



Extending the iBRoad Building Renovation Passport I

Report on the adaptation to multi-family and public buildings

ifeu – Institute for Energy and Environmental Research
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Authors (ifeu – Institute for Energy and Environmental Research)

Peter Mellwig – ifeu

Julia Lawrenz – ifeu

Contributors

Rui Fragoso – ADENE

Karolina Junak – KAPE

Horia Alexandru Petran – INCUB URBAN-INCERC

Eleftheria Touloupaki – INZEB

Alexander Stankov – EnEffect

Ander Bilbao – CÍCLICA

Reviewers

Ander Bilbao – CÍCLICA

Marianna Papaglastra – Sympraxis Team

Alexander Deliyannis – Sympraxis Team

Layout

ifeu and Sympraxis Team

Cover illustration

depositphotos.com / dhdezvalle / luzimag – Sympraxis Team

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EXECUTIVE SUMMARY

This report describes how iBRoad2EPC, and additionally also the complementary iBRoad products, can be made applicable to different building types.

The iBRoad2EPC project aims to complement the Energy Performance Certificate (EPC) with elements of the Building Renovation Passport (BRP) to enable and increase the rate and depth of renovation across the EU. In doing so, iBRoad2EPC utilises and builds upon the knowledge gained and the tools developed and tested during its predecessor, the iBRoad project. iBRoad comprised two main tools, the iBRoad individual Building Renovation Roadmap (short: iBRoad Plan or iBRoad Renovation Roadmap), representing a model implementation of the Building Renovation Passport (BRP) on the one hand, and the iBRoad Logbook short: iBRoad Log), representing a model implementation of the Digital Building Logbook (DBL) on the other.

Together iBRoad2EPC and the iBRoad tools comprise a family of products. Each of them can be implemented as a stand-alone instrument, but when all are used in parallel in a Member State, they shall complement and build on one another to offer a wider range of services.

The iBRoad project focussed only on single-family and small multi-family buildings. In order to reach as many buildings as possible, iBRoad2EPC needs to consider the peculiarities of different building types. The iBRoad2EPC concept thereby distinguishes between single-family, multi-family and public buildings to address their specific constraints and needs.

This report shows how the whole product family can be extended. The report presents a draft of iBRoad2EPC as a frame which covers all building types. The content for this framework must be specifically adapted to the different building types. The report shows which different cases have to be considered for the different building types and how text blocks for the salutation and for technical recommendations can be flexibly inserted from databases. The graphic design of iBRoad2EPC is included in this report as a quotation from the “technical report on the definition of the proposed concept, content and methodology of iBRoad2EPC”, which is a dedicated conceptualisation report.

The report starts with the general requirements for including the above building types in the three products. It provides a brief introduction of the iBRoad Renovation Roadmap and Logbook as well as of the iBRoad2EPC and explains their specific purposes and designs. Then it shows the structure of the European building stock to illustrate the importance of including additional building types.

The report analyses country-specific requirements that may result from the structure of the countries' building stock or existing instruments for the building sectors which could predefine specific delimitations between building types. These effects are analysed for the six iBRoad2EPC partner countries Bulgaria, Greece, Poland, Portugal, Romania and Spain.

Based on these preliminary investigations, solutions are presented on how iBRoad2EPC, the iBRoad Renovation Roadmap and the iBRoad Logbook can be adapted to additional building types.

A brief flashback reflects on the main outcomes of the report “Potential Extensions of iBRoad to other Building Types” (2020) which already proposed the adaptation of the iBRoad products, thus building the basis for parts of the work in the current report. This past analysis identified four categories of adaptations depending on building type and tenure status.

Building on these four categories, the current report first illustrates the technical and administrative peculiarities and concrete adaptation requirements for the iBRoad Renovation Roadmap. These include additional trigger points and prefabricated text blocks for typical situations in staged renovations for apartments, multi-family buildings and buildings owned by public bodies. A design template for the adaptation of the Renovation Roadmap to multi-family and public buildings is included in the annex. They extend the iBRoad Renovation Roadmap with additional information about legal requirements and regulations as well as information on the economic viability for both multi-family and public buildings.

The iBRoad Logbook can already store comprehensive building data in its current state so that no adjustments are required to extend the Logbook to additional building types.

The description of the iBRoad2EPC starts with an overview of the most common user stories. Since the iBRoad2EPC is envisaged as an extension of the EPC, user stories are determined by the occasions or trigger points to issue an EPC. Moreover, the user stories vary depending on the building type. They build a basis for the coverage of several building types. Specific text blocks for each building type that address standard situations are derived based on the user stories, including notes to utilise vacancies as renovation opportunities, to acknowledge legal obligations and to address the recipient. The draft form for the iBRoad2EPC presented in the annex is a quotation from the "technical report on the definition of the proposed concept, content and methodology of iBRoad2EPC". It is designed to fit single-family, multi-family and public buildings without specific graphical adaptations. The "technical report on the definition of the proposed concept, content and methodology of iBRoad2EPC" was developed later in the project and builds on the findings of the present report. Although the graphic design of iBRoad2EPC was not yet available at the time of this report, the corresponding layout documents have been included later in the present report. They represent design templates for iBRoad2EPC which - together with the specific text blocks developed in this report - can flexibly cover all building types.

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INTRODUCTION

The European Green Deal (2019) is the general strategy of the European Commission to tackle the challenges of climate change. It sets a target of zero net greenhouse gas emissions in Europe by 2050. The “Fit for 55- Package” (2021) acknowledges a set of proposals to make the EU's climate, energy, land use, transport and taxation policies fit for reducing net greenhouse gas emissions by at least 55 % by 2030, compared to 1990 levels. The building sector accounts for approximately 40 % of total energy consumption and 36 % of CO₂ emissions in the European Union. Heating, cooling and domestic hot water account for 80 % of household energy consumption. Currently, almost 75 % of the European building stock is not energy efficient, while more than 85 % of today's buildings will still be standing in 2050, when Europe must be carbon neutral. This means that existing buildings are a key element in achieving climate targets. Buildings must be ambitiously and purposefully renovated to a climate-neutral state. This is a technically and organizationally very complex challenge. In addition, the building sector is very diverse. There is a large number and variety of decision-makers who have different interests and different knowledge. Acknowledging the challenges, among which that deep renovation is not always achievable in one go, and in order to provide all decision-makers with a basic strategy for renovating their individual building, the European Commission introduced in Directive (EU) 2018/844 the concept of the Building Renovation Passport (BPR) as an optional tool “that is complementary to the energy performance certificates, in order to provide a long-term, step-by-step renovation roadmap for a specific building based on quality criteria, following an energy audit, and outlining relevant measures and renovations that could improve the energy performance”. The Building Renovation Passport is thereby expected to “provide a clear roadmap for staged renovation over the lifetime of a building, helping owners and investors plan the best timing and scope for interventions.” The Commission also acknowledged to introduce Digital Building Logbooks to “integrate all building related data provided by the upcoming Building Renovation Passports, Smart Readiness Indicators, Level(s) and EPCs to ensure compatibility and integration of data throughout the renovation journey”. Digital Building Logbooks will serve as repositories for data on individual buildings and facilitate information sharing within the construction sector, and between building owners and tenants, financial institutions and public authorities.”¹

The iBRoad project funded by the Horizon 2020 Europe programme developed and tested the concept of an individual Building Renovation Roadmap (iBRoad Plan or iBRoad Renovation Roadmap), comprising a model for the Building Renovation Passport (BRP), combined with a digital repository of building-related information (iBRoad Logbook). The project duration was from 2017 to 2020. The iBRoad project focused on single-family and small multi-family houses only. They represent 48 % of the EU building stock. The share of multi-family houses in Europe amounts to 27 % and the share of non-residential buildings amounts to 25 %.

Building on its predecessor, the iBRoad2EPC now aims to bridge the Building Renovation Passport, as developed in iBRoad, with the Energy Performance Certificate (EPC), and expand, improve and broaden their format and joint scope to consider additional features and become applicable also to multi-family and public buildings. The aim is to improve reliability, usefulness and effectiveness, thereby establishing the next generation of EPCs that will support Europe's decarbonisation ambitions while improving conditions for building occupants.

The three above mentioned products, i.e., the iBRoad2EPC, the iBRoad Renovation Roadmap and the iBRoad Logbook, are designed to build together a product family that may also be linked to the EPC.

Each of the three products can be implemented in a Member State independently of the others. However, they can also be used in parallel to complement each other. Therefore, when expanding to additional building types, all three products need to be considered in parallel so that they can function consistently

¹ Renovation Wave, 2020

with each other. In this respect, the current report not only focusses on iBRoad2EPC, but also assesses how the iBRoad tools - the Roadmap and Logbook-, can be extended to multi-family and public buildings.

The approach for the expansion and development of the three tools - iBRoad Renovation Roadmap, iBRoad Logbook and iBRoad2EPC - is similar in general but takes into account the specific requirements of each tool in particular. The tools do not necessarily address the same target groups and are not issued at the same occasions. Therefore, the adjustments are derived and presented individually for each tool. The concept of the iBRoad2EPC presented in this report is preliminary as it is subject to parallel work currently taking place and which will be presented in separate reports. Despite this, it is already briefly drafted in this report to provide a clearer understanding of the developed solutions.

OBJECTIVES OF THIS REPORT

iBRoad2EPC aims to become a widely spread information and motivation tool reaching large shares of the European building decision-makers. iBRoad2EPC aims to bridge the Energy Performance Certificate and the Building Renovation Passport. The development of iBRoad2EPC builds on the predecessor project iBRoad in which a model implementation of the Building Renovation Roadmap (BRP) and of the Digital Building Logbook (DBL) took place in the form of the iBRoad Renovation Roadmap and the iBRoad Logbook, respectively. This report looks at the iBRoad2EPC and the iBRoad Renovation Roadmap and Logbook together as they are expected to co-exist in close integration in the future. It shows how the three products can be further developed to cover as many building types as possible.

The report analyses the general requirements for including additional building types in the three products. It shows the structure of the European building stock to illustrate the importance of including additional building types. Moreover, the report shows the country-specific requirements that may result from the structure of the countries' building stock or existing instruments for the building sectors which could predefine specific delimitations between building types.

Based on these preliminary investigations, solutions are presented on how iBRoad2EPC, the iBRoad Renovation Roadmap and the iBRoad Logbook can be adapted to additional building types.

The objectives of this report are to

- introduce the existing iBRoad products and outline the iBRoad2EPC;
- quantify the various building types across the EU and in six partner countries to show the need to include further building types in the iBRoad Renovation Roadmap, the iBRoad Logbook and the iBRoad2EPC;
- analyse distinctions between building types in existing policy instruments;
- create typical user stories and derive specific adaptations for the iBRoad Renovation Roadmap and the iBRoad Logbook as well as specifications for iBRoad2EPC;
- deliver a design template to enhance the iBRoad Renovation Roadmap for multi-family and public buildings;
- deliver a framework template for the iBRoad2EPC which includes multi-family and public buildings;
- deliver prefabricated text blocks that meet the specific requirements of each building type;
- address both general and country-specific adaptations.

INTRODUCTION OF THE IBROAD PRODUCTS AND IBROAD2EPC

This chapter introduces the iBRoad and iBRoad2EPC family of products. The iBRoad Renovation Roadmap and Logbook together form the iBRoad Building Renovation Passport that was developed in the iBRoad project, whereas the iBRoad2EPC is intended to bridge the EPC with the iBRoad Building Renovation Passport. All three products are designed to support a targeted long-term perspective in building renovation, however with different approaches and means of communication. The three products can complement each other and build on one another but can as well run independently from the others. Accordingly, all three products will need specific strategies to adapt to additional building types.

This chapter briefly describes the three products and summarises their main principles and functionalities. This is the basis for extending the products to other building types.

For further details on the iBRoad Renovation Roadmap and Logbook please see the iBRoad project website (www.ibroad-project.eu).

iBRoad Renovation Roadmap

The iBRoad Individual Building Renovation Roadmap (short: iBRoad Plan or iBRoad Renovation Roadmap) is a model implementation of the iBRoad Building Renovation Passport (BRP). It covers all features of a BRP as defined in the EPBD. The iBRoad Renovation Roadmap is a tool primarily intended for building owners, which provides a diagnosis on the building's overall performance, and delivers a customised and stepwise renovation plan for single-family houses and small multi-family houses over a long-term period (e. g., 10 - 30 years). The Roadmap shows how building owners or investors can improve the building both in terms of energetic as well as comfort aspects while ensuring to avoid unwanted so-called lock-in-effects, and taking into account the preferences and capabilities of the building owner. Thus, it will allow building owners to have an overview of upcoming or pending renovation measures including additional information e. g., on how to finance these actions and how to implement them, illustrate what are practicable "renovation steps" (renovation measures that should and can be combined) and what are the expected benefits of implementation. In an owner-occupied building, the Roadmap takes the perspective of the building owner into account in terms of energy consumption, investment, and return on investment and indoor comfort. At the same time, the Roadmap is intended to achieve the highest possible GHG savings. In order to avoid a conflict of interest between the consultancy recipient (the building owner) and the climate goals, five basic principles were defined for the Roadmap:

Best-possible-principle

Renovation measures have to meet the highest standards with regard to the individual building potential for achieving high energy savings and the owner's capability.

Individual renovation context

Wishes, needs and financial situation of the property owner need to be considered.

Long-term perspective

Roadmaps are derived from building components' life spans which last for decades.

Timing and sequencing

A tailored strategy is crucial to achieve the optimal target and to avoid errors.

Attractive and motivating

Roadmaps have to be attractive and easy to understand.

Figure 1 shows the overview page of the Roadmap. It summarises the energetic building states starting with the present state and displays for each renovation step when, what and at which cost action should be

taken. Moreover, the detailed Roadmap (Figure 2) shows the expected energy demand, greenhouse gas emissions and comfort improvements. Each single renovation step is described in detail in a dedicated page (Figure 3). It comprises technical details for every renovation measure and building component subject to the renovation step. Furthermore, it shows information about specific costs and incentives and, last but not least, it includes specific notes about aspects that have to be taken into account now in order to prepare for future renovation steps and prevent lock-in situations.

The level of ambition in the Roadmap is defined by the energy auditor with respect to the building specifics and individual capability of the owner. The auditor has to consider the best-possible-principle saying that all recommended measures have to contribute to the greenhouse gas reduction targets (GHG targets) as good as possible under the given conditions. The auditor defines the time horizon together with the owner. Both, the level of ambition and the time horizon, are not necessarily aligned with the GHG targets.

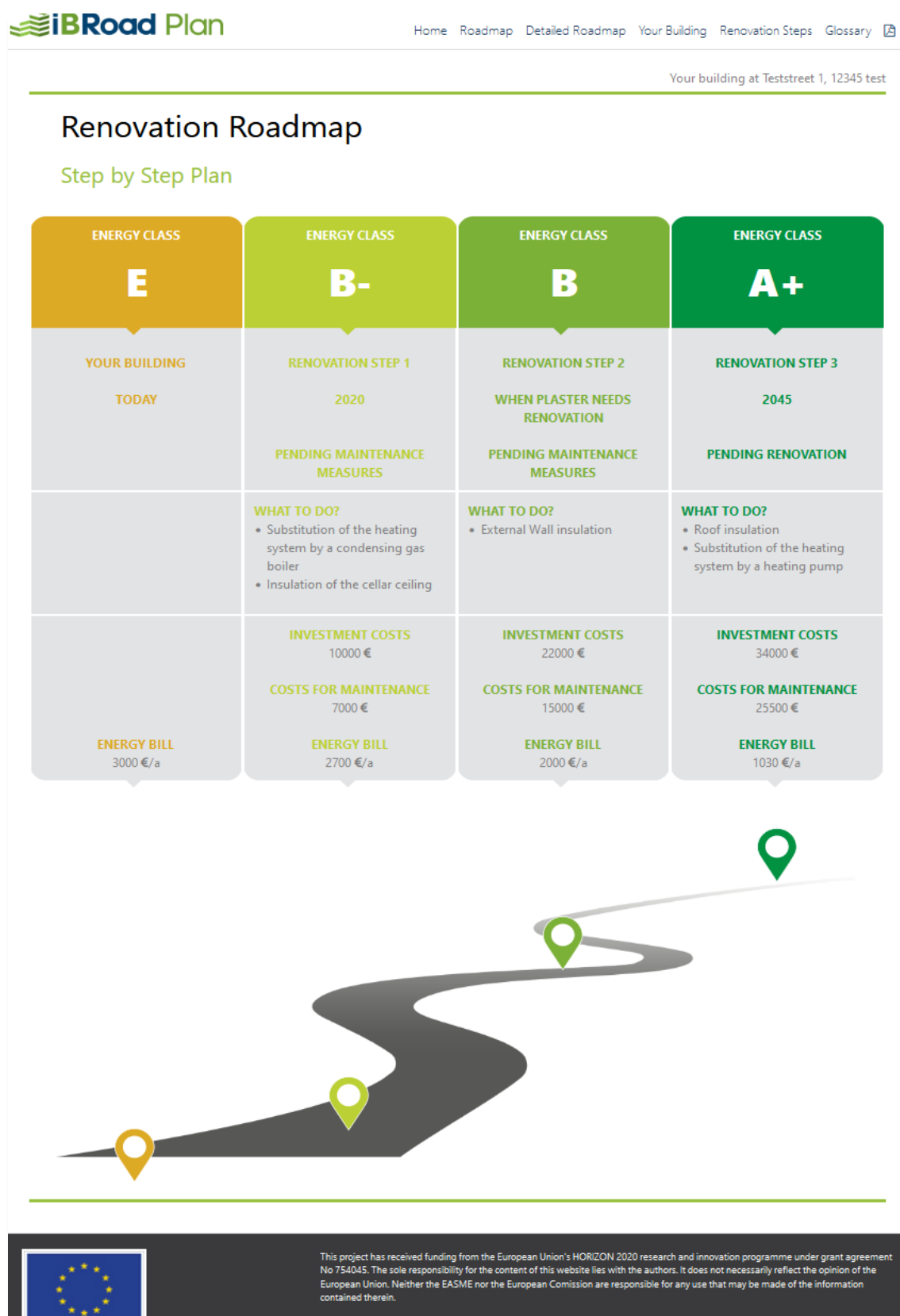


Figure 1: iBRoad individual Buildings Renovation Roadmap, overview page (source iBRoad 2020)

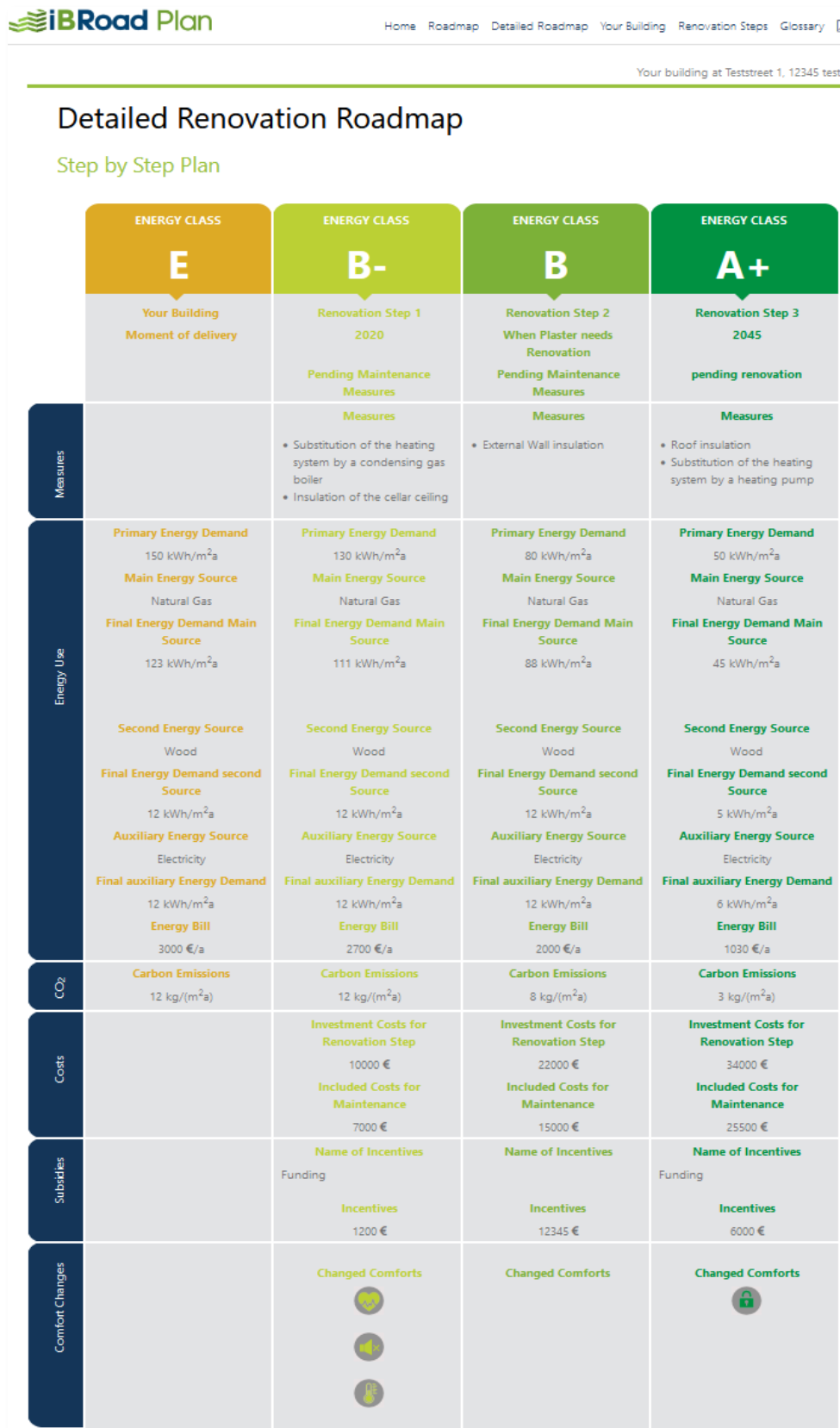


Figure 2: iBRoad individual Buildings Renovation Roadmap, detailed Roadmap (source iBRoad 2020)

Details of the renovation Roadmap

Renovation Step 1

ENERGY CLASS	
B-	
Renovation Step 1 2020	
Pending Maintenance Measures	
Primary Energy Demand	130 kWh/m ² a
Main Energy Source	Natural Gas
Final Energy Demand Main Source	111 kWh/m ² a
Second Energy Source	Wood
Final Energy Demand second Source	12 kWh/m ² a
Auxiliary Energy Source	Electricity
Final auxiliary Energy Demand	12 kWh/m ² a
Energy Bill	2700 €/a
Carbon Emissions	12 kg/(m ² a)
Investment Costs for Renovation Step	10000 €
Included Costs for Maintenance	7000 €
Name of Incentives	Funding
Incentives	1200 €

Measure	Substitution of the heating system by a condensing gas boiler
Improvement	Removal of the old boiler and hot water storage tank. Installation of a condensing boiler. Adaptation of the chimney.
Technical Details	heating capacity 11 kW
Renovation Costs	8000 €
Included Costs for Maintenance	7000 €
Note	Watch for proper hydraulic balancing of the heating system and lowest possible system temperatures.
Incentives Information only relating to this Measure	funding granted by public xy-bank
Specific Incentive Bonus	1000 €

Measure	Insulation of the cellar ceiling
Improvement	Reduced heat losses through the cellar ceiling, floor in the ground floor feels warmer.
Technical Details	Insulation of the cellar ceiling with 12 cm of polystyrene (035)
Renovation Costs	2000 €
Included Costs for Maintenance	0 €
Note	no prerequisites, measure can be carried out independently from other components; heat load in ground floor rooms drops; this influences the required heating capacity of the new boiler
Incentives Information only relating to this Measure	10% funding granted for this measure by public xy-bank
Specific Incentive Bonus	200 €

Additional Benefits

Health



warm feet on the ground floor

Reduction of Indoor Humidity, Mold and Toxins

Noise Protection



new boiler will work silently

Reduction of Noise Immissions

Thermal Comfort



warm feet on the ground floor

Reduction of Draught, Overheating and Cold

Figure 3: iBRoad individual Building Renovation Roadmap, description of a single renovation step (source iBRoad 2020)

iBRoad Logbook

The iBRoad Building Logbook (short: the Logbook) serves primarily as a building repository where all building-related information can be stored digitally (e.g., data from EPC calculation, implemented renovation measures, energy bills, building plans, energy consumption and generation, documents about incentives, loans and tax). Thus, the homeowner can keep track of everything in one single place. Main user of the Logbook is the building owner. However, he/she can grant access to third parties, for instance, energy auditors.

Within the iBRoad project, three main functionalities were developed:

- 1. Building data repository:** this functionality allows the user to enter and view the information mentioned above in the Logbook data repository. Each change (e.g., renovation) is entered in a new building state while all older states are being saved. Step by step, the Logbook will grow with each new building state and “log” all changes in time.
- 2. Building diagnosis:** this functionality allows displaying the actual building performance by showing the building’s energy class (as stated, for instance, in the EPC, Figure 4). Furthermore, there is an assessment of the building’s envelope (Figure 5) and the building’s equipment performance by showing a rating in a coloured scale.
- 3. Link to the iBRoad Renovation Roadmap:** this functionality allows displaying a summarised overview of the iBRoad Renovation Roadmap and also details of the iBRoad Renovation Roadmap.

The Logbook can contain building data in high resolution, e. g. surface areas and U-values of single components, however the visualisation of performance is kept clear and easy-to-understand for laypersons.

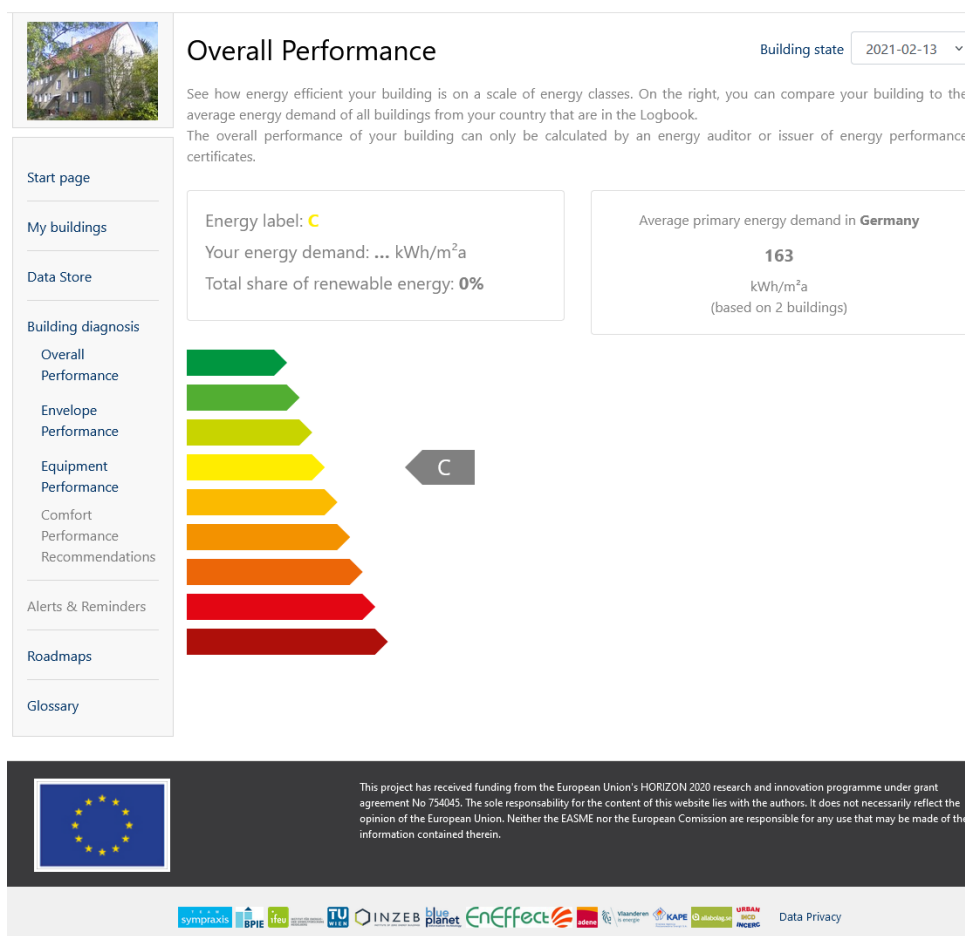


Figure 4: iBRoad Logbook, display of building energy performance (source iBRoad 2020)

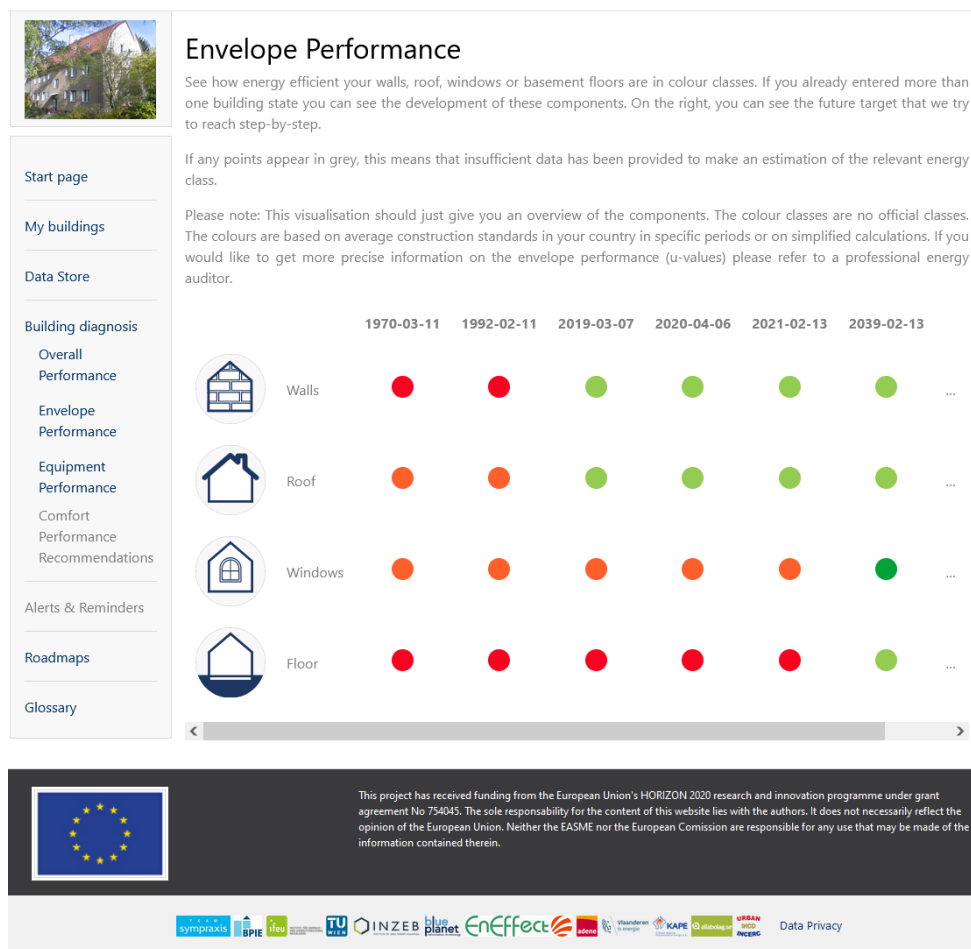


Figure 5: iBRoad Logbook, improvement of the building envelope for single components (source iBRoad 2020)

iBRoad2EPC

The aim of the iBRoad2EPC project is to merge the existing Energy Performance Certificate (EPC) with elements from Building Renovation Passports (BRP), in particular the iBRoad Renovation Roadmap. The final product will be developed during this project with the contribution of numerous stakeholders, implementing authorities and energy experts from at least six Member States. The conceptualisation of the iBRoad2EPC is subject to a parallel process and will be published in separate reports. They will describe the functionalities of the iBRoad2EPC in detail. The conceptualisation is not yet finalised while this report is being produced. Although the final product cannot be presented at this early stage of the project, one can already identify certain core features that the iBRoad2EPC will provide. Accordingly, the following list cannot be regarded as complete and remains indicative until the conceptualisation has been finalised.

- Energy performance in the present building state
- Additional indicators in the present building state, e.g., SRI or IEQ
- Obligations resulting from EU legislation, e.g., minimum energy performance standards (MEPS)
- Obligations resulting from national legislation, e.g., ban of fossil fuels or boilers
- Description of targeted renovation measures (to be carried out stepwise, if reasonable)
- Notes about aspects that have to be taken into account now in order to prepare for future renovation steps and prevent lock-in situations
- Energy performance in the target building state
- Additional indicators in the target building state

The iBRoad2EPC is closely related to existing EPCs, however with improved renovation recommendations. The occasions to issue an EPC, the EPC target groups, and the way to address them are usually laid down in the national legislation. This frame also applies for the iBRoad2EPC and influences its approach to different building types.

The similarities and differences between the iBRoad2EPC and the iBRoad Renovation Roadmap are laid down in Table 1. One main contrast results from the effort required for issuing. While the iBRoad Renovation Roadmap contains a detailed and calculated analysis for each renovation step and requires intense communication between energy auditor and building owner, the iBRoad2EPC is intended to become an extension of the EPC. The potential complexity and effort required to create an iBRoad2EPC is influenced, among other things, by the intended reach of the iBRoad2EPC. With the aim for iBRoad2EPC to replace the existing EPC or be issued even more broadly, a high processing effort can be a hindrance. There is then a risk that the number of qualified issuers will not be sufficient or that substantial funding will be necessary because customers will not accept the higher costs for a detailed iBRoad2EPC. If, on the other hand, recipients can order the iBRoad2EPC as an option, a higher level of detail can be realised. Each Member State can decide individually how detailed and elaborated the iBRoad2EPC should be. This will be a result of extensive stakeholder engagement and National Advisory Committee meetings during the process. A semi-flexible concept allows to include or omit particular content and still provide a consistent design form with high recognition value throughout Europe. Selectable contents are marked accordingly in Table 1.

Building state	Content	iBRoad2EPC	iBRoad Roadmap
Present building state	Energy class	✓	✓
	Energy consumption	✓	✓
	SRI rating	✓	can be included
	IEQ rating	✓	can be included
	Obligations from EU MEPS	✓	✓
Future renovation steps	Estimated date of renovation	can be included	✓
	Description of renovation measures	✓	✓
	Individual details of renovation measures	can be included	✓
	Notes to prevent lock-in situations	✓	✓
	Energy demand after measure	can be included	✓
	Total investment	can be included	✓
	Costs for maintenance	can be included	✓
	Incentives	can be included	✓
	Energy bill	can be included	✓
Target building state	Required energy class according to LTRS	✓	can be included
	Calculated best possible energy class	can be included	✓
	Calculated best possible energy demand	can be included	✓
	SRI rating	✓	can be included
	IEQ rating	✓	can be included
General	Next steps	✓	✓
	Reference to other iBRoad offers	✓	✓

Table 1: Content of iBRoad2EPC compared to iBRoad Renovation Roadmap

iBRoad2EPC Assistant

EPC issuers will be able to produce the iBRoad2EPC with an online tool called 'iBRoad2EPC Assistant', soon to be developed. It will foreseeably combine the following functionalities. Due to the early stage of development the list is not exhaustive.

- Entry of indicators, e.g., efficiency class, Smart Readiness Indicator, etc.
- Entry of individual texts for user specific information
- Entry of renovation measures and grouping them into specific timeframes
- Automated output of prefabricated text blocks describing the measures
- Automated output of renovation advice according to national targets
- Automated output of recommendations to prepare future renovations and avoid lock-in situations
- Display of future legal obligations concerning the specific building
- Manually overwriting of automated recommendations
- Arrangement of output data in a unified design frame

The objective of the iBRoad2EPC Assistant is to provide recommendations with a long-term perspective that lead to a carbon-neutral target state. The iBRoad2EPC Assistant will adapt to country specific content such as language, legislation or colour codes for efficiency classes. The outcomes of this report will feed into the development process of the iBRoad2EPC Assistant and the related databases.

STRUCTURE OF THE BUILDING STOCK IN THE EU

In the iBRoad project, the Roadmap and Logbook were developed especially for single-family houses. iBRoad2EPC, on the other hand, aims to cover the majority of building types as it is an extension of the regular EPC. Also, the iBRoad Renovation Roadmap and Logbook can significantly expand their potential when adapted to other building types. This chapter shows the share of different building types in the European building stock and in particular in the six iBRoad2EPC pilot countries to outline the potential of the tools.

On the basis of literature review, the building stock in Europe and particularly in the pilot countries is analysed and the specific characteristics that might affect the deployment of the iBRoad2EPC and the iBRoad products are identified. The analysis focuses on an inventory of the size, number and energy consumption of multi-family and public buildings. The detailed market analysis is part of the conceptualisation of iBRoad2EPC and is included in a separate report.

Building types and characteristics

Flashback to the European building stock as described in the report “Potential extension of iBRoad to other building types” (iBRoad 2020)

The building stock is divided into residential and non-residential buildings. While the main use of residential buildings is housing, non-residential buildings can be used for a variety of purposes. These include for example offices, educational institutions, hospitals, wholesale, retail, hotels, restaurants etc. Public buildings can be residential but are mainly non-residential.

In the EU 27, including Switzerland and Norway, the useful floor space is approx. 25 billion m² (Economidou, et al. 2011). The share of residential buildings is 75 % and that of non-residential buildings is 25 %.

The project “Hotmaps” collected and analysed historic building stock data to support public authorities, energy agencies and urban planners in strategic heating and cooling planning at local, regional and national levels, and in line with EU policies. Figure 6 shows that the residential building stock is mainly divided into three building types: single-family houses (68 %) with 2-3 floors, multi-family houses (24 %) with 4-8 floors and apartment blocks (8 %) with more than 8 floors, while the non-residential building sector is more diversified: offices (21 %), trade (45 %), education (6 %), health (5 %), hotels and restaurants (12 %), and other non-residential buildings (11 %).

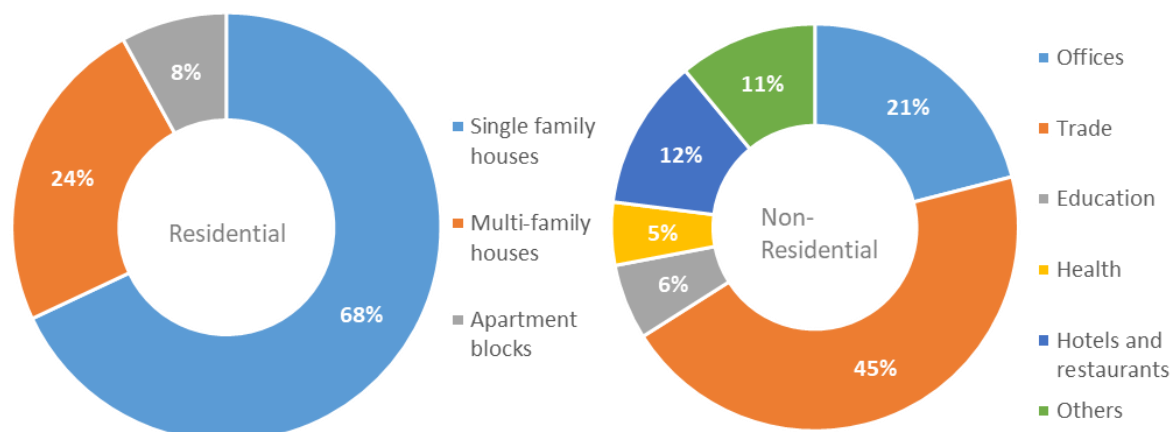


Figure 6: Building stock characterisation per building types (%). Source: (Pezzutto et al., 2019)

Figure 7 shows the share of buildings, residential and non-residential, according to the construction period (before 1945 until after 2010). Residential and non-residential buildings constructed before 1945 account for the largest share: 20 % (residential) and 24 % (non-residential), followed by buildings constructed in the period 1945-1969 and 1970-1979. Buildings constructed before 1979, when there were no energy efficiency standards in construction, together account for more than 50 % of both the residential and non-residential building stock. From the year 2000 and later, 22 % of today's residential and 20 % of today's non-residential buildings were built. These already have better or even high energy efficiency standards.

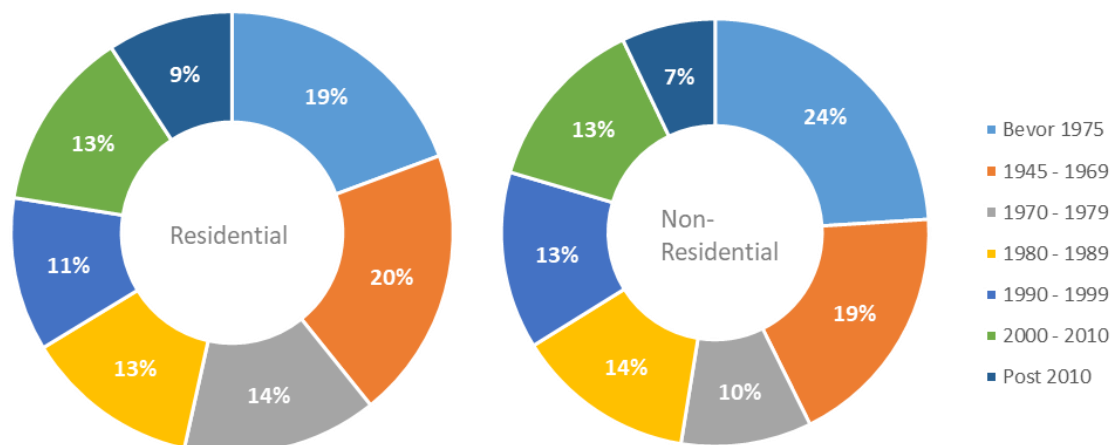


Figure 7: Building stock characterisation per construction period (%). Source: (Pezzutto et al., 2019)

For residential buildings in 2013, the average energy consumption for space heating is around 124 kWh/m²year. For non-residential buildings in 2013, the average energy consumption for space heating is 120 kWh/m²year. The overall average energy consumption for residential and non-residential buildings (including residential hot water and cooling) is 201 kWh/m²year. (European Commission 2013)

Impact of building stock structure on iBRoad2EPC, iBRoad Renovation Roadmap, and iBRoad Logbook

Although the shares of multi-family and non-residential buildings in the building stock are smaller than that of single-family houses, they represent a significant number of buildings in the EU. An expansion of

iBRoad2EPC, iBRoad Renovation Roadmap, and iBRoad Logbook seems appropriate given the large quantity. More than 50% of the building stock was built at a time when no energy requirements were imposed on the buildings. Buildings from later construction years are also not yet at the target level. The building age distribution also shows a large potential for iBRoad2EPC, iBRoad Renovation Roadmap, and iBRoad Logbook.

Public buildings

There is no uniform definition for the term public building. Most approaches describe public buildings as buildings ‘owned or occupied by public bodies’. Accordingly, the term public building does not comprise privately owned buildings like theatres, shopping malls or cinemas. On the other hand, buildings that are owned or occupied by public bodies, such as public administration buildings, are not necessarily open to the public. Residential buildings that are part of social housing programmes are usually also owned by public bodies.

In terms of energy certification, there are two main criteria for public buildings:

First, public access as a communication channel for good practices. According to the EPBD, ‘buildings where a total useful floor area over 250 m² is occupied by a public authority and frequently visited by the public’ must display their energy performance certificate in a prominent place clearly visible to the public. Although this delineation relates directly to EPCs (which are the starting point for the iBRoad2EPC), it is not a definition as such for public buildings in the context of further developments in the context of the iBRoad2EPC and iBRoad products.

Second, a public ownership that takes a pioneering role with particularly high energy efficiency ambitions. The EPBD addresses public buildings in several passages: Article 9 requires all new public buildings to be nearly-zero-energy buildings as of 2019, whereas Articles 11 and 12 describe the particular requirements for EPCs². Article 5 (exemplary role of public bodies’ buildings) of the Energy Efficiency Directive (EED)³ requires Member States to ensure that 3 % of the total floor area of central government-owned and government-occupied buildings are renovated each year to meet the minimum energy performance requirements of the Energy Performance of Buildings Directive. The scope of this obligation is narrowed as it refers to ‘central’ government-owned buildings. According to Article 2 of the EED, this means ‘administrative departments whose competence extends over the whole territory of a Contracting Party.’

Buildings that house public bodies but are not owned by public entities are not considered public buildings for this purpose. In this case, the public bodies are tenants of private building owners. Renovation decisions are usually made by the landlords.

In this report, the term ‘public buildings’ will be used in accordance to the EPBD proposal⁴ referring to ‘buildings owned or occupied by public bodies’, where ‘public bodies’ means ‘contracting authorities’ as defined in Article 2(1) of Directive 2014/24/EU.⁵ This in turn defines ‘contracting authorities’ as “the State, regional or local authorities, bodies governed by public law or associations formed by one or more such authorities or one or more such bodies governed by public law.”

This definition of public buildings includes many of the previously mentioned aspects and is above all compatible with the requirements in the EPBD proposal. These are of central importance for the long-term renovations targeted in this project.

² Directive (EU) 2018/844 on the energy performance of buildings

³ Directive 2012/27/EU of 25 October 2012 on energy efficiency 1

⁴ Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the energy performance of buildings (recast), 15.12.2021

Tenure status

It is crucial for the development of the iBRoad2EPC to know who the recipient of an EPC will be. Figure 8 shows the distribution of three ownership/tenure status groups for residential and non-residential buildings in EU 27 + UK. 70 % of the residential units are privately owned and owner-occupied. 19 % of the residential units are rented out and only 11 % of the residential units are social housing. For non-residential buildings, the distribution between owner-occupied and privately rented is more or less equal.

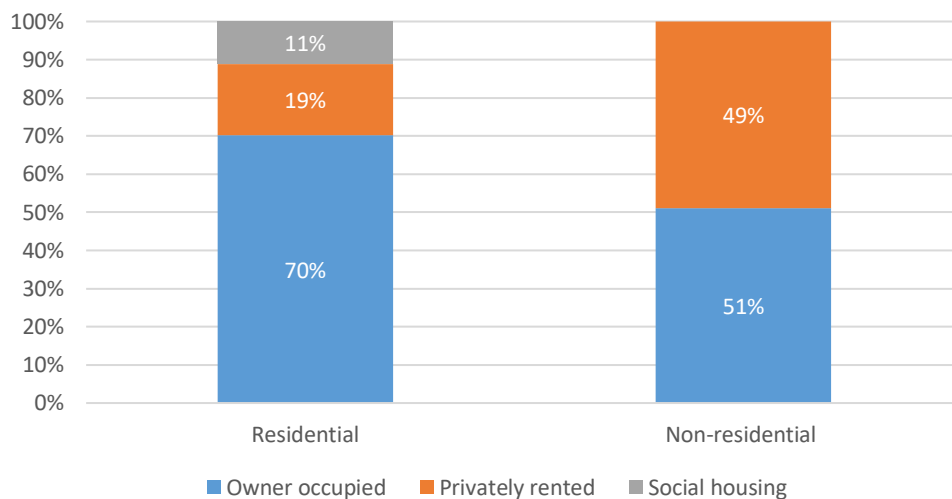


Figure 8: Building tenure/ownership status in EU27+UK [2016] (Source: (S. Pezzutto 2018))

COUNTRY-SPECIFIC REQUIREMENTS

This chapter shows the requirements of the individual iBRoad2EPC implementing countries to adapt the iBRoad2EPC, as well as the iBRoad Renovation Roadmap and Logbook to additional building types. For this purpose, it first compares the structures of the building stock in the six pilot countries Bulgaria, Greece, Poland, Portugal, Romania and Spain. Furthermore, the chapter examines the country-specific regulations for EPC, energy audits and incentives. This serves as the basis for the conceptual design of the iBRoad2EPC. If possible, it should be designed so flexibly that it can cover all country-specific requirements without changes to the programming code.

Building stock in iBRoad2EPC pilot countries

Based on a literature review, this part of the report presents a characterisation of the residential and the non-residential building stock of the iBRoad2EPC project's pilot countries (Bulgaria, Greece, Poland, Portugal, Romania and Spain). The aim is to provide an overview of the structure of the building stock in the respective countries and thus to illustrate the quantitative importance of the different building types. The focus is less on the individual building shares in the respective countries, but rather on the differences that exist between the countries. They determine whether the adjustments can be made with a uniform approach or whether they have to be adapted very flexibly to the circumstances of the individual countries. The concrete market potential in the individual countries, taking into account the respective framework conditions, will be included in the separate conceptualisation report.

Building types and characteristics

Residential building sector

Figure 9 shows the distribution of the population by dwelling type in the six pilot countries, based on data from 2007 to 2018. In Bulgaria, Portugal and Romania, more than half of the dwellings are single-family houses. The opposite is the case in Greece, Poland and Spain, where 54-68,2 % of the dwellings are apartments in multi-family houses and only about 31,8-46 % of the dwellings are single-family houses.

Non-residential building sector

There are several data sources that can be used for information on the non-residential building stock in the pilot countries. The European Union has published its own database where various information on the building sector can be found. Bulgaria, Greece, Spain, and Romania obtain the data from their national LTRS.

Figure 10 shows the distribution of non-residential floor area by area of use. The most recent data on the percentage distribution of the non-residential building stock are from 2015, 2016 and 2017. The 2017 data set is not complete, so it is supplemented with the 2016 set.

The non-residential building stock is very heterogeneously distributed in all pilot countries.

In Bulgaria, offices, hotels, retail and education buildings are almost equally represented (11-18 %) and there is a high proportion of buildings that are not classified in any of the major categories (others: 31 %).

In Greece, wholesale and retail buildings account for the largest share (30 %), followed by offices (24 %) and health care buildings (17 %).

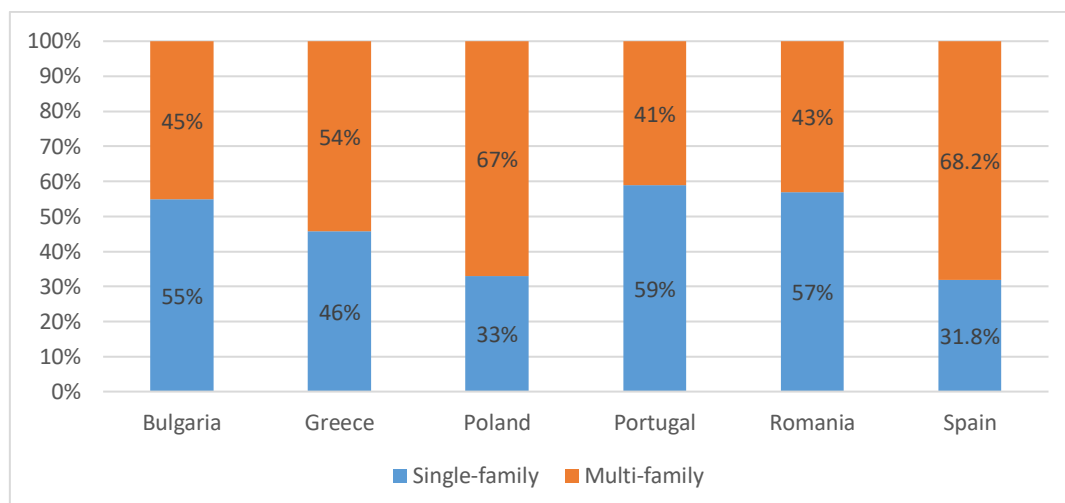


Figure 9: Distribution of multi-family houses and single family dwellings (residential) (Sources: Bulgaria (year of data: 2013, (European Commission 2017)), Greece (year of data: 2015, (LTRS Greece (Gazette 974/B/12.03.2021))); Poland (year of data: 2007, (European Commission 2017)); Portugal (year of data: 2013, (European Commission 2017)); Romania (year of data: 2011, (European Commission 2017)); Spain (year of data: 2018, (LTRS Spain 2020, MITMA based on Continuous Household Survey 2018 (INE). Figure 1.4 page 12)

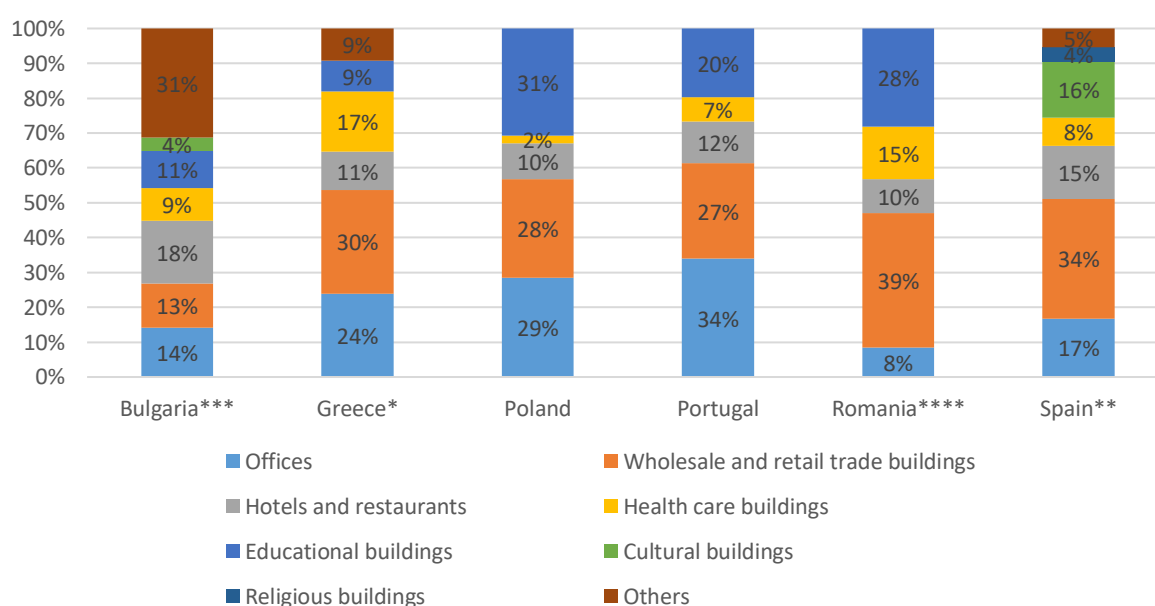


Figure 10: Distribution of non-residential floor area by area of use (Source for Greece, Poland, Portugal: (European Commission 2017) (year of data: 2017), *Source for Greece: LTRS Greece 2021 (year of data: 2015); ** Source for Spain: LTRS Spain 2020, MITMA based on Cadastral Database 2017. Figure 1.21 page 24 (year of data: 2017), *** Bulgaria: LTRS Bulgaria 2020; ****Romania: LTRS Romania 2020 (year of data: 2018))

In contrast to the other pilot countries, the share of educational buildings is highest in Poland at 31 %. Offices and wholesale and retail buildings have the same share of 28-29 %.

In Portugal, office buildings dominate with 34 %, followed by wholesale and retail trade buildings (27 %) and educational buildings (20 %).

In Romania, most non-residential buildings are wholesale and retail buildings (39%), followed by educational buildings (28 %). It is noticeable that the share of offices is particularly low at 8%.

Spain also has a particularly large number of wholesale and retail trade buildings (34 %). The share of offices, hotels and restaurants as well as cultural buildings is almost the same (15-17 %), with a particularly low share for educational buildings (4%).

No statements can be made about how high the share of public buildings is within the share of non-residential buildings. It is likely that the public buildings are distributed across all types of use of the non-residential buildings.

The proportions of the different types of non-residential buildings vary greatly in the different countries analysed. This means for iBRoad2EPC, iBRoad Renovation Roadmap and iBRoad Logbook that they have to be structured as flexibly as possible and not put a specific focus on a particular use type. This confirms the approach of creating a flexible software code and document structure that cover all building types and making adjustments at the content level. For this purpose, appropriate filter functions are to be foreseen in the text databases.

Tenure status

Figure 11 shows the distribution of owners and tenants in residential and non-residential buildings in the pilot countries.

The distribution of residential buildings is similar in all pilot countries. Owner-occupation dominates the residential buildings. The share varies between 74 % and 96 %. The highest share of privately rented apartments is in Greece, followed by Spain. Portugal has the highest proportion of social housing. The latest data for Bulgaria come from the 2011 census. In Bulgaria, 82 % of the dwellings are occupied by the owners and 6 % are rented out. A further 7 % are occupied free of charge; and 5 % are occupied by a mix of owners, guests and tenants (see 'others' in Figure 11: 12 %).

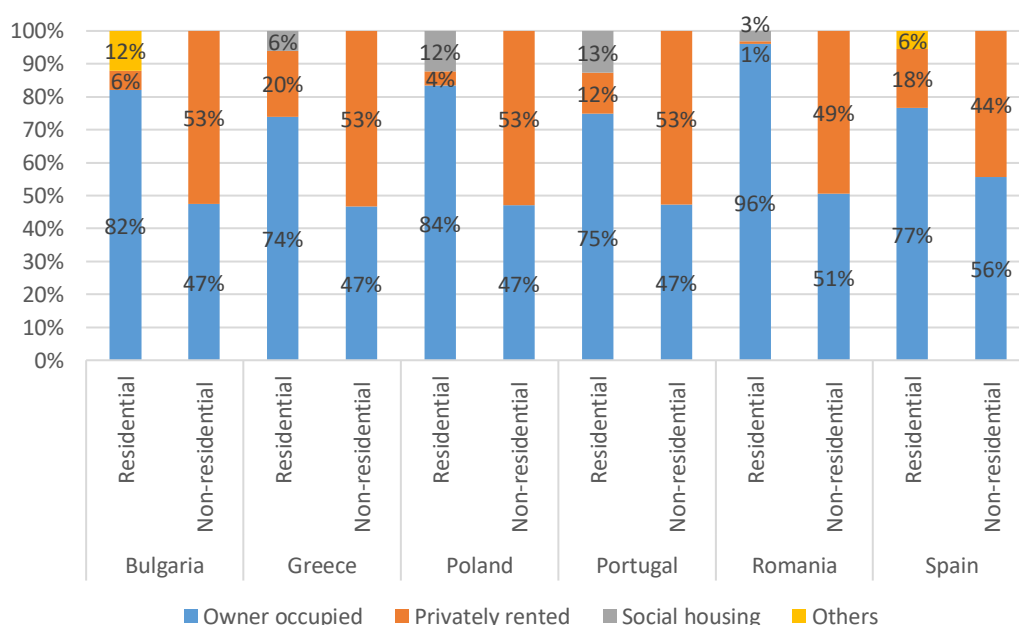


Figure 11: Distribution of the tenure/ownership per dwelling. (Source for Greece, Poland, Portugal, and Romania: (S. Pezzutto 2018) the data are from 2016; source for Bulgaria: census 2011, source for Spain: LTRS 2020, MITMA based on Continuous Household Survey 2018 (INE). Figure 1.7 page 14 (year of data: 2018)

The distribution of non-residential buildings is similar in all pilot countries. Between 47 % and 56 % of non-residential buildings are owner-occupied and 44 % to 53 % are privately rented.

The shares of owner-occupied and rented space form the basis for the user stories in chapter “making iBRoad2EPC fit for different building types”. They determine on which occasions an EPC must be issued, whether the addressee for the EPC is a building owner, unit owner or tenant, whether decisions in a renovation process must be made autonomously or in consultation with neighbours, and whether renovation measures can be carried out at the level of individual units or the entire building. As the iBRoad2EPC is intended to be closely linked to the EPC, this is essential information.

Existing EPC and auditing instruments in iBRoad2EPC Pilot Countries

iBRoad2EPC is aiming to complement the existing EPC with elements from Building Renovation Passports, e.g., enhanced recommendations supporting staged deep renovation, and additional information on long-term targets, new indicators, and other aspects. The existing EPC and its variants in the European Member States build the general basis and the framework for the iBRoad2EPC. This applies for most of the specific features of the EPC, e.g., occasions to issue, period of validity, related building units (e.g., apartments, zones of operation) or distinct variants for specific purposes (e.g., different EPCs for residential and non-residential buildings, new and existing buildings). The different features of EPCs and the scope of variations determine the development of iBRoad2EPC to a large scale. iBRoad2EPC has to flexibly adapt to the given framework. The same applies also for energy audits and incentive schemes for energy renovation as the iBRoad2EPC is closely linked to them. The exact content and scope of the audits and incentives are not considered here, only the building types to which they apply. Table 2 shows peculiarities of the general EPC and auditing framework in the iBRoad2EPC partner countries that have to be regarded. They form the starting point in answering how to consider different building types during the development of the iBRoad2EPC.

Partner Country	EPC	Energy Audits	Incentives
Bulgaria	Different EPC schemes for new and existing buildings. Same EPC scheme for all types of new buildings. Same EPC scheme for all types of existing buildings. Periodic reissue of EPC for existing buildings iBRoad2EPC can be connected to the EPC for existing buildings. No differentiation by building type required. The periodic reissuing can support the dissemination of iBRoad2EPC.	Same energy audit scheme for all building types. iBRoad2EPC can include notes on the audit scheme as a recommended next step.	Incentives for - municipal public buildings - residential buildings (should be open soon) iBRoad2EPC can include notes on the funding scheme differentiated by building type.
Greece	Same EPC schemes for new and existing buildings (EPC valid for 10 years). Same EPC scheme for all existing residential and non-residential building types (EPC valid for 10 years) excluding: - industrial buildings - religious buildings (churches) - cultural heritage buildings, monuments iBRoad2EPC can be connected to the only EPC. No differentiation by building type required. The periodic reissuing can support the dissemination of iBRoad2EPC.	Same energy audit scheme for all building types with different requirements for residential and non-residential buildings. Lighting and mechanical ventilation audited only at non-residential (tertiary) buildings. iBRoad2EPC can include notes on the audit scheme as a recommended next step. Differentiation by building type required.	Existing Incentives for residential buildings: One programme per annum (Exoikonomo programme). Programmes to be open within the current Programming period for: - municipal and Public buildings - commercial buildings, hotels and tourism buildings iBRoad2EPC can include notes on the funding scheme that have to be kept updated to frequently changing programme
Poland	Same EPC scheme for all building types iBRoad2EPC can be connected to the only EPC. No differentiation by building type required.		Different incentives for - residential buildings - municipal (public) buildings - other buildings iBRoad2EPC can include notes on the funding scheme differentiated by building type.
Portugal	Same EPC schemes for new and existing buildings; Same EPC scheme for all existing building types including apartments; periodic EPC for non-residential buildings	Different audits schemes for residential and non-residential buildings. Audit scheme is very aligned with the process and methodology to issue an EPC.	IFRRU 2020 for all building types but focus on residential buildings (single- and multi-family) (EPC mandatory). Environmental fund with support for single measures (EPC voluntary).

	iBRoad2EPC can be connected to the only EPC. No differentiation by building type required.	iBRoad2EPC may be aligned with the audit scheme. Differentiation by building type required.	iBRoad2EPC can include specific notes on the funding scheme that fits best to recommended measures.
Romania	Different EPC schemes (EPC valid 10 years) for - whole buildings - apartments revised (possible unitary) form is currently planned (under approval) iBRoad2EPC can be connected to both EPC schemes. Differentiation required according to building or apartment. Revision can be an opportunity to include iBRoad2EPC.	Same audit for all building types with different requirements for residential and non-residential buildings (e.g. HVAC) iBRoad2EPC can include notes on the audit scheme as a recommended next step. Differentiation by building type required.	Funding programmes for: - multi-family buildings and public buildings (ROP & NRRP), - single-family buildings and public buildings (Environmental Fund) iBRoad2EPC can include notes on the funding scheme differentiated by building type.
Spain	Different EPC schemes for new and existing buildings; same EPC scheme for all existing building types including apartments iBRoad2EPC can be connected to the EPC for existing buildings. Differentiation required according to building or apartment.		Different funding schemes for - housing - all building types iBRoad2EPC can include notes on the funding scheme differentiated by building type.

Table 2: Distinctions made between building types in existing EPC and auditing instruments throughout the iBRoad2EPC partner countries and impacts on the conceptualisation of iBRoad2EPC

Impact of existing EPC and auditing instruments on iBRoad2EPC

The easiest case - from the perspective of developing the iBRoad2EPC - is that only one EPC scheme is valid for all building types, as is in Bulgaria, Poland and Portugal. A distinction between new and existing buildings, like in Spain, does not influence the iBRoad2EPC as it only refers to existing buildings and their renovation. New buildings are generally assumed to be aligned with the national climate targets or rather at least with the European Performance of Buildings Directive. When there are different EPCs for whole buildings on the one hand and for apartments on the other, like in Romania, this poses a more demanding setting for iBRoad2EPC. However, the EPC for apartments is relevant only for transactions (sale/purchase/rent) related to the apartment itself, whereas the whole building has to be considered in major renovations.

The requirements resulting from the existing instruments in the partner countries determine the further development of the iBRoad2EPC, e.g., in terms of administration - end-user, occasion to issue an EPC - as well as technical issues, e.g., insulating an external wall is not possible for an apartment alone. The distinctions shown above are taken into account during the further development of iBRoad2EPC.

Country-specific Adaptations in iBRoad and iBRoad2EPC

The aim is to design the extension of the iBRoad Renovation Roadmap and Logbook, as well as the development of iBRoad2EPC, in such a way that the adaptation to the respective implementing countries does not require any adjustments to the programming code. Instead, all content will be sourced from databases specifically developed to the needs of the countries (see annex 4). Implementing countries can thus choose from these databases the contents which meet their requirements and may also add contents, if needed. In this way, a flexible tool will be created that can later be further enriched to apply also to other countries.

ADAPTING THE IBROAD RENOVATION ROADMAP TO DIFFERENT BUILDING TYPES

Multi-family houses and non-residential buildings are more complex than single-family houses. Therefore, not only the content but also the framework of the iBRoad Renovation Roadmap needs to be adapted. Additional features are proposed in the following pages.

The general approach to adapt the iBRoad Renovation Roadmap to different building types was initially considered as part of the iBRoad project. The report “Potential extension of iBRoad to other building types” (iBRoad 2020) analysed four different categories depending on building type and tenure status, each of which require a specifically adapted Roadmap. While these categories do not completely match the building types that are subject to iBRoad2EPC, they do provide a fundamental basis for the concrete adaptation requirements for the iBRoad Renovation Roadmap. The following box quotes relevant results of the iBRoad report.

Flashback to Building Categories as described in the report “Potential extension of iBRoad to other building types” (iBRoad 2020)

Based on the information about the building stock and tenure status, a summary of the possible combinations of building types and tenure statuses is given in Table 3. As a result, four specific categories for replication of iBRoad were derived and then further analysed.

	Privately owner occupied	Publicly owner occupied	Privately/ commercially/socially rented (single owner)	Mixed status (owner occupied and rented)
Residential buildings				
Single-family house	✓		✓	
Multi-family house			✓	✓
Non-residential buildings				
Office	✓	✓	✓	
Education	✓	✓	✓	
Health	✓	✓	✓	
Hotels, restaurants, trade, etc.	✓	✓	✓	

Table 3: Overview of building types and tenure status and categories to extend iBRoad to other building types

- Category 1 (blue): Residential buildings, rented from single owner
- Category 2 (red): Multi-family houses, mixed tenure status (owner occupied and privately rented)
- Category 3 (green): Non-residential buildings commercially used
- Category 4 (yellow): Non-residential publicly owner occupied

In general, residential buildings can be privately owner occupied (by private persons), privately market rented, socially rented or of mixed status (owner occupied and rented). In the case of non-residential buildings, owners can be individuals, public authorities or private companies and, depending on the building category, the building can be owner-occupied (for example in public buildings) and/or market rented. The iBRoad project focused on single-family houses, privately owner occupied, and examined its feasibility/replicability for other building types.

From the decision maker's perspective, a relevant aspect that has to be taken into account is the number of parties involved in the renovation decision-making process. In contrast to the renovation process of a single owned building, in a multi owned building owners are likely to have different priorities, especially with regard to financing and legal responsibilities. Therefore, the following four categories were identified:

- **Category 1:** Residential buildings (single or multi-family houses), rented from one single owner: Owners can be private persons, private companies or public authorities that own the whole building, and rent it to tenants.
- **Category 2:** Multi-family houses with mixed tenure status (owner occupied and privately rented): Buildings are owned by more than one party, e.g. companies or private persons who rent parts of the building to tenants, as well as private persons who live in owner occupied apartments.
- **Category 3:** Non-residential commercially used:
In this category, the building can be privately occupied or commercially rented, but in both cases it is owned by a single owner (e.g. real estate or other property owner with similar profile). Although there is a clear difference between owner-occupied and rented, in the category non-residential building with one single owner the tenure status might play a secondary role in the decision for renovation. (This category is not included in the scope of the iBRoad2EPC project.)
- **Category 4:** Non-residential publicly owner occupied:
A public authority owns and uses the building.

Based on the building categories, the analysis below aims to identify important aspects that should be covered in the adaptation of the iBRoad Renovation Roadmap to these four categories.

Adaptation: The iBRoad principles apply and must be followed for any building category. The first four principles are systematic components of the roadmap. The fifth, attractiveness, may be pursued differently depending on the specific customer.

Prefabricated recommendations

Prefabricated recommendations are offered to the auditors in the iBRoad Renovation Roadmap Assistant for single-family houses. They support the auditors by standardising frequently occurring content. They also help to remember many important contents.

Adaptation: For multi-family and non-residential buildings, additional standard text blocks will have to be offered in the text block database, as additional technologies are used and customers need to be addressed in a different way.

Non-energy benefits

Owners, tenants and employees in the role of decision-maker, investor and/or beneficiary benefit from renovations. Renovations not only help to increase living comfort, but also enhance comfort at work, at school or in hospitals⁵. The Renovation Roadmap for single-family houses lists non-energy benefits for each renovation step.

⁵ (Kockat, et al. 2018)

Adaptation: Not all benefits are suitable for the additional building categories, e. g. if the decision makers do not work or live in the building themselves. Since the benefits are nevertheless a trigger to motivate people to undertake renovations, they should be adapted and used for each individual category.

Legal aspects

The trigger for renovation is often a legal requirement that must be fulfilled. Legal requirements may be energy-related, i.e., emission control, heating system ordinance or retrofitting obligations, or other, e.g. related to safety.

Adaptation: The Roadmap should outline current and, where appropriate, future relevant requirements and show how they can be met.

Economic indicators and calculation

Economic indicators, in particular energy cost savings, payback time and real estate value, are important and play a major role in all building categories. Economic and financial aspects can hardly be handled in a unified way as the perspective varies when a building is not owner-occupied.

Adaptation: The Roadmap should include a separate page to individually describe economic and financial aspects.

Trigger points

In non-residential buildings, there may be several triggers for renovation. For example, if the tenant changes, the type of use can also be changed, which may cause a major renovation. This trigger can also be used for energy improvements. In residential apartment buildings, too, a change of tenant can be the trigger for energy-related renovations, for example, insulation of the walls from the inside.

In non-residential buildings, a broader variety of technical building systems may exist compared to residential buildings. These are not only cooling and ventilation, but also systems that are not directly relevant from an energy point of view, such as sprinklers, sensors, alarms or access controls. Work to be carried out on these systems can also trigger renovations. If, for example, claddings have to be opened over a large area, an insulation layer can be installed on this occasion. The number of technical building systems often makes it necessary to coordinate and optimise the systems to ensure that they complement each other.

Further triggers for renovation can arise from the interdependence between the building systems. For example, work on the air conditioning system can also entail adjustments to the heating system.

Adaptation: The auditors have to take these additional trigger points into account when drawing up a long-term renovation roadmap.

Auditor Trainings

Auditors who issue roadmaps for non-residential buildings in particular need extensive knowledge of their complex building technology. It is not possible to acquire the necessary knowledge foundation in a training course alone. Auditors must already have a technical background and broad experience in technical building services. They must have also received additional training that goes beyond the contents of training for auditing residential buildings.

Adaptation: The iBRoad handbook for energy auditors should be extended with specific recommendations to handle complex building technologies in the Roadmap.

Scope of the audit and roadmap report

The Roadmap for non-residential buildings touches on many topics and can therefore be very extensive. For completeness, it is necessary to show a path for all energy-relevant building systems. It should be noted, however, that the Roadmap does not constitute a full planning service. It provides an overview of the intended changes and helps avoid connection errors between the individual components. The detailed implementation planning must be provided by a specialist planner in the course of implementation.

Adaptation: The Roadmap for non-residential buildings should contain a disclaimer noting that it does not replace comprehensive planning.

Based on the adaptations that had been proposed in the report “Potential extension of iBRoad to other building types” (iBRoad 2020), concrete implementations in the iBRoad Renovation Roadmap are derived in the present project below.

Content

Prefabricated notes are a core feature of the iBRoad Renovation Roadmap. They comprise standardised information to avoid lock-in situations or general information on the construction. In the current version, the prefabricated notes only apply to single-family houses. Specific prefabricated notes for multi-family buildings and public buildings must be added as presented in Annex 1, Table 10 - Table 12). Annex 1 also shows where these have to be inserted in the iBRoad Renovation Roadmap Assistant. They are listed specifically according to multi-family houses, apartments and buildings owned by public bodies. This list may be enlarged with highly specialised or country specific issues.

Output form

Additional elements are to be included in the iBRoad Renovation Roadmap output form to make it suitable for multi-family and public buildings and provide economic information that is usually not suitable for owner-occupied buildings. The template, which is included in Annex 2, applies to both apartment buildings and public buildings.

A disclaimer clarifying the **scope of the audit and roadmap report** and noting that the Roadmap for non-residential buildings does not replace comprehensive planning is shown in Annex 2.

Assistant tool

The iBRoad Roadmap Assistant is an online tool that enables energy auditors to create an iBRoad Roadmap. All essential information about the building is entered into the Roadmap Assistant, as well as all data about future renovation states. The Roadmap Assistant offers a selection of renovation triggers for each renovation step which auditors can choose from.

In order to be able to also cover multi-family and public buildings, additional triggers are needed as shown in Annex 1, Table 9. Annex 1 also shows where they have to be inserted in the Roadmap Assistant so that they can be selected by energy auditors.

Non-energy benefits can already be selected individually in the Roadmap Assistant. They can be used for all building types, however if they do not apply to a building type, they can be omitted.

Legal aspects are not provided as standardised text blocks, as they vary from one Member State to another and must always be updated. Knowledge of the legal aspects is one of the auditors' core tasks and they must manually add relevant information to the Roadmap.

A separate page to individually describe **economic indicators and calculation** is shown in Annex 2. However, no calculation methods are shown for the economic efficiency of renovation measures in multi-family houses or buildings owned by public bodies. In multi-family houses, for example, the economic efficiency depends on whether and to what extent renovation costs can be passed on to the rent. The relevant regulations are laid down in national law. Therefore, the adaptation of the iBRoad Renovation Roadmap is limited to providing additional space for the presentation of economic viability.

Specific constraints, expectations, and requirements to adapt the iBRoad Renovation Roadmap to different building types

Building on the results of the former iBRoad report, user stories are analysed here below to illustrate the concrete peculiarities that must be observed when extending the iBRoad Renovation Roadmap to additional building types. Table 4 shows the technical and administrative specifics that need to be considered when adapting the iBRoad Renovation Roadmap to different building types. In addition to the building type (single-family house, multi-family house and buildings owned by public bodies), the tenure status is also relevant for the adaptation. It determines the framework and the direction of the renovation roadmap.

The technical particularities that need to be taken into account for single-family houses and also the administrative particularities in owner-occupied buildings were already developed during the iBRoad project. If, on the other hand, single-family houses are rented out, the so-called investor-user dilemma arises. It arises from the fact that the building owners bear the costs for the energy refurbishments, but do not themselves benefit from the reduced energy costs and comfort improvements. The iBRoad Renovation Roadmap includes additional indicators for the economic viability of renovation measures in rented buildings, such as payback time, energy cost savings and real estate value.

The iBRoad Renovation Roadmap always includes the living conditions of the occupants in the renovation strategy. In rented single-family homes, these are not only the circumstances of the owners, but also those of the tenants. An additional renovation option arises when tenants change. This must be taken into account when drawing up the roadmap. In the iBRoad Renovation Roadmap, these additional renovation opportunities that arise from residents' living conditions are created as new trigger points.

In multi-family buildings, additional technical requirements arise from the fact that individual units can be renovated. When the occupants of a unit move out, this is a good opportunity to carry out energy improvements that are not acceptable when the unit is occupied. It is a challenging task for the energy auditor to combine such individual steps into a technically sensible renovation strategy for the entire building. However, there are a number of renovation measures that can have no problems being implemented step by step in the individual units, such as interior insulation, replacement of windows, airtightness, single heating systems, single ventilation systems, single heat recovery systems, single air condition, systems, apartment lighting. In the iBRoad Renovation Roadmap, new standardised recommendation texts are added to the database for these additional technical requirements.

At the administrative level, a distinction must be made between multi-family buildings that are rented out, condominium associations that are occupied exclusively by the owners, and mixed owner occupied and rented. In rented multi-family houses, the same particularities must be observed as in rented single-family houses (see above). In condominiums, extensive renovations are often difficult to carry out because the many owners have different interests and can only agree on the smallest commonality. It is therefore all the more important to make targeted use of all renovation opportunities in condominiums. They are particularly appropriate when individual units are sold. The new owners usually carry out renovation measures anyway. Energy improvements can be implemented in this context. They are therefore particularly dependent on overarching renovation strategies, such as the iBRoad Renovation Roadmap.

Publicly owned buildings use technologies that are rarely used in residential buildings, such as central cooling systems or automatic shading devices. Specific text blocks for these technologies may need to be created in the iBRoad Renovation Roadmap. Auditors should note that buildings owned by public institutions may have higher requirements for indoor climate conditions than residential buildings. Countries implementing the iBRoad Renovation Roadmap should provide the relevant information to auditors. At the administrative level, buildings owned by public bodies may have to comply with special obligations. For example, an earlier entry into force of the minimum energy performance standards is foreseen for them. Once the revised EPBD is enacted in the implementing countries, special standard text blocks for the specific obligations for buildings owned by public bodies will need to be developed for the iBRoad Renovation Roadmap.

Building type	Tenure status	Technical peculiarities to consider in the Roadmap	Administrative peculiarities to consider in the Roadmap
Single-family house	owner occupied	as developed in iBRoad project	as developed in iBRoad project
	rented	as developed in iBRoad project	consider tenants' interests, change of tenants as additional renovation occasions, landlord-tenant-dilemma
Multi-family house	rented	additional apartment-related renovation measures (e.g. interior insulation, windows, airtightness, single heating, single ventilation systems, heat recovery, single air condition, apartment lighting) (renovation measures that address the whole building are already included in the Roadmap)	consider tenants' interests, change of tenants as additional renovation occasions, landlord-tenant-dilemma
	owner occupied		consider inhabitants interests, change of inhabitants as additional renovation occasions, condominiums typically are subject to stepwise renovations as difficult agreement processes hinder one-step renovations, owner-tenant-dilemma in rented apartments
	mixed owner occupied and rented		
Buildings owned by public bodies	owner occupied	additional energy efficiency measures related to buildings owned by public bodies (e.g. higher lighting demand in office buildings, centralised cooling systems, automatic shading)	specific requirements for buildings owned by public bodies (e.g. earlier obligations to fulfil minimum energy performance standards (EPBD), exemplary energy efficiency (EED)), renovation occasions from specific usage patterns (e.g. school holidays)

Table 4: Peculiarities to consider when an iBRoad Renovation Roadmap is issued for different building types

The peculiarities shown in Table 4 are incorporated in the additional triggers for renovation steps (Annex 1 / Table 9) and in the additional prefabricated recommendations for the iBRoad Renovation Roadmap (Annex 1 / Table 10 to Table 12).

ADAPTING THE IBROAD LOGBOOK TO DIFFERENT BUILDING TYPES

The iBRoad Logbook consists mainly of an IT tool offering digital storage of comprehensive building related data. For detailed information please see the following reports:

- The iBRoad Concept in practice - Report on suggested elements, content and layout of the iBRoad tools
- The iBRoad tool's structure

As with the iBRoad Renovation Roadmap, it depends on the national energy demand calculation methodology whether non-residential buildings are calculated differently than residential buildings. The calculation of non-residential buildings may require additional data such as zones of operation, lighting zones, floor area, and net floor space or operation profiles. These were broadly covered during the development of the iBRoad Logbook, however changes in national standards may cause a need for continuous updates.

If required, additional data of non-residential buildings can be included in the Logbook in different ways. If the data are only to be stored in the logbook in order to be available for the building operators or future planners, no changes in the logbook are necessary. There are already various ways of saving unspecified data in the logbook, e.g., as attached files. This data then, is not functionally processed by the logbook. If the non-residential building data in the logbook needs to be processed (e.g., for statistics), additional data fields may need to be provided in the logbook. This requires a similar procedure for defining the data fields as for residential buildings: the types and specifications of the additional data required by the individual Member States is collected and compared. Due to the semi-flexible data structure of the iBRoad Logbook, national versions can be created which contain only the relevant data fields. Given the above, it is estimated that no changes to the logbook structure are required at this stage. However, they are not excluded and can follow at a later stage in the project after the concept for the interaction of the Roadmap and iBRoad2EPC with the Logbook is completed. The coordination process for possible changes in the Logbook is carried out in several stages, from the basic to the specific, with the pilot countries. Annex 3 / Table 13 shows an example of a survey for the prioritisation of features from the iBRoad project.

MAKING IBROAD2EPC FIT FOR DIFFERENT BUILDING TYPES

In contrast to the iBRoad Renovation Roadmap and Logbook, the iBRoad2EPC is still in the concept phase. Therefore, the influences of different building types and the necessary adjustments cannot yet be conclusively presented. Many basic interrelationships and adaptation options can already be shown at this stage but must still be considered indicative as later additions and country-specific adaptations may be needed after the conceptualisation of iBRoad2EPC is finished.

The aim is to design iBRoad2EPC in such a way that adaptation to different building types does not require any adjustments to the programming code. Instead, it should provide a uniform framework into which content for different building types can be inserted. This flexible structure allows other building types to be easily added later. To analyse how the iBRoad2EPC can best be made fit to different building types, first typical user stories are created. They make clear on which occasions an iBRoad2EPC may be created, to whom it could be addressed, which conflicts of interest may occur, and which additional benefits it can provide. Based on the user stories, the adaptation requirements are derived. They comprise the content, the approach to end-users and the design of the iBRoad2EPC.

In order to gain an overview of the most common user stories for iBRoad2EPC, Table 5 to Table 8 show typical occasions when EPCs are issued and their peculiarities with respect to the iBRoad2EPC. For the iBRoad2EPC, far more different cases have to be distinguished than for the iBRoad Renovation Roadmap. iBRoad2EPC has the EPC as a starting point, which has to be issued on very different occasions, such as refurbishments, sales or rentals. The iBRoad Renovation Roadmap, on the other hand, is an energy audit that is ordered voluntarily by the client. The user stories are arranged by the three building types subject to iBRoad2EPC: single-family houses, multi-family houses and buildings owned by public bodies. The trigger points for EPCs to be issued result from obligations in the Energy Performance of Buildings Directive. Other triggers/opportunities to issue an EPC are added where this is regarded as useful. The proposal for a new version of the EPBD provides for the introduction of minimum energy performance standards. These so-called MEPS specify certain efficiency classes to be met by buildings at certain points in time. The efficiency class shown in the EPC serves as proof. This creates an additional trigger for issuing EPCs. The list of trigger points is not exhaustive. More occasions may follow from national regulations, however the list can be expected to already cover the majority of cases.

The tables also show to whom (end-user) the recommendations given in the iBRoad2EPC are addressed. This information is the basis for both content and phrasing of the recommendations in a wording that suits the target group. The end-user is not necessarily the same person that orders and receives the iBRoad2EPC. Especially when a building is sold, the old owner orders the iBRoad2EPC to display the efficiency class in the sales advertisement, however the renovation recommendations will refer to the new owner who will have to implement them in the future. Both parties are shown in the tables in order to identify potentially conflicting interests.

The peculiarities of the specific cases serve as the basis to tailor prefabricated recommendations to feed into the iBRoad2EPC. Their aim is to inform the target group in an appropriate manner, to communicate the long-term obligations and targets as well as which measures are needed in order to meet these targets and to incite to make best possible use of already planned renovations or given windows of opportunity. The user stories help to understand how prefabricated recommendations have to be divided depending on building type and occasion and what kind of content is required.

Single-family buildings

This category includes one- and two-family houses. The owners occupy the buildings themselves and make all decisions on purchase, sale and renovation.

Building type	Trigger point	Receiver of EPC	Recommendations addressed to	Peculiarities with respect to iBRoad2EPC
Single-family house	Purchase	Old owner	New owner	Can the old owner influence the auditor? Old owner is the auditor's client. Focus on measures that can be implemented on the occasion of the purchase.
	Rental	Owner, tenant	Owner, tenant	Can the old owner influence the auditor? Old owner is the auditor's client. Focus on measures that can be implemented on the occasion of tenants' change.
	Proof for obligations	Owner	Owner, tenant	iBRoad2EPC informs about obligations (e.g. MEPS) and supports solutions to meet these obligation requirements.
	Expiration	Owner, tenant	Owner, tenant	EPC is regarded as a formal obligation that is usually paid little attention to. Offers an opportunity to draw attention on renovation.
	Major renovation, extension	Owner, tenant	Owner, tenant	iBRoad2EPC should be mandatory BEFORE implementing major renovations. This allows to align the planned measures with the overarching targets and to recommend additional measures to implement on this occasion to avoid lock-in situations.
	No legal trigger, voluntary iBRoad2EPC, interest	Owner, tenant	Owner, tenant	iBRoad2EPC should aim for providing relevant information in an appealing layout to attract building owners
	Access to incentives	Owner, tenant	Owner, tenant	(Only if an EPC is mandatory to apply for incentives.) iBRoad2EPC aligns the planned measures with the overarching targets and may recommend additional measures to implement on this occasion to avoid lock-in situations.

Table 5: User stories and peculiarities to consider in iBRoad2EPC for common EPC trigger points in single-family houses

Multi-family buildings

In order to adapt iBRoad2EPC to multi-family buildings, it is necessary to consider the shared ownership structure, that generates a factor of additional complexity to the renovation process that must be specifically addressed, turning innovation into a key aspect of social innovation in particular.

In that sense, placing the user at the centre is necessary in order to make users more predisposed to the renovation of the building -improved material aspects- and to the change of habits -improved practices- for any initiative that wishes to boost urban renovation at a big scale. This user centred approach has already been fully accepted at European level; in this regard, it is worth recalling what the European Commission stated at the end of 2016 in its previously named Winter Package, renamed Clean Energy for All Europeans⁶.

“All consumers - not forgetting the vulnerable and energy poor - should feel involved and reap the tangible benefits of access to more secure, clean and competitive energy.”

Therefore, iBRoad2EPC not only has to take into account the interventions in the building that legislation makes mandatory, but there also has to be a process to reach agreements in the community itself on the desirability and possibility to carry out these interventions - certain steps at certain times - and other triggered interventions promoted by the community.

Working with the community also opens a door to another aspect: the cohesion of communities and strengthening cooperation between everybody who uses the buildings.

Neighbourhood communities are the main public space where people live alongside each other, where citizens have to share spaces and make decisions. It is therefore a space where processes of agreements and disagreements, consensus and conflicts over shared spaces are experienced. The processes of renovating a building not only allow awareness to be raised about the importance of making efficient use of energy, but are an opportunity to improve coexistence within the community.

Therefore, involving the different users as genuine stakeholders in the renovation process is crucial both to trigger interventions and to ensure their success.

⁶ European Commission EC (2016). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank. Clean energy for all Europeans.

Building type	Trigger point	Receiver of EPC	Recommendations addressed to	Peculiarities with respect to iBRoad2EPC
Multi-family house	Purchase whole building	Old owner, property management ⁷	New owner	Can the old owner influence the auditor? Old owner is the auditor's client. Focus on measures that can be implemented on the occasion of the purchase.
	Purchase single apartment, EPC for the whole building	Property management	New owner of the apartment, property management, all building owners and tenants	iBRoad2EPC should comprise individual recommendations for the apartment besides recommendations for the whole building. The recommendations must not be mutually contradictory. Focus on measures that can be implemented on the occasion of the purchase.
	Purchase single apartment, EPC for one apartment only	Old owner of the apartment, property management	New owner of the apartment	Can the old owner of the apartment influence the auditor? Add recommendations that can be implemented during the change of owners specifically for the respective apartment which have to be aligned with the target state of the whole building. Focus on measures that can be implemented on the occasion of the purchase.
	Rent single apartment, EPC for the whole building	Owner, property management	Owner, tenant, all building owners and tenants	Can the building owner influence the auditor? Add recommendations that can be implemented during the change of tenants specifically for the respective apartment which have to be aligned with the target state of the whole building. Focus on measures that can be implemented on the occasion of the rental.
	Rent single apartment, EPC for one apartment only	Owner, property management	Owner, tenant	iBRoad2EPC should comprise individual recommendations for the apartment besides recommendations for the whole building. The recommendations must not be mutually contradictory. Focus on measures that can be implemented on the occasion of the tenants' change.
	Proof for MEPS	Owner, property management	Owner, property management, tenant	iBRoad2EPC informs about MEPS and supports solutions to meet these MEPS requirements.
	Expiration	Owner, property management	Owner, property management, all building owners and tenants	EPC is regarded as a formal obligation that is usually paid little attention to. Offers an opportunity to draw attention on renovation.

Table 6: User stories and peculiarities to consider in iBRoad2EPC for common EPC trigger points in multi-family houses (1/2)

⁷ The term property management does not only refer to professional property managers, but also includes self-managed structures, such as dedicated apartment owners, housing associations, etc.

Building type	Trigger point	Receiver of EPC	Recommendations addressed to	Peculiarities with respect to iBRoad2EPC
Multi-family house	Major renovation, extension, EPC for the whole building	Owner, property management	Building owner, apartment owner, property management, tenant	iBRoad2EPC should be mandatory BEFORE implementing major renovations. This allows to align the planned measures with the overarching targets and to recommend additional measures to implement on this occasion to avoid lock-in situations. The energy class can refer to the building state after the measure. Thus, a second calculation is not necessary and the EPC can serve as a proof, e. g. for incentives or MEPS.
	Major renovation, extension, EPC for one apartment only	Owner, property management	Building owner, apartment owner, property management, tenant	iBRoad2EPC should be mandatory BEFORE implementing major renovations. This allows to align the planned measures with the overarching targets and to recommend additional measures to implement on this occasion to avoid lock-in situations. The energy class can refer to the building state after the measure. Thus, a second calculation is not necessary and the EPC can serve as a proof, e. g. for incentives or MEPS. Add recommendations that can be implemented together with the planned renovation specifically for the respective apartment which have to be aligned with the target state of the whole building.
	No legal trigger, voluntary, interest	Building owner, apartment owner, property management	Building owner, apartment owner, property management	iBRoad2EPC should aim for providing relevant information in an appealing layout to attract building owner even if they do not need the EPC mandatory
	Access to incentives	Owner, property management	Owner, property management	(Only if an EPC is mandatory to apply for incentives.) iBRoad2EPC aligns the planned measures with the overarching targets and may recommend additional measures to implement on this occasion to avoid lock-in situations.

Table 7: User stories and peculiarities to consider in iBRoad2EPC for common EPC trigger points in multi-family houses (2/2)

Buildings owned by public bodies

Buildings owned by public bodies must meet several specific requirements that do not apply to other building types. At both the European and Member State levels, buildings owned by public bodies are expected to play a pioneering role, meaning they must meet obligations earlier than other buildings or comply with higher standards.

Building type	Trigger point	Receiver of EPC	Recommendations addressed to	Peculiarities with respect to iBRoad2EPC
Buildings owned by public bodies	Specific obligations for public buildings	Owner, property management	Owner	Include specific information on forerunner obligations for buildings owned by public bodies into iBRoad2EPC.
	Purchase	Old owner, old property management	New owner, new property management	Can the old owner influence the auditor? Old owner is the auditor's client.
	Proof for MEPS	Owner, property management	Owner, property management	iBRoad2EPC informs about MEPS and supports solutions for the first renovation step to meet the MEPS requirements. However, iBRoad2EPC does not provide a calculated proof that MEPS are fulfilled. iBRoad2EPC should point out that this service is included in the Renovation Roadmap.
	Expiration	Owner, property management	Owner, property management	EPC is regarded as a formal obligation that is usually paid little attention to. Offers an opportunity to draw attention on renovation.
	Major renovation, extension	Owner, property management	Owner, property management	iBRoad2EPC should be mandatory BEFORE implementing major renovations. This allows to align the planned measures with the overarching targets and to recommend additional measures to implement on this occasion to avoid lock-in situations. The energy class can refer the building state after the measure. Thus, a second calculation is not necessary and the EPC can serve as a proof, e. g. for incentives or MEPS.
	No legal trigger, voluntary, interest	Owner, property management	Owner, property management	iBRoad2EPC should aim for providing relevant information in an appealing layout to attract public bodies even if they do not need the EPC mandatory
	Access to incentives	Owner, property management	Owner, property management	(Only if an EPC is mandatory to apply for incentives.) iBRoad2EPC aligns the planned measures with the overarching targets and may recommend additional measures to implement on this occasion to avoid lock-in situations.

Table 8: User stories and peculiarities to consider in iBRoad2EPC for common EPC trigger points in buildings owned by public bodies

Specific constraints, expectations, and requirements to adapt iBRoad2EPC to different building types

In the following, the specifications for the iBRoad2EPC are derived, which result from the specific peculiarities of the different user stories shown in previous tables. They are a guide for the development and structuring of the content, the addressing of the customers, the structure of the forms and the approach to the design in particular. As a result, preliminary prefabricated text blocks and draft designs are developed as shown in the annexes. The general conceptualisation and development of the iBRoad2EPC, however, is not subject of this report. It is described in two separate reports within the iBRoad2EPC project to be published in 2022.

Content

- **Align staged renovation measures with overarching targets:** The required renovation measures must be described briefly and clearly in the iBRoad2EPC. The main measures should be derived by default from the national targets for the building sector. This requires a database that gathers all relevant country-applicable targets (e.g., U-values or insulation thicknesses, recommended heating systems, etc.), if necessary depending on the building type, to allow the iBRoad2EPC issuer to see what renovation depth would theoretically be required. However, the issuer must adapt these recommendations to the individual building so that they provide real added value for the building owners. In addition, the iBRoad2EPC must provide space to include notes in relation to avoiding lock-in situations. These are, in particular, preparations for later renovation steps. See examples in Table 10 to Table 12.
- **Make use of vacancies as opportunities:** The recommendations database should comprise text blocks that address the various occasions / trigger points for renovation. Such recommendations can, e.g., relate to the momentum of a change in ownership or inhabitants, i.e., renovation measures that can only be implemented when a building or apartment is not inhabited for a foreseeable period, and which can potentially have a high impact as they might raise interest for measures that were not yet in the new inhabitants' focus. This impact, however, can only be realised when the iBRoad2EPC is issued well ahead of the detailed planning phase. Table 14 shows such example text blocks.
- **Include information about obligations (e.g., MEPS):** This requires a database for predefined text blocks that are automatically filled in depending on the country and the time horizon. Table 15 shows such example text blocks.
- **Include specific information on forerunner obligations for public buildings:** Forerunner obligations result from EU and national legislation, e.g., the EPBD draft foresees an early fulfilment of MEPS obligations for buildings owned by public bodies. The database of recommendations should comprise specific text blocks for such buildings to meet relevant obligations. Table 15 shows such example text blocks.

Addressing

- **Standard text blocks** that are not related to the content, such as introductory and general explanatory sections should be **end-user-sensitive**. This allows addressing private owner-occupiers in a more personal way and building professionals or public bodies in a more systematic manner. Examples are shown in Table 16.
- iBRoad2EPC should include a **standard text** that refers to the **advanced features** provided by the iBRoad Renovation Roadmap (see Table 16).

Design

- Include **standard text blocks** that are not related to the content in the iBRoad2EPC form, such as **introductory** and general **explanatory** sections.
- **Include information about obligations (e.g., MEPS):** This requires a predefined space where the obligations are displayed. Annex 4 shows a draft design.
- Include a **standard text** that refers to the **advanced features** provided by the iBRoad Renovation Roadmap (see Table 16).

CONCLUSIONS

The three building types mentioned in this report, which form the target group for adaptation of the iBRoad2EPC and the iBRoad tools, i.e., single-family houses, multi-family houses and public buildings, represent a high proportion of the building stock in Europe. Public buildings are also targeted because they have to comply with several specific obligations under the EPBD, for which the iBRoad tools can provide support.

To adapt the iBRoad Renovation Roadmap to multi-family and public buildings, additional text fields must be included in the output form. Text blocks are needed that take into account the specific technical and administrative characteristics of each type of building and the characteristics of each target group. A design template is developed to apply to multi-family and public buildings as provided in Annex 2. In addition, the online tool that is used to create the Roadmap needs to be modified to allow the user to edit these changes.

In its current state, the iBRoad Logbook can already comprehensively process data from single-family houses, multi-family buildings, and public buildings. More specific/suitable approaches may be recommended once the tools are tested in practice.

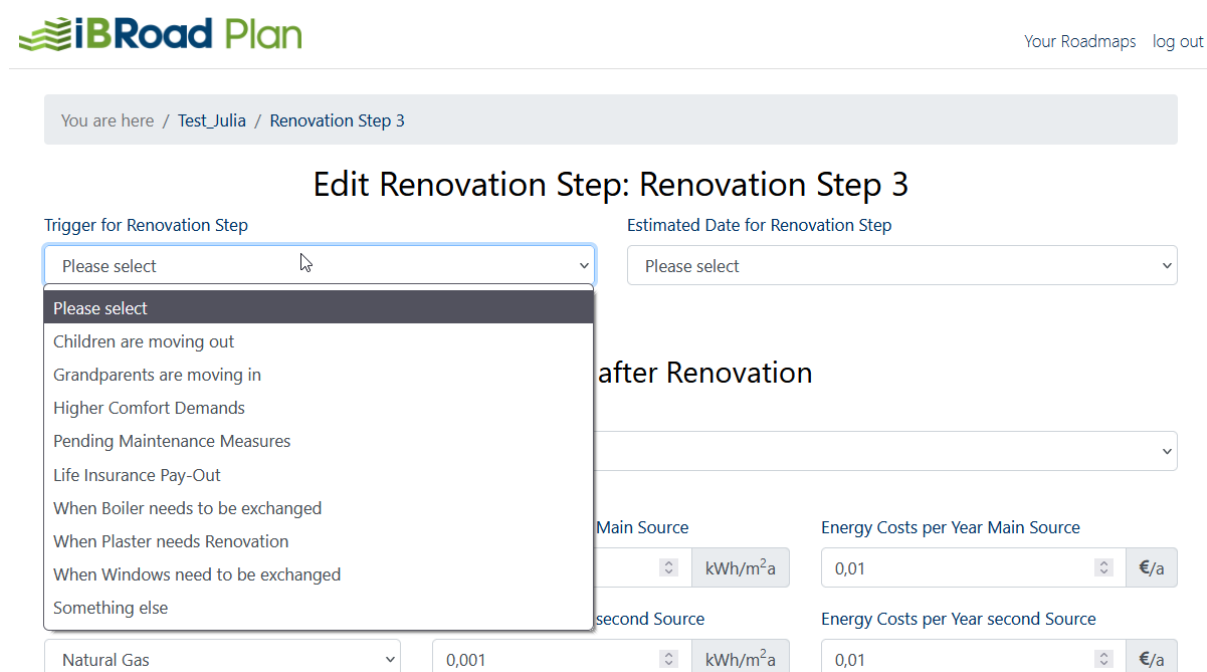
The iBRoad2EPC is in the development phase and catering for the different types of buildings needs to be considered as part of the early concept development. Adaptations to single-family, multi-family or public buildings are to be made primarily at the content level. This means, for example, that frequently expected recommendations can be standardised in building-type specific prefabricated text blocks. These relate, e.g., to the specific occasions on which an EPC is typically issued and guidance on how these occasions can be used as momentums for phased renovation. Furthermore, individual legal obligations can be included in the form of standardised text blocks, as can texts of salutation. A first sketch of the iBRoad2EPC output form is shown in Annex 5 to better understand where the elaborated content is inserted. While the content can already be derived from the user stories, the output form is still subject to change and is only shown as an indicative draft. The conceptualisation of the iBRoad2EPC will be published in a separate report.

ANNEX 1 – ADAPTATIONS IN THE IBROAD ROADMAP ASSISTANT TO MULTI-FAMILY AND PUBLIC BUILDINGS

Triggers for Renovation

The iBRoad Roadmap Assistant is an online tool that enables the energy auditor to create an iBRoad Renovation Roadmap. All essential information about the building is entered into the Roadmap Assistant, as well as all data about future renovation states. After creating the present building state, the energy auditor can add individual renovation steps. Initially, the Roadmap Assistant asks the energy auditor for the respective trigger point for the renovation step. The triggers for renovations vary depending on the building type.

Renovation triggers for single-family houses are already present in the Roadmap Assistant (Figure 12).



The screenshot shows the 'iBRoad Plan' web interface. At the top, there's a breadcrumb trail: 'You are here / Test_Julia / Renovation Step 3'. The main heading is 'Edit Renovation Step: Renovation Step 3'. Below this, there are two dropdown menus: 'Trigger for Renovation Step' and 'Estimated Date for Renovation Step'. The 'Trigger for Renovation Step' dropdown is open, showing a list of options: 'Please select', 'Children are moving out', 'Grandparents are moving in', 'Higher Comfort Demands', 'Pending Maintenance Measures', 'Life Insurance Pay-Out', 'When Boiler needs to be exchanged', 'When Plaster needs Renovation', 'When Windows need to be exchanged', and 'Something else'. Below the dropdowns, there are input fields for 'Main Source' (set to 'Natural Gas'), 'Energy Costs per Year Main Source' (set to '0,01 €/a'), 'Second Source', and 'Energy Costs per Year second Source' (set to '0,01 €/a').

Figure 12: Existing triggers for renovation steps in single-family houses

These need to be enhanced with additional triggers for multi-family houses (single apartments vs whole building) and for public buildings.

Table 9 shows a collection of triggers that should be added to the Roadmap Assistant specifically for the additional building types. Unlike single-family houses, personal reasons such as 'children moving out' or 'grandparents moving in' do not apply for other building types. Especially for public buildings, renovation obligations or legal requirements are more common triggers.

In the case of renovations that affect only one apartment of a multi-family house, triggers have to be distinguished from those in a multi-family house. In such a case, renovation measures relating to the entire building cannot be triggered. However, there is a number of targeted measures that can be implemented in a single apartment and should be included in the recommendations database.

Building Type	Additional Triggers
Multi-family house	- Purchase of a multi-family house - Extension of the building - Planned installation of smart technical systems, electrical vehicle charging, security systems or other - Planned renovation of common use areas
Apartment within a multi-family house	- Purchase of a single apartment - Rental a single apartment - Extension of the apartment - Life insurance pay out - Planned installation of smart technical systems, security systems or other - Higher comfort demands
Public buildings	- Change of building use - Change of ownership - Extension of the building - Planned installation of smart technical systems, electrical vehicle charging, security systems or other - Higher comfort demands
Independent from building type	- Planned major repairs at the supply pipes - Obligations from legal requirements - Life insurance pay out - Planned installation, change of maintenance of a centralised cooling system - Planned installation, change of maintenance of a centralised ventilation system - Change of or maintenance to a centralised heating system - Planned installation of photovoltaics - Planned renovation of the façade

Table 9: Additional triggers for renovation steps in the Roadmap Assistant

Prefabricated Notes for multi-family and public buildings

Energy auditors can add various renovation steps to the iBRoad Renovation Roadmap; they can select the desired measures from a drop-down menu in the Roadmap Assistant. Further specification of the measures takes place in a cascade of following, more detailed menus. The menus are divided into levels 0 to 3. Once the measures are specified, energy auditors can select the desired prefabricated text blocks (notes) from a resulting choice. The notes comprise standardised information to avoid lock-in situations or general information on the construction. The notes also depend on the order of measures. For example, if a roof is renovated before an outer wall insulation, it must be ensured that the roof overhang is sufficient to cover the future insulation thickness. The filter cascade ensures that the Roadmap Assistant displays only text blocks that match the measure (see Figure 13).

New Measure

You are here / Test_Julia / Renovation Step 3

Level 0

Envelope

Level 1

External Wall

Level 2

External Wall insulation

Level 3

Please Select

Note Dropdown

Outer Wall - pitched roof

Note

If the outer wall is insulated, it must be taken into account in a later pitched roof insulation. The low thermal bridge connection to the later sloping roof insulation is to be prepared.
Existing panels on the eaves must be opened and the insulation should be installed to a defined heights, e.g. to top edge rafters.

Figure 13: Filter cascade to specify new measures in the Roadmap Assistant

In the current version of the Roadmap Assistant the measures in the menus only apply to single-family houses. Specific measures for multi-family buildings and public buildings should be added (Table 10 - Table 12). In addition, the prefabricated notes must be supplemented so that they are adapted to the new building types. Table 10 to Table 12 show the concrete respective text blocks.

Level 1	Level 2	Notes for the iBRoad Renovation Roadmap
Roof	Roof - solar thermal	When the roof is being insulated, please prepare also for a future installation of a solar thermal system, by installing the necessary pipes, racks and through-holes; this will save redundant effort in the future.
Roof	Roof - PV	When the roof is being insulated, please prepare also for a future installation of PV modules, by installing the necessary lines, racks and through-holes; this will save redundant effort in the future.
Outer wall	Outer Wall - central hot water supply	When the outer walls are being insulated, please prepare also for a future centralisation of the hot water supply, by installing the necessary new pipes behind the insulation layer and lead them back inside the apartments; this will save redundant effort in the future and will avoid costly installations on the inside. The conversion to a central hot water supply can be implemented in a later stage when the heat generator will be exchanged.
Outer wall	Outer Wall - central heat supply	When the outer wall are being insulated, please prepare for a future centralisation of the heat supply, by installing the necessary heat pipes behind the insulation layer and lead them back inside the apartments; this will save redundant effort in the future and will avoid costly installations on the inside. The conversion to a central heating system can be implemented in a later stage when the heat generator will be exchanged.
Outer wall	Outer wall - shades or blinds	When the outer walls are being insulated, please prepare for a future installation of window shades or blinds, by installing in-wall boxes and lines; this will save redundant effort in the future.
Domestic hot water (DHW)	Water pipes - central hot water supply	When the fresh or waste water pipes are being renewed, please prepare a future centralisation of the hot water supply, by installing additional hot water pipes at the same time; this will save redundant effort in the future. The conversion to a central hot water supply can be implemented in a later stage when the heat generator will be exchanged.
Heating	Water pipes - central heat supply	When the fresh or waste water pipes are being renewed, please prepare a future centralisation of the heat supply, by installing additional heat pipes at the same time; this will save redundant effort in the future. The conversion to a central heating system can be implemented in a later stage when the heat generator will be exchanged.
Heating	Preparation for a heat pump	If you plan to install a heat pump in the future, please carry out preparation measures to lower the flow temperature of the heating systems (ideally below 55 °C or less). This will raise the efficiency of the heat pump significantly. The flow temperature can be lowered by carrying out a hydraulic balance, exchanging single radiators and insulating single building components. An energy auditor can identify the components and radiators that provide the maximum improvements.
Heating	Preparation for low-temperature district heating	If you plan to connect your building to a low-ex district heating in the future, please carry out preparation measures to lower the flow temperature of the heating systems (ideally below 55 °C or less). The flow temperature can be lowered by carrying out a hydraulic balance, exchanging single radiators and insulating single building components. An energy auditor can identify the components and radiators that provide the maximum improvements.
Cooling	Cooling - outer wall insulation	When cooling systems are installed that require installations on the outside of the façade, please prepare for a future insulation of the outer walls, by mounting spacers with sufficient length; this will save redundant effort in the future.

Table 10: Additional prefabricated recommendations for the iBRoad Renovation Roadmap for multi-family houses

Level 1	Level 2	Notes for the iBRoad Renovation Roadmap
Outer wall	Inside insulation - windows	When the outer walls are being insulated from the inside, please prepare for a later exchange of the windows, by installing a temporary insulation of the window soffits; this will save redundant effort in the future.
Heating	Radiators - inside insulation	When the radiators are being replaced, please prepare for a later inside insulation of the walls, by leaving a sufficient distance for the planned insulation layer. This will save redundant effort in the future.

Table 11: *Additional prefabricated recommendations for the iBRoad Renovation Roadmap for apartments*

Level 1	Level 2	Notes for the iBRoad Renovation Roadmap
Roof	Roof - solar thermal	When the roof is being insulated, please prepare also for a future installation of a solar thermal system, by installing the necessary pipes, racks and through-holes; this will save redundant effort in the future.
Roof	Roof - PV	When the roof is being insulated, please prepare also for a future installation of PV modules, by installing the necessary lines, racks and through-holes; this will save redundant effort in the future.
Outer wall	Outer Wall - central heat supply	When the outer walls are being insulated, please prepare for a future centralisation of the heat supply, by installing the necessary heat pipes behind the insulation layer and lead them back inside the apartments; this will save redundant effort in the future and will avoid costly installations on the inside. The conversion to a central heating system can be implemented in a later stage when the heat generator will be exchanged.
Outer wall	Outer wall - shades or blinds	When the outer walls are being insulated, please prepare for a future installation of window shades or blinds, by installing in-wall boxes and lines; this will save redundant effort in the future.
Domestic hot water (DHW)	Water pipes - central hot water supply	When the fresh or waste water pipes are being renewed, please prepare a future centralisation of the hot water supply, by installing additional hot water pipes at the same time; this will save redundant effort in the future. The conversion to a central hot water supply can be implemented in a later stage when the heat generator will be exchanged.
Heating	Water pipes - central heat supply	When the fresh or waste water pipes are being renewed, please prepare a future centralisation of the heat supply, by installing additional heat pipes at the same time; this will save redundant effort in the future. The conversion to a central heating system can be implemented in a later stage when the heat generator will be exchanged.
Heating	Preparation for a heat pump	If you plan to install a heat pump in the future, please carry out preparation measures to lower the flow temperature of the heating systems (ideally below 55°C or less). This will raise the efficiency of the heat pump significantly. The flow temperature can be lowered by carrying out a hydraulic balance, exchanging single radiators and insulating single building components. An energy auditor can identify the components and radiators that provide the maximum improvements.
Heating	Preparation for low-temperature district heating	If you plan to connect your building to a low-ex district heating in the future, please carry out preparation measures to lower the flow temperature of the heating systems (ideally below 55°C or less). The flow temperature can be lowered by carrying out a hydraulic balance, exchanging single radiators and insulating single building components. An energy auditor can identify the components and radiators that provide the maximum improvements.
Cooling	Cooling - outer wall insulation	When cooling systems are installed that require installations on the outside of the façade, please prepare for a future insulation of the outer walls, by mounting spacers with sufficient length; this will save redundant effort in the future.

Table 12: Additional prefabricated recommendations for the iBRoad Renovation Roadmap for buildings owned by public bodies

ANNEX 2 – TEMPLATES FOR THE ADAPTATION OF THE IBROAD RENOVATION ROADMAP TO MULTI-FAMILY AND PUBLIC BUILDINGS

The iBRoad Renovation Roadmap has already been introduced above (see chapter “Introduction of the iBRoad products and iBRoad2EPC”). This report presents additional elements that are important for multi-family and public buildings and shows how they can be included in the iBRoad Renovation Roadmap. We have placed these elements, such as economic efficiency, graphically in the following figures of the iBRoad Renovation Roadmap. We have marked new elements with a red frame. The following pages show the iBRoad Renovation Roadmap design templates for multi-family and public buildings.

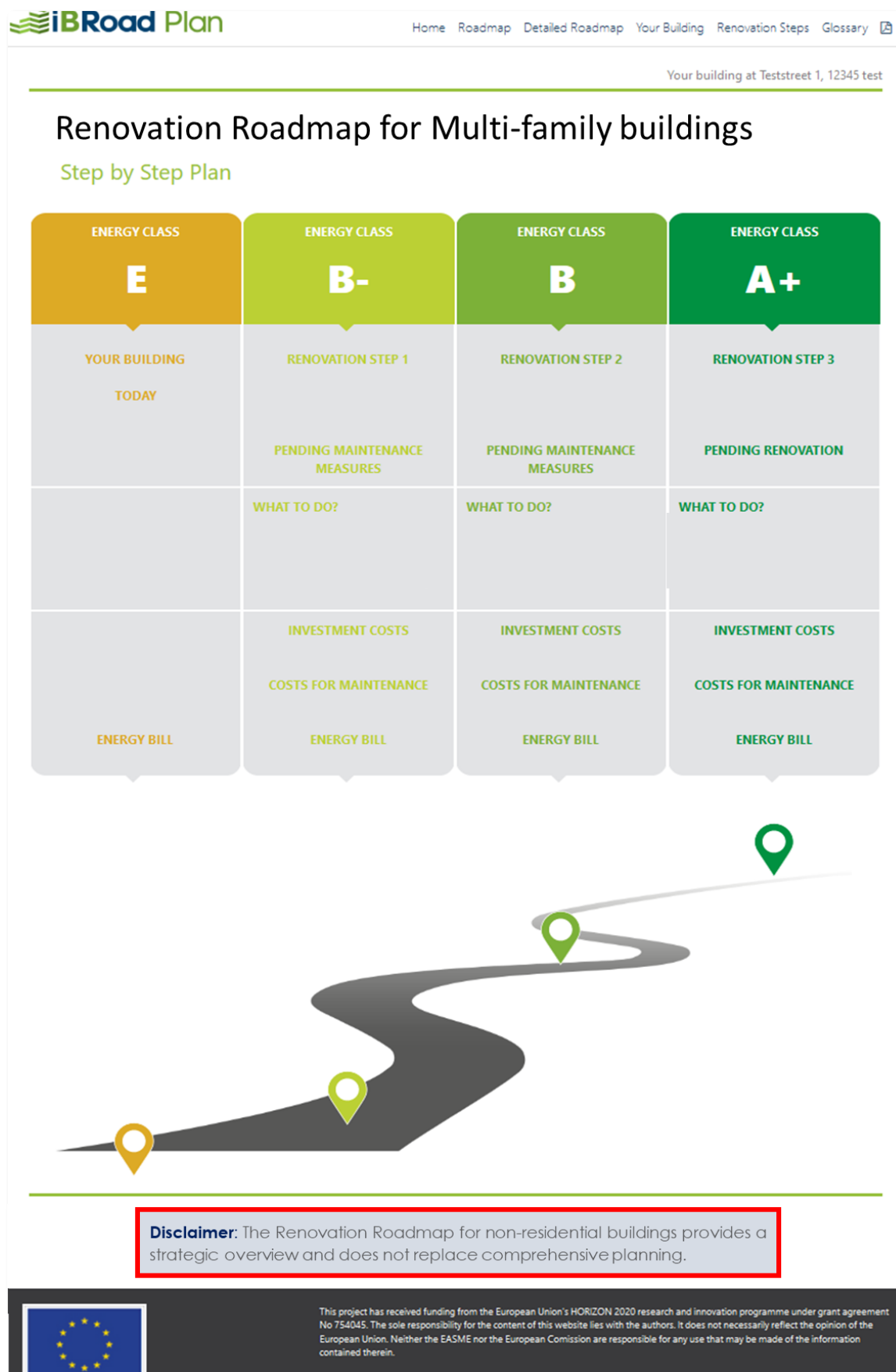


Figure 14: iBRoad individual Buildings Renovation Roadmap, design template for the overview page for multi-family buildings

Detail Renovation Roadmap for Multi-family buildings

Step by Step Plan

	ENERGY CLASS E	ENERGY CLASS B-	ENERGY CLASS B	ENERGY CLASS A+
	Your Building Moment of delivery	Renovation Step 1 2020	Renovation Step 2 When Plaster needs Renovation	Renovation Step 3 2045
		Pending Maintenance Measures	Pending Maintenance Measures	pending renovation
Measures		Measures	Measures	Measures
Requirements and Regulation		Minimum Energy Performance Standards 2029	Minimum Energy Performance Standard 2029	Minimum Energy Performance Standard 2045 No fossil fuels allowed for new Installation
Energy Use	Primary Energy Demand	Primary Energy Demand	Primary Energy Demand	Primary Energy Demand
	Main Energy Source	Main Energy Source	Main Energy Source	Main Energy Source
	Final Energy Demand Main Source	Final Energy Demand Main Source	Final Energy Demand Main Source	Final Energy Demand Main Source
	Second Energy Source	Second Energy Source	Second Energy Source	Second Energy Source
	Final Energy Demand second Source	Final Energy Demand second Source	Final Energy Demand second Source	Final Energy Demand second Source
	Auxiliary Energy Source	Auxiliary Energy Source	Auxiliary Energy Source	Auxiliary Energy Source
	Final auxiliary Energy Demand	Final auxiliary Energy Demand	Final auxiliary Energy Demand	Final auxiliary Energy Demand
	Energy Bill	Energy Bill	Energy Bill	Energy Bill
CO ₂	Carbon Emissions	Carbon Emissions	Carbon Emissions	Carbon Emissions
Costs		Investment Costs for Renovation Step	Investment Costs for Renovation Step	Investment Costs for Renovation Step
		Included Costs for Maintenance	Included Costs for Maintenance	Included Costs for Maintenance
Subsidies		Name of Incentives	Name of Incentives	Name of Incentives
		Incentives	Incentives	Incentives
Economic Viability		Energy Cost Savings Value	Energy Cost Savings Value	Energy Cost Savings Value
		Payback Time Value	Payback Time Value	Payback Time Value
		Real Estate Value Value	Real Estate Value Value	Real Estate Value Value
Comfort Changes		Changed Comforts	Changed Comforts	Changed Comforts

Figure 15: iBRoad individual Buildings Renovation Roadmap, design template for the detailed Roadmap for multi-family buildings

Requirements and Regulation		Minimum Energy Performance Standards 2029	Minimum Energy Performance Standard 2029	Minimum Energy Performance Standard 2045
				No fossil fuels allowed for new installation

Figure 16: iBRoad individual Buildings Renovation Roadmap, detail of the design template for the detailed Roadmap for multi-family buildings: information about legal requirements and regulations are included for multi-family buildings

Economic Viability		Energy Cost Savings Value Payback Time Value Real Estate Value Value	Energy Cost Savings Value Payback Time Value Real Estate Value Value	Energy Cost Savings Value Payback Time Value Real Estate Value Value

Figure 17: iBRoad individual Buildings Renovation Roadmap, detail of the design template for the detailed Roadmap for multi-family buildings: information on the economic viability are included for multi-family buildings

Details of the renovation Roadmap

Renovation Step 1

ENERGY CLASS	Measure	Substitution of the heating system by a condensing gas boiler
B-	Improvement	
Renovation Step 1	Technical Details	
2020	Renovation Costs	
Pending Maintenance Measures	Included Costs for Maintenance	
Legal Obligations	Note	
Maximum Energy Use	Incentives Information only relating to this Measure	funding granted by public xy-bank
XXX kWh/m ² a	Specific Incentive Bonus	
Maximum Carbon Emission	Energy Cost Savings	Value
XX kg/(m ²)	Payback Time	Value
Heating System Requirements	Real Estate Value	Value
Primary Energy Demand		
Main Energy Source	Measure	Insulation of the cellar ceiling
Final Energy Demand Main Source	Improvement	
Second Energy Source	Technical Details	
Final Energy Demand second Source	Renovation Costs	
Auxiliary Energy Source	Included Costs for Maintenance	
Final auxiliary Energy Demand	Note	
Energy Bill	Incentives Information only relating to this Measure	
Carbon Emissions	Specific Incentive Bonus	
Investment Costs for Renovation Step	Energy Cost Savings	
Included Costs for Maintenance	Payback Time	
Name of Incentives	Real Estate Value	
Incentives		

Figure 18: iBRoad individual Building Renovation Roadmap, design template for the description of a single renovation step for multi-family buildings

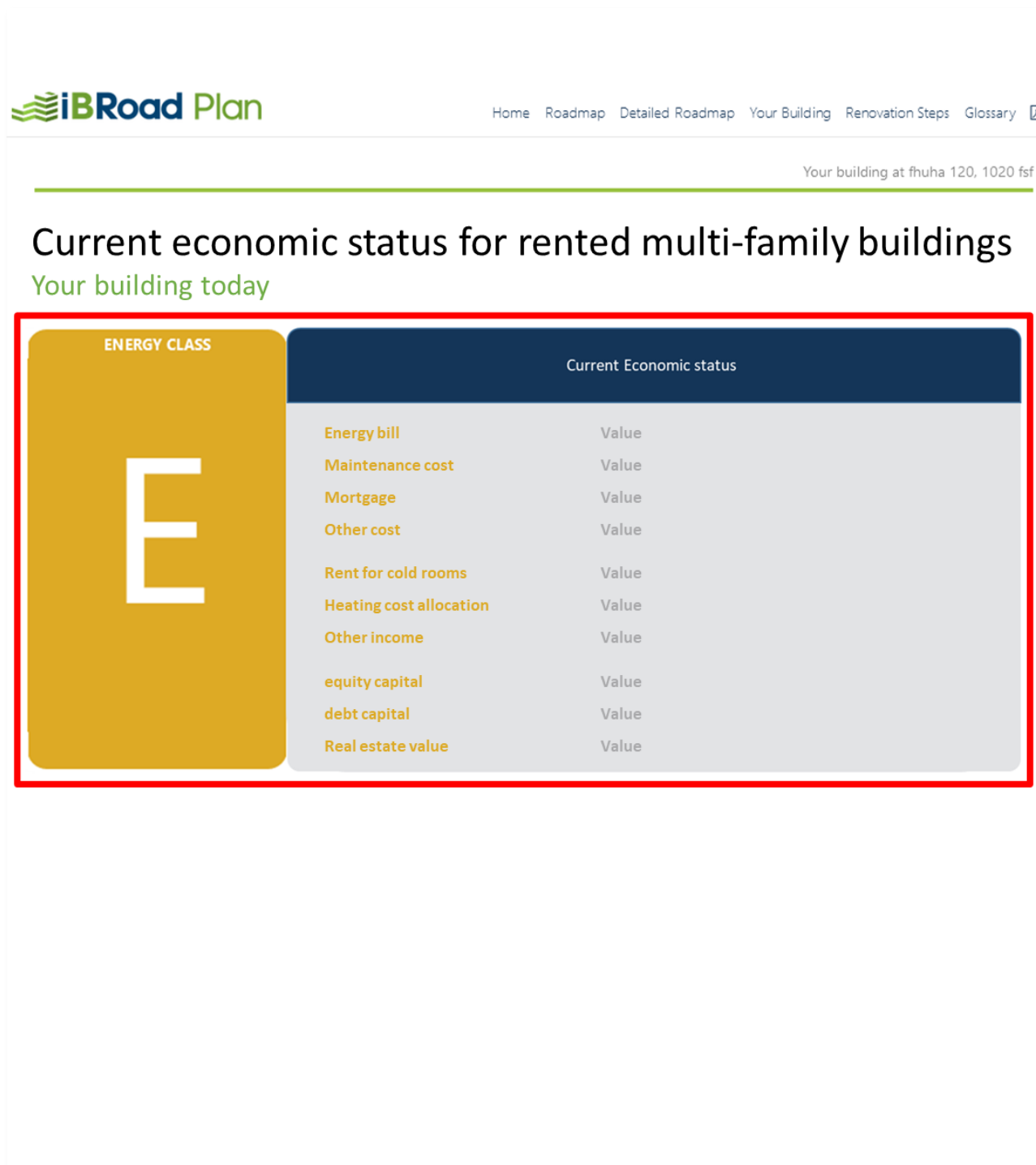


Figure 19: iBRoad individual Building Renovation Roadmap, design template for the current economic status of multi-family buildings

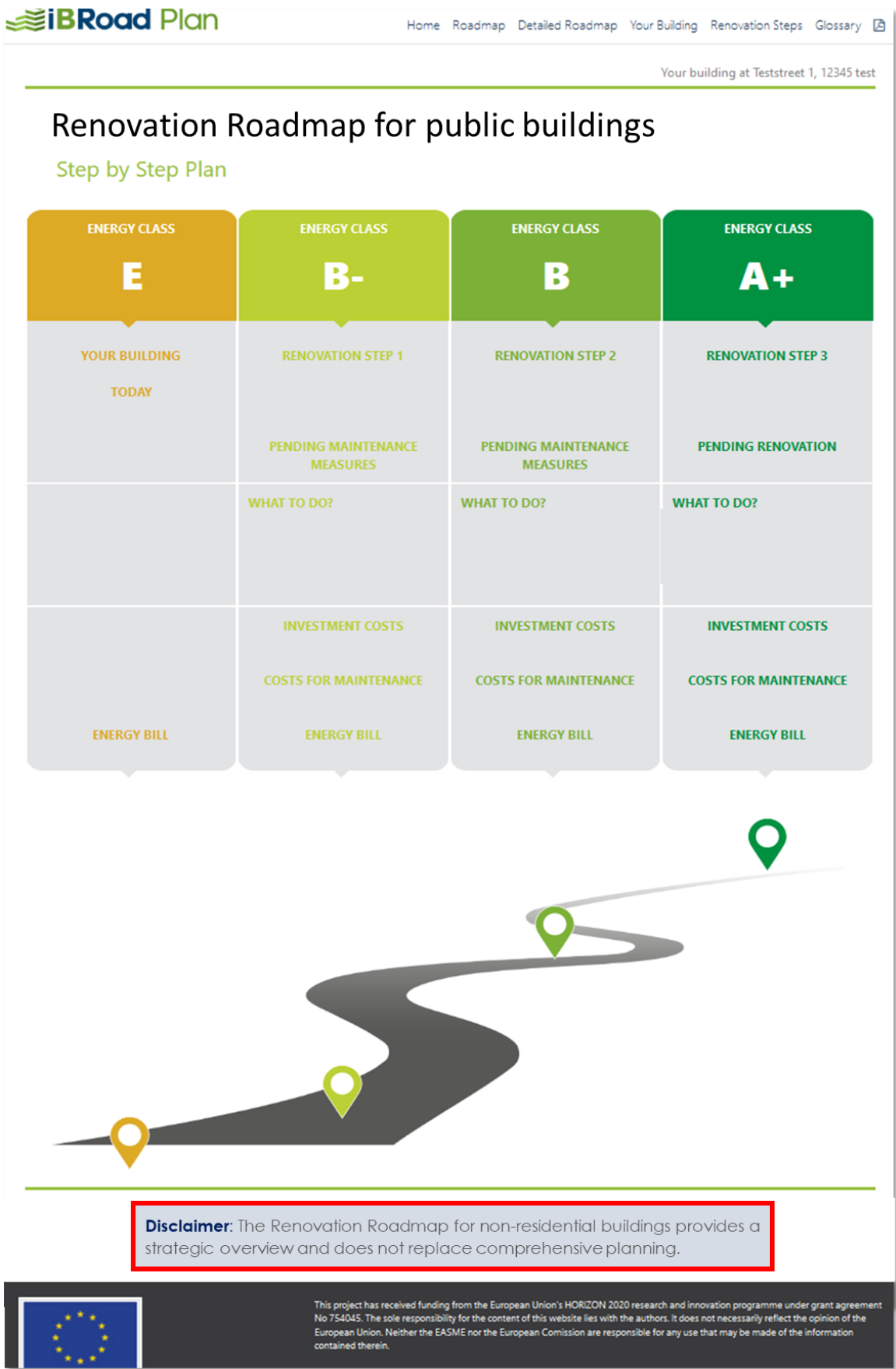


Figure 20: iBRoad individual Buildings Renovation Roadmap, design template for the overview page for public buildings

Detail Renovation Roadmap for public buildings

Step by Step Plan

	ENERGY CLASS E	ENERGY CLASS B-	ENERGY CLASS B	ENERGY CLASS A+
	Your Building Moment of delivery	Renovation Step 1 2020	Renovation Step 2 When Plaster needs Renovation	Renovation Step 3 2045
		Pending Maintenance Measures	Pending Maintenance Measures	pending renovation
Measures		Measures	Measures	Measures
Requirements and Regulation		Minimum Energy Performance Standards 2029	Minimum Energy Performance Standard 2029	Minimum Energy Performance Standard 2045 No fossil fuels allowed for new installation
Energy Use	Primary Energy Demand Main Energy Source Final Energy Demand Main Source Second Energy Source Final Energy Demand second Source Auxiliary Energy Source Final auxiliary Energy Demand Energy Bill	Primary Energy Demand Main Energy Source Final Energy Demand Main Source Second Energy Source Final Energy Demand second Source Auxiliary Energy Source Final auxiliary Energy Demand Energy Bill	Primary Energy Demand Main Energy Source Final Energy Demand Main Source Second Energy Source Final Energy Demand second Source Auxiliary Energy Source Final auxiliary Energy Demand Energy Bill	Primary Energy Demand Main Energy Source Final Energy Demand Main Source Second Energy Source Final Energy Demand second Source Auxiliary Energy Source Final auxiliary Energy Demand Energy Bill
CO ₂	Carbon Emissions	Carbon Emissions	Carbon Emissions	Carbon Emissions
Costs		Investment Costs for Renovation Step Included Costs for Maintenance	Investment Costs for Renovation Step Included Costs for Maintenance	Investment Costs for Renovation Step Included Costs for Maintenance
Subsidies		Name of Incentives Incentives	Name of Incentives Incentives	Name of Incentives Incentives
Economic Viability		Energy Cost Savings Value Payback Time Value Real Estate Value Value	Energy Cost Savings Value Payback Time Value Real Estate Value Value	Energy Cost Savings Value Payback Time Value Real Estate Value Value
Comfort Changes		Changed Comforts	Changed Comforts	Changed Comforts

Figure 21: iBRoad individual Buildings Renovation Roadmap, design template for the detailed Roadmap for public buildings

Requirements and Regulation		Minimum Energy Performance Standards 2029	Minimum Energy Performance Standard 2029	Minimum Energy Performance Standard 2045 No fossil fuels allowed for new installation
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Figure 22: iBRoad individual Buildings Renovation Roadmap, detail of the design template for the detailed Roadmap for multi-family buildings: information about legal requirements and regulations are included for public buildings

Economic Viability		Energy Cost Savings Value Payback Time Value Real Estate Value Value	Energy Cost Savings Value Payback Time Value Real Estate Value Value	Energy Cost Savings Value Payback Time Value Real Estate Value Value
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Figure 23: iBRoad individual Buildings Renovation Roadmap, detail of the design template for the detailed Roadmap for multi-family buildings: information on the economic viability are included for public buildings

Details of the renovation Roadmap

Renovation Step 1

ENERGY CLASS	Measure	Substitution of the heating system by a condensing gas boiler
B-	Improvement	
Renovation Step 1	Technical Details	
2020	Renovation Costs	
Pending Maintenance Measures	Included Costs for Maintenance	
Legal Obligations	Note	
Maximum Energy Use	Incentives Information only relating to this Measure	funding granted by public xy-bank
XXX kWh/m ² a	Specific Incentive Bonus	
Maximum Carbon Emission	Energy Cost Savings	Value
XX kg/(m ²)	Payback Time	Value
Heating System Requirements	Real Estate Value	Value
Primary Energy Demand		
Main Energy Source		
Final Energy Demand Main Source		
Second Energy Source		
Final Energy Demand second Source		
Auxiliary Energy Source		
Final auxiliary Energy Demand		
Energy Bill		
Carbon Emissions		
Investment Costs for Renovation Step		
Included Costs for Maintenance		
Name of Incentives		
Incentives		

Figure 24: iBRoad individual Building Renovation Roadmap, design template for the description of a single renovation step for public buildings

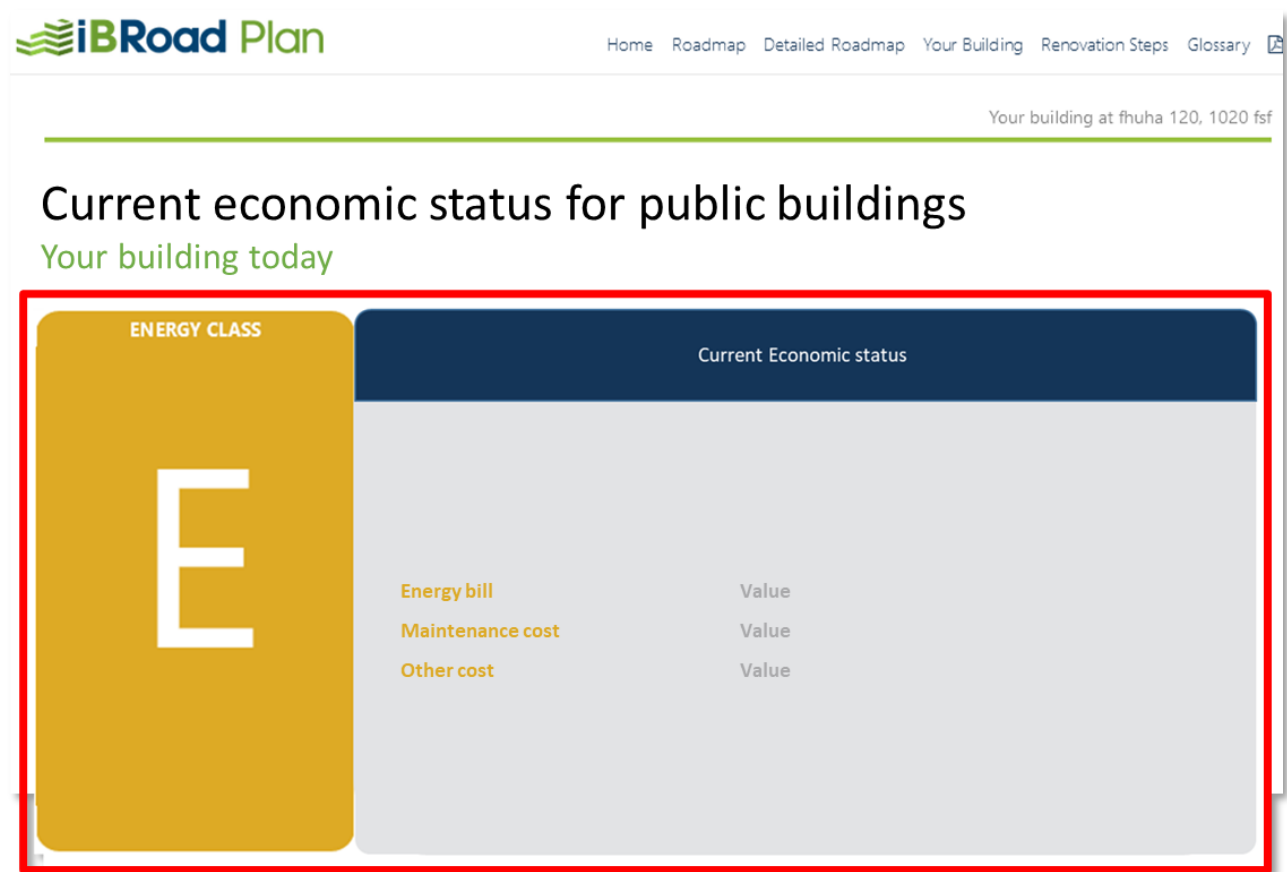


Figure 25: iBRoad individual Building Renovation Roadmap, design template for the current economic status of public buildings

ANNEX 3 – TEMPLATE FOR THE ADAPTATION OF THE IBROAD LOGBOOK TO MULTI-FAMILY AND PUBLIC BUILDINGS

The iBRoad Logbook can be flexibly adapted to the requirements of individual implementing countries. For example, specific data fields for multi-family and public buildings can be inserted. However, it may be useful to coordinate adaptations with other implementing countries. For this purpose, countries can enter their priorities in a survey. The table shows an example survey from the iBRoad project.

Logbook feature	BUL	GRE	POR	POL	SPN	ROM
Inventory of non-dynamic information. Relevant individual building related information such as:						
Data required to calculate energy demand of the building, i.e. building geometry data, U-values of building components, heating system specification etc.	1	1	1	1	1	1
Contacts of building professionals who executed on-site works	2	2	1	1	2	1
Building plans	2	1	2	2	2	2
Statistical relevant info of the building (from Census)	2	3	2	3	?	2
Government related information (cadastre, taxes...)	2	1	1	3	2	1
Historical energy consumption & production	2	1	1	2	1	1
Interactive & dynamic tools						
Automated renovation advice (linked to the techno-economic assessment of renovation steps described in task 3.1 and 3.2)	2	1	1	1	2	1
Benchmark with other buildings	1	2	3	2	3	2
Tentative monitoring and comparing real energy consumption with designed/nominal energy consumption	2	2	2	2	3	2
Monitoring real energy production	2	1	2	2	2	1
Alerts in case of strange consumption patterns - flaws in technical installations	2	2	2	3	3	2
Alerts in case of availability of specific incentives for renovation	1	1	1	2	3	1
Alerts in case of high calculated energy demand	2	2	2	2	3	2
Alerts in case of old equipment or building components which need to be replaced soon	1	1	2	2	2	1
Guidance through renovation (long term) and maintenance (e.g. semi-automatic request for maintenance)	1	1	1	1	2	1
Detailed information on the individual renovation roadmap	1	1	1	1	-	1
Key information on the individual renovation roadmap	1	1	1	1	1	1

Table 13: Example of a survey for the prioritisation of features from the previous project. Priority: (1) high priority, needs to be implemented in the iBRoad Logbook; (2) nice to have; (3) no implementation

ANNEX 4 – MAKING IBROAD2EPC FIT FOR MULTI-FAMILY AND PUBLIC BUILDINGS

In iBRoad2EPC, frequently occurring renovation recommendations are stored as prefabricated text blocks. The renovation recommendations standardised text blocks represent a large number of possible cases, but do not claim to be exhaustive. It is possible that country-specific recommendations will be added in cooperation with the pilot countries or that special cases will have to be entered manually.

Table 14 shows examples of how vacancies in individual apartments can also be good opportunities to implement important renovation steps for the entire building. It is important that such measures in individual apartments be systematically planned in advance so that the windows of opportunity can be quickly exploited when the apartment is vacant and so that the measures in the individual apartments can complement one another so that together they contribute to the desired target.

Building type	Trigger point	Receiver of EPC	Recommendations addressed to	Text blocks / description of renovation measures
Multi-family house	Purchase single apartment, EPC for the whole building	Property management	New owner of the apartment, property management	The time when an apartment is vacant can be used for a variety of energy-related renovation measures. This is a good opportunity to carry out work that is not possible when the apartment is occupied. The measures must be embedded in an overarching renovation concept for the entire building, so that in the long term they lead to a deep renovation.
	Purchase single apartment, EPC for one apartment only	Old owner of the apartment, property management	New owner of the apartment	Installing interior insulation on the exterior walls of the apartment if insulation of the entire building from the outside is not planned. Replacing the windows in the apartment.
	Rent single apartment, EPC for the whole building	Owner, property management	Owner, tenant	Installation of an energy-efficient heating system in the apartment if a central heat supply for the entire building is not planned. Installation of an energy-efficient hot water system in the apartment if a central hot water supply for the entire building is not planned.
	Rent single apartment, EPC for one apartment only	Owner, property management	Owner, tenant	Installation of an apartment ventilation system with heat recovery if a central building ventilation system is not planned. Installation of an apartment cooling system if a central building cooling system is not planned. Installation of apartment PV modules if façade /balcony / roof is suited.

Table 14: Text blocks for the iBRoad2EPC to utilise vacancies in single apartments in multi-family houses

Building type	Member State	Date	Legal Obligation
Single-family house	All Member States	01.01.2030	All residential buildings have to comply with at least efficiency class F
	All Member States	01.01.2033	All residential buildings have to comply with at least efficiency class E
	Germany	01.01.2025	New installed heating systems have to use at least 65% of renewable energies.
Multi-family house	All Member States	01.01.2030	All residential buildings have to comply with at least efficiency class F
	All Member States	01.01.2033	All residential buildings have to comply with at least efficiency class E
	Germany	01.01.2025	New installed heating systems have to use at least 65% of renewable energies.
Buildings owned by public bodies	All Member States	01.01.2027	All buildings owned by public bodies have to comply with at least efficiency class F
	All Member States	01.01.2030	All buildings owned by public bodies have to comply with at least efficiency class E

Table 15: Text blocks for the iBRoad2EPC for legal obligation

Building type	Recommendations addressed to		Text blocks / Welcome, introduction
Single-family house	Owner	Welcome	Welcome to your iBRoad2EPC The shows which measures can make your building climate neutral in the future and how you can avoid costly mistakes in the process.
	Owner	Disclaimer	Your iBRoad2EPC does not substitute detailed planning. Here you can ask for a comprehensive energy audit: www.local-energy-agency.eu
	Owner	Next steps	We recommend that you engage a professional building planner before starting the renovations. If you need help with this, you can first contact the local advisory service: www.local-energy-agency.eu . Here you can also get information about funding
	New owner	Vacancy	The time when a building is vacant can be used for a variety of energy-related renovation measures. This is a good opportunity to carry out work that is not possible when the building is occupied.
Multi-family house	Building owner, property manager	Welcome	Welcome to your iBRoad2EPC The iBRoad2EPC shows which measures can make your building climate neutral in the future and how you can avoid costly mistakes in the process.

	Building owner, property manager	Disclaimer	An iBRoad2EPC does not substitute detailed planning. Here you can ask for a comprehensive energy audit: www.local-energy-agency.eu
	Building owner, property manager	Next steps	We recommend that you engage a professional building planner before starting the renovations. You can contact the local advisory service (www.local-energy-agency.eu) for information about funding.
	(new) building owner, property manager	Vacancy	The time when a building or apartment is vacant can be used for a variety of energy-related renovation measures. This is a good opportunity to carry out work that is not possible when the building or apartment is occupied.
	New apartment owner	Vacancy	The time when an apartment is vacant can be used for a variety of energy-related renovation measures. This is a good opportunity to carry out work that is not possible when the apartment is occupied.
Buildings owned by public bodies	Property management	Welcome	Welcome to your iBRoad2EPC The iBRoad2EPC shows which measures can make the building climate neutral in the future and gives an overview of the process.
	Property management	Disclaimer	An iBRoad2EPC does not substitute detailed planning. Here you can ask for a comprehensive energy audit: www.local-energy-agency.eu
	Property management	Next steps	The building management department should prepare a concrete roadmap for future renovation steps in this building based on this iBRoad2EPC.
	Property management	Vacancies	The time when a building or a part of a building is vacant can be used for a variety of energy-related renovation measures. This is a good opportunity to carry out work that is not possible when the building is occupied.

Table 16: Standard text blocks that are not related to the content but depend on the end-user the recommendations are addressed to.

ANNEX 5 – DRAFT FORM FOR THE IBROAD2EPC FOR SINGLE-FAMILY, MULTI-FAMILY AND PUBLIC BUILDINGS

The following texts and illustrations are quotations from the report "technical report on the definition of the proposed concept, content and methodology of iBRoad2EPC". Among other things, the report presents the graphical design of iBRoad2EPC and describes the criteria for its development. The present report develops the basis for the coverage of several building types (single-family houses, multi-family houses and public buildings). The "technical report on the definition of the proposed concept, content and methodology of iBRoad2EPC" was developed later in the project and builds on the findings of the present report. Although the graphic design of iBRoad2EPC was not yet available at the time of this report, the corresponding layout documents have been included later in the present report. They represent design templates for iBRoad2EPC which - together with the specific text blocks developed in this report - can flexibly cover all building types.

Quotations from the report "technical report on the definition of the proposed concept, content and methodology of iBRoad2EPC"

Central Graphic

iBRoad2EPC uses a central graphic that explains to the building owners at a glance what is being renovated and when. It has a modular structure and shows the most important results and facts at a glance.

The central graphic has a modular structure and can be adapted for all iBRoad tools and media.

The graphic should be easy to understand and appealing to the eye. It summarises the current building state, all renovation steps and renovation measures.

A pictogram of a house shows renovation measures on the building envelop step by step. It symbolises all building types, such as single- and multi-family houses, residential and non-residential buildings. The house icon shows the main building components which are present in every building: floor, exterior wall, windows and doors, and roof. Icons symbolise measures on the technical building equipment. By default, measures on the heating, cooling, DHW and ventilation technology are shown. However, implementing countries can choose to display other technologies. Renovations of building components are shown by the respective symbol changing colour (see **Error! Reference source not found.**).

Arrows containing text clarify when the steps are to take place and which measures they contain. The steps are shown in chronological order. Components that are to be renovated in the respective step are visually highlighted.

The central graphic only distinguishes whether a building component has been refurbished or not, but not the energy quality of the renovation. In iBRoad2EPC, the energy quality of all renovation measures is derived from the long-term renovation strategy (LTRS) of the respective country. This means that all recommended renovation measures are in line with the climate targets. However, the iBRoad2EPC does not consider whether the proposed energy qualities can be technically realised in the respective building. Such individually coordinated renovation recommendations require a significantly higher planning effort than envisaged for the iBRoad2EPC, which is intended to be a "light version" of the Building Renovation Passport (BRP). Building owners who want such individual recommendations can request a complete BRP such as the iBRoad Renovation Roadmap. iBRoad2EPC takes up the common colour scheme of efficiency depictions, which runs from red to green. Since iBRoad2EPC only recommends measures that are in line with the targets, all renovations are always displayed in green. The renovation measures accumulate with each step. The house symbol and the icons therefore become greener and greener as time progresses.

In general, the efficiency class of the whole building is shown only for the current and target state. The efficiency class for the current state is taken from the energy performance certificate, for the target state it is taken from the Long Term Renovation Strategy (LTRS). Therefore, no additional building calculations are required for the iBRoad2EPC.

In the central graphic, only the most important information is shown as an overview. Thus, it remains clear and does not intimidate building owners with too much technical data (see Figure 26). The technical details for each renovation measure are shown on a separate detail page for each renovation step (Figure 27).

The layouts shown below are designed in a first step for the print area/DIN A4 and will be adapted for other media in the next step (see chapter “**Error! Reference source not found.**”) because the layout of the print version is more demanding and less flexible than the online version.

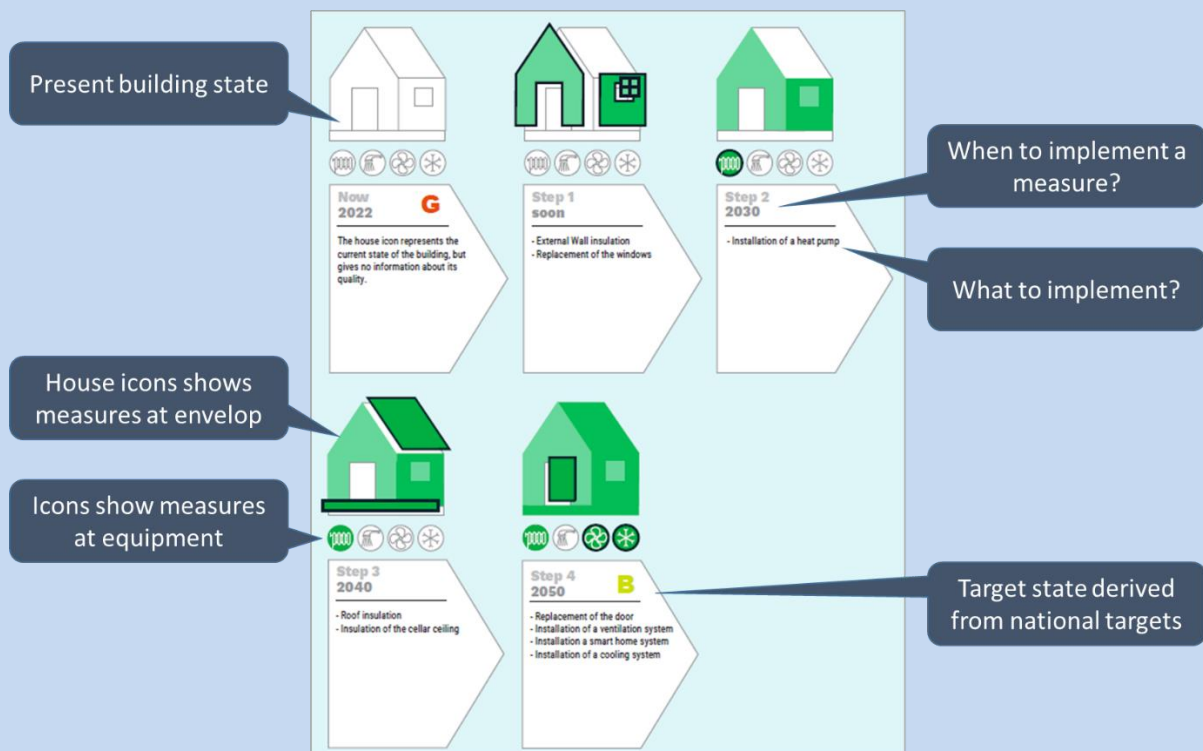


Figure 26: Central graphic, graphic implementation of the content in an overview page

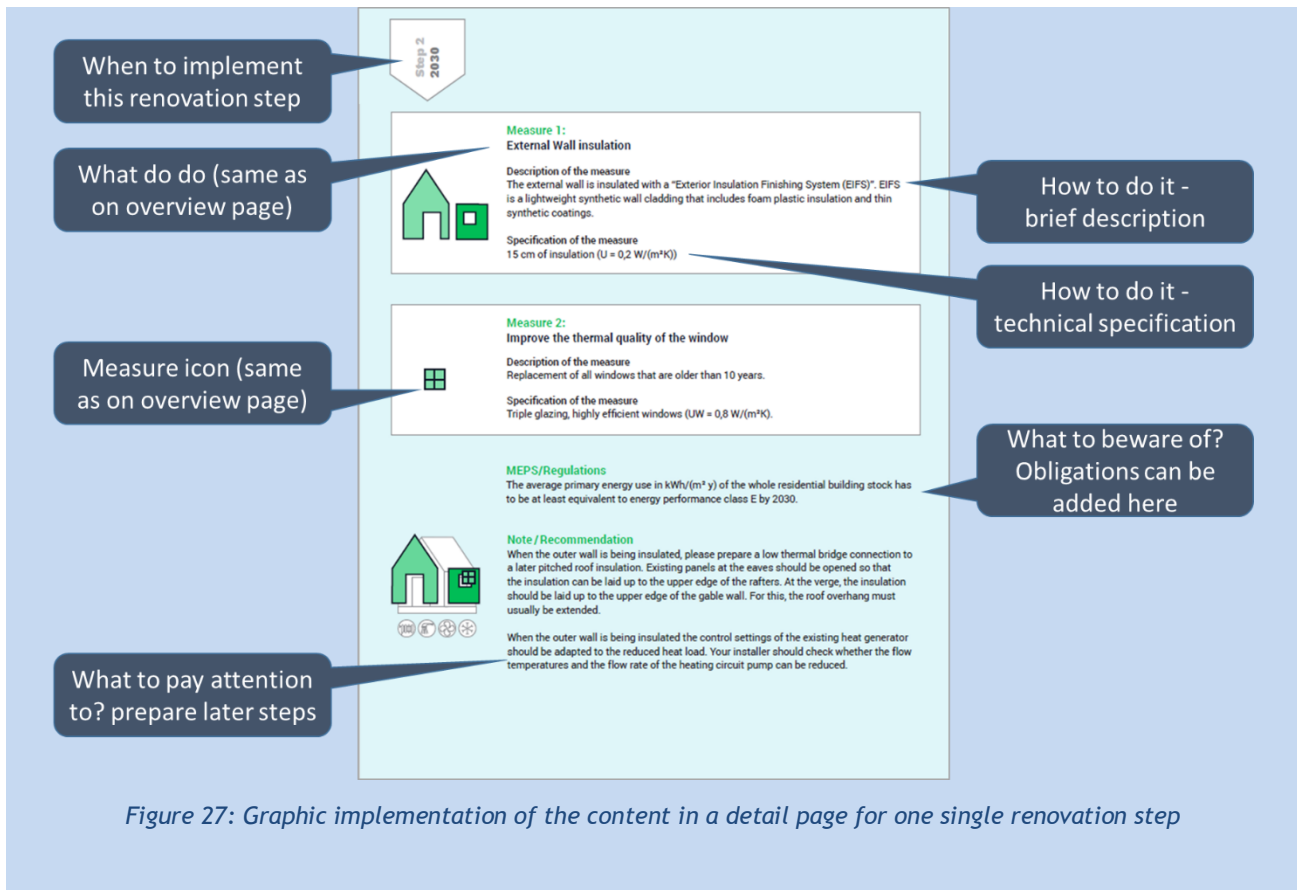


Figure 27: Graphic implementation of the content in a detail page for one single renovation step

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Detail Pages

All renovation steps are shown in an overview on the central graphic. A detail page is shown for each renovation step. All relevant information for the respective step is shown here. As described in Chapter "Error! Reference source not found.", the following questions are answered:

- What and when should be renovated?
The name of the measures and the time period are taken from the central graphic.
- How should the renovation be carried out?
For each recommended measure, the target execution quality is specified. For insulation measures, this is in particular the insulation thickness or the U-value.
- What to beware of?
If there are certain obligations to be met by the date of the step, they will be shown in the detail page.
- What to pay attention to?
For each renovation step, measures are recommended that can be used to prepare future renovation steps. In this way, deep renovation can also be achieved in several steps.

The renovation plan consists of several renovation steps. They mark certain occasions when construction work is carried out in the building. One renovation step can comprise several renovation measures. Measures refer to the renovation or renewal of one specific building component, e. g. the roof, the heating system or the windows.





Measure 1:
External Wall insulation

Description of the measure
The external wall is insulated with a "Exterior Insulation Finishing System (EIFS)". EIFS is a lightweight synthetic wall cladding that includes foam plastic insulation and thin synthetic coatings.

Specification of the measure
15 cm of insulation ($U = 0,2 \text{ W}/(\text{m}^2\text{K})$)



Measure 2:
Improve the thermal quality of the window

Description of the measure
Replacement of all windows that are older than 10 years.

Specification of the measure
Triple glazing, highly efficient windows ($UW = 0,8 \text{ W}/(\text{m}^2\text{K})$).

MEPS/Regulations
The average primary energy use in $\text{kWh}/(\text{m}^2 \text{ y})$ of the whole residential building stock has to be at least equivalent to energy performance class E by 2030.



Note / Recommendation

When the outer wall is being insulated, please prepare a low thermal bridge connection to a later pitched roof insulation. Existing panels at the eaves should be opened so that the insulation can be laid up to the upper edge of the rafters. At the verge, the insulation should be laid up to the upper edge of the gable wall. For this, the roof overhang must usually be extended.

When the outer wall is being insulated the control settings of the existing heat generator should be adapted to the reduced heat load. Your installer should check whether the flow temperatures and the flow rate of the heating circuit pump can be reduced.

Figure 28: Detail page (example for Step 2), Basic Layout

Frame

The graphical content presented above is embedded in a framework document. This frame is the basis for all pages of the iBRoad2EPC and also for the online version. It contains basic information and a navigation system through the iBRoad2EPC document. The design of the iBRoad2EPC should express quality and value, reflecting the official nature of the document. The aim is to convey to building owners that this is a trustworthy, product-neutral and value-based consultation.

The header of the document contains the logo, address data, page number and date. The header colour dark blue signals the high-quality and official character of the document. On the right side of the document, there is a tab that shows which module you are in. This is built like a register in different colours. The basic

module shows the renovation strategy and is displayed in a blue register tab. The number of register tabs depends on how many additional modules are implemented in an MS.

In addition, below the current module, the other modules contained in the document are indicated by coloured bars. Additional information can be shown in the footer, such as a disclaimer.

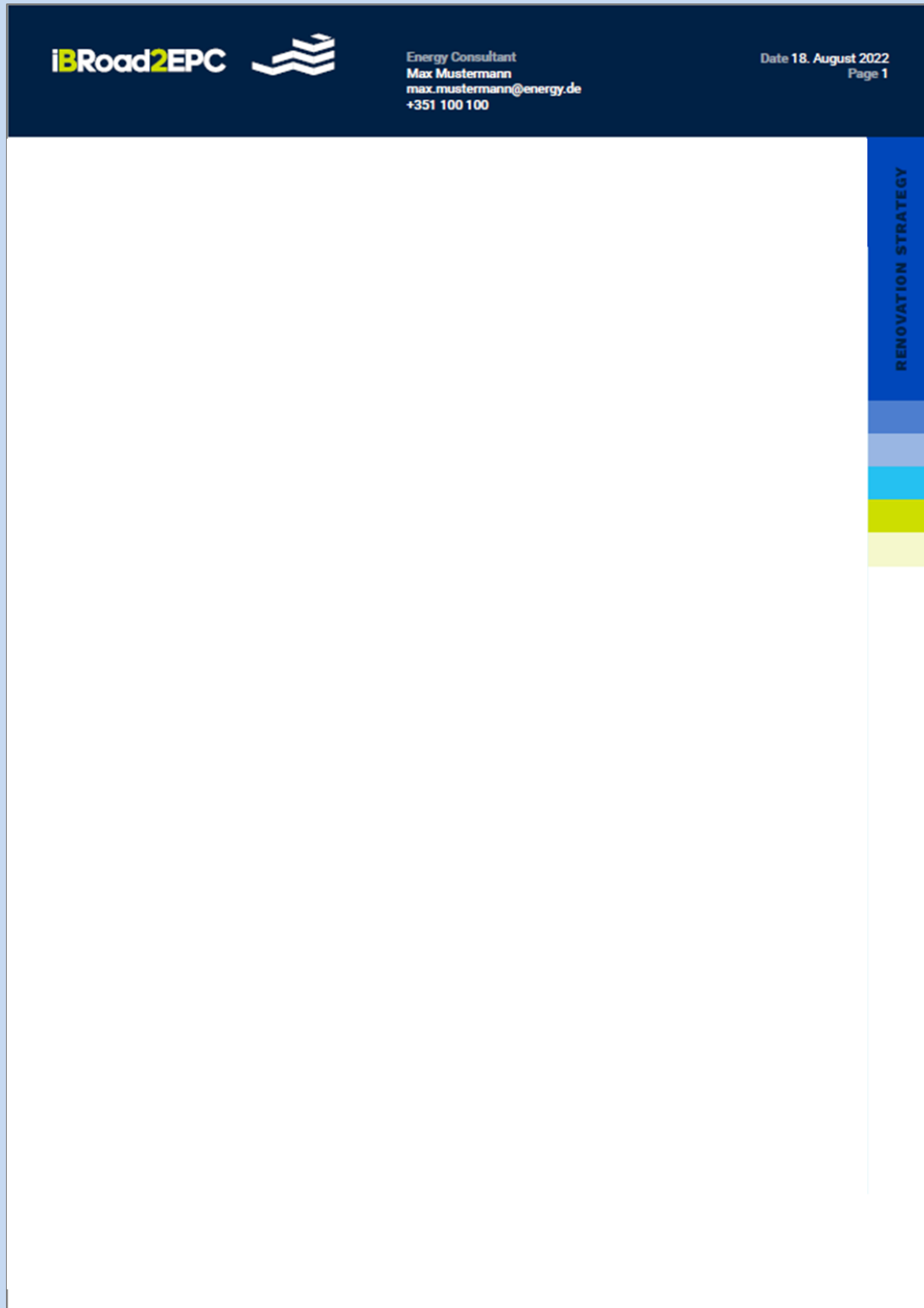


Figure 29: Document frame, basic Layout

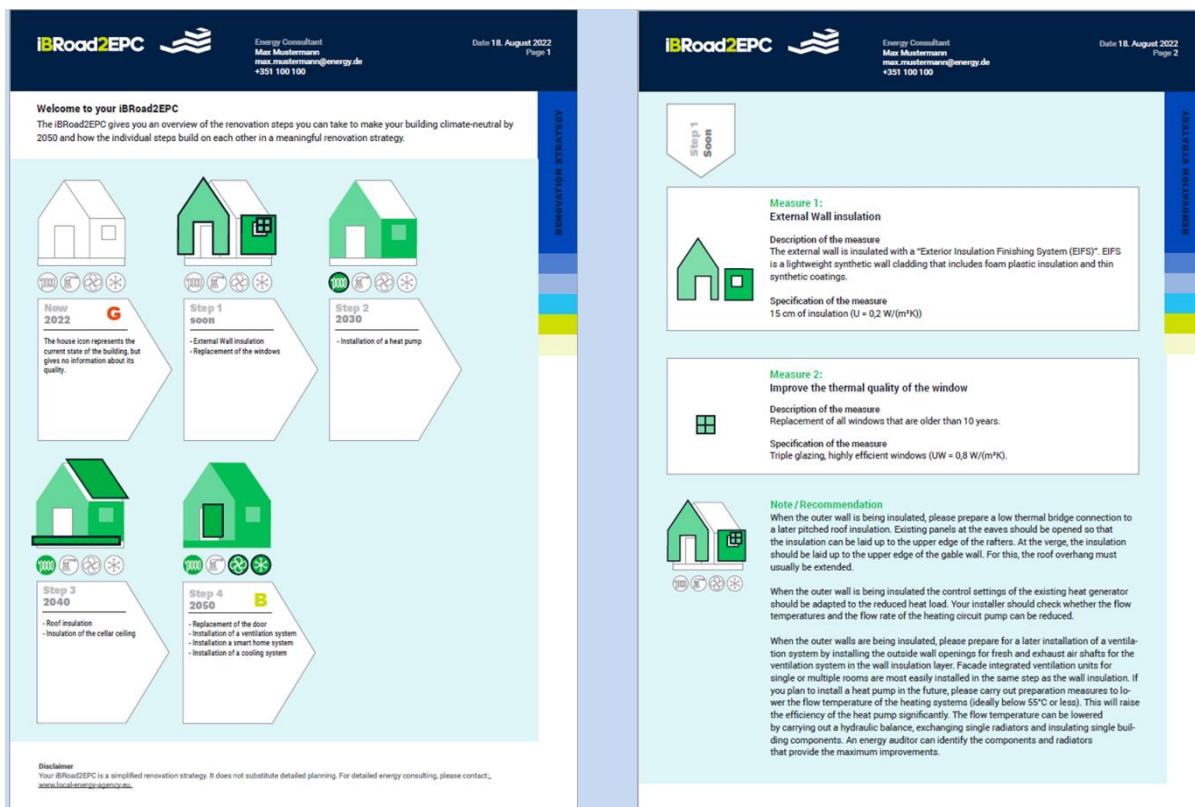


Figure 30: Document frame with central graphic and detail page inserted

Online Version

In addition to the print version of iBRoad2EPC, there is an online version that makes iBRoad2EPC an attractive digital experience. The online version allows for additional functions, such as mouse-over texts and links to further information. It enables easy and intuitive navigation through the document. iBRoad2EPC will be implemented as a responsive website and will therefore adapt to all common screen sizes. The online version consists of the same elements as the print version. The following images show the online version of the central graphic and a detail page. Explanatory texts can be displayed on request ("About the iBRoad2EPC"). Users can navigate to other pages in several ways. They can use the navigation menu, which can be pulled out in the upper right corner. They can also click on a renovation step to go to the corresponding detail page.

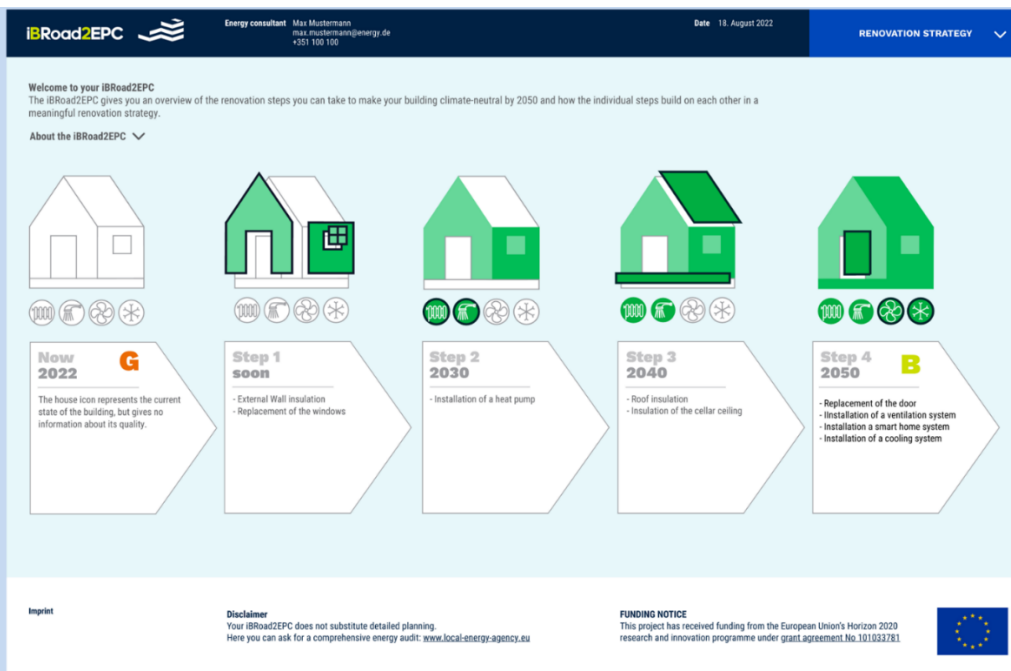


Figure 31: Online version of iBRoad2EPC: central graphic

Measure 1 External wall insulation

Description of the measure
The external wall is insulated with a "Exterior Insulation Finishing System (EIFS)". EIFS is a lightweight synthetic wall cladding that includes foam plastic insulation and thin synthetic coatings.

Specification of the measure
15 cm of insulation ($U = 0,2 \text{ W/(m}^2\text{K)}$)

Measure 2 Replacement of the windows

Description of the measure
Replacement of all windows that are older than 10 years.

Specification of the measure
Triple glazing, highly efficient windows ($UW = 0,8 \text{ W/(m}^2\text{K)}$)

MEPS/Regulations
By 1 January 2024, every newly installed heating system is to be based on 65 percent renewable energies

Note/Recommendation
When the outer wall is being insulated, please prepare a low thermal bridge connection to a later pitched roof insulation. Existing panels at the eaves should be opened so that the insulation can be laid up to the upper edge of the rafters. At the verge, the insulation should be laid up to the upper edge of the gable wall. For this, the roof overhang must usually be extended. When the outer wall is being insulated the control settings of the existing heat generator should be adapted to the reduced heat load. Your installer should check whether the flow temperatures and the flow rate of the heating circuit pump can be reduced.

When the outer walls are being insulated, please prepare for a later installation of a ventilation system by installing the outside wall openings for fresh and exhaust air shafts for the ventilation system in the wall insulation layer. Facade integrated ventilation units for single or multiple rooms are most easily installed in the same step as the wall insulation.

If you plan to install a heat pump in the future, please carry out preparation measures to lower the flow temperature of the heating systems (ideally below 55°C or less). This will raise the efficiency of the heat pump significantly. The flow temperature can be lowered by carrying out a hydraulic balance, exchanging single radiators and insulating single building components. An energy auditor can identify the components and radiators that provide the maximum improvements.

Figure 32: Online version of iBRoad2EPC: detail page

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iBRoad2EPC

www.ibroad2epc.eu



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