of Awad and Ghaziri [55] is well suited to the W-step of the ALDREN approach providing a vision foresight with the ability to communicate with core indicators – derived from the raw data of the first step – the path to follow per a specific non-residentia building, the so called ALDREN renovation roadmap, and describing clearly “when, where and how renovate” buildings to reach the NZEB target.

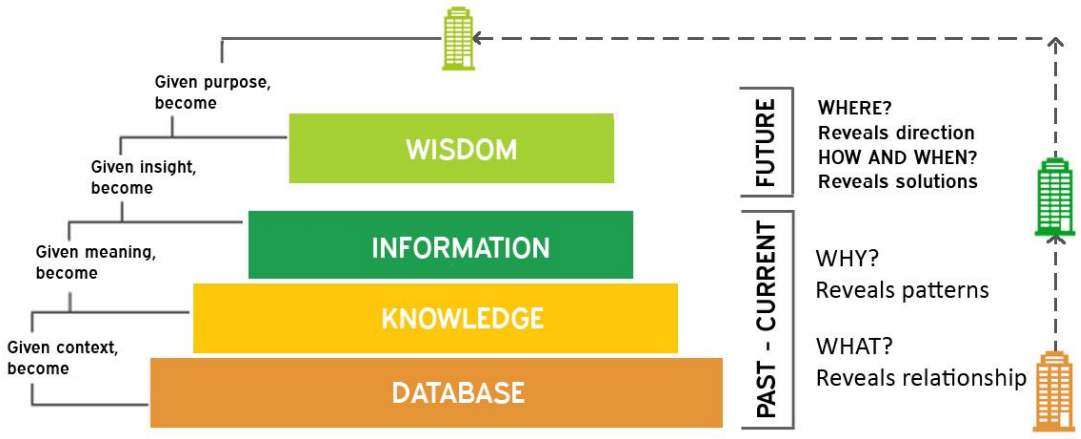


Figure 22. DIKW through the eyes of the ALDREN approach – a focus on decisions and actions

Looking at the DKIW throught the eyes of the ALDREN approach it means to provides concrete replies on a series of questions related to the building renovation process that they lead to concrete decisions and actions increasing confidence in the investors/decision makers/owners. This is the added value of the ALDREN Data Model, because without action there is little sense in gathering, capturing, understanding, leveraging, storing and even talking about data, information and knowledge.

The decision to adopt the knowledge management process is because it enables actors to improve the quality of management decision making by ensuring that reliable and

secure information and data is available throughout all the step of the ALDREN approach, but also looking at the bottom of the pyramide as the Renovation Action – considering action as in business and customer outcomes – it means creating building value in an informed way.

2.3. Level of Information and actors along the ALDREN approach

The Data Model structure definition was the first and fundamental step to reach the scope of the Task 2.6: rendering all the collected data and results in a building renovation passport. As stated in the conclusion of the overview on current existing initiatives on BRP, there is still not a clear a unique definition of building passport, but the more used in literature - defined by BPIE in 2016 [56] and in use also within the IBroad project [57] for the development of their outcome, foreseen the building passport cstructure composed by two main elements: 1) a data repository, the so-called logbook and 2) the renovation roadmap. Considering this point the basic element of the structure, the ALDREN BRP for non residential buildings – in particular office and hotel are under investigation within the project – is composed by those two elements defined respectively as ALDREN BuildLog and ALDREN RenoMap (Figure 23). The section 3 of the presented deliverable will present in detail both elements, but at this point it is fundamental specify the data flow and the actors involved in the process.

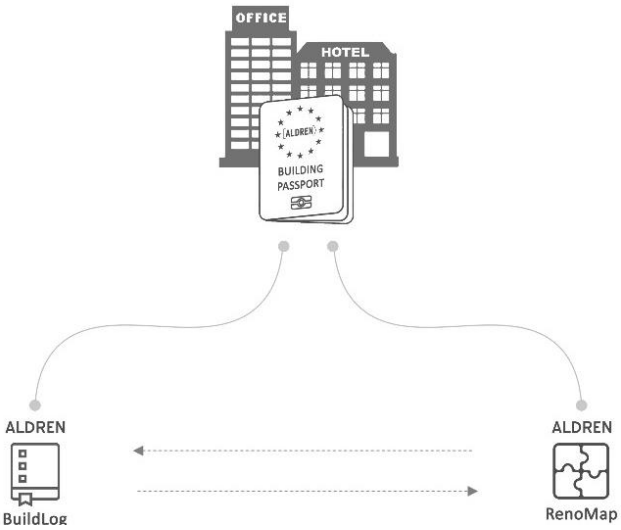


Figure 23. ALDREN Building Renovation Passport elements: 1) ALDREN BuildLog and 2) ALDREN RenoMap

In particular in this paragraph, the structure of the BuildLog is anticipated to clarify the data flow process, referring to the DKIW methodology adopted for the Data Model definition (Figure 22).

The ALDREN BuildLog is characterized by different level of information (LoI) to facilitate the data flow along the process and the data comprehension according to the user's expertise or needs. This concept has been represented in Figure 24 through a transposition of the traditional Russian masterpiece: the Matrioska.

Each doll representing a data set level and the main concept underlined the importance that no one indicator will be lose, nesting one inside the other; but from the bigger (all raw data) to the smallest (core indicators), a selection from the previous LoI will be performed.

Figure 24. ALDREN BuildLog is the repository of the approach organized by Level of Information with different data granularity

The four dolls correspond to the LoI that along the ALDREN approach different users could have access according to their needs and expertise. The big doll corresponds to the higher LoI a sort of “data lake” which contains all the informations needed along the process.

Referring to the DKIW method presented in the paraghpraph 2.2 and starting from the first step (Figure 22), the ALDREN Database contains all the six distinct databases correspondent and developed within each single task of the WP2 project (Figure 25): Energy rating & target (Task 2.2), Energy verification (Task 2.3), Comfort and Well-being (Task 2.4), Cost value and risk (Task 2.5), Building Picture (Task 2.6.2), Documentation and BIM (Task 2.6.3).

Figure 25. ALDREN DATABASE is the sum up of the respective databases developed within each task of the WP2

Each database contains dedicated indicators, and methodology according to its respective protocol (for more details refers to their respective deliverables), but at the same time they are joined into a unique one, the ALDREN database, through a common language (Task 2.6.1) and some typical characteristics of a DB fundamental to make this repository a useful instrument (Figure 26):

- database format;
- access;
- system connection;
- data upload.

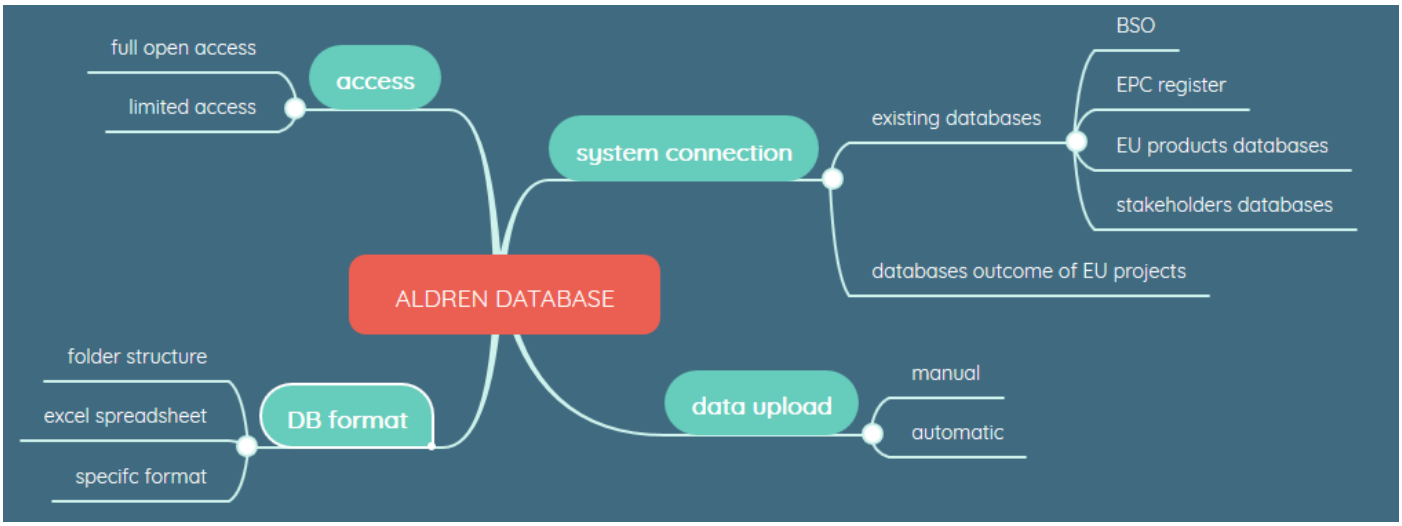


Figure 26. main characteristics of the ALDREN Database

03 – BUILDING PASSPORT FORM DEFINITION (Task 2.6.3)

ALDREN ALliance for Deep RENovation in buildings

3.1. The ALDREN approach

In the context outlined in the previous sections, the ALDREN (Alliance for Deep Renovation in Buildings) project is the further and extended development and the implementation of a common European Voluntary Certification Scheme (EVCS) for non-residential buildings based on the EPBD Art. 11 (9) and CEN and ISO standards. The main goal of ALDREN is to motivate the construction sector value chain stakeholders to undertake deep renovation projects on their properties.

In its “Roadmap for moving to a competitive low carbon economy in 2050” [51] the European Commission established a long-term objective of decreasing the CO2-emissionlevels for the building sector by 88%-91% in 2050, compared to 1990 levels. According to an ECOFYS report commissioned by Eurima [52] on renovation tracks for EU up to 2050, non-residential buildings account approximately for 25% of the floor area distribution in Europe and can be drivers of the energy transition that Europe is looking for. To match the ambitious EU commitments several complementary actions have been made at the same time, with different actors: the development of tools (CEN standards), capacity building (CEN-CE) and consultancy support (EPB Center). The revised EPBD [22] provide the chance to contribute all together at EU level.

The Table 12 hereafter is showing how the ALDREN outcomes could help to fulfil the new requirements of the amended EPBD. The adoption of the ALDREN procedures and outcomes, it could facilitate on one hand the transposition of the revised EPBD and on the other to be in line with the suggested European harmonization.

ALDREN intends to encourage investment and accelerate the movement towards a nearly zero energy non-residential building stock across the EU, as targeted by 2050 to meet Paris Agreement commitments. The back-bone of ALDREN is the European common Voluntary Certification Scheme (ALDREN EVC) which will be used to track the deep renovation process. For office buildings and hotels – as for the overall building stock – deep renovation (ambitioning 60% primary energy savings through building retrofit), or even the move to NZEB level, will not be triggered for the only sake of energy performance and related direct financial benefits over buildings lifespan.

The development of holistic procedures, assessing the overall benefits from building deep renovation – regarding energy performance, confidence in the savings, high quality indoor environments, financial valuation – are needed to engage property owners and stakeholders on deep renovation pathways.

The ALDREN procedure consolidates an approach to deep renovation assessment, integrating:

- a European harmonized energy performance rating, offering comparability and transparency across the EU;
- an energy Performance verification protocol to enhance confidence (you got what has been promised), building value and management tools;
- a health and well-being assessment framework offering the integration of indoor air quality, comfort and health in the scope of deep energy renovation;
- the financial valuation of both energy and non-energy benefits (such as increased productivity in office buildings);
- a Building Renovation Passport (BRP).

Table 12. Comparative reading of selected articles of the (EU) 2018/844 with ALDREN issues

2018/844 articles	Common language	ALDREN VCS	Measured energy	Wellbeing evaluation	Financial evaluation	ALDREN BRP	Training and dissemination
Article 2a Long-term renovation strategy	highly energy efficient and decarbonized build stock by 2050				(b) cost-effective approaches considering potential relevant trigger points	(c) introducing an optional scheme for building renovation passports;	(f)…. skills and education in construction and energy efficiency sectors;
		(g) evidence of expected energy savings and related to health, and air quality.					
	3. Mobilization of investments into the renovation needed		(b) the reduction of the perceived risk		(e) accessible and transparent advisory tools on energy efficiency renovations and financing instruments	(a) aggregation of projects to enable access as well as packaged solution	
	4. collect				on successful public/private financing schemes		and disseminate best practices
Article 7 existing buildings				high-efficiency alternative systems and shall address healthy indoor climate'.			
Article 8		'1 overall energy performance 9. the complete altered system, is assessed.				The results shall be documented.	

2018/844 articles	Common language	ALDREN VCS	Measured energy	Wellbeing evaluation	Financial evaluation	ALDREN BRP	Training and dissemination
Article 10					'6. link their financial measures to the targeted or achieved energy savings		
						6a. Databases for energy performance certificates shall allow data to be gathered	
	(c) comparing EPC's issued					before and after renovation	
Article 11	..adopt a voluntary European certification scheme for non-residential buildings.						
Article 19a	**Feasibility study**					…building renovation passport …to provide LTRS and step-by-step renovation	
Annex 1		a1 Member States shall describe their national calculation methodology					
				b2. calculated in order to optimize health, indoor air quality and comfort levels			
		optimal energy performance of the building envelope					
		d4 The positive influence of the following aspects shall be taken into account:'					

The ALDREN approach is designed to be adopted either as a standalone standard or as a set of individual methodological pieces (distinct protocol described in details in the respective deliverable of the dedicated tasks of the WP2) that may be taken up in already existing voluntary environmental certification schemes across the EU (i.e. BREEAM, HQE, DGNB, IVE).

ALDREN is not only the superimposition of these individual methodological pieces but also their overall integration, exploiting the interactions in between. For example, a given energy retrofit action will contribute to the improvement of the predicted energy performance (rating) but also to the assessment of refined actual energy targets, to the enhancement of thermal comfort, indoor environments, to increased well-being and productivity.

Moreover, the ALDREN approach is designed in the perspective of a European library for building components, systems and equipment description, according to the EU Eco-design directive implemented into industry standards and coupled with the Energy Labelling Directive.

The soundness of the ALDREN concept, represented in **Erreur ! Source du renvoi introuvable.**, is based on three components: 1) quality of the individual pieces; 2) commitment of different stakeholders and 3) a backbone plan to build the holistic ALDREN approach.

Those three key points also correspond to the WP structure of the whole project activities:

WP1 - related to coordination and stakeholders exchange;

WP2 - technical to work on the different components and the overall integration in the assessment procedure of buildings and in the building passport;

WP3 is dedicated to dissemination / communication and market uptake.

Figure 27. ALDREN approach soundness components

3.2. The ALDREN Building Renovation Passport

In Europe, the introduction of Building Passport (BP) has the objective to provide information to a potential purchaser, investors, renter or user of the building. An important premise of the BP is that the quality assurance system for buildings relies heavily on documentation processes that are often not sufficiently robust to support this reliance. The term Building Passport is currently being used with differing meanings and there is no a single definition. It can denote a certificate displaying the most important performance characteristics and technological data of a building - comparable with motor vehicle documents – as well as a comprehensive collection of various building-related documents (plans, calculations, lists and declarations of materials and products used, operating and maintenance guidelines, etc.). Name, type, scope and content of building passports have evolved over time and continue to evolve into a tool for communicating diverse characteristics of buildings to multiple beneficiaries in different European countries [61].

One of the most often quoted barriers of building renovation is the lack of knowledge about what to do, where to start, and which measures to implement in which order. In this framework, the EU directive 2018/844 [22] underlines the need for Member States to prepare and implement national Long-Term Renovation Strategies (LTRS) for their building stock and introduces the possibility for Member States (MS) to introduce an optional scheme for individual building renovation passport (BRP (Article 2a.1(c)). Within the state of the art on available knowledge on voluntary certification schemes and EPCs for Non-residential buildings, ALDREN project clearly demonstrated a lack of data and connections between those instruments with the BRP. Similarly, it has been stated within iBroad project [38] for Residential buildings.

ALDREN has started from one side collaboration with the Global Alliance for Buildings and Construction (GABC), who has created a workgroup to define the Building Renovation Passport, but also ALDREN has instaurare close synergies with other H2020 ongoing projects focused on similar topics with the aim of setting up a dedicated stakeholder Building Passport Task Force to define scope and approach, key characteristics, data storage and data ownership of the new building passport and also synergies related to the BRP (i.e. Ibroad [38], TripleA-reno [58], HAPPEN [59] and Fit-to-NZEB [60]) with the final im to establish interactions, to collect as much as possible input, points of view, requests and needs from different actors and to join lessons learned and suggestion to reach the common goal to trigger renovation for existing buildings of different typologies and become NZEB.

As clarified at the beginning of this section (Table 12), the BRP (Building Renovation Passport) has been introduced for the first time within Directive 2018/844/EU in the context of the LTRS preparation for the Member States. Article 19a sets out the concept of a novel tool that is “complementary to the energy performance certificates”. It is aimed at providing a long-term step-by-step renovation strategy which should be “based on quality criteria, following an energy audit”. The BRP that is currently being developed within the ALDREN project for office buildings and hotels seeks therefore to meet the objectives of Article 19a. While initially analyzing the available knowledge on voluntary certification schemes and EPCs for Non-Residential buildings, the ALDREN project was faced with a lack of data and connections between those instruments and the BRP. To overcome these barriers, the ALDREN approach for the BRP definition has been developed under the following important key points.

- The ALDREN BRP should not only provide detailed energy renovation strategies with all the relevant technical details (like lifespan of components and sequence of pose for each systems), but also include relevant indicators about the impacts of these strategies on the building's health quality and the well-being of its occupants. The improved energy and environmental quality of the foreseen improvements should also be translated into economic and financial criteria.
- Audience and target people of the ALDREN BRP should be various: from technical staff, designers, energy manager or building asset manager to the single building owners, in order to facilitate the decision-making process.
- There is a need to agree on a common language ("How can a thermal bridge talk to a banker?") with all the target group belonging to the renovation process and to individuate a valuable source of data at European level such as the Building Stock Observatory. This allows to have a statistic reference value in case of absence of history knowledge of the building from different data point sets (i.e. geometrical, technological, constructive, certification, etc.)
- The ALDREN BRP should be linked and complementary to the existing voluntary certification schemes and the EPC. There is a strong case for cross-referencing data between these tools. Still, data provided within the BRP should be updated along the lifetime of the building rather than constitute a one-time overview of the building state at a specific time.

In this framework and keeping in mind the above listed key points, the ALDREN Building Renovation Passport has been developed to become a coherent element in a common EU solution: "*an instrument complementary to the EPC* (ALDREN EVC)*, that can stimulate cost-effective renovation in the form of long-term, step-by-step renovation roadmap for a specific building* (ALDREN RenoMap); *based on quality criteria, following an energy audit and outlining relevant measures and renovations*…(ALDREN BuildLog) *(from Directive 2018/844/EU Art 19a).*

Figure 28. ALDREN BRP: a coherent element in a common EU solution

The added value of the ALDREN BRP is not only the compliancy to the regulations, but also the harmonization activities done for its development to avoid the creation of many BRP like happened for the VCS as analyzed in paragraph 1.5.2 and it is the right moment to avoid it (Figure 29).

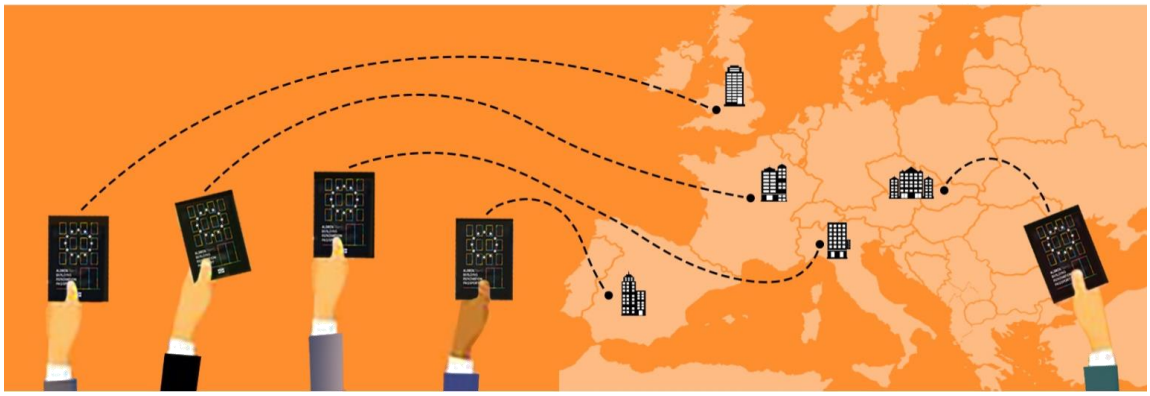


Figure 29. Why ALDREN BRP? Two main reasons: 1) compliancy and 2) harmonization

The ALDREN BRP – as anticipated in the previous section (Figure 23) – is composed by two main elements: the ALDREN BuildLog and the the ALDREN RenoMap. Both elements are composed by respective modules and represented by respective stamp in the passport to be completed along the ALDREN approach (Figure 30).

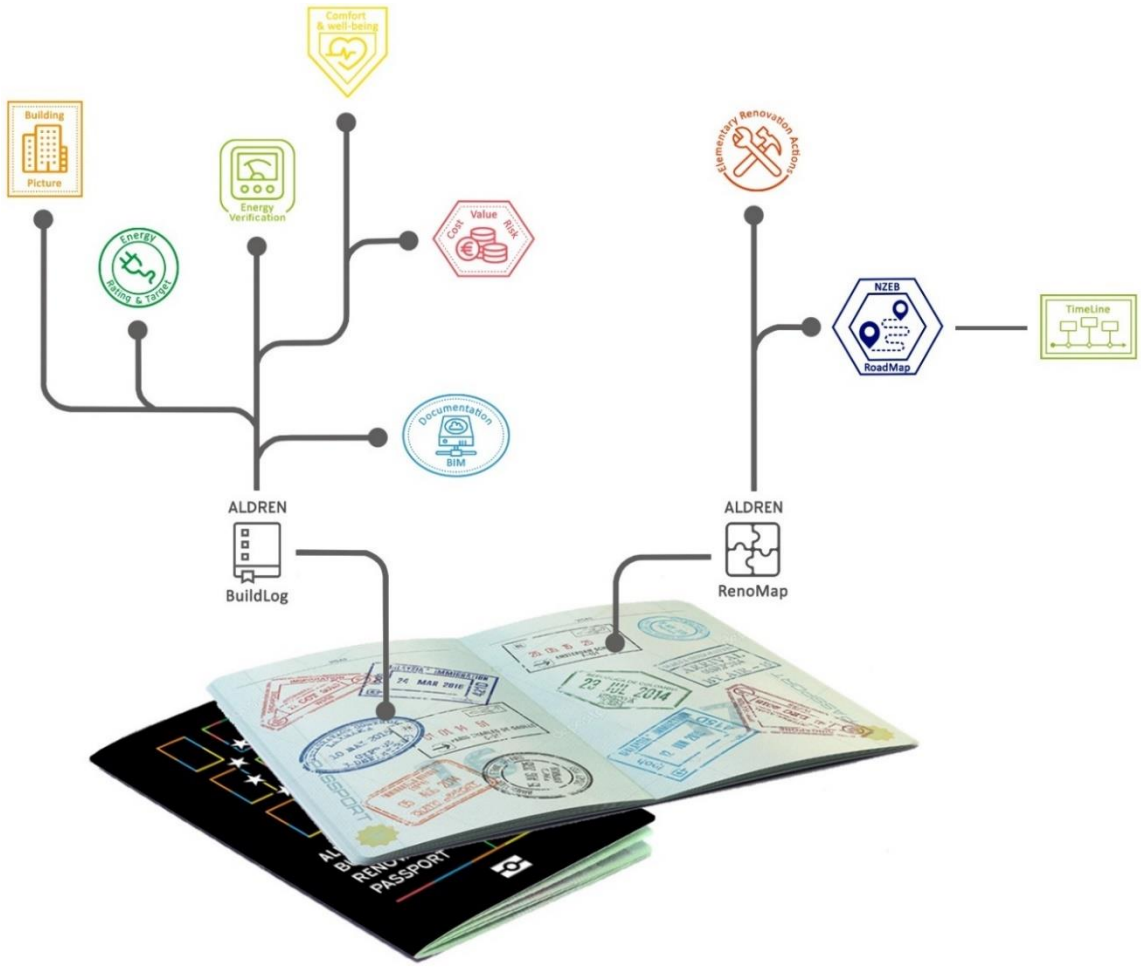


Figure 30. ALDREN BRP elements and respectives modules scheme

Where data come from and which is the data flow that lead to the ALDREN BRP creation is clarified in the Figure 31 taking also in consideration the different LoI (Figure 24) and the characteristics identified in the mind map for ALDREN DB (Figure 26).

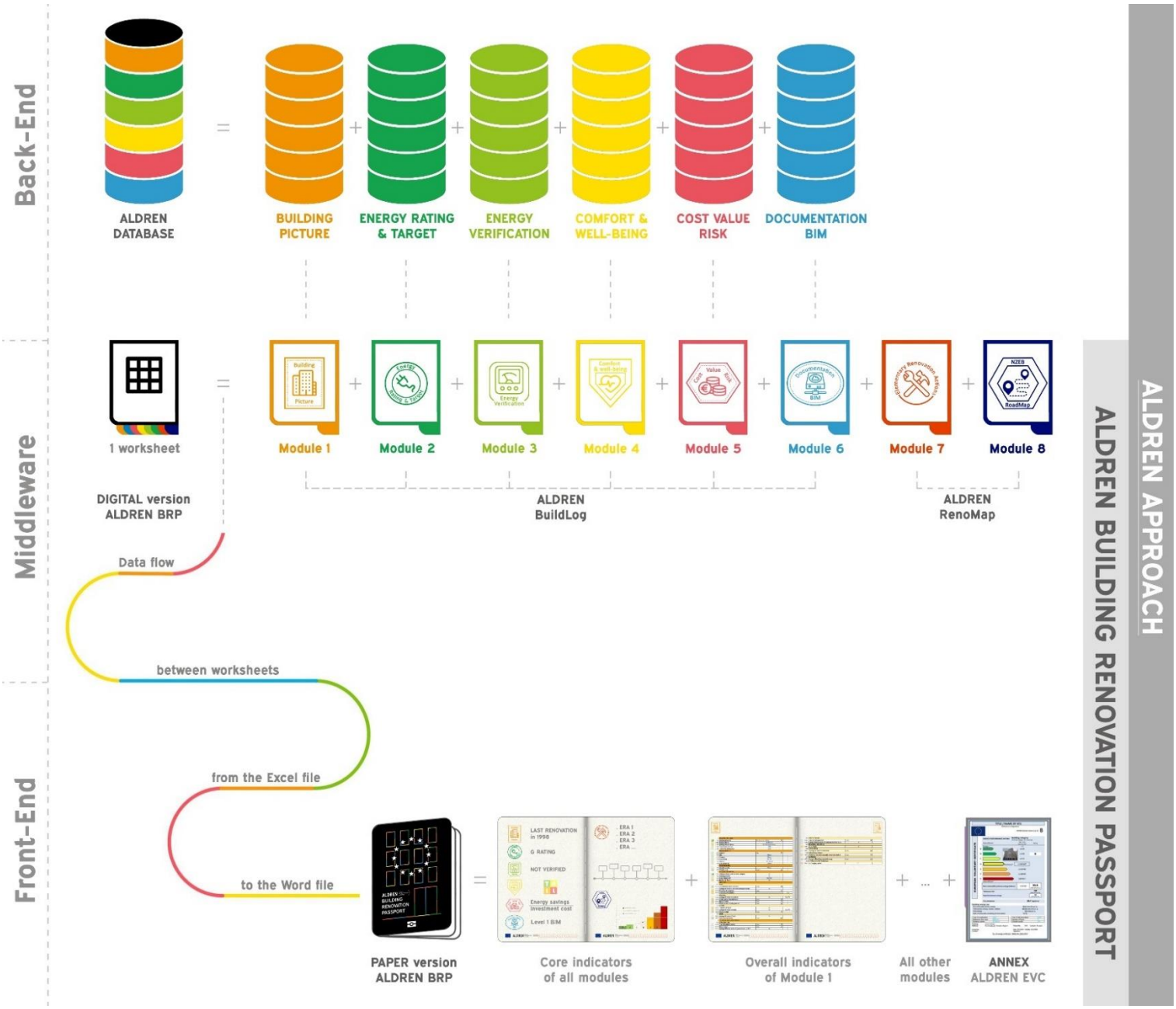


Figure 31. ALDREN approach scheme with a drafted data flow path to the ALDREN BRP

The whole ALDREN approach foreseen three main phases that could be defined, with a similarity to the computer science, Back-End, Middleware and the Front-End. The whole amount of raw data collected at the beginning of the process are joined into the ALDREN Database and this correspond to the higher LoI. Then continuing the path, in the middleware it happens a first selection of data which structure the spreadsheets of the digital version of the ALDREN BRP. In order to avoid the creation of a static instrument, the ALDREN BRP has been created to have both a digital and paper version.

This structure permits to have access to different LoI of data sets in function of the user types. The experts – that will be trained to apply the ALDREN approach – will start the

application of the approach using the excel file, having access to the whole indicators collected since the databases, applying the respective protocols to manually insert the overall indicators into the excel worksheets.

Figure 32. Modular structure of the digital version of the ALDREN BRP

The final passage that permits to realize the ALDREN BRP paper version, it is realized thanks to a word file linked to the excel worksheet of the digital version. This user-friendly format has been chosen to increase accessibility and feasibility to maintain the data update through the time.

ALDREN BRP is not to be intended only as a data collection of sustainable performance indicators that describes in an easy and transparent format the performance of building to anybody it may concern, because the indicators have been chosen to give a triple bottom line picture of building's operation i.e. environmental, comfort and economic performance. It was important to specify the common language and protocol identified to calculate and measure all indicators as this allows to compare different buildings and projects over the life time and also it gives a solid basis to communicate between owner, investor, maintenance people and tenants and to set targets and milestones based on life time of the building operation and to follow the targets afterwards (Figure 33).

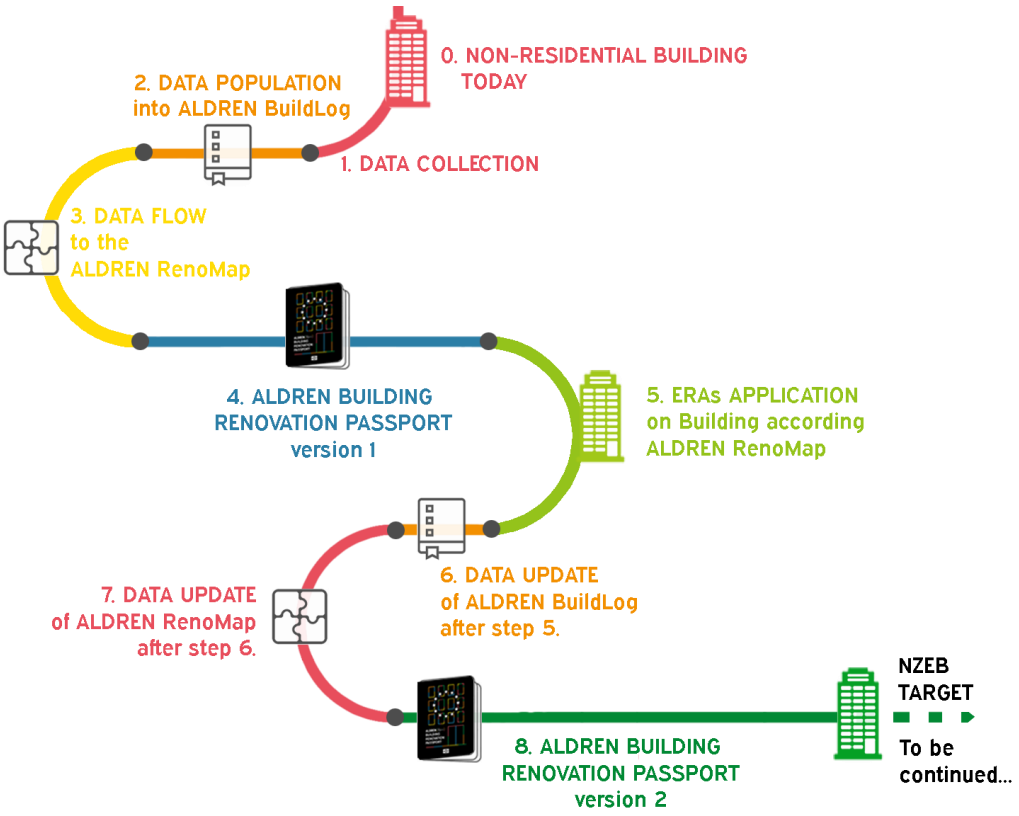


Figure 33. An example of application through the time of the ALDREN approach

04 – THE PROTOCOL STEPS: how to use ALDREN BRP

ALDREN ALliance for Deep RENovation in buildings

4.1. Elements and functionalities of the ALDREN BRP: how to use it

The ALDREN BRP, which was elaborated during the first year of the ALDREN project and it will be tested on Pilots building, provides a framework for the data to be collected and calculated within the ALDREN approach application. The ALDREN BRP has been developed considering the lessons learned outlined in the section 1 and the data model characteristics identified in the section 2.

The ALDREN BRP has been settled with two possible versions (Figure 31):

1. the digital version composed by an Excel file (Figure 32);
2. the paper version realized by printing a Word file linked to the digital version.

The current version of the Excel worksheets v1.0 will be used by ALDREN partners for testing the ALDREN BRP on the different pilot buildings (Task 3.1). Once completed and validated the testing phase, the Excel file will be tuned and updated considering the suggestions and weakness points that eventually comes up from the real application on pilot buildings. Once ready the Excel file will be downloaded from the project website.

The Excel file is composed by different worksheets representing all modules of the two main elements: ALDREN BuildLog and ALDREN RenoMap. In the following paraghraphs of this section, those two elements are described more in details clarifying their structure, development and functionalities; while Annex c of this report provides the guidance of each modules (for BuildLog Annex c1 - for RenoMap Annex c2) with a detailed clear description per all the indicators (code no., definition, source, unit and notes for entry to avoid misunderstaing during the compilation of the file and to support and guide the compiller since the initial audit building phase).

4.2 ALDREN BuildLog

Logbook is defined in literature as the repository of all the data and documentation for a building, the ALDREN BuildLog is in line with this definition plus the added value to be clearly identified by data set indicators per each module in which is composed and corresponding to the tasks of the WP2.

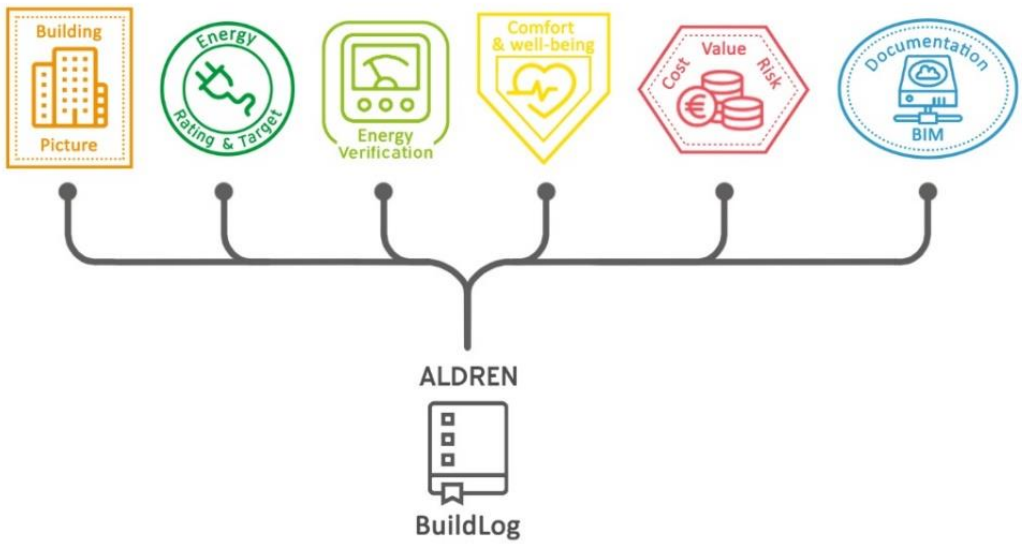


Figure 34. Identification of the ALDREN BuildLog modules through their passport stamps

Following the list of ALDREN BuildLog modules and respective description (Figure 34):

1. Building Picture = overall indicators that permit to outline the current state of the building in term of geometry data, location, documentation, certification, technical components, general information of ownership;
2. Energy rating and targets = overall indicators related to energy consumptions, system plant and energy rating
3. Energy verification = overall indicators related to the measured energy consumptions;
4. Comfort and well-being = overall indicators that permit to outline the state of the building in term of comfort, indoor air quality and lighting;
5. Cost value and risk = overall indicators related to financial aspects, market trend and building value;
6. Documentation and BIM = overall indicators related to the existing materials for different issues to check the availability and format of all the information.

Figure 35. ALDREN BuildLog is composed by 6 modules correspondent to the WP2 tasks

As anticipated in Data Model definition (section 2), the indicators of the ALDREN BuildLog represents a second LoI extrapolated from the higher level of the ALDREN database to facilitate the data comprehension and the data flow by the users along the process (Figure 35).

The ALDREN BuildLog modules have been defined to be as comprehensive as possible, including all relevant indicators. However, it had to be kept as simple as possible to be practicable, for that reason there was an effort to reach a compromise between these two aims and a consensus among all project partners. Each worksheet has a dedicated

protocol to follow for the data entry and the data calculation being different, but they refer to a common language defined in Task 2.1.

Particular attention has been invested regarding the source compliancy for the choice of each single indicators for two main reasons: (i) define a common language for the whole modules which compose the BuildLog in order even to share some of the indicators and (ii) to refer to standardize and already in use indicators definition to harmonized the procedure.

For each indicator in the worksheet a colour has been assigned correspondent to the source compliancy as represented in the legend in Figure 36. The novelties introduced by the project has been identified as ALDREN methodology and in some cases being targeted only Non-Residential buildings, the typology is further identified by the initial letter (H=hotel, O=office). The source compliancies used are listed following: Building Stock Observatory; EVC; Smart Readness indicators; Previous EU projects; ALDREN methodology; LEED; Well; DGNB and International Valuation Standard. In some cases, an indicator could have associated double color in case of double compliancy.

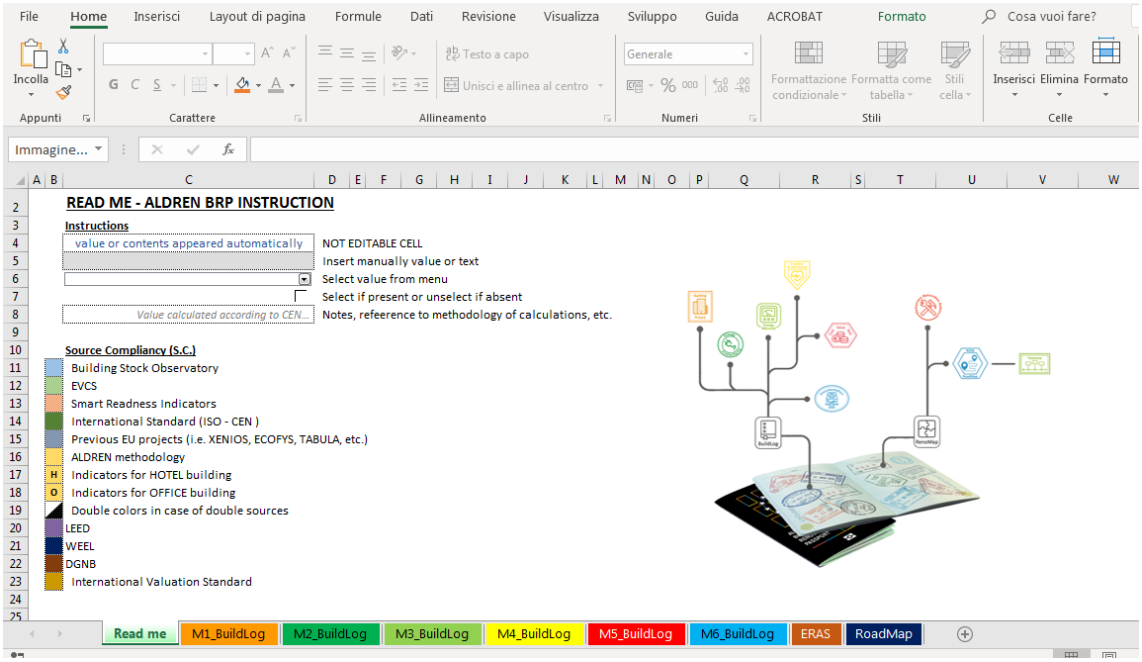
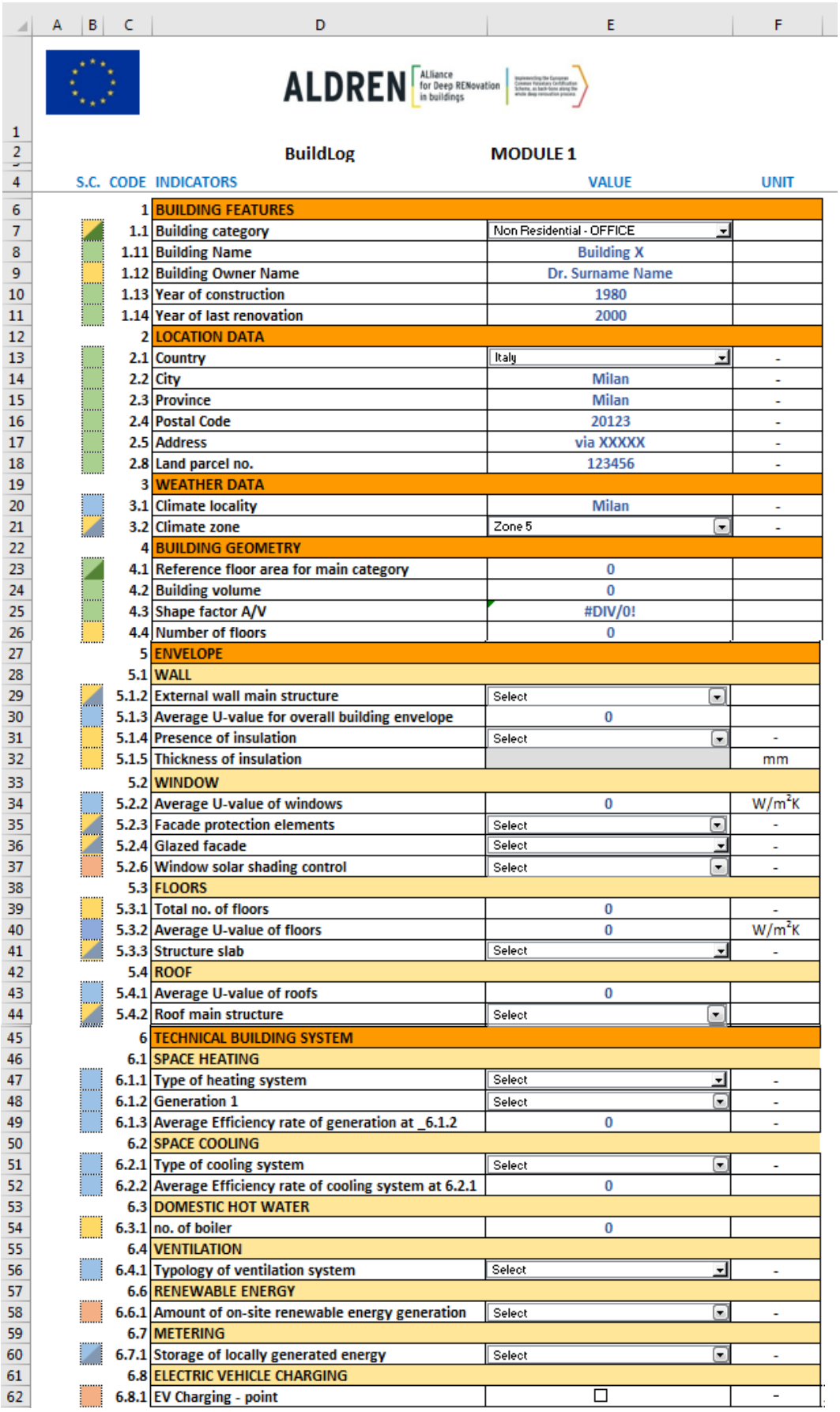


Figure 36. Screenshot from the worksheet "Read me" of the digital version of the ALDREN BRP

At the moment data are fed to the ALDREN BuildLod manually by experts trained by ALDREN dedicated training. Information could also be automatically fed into the ALDREN BuildLog through an automated connection to existing databases and other various sources (e.g. EPC database, BMS, BSO or other) already identified and integrating/increasing also the BIM LoD (see Annex b for further details) by dedicated user interfaces not realized within the ALDREN project, but that they could be a further implementation after the end of the project.

Figure 37 is an example of how an Excel spreadsheet of ALDREN BuildLog looks like. Following the same criteria of harmonization for source compliancy and indicators

clustering by family data sets, all the other modules - which composes the ALDREN BuildLog – have been structured.



BuildLog MODULE 1

S.C. CODE	INDICATORS	VALUE	UNIT
1	BUILDING FEATURES		
1.1	Building category	Non Residential - OFFICE	
1.11	Building Name	Building X	
1.12	Building Owner Name	Dr. Surname Name	
1.13	Year of construction	1980	
1.14	Year of last renovation	2000	
2	LOCATION DATA		
2.1	Country	Italy	-
2.2	City	Milan	-
2.3	Province	Milan	-
2.4	Postal Code	20123	-
2.5	Address	via XXXXX	-
2.8	Land parcel no.	123456	-
3	WEATHER DATA		
3.1	Climate locality	Milan	-
3.2	Climate zone	Zone 5	-
4	BUILDING GEOMETRY		
4.1	Reference floor area for main category	0	
4.2	Building volume	0	
4.3	Shape factor A/V	#DIV/0!	
4.4	Number of floors	0	
5	ENVELOPE		
5.1	WALL		
5.1.2	External wall main structure	Select	
5.1.3	Average U-value for overall building envelope	0	
5.1.4	Presence of insulation	Select	-
5.1.5	Thickness of insulation		mm
5.2	WINDOW		
5.2.2	Average U-value of windows	0	W/m^2K
5.2.3	Facade protection elements	Select	-
5.2.4	Glazed facade	Select	-
5.2.6	Window solar shading control	Select	-
5.3	FLOORS		
5.3.1	Total no. of floors	0	-
5.3.2	Average U-value of floors	0	W/m^2K
5.3.3	Structure slab	Select	-
5.4	ROOF		
5.4.1	Average U-value of roofs	0	
5.4.2	Roof main structure	Select	
6	TECHNICAL BUILDING SYSTEM		
6.1	SPACE HEATING		
6.1.1	Type of heating system	Select	-
6.1.2	Generation 1	Select	-
6.1.3	Average Efficiency rate of generation at _6.1.2	0	-
6.2	SPACE COOLING		
6.2.1	Type of cooling system	Select	-
6.2.2	Average Efficiency rate of cooling system at 6.2.1	0	
6.3	DOMESTIC HOT WATER		
6.3.1	no. of boiler	0	
6.4	VENTILATION		
6.4.1	Typology of ventilation system	Select	-
6.6	RENEWABLE ENERGY		
6.6.1	Amount of on-site renewable energy generation	Select	-
6.7	METERING		
6.7.1	Storage of locally generated energy	Select	-
6.8	ELECTRIC VEHICLE CHARGING		
6.8.1	EV Charging - point	☐	-

Figure 37 – Screenshot from Excel worksheet of Building Picture – Module 1 ALDREN BuildLog

The main functionalities of the ALDREN BuildLog are described following.

1) Repository of the all main building data in a unique “place” (Excel spreadsheets). All the data collected and the indicators calculated in each module according their respective protocol could be stored and available for consultancy by different users and also they could be updated trough the time by a trained person on the ALDREN approach.

2) Building analysis and status for the topics constituting the BuildLog (1.Building Picture - 2.Energy rating and target – 3. Energy Verification – 4. Comfort and Well Being – 5. Cost Value and Risk). The

3) Data sets indicators as input for the ALDREN RenoMap definition. The ALDREN BuildLog is strictly linked with the RenoMap providing input data for the ERA evaluation and calculation and then also for the RenoMap identifications by steps.

4) Checklist of existing documentation for the building and BIM level implementation. Standardized verification of documentation availability and readness of the BIM level with the possibility to improve the grade with the update of the data trough the time and provide a link to cloud repository of digital documentations of the building.

5) Source of data set points for existing databases. The ALDREN Database and consequentely also both the ALDREN BuildLog and RenoMap have been structured in compliancy with DM and indicators definition of the main existing databases and standards in order to (for example the BSO).

4.3 ALDREN RenoMap

4.3.1 Challenges and positionning of ALDREN renovation roadmap

ALDREN project aims at producing a set of methodologies and and frameworks to promote the deep renovation of non-residential buildings. Mots of the topics dealt with concern evaluation of building performance in order to encourage good practices. Beyond the valuation processes the building renovation passport and its Renovation roadmap, called RenoMap, is a proposal to encompass a reflexion about long term planning of building renovation in the every-day management. This prospective process can be structured in order to support the trigger of retrofit actions.

The proposed approach has to ne easily implementable to support the owners' choices during the decision phase of renovation projects but also has to provide usefull information during the remaining building lifetime, including efficient updatings at the time of new retrofit plans.

One of the main challenges is to provide enough information to guide building managers and trigger renovation works with limited knowledge and means. The first main goal of the RenoMap is to define an ambitious target and all te actions to engage to reach it. NZEB compliant guidelines support the desgn choices and the step-by-step renovation can be compared both to the initial state and the final configuration.

The second objective is to integrate the methodology into the current professional practices and to provide a proper added value. For an initiated renovation project, RenoMap proposals will be adapted by design teams implementing the project. Moreover, it makes no sense to plan detailed actions on the next thirty years right before a coming retrofit for which the precise scope is not decided yet. For these reasons ALDREN RenoMap concentrates on detailed proposals on a short-term period whereas actions to be caaried out in a longer term are more roughly studied and developed. Primary renovation packages can potentially be implemented during the coming retrofit project. Other actions are proposed on a timeline depending on the obsolescence level of the associated components. The primary proposals which will not be engaged will still be highlighted among the remaining actions to perform.

The RenoMap is also the enforcement of other ALDREN developments. It is based on energy rating methodology covered in T2.2, which is based on hourly timested energy simulation of the studied building in standard conditions. Outcomes of T2.4 concerning internal environmental quality (IEQ) will be evaluated for the primary renovation actions in order to provide multicriteria feedbacks. Indicators related to cost and financial valuation are developed in T2.5 and will also support the decision process of the renovation roadmap.

The Renovation RoadMap template is composed of two main sections: The evaluation table of Elementary Renovation Actions and the final step-by-step roadmap. They have to be filled in during the process and are parts of the building renovation passport.

Table 13. Templates and documents to be used in RenoMap process

Document	Status	Tasks	Reference
Interviews guide	Guidance document	1-3	Annex c2
Audit guide	Guidance document	2	Annex c2
Building Logbook	Input data – to complete	2-4	D2.6 + BRP template
Evaluation guide	Guidance document	2-3-4	Annex c2
Evaluation table of ERAs	Output template to fill in	2-3-4	Renomap template
Strategy guide	Guidance document	6-7	D2.6 +Renomap template
Step-by-step roadmap	Output template to fill in	5-6-7-8	RenoMap template

The table above presents the other documents which are necessary to implement the RenoMap methodology. They contain guides providing additional technical information which are complementary to the following detailed methodology.

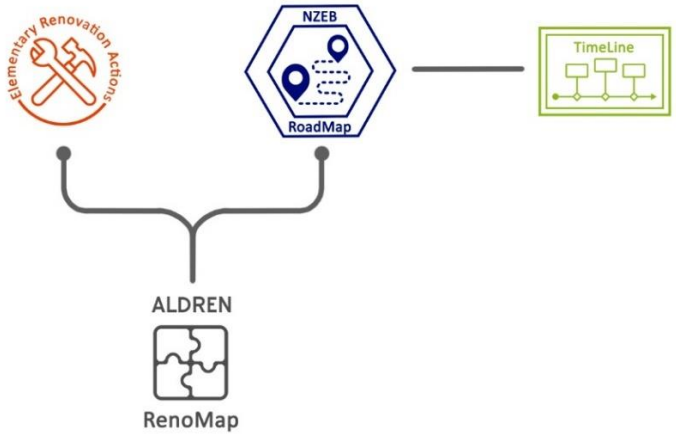


Figure 38. Modular structure of the ALDREN RenoMap

4.3.2 RenoMap Methodology

Stage 1: Identification and evaluation of Elementary Renovation Actions (ERAs)

The first stage of the methodology is mainly composed of groundwork and pre-pocessing tasks. Preliminiary studies are conducuted in order to identify a set of Elementary Renovation Actions (ERAs) related to the building specificities and actual potential. Following this identification phase, an evaluation of the ERAs is carried out in order to assess the associated benefits according to different criteria.

The outcome of Stage 1 is the Evaluation Table of ERAs. This matrix is presented in the Building Renovation Passport. It shows a basic picture of unsorted potential renovation actions and their potential benefits. Even if the identification and evaluation processes have to be updated for a future renovation project, this gathered information will be useful and has to be kept. The detailed tasks of Stage 1 are presented below with the input documents and expected outcomes.

Task 1: Owner's upstream interview

An initial interview of the owner or manager of the building can be carried out to collect his point of view about the renovation process and the main actions to engage. It is a collection of owner's remarks and wishes. This interview is executed in an unrestricted framework and without particular guidelines. This first task is optional, but its outcomes

can provide guidance for the next steps. Some specific advices are presented in the interviews guide in Annex c2 to help carrying this task out.

Task 2: Detailed audit

The detailed audit aims at identifying the potential renovation actions according to the actual state of the building. This audit process can be conducted at the same time as a general energy audit evaluating building energy performance, but it needs a look which is specific to this protocol.

- Definition of renovation actions

The empty template of the evaluation of ERAs provide a list of actions to study. These generic actions have to be "assigned" on the different parts of the buildings according to the actual constraints and specificities. These parts to be separately considered can be related to different façades, different zones or HVAC systems, different components. Actions have to be adapted to the onsite actual context.

The expected level of performance associated to each ERA is chosen by the designer. NZEB compliant levels are proposed as guidelines for each generic ERA. Other constraints may limit the potential actions. Chosen settings have to be as close as possible to these guidelines in order to achieve a deep renovation. The table below presents the exhaustive list of generic ERAs and NZEB level of performance in the French context.

The general energy audit which assesses the current state of building is not specificly mentioned in this protocol. This process has to be conducted to model and run energy simulations of the building. The knowledge of current building energy settings is a pre-requisite and can be provided by the same energy audit that the one described here. This information has to be reported in the Logbook part of the BRP.

Table 14. List of generic ERAs and associated NZEB compliant performance level (French context)

ERA #	Elementary Renovation Actions	NZEB level - FR context	
E.	**ENVELOPE**		
E.1	**Thermal insulation of external walls**	U = 0,17 W/m².K	
E.2	**Thermal insulation of roof surfaces**	U = 0,15 W/m².K	
E.3	**Thermal insulation of bottom floor surfaces**	U = 0,5 W/m².K	
E.4	**Thermal bridges treatment : Facades to roof**	ΔU = 0,02-0,05 W/m².K	
E.5	**Thermal bridges treatment : Windows to walls**		
E.6	**Windows replacement**	U = 0,75-1 W/m².K - triple/double glazing	
E.7	**Doors replacement**	U = 1,4 W/m².K	
E.8	**Integration of a double-door entrance**	-	
E.9	**Blinds and solar protections**	-	
E.10	**Envelope air tightness treatment**	Q4pa = 1 m3/h.m²	
V.	**VENTILATION**		
V.1	**Ventilation : Ventilation system replacement**	Central ventilation system / double-flow (Eff>0,75)	
V.2	**Ventilation : Controls**	Occupancy	
H.	**HEATING**	**Air solution**	**Water solution**
H.1	**Heating : Heat generation system replacement**	Heat pump / air conditioning electric system	district heating
H.2	**Heating : Distribution network replacement**	air network	low temperature bi-tube network
H.3	**Heating : Thermal insulation of distribution network**		Classe 4 (out of heated space)
H.4	**Heating : Emission systems replacement**	air-conditioning diffusers (air)	Low-temperature radiators/ emission
H.5	**Heating : Controls**	Occupancy, night/week end setback	
C.	**COOLING**	**Air solution**	**Water solution**
C.1	**Cooling : Cooling generation system replacement**	air/air chiller	air/water chiller
C.2	**Cooling : Distribution network replacement**	Central air-conditioning, insulated tubes under ceiling	bi-tube network
C.3	**Cooling : Thermal insulation of networks**	Classe 4 (refrigerant)	Classe 4 (refrigerant+ water network)
C.4	**Cooling : Emission systems replacement**	Air-conditioning diffusers,	fan coils, emission panels, underfloor
C.5	**Cooling : Controls**	Occupancy, night/we setback	
DHW.	**DOMESTIC HOT WATER**		
DHW.1	**DHW : DHW generation system replacement**	electric water heater, with storage	
DHW.2	**DHW : Thermal insulation of the storage**		
DHW.3	**DHW : Thermal insulation of distribution network**		
DHW.4	**DHW : Emission-taps systems replacement**		
DHW.5	**DHW : Controls**	PV autoconsumption, thermal panels control	
L.	**LIGHTING**		
L.1	**Lighting : Lighting system replacement**	LED - 10 W/m² (offices), 15 W/m² (meeting rooms), 5	
L.2	**Lighting : Controls**	manual/automatic - occupancy detection	
Ren.	**RENEWABLES**		
Ren.1	**Renewable energies : Photovoltaïcs**		
Ren.2	**Renewable energies : Thermal panels**		
Ren.3	**Renewable energies : Geothermal system**		

- Evaluation of obsolescence level

The audit phase also allows a partial evaluation of the obsolescence level of components associated to ERAs, which is one of the indicators of the evaluation table. The time period of a necessary change of the component related to the actions has to be specified. A simplified qualitative indicator (priority level) can also be defined. For each ERA, one has to specify if the action has a “low emergency” level, high emergency” level, or if it is not concerned by the obsolescene of a specific component.

Task 3: Owner's final interview

The final interview aims at recording owner's and/or manager's preferences among the ERAs which have been defined by the RenoMap designer. The owner has to associate to each ERA an opinion, which is either a clear will of change, a neutral opinion or a will not to implement the action. The approximate expected time the owner wishes to realize the renovation action has to be defined too.

At the end of this task, the column corresponding to "owner will" in the evaluation table of ERAs has to be filled in.

Task 4: Evaluation achievment

The last Task of Stage 1 focuses on evaluating criteria for each ERAs. These criteria are related to obsolescence level, owner preferences, cost and energy potential.

Obsolescence priority level and replacement periods are mainly evaluated during Task 2 (detailed building audit) but complementary information can be obtained during Task 4 post-processing (e.g. technical information on systems or components life time).

Owner's preferences about the decision for ERAs implementation and the associated time are collected during Task 3.

The investment cost of renovation actions has to be evaluated and collected in the evaluation table. A criterion is also related to the typical return for generic actions. This qualitative indicator is provided by the evaluation guide (Annex c2). A rating between one and three stars is associated to each action.

The evaluation guide (annex c2) also provides a rating process of ERAs' energy potential. Four levels of performance ranges are defined for each generic ERA. Depending on ERAs, this performance can be formulated with U-values, components' technology, quality indicators referring to standards… By comparing initial and expected state of ERA's components a qualitative score between one and three stars is calculated as a difference between level for initial and renovated state.

Finally, interacting ERAs are specified from the interaction matrice in the evaluation guide. For each generic ERA, related interacting actions are mentioned. Actions to implement before or in the same time are differentiated. A difference is also made between imperative and recommended interactions to consider for the renovation roadmap.

Table 15. Indicators in the evaluation table of ERAs

0 : Not concerned		-1 : No change	0 : unknown										
1 : low emergency		0 : neutral	1 : long term										
2 : High emergency		2 : Clear will for change	2 : ASAP	cf. Evaluation guide		cf. Evaluation guide		cf. Evaluation guide					
Obsolescence level		**Owner preferences**		**Cost**		**Energy potential**		**Interactions**					
priority level	period (yr)	decision	Approximate time	Investment cost (€)	returns on investme	Energy efficiency upgrade of the component		#	interacting ERAs		Type of interactio		

Simplified qualitative criteria are needed to limit the complexity of Stage 1. The detailed energy gains would require a significant work for energy modelling and simulation. Such an extensive study is difficult to implement in a project's decision stage. The completed evaluation table of ERAs gives a complete overview of the actions to implement towards

the deep renovation and the associated pros and cons. From this table, a step-by-step roadmap based on strategic rules can be designed.

Stage 2: Detailed step-by-step renovation process

The second stage of ALDREN RenoMap protocol aims at designing a structured roadmap to support the decision process. As mentioned in introduction, more detailed guildelines are provided for short-term packages of renovation actions. Modularity of proposed is also important to reflect the needs specific to the decision phase of renovation projects.

Stage 1 objective was to complete the evaluation table of ERAs, part of the BRP (Building Renovartion passport). The second template included in the passport which shall be filled in during Stage 2 is the step-by-step roadmap.

Task 5: Reference points calculation

One of the main outcomes of the RenoMap process is the assessment of expected energy performance of the fully renovated building, and the associated gain compared to initial state. Thus, detailed energy simulation of the building before renovation and the potential renovated building enhanced with all the defined ERAs are carried out. The simulation sotware has to follow ALDREN expectations specified in ALDREN D2.2 deliverable. These requirements are mainly related to dynamic hourly calculation and the respect of European standards. This evaluation is similar to the energy rating protocol described in D2.2.

Calculated final and primary energy are displayed on the main template as well as energy gains describing the deep renovation potential. Energy labels are associated to these reference points. Intermediate renovation will be compared to these references which provide an interesting feedback on the progress state of the RenoMap.

Task 6: Processing of renovation strategy

This task deals with the identification of Primary renovation actions according to obsolescence level, owner will, energy efficiency and other indicators. This is the key process of Stage 2 in order to define the step-by-step roadmap.

- Primary renovation packages

Highlighed ERAs are selected from the evaluation table completed in Stage 1. The motivation and associated values of criteria are presented in the table below. In the following priority sequence, actions with immediate needs of work or clear owner preference for an immediate implementation have to be filtered. Then, ERAs with high economic benefit corresponding to three stars rating on typical return on investment are selected. A Threshold on investment cost can also be defined to select the cheapest actions. Actions with high energy potential are also highlighted, as well as potentially immediate actions, which are not related to the replacement of compoenets and could be implemented immediately.

Table 16. Selection of the highlighted ERAs to design the primary renovation packages

Priority	Motivation	Indicators
1a	**Immediate need of works**	Obsolescence priority level = 2
		Obsolescence approximate time < 2 years
1b	**Owner will for immediate implementation**	Owner will decision = 2
		Retlated approximate time = 2
3	**ERAs with high economic benefit**	Return on investment : ***
		Cost < chosen threshold
4	**ERAs with high energy gain**	Energy efficiency upgrade of the component : ***
5	**Potentially immediate actions**	Obsolescence level priority level = 0

The highlighted ERAs will be integrated in Primary renovation packages. Before constituting these packages, some other actions can be associated th the highlighted ERAs depending on interactions. Interacting highlighted ERAs can also be gathered. Imperative interactions must be taken into account whereas a greeater freedom is left to the designer concerning recommended interactions. Logical considerations related to logistics, occupancy or other specific issues can also lead to the selection and gathering of ERAs. All these motivations are reminded in the table below.

Table 17. Gathering of ERAs according to interactions and logical considerations

Priority	Motivation
Imperative	Imperative interactions (Table B)
Recommended	Recommended interactions (Table B)
Recommended	Logistics, uses/occupancy of spaces

Primary packages are composed of highlighted and interacting ERAs. The first package of actions is related to ERAs implemented in the coming renovation with high certainty because of immediate need of work and owner will. Other primary packages are then made with other highlighted ERAs. The following table shows the principle of packages constitution. Packages can also be gathered in order to reduce the nmber of studied configurations.

Table 18. Constitution of primary packages

	Priority	Consitution
Certain package	**1a-1b**	All ERAs firsly implemented with high certainty : Immediate need of work, owner will (+interacting ERAs)
Secondary packages	**3**	According to gathered highlighted and interacting ERAs. Ranked by priority level
	4	
	5	

- Long-term timeline

All the remaining actions which are not in primary packages are ranked according to the expected replacement period of the associated components. They constitute a long-term timeline. These ERAs may also be gathered according to interactions and logical issues.

Task 6 leads to the sorting of elementary renovation actions in two main groups: The primary renovation packages and the long-term timeline. The former is composed of several packages to be studied for an immediate implementation. These packages are organized and ranked depending on the reason for which they were highlighted. They could all be considered in the coming project or only some of them can be launched.

Task 7: Evaluation of primary packages of ERAs

To support the expression of preferences during the decision phase, the primary renovation packages are evaluated with outcomes and criteria defined in ALDREN tasks. These criteria are related to energy performance, internal environmental quality and financial valuation.

Energy simulation of the bulding enhanced with the primary packages of ERAs are performed. Configurations with cumulated renovation packages have to be study as well as cases whit individual packages only enabling to study the cumulated gains and to compare the packages to each other. The energy rating process mentioned in Task 5 must be followed for these building energy simulations. Primary energy consumption is the final output of this first assessment.

Costs should also be evaluated for each package according to outcomes of ALDREN task 2.5. The main indicators are related to the investment cost, the cost efficiency and the cost of the renovation package compared to the asset value.

Complementary studies concenring health and well-being can be carried out following outcomes of ALDREN task 2.4. For example, the thermal comfort can be assessed from hourly calculation results.

Indicators related to the main ALDREN outcomes are finally evaluated for each primary renovation packages to support decision considering all the key aspects required to offer a successful retrofit.

Task 8: Results report and vizualisation for decision support

The reporting of all the information related to the renovation actions gathered in primary packages ir in the long-term timeline aims at providing a complete and clear view to the owner in order to help decision. This tasks specifically deals with vizulaisation of results in the final template of the RenoMap, which is the step-by-step roadmap.

The top of the template is composed of the energy rating scale on which are set the reference points. A comparison with renovation configurations can be made by specifying a primary energy consumption and vizualise the relative energy performance on the figure.

The middle section is related to primary packages, ranked by priority order. This ranking is directly related to the priority order defined in the table above, but the packages can be compared and re-prioritize according to the final study of the renoMap outcomes. The highlighted ERAs and associated motivations are recalled. Indicators related to energy performance (individual and cumulated), cost and IEQ, give a clear view of the benefits of each package.

The bottom section shows the long-term timeline composed by the remaining ERAs and the obsolescence period of the components.

From this template, building owners or managers have an overview of their building's renovation potential, the main actions to implement, the synergies between renovation actions and the associated benefits.

4.3.3 Summary

The table below presents a summary of the RenoMap protocol's tasks, with a descrition and the required input and output documents. The additional information and guidances as well as the RenoMap templates are available in Annex c2.

Table 19. Summary of the RenoMap protocol's tasks

#	Task	Status	Description	Inputs	Outputs
1	**Owner's upstream interview**	Optional	Collecting owner's remarks and wishs.	Interviews guide	Internal note
2	**Detailed audit**	Mandatory	Refering to BRP LOGBOOK to verify and complete initial state description. Definition of renovation actions. NZEB compliant level is recommended if there is no specific constraint. Evaluation of obsolescence level.	Evaluation Table of ERAS v0 Audit guide Evaluation guide	Evaluation Table of ERAs v1
3	**Owner's final interview**	Mandatory	Getting owner's comment for each of the identified ERA from the constituted list. Completing ERAs Evaluation Table.	Evaluation guide	Evaluation Table of ERAs v2
4	**Evaluation achievment**	Mandatory	Post-processing evaluation to complete ERAs indicators in ERAs Evaluation Table.	Evaluation guide	Evaluation Table of ERAs consolidated version
5	**Reference points calculation**	Mandatory	Energy simulation of the building before renovation. Energy simulation with the potential renovated building enhanced with all the defined ERAs. Filling in of the labels curve on the template of the final renovation roadmap.	Building LOGBOOK Evaluation Table of ERAs Step-by-step roadmap v0	Step-by-step roadmap v1
6	**Processing of renovation strategy**	Mandatory	Identification of Primary renovation actions according to obsolescence level, owner will, energy efficiency and other indicators. Constitution of packages with interacting ERAs. Definition of the timeline for remaining ERAs.	Strategy guidance	Step-by-step roadmap v2
7	**Energy performance calculation of primary renovation packages**	Mandatory	Energy simulation of the bulding enhanced with the selected packages of ERAs.	Strategy guidance	Step-by-step roadmap v3
8	**Results report for decision support**	Mandatory	Choice of the final renovation configuration. Viewing on the labels curve.		Step-by-step roadmap consolidated version

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06 - ANNEXES

ANNEX a - Analysis on emerging databases for Non-Residential buildings across Europe

Annex a is the results of the analysis conducted on the available knowledge and information with dedicated focuses on EPC databases in selected countries and Building Stock Obesrvatory (BSO) as a valuable source for Non-Residential Building Data.

ANNEX a1 - EPC databases in selected EU countries: lessons learned and potential barriers

Energy Performance Certificates were first introduced at European level under the 2002 Energy Performance of Buildings Directive (EPBD). A handful of Member States already had some building energy rating and labelling systems in place, and these went some way to complying with the original Directive. The 2010 Recast of the EPBD clearly strengthens the importance and role of EPCs, in Articles 11, 12 and 13.

As was required by the 2002 Directive, EPCs must contain details of the performance of the building or building unit and they must give reference values so that owners and tenants can compare performance with other buildings. They must now also include more advanced recommendations for improving the building's energy performance. These should include specific building elements to be improved as well as major renovations comprising multiple building elements and building systems. An important change is that the recommended improvements must be cost-optimal (see factsheet on Cost Optimality), whereas before they needed to be 'cost-effective'. EPCs must provide information about the work needed to implement the recommendations and they must say where more detailed information can be found. Estimates of cost savings resulting from improvements must also be included, and a forecast of underlying energy prices. In the public sector, governments must encourage implementation of all the recommendations on the EPC within its validity period – which must not exceed ten years. Units within a block are still allowed to have a common EPC based on the whole building (if it shares a heating system), or an individual EPC based on a similar unit with the same energy characteristics. In addition, a single-family home may now have an EPC based on a building of similar design and performance, but only if this similarity can be guaranteed by an accredited energy assessor.

An EPC must be issued upon construction, sale or rent of a building to the new owner or occupier. If a building is occupied by a public authority, frequently visited by the public and over 500m^2 (down from 1,000m^2), then an EPC must be produced immediately. The size threshold falls to 250m^2 after 9th July 2015. The EPC rating (or 'indicator') must now also be advertised with the details of a building when it (or a part of it) is marketed for sale or lease. If the building is still under construction, an assessment of future energy performance must be provided and advertised, to be replaced by a full EPC when the building is completed.

According to Article 12 of the EPBD, an EPC must be presented and handed over to the prospective tenant or buyer. The role of the EPC is strengthened by mandatory publication of the energy performance indicator contained in the EPC, according to the national legislation valid at the time for advertising a building for sale or rent.

While it is not compulsory under EU legislation to establish a centralised EPC register, almost all Member States gone beyond the obligations and set up systems to collect

EPC data. In most cases, the main motivation for creation of the EPC register, beside buildings data collection per se, was to support the quality control of the energy certification processes required by the EPBD, Article 18 [62].

A system of data collection can be created at national or regional level according to the country specific administrative organization. In 2005 some regions of Austria set up the firsts EPC register and in 2014 the number of MS that introduced EPC register increased to 24.

As remarked by REQUEST2ACTION investigation, lack of guidance on design and implementation of EPC registers resulted in a large variety of data available in the registers across Europe. The main differences are related to: databases format, data upload method, data accessibility and functionalities of EPC databases and also development of EPC databases distinct per building typology.

Table 20 and Table 21 provides an overview on existing EPC databases data and characteristics available at the moment in selected EU countries.

Table 20. Overview on existing EPC database in selected EU countries (Source: authors rielaborations from data results of REQUEST2ACTION project)

Country	Database name	Level of development	Year of establishment	Authors / compiller	Data availlability
Austria	Zeus	Regional	2004	Registered energy expert	Aggregated statistics. Limitet access
Belgium	-	Regional	2008	Registered energy expert	Aggregated statistics. Limited access
France	-	National	2005	Qualified expert	Aggregated statistics
Germany	-	Regional	-	-	No public access
Greece	-	National	2011	Registered energy expert	Aggregated statistics
Ireland	-	National			Open access
Italy	CENED (for Lombardia)	Regional	2005	Registered energy expert	Depend on region*
Poland	-	National	2015	-	-
Portugal	-	National	2007	Qualified expert	Aggregated statistics
Spain	-				Depend on region
Slovakia	-	National	2010	Qualified expert	Aggregated statistics
The Netherland	-	National	2007		Aggregated statistics
United Kingdom	-	Regional	2006		Aggregated statistics

Table 21. Analysis of the data collected in the EPC database register

Country	Building's general information	Energy performance indicators	Recommendations	Qualified expert details	Calculation input	Source
Austria	✓	✓	✓	✓	✓	
Belgium (flanders)	✗					http://www.energiesparen.be
Denmark	✓	✓				http://boligejer.dk/
France	✓	✓	✓	✓	✓	
Greece	✓	✓	✓	✓	✓	
Hungary	✓	✓				https://www.e-epites.hu
Italy (lombardy region)	✓	✓	✓	✓	✓	www.cened.it
Ireland	✓	✓	✓	✓	✓	https://ndber.seai.ie
Portugal	✓	✓	✓	✓	✓	http://academia.adene.pt/
Slovakia	✓	✓	✓	✓	✗	http://www.inforeg.sk/ec/
The Netherland	✓	✓				http://www.ep-online.nl
United Kingdom (England and Wales)	✓	✓	✓	✓	✓	https://epc.opendatacommunities.org/

Energy Performance Certificate register in Italy

According to the national report on energy efficiency and Eurostat database, Italy's building account for 41.1% of the final energy consumption (data related to 2015). EPCs were introduced in Italy in 2005 with EPBD implementation (decree 192/05) and implemented by some regions since 2007/2008 (Lombardy, Emilia Romagna and Piemont). EPC guidelines were published in 2009 (decree 59/2009) and followed by most of the Italian regions. Regions are in charge of activities related to the monitoring and control of buildings, establishing their own heating/cooling systems register and EPC register.

Responsible authority	Enea
Availlability of the national database	Yes with regional registry
Acces of the EPC database	Yes open in Lombardia region
Number of EPCs issued	3.600.000
Percentage of non-residential building with EPCs	N.A. at national level
Reccomandations included	Yes
Energy rating	From G to A4
Median EPC class	D

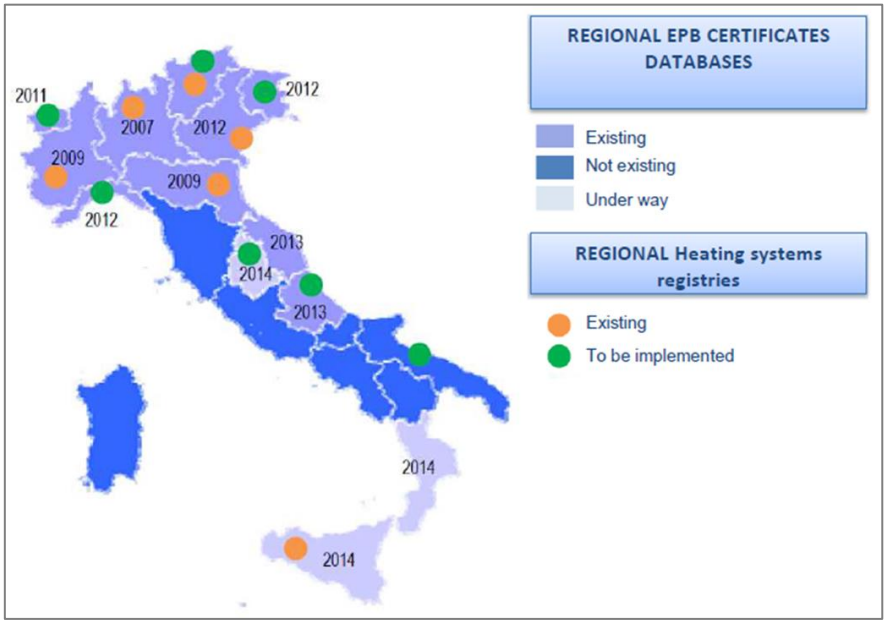


Figure 39. Existing regional EPC database information systems and year they were established (Source: CTI, 2014)

EPC in Italy: definition, implementation and main carachteristics

Since 1st July 2009, the Energy Performance Certificates (EPCs) is mandatory for all types of properties which are constructed, sold or rented out to a new tenant, for new building and for buildings with a total useful floor area below 1000 m^2. Thanks to the Decree No. 63/2013, the new Italian EPC Regulations (APE) will replace the previously EPC model (ACE), aimed at establishing new methodology frameworks to calculate the energy performance of buildings. This is the result of European Union Directive No. 2010/31 of the European Parliament and of the Council of 19th May 2010 on the Energy Performance of Buildings (EPBD, recast of the Directive 2002/91/EC), by setting a target for all “new buildings to be nearly zero-energy”. Since 2013 the EPC includes a section with recommendations and potential measures on how to reduce energy consumption in building.

The Energy Performance Certificate is the "building label". As an informative document it allows to know in a simple and intuitive way the energetic performances of the building, that is the annual quantity of primary energy actually consumed or that is expected to be necessary to satisfy, with a standard use of the building, the various energy needs of the building (winter and summer air conditioning, hot water preparation for sanitary purposes, ventilation and, for the tertiary sector, lighting, lifts and escalators).

The annual quantity of primary energy is expressed by one or more descriptors, which take into account the level of insulation of the building and the installation characteristics of the technical systems. This value can be expressed in primary energy not renewable, renewable or total (sum of previous energies).

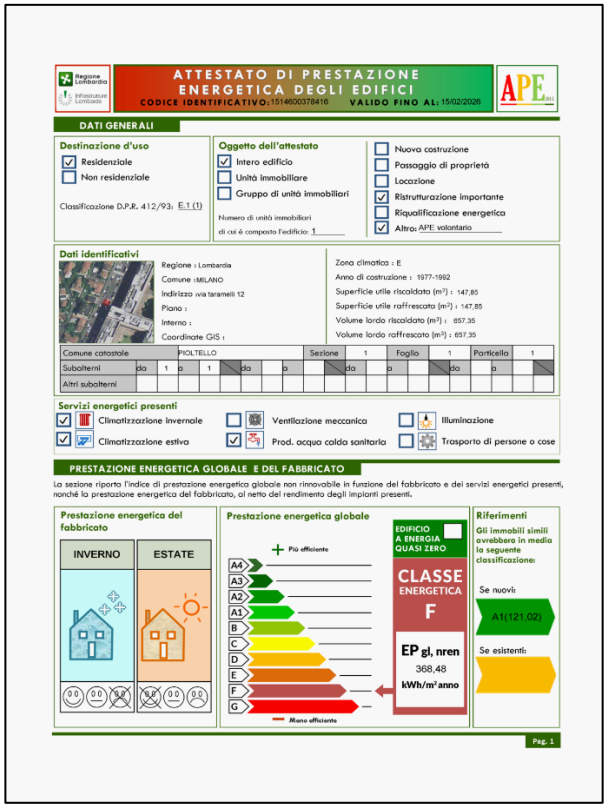
EPC focus at regional level: the Lombardia region example

Model of APE s the current model of Energy Performance Certificate, which was approved by the Lombardy Region with DGR X / 3868 and relative DDUO no. 6480 of 30 July 2015 in implementation of the interministerial decrees of 26 June 2015.

The new APE has the following characteristics:

- four levels of class A (A1, A2, A3, A4);
- provides information on the quantity of energy exported;
- provides an estimate of annual energy consumption (under standard conditions);
- it provides detailed data on existing plants (year of installation, power, cadastre code of thermal plants, ...);
- the quantitative indicators (energy class and global performance index) support qualitative indicators ("emoticons").

Following a picture of the whole pages which compose the EPC are reported for a graphical comparison between the selected countries investigated within ALDREN.



ATTESTATO DI PRESTAZIONE ENERGETICA DEGLI EDIFICI

CODICE IDENTIFICATIVO: 1514600376416 VALIDO FINO AL: 15/02/2026

DATI GENERALI

Destinazione d'uso
- [x] Residenziale
- [ ] Non residenziale

Classificazione D.P.R. 412/93: E.1 (1)

Oggetto dell'attestato
- [x] Intero edificio
- [ ] Unità immobiliare
- [ ] Gruppo di unità immobiliari

Numero di unità immobiliari di cui è composto l'edificio: 1

- [ ] Nuova costruzione
- [ ] Passaggio di proprietà
- [ ] Locazione
- [x] Ristrutturazione importante
- [ ] Riqualificazione energetica
- [x] Altro: APE volontario

Dati identificativi

Regione : Lombardia
Comune : MILANO
Indirizzo : via taramelli 12
Piano :
Interno :
Coordinate GIS :

Zona climatica : E
Anno di costruzione : 1977-1992
Superficie utile riscaldata (m²) : 147,85
Superficie utile raffrescata (m²) : 147,85
Volume lordo riscaldato (m³) : 657,35
Volume lordo raffrescato (m³) : 657,35

Comune catastale	PIOLTELLO	Sezione	1	Foglio	1	Particella	1
Subalterni	da 1 a 1	da	a	da	a	da	a
Altri subalterni							

Servizi energetici presenti
- [x] Climatizzazione invernale
- [x] Climatizzazione estiva
- [ ] Ventilazione meccanica
- [x] Prod. acqua calda sanitaria
- [ ] Illuminazione
- [ ] Trasporto di persone o cose

PRESTAZIONE ENERGETICA GLOBALE E DEL FABBRICATO

La sezione riporta l'indice di prestazione energetica globale non rinnovabile in funzione del fabbricato e dei servizi energetici presenti, nonché la prestazione energetica del fabbricato, al netto del rendimento degli impianti presenti.

Prestazione energetica del fabbricato

Prestazione energetica globale

EDIFICIO A ENERGIA QUASI ZERO

CLASSE ENERGETICA F

EP gl, nren 368,48 kWh/m² anno

Riferimenti

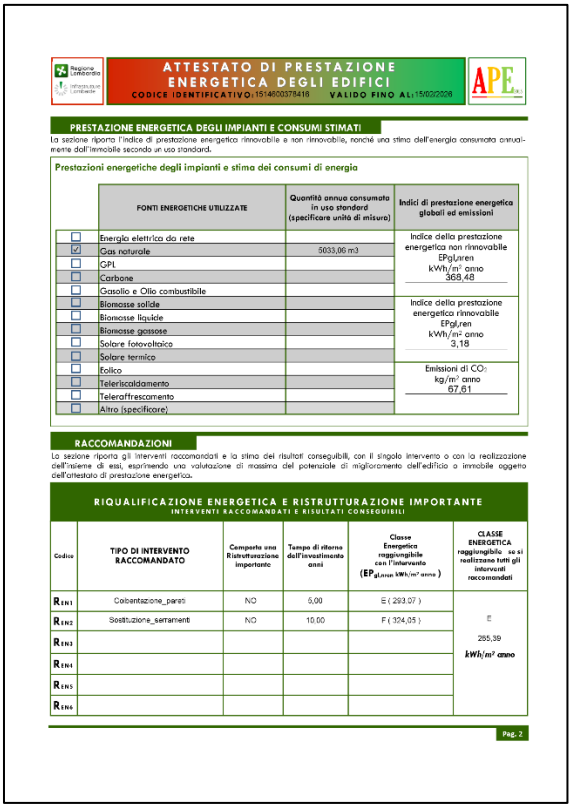
Gli immobili simili avrebbero in media la seguente classificazione:

Se nuovi: A1(121,02)

Se esistenti:

Pag. 1

PAGE 1



ATTESTATO DI PRESTAZIONE ENERGETICA DEGLI EDIFICI

CODICE IDENTIFICATIVO: 1514600376416 VALIDO FINO AL: 15/02/2026

PRESTAZIONE ENERGETICA DEGLI IMPIANTI E CONSUMI STIMATI

La sezione riporta l'indice di prestazione energetica rinnovabile e non rinnovabile, nonché una stima dell'energia consumata annualmente dall'immobile secondo un uso standard.

Prestazioni energetiche degli impianti e stima dei consumi di energia

	FONTI ENERGETICHE UTILIZZATE	Quantità annua consumata in uso standard (specificare unità di misura)	Indici di prestazione energetica globali ed emissioni
[ ]	Energia elettrica da rete		Indice della prestazione energetica non rinnovabile EPgl,nren kWh/m² anno 368,48
[x]	Gas naturale	5033,06 m3	
[ ]	GPL		
[ ]	Carbone		
[ ]	Gasolio e Olio combustibile		
[ ]	Biomasse solide		Indice della prestazione energetica rinnovabile EPgl,ren kWh/m² anno 3,18
[ ]	Biomasse liquide		
[ ]	Biomasse gassose		
[ ]	Solare fotovoltaico		
[ ]	Solare termico		
[ ]	Eolico		Emissioni di CO_2 kg/m² anno 67,61
[ ]	Teleriscaldamento		
[ ]	Teleraffrescamento		
[ ]	Altro (specificare):		

RACCOMANDAZIONI

La sezione riporta gli interventi raccomandati e la stima dei risultati conseguibili, con il singolo intervento o con la realizzazione dell'insieme di essi, esaminando una valutazione di massima del potenziale di miglioramento dell'edificio o immobile oggetto dell'attestato di prestazione energetica.

RIQUALIFICAZIONE ENERGETICA E RISTRUTTURAZIONE IMPORTANTE

INTERVENTI RACCOMANDATI E RISULTATI CONSEGUIBILI

Codice	TIPO DI INTERVENTO RACCOMANDATO	Comporta una Ristrutturazione importante	Tempo di ritorno dell'investimento anni	Classe Energetica raggiungibile con l'intervento ($EP_{gl,nren}$ kWh/m² anno)	CLASSE ENERGETICA raggiungibile se si realizzano tutti gli interventi raccomandati
R_{EN1}	Coibentazione_pareti	NO	5,00	E (293,07)	E 265,39 kWh/m² anno
R_{EN2}	Sostituzione_serramenti	NO	10,00	F (324,05)	
R_{EN3}					
R_{EN4}					
R_{EN5}					
R_{EN6}					

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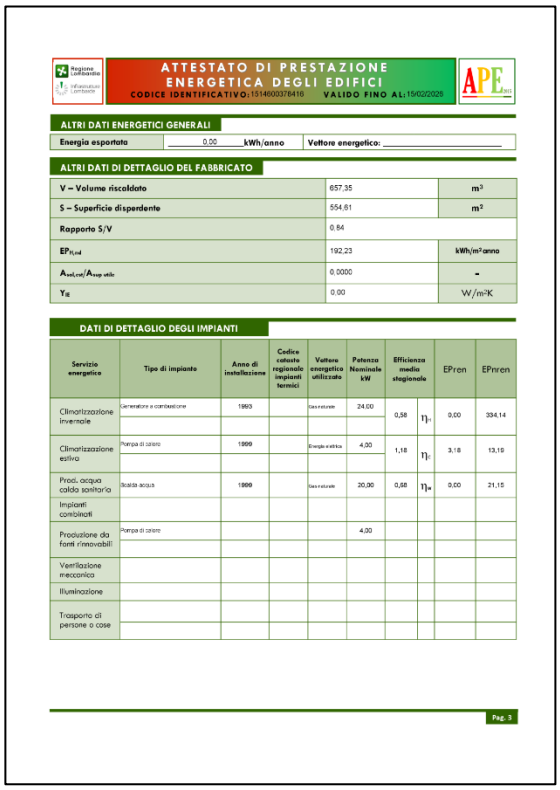

ATTESTATO DI PRESTAZIONE ENERGETICA DEGLI EDIFICI

CODICE IDENTIFICATIVO: 1514600376416 VALIDO FINO AL: 15/02/2026

ALTRI DATI ENERGETICI GENERALI

Energia esportata: 0,00 kWh/anno — Vettore energetico:

ALTRI DATI DI DETTAGLIO DEL FABBRICATO

V – Volume riscaldato	657,35	m³
S – Superficie disperdente	554,61	m²
Rapporto S/V	0,84	
$EP_{H,nd}$	192,23	kWh/m²anno
$A_{sol,est}/A_{sup\ utile}$	0,0000	-
Y_{IE}	0,00	W/m²K

DATI DI DETTAGLIO DEGLI IMPIANTI

Servizio energetico	Tipo di impianto	Anno di installazione	Codice catasto regionale impianti termici	Vettore energetico utilizzato	Potenza Nominale kW	Efficienza media stagionale		EPren	EPnren
Climatizzazione invernale	Generatore a combustione	1993		Gas naturale	24,00	0,58	η_H	0,00	334,14
Climatizzazione estiva	Pompa di calore	1999		Energia elettrica	4,00	1,18	η_C	3,18	13,19
Prod. acqua calda sanitaria	Bollitore acqua	1999		Gas naturale	30,00	0,88	η_W	0,00	21,15
Impianti combinati									
Produzione da fonti rinnovabili	Pompa di calore				4,00				
Ventilazione meccanica									
Illuminazione									
Trasporto di persone o cose									

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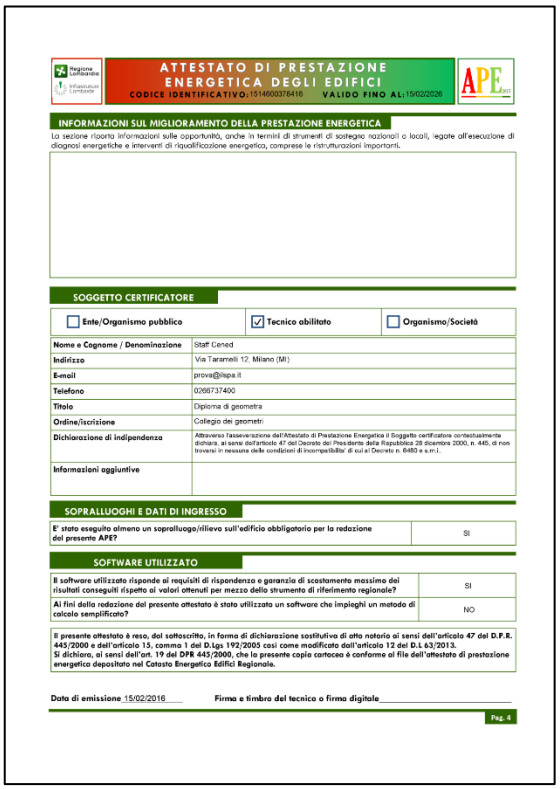

ATTESTATO DI PRESTAZIONE ENERGETICA DEGLI EDIFICI

CODICE IDENTIFICATIVO: 1514600376416 VALIDO FINO AL: 15/02/2026

INFORMAZIONI SUL MIGLIORAMENTO DELLA PRESTAZIONE ENERGETICA

La sezione riporta informazioni sulle opportunità, anche in termini di strumenti di sostegno nazionali o locali, legate all'esecuzione di diagnosi energetiche e interventi di riqualificazione energetica, comprese le ristrutturazioni importanti.

SOGGETTO CERTIFICATORE

- [ ] Ente/Organismo pubblico
- [x] Tecnico abilitato
- [ ] Organismo/Società

Nome e Cognome / Denominazione	Staff Cened
Indirizzo	Via Taramelli 12, Milano (MI)
E-mail	prova@lispa.it
Telefono	0266737400
Titolo	Diploma di geometra
Ordine/iscrizione	Collegio dei geometri
Dichiarazione di indipendenza	Attraverso l'asseverazione dell'Attestato di Prestazione Energetica il Soggetto certificatore contestualmente dichiara, ai sensi dell'articolo 47 del Decreto del Presidente della Repubblica 28 dicembre 2000, n. 445, di non trovarsi in nessuna delle condizioni di incompatibilità di cui al Decreto n. 6480 e s.m.i.
Informazioni aggiuntive	

SOPRALLUOGHI E DATI DI INGRESSO

E' stato eseguito almeno un sopralluogo/rilievo sull'edificio obbligatorio per la redazione del presente APE?	SI

SOFTWARE UTILIZZATO

Il software utilizzato risponde ai requisiti di rispondenza e garanzia di scostamento massimo dei risultati conseguiti rispetto ai valori ottenuti per mezzo dello strumento di riferimento regionale?	SI
Ai fini della redazione del presente attestato è stato utilizzato un software che impieghi un metodo di calcolo semplificato?	NO

Il presente attestato è reso, dal sottoscritto, in forma di dichiarazione sostitutiva di atto notorio ai sensi dell'articolo 47 del D.P.R. 445/2000 e dell'articolo 15, comma 1 del D.Lgs 192/2005 così come modificato dall'articolo 12 del D.L 63/2013.
Si dichiara, ai sensi dell'art. 19 del DPR 445/2000, che la presente copia cartacea è conforme al file dell'attestato di prestazione energetica depositato nel Catasto Energetico Edifici Regionale.

Data di emissione 15/02/2016 — Firma e timbro del tecnico o firma digitale

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<u>EPC countries factsheet will be implemented in the next months for Spain, France, Slovakia and UK.</u>

ANNEX a2 - Overview on Building Stock Observatory and data for existing Non-Residential buildings in Europe

This annex provides an overview on the BSO in order to clarify its structure and data contents with a focus on data for Non-Residential Buildings.

The EU BSO is a European Commission initiative to monitor the energy performance of buildings across Europe available at:

https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-performance-of-buildings/eubuildings

There are six data topics contained within the current structure of the BSO, but this structure is applicable only to residential building stock.

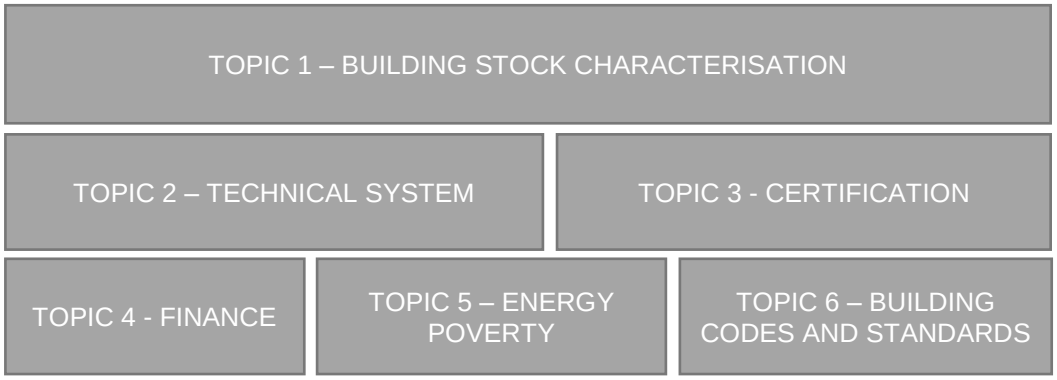


Figure 40. BSO Data structure

The BSO database has historically had significantly low levels of data population, it contains approximately 70000 individual data points (2400 per MS) of which 87% are not currently populated with data.

Starting from the main topic on which the BSO is structured (Figure 42 - for more details see), in the following subparagraphs, the respective graphics has been realized to give an overview within the European area and in some cases on selected countries corresponding to the partners' consortium country.

The most significant data gaps occur for Non-Residential buildings in: Topic 1 and Topic 2 and those are the current priority for data collection and population.

Most MS have more than 80% of their data missing or put another way less than 20% of the current indicators are populated with data.

The data source is another priority because, of the 13% of data present in the BSO database, approximately:

- 8% is sourced from high quality, reliable data: National Statistics, Eurostat and Odyssee-Mure;
- 5% is sourced from completed EU projects: Tabula, Entranze, Inspire, etc.

The following figures have been derived from the data download from the BSO in order to set up a picture of the available data for Non-Residential buildings.

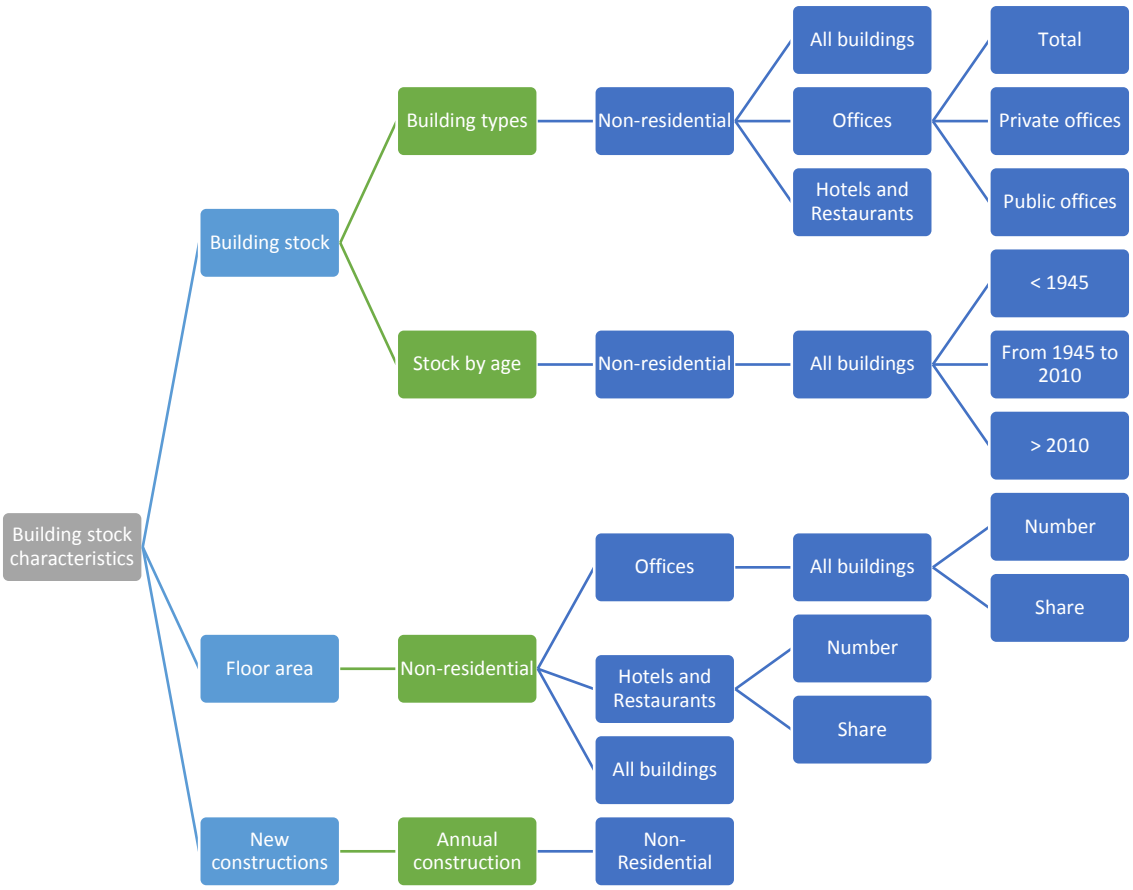


Figure 41. BSO database structure of the topic "Building stock characteristics" (Source: rielaboration from authors)

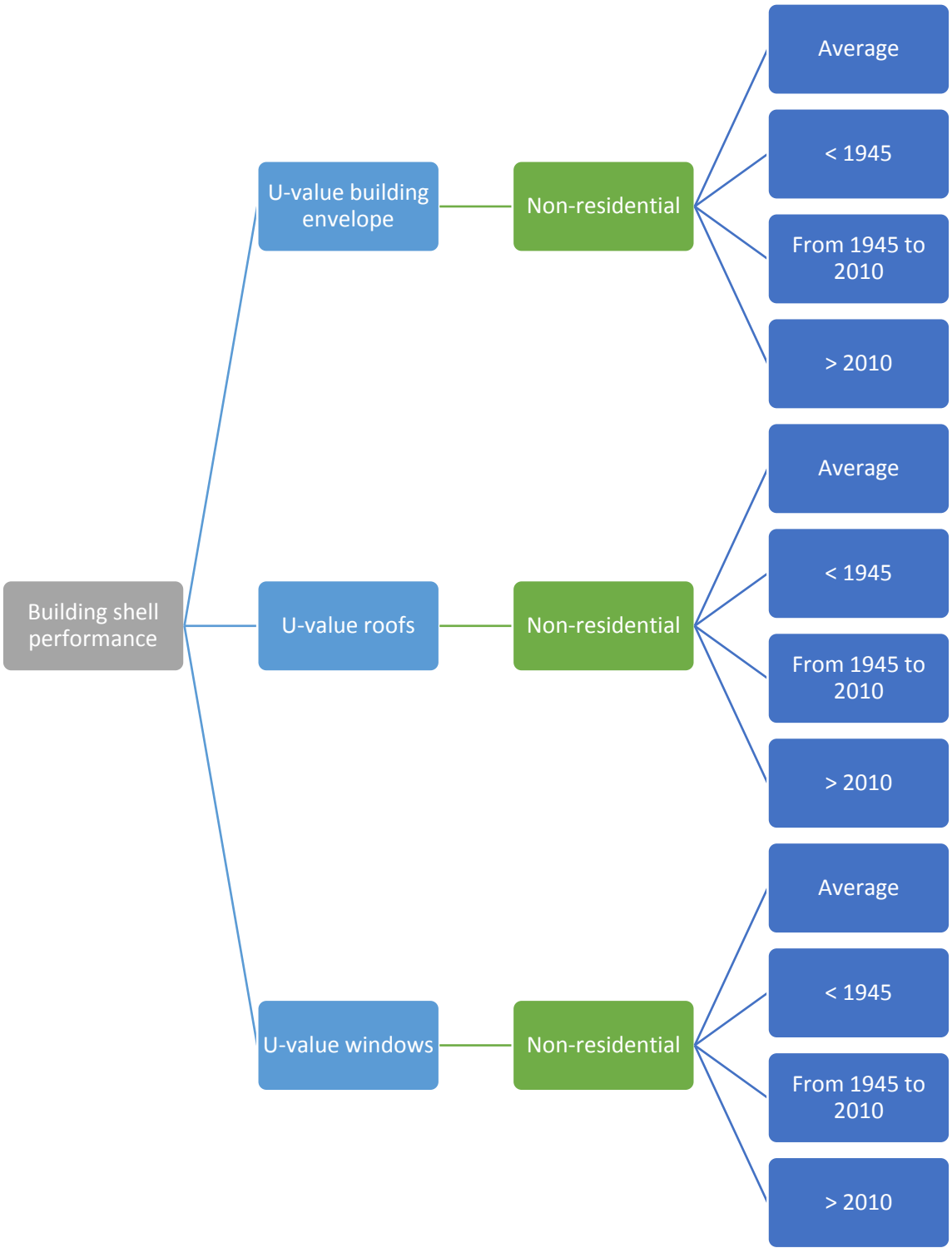


Figure 42. BSO database structure of the topic "Building shell performance" (Source: rielaboration from authors)

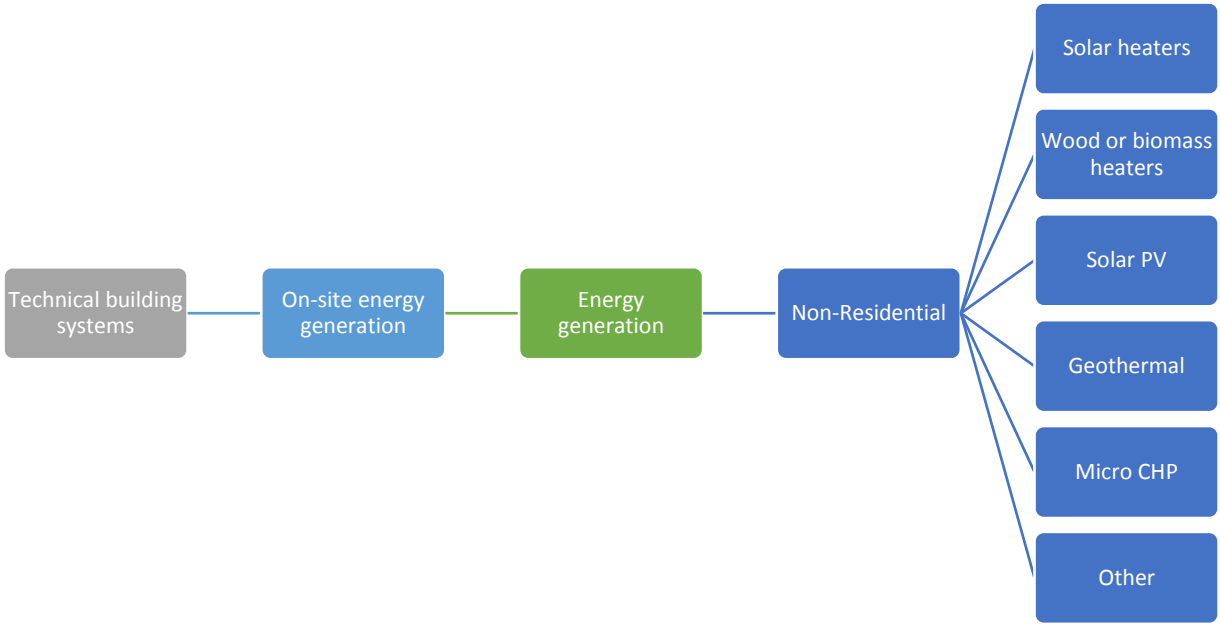


Figure 43. BSO database structure of the topic "Technical building systems" (Source: rielaboration from authors)

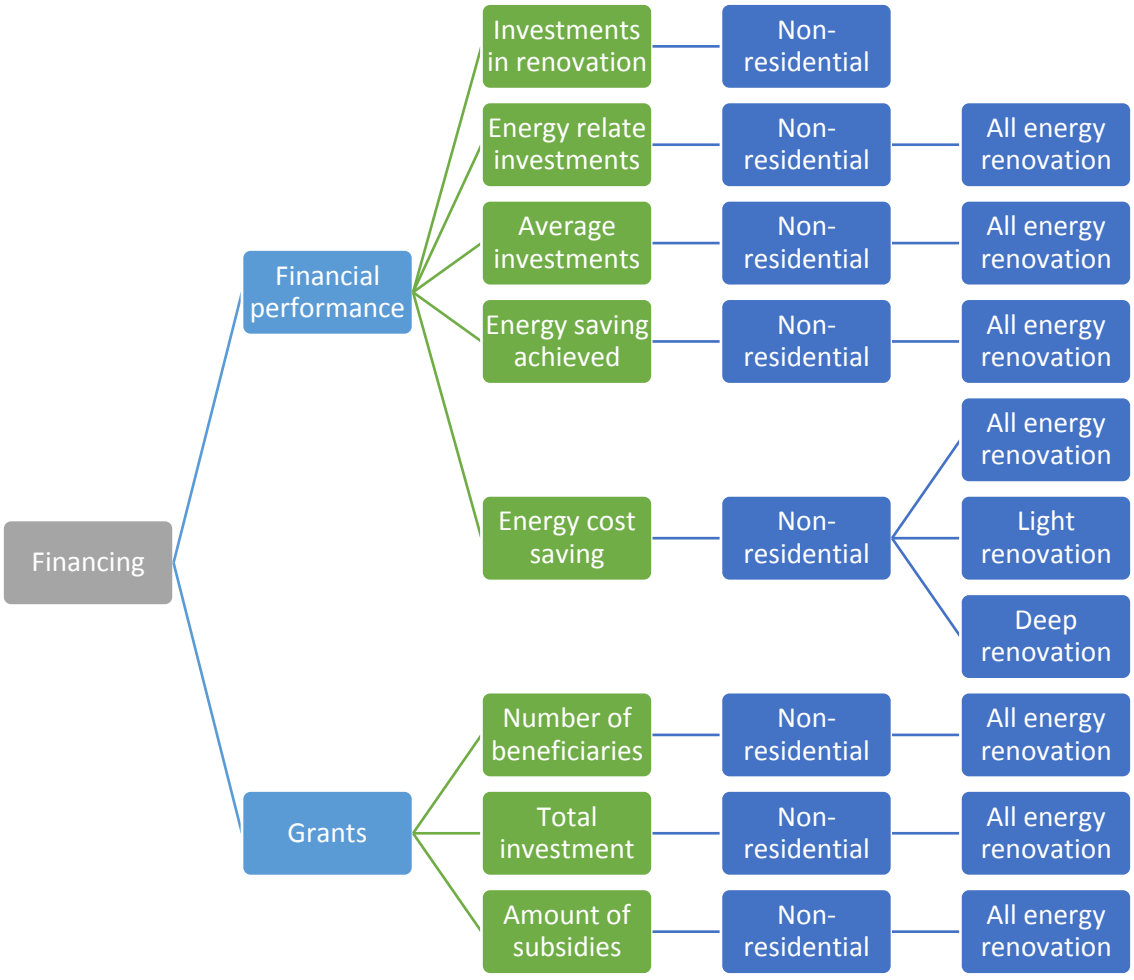


Figure 44. BSO database structure of the topic "Financing" (Source: rielaboration from authors)

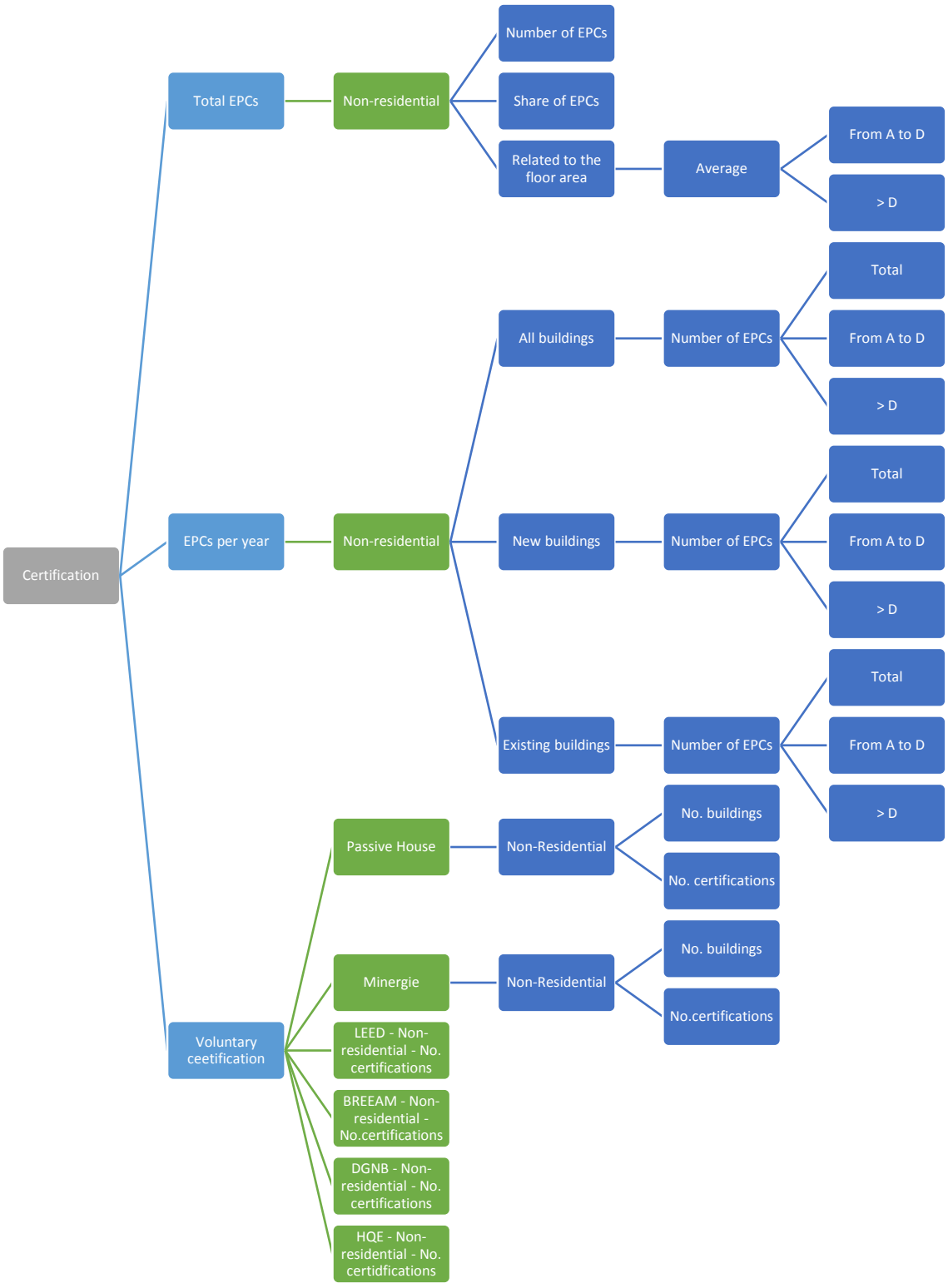


Figure 45. BSO database structure of the topic "Certification" (Source: rielaboration from authors)

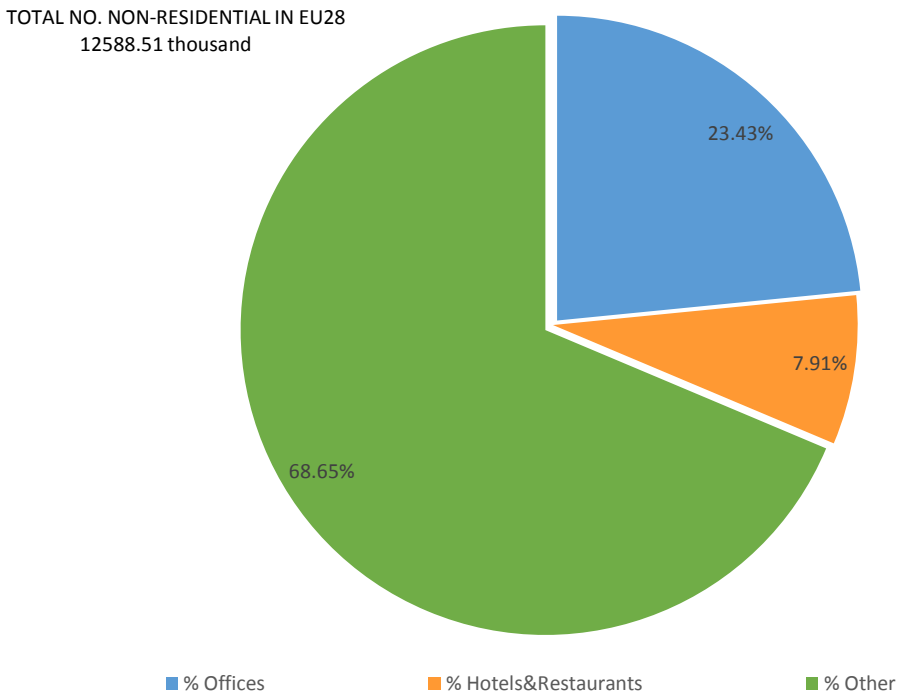


Figure 46. Percentage of Offices and Hotels & Restaurants on the total of Non - Residential buildings – EU28 (Source: rielaboration of the authors with BSO data)

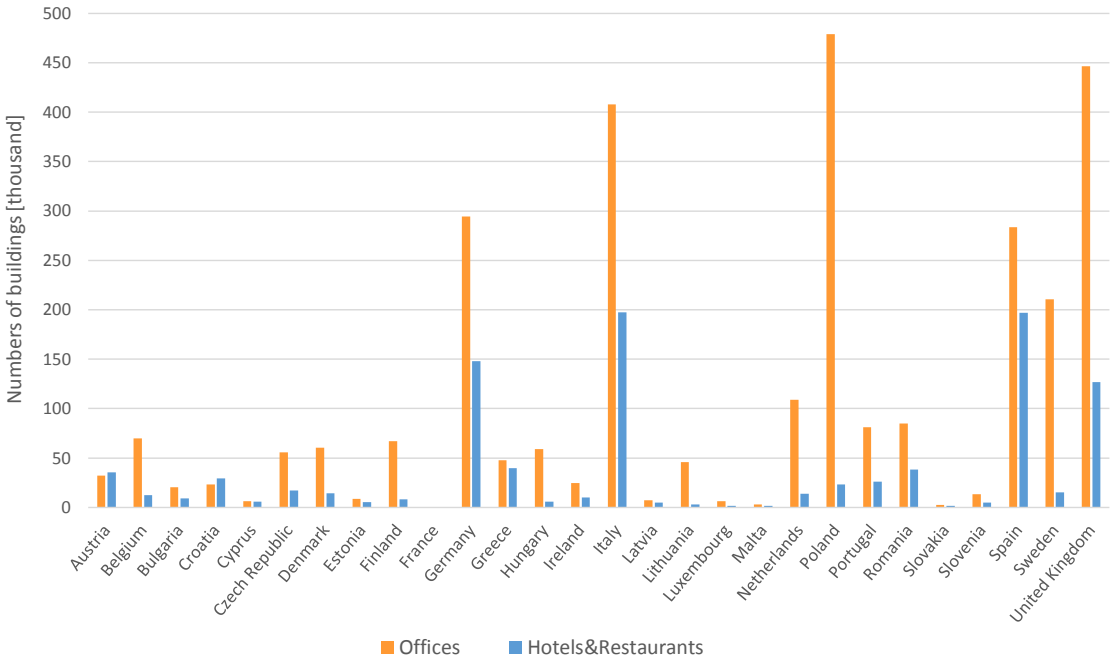


Figure 47. Relation between the total no. of Offices and Hotels&Restaurants – EU28 (Source: rielaboration of the authors with BSO data)

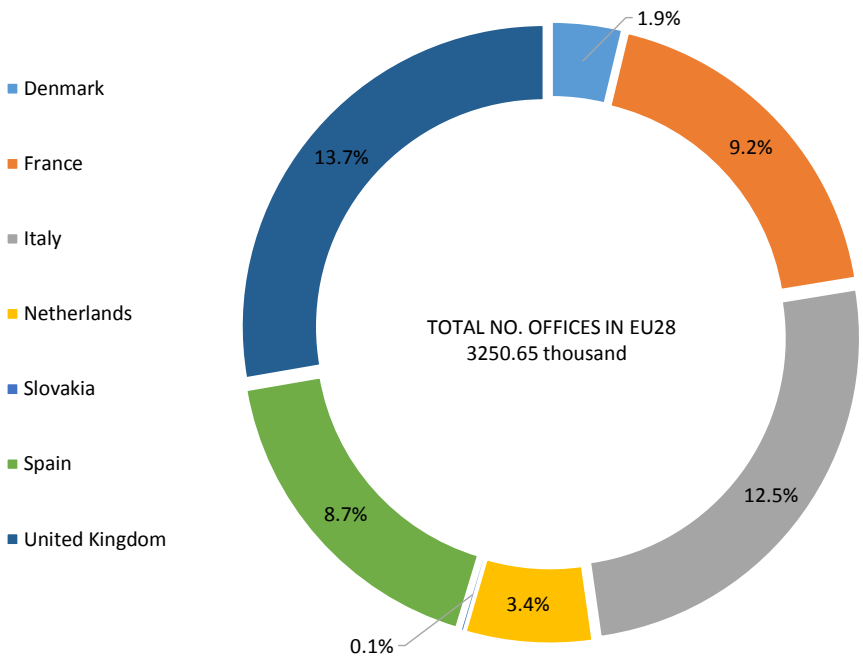


Figure 48. Percentage of Offices on the total no. related to the EU28 – Seven countries zoom (Source: rielaboration of the authors with BSO data)

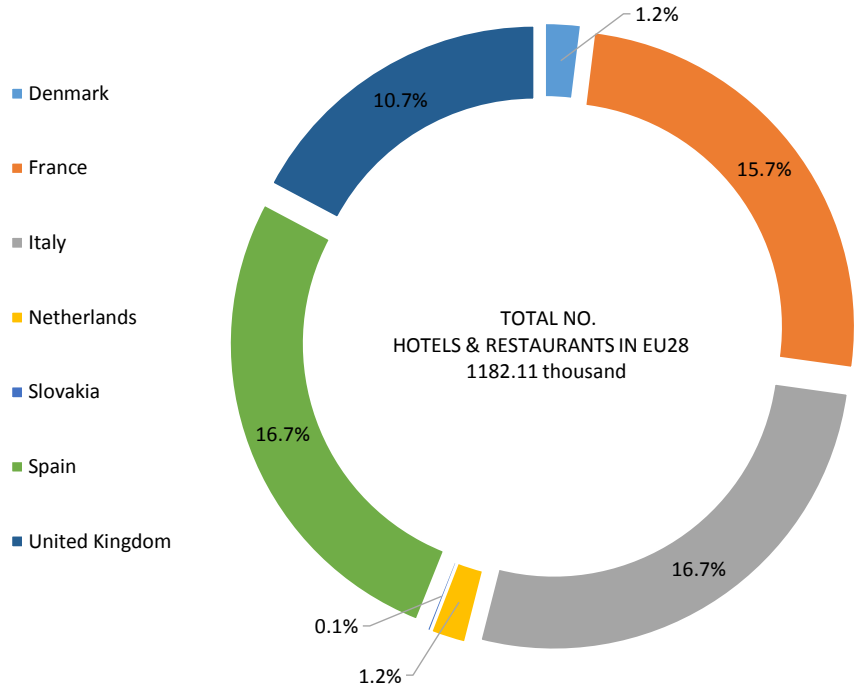


Figure 49. Percentage of Hotels&Restaurants on the total no. related to the EU28 – Seven countries zoom (Source: rielaboration of the authors with BSO data)

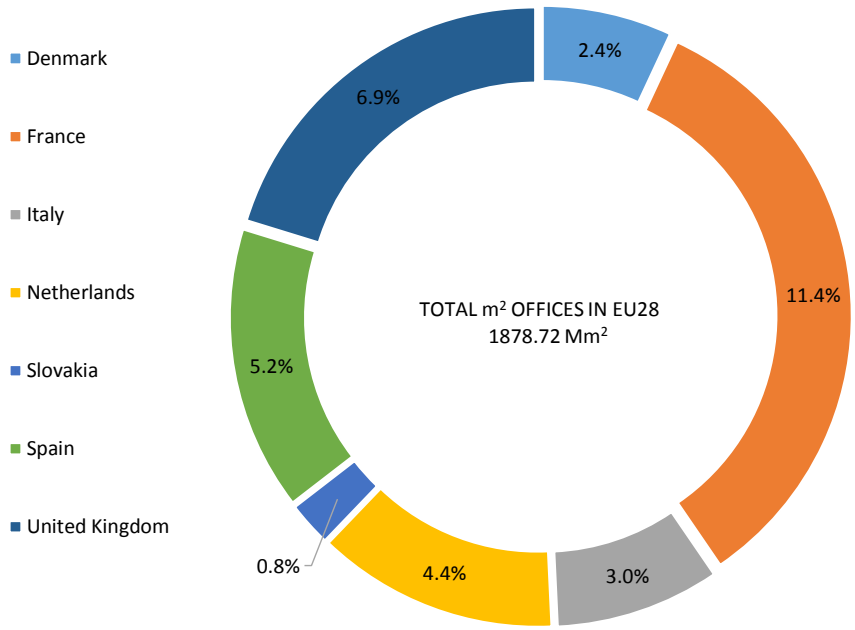


Figure 50. Focus on % of Non-Residential office building per m2 compared to the total in EU28 for selected countries (Source: rielaboration of the authors with BSO data – 2013 year of reference)

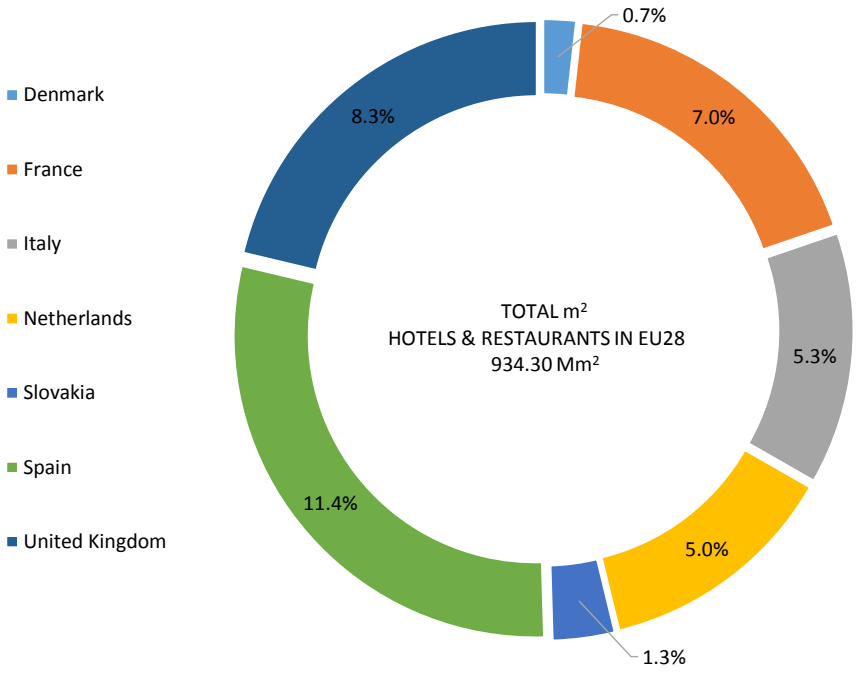


Figure 51. Percentage of m² of Hotels & Restaurants on the total related to the EU28 – Seven countries zoom (Source: rielaboration of the authors with BSO data)

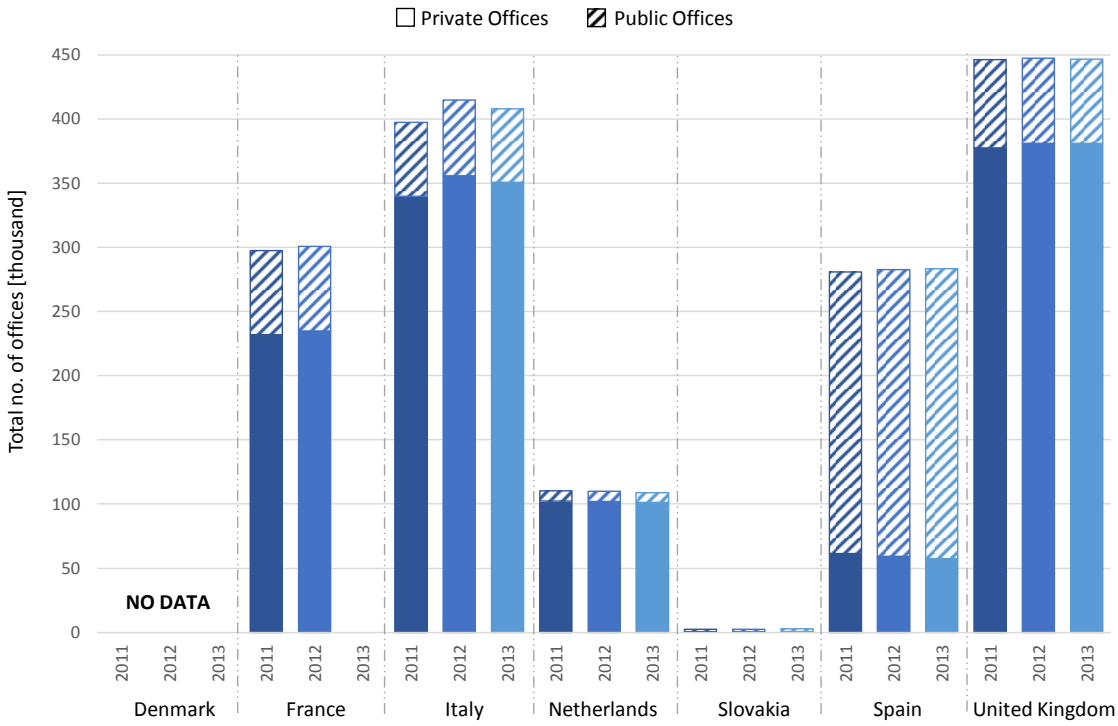


Figure 52. Relation between total no. of Private and Public Offices, in three different years – Seven countries zoom (Source: rielaboration of the authors with BSO data)

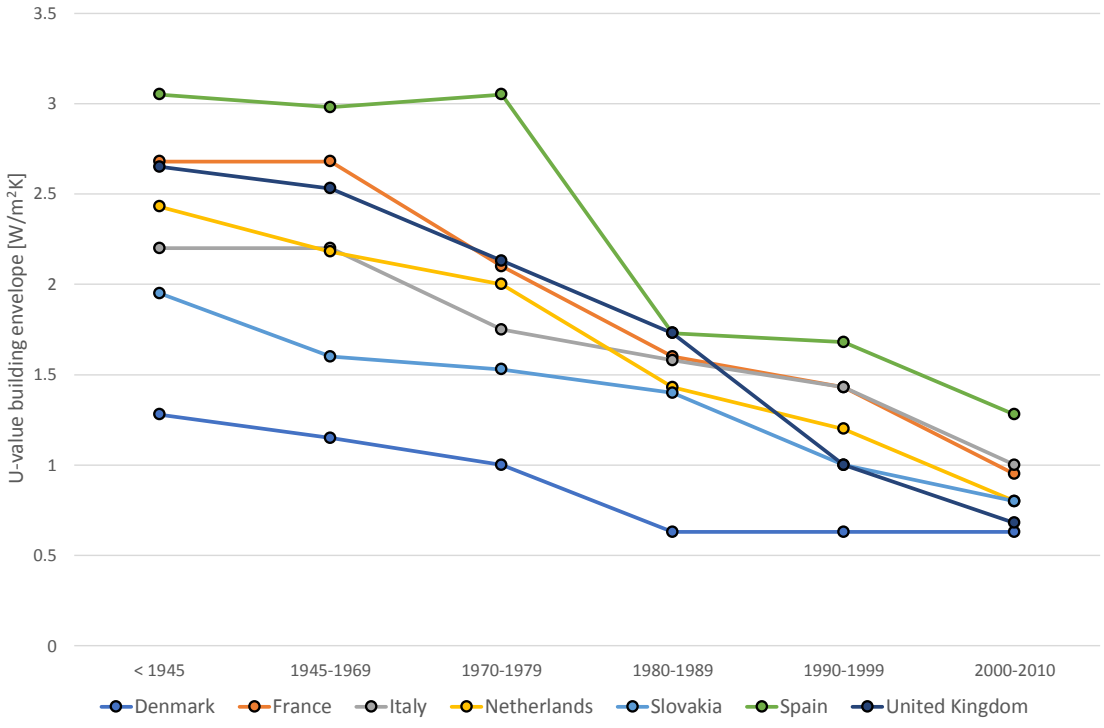


Figure 53. Trend of the U-value building envelope – Seven countries zoom (Source: rielaboration of the authors with BSO data)

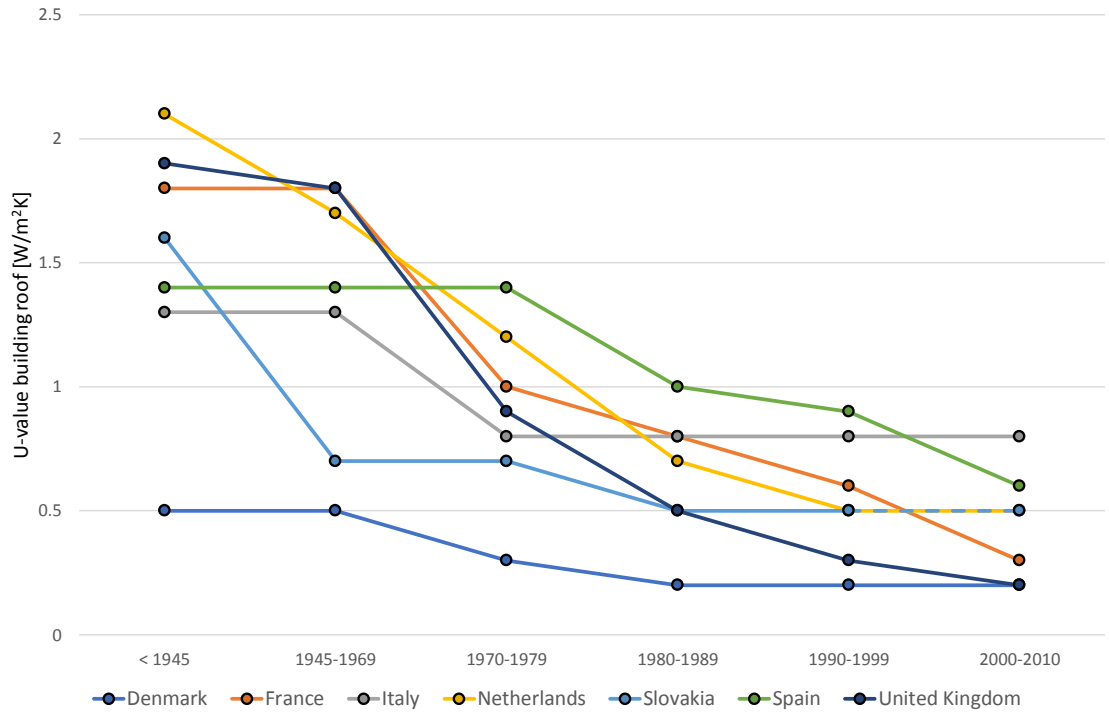


Figure 54. Trend of the U-value building roof – Seven countries zoom (Source: rielaboration of the authors with BSO data)

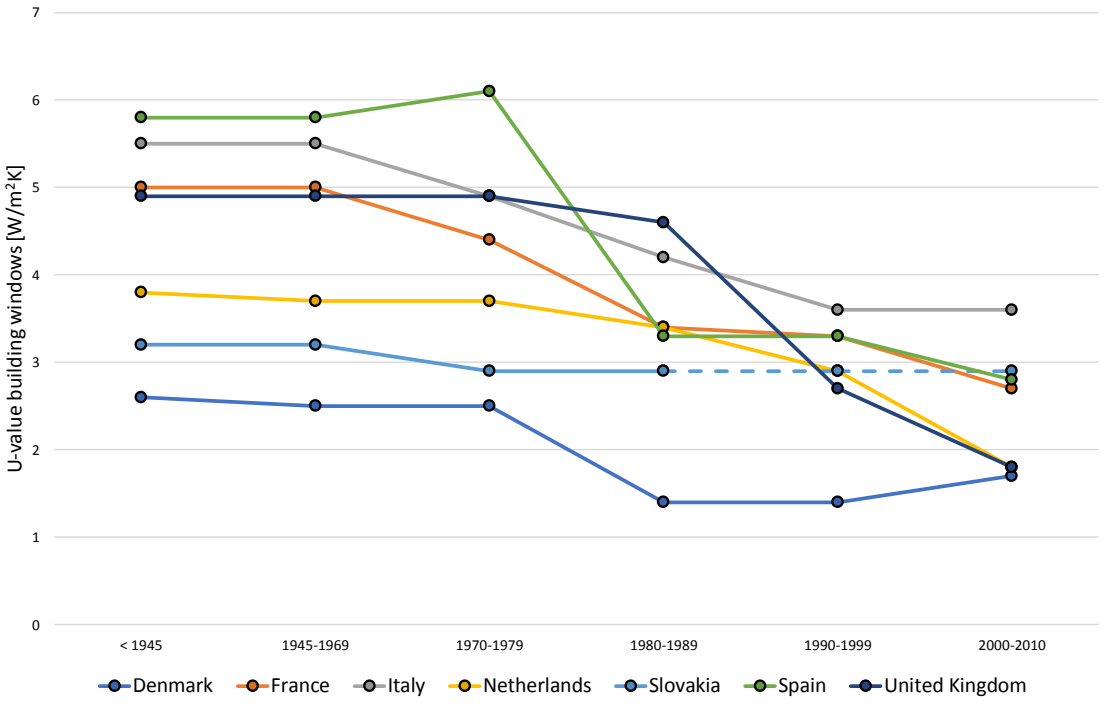


Figure 55. Trend of the U-value building windows – Seven countries zoom (Source: rielaboration of the authors with BSO data)

ANNEX b - Overview on existing dataset and evaluation of the BIM integration within the ALDREN approach

This annex presents an overview of the BIM process and its possible integration within the framework of the ALDREN Building Passport.

“BIM is essentially value creating collaboration through the entire life-cycle of an asset, underpinned by the creation, collation and exchange of shared three-dimensional (3D) models and intelligent, structured data attached to them.” (What is BIM? UK Building Information Modelling Task Group, 2013)

This definition highlights that BIM, short for Building Information Modelling, is a process based on digital platforms for integrated design, modelling, asset planning running and cooperation in the construction sectors. It provides all stakeholders with a digital representation of a building's characteristics in its whole life-cycle. The great advantage of BIM process with respect to traditional processes in the AEC domain is the possibility to share information in a common environment reducing gaps and barriers for an efficient communication among stakeholders (Figure 33).

In a BIM process data associated to 3D models are the real key element to drive entire process and the possibility to increase efficiency and allow gains. Indeed, the availability of data and the ability to understand and act on it are fundamental for decision making (Figure 34).

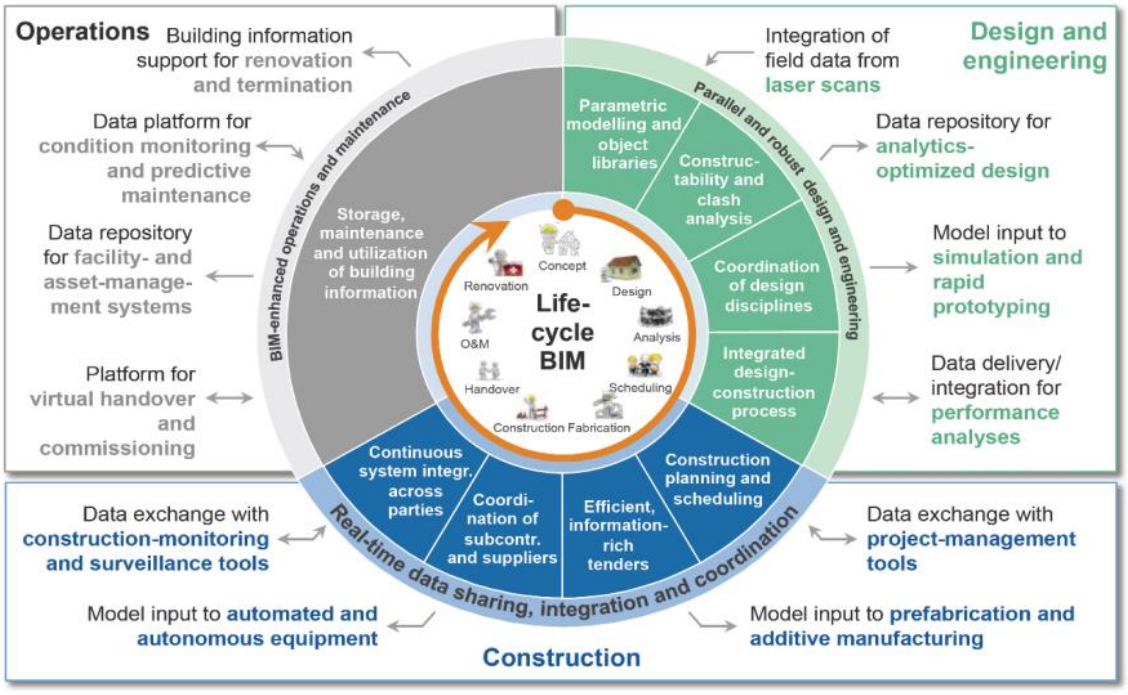


Figure 56. Applications of BIM along the engineering and construction value chain (Source: Shaping the Future of Construction)

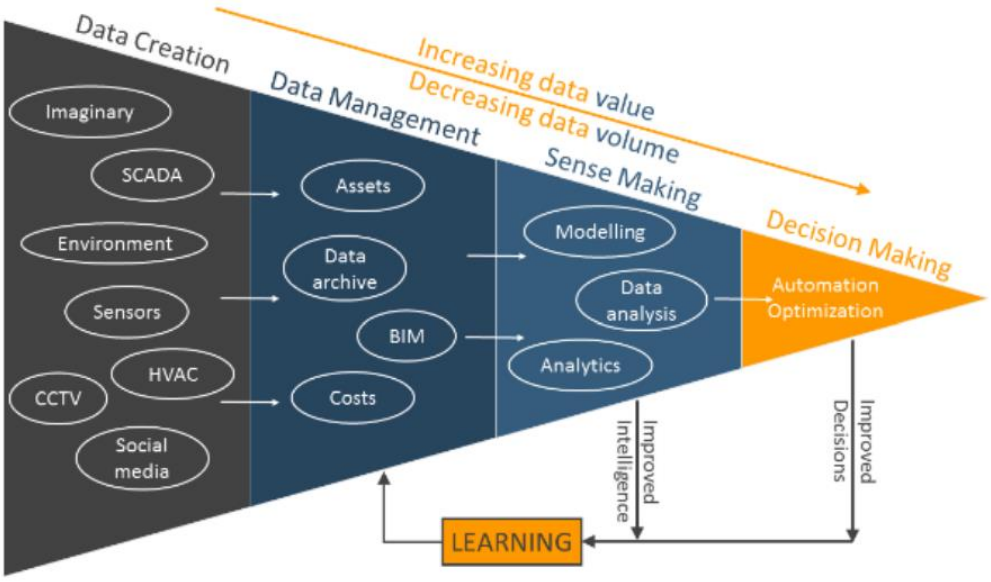


Figure 57. Smart Buildings: from data to information (Source: Building Information Modelling (BIM) standardization)

The passage from traditional approaches to the BIM paradigm is associated with the concept of maturity level according to some indicators: content, digitalization, interoperability and collaboration:

- Level 0 BIM. Unmanaged computer aided design (CAD) including 2D drawings, and text with paper-based or electronic exchange of information but without common standards and processes. Essentially this is a digital drawing board.
- Level 1 BIM. Managed CAD, with the increasing introduction of spatial coordination, standardized structures and formats as it moves towards Level 2 BIM. This may include 2D information and 3D information such as visualizations or concept development models. Level 1 can be described as 'Lonely BIM' as models are not shared between project team members.
- Level 2 BIM. Managed 3D environment with data attached but created in separate discipline-based models. These separate models are assembled to form a federated model, but do not lose their identity or integrity. Data may include construction sequencing (4D) and cost (5D) information. This is sometimes referred to as 'pBIM' (proprietary BIM).
- Level 3 BIM. A single collaborative, online, project model with construction sequencing (4D), cost (5D) and project lifecycle information (6D). This is sometimes referred to as 'iBIM' (integrated BIM) and is intended to deliver better business outcomes.
- Level 4 BIM. Level 4 introduces the concepts of improved social outcomes and wellbeing.

As observed by the European Construction Sector Observatory in the report “Building Information Modelling in the EU construction sector” governments play a key role in BIM standardization, whether at the domestic or international level. By influencing BIM standards at the European and/or international level, governments have the opportunity to ensure that BIM standards match their industry’s interests and ambition.

In the BIM process key concepts that needs to be standardized are generally subdivided into concepts, data models and process.

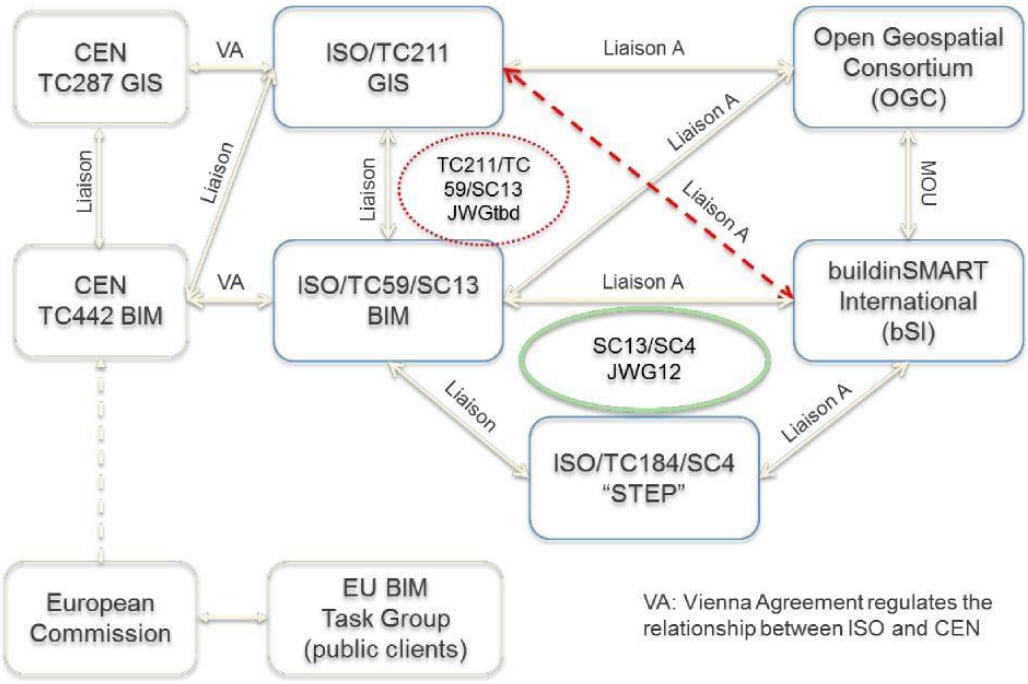


Figure 58. International BIM standardization (Source: Building Information Modelling (BIM) standardization)

Common concepts and classification of concepts are necessary to use the same language. Common conceptualization requires the definition of standards for the definition of the following key concepts:

- LOD (Level of Definition): describes how detailed objects should be in terms of graphic representation and data content in order to support dataflow and process execution between one software platform and another. LOD only describes model content in a software context.
- LOG (Level of Geometry): the geometrical part of the model is the Level of Geometry (also called level of detail). It defines how detailed is the geometry of a building element. Country-specific LOG descriptions can be found. They are based on a common assumption, namely, that digital objects/building parts are becoming progressively more detailed in terms of their graphic representation from phase to phase.
- LOI (Level of Information): the non-geometric part of the building is the LOI or Level of Information. In BIM models, the LOI stands for the non-geometric, technical information of a model. Content with a high LOI, for example, contains manufacturer-specific information such as price and stock information.
- LOR (Level of Reliability): describes the contractual frame for the reliability of models/objects and model content. The Level of Reliability, which takes into account both the geometrical correspondence and the ontological reliability of the model, summarize the level of global coherence of the process of defining a digital object.

The LOD will increase as the design progresses and may vary between disciplines at each work stage, plus not all elements or objects within the same discipline will necessarily be at the same LOD at the same stage of the project lifecycle.

A BIM object should be a combination of information to define the product, geometry to give it physical characteristics and data relating to its function and visual appearance. They can be imported into a model by the designer and when objects all follow the same naming convention they can then be scheduled and compared. BIM objects may be produced and shared by the team. These may be from a central 'client or project' library or from external sources. These object libraries are quite often used for portfolios of work. There are two main types of objects, components and layered. (Components have defined geometrical shape, e.g. doors. Layered objects do not have a fixed shape, e.g. carpets.) The NBS has developed a BIM Object Standard for the creation of BIM objects to a clear set of guidelines, following a specific naming structure and can be used as a system to follow. Objects such as walls, floors, doors etc. are assessed against this standard, prior to inclusion in the NBS National BIM library.

Data models' standards are required to specify data structures for entities, geometry and related properties ensuring exchange of object-based information. IFC (Industry Foundation Classes) is an industry-wide open and neutral data exchange format that will interact with the majority of software. IFC is also an international standard, EN ISO16739:2017 and represents an open international standard for BIM data that is exchanged and shared among software applications used by the various participants in a built environment construction or asset management project. buildingSMART International has the ownership for the IFC standard.

Establishment of BIM guidelines and standards for the entire BIM process are fundamental for an effective generation of further business opportunity. As highlighted by the European Construction Sector Observatory in the report "Building Information Modelling in the EU construction sector " several governmental and industry's initiatives focus on establishing BIM guidelines and standards, at the domestic and sometimes international level For example, in Denmark, seven leading operators in the construction sector started the Digital Convergence (DiKon), which is a business platform, aiming to implement and disseminate common IT standards in the entire Danish construction sector. From a governmental point of view EN ISO 19650 outlines the concepts and principles for information management. This document provides recommendations for a framework to manage information including exchanging, recording, versioning and organizing for all actors. This document is applicable to the whole life cycle of any built asset, including strategic planning, initial design, engineering, development, documentation and construction, day-to-day operation, maintenance, refurbishment, repair and end-of-life.

In the framework of ALDREN project BIM can be integrated at three different stages:

- Documentation and BIM is one module of the ALDREN BuildLog and the datasets contained in that module are a key part of the ALDREN approach and they are basically in the back-end phase.
- Within the ALDREN project development, the goal of this investigation was to set up a clear picture of the needs, requests and characteristics necessary for a whole BIM integration within the approach.

- The developed structure of the ALDREN BRP foreseen a BIM module of the BuildLog at the middle-ware phase, which contains the main building data and information, collected by the compiller and manually inserted within the file.
- A further BIM implementation in the next future, it could be the automation of the data transfer, through the use of the IFC file or an online repository, along the data flow of the ALDREN approach. At the back-end phase allowing data sharing between databases of each topic to increase data availability, standardization and quality and targeting the increase of the LoI through the time with the aim to reach a BIM level of maturity 3 and 4.

A first example of BIM-based passport has been developed within the BAMB (Buildings as Material Banks) [63] project as a a qualitative and quantitative documentation of the materials composition of a building, displaying materials embedded in buildings as well as showing their recycling potential and environmental impact. The BIM-based Material Passport (MP) is moreover an optimization tool in early design stages and acts as an inventory at the end of the life-cycle of a building, therefore serving as a basis for a secondary raw materials cadastre. Through knowledge gathered in previous projects, as well as through expert interviews, the content of MP as well as the vital characteristics were defined. These are the type, amount, allocation and quality in terms of recyclability and environmental impact of materials, as well as the separability of two enclosed materials. The separability of two enclosed materials is an important information, since materials which are glued to each other are difficult to separate and lead to unclean fractions.

The framework is based on a prior research from Markova and Rechberger [64], whereby two approaches were tested, which are the bottom-up top-down approaches. For the BIM-based MP a mix of these two approaches was used, by starting with the element level. The developed framework, which consists of four levels: the building-, component-, element- and material- level. Through up- and down-scaling, one component, element or material can be reached. In the building-level, all components existing in a building, such as the slabs, exterior walls, are added up.

Through downscaling from the element-level, the material-level is reached, where properties for the MP are linked to each material.

The BIM-based MP has varying purposes throughout the life-cycle, as displayed in figure 2. Four stages were considered for the MP, whereby the focus of this paper is on the conceptual and preliminary design stage.

The main results obtained from the BIM-supported MP is the total material composition of the building including the masses and the recycling grade (from 1-5), which contrasts the share of recyclable materials with the share of waste created by the building. Apart from that, the BIM-based MP assesses the element-based disposal indicator, which is displayed in the BIM-model in colours from green to red (green: very good, yellow: average, red: bad disposal grade). The BIM-supported MP also shows the environmental impact of the building, expressed in Global Warming Potential (GWP), Acidification Potential (AP) and Primary Energy Intensity (PEI). All results are obtained on building-, component-, element- and material-level [65].

All above mentioned data, the method as well as the building elements, which were used for the templates, were obtained from the Institute for Building and Ecology (IBO) [66].

ANNEX c - Report on the definition of the Data Model of all the collected knowledge

In Annex c the whole indicators structured in the digital version of the ALDREN BRP are presented in dedicated guidance per each module of the BuildLog specifying in particular, name, code, definition, source and unit.

The current first release of the D2.6 presents only the Guidance for the Module 1 of the ALDREN BuildLog, but the other guidance are under conclusions and they will be soon integrated in the present annex.

ANNEX c1 - Guidance for the ALDREN BuildLog Modules

ALDREN BuildLog Module 1: Building picture

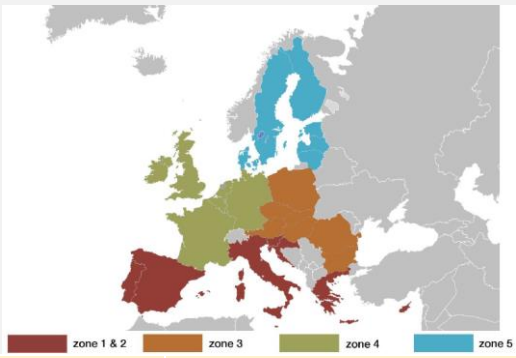
Indicator	Code	Definition	Source	Unit
BUILDING FEATURES	**M1.1**			
Building category	ML1_1.1	Classification of building related to its main use.	EVCS, ISO 52000-1:2016 and ALDREN methodology (see note 1)	-
		Note 1 to entry: the categories proposed are only NON RESIDENTIAL HOTEL or OFFICE being the main focus of ALDREN project.		
		Note 2 to entry: some buildings or building units could contain spaces of different (use) categories; for instance an office building may contain a restaurant; add this other categories to the main (ML1_1.1) considering ML1_1.2, ML1_1.3 and ML1_1.4.		
Mixed use – space category 2	ML1_1.2	Classification of other category use of other building spaces - in addition to the main category – related to a specific set of use conditions (ML1_1.1)	ALDREN methodology + ISO 52000-1:2016 definition	-
		Note 1 to entry: the most common choices for other uses complementary to the Non-Residential building use are available from the menu (Bar -Restaurant – Retail Non Food – Retail Food - Other). The space category is relevant for the calculation of the energy performance assessment and for defining reference size (source ISO 52000-1:2016).		
Mixed use – space category 3	ML1_1.3	See ML1_1.2	ALDREN methodology + ISO 52000-1:2016 definition	-
Mixed use – space category y 4	ML1_1.4	See ML1_1.2	ALDREN methodology + ISO 52000-1:2016 definition	-
Type of hotel	ML1_1.5	Classification of hotel benchmarks	Tabula project and German study on benchmarks for non-residential buildings BBSR 2009	-

		Note 1 to entry: choice a type of hotel available from the menu (1- and 2- star hotel; 3- star hotel; 4- and 5- star hotel; younth hostel/guest house; holiday accommodation; club houses; communal accomodations; others).		
No. of rooms in hotel building	ML1_1.6	Number of rooms available for the hotel	EDGE app (tool developed by International Finance Corporation IFC World Bank Group) + ALDREN methodology	number
		Note 1 to entry: range numbers for rooms are available from the menu to chose.		
No. of offices private/closed in office buildings	ML1_1.7	Number of office space (private or closed) available in the building	ALDREN methodology	number
		Note 1 to entry: insert value if available.		
No. of workstation in open space in office building	ML1_1.8	Number of workstation in open space available in the office building	ALDREN methodology	number
		Note 1 to entry: insert value if available.		
No. of workstation in open space in office building	ML1_1.9	Sport facilities, thermally conditioned which contribute to the reference size (ML1)	ALDREN methodology – ISO 52000-1:2016	m^2
		Note 1 to entry: If available indicate relative m^2(example od spaces: Swimming Pool / Health Spa / Gym…) of sport space thermally conditioned (=heated and/or cooled space)		
No. of workstation in open space in office building	ML1_1.10	Sport facilities, thermally unconditioned which contribute to the reference size (ML1)	ALDREN methodology – ISO 52000-1:2016	-
		Note 1 to entry: Click if available sport space thermally unconditioned (=room or enclosure that is not part of a thermally conditioned space)		
Building Name	ML1_1.11	Building Name of Hotel or Office if available	ALDREN methodology	-
Building Owner Name	ML1_1.12	Building Owner Name if available	ALDREN methodology	-
Year of construction	ML1_1.13	Year of building construction	EVCS	-
Year of last renovation	ML1_1.14	Year of last building renovation. Refer to note 1 to understand differences between renovation and maintenance.	EVCS + ALDREN methodology	-

		Note 1 to entry: Maintenance refers to the repair, upkeep and operation of facilities or deficiencies during the time period in which they occur. This includes preventive maintenance for buildings, structures, and installed building equipment (IBE) as recommended by the manufacturer. It also includes engineering and/or contracted Architectural and Engineering services that support planning, design, and execution of maintenance activities. Renovation refers to the replacement of components in existing facilities and / or technical construction component of the building.
Bearing structure	ML1_1.15	Corridors
		Note 1 to entry:

Indicator	Code	Definition	Source	Unit
LOCATION DATA	**ML1_2**			
Country	ML1_2.1	Country	ALDREN methodology	-
		Note 1 to entry: chose the EU country from the menu.		
City	ML1_2.2	City of building localization	ALDREN methodology	-
		Note 1 to entry: insert name of the city in mothertongue.		
Province	ML1_2.3	Province of building localization	ALDREN methodology	-
		Note 1 to entry: in case of availability indicate both Province and State.		
Postal code	ML1_2.4	Postal code of city localization	ALDREN methodology	-
		Note 1 to entry: insert no. of city postal code.		
Address	ML1_2.5	Address of building localization	ALDREN methodology	-
		Note 1 to entry: insert address of the building.		
Latitude	ML1_2.6	Latitude of city localization	ALDREN methodology	-
		Note 1 to entry: insert latitude if the data is available.		
Longitude	ML1_2.7	Longitude of city localization	ALDREN methodology	-
		Note 1 to entry: insert longitude if the data is available.		
Land parcel no.	ML1_2.8	Land parcel number	ALDREN methodology	-
		Note 1 to entry: enter number of land parcel according to the local regulation register.		

Indicator	Code	Definition	Source	Unit
WEATHER DATA	**M1.3**			

Climate locality	3.1	Climate locality	EVCS + Ecofys climate zone map	-
		Note 1 to entry: write the name of the city used as reference for the climate conditions.		
		Note 2 to entry: consider the map [Ecofys and European climate zones and bio-climatic design requirements PVSITES project] below to verify to which zone belongs the locality in object 		
Heating degree days	3.2		ALDREN methodology	-
		Note 1 to entry:		
Cooling degree days	ML1_3.3		ALDREN methodology	-
		Note 1 to entry:		
Indicator	**Code**	**Definition**	**Source**	**Unit**
BUILDING GEOMETRY	**ML1_4**			
Reference floor area	ML1_4.1	Floor area used as a reference size for the main space use.	ALDREN methodology – ISO 52000-1:2016 - ISO 9836:2017-1 - EVCS	m^2
		Note 1 to entry: reference size is relevant metric to normalize the overall or partial energy performance and energy performance requirements to the size of the building or part of a building and for the comparison against benchmarks. For the calculation you can refer to the net floor area = total floor area – floor area of structural elements (ISO 9836:2017-1 Figure 2 and 5.1.5 definition).		
Building volume	ML1_4.2	Building volume is the heated volume of the building.	ALDREN methodology - EVCS	m^3
		Note 1 to entry:		
Shape factor A/V	ML1_4.3	Shape factor calculated as a ratio between ML1_4.1 and ML1_4.2 = ratio between the outside surface area of the thermal insulation in the building envelope (A) and the heated volume (V).	ALDREN methodology – ISO 52000-1:2016 - ISO 9836:2017-1 - EVCS	m^2 / m^3
		Note 1 to entry: automatically calculated by excel		

Number of floors	ML1_4.4	Total guest rooms no. of the hotel.	ALDREN methodology	-
		Note 1 to entry: insert no. of guest rooms without indicating their respective size (single, double, family, etc.).		
Guest rooms no.	ML1_4.5	Guest rooms no.	ALDREN methodology	-
		Note 1 to entry: insert no. of rooms without specifying the room typology		
Corridors	ML1_4.6	Conference	ALDREN methodology	m^2
		Note 1 to entry:		
Conference	ML1_4.7	Banquet/ Common Areas	ALDREN methodology	m^2
		Note 1 to entry:		
Banquet / Common Areas	ML1_4.8	Office space room	ALDREN methodology	m^2
		Note 1 to entry:		
Office space room	ML1_4.9	Open Space / working station	ALDREN methodology	m^2
		Note 1 to entry:		
Open space / working station	ML1_4.10	Common restrooms	ALDREN methodology	m^2
		Note 1 to entry:		
Common restrooms	ML1_4.11	Sport space	ALDREN methodology	m^2
		Note 1 to entry:		
Sport space	ML1_4.12	Sport space	ALDREN methodology	m^2
		Note 1 to entry:		

Indicator	Code	Definition	Source	Unit
ENVELOPE	**ML1_5**			
WALL	**ML1_5.1**			
External wall finiture	ML1_5.1.1	External wall finish is the final surface or layer of the external wall.	ALDREN methodology + XENIOS project	-
		Note 1 to entry: select from the menu the possible choice of wall finish		
External wall main structure	ML1_5.1.2	External wall main structure considers the structure layer of the outer façade solution.	ALDREN methodology + XENIOS project	-

		Note 1 to entry: select from the menu the possible choice of wall structure		
External wall U value (average)	ML1_5.1.3	A U-value is a measure of heat loss through a building envelope element or it's also called a heat transfer coefficient. A low U-value indicates a high level of insulation. In case of different solutions, insert an average value.	ALDREN methodology	-
		Note 1 to entry: you can use one of the following links to calculate online the U value of the external wall: https://www.vesma.com/tutorial/uvalue01/uvalue01.htm *https://www.rockwool.co.uk/technical-resources/tools/u-value-calculator/*		
Presence of insulation	ML1_5.1.4	Presence of insulation indicate if at the audit time, the external wall is insulated or not.	ALDREN methodology	-
		Note 1 to entry: use the menu to select yes or no.		
Thickness of insulation	ML1_5.1.5	Thickenss of insulation.	ALDREN methodology	mm
		Note 1 to entry: in case of presence at ML1_5.1.4 and data availability, insert manually the thickness of insulation [mm].		

Indicator	Code	Definition	Source	Unit
ENVELOPE **WINDOW**	**ML1_5** **ML1_5.2**			
External windows opening	ML1_5.2.1	External windows could be openable or non-openable	ALDREN methodology + XENIOS project	-
		Note 1 to entry: select from the menu the possible choice of external window opening.		
External windows U value (average)	ML1_5.2.2	See ML1_5.1.3 definition for U value. The U-value is calculated for window pane and frame together.	ALDREN methodology + BSO indicator	-
		Note 1 to entry: you can use the following link to calculate online the U value of window: *https://www.onyxsolar.com/it/u-termical-it*		
Facade protection elements	ML1_5.2.3	Façade protection elements are important to evaluate the lighting comfort and the façade component.	ALDREN methodology + XENIOS project	-
		Note 1 to entry: select from the menu the possible choice of façade protection elements.		

Glazed facade	ML1_5.2.4	Glazed façade identifies the performance of the glazing element.	ALDREN methodology + XENIOS project	-
		Note 1 to entry: select from the menu the possible choice of glazed façade.		
Shutters and solar protection	ML1_5.2.5	Shutters and solar protection for the transparent element.	ALDREN methodology + XENIOS project	-
		Note 1 to entry: select from the menu the possible choice of shutters and solar protection.		

Indicator	Code	Definition	Source	Unit
ENVELOPE **FLOOR**	**ML1_5** **ML1_5.3**			
Total no. of floors	ML1_5.3.1	No. of floors heated or cooled	ALDREN methodology	-
		Note 1 to entry: insert manually the number of floor heated or cooled of the building		
Floor U value (average)	ML1_5.3.2	See ML1_5.1.3 definition for U value. The U-value is calculated as an average of all floors.	ALDREN methodology + BSO indicator	-
		Note 1 to entry: you can use the following link to calculate online the U value of window: *https://www.ubakus.de/u-wert-rechner/?*		
Structure slab	ML1_5.3.3	Typology structure of the slab	ALDREN methodology + XENIOS project	-
		Note 1 to entry: select from the menu the option available and identified by XENIOS project.		

Indicator	Code	Definition	Source	Unit
ENVELOPE **ROOF**	**ML1_5** **ML1_5.4**			
Roof covering	ML1_5.4.1	Roof covering typology.	ALDREN methodology	-
		Note 1 to entry: select from the menu the possible choice of roof covering.		
Roof U value (average)	ML1_5.4.2	See ML1_5.1.3 definition for U value. The U-value is calculated as an average of all floors.	ALDREN methodology + BSO indicator	-
		Note 1 to entry: you can use the following link to calculate online the U value of window: *https://www.ubakus.de/u-wert-rechner/?*		

Roof main structure	ML1_5.4.3	Typology structure of the roof.	ALDREN methodology + XENIOS project	-
		Note 1 to entry: select from the menu the possible choice of roof main structure.		

Indicator	Code	Definition	Source	Unit
TECHNICAL SYSTEM	**ML1_6**			
SPACE HEATING	**ML1_6.1**	**Space heating** refers to the use of energy to provide heat (i.e. thermal energy) in an interior area of a dwelling. Space heating can be ach.	Eurostat	
Type of heating system	ML1_6.1.1	This indicators refairs to the heating system feature for the building as a whole.	ALDREN methodology + EVCS	-
		Note 1 to entry: select from the menu the possible choice of heating system type.		
Generation 1	ML1_6.1.2	Considering the BSO heating system typology, this indicator will characterize each generator system available for heating.	ALDREN methodology + BSO indicator	-
		Note 1 to entry: select from the menu the possible choice of heating generation.		
Generation 2	ML1_6.1.3	See ML1_6.1.2 for definition	ALDREN methodology + BSO indicator	-
		Note 1 to entry: select from the menu the possible choice of heating generation.		
Generation 3	ML1_6.1.4	See ML1_6.1.2 for definition	ALDREN methodology + BSO indicator	-
		Note 1 to entry: select from the menu the possible choice of heating generation.		
Generation x	ML1_6.1.5	See ML1_6.1.2 for definition	ALDREN methodology + BSO indicator	-
		Note 1 to entry: select from the menu the possible choice of heating generation.		
Average efficiency rate of generation at ML1_6.1.2	ML1_6.1.6	See ML1_6.1.2 for definition	ALDREN methodology + BSO indicator	-
		Note 1 to entry: select from the menu the possible choice of heating generation.		
Average efficiency rate of generation at ML1_6.1.3	ML1_6.1.7	See ML1_6.1.2 for definition	ALDREN methodology + BSO indicator	-
		Note 1 to entry: select from the menu the possible choice of heating generation.		
Average efficiency rate of	ML1_6.1.8	See ML1_6.1.2 for definition	ALDREN methodology + BSO indicator	-

generation at ML1_6.1.4		*Note 1 to entry: select from the menu the possible choice of heating generation.*		
Average efficiency rate of generation at ML1_6.1.5	ML1_6.1.9	See ML1_6.1.2 for definition	ALDREN methodology + BSO indicator	-
		Note 1 to entry: select from the menu the possible choice of heating generation.		
System 1 – Brand name	ML1_6.1.10	Brand name of heating system 1	ALDREN methodology	-
		Note 1 to entry: insert manually if available		
System 1 – Energy label	ML1_6.1.11	Energy label of heating system 1	BSO indicator / energy labelling directive	-
		Note 1 to entry: insert manually if available		
System 1 – Age	ML1_6.1.12	Age of the heating system 1	Eurostat + BSO indicator	-
		Note 1 to entry: insert manually if available		
System 1 – Power	ML1_6.1.13	Power of heating system 1	BSO indicator	-
		Note 1 to entry: insert manually if available		
System 2 – Brand name	ML1_6.1.14	Brand name of heating system 2	ALDREN methodology	-
		Note 1 to entry: insert manually if available		
System 2 – Energy label	ML1_6.1.15	Energy label of heating system 2	BSO indicator / energy labelling directive	-
		Note 1 to entry: insert manually if available		
System 2 – Age	ML1_6.1.16	Age of the heating system 2	Eurostat + BSO indicator	-
		Note 1 to entry: insert manually if available		
System 2 – Power	ML1_6.1.17	Power of heating system 2	BSO indicator	-
		Note 1 to entry: insert manually if available		
System 3 – Brand name	ML1_6.1.18	Brand name of heating system 3	ALDREN methodology	-
		Note 1 to entry: insert manually if available		
System 3 – Energy label	ML1_6.1.19	Energy label of heating system 3	BSO indicator / energy labelling directive	-
		Note 1 to entry: insert manually if available		
System 3 –	ML1_6.1.20	Age of the heating system 3	Eurostat + BSO indicator	-

Age		*Note 1 to entry: insert manually if available*		
System 3 – Power	ML1_6.1.21	Power of heating system 3	BSO indicator	-
		Note 1 to entry: insert manually if available		
System x – Brand name	ML1_6.1.22	Brand name of heating system x	ALDREN methodology	-
		Note 1 to entry: insert manually if available		
System x – Energy label	ML1_6.1.23	Energy label of heating system x	BSO indicator / energy labelling directive	-
		Note 1 to entry: insert manually if available		
System x – Age	ML1_6.1.24	Age of the heating system x	Eurostat + BSO indicator	-
		Note 1 to entry: insert manually if available		
System x – Power	ML1_6.1.25	Power of heating system x	BSO indicator	-
		Note 1 to entry: insert manually if available		

Indicator	Code	Definition	Source	Unit
TECHNICAL SYSTEM	**ML1_6**			
SPACE COOLING	**ML1_6.2**	**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	
Type of cooling system	ML1_6.2.1	This indicators refairs to the cooling system feature for the building as a whole.	ALDREN methodology + EVCS	-
		Note 1 to entry: select from the menu the possible choice of cooling system type.		
Average Efficiency rate of cooling system at ML1_6.2.1	ML1_6.2.2	This indicator will reflex the average efficiency of space cooling equipment. Energy conversion efficiency (η).	ALDREN methodology + BSO indicator	-
		Note 1 to entry: select from the menu the possible choice of heating generation.		
System 1 –	ML1_6.1.10	Brand name of heating system 1	ALDREN methodology	-

Brand name		*Note 1 to entry: insert manually if available*		
System 1 – Energy label	ML1_6.1.11	Energy label of cooling system 1	BSO indicator / energy labelling directive	-
		Note 1 to entry: insert manually if available		
System 1 – Age	ML1_6.1.12	Age of the cooling system 1	Eurostat + BSO indicator	-
		Note 1 to entry: insert manually if available		
System 1 – Power	ML1_6.1.13	Power of cooling system 1	BSO indicator	-
		Note 1 to entry: insert manually if available		
System 2 – Brand name	ML1_6.1.14	Brand name of cooling system 2	ALDREN methodology	-
		Note 1 to entry: insert manually if available		
System 2 – Energy label	ML1_6.1.15	Energy label of heating system 2	BSO indicator / energy labelling directive	-
		Note 1 to entry: insert manually if available		
System 2 – Age	ML1_6.1.16	Age of the cooling system 2	Eurostat + BSO indicator	-
		Note 1 to entry: insert manually if available		
System 2 – Power	ML1_6.1.17	Power of cooling system 2	BSO indicator	-
		Note 1 to entry: insert manually if available		
System 3 – Brand name	ML1_6.1.18	Brand name of cooling system 3	ALDREN methodology	-
		Note 1 to entry: insert manually if available		
System 3 – Energy label	ML1_6.1.19	Energy label of cooling system 3	BSO indicator / energy labelling directive	-
		Note 1 to entry: insert manually if available		
System 3 – Age	ML1_6.1.20	Age of the cooling system 3	Eurostat + BSO indicator	-
		Note 1 to entry: insert manually if available		
System 3 – Power	ML1_6.1.21	Power of cooling system 3	BSO indicator	-
		Note 1 to entry: insert manually if available		
		Note 1 to entry: insert manually if available		

Indicator	Code	Definition	Source	Unit
TECHNICAL SYSTEM	**ML1_6**			
DOMESTIC HOT WATER	**ML1_6.3**	**Domestic hot water** refers 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. Domestic hot water can be produced alone or in combination with space heating systems.	Eurostat	
No. of boiler	ML1_6.3.1	This indicators refairs to the no. of Water Heater/Boiler: A thermally insulated vessel designed for heating and storing hot water.	BSO indicator – Eurostat definition	-
		Note 1 to entry: select from the menu the possible choice of cooling system type.		
Boiler 1	ML1_6.3.2	Presence or absence of boiler	ALDREN methodology + BSO indicator	-
		Note 1 to entry: select from the menu if it is available the boiler.		
Boiler 1 – Tank size	ML1_6.3.3	The volume (litres) of the water heater. Broad classes may be used for reporting tank size.	BSO indicator – Eurostat definition	-
		Note 1 to entry: insert manually if available		
Boiler 1 – Tank age	ML1_6.3.4	The age of the water heater. Broad classes may be used for reporting tank age.	BSO indicator – Eurostat definition	-
		Note 1 to entry: insert manually if available		
Boiler 2	ML1_6.3.5	Presence or absence of boiler	ALDREN methodology + BSO indicator	-
		Note 1 to entry: insert manually if available		
Boiler 2 – Tank size	ML1_6.3.6	The volume (litres) of the water heater. Broad classes may be used for reporting tank size.	BSO indicator – Eurostat definition	-
		Note 1 to entry: insert manually if available		

Boiler 2 – Tank age	ML1_6.3.7	The age of the water heater. Broad classes may be used for reporting tank age.	BSO indicator – Eurostat definition	-
		Note 1 to entry: insert manually if available		

Indicator	Code	Definition	Source	Unit
TECHNICAL SYSTEM	**ML1_6**			
VENTILATION	**ML1_6.4**			
Typology of ventilation system	ML1_6.3.1	This indicators refairs to the typology of ventilation system in the building.	BSO indicator	-
		Note 1 to entry: select from the menu the possible choice of ventilation system type.		
Average Efficiency rate of ventilation system	ML1_6.3.2	This indicator will reflex the average efficiency of ventilation equipment. Energy conversion efficiency (η).	ALDREN methodology + BSO indicator	-
		Note 1 to entry: insert manually if available		

Indicator	Code	Definition	Source	Unit
TECHNICAL SYSTEM	**ML1_6**			
LIGHTING	**ML1_6.5**	This category includes the use of electricity for lighting. Incandescent lamps are slowly being replaced by more efficient fixtures.	Eurostat definition	
CFL lamps no.	ML1_6.5.1	A compact fluorescent lamp, or light (CFL) and compact fluorescent tube, is a fluorescent lamp designed to replace an incandescent lamp.	BSO indicator	-
		Note 1 to entry: insert manually no. if available		
Halogen lamps no.	ML1_6.5.2	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 a halogen such as iodine or bromine added.	BSO indicator	-
		Note 1 to entry: insert manually no. if available		

LED lamps no.	ML1_6.5.3	A LED lamp is a light-emitting diode (LED) product that is 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.	BSO indicator	-
		Note 1 to entry: insert manually no. if available		
Other lamps no.	ML1_6.5.4	Lamps other than the above-mentioned types.	BSO indicator	-
		Note 1 to entry: insert manually no. if available		

Indicator	Code	Definition	Source	Unit
TECHNICAL SYSTEM **RENEWABLE ENERGY**	**ML1_6** **ML1_6.6**			
Amount of on-site renewable energy generation	ML1_6.6.1	This indicators refairs to the typology of on-site RES generation	SRI	-
		Note 1 to entry: select from the menu the possible choice		
Reporting information regarding energy generation	ML1_6.6.2	This indicators refairs to the RES generation	SRI	-
		Note 1 to entry: select from the menu the possible choice		
Storage of locally generated energy	ML1_6.6.3	This indicators refairs to the storage generation	SRI	-
		Note 1 to entry: select from the menu the possible choice		
Optimizing self-consumption of locally generated energy	ML1_6.6.4	This indicators refairs to the optimizing self-consumption	SRI	-
		Note 1 to entry: select from the menu the possible choice		
CHP control	ML1_6.6.5	This indicators refairs to the CHP control	SRI	-
		Note 1 to entry: select from the menu the possible choice		

Indicator	Code	Definition	Source	Unit
TECHNICAL SYSTEM	**ML1_6**			
METERING	**ML1_6.7**			
Control system for heating and cooling	ML1_6.7.1	This indicators refairs to the typology of ventilation control system for heating and cooling.	BSO indicator + XENOS project typologies for control system	-
		Note 1 to entry: select from the menu the possible choice of control system type.		
Emission control for TABS (Heating mode)	ML1_6.7.2	This indicators refairs to the TABS control type	SRI	-
		Note 1 to entry: select from the menu the possible choice		
Control of distribution heat temperature	ML1_6.7.3	This indicators refairs to the distribution H control temperature	SRI	-
		Note 1 to entry: select from the menu the possible choice		
Control of distribution pumps in network	ML1_6.7.4	This indicators refairs to to the distribution pumps	SRI	-
		Note 1 to entry: select from the menu the possible choice		
Intermittent control of emission and/or distribution	ML1_6.7.5	This indicators refairs to the intermittent control	SRI	-
		Note 1 to entry: select from the menu the possible choice		
Thermal Energy Storage for building heating (no TABS)	ML1_6.7.6	This indicators refairs to the termal energy storage for heating no TABS	SRI	-
		Note 1 to entry: select from the menu the possible choice		

Indicator	Code	Definition	Source	Unit
TECHNICAL SYSTEM	**ML1_6**			
ELECTRIC VEHICLE CHARGING	**ML1_6.8**			
EV Charging point	ML1_6.8.1	This indicator refairs to the EV charging point	SRI	-
		Note 1 to entry: select from the menu the possible choice of control system type.		
EV Charging types	ML1_6.8.1	This indicator refairs to the EV charging types	SRI	-
		Note 1 to entry: select from the menu the possible choice of control system type.		

The following guidance for the whole ALDREN BuildLog modules will be implemented in the next month in time for the pilots' phase application.

ANNEX c2 - Guidance for the ALDREN RenoMap Modules

The guidance for the whole ALDREN RenoMap modules will be implemented in the next month in time for the pilot's phase application. In this annex are presented the templates of the RenoMap tool and general information included in the guide documents.

TEMPLATE : Evaluation Table of ERAs

ERA #	Elementary Renovation Actions	NZEB level - FR context	
E.	**ENVELOPE**		
E.1	**Thermal insulation of external walls**	U = 0,17 W/m².K	
E.2	**Thermal insulation of roof surfaces**	U = 0,15 W/m².K	
E.3	**Thermal insulation of bottom floor surfaces**	U = 0,5 W/m².K	
E.4	**Thermal bridges treatment : Facades to roof**	ΔU = 0,02-0,05 W/m².K	
E.5	**Thermal bridges treatment : Windows to walls**		
E.6	**Windows replacement**	U = 0,75-1 W/m².K - triple/double glazing	
E.7	**Doors replacement**	U = 1,4 W/m².K	
E.8	**Integration of a double-door entrance**	-	
E.9	**Blinds and solar protections**	-	
E.10	**Envelope air tightness treatment**	Q4pa = 1 m3/h.m²	
V.	**VENTILATION**		
V.1	**Ventilation : Ventilation system replacement**	Central ventilation system / double-flow (Eff>0,75)	
V.2	**Ventilation : Controls**	Occupancy	
H.	**HEATING**	**Air solution**	**Water solution**
H.1	**Heating : Heat generation system replacement**	Heat pump / air conditioning electric system	district heating
H.2	**Heating : Distribution network replacement**	air network	low temperature bi-tube network
H.3	**Heating : Thermal insulation of distribution network**		Classe 4 (out of heated space)
H.4	**Heating : Emission systems replacement**	air-conditioning diffusers (air)	Low-temperature radiators/ emission
H.5	**Heating : Controls**	Occupancy, night/week end setback	
C.	**COOLING**	**Air solution**	**Water solution**
C.1	**Cooling : Cooling generation system replacement**	air/air chiller	air/water chiller
C.2	**Cooling : Distribution network replacement**	Central air-conditioning, insulated tubes under ceiling	bi-tube network
C.3	**Cooling : Thermal insulation of networks**	Classe 4 (refrigerant)	Classe 4 (refrigerant+ water network)
C.4	**Cooling : Emission systems replacement**	Air-conditioning diffusers,	fan coils, emission panels, underfloor
C.5	**Cooling : Controls**	Occupancy, night/we setback	
DHW.	**DOMESTIC HOT WATER**		
DHW.1	**DHW : DHW generation system replacement**	electric water heater, with storage	
DHW.2	**DHW : Thermal insulation of the storage**		
DHW.3	**DHW : Thermal insulation of distribution network**		
DHW.4	**DHW : Emission-taps systems replacement**		
DHW.5	**DHW : Controls**	PV autoconsumption, thermal panels control	
L.	**LIGHTING**		
L.1	**Lighting : Lighting system replacement**	LED - 10 W/m² (offices), 15 W/m² (meeting rooms), 5	
L.2	**Lighting : Controls**	manual/automatic - occupancy detection	
Ren.	**RENEWABLES**		
Ren.1	**Renewable energies : Photovoltaïcs**		
Ren.2	**Renewable energies : Thermal panels**		
Ren.3	**Renewable energies : Geothermal system**		

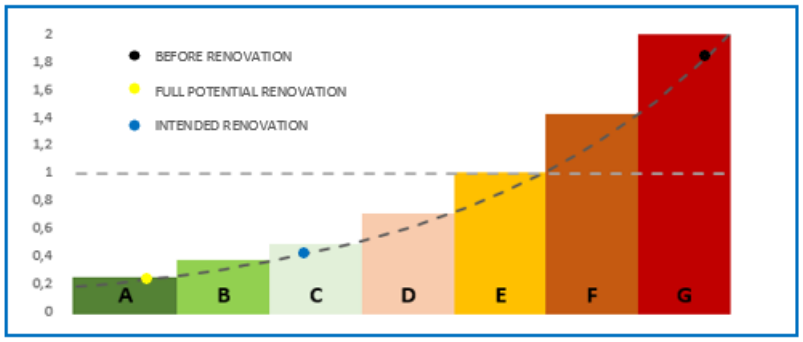
Figure 59 - List of generic ERAs and associated NZEB compliant performance level (French context)

0 : Not concerned		-1 : No change	0 : unknown		
1 : low emergency		0 : neutral	1 : long term		
2 : High emergency		2 : Clear will for change	2 : ASAP	cf. Evaluation guide	cf. Evaluation guide	cf. Evaluation guide

Obsolescence level		Owner preferences		Cost		Energy potential	Interactions		
priority level	period (yr)	decision	Approximate time	Investment cost (€)	returns on investme	Energy efficiency upgrade of the component	#	interacting ERAs	Type of interactic

Figure 60 - Indicators of the evauation table of ERAs

TEMPLATE : Step-by-step roadmap



	ENERGY CONSUMPTION [KwhFE/m2.y]	[KwhPE/m2.y]	SAVINGS PE [%]	LABEL
BEFORE RENOVATION	178	220		G
FULL POTENTIAL RENOVATION	22	28	87,3%	A
INTENDED RENOVATION	35	50	77,3%	C

Figure 61 - Exemple of the top part of the step-by-step roadmap template dealing with energy potential and energy gains

Primary renovation actions

#	RENOVATION ACTIONS	OPPORTUNITY	Renovation package / before renovation: ENERGY CONSUMPTION [KwhFE/m2.y]	ENERGY CONSUMPTION [KwhPE/m2.y]	ENERGY SAVINGS - PE [%]	Cumulated energy savings: ENERGY CONSUMPTION [KwhFE/m2.y]	ENERGY CONSUMPTION [KwhPE/m2.y]	ENERGY SAVINGS - PE [%]	ENERGY RATING (cumulated)	Cost indicators: INVESTMENT COST [k€]	COST EFFICIENCY [k€/kWh]	COST TO ASSET VALUE [%]	IEQ indicators
	Thermal insulation of bottom floor surfaces	Immediate need of works	155	175	20,5%	155	175	20,5%	G	80	1,78	6,7	
	Integration of a double-door entrance												
	Blinds and solar protections	Owner will											
	Renewable energies : Thermal panels	Owner will - potentially immediate	160	200	9,1%	135	150	31,8%	F	12	0,60	1,0	
	Heating : Thermal insulation of distribution network	potentially immediate	165	190	13,6%	75	95	56,8%	E	15	0,50	1,3	
	DHW : Thermal insulation of the storage												
	DHW : Thermal insulation of distribution network	potentially immediate											
	Cooling : Thermal insulation of distribution network (fluids)												
	Renewable energies : Photovoltaics	High economy efficiency - potentially immediate	130	160	27,3%	40	55	75,0%	C	40	0,67	3,3	

Figure 62 - Exemple of the central part of the step-by-step roadmap template presenting primary energy packages description and evaluation

Potential sequence overtime (in line with renovation-maintenance needs and opportunities)

#	RENOVATION ACTIONS	EXPECTED REPLACEMENT PERIOD
	Heating : Heat generation system replacement	2020 - 2025
	Heating : Controls	
	DHW : Heat generation system replacement	
	DHW : Controls	2020 - 2025
	Lighting : Lighting system replacement - lobby	2023 - 2028
	Lighting : Controls - lobby	2023 - 2028
	Lighting : Lighting system replacement - corridors	2023 - 2028
	Lighting : Controls - corridors	2023 - 2028
	Lighting : Lighting system replacement - bedrooms	2023 - 2028
	Lighting : Controls - bedrooms	2023 - 2028
	Cooling : Heat generation system replacement - Group 1	2025 - 2027
	Thermal insulation of external walls S	2025 - 2027
	Windows replacement (2nd - 5th floor ; bedrooms)	2028 - 2033
	Thermal bridges treatment : Windows to walls	
	Envelope air tightness	
	Ventilation : Ventilation system replacement	2030 - 2035
	Ventilation : Controls	2030 - 2035
	Thermal insulation of roof surfaces	2030 - 2035
	Thermal bridges treatment : Facades to roof	
	Cooling : Heat generation system replacement - Group 2	2033 - 2038
	Cooling : Emission systems replacement	2033 - 2038
	Cooling : Controls	2033 - 2038
	Thermal insulation of external walls N	2035 - 2040
	Windows replacement (1st floor ; lobby)	2038 - 2043
	Thermal bridges treatment : Windows to walls	
	Doors replacement	2038 - 2043

Figure 63 - Exemple of the bottom part of the step-by-step roadmap template presenting the long-term renovation timeline

Interviews guide

A document dealing with interviews of owner and/or manager will be implemented after the application of the pilot's phase. The main guidances are presented below.

An upstream interview can be carried out in order to collect the general overview of the building manager. The main expectations should be recorded. They will influence the study, especially the audit pase.

The main interview is related to the evaluation of identified elemenrary renovation actions. The owner's opinion is recorder for each action. Both the decisión of the ERAs implementation and the expected time are required. The allowed answers are presneted on the figure below.

-1 : No change	0 : unknown
0 : neutral	1 : long term
2 : Clear will for change	2 : ASAP

Owner will	
decision	Approximate time

Figure 64 - Evaluation of the owner will in the table of ERAs

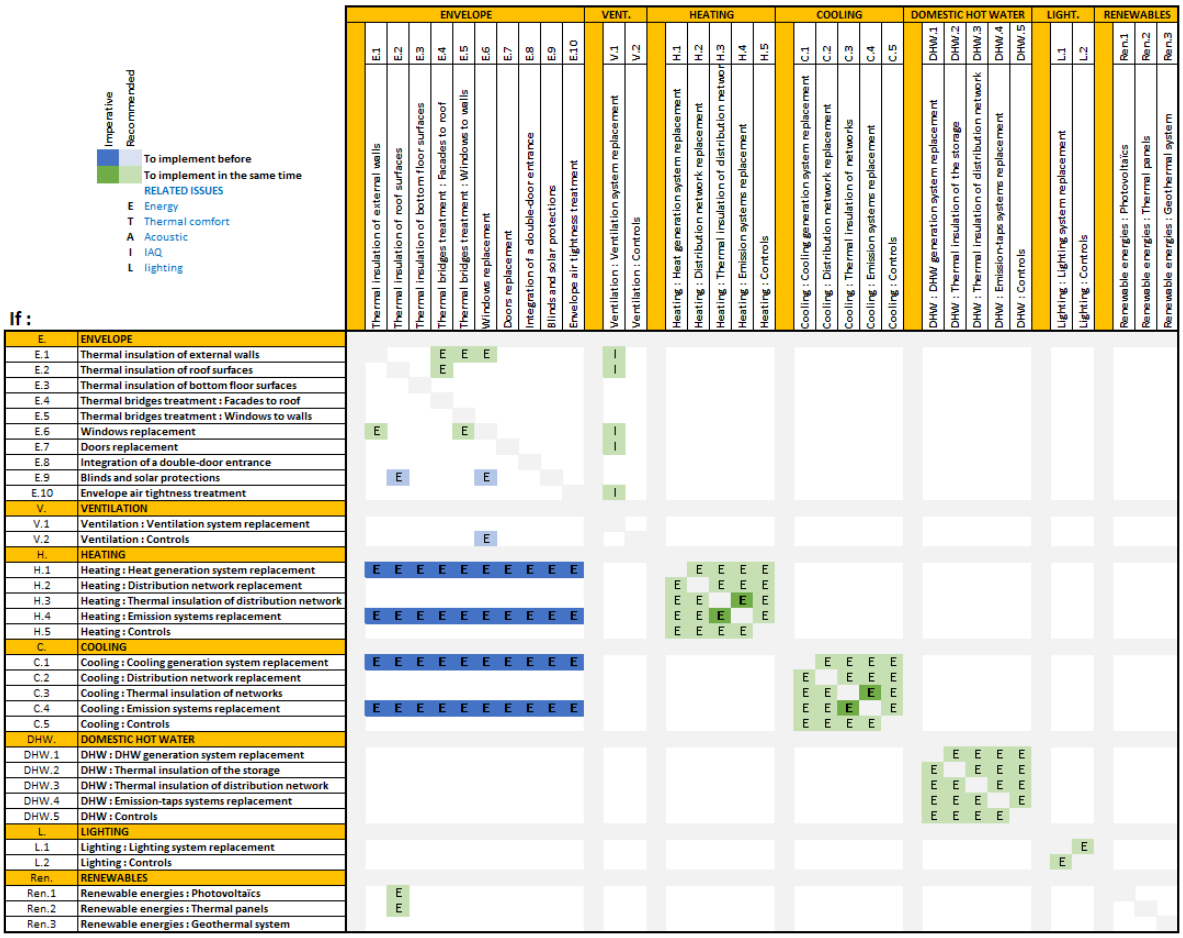
Audit guide

The audit phase of the RenoMap process is closed to a general building energy audit. The main difference is the study of potential renovation actions, completing the current building state description.

Design choices are also supported by NZEB compliant guidelines. The study is also based on the determination of the actual potential of renovation related to each element. The potential can be reduced by technical, gometrical or logistical issues. A good technical knowledge of the implementation of the renovation actions is required. Other constraints can influence the design. Even if NZEB compliant performance guidelines are described and recommended, the RenoMap process provides the designer with a complete freedom of choice. More technical advices will be provided in the audit guide document and the specific issues related to the building components will be addressed.

Evaluation guide

The evaluation guide will gater all the guidelines to fullfil the evaluation table of ERAs. The main indicators concern obsolescence level, owner will, cost, energy potential and Interactions between renovation actions. The evaluation process has been described in the RenoMap description. The table below describes the matrix of interactions to be studied and reported in the evaluation table. Imperative and recommended interactions are specified as well as related energy or indoor environmental quality issues.



E.	ENVELOPE
E.1	Thermal insulation of external walls
E.2	Thermal insulation of roof surfaces
E.3	Thermal insulation of bottom floor surfaces
E.4	Thermal bridges treatment : Facades to roof
E.5	Thermal bridges treatment : Windows to walls
E.6	Windows replacement
E.7	Doors replacement
E.8	Integration of a double-door entrance
E.9	Blinds and solar protections
E.10	Envelope air tightness treatment
V.	VENTILATION
V.1	Ventilation : Ventilation system replacement
V.2	Ventilation : Controls
H.	HEATING
H.1	Heating : Heat generation system replacement
H.2	Heating : Distribution network replacement
H.3	Heating : Thermal insulation of distribution network
H.4	Heating : Emission systems replacement
H.5	Heating : Controls
C.	COOLING
C.1	Cooling : Cooling generation system replacement
C.2	Cooling : Distribution network replacement
C.3	Cooling : Thermal insulation of networks
C.4	Cooling : Emission systems replacement
C.5	Cooling : Controls
DHW.	DOMESTIC HOT WATER
DHW.1	DHW : DHW generation system replacement
DHW.2	DHW : Thermal insulation of the storage
DHW.3	DHW : Thermal insulation of distribution network
DHW.4	DHW : Emission-taps systems replacement
DHW.5	DHW : Controls
L.	LIGHTING
L.1	Lighting : Lighting system replacement
L.2	Lighting : Controls
Ren.	RENEWABLES
Ren.1	Renewable energies : Photovoltaïcs
Ren.2	Renewable energies : Thermal panels
Ren.3	Renewable energies : Geothermal system

Figure 65 - Matrix of interaction between Elementary renovation actions

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