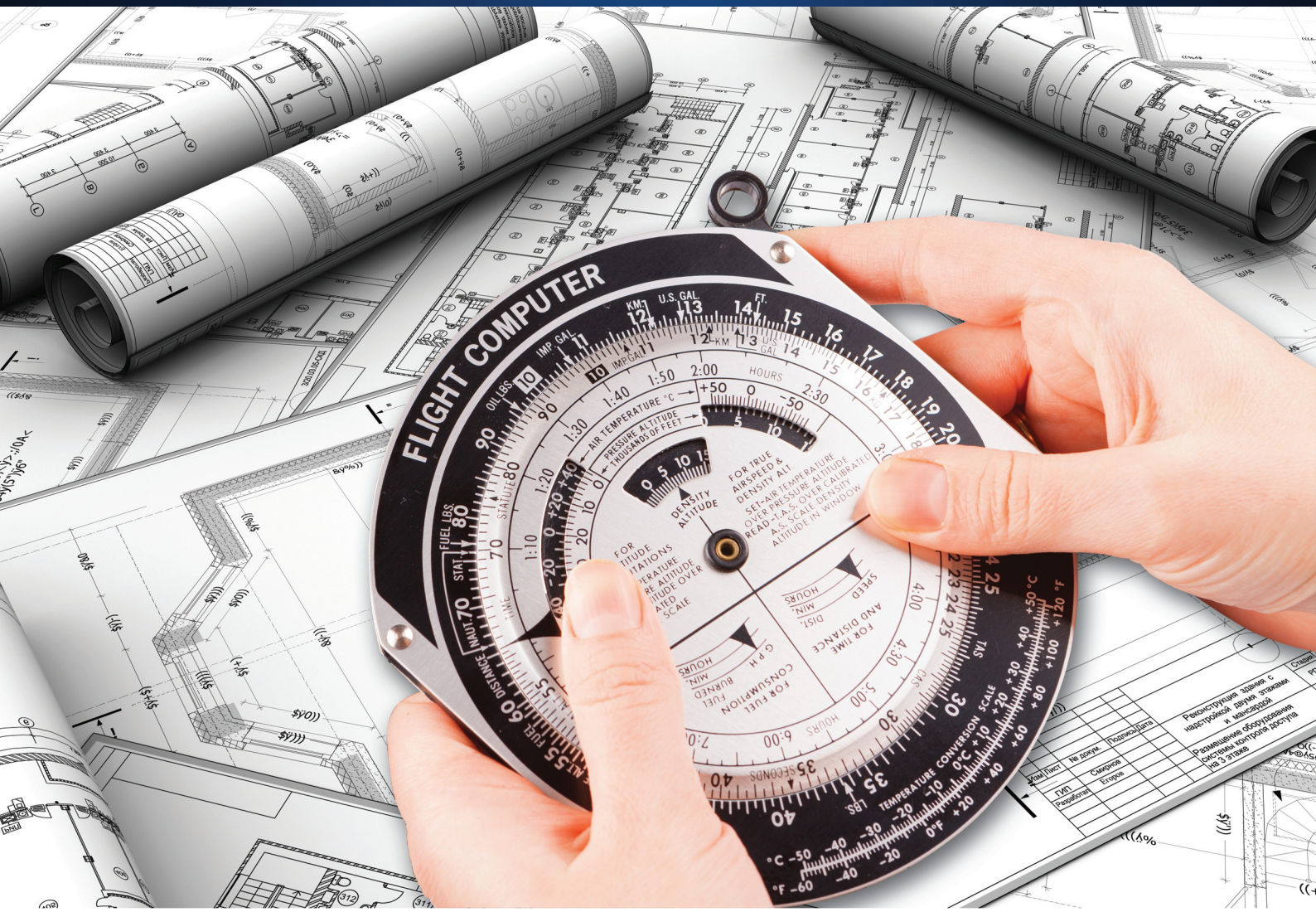
iBRoad

Individual Building
Renovation Roadmaps




# The Concept of iBRoad: the Individual Building Renovation Roadmap and building logbook

## Potential functionalities and graphical guidelines when setting up the iBRoad concept

**ADENE – Agência para a Energia**

September 2018

**www.ibroad-project.eu**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nº 754045

**Authors (ADENE)**

Cláudia Sousa Monteiro

Rui Fragoso

**Authors (Sympraxis Team)**

Marianna Papaglastra

Alexander Deliyannis

**Authors (ifeu)**

Martin Pehnt

Peter Mellwig

Julia Lempik

Mandy Werle

**Reviewers**

Vivian Dorizas, Ivan Jankovic, Mariangiola Fabbri, Maarten de Groote (BPIE)

Lukas Kranzl, Ina Maia (TU Wien)

Tine Vande Casteele (VEA)

**Page layout**

Sympraxis Team

Functionality icons licensed from the Noun Project

**Cover illustration**

depositphotos.com/mmaxer/Amaviael / Sympraxis Team

Published in November 2018 by iBRoad.

# TABLE OF CONTENTS

# TABLE OF FIGURES

# EXECUTIVE SUMMARY

To achieve the European climate goals, it is necessary to move the existing building stock to higher energy performance standards and tap into the full potential of energy savings through renovation. The challenges towards this goal are significant, the main ones being the lack of finance and awareness at the building owner level on how to handle this renovation process. It is therefore necessary to establish policy pathways that prioritise the building stock's deep renovation, to create awareness and the conditions for undertaking renovation works in the existing building stock, but also to guarantee the energy performance improvement whenever a renovation activity takes place. Further to improving the environment, this energy efficiency improvement will be a good investment for building owners as it not only improves their housing conditions and comfort levels but also reduces their energy bills and increases their property value.

The iBRoad project has the goal to guide the building owner through their building renovation process by providing a customised step-by-step renovation plan. The concept envisaged includes two main tools, to be implemented as discrete software programmes: the building logbook (iBRoad-Log), which is a repository for all building related information, and the individual building renovation roadmap (iBRoad-Plan), providing a customised long term horizon renovation plan for the specific building and use. Each of the two tools can provide several services to the building owner, such as access to the building logbook data, an in-depth building diagnosis, alerts and reminders, benchmark with other buildings, access to the detailed version of their renovation roadmap and relevant financing options available for the specific renovation. Together, the iBRoad-Log and iBRoad-Plan are envisaged to be a real driver for deep renovation of existing buildings.

This report aims to elaborate on the concept and benefits of the Individual Building Renovation Roadmap, giving an overview of the potential services to be provided by the relevant software itself, as well as of the potential links with other tools or services available on the market, and present the ones that are to be actually implemented and tested under the iBRoad project. In this context, Chapter I of the report includes objectives and describes the iBRoad concept. Chapter II presents the methodology followed to identify potential services, translated into IT functionalities, and relevant links. Since these functionalities are related to the logbook data structure and the user's needs, Chapter II also presents a summary of these to guide the reader. Chapter III is the core of this report, exploring the possible iBRoad functionalities, while Chapter IV dives deeper into the functionalities to be implemented during the iBRoad project. Chapter V exemplifies the graphical guidelines for the visual layout of the two software tools. Finally, Chapter VI presents the final considerations on this topic, highlighting some recommendations and future work.

The "*Report on how to integrate techno-economic assessment modules and logbook components in iBRoad programmes*"[1] will dive deeper into methodological aspects on how to implement these functionalities in reality and in related IT tools.

# I. INTRODUCTION

## i. Overall

Building renovation is the key to meet the European energy efficiency and $CO_2$ emission reduction targets. However, the current building energy efficiency has been improving by only 1.4% per year, largely due to low renovation rates [2], while the vast majority of these renovations do not achieve the full potential of their energy savings [3]. To accomplish the commitments taken in 2015 with the Paris agreement [4], it will be necessary to significantly increase the efforts of building renovation.

To achieve this goal of a highly efficient and decarbonised building stock by 2050, there is a need to overcome multiple barriers. Some of these barriers are specifically related to the building owners and their house renovation such as, for example, the difficulty in accessing finance, or the lack of knowledge about what steps to take to perform a building renovation and in which order. Furthermore, building renovation is often considered a burden related to time-consuming planning, uncertainty about the value of the planned measures, dust and unreliable professionals [5].

The iBRoad project works on addressing these barriers by developing an Individual Building Renovation Roadmap (iBRoad-Plan) for single-family houses. This tool provides a customised renovation plan over a long-term period of time (5-20 years). The roadmap is at its core a home-improvement plan which considers the occupants' needs at specific conditions (e.g. building age, occupant financial situation, composition and expected evolution of the household, etc.) and avoids the risk of 'locking-out' future renovation solutions due to lack of planning.

The renovation roadmap is combined with a building logbook (iBRoad-Log), a repository of building-related information which may include and be updated with data such as the energy consumption and production, executed as well as expected maintenance and building plans, providing several functionalities to different stakeholders which in future can go beyond the building energy performance. As exemplified by the *Woninpass* initiative implemented in Flanders, these may be Urban Planning, Water, Living Quality, Soil, Accessibility, Electricity, Daylight and Aesthetics, and Stability [6].

## ii. Objective

This report has the goal to explain the concept of the Individual Building Renovation Roadmap and identify and characterise the possible functionalities that can be implemented in a Logbook and a Renovation Plan by reporting on the suggested elements, concepts and layout of the iBRoad software. The idea is to empower the data structure available in the logbook by connecting it with the stakeholders needs (Figure 1). In this way, several functionalities are identified and described in this report, which are useful for different stakeholders (building owners, public authorities, banks, energy auditors, the building sector, installers, architects, etc.), but especially for the building owner who is the main user and owner of the available information.

The logbook data structure results, amongst others, from the previous work undertaken under the iBRoad project, namely in the publication The logbook data quest: Setting up the data indicators and other requirements for a renovation passport [7], where the goal was to map the data associated to an individual building, identify which stakeholders could provide or benefit from accessing that information, where is the information stored, who owns the data and how could it be accessed, and finally discusses issues related to data availability and protection. The building owner's needs resulted from a survey taken to 1,500+ participants from Bulgaria, Poland and Portugal, described in detail in the report *'Understanding potential user needs: A survey analysis of the markets for Individual Building Renovation Roadmaps in Bulgaria, Poland and Portugal'* [8]. This survey gathered information about the end-users needs and preferences, which enabled a more effective design of the individual building renovation roadmaps, tailored to the specific markets.

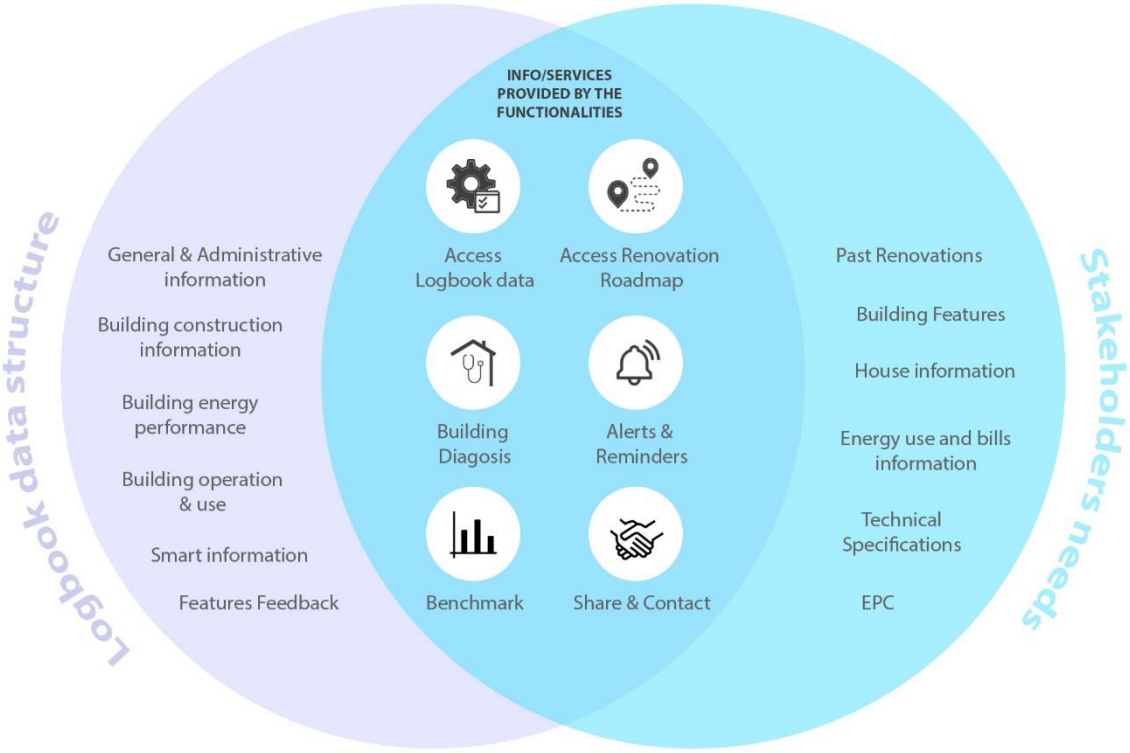



***Figure 1**. Report objective.*

In the current report, we build upon the available logbook data and the identified stakeholders' needs to explore the possible iBRoad functionalities based on the core services and information it should provide. Furthermore, we present in detail the functionalities to be tested and implemented under the iBRoad project. Nevertheless, the information currently identified and stored in the logbook and the functionalities that result from here can and might evolve over time, and therefore this report intends to provide a first exploration of this thematic.

## iii. The iBRoad Concept

As already mentioned, the iBRoad project works on addressing the barriers for building renovation, by developing an Individual Building Renovation Roadmap for single-family houses, consisting of a repository for all building related information, the building logbook (iBRoad-Log), and a customised long-term horizon renovation plan for the specific building and use, the individual building renovation roadmap (iBRoad-Plan). How this concept is envisaged, is described in detail below.

### Logbook

*Definition*

The logbook (iBRoad-Log) is the main repository of all relevant building related information and includes, e. g., actual energy consumption, energy performance, maintenance requirements, design plans, etc. The logbook is a sort of dynamic building identity card that could also include other sets of individual building related information, such as the financing options available in the area for renovation projects (e.g., green loans, incentives, tax credits), as well as energy bills, equipment maintenance recommendations, insurance and property obligations. This information could be inventoried in a digital register, available to property owners. The main user of the logbook is the building owner, who could grant access to certain parts of the available information to other parties,

e.g., public authorities, make certain information publicly available while keeping other data private or restricted (semi-public upon authorisation to third parties). In its most sophisticated form, the logbook could be used as an interactive tool to monitor and compare real energy consumption with designed energy consumption, send alerts in case of strange consumption patterns or flaws in technical installations and could also be linked to market actors and provide information regarding (certified) contractors and installers, facilitate invoicing and simplify the process for subsidies or loans repayment.

The logbook may serve several purposes:

- Repository and database for the building owner.
- Simple automated renovation recommendations. E. g. if the heating is > 20 years old, the system can produce an automated alert. Also, if the energy consumption seems untypically high, alerts can be produced, e. g. indicating flaws in the technical installation.
- Automated reminders for maintenance, e. g. for the heating system.
- Automated energy saving tips on a regular basis.
- Benchmark with surrounding buildings, based on the energy performance, indicating for instance the performance of the buildings in the neighbourhood, thus creating an incentive to renovate.
- Marketplace for qualified building professionals and materials.

Further functionalities are desirable, such as troubleshooting (ability to search for symptoms of the house's poor performance, e.g., the appearance of mold, and subsequently provide information on their cause and recommended treatment), and simple economic calculations.

With the main function of the iBRoad-Log being a repository for building information, the iBRoad-Log starts with the development and testing of specific functions but can evolve over time, adding each time more sophisticated concepts.

### *How the information can be supplied to the iBRoad-Log*

The logbook helps to collect and structure all building related information into one single platform. The iBRoad-Log is primarily property of the building owner, who can grant access to others in order to view or to input data, and access rights need to be defined accordingly per data field. Data may then be fed to a logbook manually by either the energy auditor, the building owner/user, or other parties (Figure 2). E.g., information on subsidy schemes, available craftsmen nearby, energy prices or others can be supplied externally by the local energy agency, or municipality. Information can also be automatically fed into the logbook, through a dedicated user interface from various sources, e.g. through a public EPC database, an energy management system, or other. Within the iBRoad project, such user interfaces are not realised and data is entered to the iBRoad-Log only manually by the energy auditor.

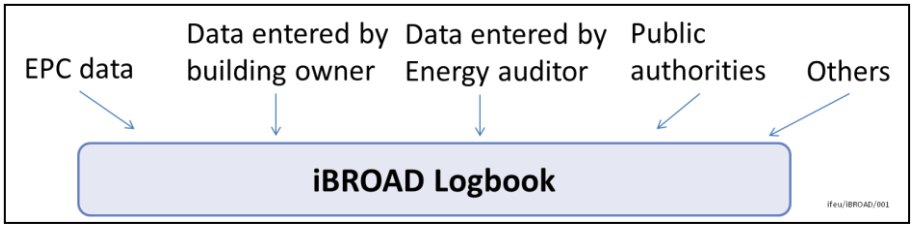



***Figure 2**. Data sources for the logbook.*

**Roadmap**

*Definition*

The individual building renovation roadmap, iBroad-Plan, provides a "health check" on individual buildings and, building on this check, tailored advice to owners and investors on how to improve them by avoiding unwanted lock-in-effects.

By supporting staged renovations adapted to the preferences of individual building owners, these initiatives will allow building owners to have an overview of the full range of renovation options in a specific sequence, to easily identify each renovation step from start to end at the same time (step by step approach), including additional information, e.g., on how to finance these actions and how to implement them. The energy auditor shall discuss renovation preferences – if possible, based on a comparison of different feasible renovation measures and pathways –with the building owner.

The roadmap follows the guiding principles indicated in the text box.

The roadmap consists of several elements:

**Guiding principles**

- Long-term perspective: help the owner to understand the importance of having a long-term renovation strategy in order to avoid lock-in effects when installing individual components.
- Consideration of individual renovation context: the wishes, needs and the financial situation of the homeowners must be considered. These include, for example, financial opportunities, living space changes, or family planning (e.g., having a baby or children moving out).
- Attractiveness and motivation: iBRoad should be attractive and easily understandable for the users. Building owners have to be guided throughout the process and receive clear indications so that they can take action without getting lost.
- Timing and Sequencing of actions: frequently, renovations cannot be performed in one go. That is why many buildings are only partially renovated. Early replacement of components may also result in economic losses. Rented stocks can often only be renovated gradually as well. In many cases, the financial situation of the owner allows no extensive refurbishment all at once. However, even a gradual modernisation leads to the end goal, if at each step, the next steps are considered.
- Automation: To reduce costs, the iBRoad-Plan should also be implemented as a user-friendly tool for the expert who will deliver the audit. The tool, based on the input data itself, should work with prefabricated text blocks as much as possible, to make the message clear and directly understandable. Once the audit is concluded, prefabricated blocks of text will also be filled with specific property parameters so that the advice is personalised.

- A roadmap as illustrative graph, serving as an overview of the results and recommendations (step-by-step advice of the audit).
- A more detailed (e. g. 10-12 page) report, detailing the various renovation steps.
- A datafile, containing the information (data, graphs, text, photos) of the report. This file can be uploaded in the logbook, allowing future alterations and also updating by the energy auditor.

The iBRoad roadmap assistant is the corresponding software tool which assists in the production of the roadmap documents. The roadmap assistant is used by the auditor only, not by the building owner, as it requires expert knowledge. Data is entered into the iBRoad-Plan only by the energy auditor.

*How the roadmap is produced*

Step 1: Initial contact. The customer contacts an energy auditor (e.g., by phone) and makes an appointment. The auditor accesses the logbook, if it is available and if the customer agrees to that; if not available, the auditor initiates a logbook file of the respective building. If an EPC database is available and accessible to the auditor, he/she can use this information to get prepared.

Step 2: Onsite visit. The auditor visits the building, documents the components of the building (U values of walls, windows, roof, etc., available heating and ventilation, weaknesses of the building etc.) and talks to the customer with the help of a checklist, takes photos of the building and inspects it. Here, the validity of eventual EPC data is checked as well. Performance measurements will typically not be necessary because either the real consumption is available, or the building is modelled using the recorded data (U values, etc.). However, the auditor might have to measure thicknesses of insulation, size of surfaces, etc. Special focus is on the various required renovation steps. The auditor gathers missing data, discusses and interviews the building owner regarding personal preferences and financial capabilities and develops a rough concept together with the building owner.

Step 3: Calculation of the building as it is. As starting point for the technical modelling of the roadmap, the auditor models the building as it is today (the U values of the building envelope, the heating demand, the efficiency of the heating system, etc.). This data may be based on the EPC register, if available and up to date. Towards this end, the auditor should check the recency of the information. If not available or not up-to-date, the auditor needs to determine the available components and the respective surfaces, technical data, etc. If available and generally accepted, the auditor uses the national calculation/simulation software, which calculates the energy demand of the building based on the national calculation procedures (building code, etc.). If a national calculation software is not available, the auditor may use a simple streamlined techno-economic calculation tool provided by iBRoad. The auditor compares the calculated demand with the actual consumption and carries out an adjustment/calibration so that the model pictures the actual building situation as best as possible. Based on this calculation, the final and primary energy demand, the actual energy costs, the CO2 emissions and the energy label of the building (if nationally defined) can be provided. This information will then be fed into the roadmap assistant using either a manual interface or an interface file (XML), if possible.

Step 4: Definition of the renovation packages and calculating the resulting energy demand after renovation. Based on the current energy demand and the detected weak points of the building, in combination with the wishes and preferences of the building owner, and using the same national calculation software as in step 3, the auditor defines the energy demand of a set of renovation packages to be implemented in a specific sequence.

The proposed renovation packages/measures will be discussed with the building owner, and adjusted together; however the owner cannot alter the plan him/herself, as s/he lacks the technical background knowledge of interdependencies that need to be considered.

Step 5. Production of the iBRoad-Plan. With the energy demand of the building as it is and after carrying out the renovation packages, the auditor produces the renovation roadmap (iBRoad-Plan), describing which renovation packages to implement at which points in time, and including technical advice, as well as financing advice/information on supportive schemes.

If, in the future, the national calculation software can be directly called from within the iBRoad roadmap assistant, the interplay between calculation of the renovation packages and the production of the roadmap can be speeded up. Within the iBRoad pilot phase, however, such an automatic interface is not foreseen to be implemented.

Last but not least, all relevant information, in particular input data, results of the energy demand and economic calculations, and the roadmap document, is uploaded to the logbook, either manually or automatically depending on the available interfaces.

To be effective and complete, the implementation of the iBRoad-Plan should:

- ensure the quality and reliability of the data, therefore, the energy auditor has to be qualified according to national provisions;
- foresee training of the energy auditors;

- establish effective communication channels with the building owners;
- include at least one on-site visit by the energy auditor.

### *Relationship between the iBRoad concept and the Energy Performance Certificate (EPC)*

The development of an iBRoad-Plan does not depend on the pre-existence of an iBRoad-Log or an Energy Performance Certificate (EPC). However, whenever possible, e.g., depending on availability, quality and accessibility of the EPC, existing official input data takes precedence over new data. A relevant module can therefore be developed in the future, to allow the transfer of data from one chosen and approved national database/calculation tool to iBRoad.

### *Functional overview*

The functionalities of the logbook and the renovation roadmap are relevant to help different stakeholders become aware about the actual building status, past activities related to the building, and more particular, future potential for energy savings. Moreover, they should support building owners through the building renovation journey, for example, by presenting to the user an assessment of relevant parameters through the *Building Diagnosis, or by giving advice on the need for maintenance, for example, through Alerts & Reminders*, but mainly by guiding them step-by-step through the specific renovation actions to be undertaken at each point in time.

The logbook may further be combined with external tools that already exist or are developed independently from the logbook, either by using/providing information from/to the logbook or by direct/indirect links from one to the other. Such examples are *One-stop-Shops* or *Energy Management* tools. The *Energy Demand Calculation* tool, which in the ideal scenario should be the official country specific energy performance calculation software, can use relevant input data stored in the logbook to perform the calculations and later feed the calculation results directly or indirectly into the logbook or serve as input for the Roadmap Assistant (Figure 3).

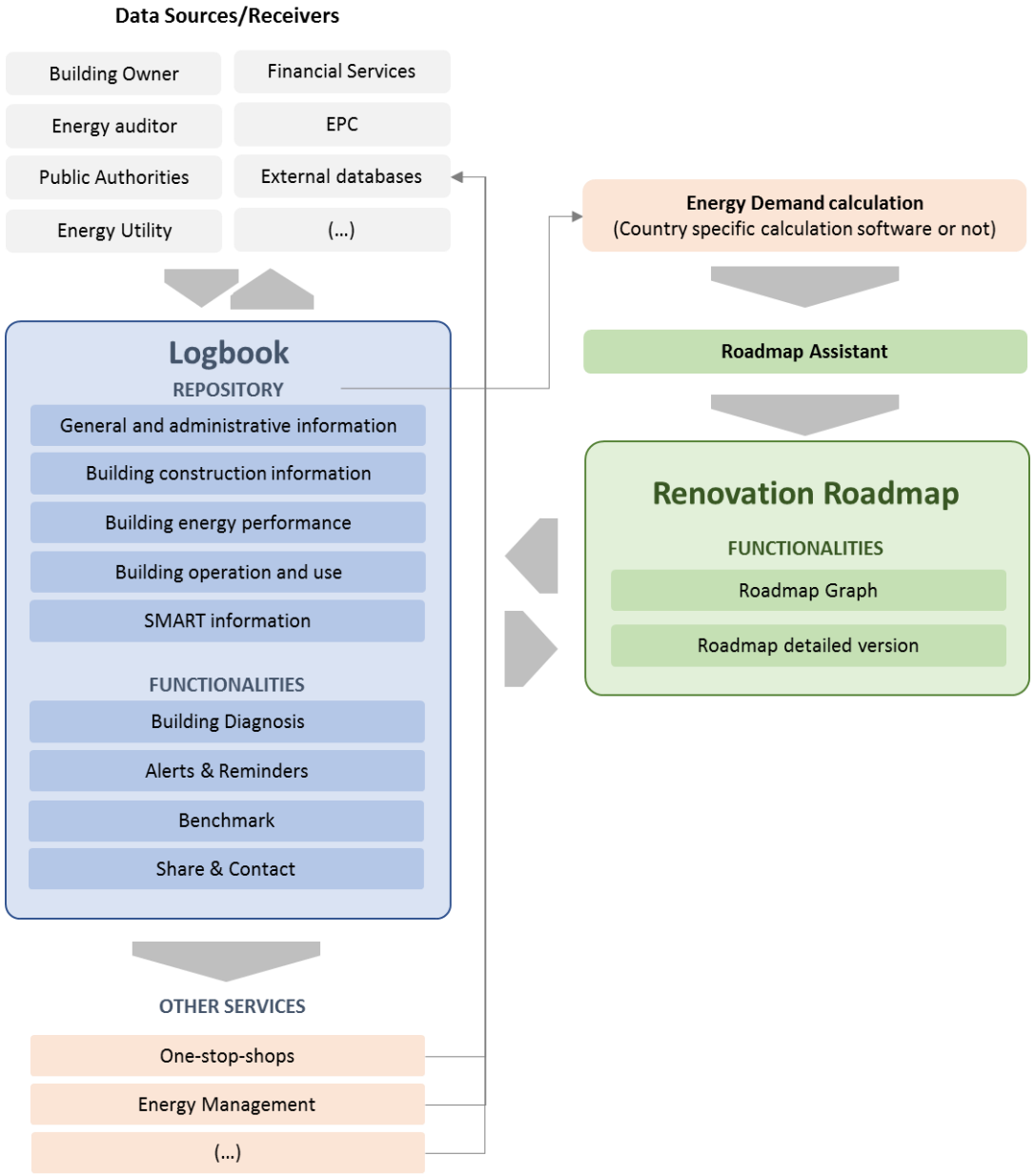



***Figure 3**. iBRoad Concept*

Under the iBRoad project, some of these functionalities will be tested and implemented; these are described in Chapter V. More technical details are given in the "*Report on how to integrate techno-economic assessment modules and logbook components in iBRoad programmes including possible data flows and required database structure*" [1].

# II. METHODOLOGY

The methodology followed in order to define the necessary and potential services which the individual building renovation roadmap can provide, results from the combination of several steps (Figure 4). First, potential stakeholders were mapped, as described in the iBRoad Report *"iBRoad stakeholders as real driver of positive change – Identification process across Europe" [9] and, following the iBRoad Report "The logbook data quest - Setting up indicators and other requirements for a renovation passport"* [7], it was determined how stakeholders could contribute to and benefit from the iBRoad concept (step 1). Then, the main potential users needs were identified (step 2) through a survey described in the iBRoad report *"Understanding potential user needs: a survey analysis of the markets for Individual building renovation roadmaps in Bulgaria, Poland and Portugal"* [8]. Afterwards, based on the survey and a review of existing and ongoing examples and activities [10], a structure encompassing different functionalities was proposed (step 3), followed by a brainstorming session to identify other potential functionalities, suitable for other stakeholders (step 4). The potential functionalities were then weighted by the iBRoad partners (step 5) according to their priority to implement and test them within the iBRoad project (step 6).

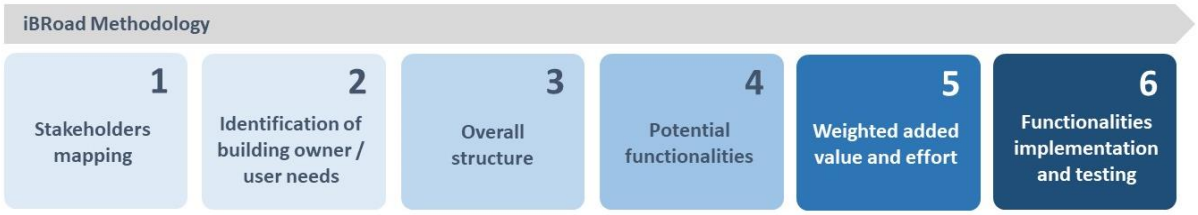



***Figure 4**. iBRoad – Methodology.*

## i. Individual Building Renovation Roadmap Data and Stakeholders

As explained in the introduction, the goal of this report is to direct the data to the stakeholders' needs, first by identifying the stakeholders and then by identifying several potential functionalities relevant to them. The overall stakeholders' identification was first undertaken in "*iBRoad stakeholders as real driver of positive change – Identification process across Europe" [9]*, whereas the link between the logbook data structure and the involved stakeholders is tackled in detail in "*The logbook data quest - Setting up indicators and other requirements for a renovation passport" [7]*.

### Stakeholders identification

In the process of setting up the iBRoad tools, it was essential to identify the stakeholders that can contribute or benefit from participating in that process, not only considering the data that they can provide/retrieve. Error! Reference source not found. Figure 5 illustrates some of the stakeholders identified along this process.

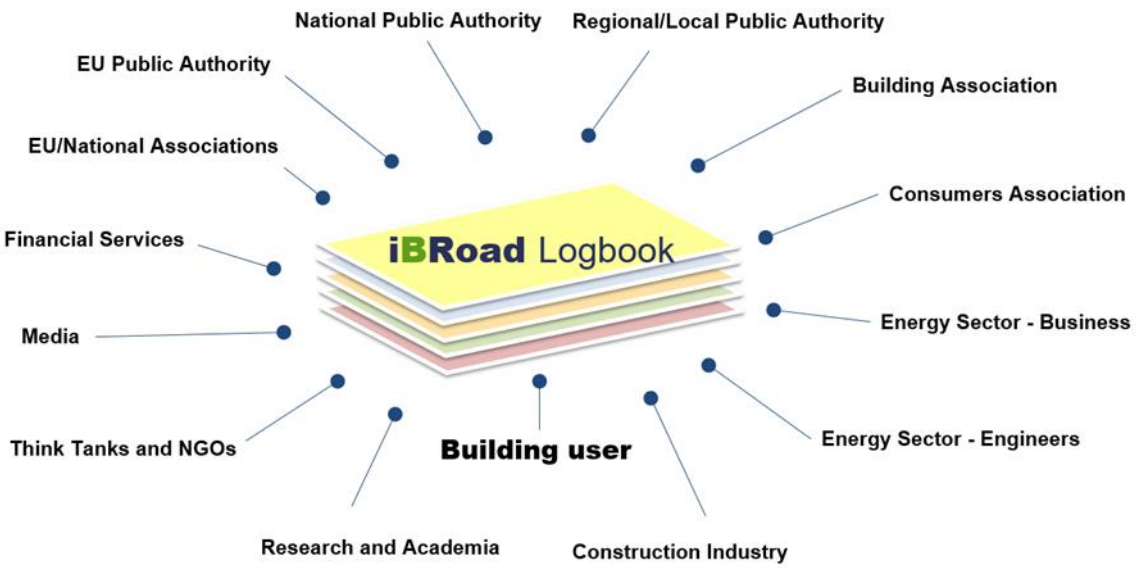



***Figure 5**. Type of Stakeholders interacting with the iBRoad concept.*

The focus during the identification and description of the functionalities was firstly on the building owner, being the main owner and user of the individual building renovation roadmap, and secondly on those types of stakeholders that could contribute but at the same time benefit from the logbook available information.

### Input data

The roadmap establishment requires the definition of which data should be stored, where this data stems from and who holds or can supply that data. Considering the expected use of the logbook and roadmap, the stakeholders involved and the existing data, it is possible to identify the data sources and limitations as for example data availability, quality, integration, coverage, update, sharing protocols, among other aspects. This means that there are some functionalities of the building repository where the data input is limited to the specific stakeholder type. For example, the building owner can input data such as personal information, user behaviour, profile and preferences, photos, etc. but cannot input official and technical data such as the energy label, building envelope information or system technical information. Official sources, such as the energy auditor, public authority, etc. should be the only data sources to feed, either directly or indirectly, manually or automatically, these parameters into the logbook. This is important to best guarantee the quality of the input data and the reliability of the building logbook as a data repository for functionalities to produce reliable outcomes. Table 1 illustrates the official sources for certain types of data necessary for the individual building renovation roadmap.

| *Type of stakeholder* | *Source of data for…* |
|---|---|
| *National/Regional/Local Public Authorities* | • Building address and identification<br>• Fiscal and cadastre identification of the building<br>• Building categorisation<br>• Building design plans<br>• Existing taxation and incentives related with building renovation<br>• Energy Performance Certificates and associated data<br>• Energy efficiency schemes/incentives<br>• Existing financing schemes<br>• List of (accredited) companies or installers to implement solutions to renovate buildings<br>• List of accredited energy auditors |
| *Energy sector – Energy experts/ auditors* | • Energy audits<br>• Energy Performance Certificates and associated data<br>• Technical building and system information |
| *Financial services* | • Existing financing schemes |
| *Construction Industry*<br>*Energy sector - Business* | • Existing construction solutions to renovate buildings<br>• List of (accredited) companies or installers to implement solutions to renovate buildings<br>• Technical product/system/building characteristics |
| *Research and Academia* | • State of the art solutions that can guide the level of ambition established in the building renovation |
| *Building user* | • Building user information<br>• Building user profile and patterns<br>• Energy suppliers contracted<br>• Type and characteristics of the energy supply contracted<br>• Relevant documentation and evidences of performed actions in the building<br>• Energy bills<br>• Product information |
| *Real estate market* | • Market price of the building<br>• Benchmark/statistical data for comparison purposes |
| *Utility companies* | • Real consumption data / energy bills |

***Table 1.*** *Potential sources of data for the iBRoad.*

Sharing information and engaging the right type of stakeholders in a trustful environment are important aspects to establish a robust and long-lasting database to support the iBRoad building rehabilitation national policies. Besides the data sources, knowing who holds the data will be crucial to successfully implement this concept in each country partner. In this sense, knowing where the information is and who owns it opens the door to the necessary understanding that contributes to the positive environment that an innovative programme needs in order to evolve. The detailed identification of the different types of stakeholders (e.g. public authority, building user, financial services, etc.) providing data to each of the building logbook modules for the four implementing pilot countries (Portugal, Bulgaria, Germany and Poland) can be found in "*The logbook data quest - Setting up indicators and other requirements for a renovation passport*" [7].

## ii. Identifying the needs of building owners

As a first step, a survey undertaken to 1500+ building owners in the three iBRoad pilot countries (Bulgaria, Poland and Portugal) [8] identified the needs of the main potential users of the individual building renovation roadmap.

According to this survey, the services that the respondents mostly would like to see in the logbook are the following:

- Building Features (49-55%)
- Technical specifications (46-58%)
- Basic information about the house (48-55%)
- Energy renovations completed in the past (Bulgaria, 57%)
- Information on energy use and bills (Poland, 51%)
- Information on Energy Performance Certificate (Portugal, 62%)

Similarly, the services market respondents would mostly like to see in the renovation roadmap are:

- Estimated costs of each renovation step (59% - 69%)
- Expected benefits in terms of reduced heating/bills (48% - 60%)
- Technical information to help them avoid mistakes (47% - 56%).

Concerning the logbook and roadmap ownership and responsibility, the partner countries revealed the following:

- The roadmap should be passed from owner to owner (Bulgaria, 36%; Poland, 30%; Portugal, 44%)
- New owners would be responsible for keeping the logbook up-to-date (Bulgaria, 36%; Portugal, 44%)
- Each owner would be responsible for creating their own logbook (Poland, 34%)

## iii. Overall structure

Considering the above, an overall structure was designed to organise different sets of services into specific functionalities. The three main categories initially identified were:

a) Inventory of non-dynamic information: relevant individual building information such as historical energy consumption and generation, contacts of building professionals who executed on-site works, building plans, statistical relevant information of the building (from Census), government related information (cadastre, taxes, etc.);
b) Interactive and dynamic tools, such as automated renovation advice (linked to a techno-economic assessment of the renovation steps), benchmark with other buildings, tentative monitoring and comparing real energy consumption with designed/nominal energy consumption, monitoring of real energy generation, alerts in case of strange consumption patterns (e.g. flaws in technical installations), alerts in case of availability of specific incentives for renovation, guidance through renovation (long-term) and maintenance (e.g. semi-automatic request for maintenance);
c) Linking building owners (users) and third parties, such as governments (more than energy related, e.g. cadastre, taxes, incentives, etc.) and market actors (marketplace for qualified building professionals);

The logbook, supporting the renovation roadmap, must be structured in a way that allows the registration of all relevant data within distinct areas. The logbook general framework proposed under the iBRoad project is organised in five thematic areas [7] which accommodate all the information necessary to support the concept of a building renovation passport, namely: General and Administrative information, Building Construction information, Building Energy Performance, Building Operation and Use, and Smart information. These five areas, referred to here as “modules”, have the goal to facilitate the aggregation of information and the use of the database among different stakeholders, making a clear distinction between the topics related to administrative data on one side, or the EPC and ‘smart’ data on the other side. This module framework (Figure 6) is also considered to draw the functionalities presented in the building logbook data repository (Figure 7).

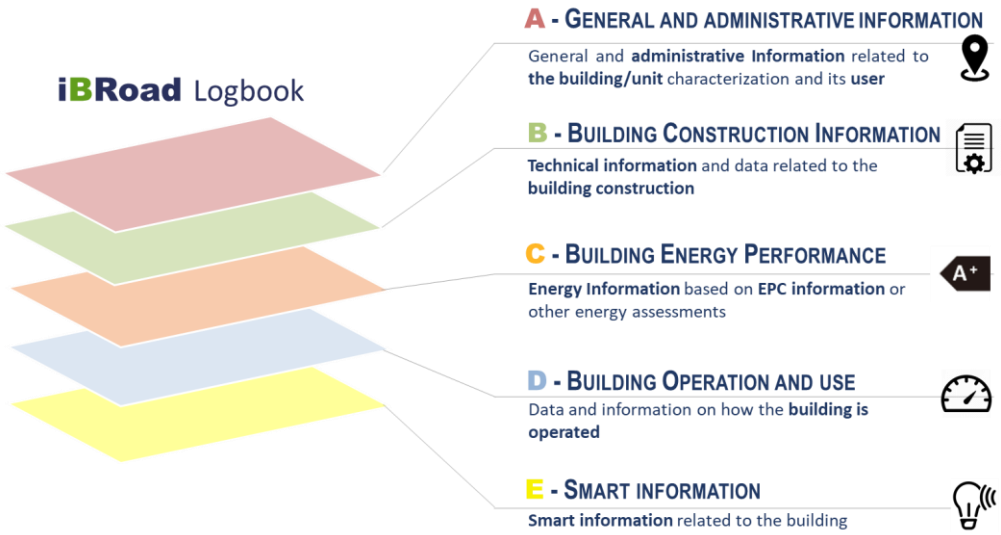



***Figure 6**. iBRoad-Log modules.*


***Figure 7**. Functionalities of the building logbook data repository.*

It is recommended that the logbook data structure supporting the renovation roadmaps (within the renovation passport concept) must allow for a certain flexibility to serve both national/regional needs but also to integrate into a wider European approach. This means that the logbook data structure should have a first part with a core/fixed structure representing the common European approach, and a second part with a flexible structure to include the countries specificities and support a national/regional implementation [1].

The flexible structure follows after --and therefore depends on-- the fixed one; the key issue is to exactly define the point where the fixed structure should turn into a flexible one, thereby allowing the different logbook functionalities, which depend on the data entered by the user, to be properly functional. For example, a functionality with the goal of presenting the building year of construction considering a colour coding would be very hard to implement if the 'construction year' parameter could be freely defined by the country. The problem is that it is not clear in advance how to extract this value: it depends on the choice of parameters made by the country. It might require one or more operations or transformations, and it might not even be present if the country chooses not to include it. Based on this understanding, two main questions/challenges arise:

- How to combine the inherently fixed and predefined structure of a relational database with the need for high country/region specificity in determining what data to store?

- How do we combine logbook functionalities that depend on data with the need for a flexible data structure?

To overcome this challenge, the logbook data structure defined for the iBRoad project is based on a hybrid approach, where the threshold between what is fixed and what is flexible is subject-dependent.

## iv. Potential functionalities

With the user needs and overall structure identified, a brainstorming session with technicians of different backgrounds (Architects, Engineers, etc.) was undertaken in order to summarise the functionalities proposed in the previous steps, to identify other possible functionalities, and to organise all of the above in higher order groups. The result is presented below.

The Logbook related functionalities identified are:

### 1. Building data depository

- Access logbook data depository
- Input data
- Upload documents and plans

### 2. Building diagnosis

- Building energy performance
- Envelope energy performance
- Equipment energy performance
- Comfort performance
- Recommendations

### 3. Display renovation roadmap

- Summarised overview of the building renovation roadmap
- Details of the building renovation roadmap

### 4. Alerts & Reminders

- Notification on Energy performance
- Alerts on Refurbishment needed
- Alerts on maintenance needed
- Energy consumption
- Available financing

### 5. Share & Contact

- Market place
- Best practices
- Granting access

### 6. Benchmark

- Building stock
- RES potential
- Municipalities performance

The roadmap related functionalities are:

### 1. Roadmap graph

- Visual overview of all renovation steps foreseen

2. Roadmap detailed version

- Full presentation of each individual step

Finally, certain possibilities to link iBRoad with external databases or services were identified.

The above are described in detail in Chapter III.

## v. Weighted added value and effort

Although a multitude of functionalities is possible, for the iBRoad project a selection was made according to their relevance and resources availability. Considering all the inputs collected up to this stage, the project partners voted which functionalities would be considered a priority to be implemented under the iBRoad project. The outcome is presented in Figure 8, whereas the functionalities are presented in Chapter IV.

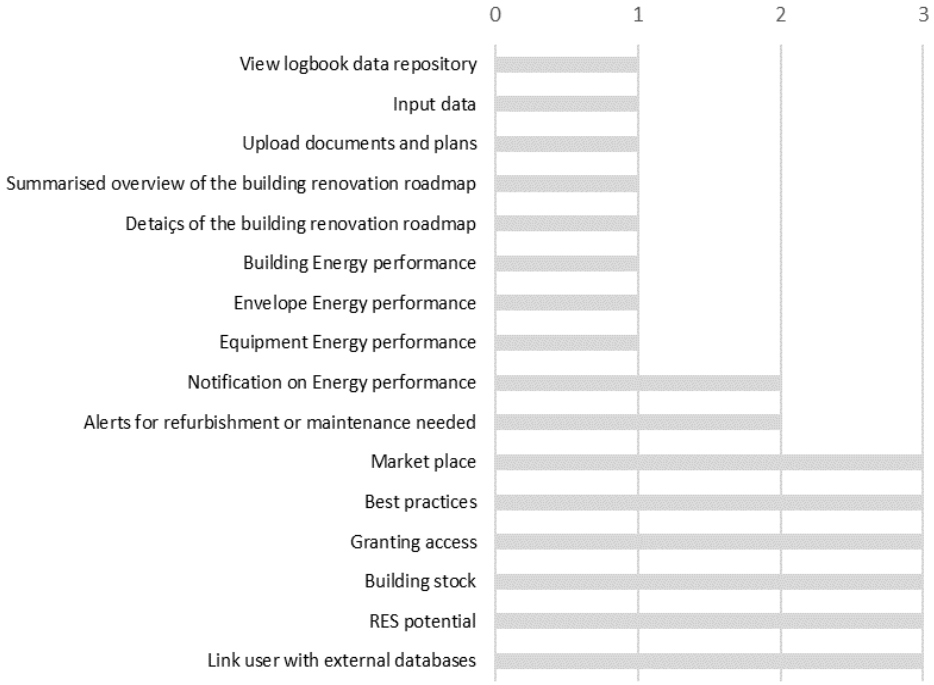



***Figure 8.*** *Functionalities ordened based on priority rates (1 = highest)voting results.*

## vi. iBRoad implementation and testing

The functionalities selected after following this process, will be implemented and tested in the iBRoad project. For each of these functionalities, clear guidelines are developed and described in the iBRoad *"Report on how to integrate techno-economic assessment modules and logbook components in iBRoad programmes including possible data flows and required database structure"* [1], in order to operationalise the concept to facilitate the implementation on the national or regional level.

# III. EXPLORING POSSIBLE iBRoad FUNCTIONALITIES

## i. Logbook functionalities

From a holistic point of view, the logbook builds on a modular approach being able to provide several functionalities to the building user and participating stakeholders. A total of 21 functionalities were identified in different moments of the iBRoad project (partners review and voting, users' survey and stakeholders' brainstorming session), which were organised into the following 7 categories (Figure 9):

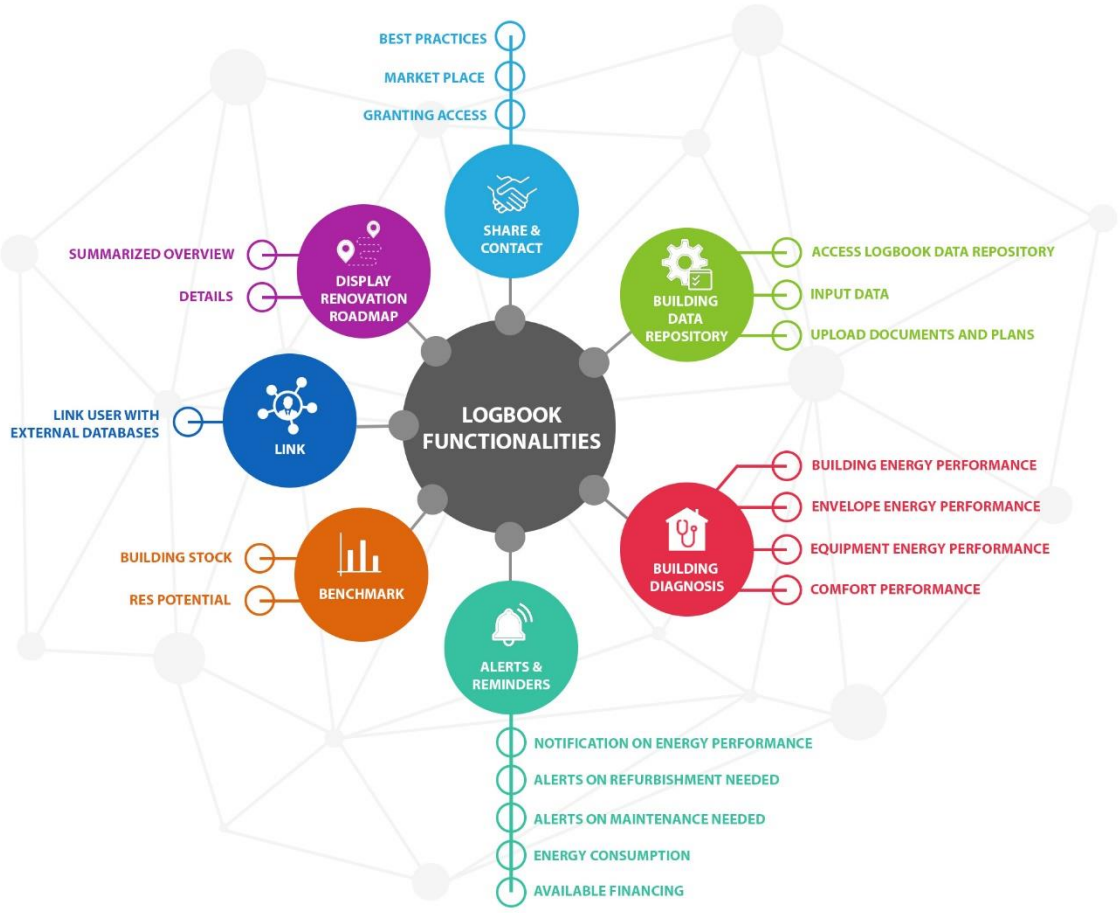



***Figure 9.*** *Logbook functionalities mindmap.*

- Building data repository: The user has access to the building data repository (logbook) divided in the five modules presented earlier, namely: General and Administrative information, Building Construction information, Building Energy Performance, Building Operation and Use, and Smart information. Also, a functionality allowing to input building data and another allowing to upload documents and plans needs to be available.
- Building Diagnosis: All the data collected and stored in the logbook allows for a preliminary building diagnosis which the user can access to follow-up on his/her house performance. Functionalities such as building general performance, building envelope performance, equipment performance, comfort performance and recommendations are available.

- Alerts & Reminders: Based on programmed thresholds (e.g. heating system older than 30 years), alerts and reminders on e.g. maintenance and/or refurbishment needs, building energy performance or available financing incentives are available.
- **Benchmark:** By linking the individual building logbook database with external databases (e.g. other logbooks, real estate prices, etc.), it is possible to perform and display benchmark results. Therefore, benchmark functionalities, such as building stock, RES potential and the average performance of buildings in the municipality or neighbourhood, become available.
- Link users with external databases: link the building owner or user to external resources of information relevant to the building, such as the cadastre, the fiscal authorities, land value tables, etc. Therefore, the logbook becomes the window to all the individual building-related information, irrespective of where this is maintained.
- Display renovation roadmap: provide a summary overview and a detailed view of the renovation steps proposed by the energy auditor, including the updated building characteristics and expected energy performance after the completion of each step.
- Share & Contact: link the building owner or user to third parties with the goal of reducing the gap between the market supply and demand. Functionalities which may stem from this link are the list of finance providers given the building location, the market operators available (with companies' rating based on other users' opinions), the possibility to make and receive proposals for technical works and the access to guidance through best practice projects. The building owner should then be able to share, with such third parties, all information needed for them to provide their services.

The functionalities' description as well as the identification of the potential stakeholders' involvement and their interests are described in detail hereafter.

### Building data repository

The building logbook data is divided in 3 main functionalities: 1) Access to logbook data repository, 2) Input building data and 3) Upload documents & plans (Figure 10).

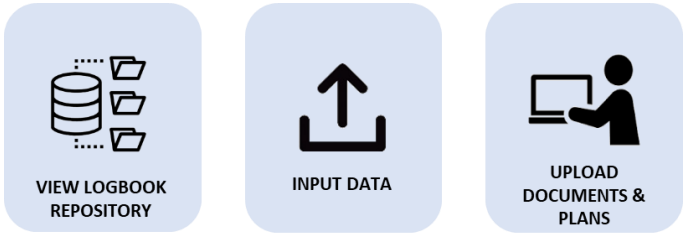



***Figure 10.*** *Building data functionalities*

#### 1. *Access logbook data repository*

Access to the logbook data repository is the main functionality of the iBRoad-Log. All the general data collected related to the building, the building unit (dwelling) and the building owner/user is stored here. The information is stored in and accessible through the 5 logbook modules (General and Administrative information, Building Construction information, Building Energy Performance, Building Operation and Use, and Smart information ). In this way, the user has access to the raw data that is available and stored in the logbook digital file, which in the Portuguese case, for example, can consider up to 600 different parameters [7]. The main goal of this functionality is to display historic information on the building construction, refurbishment, maintenance, as well as energy performance, operation and energy use. Different stakeholders could benefit from this information access: for archive (e.g. the building owner and the public local authority), for risk assessment (in the

case of the finance sector), to support energy audits (in the case of the energy sector) or for research and development of products and services (as in the case of research and academia).

*2. Input data*

In this functionality, different users may have different access permissions to view the data or enter new values or update old values in the different logbook modules. The stakeholders' interaction would be different according to their access restrictions: the building user could input or update mainly personal information, for example name, contacts and user preferences, leaving the technical data to be filled in by the corresponding entities, whereas the energy auditor should be granted access to enter all technical building and system data (e.g. the wall U-values). Upon certain conditions, considering national circumstances as well as personal data protection rules and legal disclaimers, other entities could have access to view or even permission to input data on the repository. For example, the public authority could input official and technical data related to the building (e.g. EPC, building taxes).

*3. Upload documents and plans*

Similarly, in this functionality the user can upload files related to building plans, energy bills, building photos or other relevant documents. This applies to stakeholders such as the building user (which can upload e.g. energy bills and photos), to public authorities (which can upload official documents e.g. building plans), to the energy sector (which can upload official documents e.g. the EPC or report on the energy audits and inspections) and to the construction industry (which can upload proposals).

**Building Diagnosis**

The building diagnosis has the goal to provide the user with understanding about the current building status in the following fields: Building energy performance, Envelope energy performance, Equipment energy performance and Comfort performance (Figure 11).

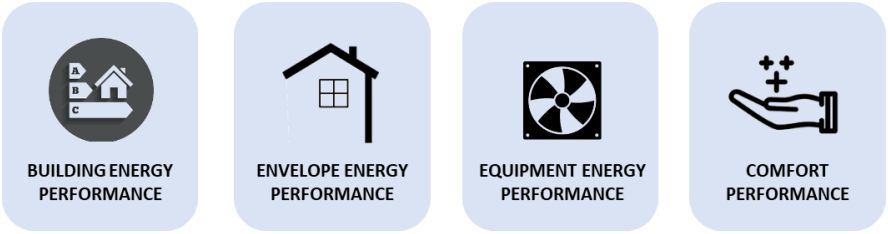



***Figure 11.*** *Building Diagnosis functionalities.*

*1. Building energy performance*

The general building energy performance is presented to the user based on the energy label, the technical building or system characteristics and other performance indicators such as the energy needs for heating, cooling or domestic hot water. Several stakeholders would benefit from this diagnosis for different purposes: in the case of the building user, to raise awareness on general building energy performance; in the case of the public authority, for regulation purposes (e.g. to regulate the renting market if the energy class is based on an official document such as the EPC) or for monitoring and statistics; in the case of the energy sector, to support future energy audits, for example; in the case of the construction industry, to target products and services; and in the case of research and academia, to support the development of prospective studies.

*2. Envelope energy performance*

The goal of this functionality is to facilitate the understanding about the current building envelope performance. This can be materialised by displaying different building elements (such as roof, windows, façade, etc.) in a colour associated to their energy performance. This energy performance rating could be established by comparing the current U-value with the normative values in each country. Other indicators besides the energy performance could be the conservation status of the building element. This functionality can be linked with other functionalities such as the alerts on refurbishment needs, for example. The stakeholders' interest in this functionality would be similar to the one presented previously.

*3. Equipment energy performance*

Similarly, in this functionality the goal is to display the energy performance of different equipment and systems available in the building, rated according to a colour coding when compared with the normative values in each country for a similar equipment or system. This functionality can be linked with other functionalities such as alerts on maintenance or replacement needs. The stakeholders' interest in this functionality would be similar to the one presented previously.

*4. Comfort performance*

So far, the functionalities presented are more related to the building energy performance or the building conservation status. This functionality focuses particularly in providing the user with a diagnosis regarding the building comfort performance provided by the building itself but also by the existing equipment. Indicators such as the thermal quality, indoor air quality, lighting quality, acoustics quality, and accessibility quality can be considered to provide a full building comfort assessment. The comparison of these indicators with considered 'best practice' reference values would enhance awareness regarding the current building comfort status. The main stakeholder benefiting of such a functionality would necessarily be the building user, namely in understanding the comfort the house actually delivers, in a qualitative and quantitative manner. Nevertheless, the public local authority could also have interest in such indicators for statistics to monitor the susceptibility for energy poverty or health issues, for example. In the same way, research and academia would also benefit from such information to develop, e.g., studies relating the comfort to other co-benefits other than energy savings, and to identify market trends.

**Display renovation roadmap**

One of the main functionalities of the logbook is to display the individual building renovation roadmap (iBRoad-Pan). This includes a summarised overview, as well as the full or detailed version including all details necessary to carry out the renovations properly (Figure 12).


***Figure 12.*** *Renovation roadmap functionalities.*

1. *Summarised overview of the building renovation roadmap*

This functionality displays the building's roadmap graph, i.e. the summarised overview of the specific building renovation roadmap as this stems from the iBRoad-Plan, presenting the renovation measures, the energy demand and the CO2 emissions for each renovation step, the cost of the measures, the subsidies and the energy costs before and after the renovation. This functionality is specifically addressing the building owner.

2. *Details of the building renovation roadmap*

Following the previous functionality, this one displays the detailed version of the iBRoad-Plan with all technical and financial details that guide the building owner through his/her stepwise renovation process.

**Alerts & Reminders**

The Alerts & Reminders functionality has the goal to increase the user's awareness about the building status, by showing alerts and reminders in a timely basis whenever an action is required on the following areas: Energy consumption, Refurbishment needs, Maintenance needs and Available financing (Figure 13). It can be linked to the Renovation Roadmap, if available.

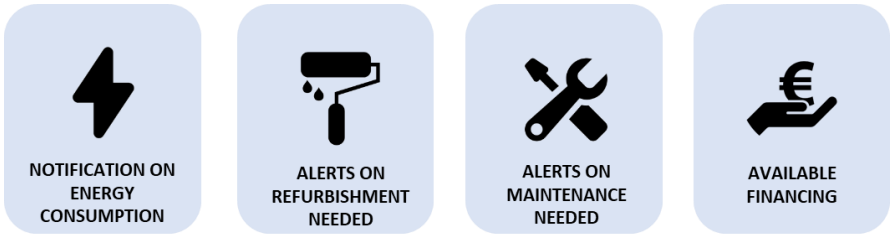



***Figure 13.*** *Alerts & Reminders functionalities.*

1. *Low energy performance*

Based on the building diagnosis, alerts triggered in case of low energy performance of the building or its systems could increase awareness and motivate the user to undertake action, e.g., to seek the advice of an energy auditor, request an renovation plan or other. The functionality is mainly addressed to the building user.

2. *Refurbishment needed*

Resulting from the envelope performance diagnosis or the renovation roadmap, this functionality shows alerts and reminders when there is a need for refurbishment. For example, if the window U-value deviates from the reference value, the user receives an alert to replace the window by a more efficient one. After this first alert, a monthly reminder can also be set. In most cases, this functionality will include an advice to consult the renovation roadmap or contact an energy expert for further advice. The stakeholders' interested in this functionality would be the user, but also the public authority for regulation and monitoring purposes and the construction industry to target services and products. This last one could be linked with the 'proposal' functionality available in a one-stop-shop functionality.

*3. Maintenance needed*

Resulting mainly from the equipment performance diagnosis or the renovation roadmap, this functionality displays alerts and reminders in case of old equipment or building components which need to be checked and or replaced. This functionality indicates if the equipment or building component needs maintenance or needs to be replaced based on the maintenance history, equipment's age and component's life cycle. Also, an alert function can be set by the user as well: e.g. the user edits a reminder to call the heating installer for the annual maintenance or the chimney sweeper. In many cases, this functionality will include an advice to consult the renovation roadmap or contact an energy expert for further advice. The stakeholders' interest in this functionality would be similar to the one presented previously.

*4. Energy consumption*

This includes alerts in case of strange consumption patterns (e.g. possibly caused by flaws in technical installations) or alerts in case of uncommon peaks of energy consumption, available only if smart meter data are stored in the logbook. Energy alerts can also be set to predict future consumption according to the user energy consumption trends or to prevent specific consumption patterns. For example, it would be possible to set an alert to occur within the first week of a monthly billing period to allow the user to adjust their consumption pattern throughout the month. These alerts increase the user's awareness on his/her own consumption and allows him/her to change the behaviour based on that knowledge. Since this is considered private information, the only stakeholder having access to and benefiting from these alerts would necessarily be the building owner and user.

*5. Available financing*

This functionality has the goal to provide up to date information on available financial incentives and schemes for renovation. Based on the previous alerts and reminders, the user receives an alert if specific incentives are available. For example, if the user is given an alert to replace windows and, in the meantime, a subside becomes available, the user receives an alert with information on that. This functionality can be linked to an incentive database, if available or to the 'finance providers' functionality available in a one-stop-shop. The stakeholder interested in such a functionality would mainly be the building owner since he/she would be the direct beneficiary of these incentives.

**Share & Contact**

The share & contact functionality aims to link the building owner with third parties, providing a service that can help the user to take action and to implement refurbishment measures. It is divided in the following functionalities: Granting access, Market Place, and Best Practices (Figure 14).


***Figure 14**. Share & contact functionalities.*

*1. Granting access*

Through this functionality, the logbook owner can grant access to other parties, either to view or to enter data into the logbook. Granting access may be restricted to specific parts of the logbook for

specific people, e.g., the energy auditor may receive access to input or update data into the whole logbook, whereas the municipality may only view the buildings' overall energy performance.

*2. Market place*

This functionality should allow the user to get linked with qualified building professionals. A list of professionals registered in a web portal with contacts and with a quality rating by other users can be made available in order to facilitate the user's choice. Through the logbook information, this list can be narrowed by considering the building location and the type of improvement measures needed. This way, a tailored list is presented avoiding the user to go through millions of entries and allowing him/her to make a more thoughtful decision. For example, the user obtains the contact information of craftsmen and/or architects, who could plan or work on the renovation activities. Building up on this, the list of service providers allows the user to contact them and request more information or a proposal based on the logbook or renovation roadmap recommendations. Data on products and systems specifications (as guarantees, suppliers, etc.) can also be made available to the user through this functionality.

*3. Best practices*

Inspiring the building owner to undertake action, the best practice section should include real case examples of successful renovation works completed or under development. Each best practice would preferably include the respective technical details of the renovation, as well as the benefits gained from that renovation. Works may be undertaken either using the iBRoad concept or independently from that.

**Benchmark**

The benchmark functionality has the goal to allow the user to make comparisons of specific characteristics of one building to others, as well as to have an overview of a specific parameter in an aggregate basis. Two such functionalities are presented below: Building stock and Renewable Energy Sources (RES) potential (Figure 15).

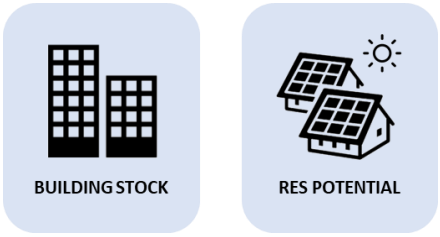



***Figure 15.*** *Benchmark functionalities.*

*1. Building stock*

Several parameters are described in the building logbook repository that allow for a massive comparison when other logbook databases are available. This enhances different types of analysis that are not necessarily energy driven (building stock conservation status, typology, etc.). The availability of such analysis brings several benefits to different stakeholders:

- building users: to compare their building performance or the building market price value with other buildings (e.g. similar in terms of typology or belonging to the same neighbourhood);
- public authority: to monitor and to perform updated statistics comparing different parameters (e.g. building stock construction period or energy performance) and also support strategic urban

planning or policy development (e.g. prioritise areas with families with lower income and buildings with worst energy performance);
- finance sector: to draw incentives based on knowledge on where lies the highest priority or it is most beneficial to renovate (e.g. promote subsidies in groups of buildings where it is more cost-effective to invest);
- real estate market: to compare market prices of similar buildings and zones;
- the construction industry: to target their products and services to specific zones and clients;
- research and academia: for R&D.

*2. RES potential*

This functionality has the goal to map the building's RES generation by linking the logbook data (e.g. existent systems, current energy demand, roof type, etc.) with data from external databases (e.g. current energy generation, potential for RES installation, potential for RES production, etc.). This type of functionality is more appealing to stakeholders such as the public authority for statistics (e.g. to monitor the penetration of RES regarding the potential available) and policy (e.g. to establish mid to long-term RES penetration targets) but also to the finance sector enabling to draw and drive financial incentives based on RES potential. Other stakeholders benefiting from this functionality would be the real estate market to empower the marketing and sales/rent of their houses, the energy sector as for example the energy agencies for quality assessment on the EPC RES potential through comparison, the construction industry to target their products and services to specific areas, research and academia for R&D, and the energy utilities to have a better understanding of the buildings' energy profile for their supply and demand forecast.

## ii. Roadmap functionalities

**Renovation Roadmap**

The renovation roadmap provides tailored advice to owners and investors on how to improve the building, following the natural renovation cycles and avoiding unwanted lock-in-effects. The roadmap will provide building owners with an overview of the full range of renovation options in a specific sequence, identifying each renovation step from beginning to end (step-by-step approach), including additional information, e.g., on how to finance these actions and how to implement them.

Two functionalities are provided by the renovation roadmap: the Roadmap graph and the Roadmap detailed version (Figure 16).

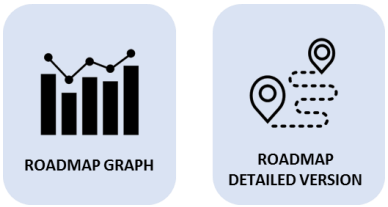



***Figure 16.*** *Renovation roadmap functionalities.*

*1. Roadmap graph*

The roadmap graph displays a summarised overview of the building renovation roadmap. This can be presented through an illustrative roadmap where the user visualises the summary of 'individual renovation steps' developed with the energy auditor. A table gathering the renovation measures, the

energy demand and the CO2 emissions for each renovation step, the cost of the measures, the subsidies and the energy costs before and after the renovation, may be used for this summary overview. The stakeholders more interested in this functionality would be the building owner since he/she is the main beneficiary.

*2. Roadmap detailed version*

Following the previous functionality, the detailed version of the roadmap has the goal to describe the renovation steps and measures. This includes technical details as well as the trigger points for the renovation step and the preparations for later renovation steps that ensure a high quality interlinkage between components. This way, the user has access to specific information for stepwise renovation (through texts and graphics) and a data annex with the description of what, when and how to renovate in each step. The main goal of this functionality is to show the user the detailed information available in the individual building renovation roadmap, which was developed with the energy auditor. The main benefit for the building user, which is also the main stakeholder of this functionality, is to obtain guidance on how to proceed with a building renovation, in a step by step procedure (e.g. step 1 description of actions including investment, timing, savings, benefits and others). A data file, containing the information (data, graphs, text, photos) of the roadmap, can be uploaded in the logbook, allowing future alterations and updating by the energy auditor.

## iii. iBRoad link to other services

The iBRoad concept can be linked to other software or services operated or under development in the market that are external to the logbook and the roadmap (Figure 17). These can either provide input to or use inputs coming from the logbook and roadmap to produce new data and information and provide more holistic services to a range of stakeholders supporting the energy renovation process.


***Figure 17.*** *Link user with external databases.*

Energy Management: Energy management systems have the goal of planning and operating the energy production and consumption of a building. The main goal is to allow the user to have a more energy efficient behaviour. Linking the logbook with energy suppliers' metered energy data (e.g. electricity consumption from a smart-meter), would allow the user to have access to their actual and historical energy consumption billing data (e.g. gas, electricity, etc.) in one single web portal or platform. Ideally, with the deployment of smart-meters this could be the real-time energy consumption in a high-resolution temporal disaggregation linked with the demand response. Similarly, this linkage should allow the user to have access to data of the building energy generation, possibly linked with the energy consumption monitoring and demand response, to allow for a complete analysis for the building energy demand and supply. With this information at hand, the user could have the ability to change his/her consumption behaviour towards a more energy efficient one. Real-time energy alerts could also be set to predict future consumption or demand peaks according to her/his energy use trends, helping the user build a knowledgebase of what is contributing to his/her energy consumption, giving him/her the ability to cut the energy bill costs before they occur.

Demand Calculation and EPC register: The logbook data can serve as initial input for several demand calculation models, including the official country specific energy demand calculation software which is used to issue the EPC. Conversely, the input data of the energy demand calculation or EPC could feed the logbook. Both ways, this interlinkage would simplify the energy calculation procedure and at the same time serve as a quality check for the data used. It would allow the user to estimate their baseline energy consumption considering the energy model specifications in order to apply different refurbishment scenarios and estimate the savings impacts and eventually other co-benefits that may arise. The above may also drive a comparison of real with designed energy consumption. This allows for an energy model validation and calibration, reducing the gap between the simulated and real energy consumption, improving the energy model reliability and therefore, improving the scenarios and allow the building performance potential estimation to become more precise.

At the same time, such interlinkage could feed the national EPC register database, holding aggregated information about the national building stock, with reliable data. By having a considerable number of buildings associated with the logbook, the municipalities might start building a very rich and up-to-date database of their building stock. This would allow different municipalities to compare specific indicators with others (e.g., building stock energy performance, the RES penetration and potential, etc.), thereby supporting building stock comparison and statistics, leading to targeted policy development.

# IV. FUNCTIONALITIES TO BE IMPLEMENTED WITHIN THE iBRoad PROJECT

Based on the methodology deployed earlier, 11 functionalities were chosen for development and testing under the iBRoad project, to enable, in a first stage, the pilot implementation of the individual building renovation roadmaps, and to promote a learning experience to apply deep renovation in different countries.

As has been explained earlier, the main function of the iBRoad-Log is being the repository for building related information; in addition, under the context of the iBRoad project, some additional functionalities will be conceptualised, namely the building diagnosis, the display of the renovation roadmap, as well as alerts and reminders.

Although the iBRoad-Log starts as something static, it can evolve into a very dynamic tool in the future. Data can at some point be fed to the iBRoad-Log by either the energy auditor, the building owner, or other sources (e.g. if a public EPC database is available in the country, some information may be supplied to the iBRoad-Log, containing building information such as address and building performance) where access rights should be defined accordingly per data field. Within the iBRoad project, however, an automatic interface to national or regional EPC databases may not be realised and, initially, data will only be fed by the energy auditor.

*Functionalities related to the building data repository*

- View logbook data depository: This functionality allows the user to view the information in the logbook data depository. It is the first basic principle of the iBRoad concept.
- Input data: Allows authorised persons to enter (input new or update old) values in the logbook (through the back-end).
- Upload documents and plans: Allows authorised persons to upload information (photos, documents, plans) of other formats (e.g. jpeg, excel, PDF, etc.).

*Functionalities related to the building diagnosis:*

- Display actual building energy performance: This facilitates understanding of the current building status as a whole, e.g., by displaying the energy class.
- Display envelope energy performance: This functionality facilitates understanding about the current building envelope status, by displaying its rating in a colour scale associated to its energy efficiency.
- Display equipment energy performance: Similarly, this functionality facilitates understanding of the buildings' current technical equipment energy performance by displaying their rating(s) in a corresponding colour scale.

*Functionalities related to the Renovation Roadmap:*

- Display a summarised overview of the building renovation roadmap: A visualised overview of the individual building renovation roadmap with the step by step renovation measures over the years and performance to be achieved (including investment costs, energy savings and others).
- Display details of the building renovation roadmap: This functionality will allow the user to access the detailed description of his/her individual building roadmap developed with the energy auditor per renovation including technical details, application, investment, timing, savings, benefits, triggers and others.

*Functionalities related to the Alerts & Reminders:*

- Low energy performance: Notifications for motivating the user to undertake action in case of low energy performance of their building or systems.
- Refurbishment or maintenance needed: Timely alerts for specific refurbishment or maintenance actions needed, mainly linked to the measures defined in the iBRoad-Plan, or to the specific characteristics of equipment installed.
- Available financing: Notifications for financial incentives available relevant to the measures or actions needed.

# V. GRAPHICAL GUIDELINES

*Context*

The present chapter summarily presents the design principles and graphical guidelines to be applied to the iBRoad tools i.e., iBRoad-Log logbook and iBRoad-Plan roadmap. Further elaboration of these guidelines will take place during the actual production of the tools; in addition, specific refinements may follow after user feedback during the pilot implementation phase.

*Approach*

The approach to be followed for the development of the graphical guidelines for a software application is primarily determined by its target group. In the case of the iBRoad tools, this is mixed: both non-specialists (home owners) and professionals will have access to the Logbook and Roadmap, though it is only the latter that will enter data in the context of the iBRoad project implementation. Moreover, in the case of the Roadmap, it is also a matter of principle that only trained energy auditors are to submit the relevant data and propose the staged renovation steps.

In practice, the iBRoad software tools are expected to have a user-friendly 'front-end', accessible by non-specialists, and a data entry 'back-end', for the professional auditors to enter data. The current guidelines focus on the front-end, which represents the main challenges for information design, aiming for a setup which is intuitive and self-explanatory to the greatest extent possible.

Modern software applications tend to look more and more like websites. A clear trend of convergence has arisen, whereby interfaces appear infrastructure-agnostic, i.e. largely independent of the underlying operating system which may itself be web-based (Chrome OS). Users can nowadays expect a very similar experience whether working on the 'classic' desktop implementation of a programme (e.g. Microsoft Office Word for Windows) or its web counterpart if/when this is available (e.g. Microsoft Office online).

A similar logic is presented for the iBRoad software tools, which may be implemented as either self-standing desktop programmes, or as client-server applications accessible locally or remotely via web. The latter makes particular sense if the tools, particularly the Logbook, are linked to external databases and services. The present proposals are valid in all cases, as they are not tied to a specific implementation.

A compatible look and feel is proposed for the two tools, reflecting their relation, as well as allowing for full integration if this is needed or convenient. The look and feel is an extension of the iBRoad identity, both for branding purposes and for ensuring association with the relevant information provided by iBRoad in support of the software adoption and use.

*Content structure*

In respect to the Logbook, the main content structure has been defined in detail in the iBRoad project report “The logbook data quest: setting up indicator and other requirements for a renovation passport” [7]. They are gathered in a worksheet of five sections, covering different types of information related to a building. In the present report, they have been summarised in chapter II.iii.

In respect to the Roadmap, the main content structure is summarised in the present report in chapter III.ii.

*Overview*

Figure 18 summarises the proposed organisation of the main software screen. The structure follows a top-down / left-to-right flow, which is considered the most effective in left-to-right writing cultures. The itinerary can be described as the visual reply to a series of hypothetical questions, such as:

Q. Where am I?

A1. Software identification, i.e. iBRoad-Plan or iBRoad-Log.

A2. Software menu, e.g. Current State of building.

Q. What is this about?

A. Building identification, i.e. photo and name.

Q. What information am I seeing?

A. Main information area, e.g. General and Administrative Information on the building.

Q. Whom does this information concern?

A. Owner of the building, issuer of the information (auditor).

Similarly, the screen footer provides additional information, such as funding, disclaimers, associated brands (partners), etc.

The full inventory of layouts proposed may be found in Annex I of this report. This includes the printed version of the iBRoad-Plan.

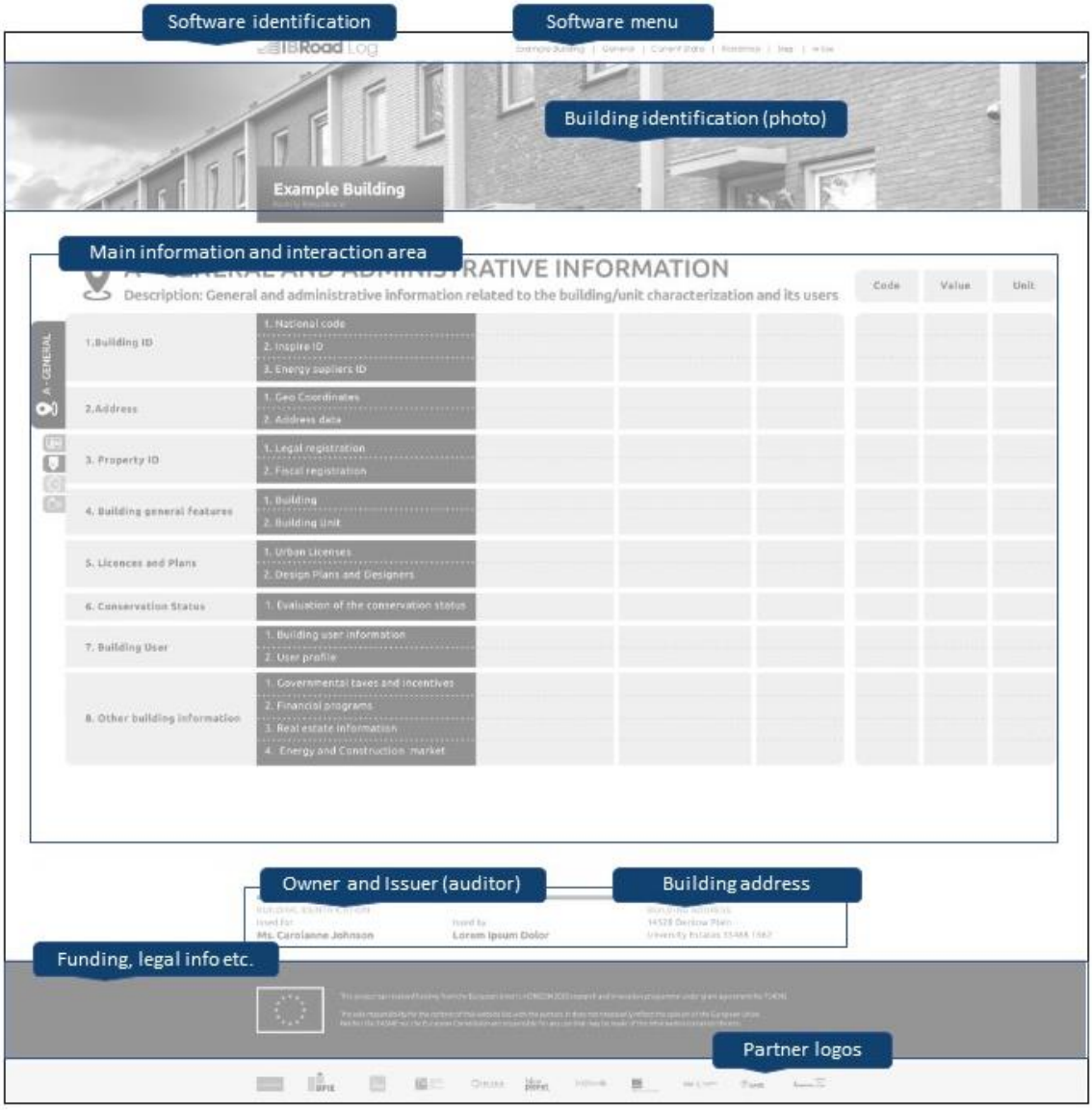



***Figure 18.*** *Proposed organisation of the main software screen.*

### *Further steps*

The various screen templates were designed in vector format (Adobe Illustrator) and have been made available to the iBRoad software development team for the implementation. Additional templates may be produced if needed.

# VI. CONCLUSIONS AND RECOMMENDATIONS

The individual Building Renovation Roadmap as described above is at its core envisaged and expected to empower the building user, and in particular in the following ways:

- support them in collecting all building related information in a single place, the building repository or logbook;
- support them in understanding the actual status and potential of their building, and in particular of their building's energy performance;
- showcasing and quantifying the expected multiple benefits of their building's energy renovation;
- enabling and guiding them to undertake customised (energy) renovation action;
- providing insurance/guarantee about the quality of the renovation works and the targeted impact;
- alerting them in a timely manner of any necessary maintenance or other actions;
- enabling them to compare their building status, potential and market value with that of similar buildings;
- allowing them to profit of the collective experience available around building renovation;
- providing them easier access to financing for building renovation;
- enabling direct communication with public authorities and other actors, if/when so desired.

Thereon, the building renovation plan may address, support and affect many other stakeholders, entities and professions, as already defined in this report.

The Logbook and Roadmap functionalities listed are only an indication of what these tools may actually serve for. Depending on the country situation, the Logbook and Roadmap may serve a significant further potential. At the forefront of this potential lies the possibility for them to become the natural extension of the Energy Performance Certificate (EPC) scheme: this could be achieved by automatically linking them to the official national software for energy demand calculation and the relevant national/regional EPC building stock database, in order to guarantee the quality of the EPC input data, energy assessment and proposed interventions, provide access to relevant financing and feed in the relevant benchmark and statistical data.

Other possible functions for the Logbook and Roadmap could include: to become part of a broader service offered to the citizens, similar to that of a One-Stop-Shop for building renovation; to include information on other, non-energy related building related data like soil, water, safety, security, accessibility, seismic effect, sustainability, and others; to be linked further to other relevant databases available at national scale as e.g. for statistical-, utility related- or tax- purposes; to be set as an eligibility requirement for obtaining certain renovation financing. All of the above potential functions contribute to the Logbook and Roadmap concept becoming a central point which connects the building user with relevant external entities.

The precise Logbook and Roadmap functionalities to be implemented are to be selected according to the specific country related situation and needs, and can be established on an evolutionary basis, gradually making new functionalities available to different stakeholders. Through relevant training, testing, monitoring and evaluation, further improvements may be performed continuously, improving the reliability and trustworthiness of the tools.

For this to take place, additional effort is required to investigate the relevant national parameters. The particular market set-up plays a special role in this: Will the instruments be run on a voluntary or a mandatory basis? Will they be managed by the government/local authorities, be market driven or on individual basis, etc.? Who will have access to which set of data? To which external tools/databases should they be directly linked? Continuous stakeholder involvement is a prerequisite for such

discussions to succeed. These areas deserve further investigation but fall outside the scope of the iBRoad project.

In all cases, there are several benefits resulting from this effort:

- create or increase the building stakeholders' perception on the logbook and renovation roadmap added value, namely as an important tool to enhance the action on the building renovation, promote energy efficiency and to achieve a decarbonised building stock by 2050;
- facilitate and improve the stakeholders' experience in building renovation initiatives;
- bridge the gap between the building user and third parties, reducing the barriers that currently hinder the building renovation processes;
- further increase stakeholders' perception of building's available data, integrating all the relevant information in a single repository (the Logbook), namely regarding building general and administrative information, construction, energy performance, operation and use, and smart information;
- support a robust national buildings' information database, further allowing for public authorities to define and implement long term renovation strategies according to national specific needs and goals.

The building renovation plan is thus expected to hold a major potential for increasing the building renovation rate and building renovation depth over a longer-term horizon, thereby significantly contributing to the European Union climate and energy targets.

# REFERENCES

[1] tbd, "Report on how to integrate techno-economic assessment modules and logbook components in iBRoad programmes including possible data flows and required database structure," iBRoad, 2018.

[2] BPIE, "BPIE's response on the EPBD consultation," BPIE, 2015.

[3] I. Artola, K. Rademaekers, R. Williams and J. Yearwood, "Boosting Building Renovation: what potential and value for Europe?," European Union, 2016.

[4] U. Nations, "Paris Agreement," 2015.

[5] A. Karlsoon and et al, "Common barriers and challenges in current nZEB practice in Europe," ZenN – Nearly Zero energy Neighborhoods, 2013.

[6] M. Fabbri, M. D. Groote and O. Rapf, "Building Renovation Passports: Customised roadmaps towards deep renovation and better homes," BPIE, 2016.

[7] P. Libório, R. Fragoso, C. S. Monteiro, J. Fernandes, E. Silva and T. V. Casteele, "The logbook data quest: setting up indicator and other requirements for a renovation passport," iBRoad, 2018, https://ibroad-project.eu/news/the-logbook-data-quest/.

[8] J. Volt, M. Fabbri and M. de Groote, "Understanding potential user needs: a survey analysis of the markets for Individual building renovation roadmaps in Bulgaria, Poland and Portugal," iBRoad, 2018, https://ibroad-project.eu/news/understanding-user-needs/.

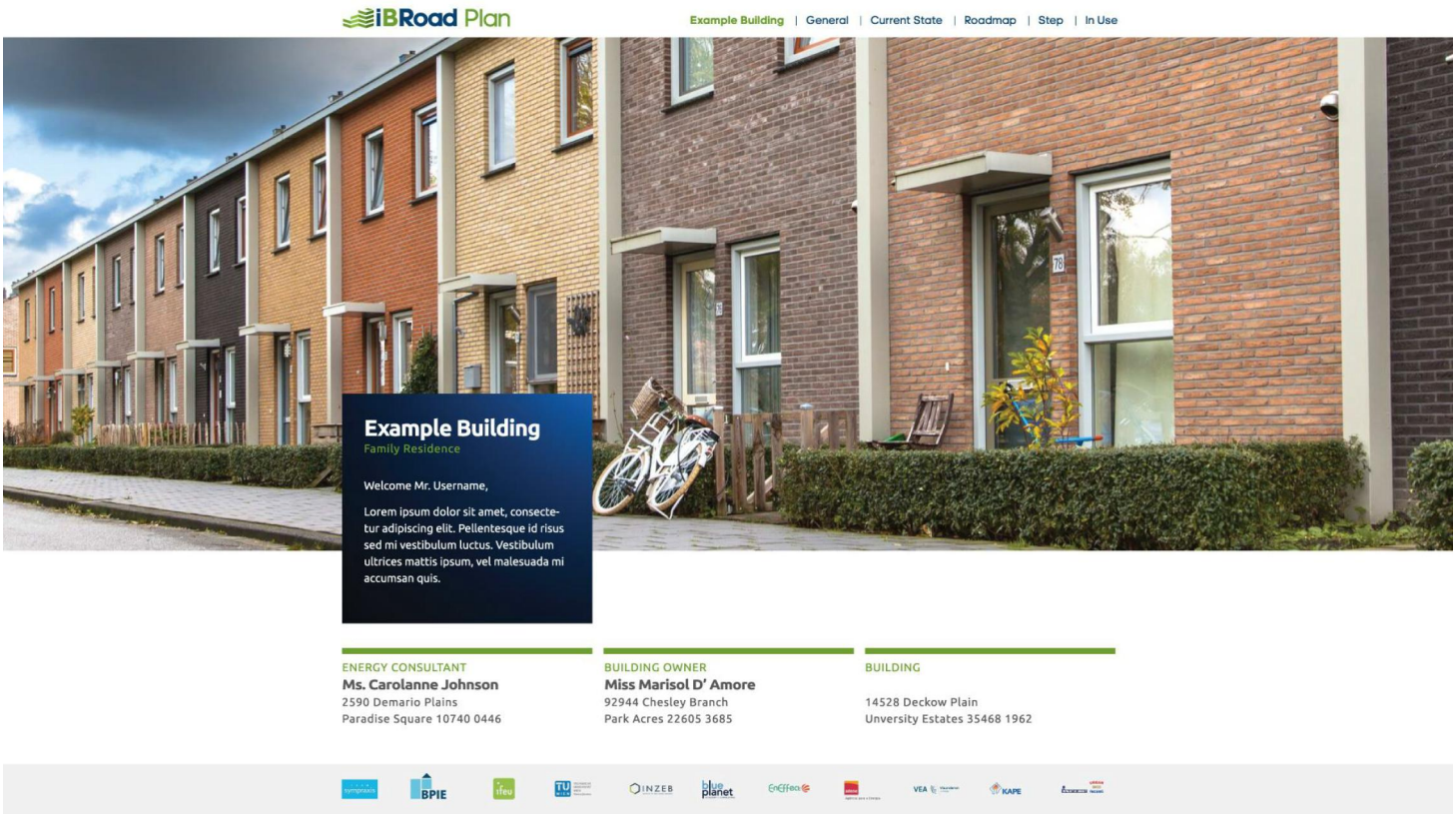
[9] A. Corovessi and E. Kanellou, iBRoad stakeholders as real driver of positive change – Identification process across Europe, iBRoad, 2017, https://ibroad-project.eu/news/stakeholder-mapping/.

[10] M. Fabbri, J. Volt and M. de Groote, "The Concept of the Individual Building Renovation Roadmap - An in-depth case study of four frontrunner projects," iBRoad, 2017, https://ibroad-project.eu/news/the-concept-of-the-individual-building-renovation-roadmap/.

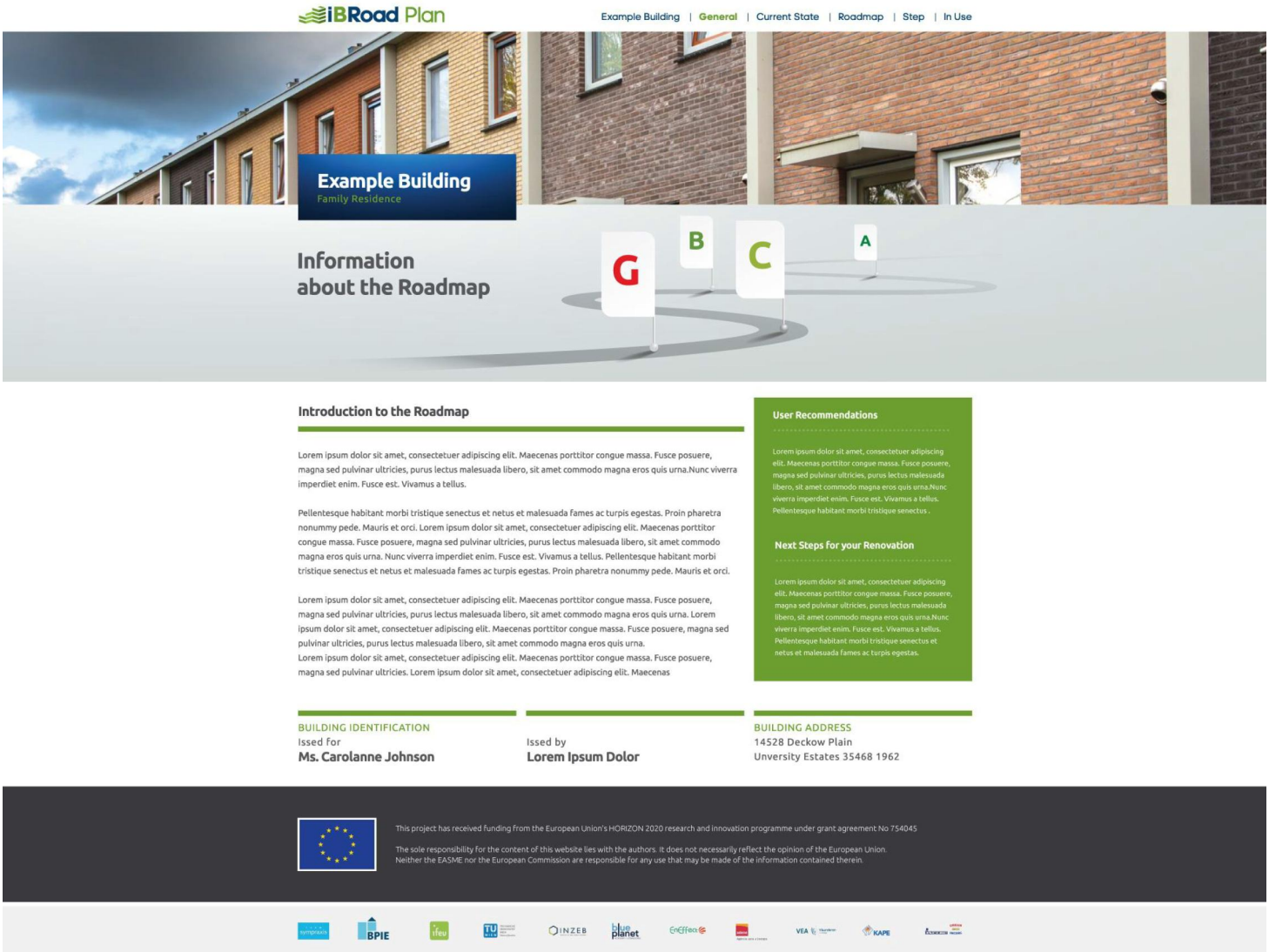
# ANNEX: INVENTORY OF PROPOSED LAYOUTS

# iBRoad-Plan home screen

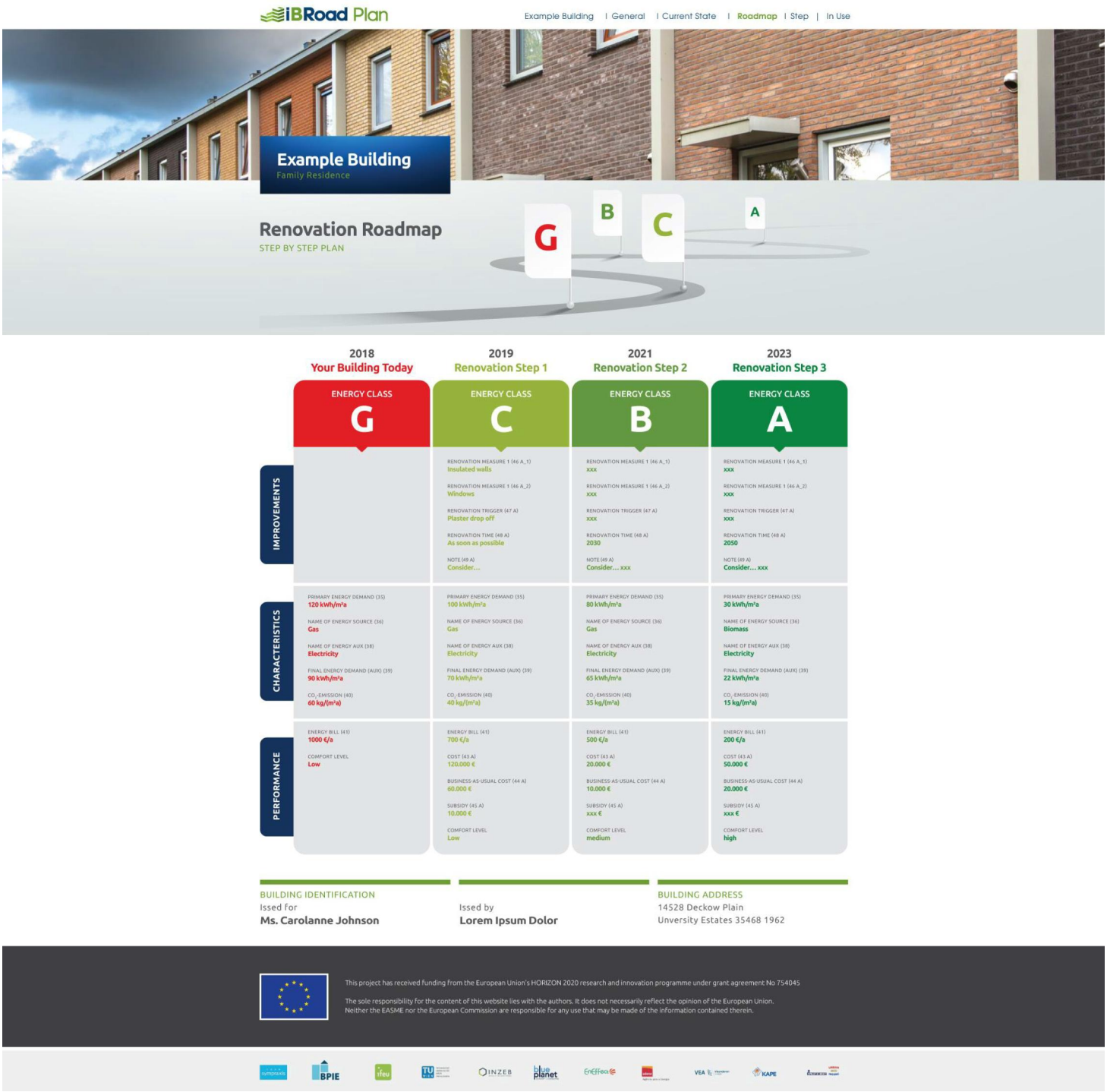
# iBRoad-Plan home screen alternative



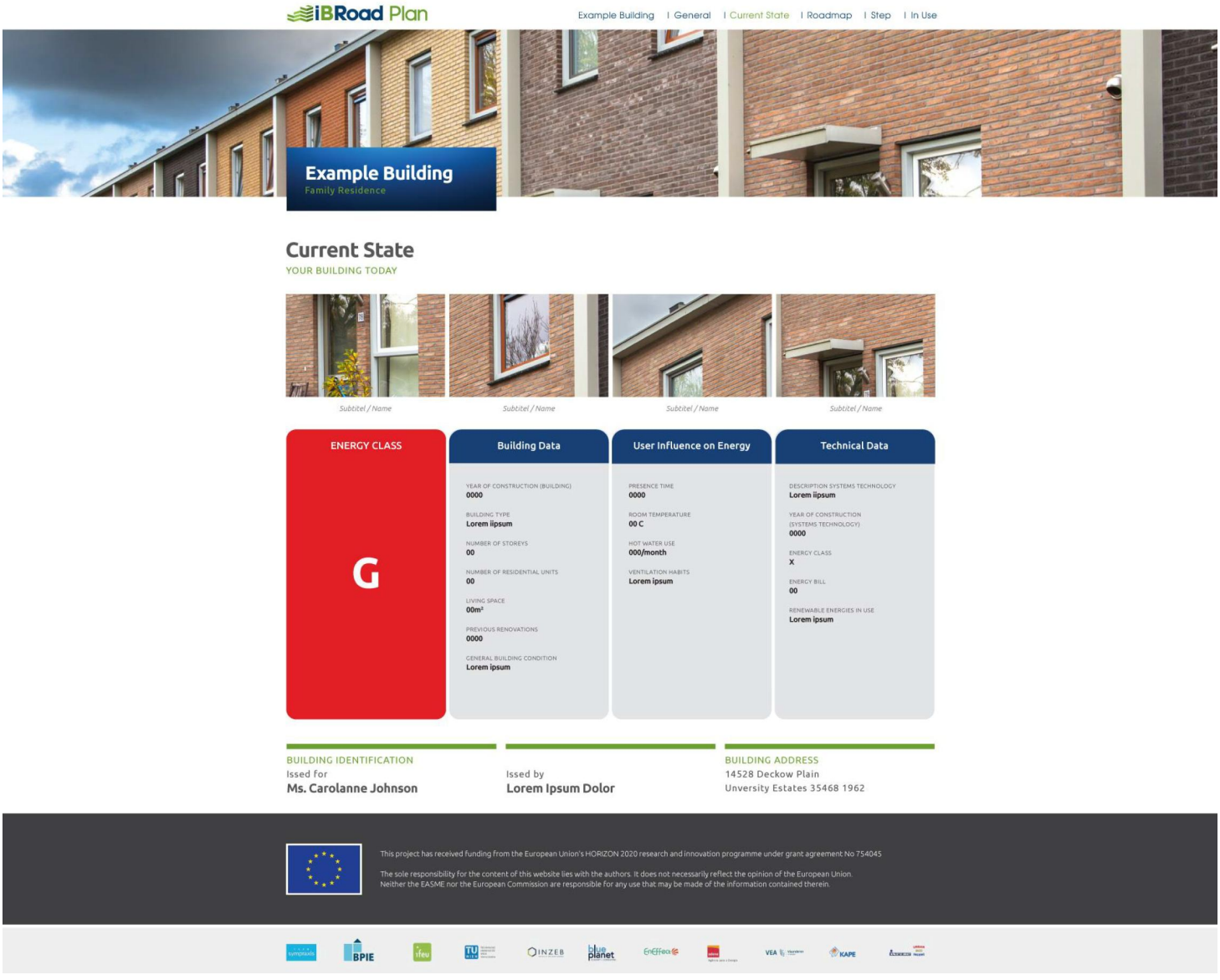
# iBRoad-Plan introduction



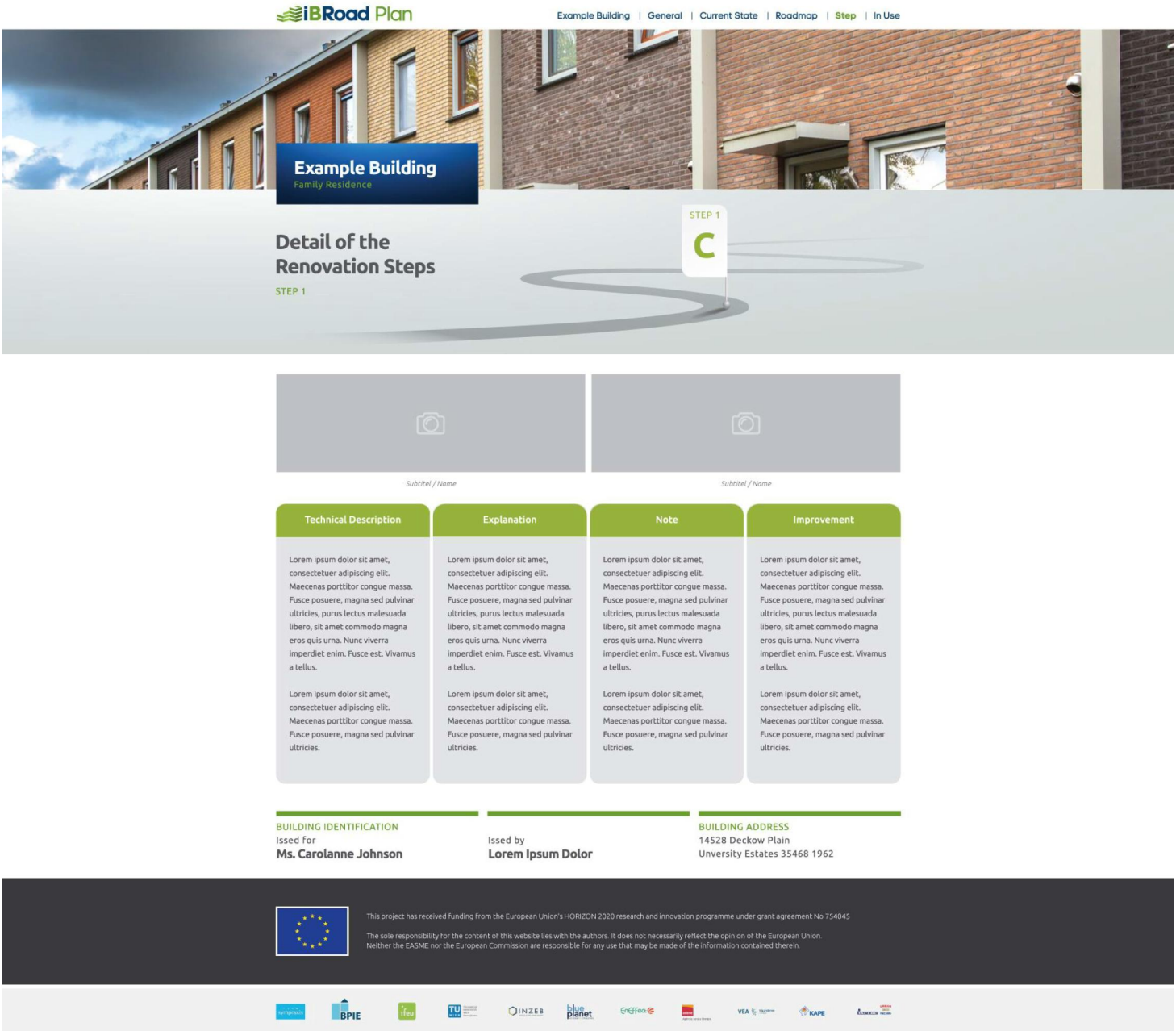
# iBRoad-Plan overview of steps



# iBRoad-Plan current state of building



# iBRoad-Plan individual step details



# iBRoad-Log section A

iBRoad Log

Example Building | General | Current State | Roadmap | Step | In Use


## A - GENERAL AND ADMINISTRATIVE INFORMATION

**Description: General and administrative information related to the building/unit characterization and its users**

A - GENERAL

| | | | Code | Value | Unit |
|---|---|---|---|---|---|
| 1.Building ID | 1. National code<br>2. Inspire ID<br>3. Energy supliers ID | | | | |
| 2.Address | 1. Geo Coordinates<br>2. Address data | | | | |
| 3. Property ID | 1. Legal registration<br>2. Fiscal registration | | | | |
| 4. Building general features | 1. Building<br>2. Building Unit | | | | |
| 5. Licences and Plans | 1. Urban Licenses<br>2. Design Plans and Designers | | | | |
| 6. Conservation Status | 1. Evaluation of the conservation status | | | | |
| 7. Building User | 1. Building user information<br>2. User profile | | | | |
| 8. Other building information | 1. Governmental taxes and incentives<br>2. Financial programs<br>3. Real estate information<br>4. Energy and Construction market | | | | |

BUILDING IDENTIFICATION
Issed for
**Ms. Carolanne Johnson**

Issed by
**Lorem Ipsum Dolor**

BUILDING ADDRESS
14528 Deckow Plain
Unversity Estates 35468 1962

This project has received funding from the European Union's HORIZON 2020 research and innovation programme under grant agreement No 754045

# iBRoad-Log section B

iBRoad Log

Example Building | General | Current State | Roadmap | Step | In Use


## B - BUILDING CONSTRUCTION INFORMATION

**Description: Technical information and data related to the building construction**

B - CONSTRUCTION

| | | | Code | Value | Unit |
|---|---|---|---|---|---|
| 1. Envelope | 1. Walls | | | | |
| | 2. Roofs | | | | |
| | 3. Floors | | | | |
| | 4. Thermal Bridges | | | | |
| | 5. Doors | | | | |
| | 6. Windows | | | | |
| 2. Technical building systems (TBS) | 1. Ventilation systems | | | | |
| | 2. Heating system | | | | |
| | 3. Cooling System | | | | |
| | 4. DHW system | | | | |
| | 5. Lighting system | | | | |
| | 6. Building automatization & controls (BAC) | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

BUILDING IDENTIFICATION
Issed for
**Ms. Carolanne Johnson**

Issed by
**Lorem Ipsum Dolor**

BUILDING ADDRESS
14528 Deckow Plain
Unversity Estates 35468 1962

This project has received funding from the European Union's HORIZON 2020 research and innovation programme under grant agreement No 754045

# iBRoad-Log section C

iBRoad Log

Example Building | General | Current State | Roadmap | Step | In Use


## A+ C - BUILDING ENERGY PERFORMANCE

**Description: Energy Information based on EPC information or other energy assessments**

C - ENERGY

| | | Code | Value | Unit |
|---|---|---|---|---|
| 1. EPC general information | 1. Expert Name | | | |
| | 2. Expert ID | | | |
| | 3. Type of EPC | | | |
| | 4. EPC number | | | |
| | 5. Energy label | | | |
| | 6. Date (issue) | | | |
| | 7. Date (term) | | | |
| | 8. Photograph report | | | |
| | 9. EPC support documentation | | | |
| 2. Audit general information | 1.Expert Name | | | |
| | 2. Professional Order (PO) | | | |
| | 3. Audit date | | | |
| | 4. Energy label | | | |
| | 5. Photograph report | | | |
| | 6. Energy audit support documentation | | | |
| 3. Energy and other Indicators | 1. Energy use | | | |
| | 2. Delivered energy | | | |
| | 3. Primary energy | | | |
| | 4. Environmental and energy indicators | | | |
| | 5. Other indicators | | | |
| | 6. Comfort level | | | |
| 4. Recommendations | 1. Individual impact | | | |
| | 2. Collective impact | | | |

BUILDING IDENTIFICATION
Issed for
**Ms. Carolanne Johnson**

Issed by
**Lorem Ipsum Dolor**

BUILDING ADDRESS
14528 Deckow Plain
Unversity Estates 35468 1962

This project has received funding from the European Union's HORIZON 2020 research and innovation programme under grant agreement No 754045

The sole responsibility for the content of this website lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained therein.

# iBRoad-Log section D

iBRoad Log

Example Building | General | Current State | Roadmap | Step | In Use


## D - BULDING OPERATION AND USE

**Description: Data and information on how the building is operated**

D - OPERATION

| | | | | | Code | Value | Unit |
|---|---|---|---|---|---|---|---|
| 1. Energy consumption | 1. Energy source<br>2. Metering system information | | | | | | |
| 2. Energy generation | 1. Renewable energy system<br>2. Metering system information | | | | | | |
| 3. Energy Suppliers | 1. Energy source<br>2. Metering system information | | | | | | |
| 4. Inspections | 1. Building element<br>2. Inspection information | | | | | | |
| 5. Maintenance | 1. Building element<br>2. Maintenance Information | | | | | | |
| 6. Climate data | 1- Weather data | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

BUILDING IDENTIFICATION
Issed for
**Ms. Carolanne Johnson**

Issed by
**Lorem Ipsum Dolor**

BUILDING ADDRESS
14528 Deckow Plain
Unversity Estates 35468 1962

This project has received funding from the European Union's HORIZON 2020 research and innovation programme under grant agreement No 754045

# iBRoad-Log section E

iBRoad Log

Example Building | General | Current State | Roadmap | Step | In Use


## E - SMART INFORMATION

**Description: Smart information related to the building**

E - SMART

| | | Code | Value | Unit |
|---|---|---|---|---|
| 1. Smart indicator | 1. SRi - Smart readiness indicator | | | |
| | 2. Other smart indicators | | | |
| 2. E-mobility | 1. EV Charging points | | | |
| 3. Smart district | 1. Smart district indicators | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

BUILDING IDENTIFICATION
Issed for
**Ms. Carolanne Johnson**

Issed by
**Lorem Ipsum Dolor**

BUILDING ADDRESS
14528 Deckow Plain
Unversity Estates 35468 1962

This project has received funding from the European Union's HORIZON 2020 research and innovation programme under grant agreement No 754045

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nº 754045