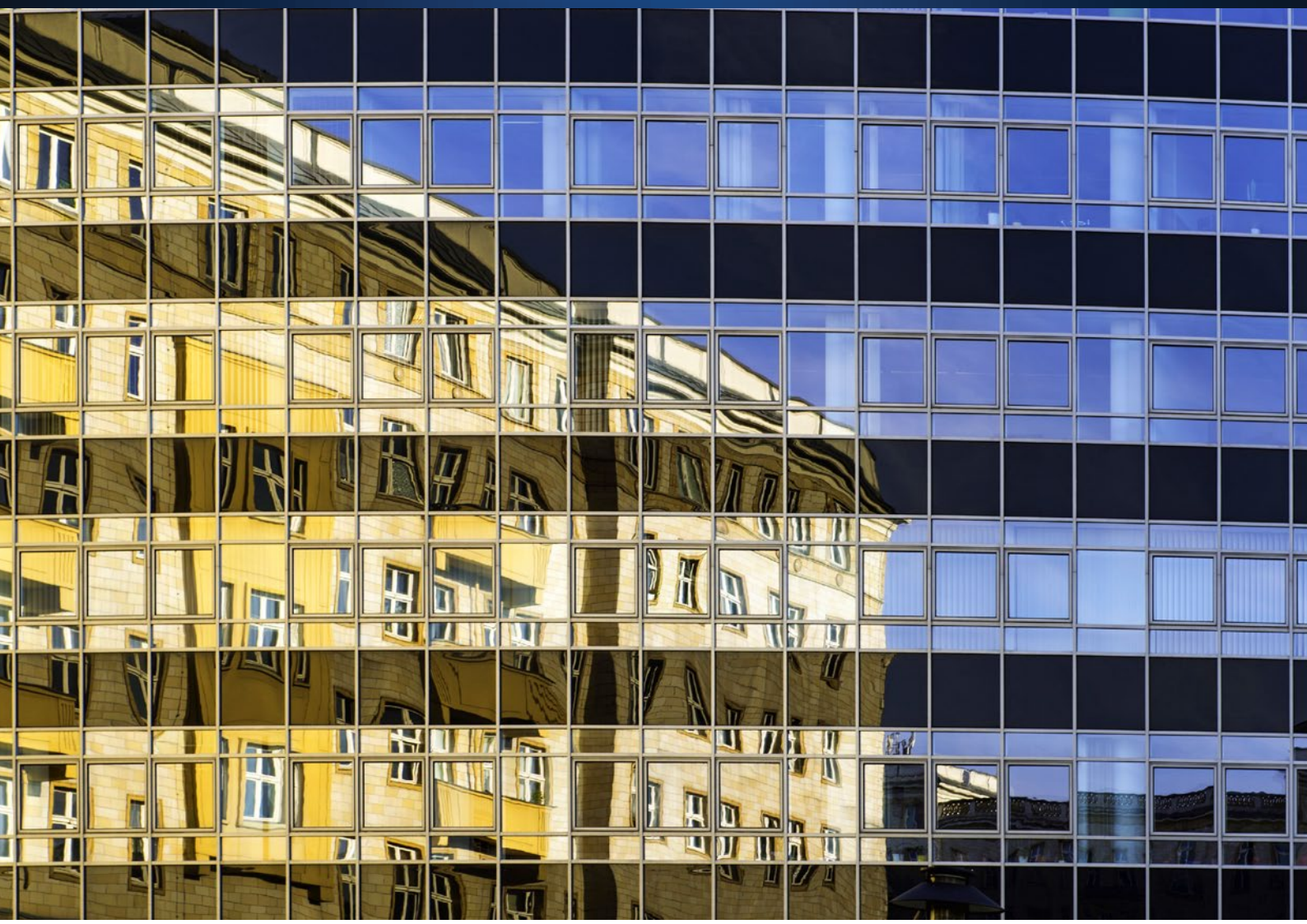
iBRoad

Individual Building
Renovation Roadmaps



Beyond the single-family house

Potential extension of iBRoad to other building types

ifeu – Institute for Energy and Environmental Research

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EXECUTIVE SUMMARY

This report investigates the potential extension of iBRoad to different building types. It shows how iBRoad methods can be useful for deep stepwise renovation in multi-family and non-residential buildings and describes how the iBRoad renovation roadmap and logbook, which were initially targeting single-family home owners, can be adapted to meet the requirements of other target groups. The report also examines available political and funding instruments for non-residential and multi-family buildings, as well as existing energy consulting programmes in Poland, Bulgaria, Portugal and Germany. In addition, existing European renovation roadmaps or logbooks are examined. This demonstrates if the replication of the iBRoad tools to other building typologies can be supported and what adjustments are necessary.

An analysis of the share and characteristics of various market segments of the building stock in European countries, and specifically in the iBRoad pilot countries, resulted in the identification of four building typologies to be further investigated:

- Category 1: Residential buildings (single and multi-family houses), rented by single owner;
- Category 2: Multi-family houses, mixed tenure status (owner occupied and privately rented);
- Category 3: Non-residential buildings commercially used;
- Category 4: Public non-residential buildings.

Each category involves different actors and needs. While the five guiding principles of the iBRoad Renovation Roadmap (best-possible-principle, individual renovation context, long-term perspective, timing and sequencing, attractive and motivating) must be applied to all categories, there are specific adjustments to be made to the iBRoad roadmap to make it fit for use for other building typologies. In particular:

- The format of the roadmap should allow for flexible adaptation to the possibly complex requirements of non-residential buildings. E.g., it could be designed as an outline instead of a template. This would allow auditors to better respond to different technical and legal requirements. However, minimum format and structure requirements should be observed, e.g., a standardised audit structure and a standardised overview page.
- Additional standard recommendation text blocks must be added.
- Non-energy benefits, which motivate decision makers to undertake renovations, should be adapted to each individual category.
- The roadmap should outline current and, where appropriate, future energy-related legal requirements and show how they can be met.
- A separate page is needed to describe economic and financial aspects.
- The roadmap can be adapted to fit building portfolios if required.
- A much greater depth of technical information cannot be specified in a standardised way. Auditors have to tailor the roadmap to each specific customer and building.
- In multi-family and non-residential buildings there may be additional triggers for renovations which the auditors have to take into account.
- Auditors training must be extended or adapted to cover the specific characteristics of multi-family and non-residential buildings.

Individual strengths, weaknesses, opportunities and threats are evaluated for each of the four categories identified above. These strongly depend on the decision-making structures, on the type of building use, and on the relationship between users and those, if different from the users, who take decisions on measures concerning the building (e.g., facility managers). Based on this, central elements of the iBRoad roadmap are specifically considered in a dedicated factsheet for each category, covering: prefabricated recommendations, economic indicators, non-energy benefits, regulatory requirements, financial aspects and trigger points for renovations. The relevance of each element is assessed, and any

necessary specific adjustments are identified. Changes or additional features to the iBRoad logbook are also described. The logbook can be easily adapted to non-residential buildings or multi-family houses. For example, data for non-residential buildings are currently not included in the logbook and should be added.

Overall, the analysis shows that all building types considered in the report would benefit from having a long-term step-by-step renovation plan and logbook. Both the iBRoad roadmap and the iBRoad logbook for single-family houses can be adapted to meet the specific requirements of multi-family homes and non-residential buildings. The analysis of existing policy instruments shows that there is hardly any instrument that supports stepwise renovation plans for the non-residential and multi-family market. For iBRoad to be implemented to multi-family and non-residential buildings in the pilot countries in the future, policy instruments would ideally have to be rearranged to specifically support step-wise renovations for these types of buildings.

I. INTRODUCTION

The building sector accounts for approximately 40 % of total energy consumption and 36 % of CO_2 emissions in the European Union. Currently, almost 75 % of the European building stock is not energy efficient, while the building renovation rate is very low[1].

Deep building renovation has the potential to lead to significant energy savings and lower CO_2 emissions and contribute to the energy and climate objectives at national and European level.

The iBRoad project funded by the Horizon 2020 European programme aims at overcoming and eliminating barriers to deep renovation and at the same time avoiding the risk of lock-in effects by developing, designing and demonstrating the concept of an individual Building Renovation Roadmap (iBRoad Plan) for residential buildings, combined with a digital repository of building-related information (iBRoad Logbook). Thus, iBRoad focuses on an evolution of existing energy audit products and Energy Performance Certificates (EPCs) in order to become a real driver for deep renovations.

The iBRoad project focuses on single-family and small multi-family houses only. They represent 48 % of the EU building stock. The share of large multi-family houses in Europe amounts to 27 % and the share of non-residential buildings amounts to 25 %. This report shows how iBRoad products can be adapted to become suitable for these two additional building types. Expanding iBRoad to other building types can substantially reduce carbon emissions.

In contrast to single-family houses, the ownership structure in multi-family houses and non-residential buildings is very heterogeneous. Examples are multi-family houses occupied by different owners, multi-family houses with private owners who rent out individual apartments or publicly owned. Each of these ownership structures is characterised by different needs, decision-making process, requirements and motivations to renovate.

As a consequence, specific motivation and supporting strategies must be followed for each category. For example, while homeowners in single-family houses are more emotionally involved in the decision making process for renovation, decision makers of non-residential buildings can be approached in a more rational way. In this case, the renovation roadmap may be more technically detailed and accurate, because the recipients are usually building or energy experts. When considering the transferability analysis of the iBRoad products to other building types, these and other aspects must be taken into account.

This report is structured as follows: chapters I and II give an introduction and show the objectives of this report. Chapter III presents the structure of the EU building stock, highlighting the characteristics in the pilot countries. Chapter IV gives an overview of existing energy consulting programmes and initiatives in the EU. It demonstrates the relevance of the tools developed by iBRoad in a broader context. Chapter V identifies categories to potentially replicate the iBRoad products. Finally, chapter VI presents more details of the replicability in terms of target groups and content, also applying to the four pilot countries.

[1] EU annual average renovation rate is confirmed at 1%, with deep renovations accounting for only 0.2-0.3% of the renovated floor area (Navigant, Ipsos Belgium, 2019).

II. OBJECTIVES OF THIS REPORT

This report shows the potential extension of iBRoad to different building types. Although the iBRoad project focuses on single-family and small multi-family houses only, qualitative analysis is carried out to extend the developed methods to other building types such as larger multi-family houses or non-residential buildings.

The objective of this report is to show how iBRoad methods can be useful for deep stepwise renovation of existing multi-family and non-residential buildings. The report describes how the iBRoad renovation roadmap and the logbook can be adapted to meet the requirements of different target groups.

Methodology

Identification of general building operation categories taking into account the building types and tenure status. Analysis of strengths, weaknesses, opportunities and threats for each category and composition in a matrix. Qualitative analysis of required content of the roadmaps in detailed factsheets.

III. STRUCTURE OF THE BUILDING STOCK

In order to investigate the iBRoad Renovation Roadmap's potential for replicability to other building types, the European and the pilot countries' building stock must be analysed and specific characteristics that might affect the deployment of a Renovation Roadmap must be identified.

European Building Stock

There are different parameters that can be used to classify a building stock: number of buildings, type of use, type of format, tenure status, building age, etc. This report focuses mainly on the type of use and the tenure status.

Building types and characteristics

Based on type of use, the building stock is divided into residential and non-residential.

Residential buildings are mainly designed for living purpose. Non-residential buildings comprise all other buildings types, i.e. offices, educational buildings, hospitals, wholesale, retail, hotels, restaurants etc.

A study about the European building stock, (Economidou, et al. 2011) estimated 25 billion m² of useful floor space in the EU27, Switzerland and Norway, with a share of 75 % residential and 25 % non-residential buildings (Figure 1:):

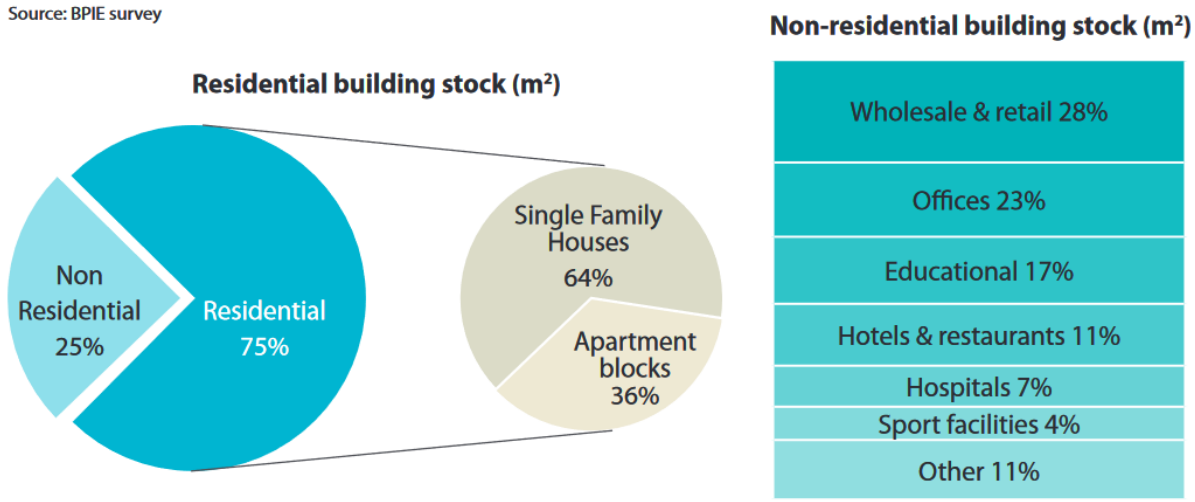


Figure 1: Share of residential and non-residential buildings in the EU27, Switzerland and Norway building stock. (Source: BPIE, 2011)

Recently, the project "Hotmaps" collected and analysed historic building stock data. Figure 2 shows the share of buildings, both residential and non-residential, according to the construction period (before 1945 until after 2010). In both cases, buildings constructed before 1945 represent the highest share – 20 % (residential) and 24 % (non-residential), followed by buildings constructed between 1945-1969 and 1970-1979 when building construction practice did not incorporate energy efficiency standards. Together, buildings constructed before 1979 represent more than 50 % of both residential and non-residential building stock.

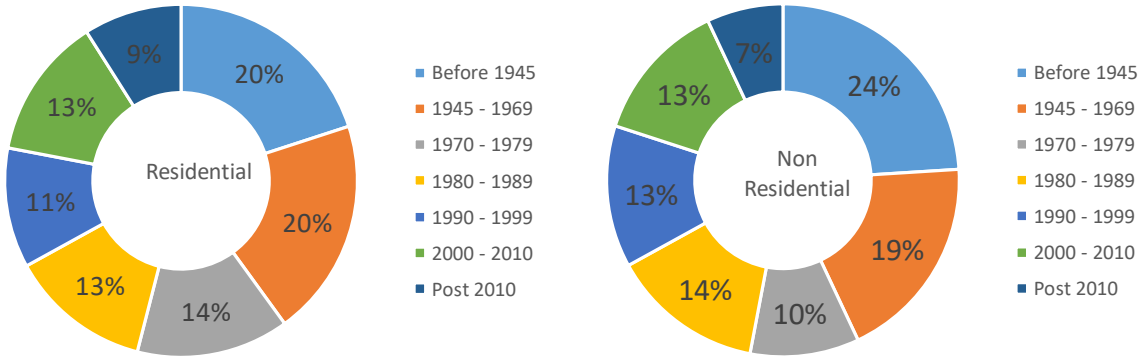


Figure 2: Building stock characterisation per construction period (%, European Union 28). Source: (Pezzutto et al., 2019)

Figure 3 shows that the residential building stock is mainly divided in three building types: single-family houses (68 %), multi-family houses (24 %) and apartment blocks (8 %), while the non-residential building sector is more diversified: offices (45%), trade (21 %), hotels and restaurants (12 %), other non-residential buildings (11 %), education (6 %) and health (5 %).

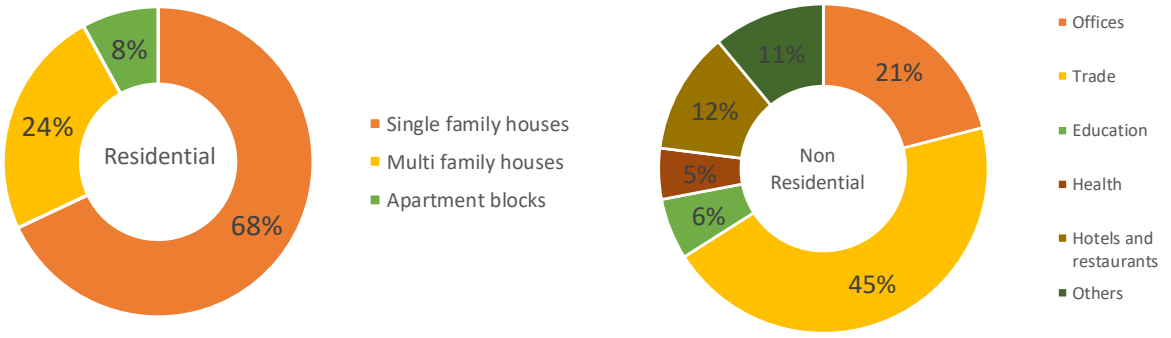


Figure 3: Building stock characterization per building types (%, European Union 28). Source: (Pezzutto et al., 2019)

Figure 4 and Figure 5 present the development of the specific useful energy demand for space heating, domestic hot water and space cooling for both residential and non-residential sectors for the EU-28 countries respectively.

Figure 4 shows that the useful energy demand for space heating and domestic hot water is directly related to the construction period of the building. For residential buildings constructed before 1945, the specific useful energy demand amounts to 200 kWh/m²a, whereas the specific useful energy demand of buildings constructed after 2010 is 80 kWh/m²a. In the non-residential sector this difference is not as significant and varies between 80 kWh/m²a (buildings constructed before 1945) and 50 kWh/m²a (buildings constructed post 2010).

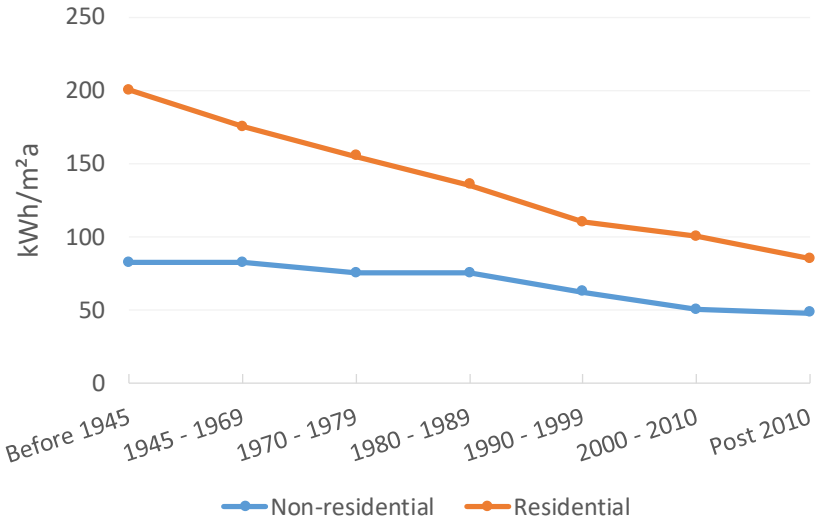


Figure 4: Development of the specific useful energy demand for space heating and domestic hot water in the residential and non-residential sectors (Before 1945 - Post 2010), (kWh/m² a), European Union 28. Source: (Pezzutto et al., 2019)

Figure 5 shows that the useful energy demand for space cooling increased from 30 to 48 kWh/m²a in the period from before 1945 to 1945-1969. In the residential sector, the useful energy demand for space cooling remains quite stable until 2000-2010. In the years 2000-2012, energy demand reached its peak and then decreased again. In the non-residential sector, energy demand reached its peak in the 60s and then decreased steadily.

Even though the useful space cooling demand for both the residential and non-residential sectors is expected to increase in the future, cooling demand currently plays a rather minor role in the residential building sector compared to useful energy demand for space heating and domestic hot water.

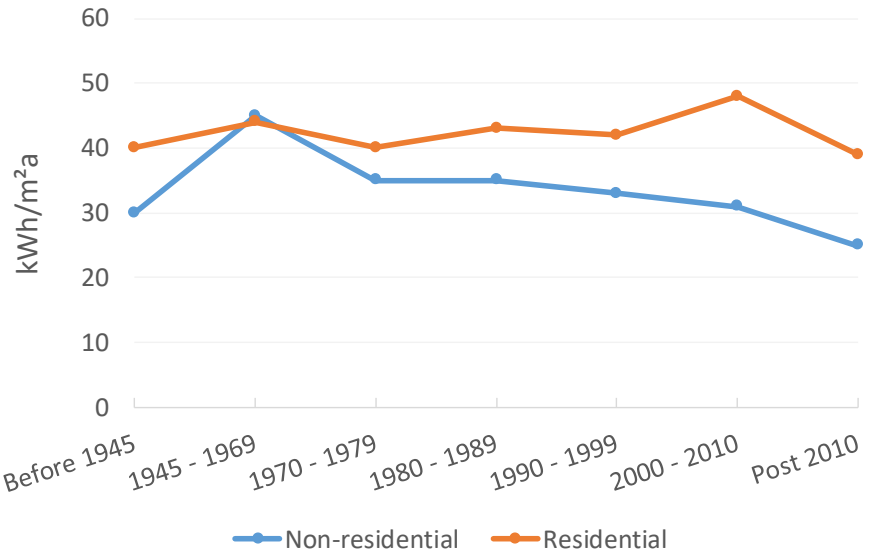


Figure 5: Development of the specific useful energy demand for space cooling in the residential and non-residential sector (Before 1945 - Post 2010), (kWh/m² a), European Union 28. Source: (Pezzutto, et al. 2019)

Tenure status

Parallel to the type and technical characteristics of the buildings, tenure status greatly influences the way deep renovation may be approached. In this context, it is important to define the main types of tenure status of buildings and of players in the decision-making process.

The most frequent forms of tenure status may be summarised into owner occupancy, tenancy and mixed forms of the previous two.

It is also important to make a distinction between decision maker, investor and beneficiary. The decision maker is normally the person who owns a building, or manages a building on behalf of the owner, and therefore has to fulfil specific regulations, expectations or requirements. Investor is the person who invests money in the building or building renovation. Beneficiary is the person who derives the direct benefits of using the building, normally the owner or tenant. In certain cases, the decision maker may also be the investor and/or the beneficiary.

For example, in an owner-occupied single-family house, decision maker, investor and beneficiary may be the same person. The owner, who invests in the renovation, may also be the user who benefits directly from its advantages (e.g. economic, energy and comfort-related, and others).

In a rented apartment, decision maker and beneficiary might not be the same - the building owner might be a private person, private company or public authority (in the case of social housings), whereas the beneficiary is the building occupant, which means the person who uses the building. For example, in offices the direct beneficiary would be the worker, and in residential buildings the tenant.

Below, different tenure statuses for buildings are explained:

- Owner-occupied: that is the only category, where the building user and the building owner are the same party. It might also be a public authority, in the case of non-residential buildings.
- Privately rented: tenants pay rent to landlords at a market price. Landlords (private persons or companies) pursue commercial purposes.
- Socially rented: tenants pay a subsidised rent to landlords, usually public entities or housing associations.

Also, the different building owner types are:

- Private: private persons or companies, for example real estate companies
- Public: public entities or housing associations

Building stock in iBRoad pilot countries

Based on a literature review, this part of the report presents a characterisation of the residential and the non-residential building stocks of the iBRoad project's pilot countries (Bulgaria, Germany, Poland and Portugal) – both by building categories and tenure status.

Building types and characteristics

Residential building sector

Figure 6 shows the distribution of the population by dwelling type in the four pilot countries compared to the EU 28 average, based on data from 2016.

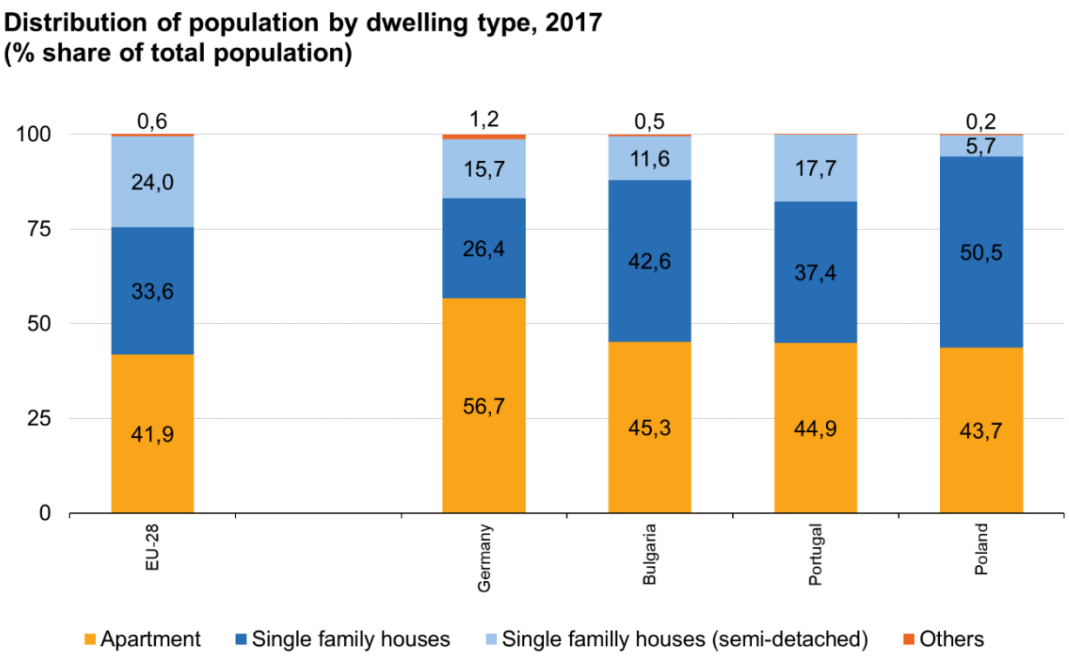


Figure 6: Distribution of population by dwelling type (Source: (Eurostat 2017))

In general, in all four countries most of the population lives in apartments and single-family houses. In Portugal, Bulgaria and Germany, the highest share of the population lives in apartments, respectively 45 %, 45 % and 57 %. Germany is the country with the highest share of population living in apartments. In contrast to the three other countries, in Poland the highest share of the population lives in single-family houses (about 51 %).

Non-residential building sector

Unfortunately, up to date statistical data about the distribution of the non-residential building stock in the pilot countries (Bulgaria, Poland and Portugal) based on building type and tenure status are not available.

The non-residential building stock in Germany on the other hand has been subject of several studies. However, the results vary significantly (see Figure 7).

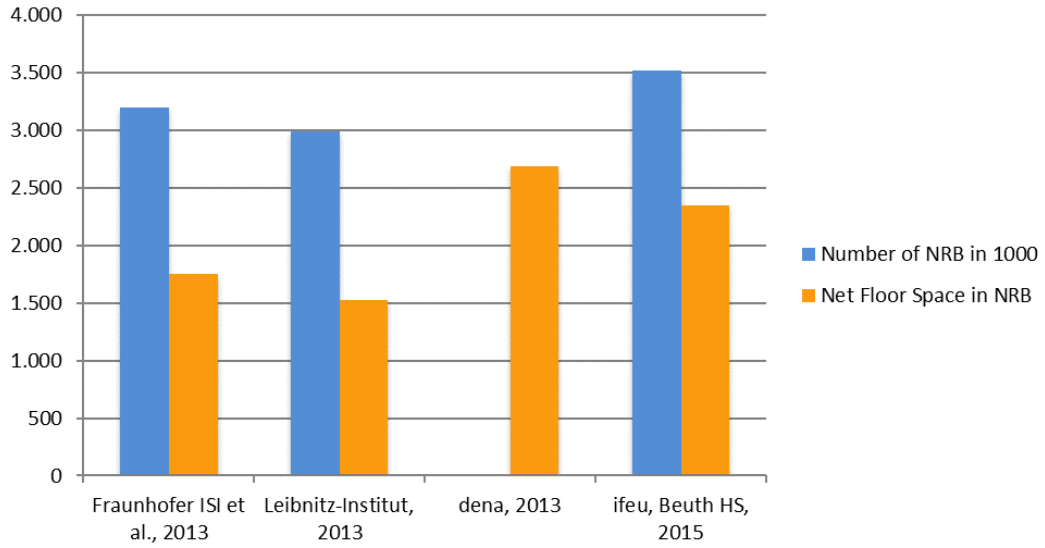


Figure 7: study comparison for the non-residential building stock in Germany (Source: ifeu, Beuth HS, 2015)

Figure 8 shows the distribution of German non-residential buildings into specific building types. As can be seen, office buildings make the largest share of non-residential buildings in Germany. Manufacturing buildings, industrial and construction industry buildings also cover a large proportion, whereas hospitals, education and sports facilities only occupy a small share.

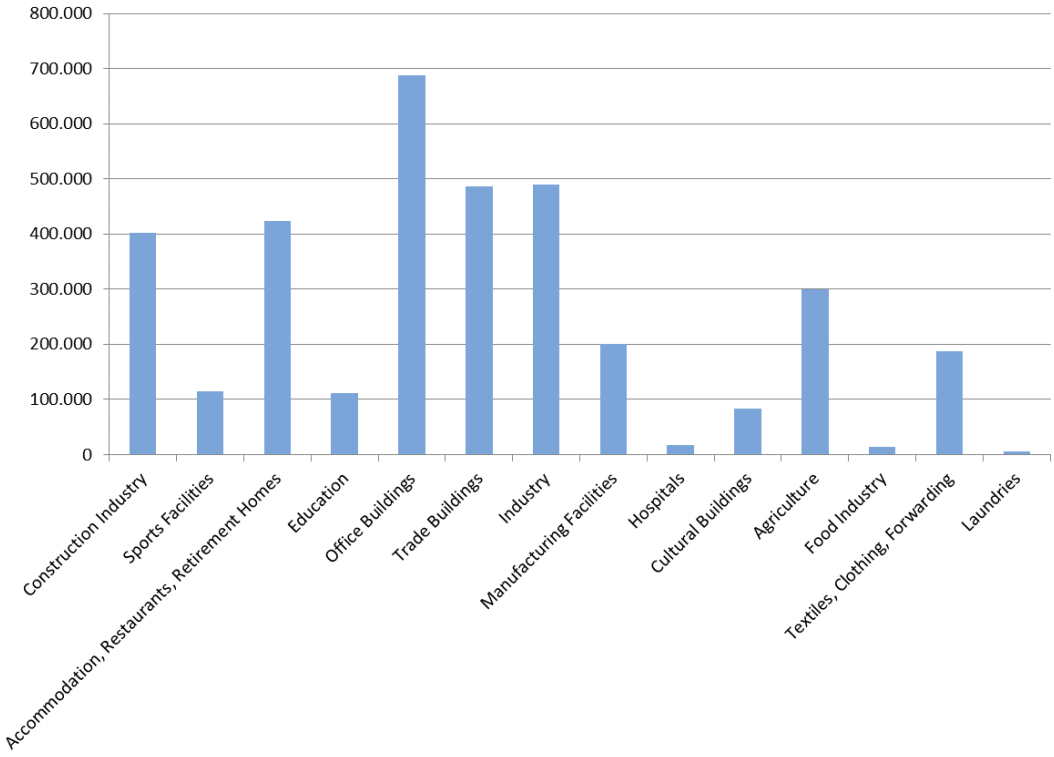


Figure 8: Distribution of non-residential building types in Germany (Source: ifeu, Beuth HS, 2015)

Tenure status

Figure 9 compares the distribution of the population in the four pilot countries by tenure status in residential buildings against the EU 28 average, based on data from 2016. Poland and Bulgaria have high shares of owner-occupied dwellings without outstanding mortgage or housing loan (respectively, 73 % and 80 %), followed by Portugal (approx. 38 %) and Germany (approx. 26 %). In Portugal, a relevant share (37 %) is also owner-occupied with outstanding mortgage or housing loan. In Germany, in contrast to the other countries, the highest share of dwellings (40 %) is tenant-occupied, rented at a market price.

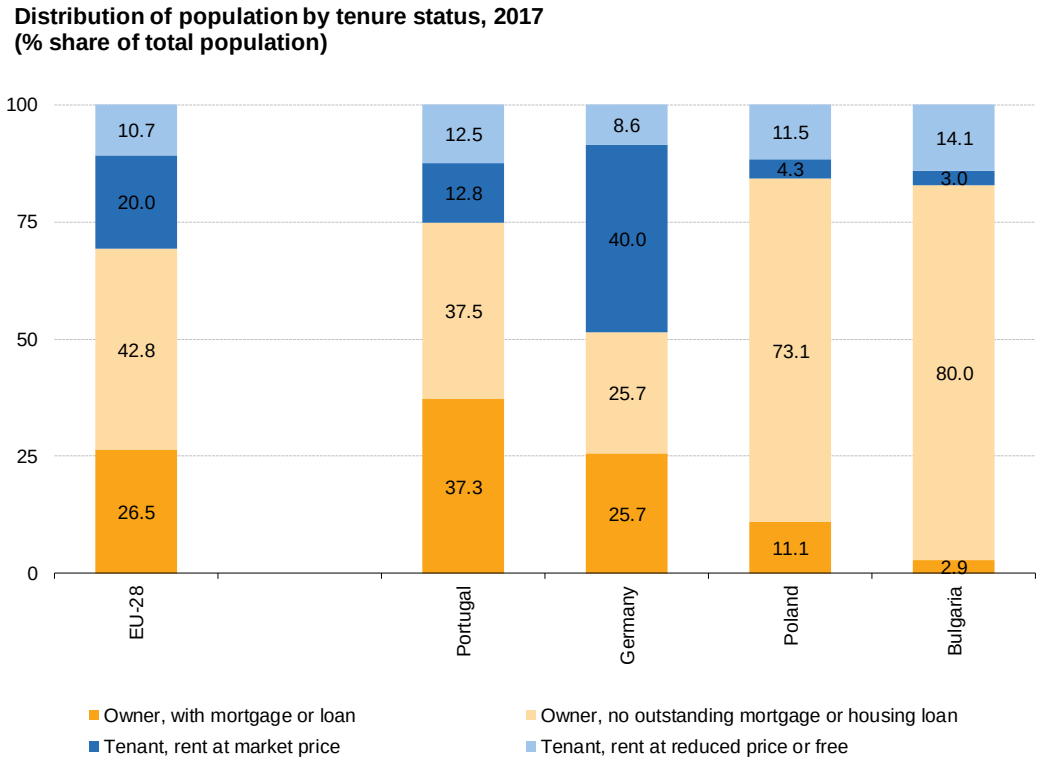


Figure 9: Distribution of population by tenure status. (Source: Eurostat, 2017)

Conclusion

The overview above shows that besides owner occupied single-family houses – which are the target group of the iBRoad project – there are other market segments to be targeted by an individual building renovation roadmap, in particular:

1) Rented residential buildings (single-family houses or multi-family house) owned by one single owner. This owner can be a private person, a private company or a public authority.
2) Multi-family houses mixed status, which means, that some units are owner occupied while other are rented.
3) Non-residential buildings commercially rented (by private companies or public authorities)
4) Non-residential buildings occupied by a publicly owner

To assess the Roadmap's feasibility, other aspects, like the tenant-owner relation or decision maker's interests must be considered.

The decision makers are the most important target group to be addressed, followed by the investors and the beneficiaries of the investment. In rented buildings, the beneficiary and the decision maker are not the same and in non-residential buildings a distinction between commercially rented and owner occupied must be made.

In order to better understand the feasibility and the potentials to replicate iBRoad to the identified market segments, chapter IV identifies supportive instruments for energy consulting in non-residential and multi-family houses.

IV. EXISTING POLICY INSTRUMENTS FOR NON-RESIDENTIAL AND MULTI-FAMILY HOUSES

The European Union has set itself ambitious climate protection targets. The key targets for 2030 are:

- At least 40% cuts in greenhouse gas emissions (from 1990 levels)
- At least 32% share for renewable energy
- At least 32.5% improvement in energy efficiency

Significant efforts must be made in all sectors in order to achieve these.

For buildings, it means in particular increasing the rate of renovation and encouraging the replacement of fossil fuel heating systems.

Unlike single-family houses, the ownership structure of multi-family houses and non-residential buildings is heterogeneous. The incentives for renovation are different. Existing programmes and subsidies can motivate owners of multi-family houses and non-residential buildings to carry out renovations.

For the iBRoad method to be efficiently adapted to non-residential and multi-family buildings, supporting instruments must be in place in each relevant market. A quick review of political and funding instruments available for non-residential and multi-family buildings, as well as existing energy consulting programmes in Poland, Bulgaria, Portugal and Germany is given in the chapter below. In addition, existing European renovation roadmaps or logbooks are examined. This will determine how the replication of the iBRoad tools to other building typologies can be supported and what adjustments are necessary. The integration of the iBRoad tools in existing policy instruments can increase the motivation for renovations, lead to the realisation of more and deeper renovations, and thus to the achievement of climate protection goals.

Financial support for multi-family and non-residential buildings

Project partners in the pilot countries were asked about existing policy instruments that include financial support for non-residential renovation measures. In none of the pilot countries there is specific support for step-by-step deep renovation.

The programmes which would be suitable to be linked to the iBRoad Renovation Roadmap and Logbook are described below. Special adjustments would have to be made to apply to non-residential buildings and multi-family houses. Primarily, the programmes should promote step-by-step renovation regardless of the use of the building.

Thermo-modernisation and Repairs Fund – Poland

The Thermo-modernisation and Repairs Fund is a renovation programme managed by the Bank "Gospodarstwa Krajowego" (BGK), providing renovation loans. The loans are awarded by banks that have signed a co-operation agreement with BGK.

Beneficiaries are owners of multi-family houses, owners and administrators of all other housing facilities and local governments. Three different bonuses may be obtained in addition to the loan: thermo-modernisation bonus; repairs bonus; and compensational bonus. The loan is issued e.g. if the energy audit shows that the building will reduce the annual energy demand (by at least 10 % depending on the age of the building and the state of renovation) or change the energy source to renewable energies or cogeneration. The amount of the thermo-modernisation bonus is 20 % of the loan (BUILD UP 2013).

The BGK programme supports multi-family houses and non-residential buildings, even though it does not promote step-by-step renovation. Nevertheless, it would be suitable to promote energy audits and renovation roadmaps. Since the roadmap usually suggests a step-by-step renovation, the bank could build a long-term relationship with its customers and grant them several loans overtime.

Regional Operational Programme and Programme Infrastructure and Environment - Poland

The Regional Operational Programme and the Programme Infrastructure and Environment are detailed planes planning documents which define the tasks which the regional administration will perform for the purpose of development.

The main sectors supported under the programme are: low carbon economy, environmental protection, climate change mitigation and adaptation, transport and energy security as well as healthcare and cultural heritage (European Commission 2014). There are three sources of financing for the Infrastructure and Environment Programme:

- European Regional Development Fund,
- Cohesion Fund,
- National funds.

Any potential future expansion or application as well as their objectives, being the long-term reduction of carbon emissions on the one hand and the maximisation of the additional benefits that arise during a renovation on the other, would greatly benefit from a link to the iBRoad tools.

IFRRU 2020 (Financial Instrument for Urban Regeneration and Revitalisation) – Portugal

This financial instrument aims to support investments in urban rehabilitation and energy efficiency, covering the entire Portuguese territory. To boost investment, IFRRU 2020 brings together various sources of financing. These include European funds of PORTUGAL 2020, as well as funds from other entities such as the European Investment Bank and the Development Bank of the Council of Europe, in combination with funds from commercial banks. A simple process, with one single application, was introduced to increase the number of submissions. The EPC plays a relevant role in this scheme, since it is used to identify the actual and future building performance and the cost and type of financed energy efficiency improvement measures. Thus, it leads to a better understanding of the impact of different measures (IFRRU2020 2019).

The focus of IFRRU 2020 is on residential buildings (including multi-family house), although it does not exclude non-residential. The initial available budget is 1.400 million euros. The programme does not specifically promote step-by-step renovation and energy consulting.

Although the iBRoad tools do not particularly fit into the current IFRRU 2020 specifications, the programme has the potential to be adapted to cater for a relevant win-win collaboration with iBRoad.

Existing political instruments for non-residential buildings or multi-family houses – Bulgaria

There is currently no funding programme running in Bulgaria that supports the renovation of non-residential buildings or multi-family houses. Private non-residential buildings are obliged to have an energy audit, but there are no financial or other schemes to encourage them to renovate the building. In addition, there are no penalties for neglecting to have an energy audit, and many of the owners are likely to not have one. Public owners of non-residential buildings usually resort to grant schemes in the framework of the operational Programmes, National Trust Eco-Fund, EEA financial mechanisms, etc. They have the same obligations as energy audits and a comparatively higher level of compliance – mostly due to the requirements for participation in grant schemes.

Conclusion

The analysis of existing policy instruments shows that there is hardly any instrument that supports stepwise renovation plans for the non-residential and multi-family market. This is partly due to the fact that the multi-family and non-residential building sector is very heterogeneous - not only in the nature of the building types, but also in the nature of the tenure structures.

In the case of non-residential buildings or multi-family houses, most programmes only support partial renovation (e.g. thermo-modernisation). The iBRoad products do not fit into any of the presented funding programmes. The Programme Infrastructure and Environment in Poland may provide financial support for the iBRoad tools because the top priority of the programme is climate protection. It covers the whole building stock and reduction of energy consumption in the building sector in general.

If iBRoad should be implemented to multi-family and non-residential buildings in the pilot countries in the future, policy instruments would ideally have to be rearranged to specifically support step-wise renovations for these types of buildings.

In Germany, the Individual Renovation Roadmap was introduced as early as 2017. The Federal Government promotes energy consulting for residential buildings. In this context, the energy consulting service must provide a long-term renovation concept that allows the buildings to be comprehensively renovated in a stepwise manner over a longer period of time through coordinated measures while the primary energy consumption is being reduced as much as possible. The entire energy consulting service can be supported in this process. The subsidy programme favours energy advice and encourages the use of the individual renovation roadmap, offering an incentive to use it.

Just like the funding of the individual renovation roadmap in Germany, similar offers can also be created for the iBRoad tools and serve as an incentive to use the tools.

The European Green Deal can be an incentive to create support programmes that offer energy consulting. This could help to achieve the European targets of doubling the renovation rate and reducing energy consumption.

Existing energy consulting programmes for multi-family and non-residential buildings

Existing consulting programmes for non-residential and multi-family buildings were examined and reviewed to determine whether they could support the iBRoad renovation roadmap and logbook.

Renovation Roadmap of Baden-Württemberg (Germany)

With the Renewable Energies Heat Act (EWärmeG), the federal state of Baden-Württemberg passed the first state law of its kind in Germany in 2007. It came into force at the beginning of 2008 with the aim of increasing the share of renewable energies in the heat supply and, through the resulting reduction in greenhouse gas emissions, to contribute to climate protection and air pollution control. An amendment to the EWärmeG was introduced in 2015. The amended EWärmeG stipulates that when heating systems are replaced in existing residential and non-residential buildings, 15 % of the heating energy demand must be covered by renewable energies, or alternative measures must be taken. For non-residential buildings, a renovation roadmap can be used to meet this legal requirement.

The Baden-Württemberg renovation roadmap is an instrument for step-by-step energy consulting for buildings. The renovation roadmap was designed in two variants: for residential and non-residential buildings. The two roadmaps differ in structure and type and are adapted to the specific needs of each sector. The renovation roadmap for non-residential buildings does not distinguish between different building types, such as office buildings, hospitals or hotels.

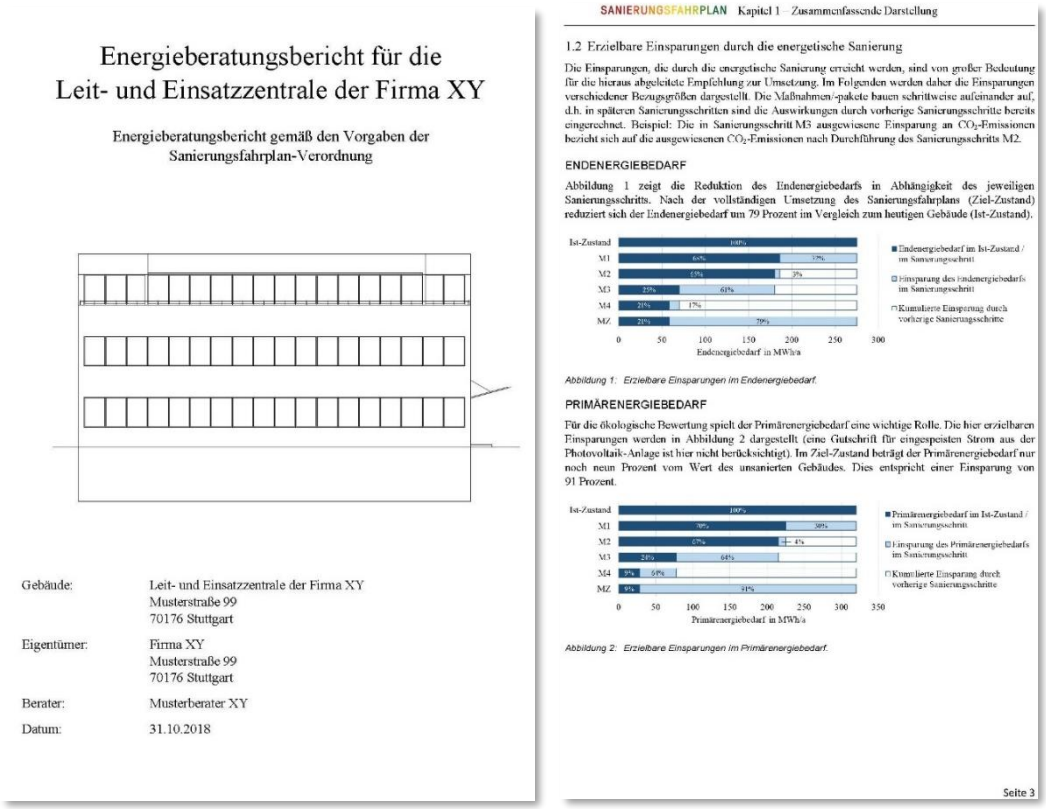
The Baden-Wuerttemberg renovation roadmap is a target-oriented instrument from which recommendations and suggestions can also be derived for the non-residential building variant of the iBRoad renovation roadmap.

The Baden-Württemberg renovation roadmap for non-residential buildings shows the long-term energy-saving potential of the building. At the same time, the renovation roadmap takes into account structural, building, cultural and personal starting conditions. It is intended to sensitise and motivate owners to renovate buildings to make them more energy-efficient.

The renovation roadmap is issued by an energy auditor. It includes an on-site analysis of the building with regard to thermal insulation and the systems engineering for heating, cooling and domestic hot water as well as ventilation, air conditioning and lighting. Afterwards, a renovation roadmap is issued. This should provide a complete overview of the energy quality of the building, for the current state on the one hand and for the target state on the other. In consultation with the building owner, the renovation roadmap usually comprises one to five renovation steps. Renovation measures have to adapt to the future plans of the building owners.

The following parameters are considered in the renovation roadmap for non-residential buildings in addition to those considered for residential buildings:

- Ventilation
- Cooling
- Air conditioning
- Lighting



Energieberatungsbericht für die
Leit- und Einsatzzentrale der Firma XY

Energieberatungsbericht gemäß den Vorgaben der
Sanierungsfahrplan-Verordnung

Gebäude:	Leit- und Einsatzzentrale der Firma XY Musterstraße 99 70176 Stuttgart
Eigentümer:	Firma XY Musterstraße 99 70176 Stuttgart
Berater:	Musterberater XY
Datum:	31.10.2018

SANIERUNGSFAHRPLAN Kapitel 1 – Zusammenfassende Darstellung

1.2 Erzielbare Einsparungen durch die energetische Sanierung

Die Einsparungen, die durch die energetische Sanierung erreicht werden, sind von großer Bedeutung für die hieraus abgeleitete Empfehlung zur Umsetzung. Im Folgenden werden daher die Einsparungen verschiedener Bezugsgrößen dargestellt. Die Maßnahmen/-pakete bauen schrittweise aufeinander auf, d.h. in späteren Sanierungsschritten sind die Auswirkungen durch vorherige Sanierungsschritte bereits eingerechnet. Beispiel: Die in Sanierungsschritt M3 ausgewiesene Einsparung an CO_2-Emissionen bezieht sich auf die ausgewiesenen CO_2-Emissionen nach Durchführung des Sanierungsschritts M2.

ENDENERGIEBEDARF

Abbildung 1 zeigt die Reduktion des Endenergiebedarfs in Abhängigkeit des jeweiligen Sanierungsschritts. Nach der vollständigen Umsetzung des Sanierungsfahrplans (Ziel-Zustand) reduziert sich der Endenergiebedarf um 79 Prozent im Vergleich zum heutigen Gebäude (Ist-Zustand).

Abbildung 1: Erzielbare Einsparungen im Endenergiebedarf.

PRIMÄRENERGIEBEDARF

Für die ökologische Bewertung spielt der Primärenergiebedarf eine wichtige Rolle. Die hier erzielbaren Einsparungen werden in Abbildung 2 dargestellt (eine Gutschrift für eingespeisten Strom aus der Photovoltaik-Anlage ist hier nicht berücksichtigt). Im Ziel-Zustand beträgt der Primärenergiebedarf nur noch neun Prozent vom Wert des unsanierten Gebäudes. Dies entspricht einer Einsparung von 91 Prozent.

Abbildung 2: Erzielbare Einsparungen im Primärenergiebedarf.

1.4 Wirtschaftlichkeit

Kapitel 1.4 gibt einen Überblick über die Wirtschaftlichkeit der vorgeschlagenen Sanierungsmaßnahmen. Hierbei werden einerseits die jährlichen Kosten betrachtet, die im jeweiligen Sanierungsschritt anfallen, andererseits wird dargestellt, wie sich die Kosten für die energetische Sanierung über einen längeren Zeitraum entwickeln. Bei der Berechnung der Kosten wurden folgende Aspekte berücksichtigt: Energie- und Wartungskosten, energetisch bedingte Mehrkosten, öffentliche Fördermittel und Gutschrift für die Eigenstromerzeugung durch die Photovoltaik-Anlage.

1.4.1 Betrachtung jährlicher Kosten

Abbildung 6 gibt einen Überblick über die jährlich anfallenden Kosten ohne Zinsen und Preissteigerung.

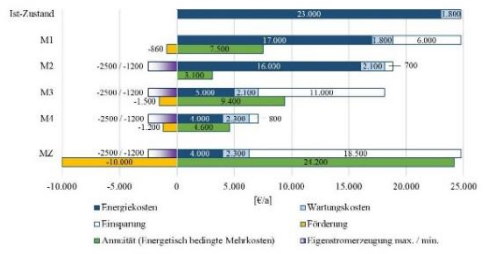


Abbildung 6: Darstellung finanzieller Aspekte der energetischen Sanierung.

ENERGIE- UND WARTUNGSKOSTEN

Für den Betrieb des unsanierten Gebäudes fallen neben den Energiekosten (Erdgas, Strom) auch Kosten für die Wartung der Anlagentechnik an, wobei der Anteil der Kosten für den Bezug der Energie wesentlich stärker ins Gewicht fällt. Durch die schrittweise Sanierung des Gebäudes reduzieren sich die Energiekosten deutlich, die Wartungskosten hingegen verändern sich nur geringfügig: In den ersten beiden Sanierungsschritten ist ein leichter Rückgang zu verzeichnen, in den Sanierungsschritten M3 und M4 steigen diese sogar bis über die Wartungskosten des unsanierten Gebäudes hinaus an. Im Vergleich zu den Energiekosten nehmen die Wartungskosten daher im sanierten Zustand eine weitaus bedeutendere Rolle als beim unsanierten Gebäude ein.

ENERGETISCH BEDINGTE MEHRKOSTEN UND ÖFFENTLICHE FÖRDERMITTEL

Abbildung 6 zeigt – neben den Energie- und Wartungskosten – auch die energetisch bedingten Mehrkosten der Sanierung, die anhand der Annuität dargestellt sind. Der gewählte Betrachtungszeitraum beträgt hierbei zehn Jahre. Dem gegenüber stehen öffentliche Fördermittel, die die Annuität um den ausgewiesenen Betrag reduzieren. Die Höhe der Tilgungszuschüsse wurde ebenfalls auf zehn Jahre heruntergebrochen.

EIGENSTROMERZEUGUNG DURCH PHOTOVOLTAIK-ANLAGE

Durch die Installation der Photovoltaik-Anlage in Sanierungsschritt M2 wird Strom erzeugt, der nicht vollständig für den Betrieb der Anlagentechnik im Gebäude verwendet werden kann. Der überschüssige Strom wird entweder in das öffentliche Stromnetz eingespeist oder im Gebäude, beispielsweise für den Betrieb der PCs (diese gehören nicht zur Anlagentechnik im Sinne der DIN V 18599:2011-12), eingesetzt.

Es wird angenommen, dass der durch die Photovoltaik-Anlage erzeugte Strom zu einem Anteil von 30 Prozent im Gebäude verwendet werden kann (dieser Anteil wurde bei den Berechnungen direkt vom Endenergiebedarf abgezogen). Die verbleibenden 70 Prozent werden demnach in das öffentliche Stromnetz eingespeist. Diese Annahme ist eher konservativ gewählt, gegebenenfalls ist auch ein höherer Anteil an Eigenstromversorgung möglich. Daher ist beim Erlös eine Spanne angegeben. Der minimale Erlös bezeichnet den Erlös, der entsteht, wenn der überschüssige Strom der Photovoltaik-Anlage über die Einspeisevergütung nach dem Gesetz für den Ausbau erneuerbarer Energien (Erneuerbare-Energien-Gesetz – EEG) vergütet wird. Der maximale Erlös bezeichnet eine vollständige Nutzung des insgesamt produzierten Stroms durch die Photovoltaik-Anlage.

1.4.2 Betrachtung der Kosten über einen Zeitraum

Die Sanierung des Gebäudes endet mit der Umsetzung des letzten Sanierungsschritts M4, der für das Jahr 2029 vorgesehen ist. Bei einem Betrachtungszeitraum der Annuität von zehn Jahren sind die Kosten mit dem Ablauf des Jahres 2038 abgegolten, d.h. ab diesem Zeitpunkt fallen nur noch die Energie- und Wartungskosten an. Abbildung 7 zeigt die Entwicklung der jährlichen Gesamtkosten einschließlich Zinsen sowie die kumulierten Kosten über einen Zeitraum von 22 Jahren (2018 bis 2039). Bei den Sanierungsmaßnahmen wurden nur die energetisch bedingten Mehrkosten berücksichtigt.

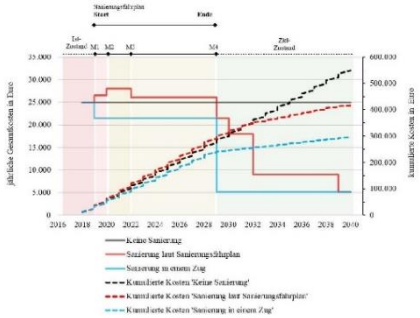


Abbildung 7: Übersicht über die Gesamtkosten über einen Zeitraum von 22 Jahren.

Es wird ersichtlich, dass die kumulierten Kosten am höchsten liegen, wenn das Gebäude nicht saniert wird. Die Kosten für eine Sanierung in einem Zug hingegen liegen aufgrund der erhöhten Förderung am geringsten. Dazwischen befinden sich die kumulierten Kosten für eine Sanierung in Schritten.

Figure 101: Extract from the sample renovation roadmap for non-residential buildings (Econsult 2019). Format and diagrams are not standardised.

Due to the diversity of building types, owner structure and types of use, there is no unified sample renovation roadmap for non-residential buildings. The regulation for the renovation roadmap contains a list of fields of action which have to be examined and presented. A model renovation roadmap for an office building is available for download on the website of the Ministry for the Environment, Climate Protection and Energy Sector Baden-Württemberg[2]. A checklist for non-residential buildings is also available for download as well as a model annex and an overview table for the renovation roadmap.

The Institute for Energy and Environmental Research ("ifeu") analysed the effects of the law in 2018. ifeu reviewed the options for compliance and evaluated the renovation roadmap. Random samples were taken to check the renovation roadmap for residential and non-residential buildings (ifeu 2018).

The results of the study in relation to the non-residential building renovation roadmap are as follows:

- The roadmap for non-residential buildings received a good response from the owners. However, measures from the renovation roadmap are more likely to be implemented in residential buildings rather than in non-residential buildings.
- The quality of the reviewed renovation roadmaps for non-residential buildings was not always satisfactory. The renovation roadmaps did not sufficiently consider user wishes, objectives and funding possibilities. Moreover, the majority of reports was incomplete. The checklist prepared by the Ministry to support energy auditors was probably not used.
- Measures should not only be specified for the entire building, but also for building sections.
- The renovation roadmap encourages the owners/users of a non-residential building to pay more attention to their buildings.
- The renovation roadmap bundles the information that is relevant for the renovation of buildings.

The evaluation of the German non-residential building renovation roadmaps showed which parts of the renovation roadmap are considered necessary, successful and/or useful. The recommendations, in summary, indicate a need for:

- Further development of training courses and preparation of information materials, implementation of random checks, and publication of sample renovation roadmaps for non-residential buildings.
- Deployment of a checklist for renovation roadmaps and the obligation for energy auditors to hand the checklist over together with the report.
- Intense promotion of the renovation roadmap.

Conclusions

The renovation roadmap for Baden-Wuerttemberg is a programme introduced by the federal state government. The experiences from the evaluation of the roadmap can be transferred to the iBRoad tools.

It has been shown that it is of advantage to offer a tool that is supported by the government. Investors, e.g. of non-residential buildings, can get a uniform product that is known and trusted.

In addition, larger investments, for example, can be precisely planned and controlled through a renovation roadmap. Financial gaps can thus be cushioned.

2 https://um.baden-wuerttemberg.de/fileadmin/redaktion/m-um/intern/Dateien/Dokumente/5_Energie/Beratung_und_Information/SanierungsfahrplanBW/190212_Muster_Sanierungsfahrplan_Nichtwohngebaeude_Anhang.pdf

The partial obligation in Baden-Württemberg to use a renovation roadmap shows many owners' perspectives on their buildings that they might not have found without the creation of a renovation roadmap.

Especially, the combination of obligations with official control should be considered when introducing the iBRoad tools.

V. DEFINITION OF CATEGORIES FOR THE REPLICATION OF IBROAD

Based on the information collected in chapter III, a summary of the possible combinations of building types and tenure statuses is given in Table 1. Also, 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.	✓	✓	✓	

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

Table 1: Overview of building types and tenure status and categories to extend iBRoad to other building types

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 focuses on single-family houses, privately owner occupied, and examines its feasibility in 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.

Category 4: Non-residential publicly owner occupied:
A public authority owns and uses the building.

The analysis below aims to identify important aspects that should be covered in the replication of the iBRoad to these four categories. Therefore, the opportunities, threats, strengths and weakness for each category are presented in a matrix format. Based on that, the suitability/usefulness of a renovation roadmap is also briefly analysed.

Category 1: Residential (single and multi-family houses), rented from single owner

In category 1, the building is owned by a private person, private company or public authority which is the main decision maker and/or responsible for financing the deep renovation. In this category, formal agreements between building owner and tenants, in terms of relocation, cost-split, rent adjustment, etc., play the most important role. Additionally, the lack of technical knowledge about the deep renovation process might also be an important aspect. This means that the owners do not have knowledge about the type of renovations that are mandatory or sensible for a building. Without expertise, most owners would favour simple renovations, such as painting the facade, rather than planning a deep renovation. Accordingly, support from energy auditors and energy experts (especially if private or publicly owned) should be foreseen in the planning (EEFIG 2015).

In particular, for cases where there is insufficient access to finance, insufficient or missing incentives, or there is no final agreement achieved between building owner and tenants, the step-by-step deep renovation plan can provide a manageable approach. For tenants in particular, a common problem is the proportionate increase in rent. Especially in socially deprived areas, an increase in rent due to renovation can have extreme effects.

	Strength	Weakness
Opportunity	Certain need for common agreement between different parties	Only one party is financially responsible. This is particularly critical when financial resources are limited.
Threats	Owner-tenant cost-split. The owner has to invest but can pass the costs on to the tenant. However, the tenant or resident always enjoys the advantages of a renovation (additional benefits).	Owner-tenant conflicts regarding relocation, rent adjustment, etc.

Table 2: Category 1 – Residential (single and multi-family houses), rented by one single owner

Category 2: Multi-family houses, mixed tenure status

In category 2, the building is partly owner occupied and partly rented, which indicates the presence of different parties. This is the most complex category, because of the number of parties involved, who possibly have conflicting interests and different financial capabilities. Therefore, the decision-making process and clarification of legal and practical responsibilities are key points in this category. This is also the case when a building is owned by many different private persons. Here, the non-energy aspects gain importance, as additional benefits (like thermal comfort, security and aesthetics) are additional arguments in favour of deep renovation.

Due to its complexity, category 2 is most likely to follow a stepwise approach in order to avoid divergences between the parties involved.

	Strength	Weakness
Opportunity	For the investor, the single units can become more attractive for commercial purpose (change from owner-occupied to privately rented); Different parties are financially responsible	A number of parties involved to the decision-making process and planning; Opportunity to invest in non-energy related improvements for common areas (installation of new components as elevators, balconies, etc.)
Threats	All parties involved in the decision-making process; Owner-tenant cost-split. Part of the renovation costs can be passed on to the tenants; Different payment capacity between building owners/building tenants	Different interests between the building owners could hinder reaching a common consensus Lack of technical assistance (if higher share of privately owned dwellings)

Table 3: Category 2 - Multi-family house, mixed tenure status

Category 3: Non-residential, commercially used

In category 3, the building is owned by a natural person or private company, e.g. real estate or other property owner, who rents it to tenants who in their turn use it mainly for commercial purposes. In this category, the decision for deep renovation is usually strongly related to a short-time horizon and financial risks, indicated e.g. through a short payback time and risk assessment indicator (EEFIG 2015).

From the building owner perspective, the tenants can be invited to participate in the deep renovation costs, enabling a cost-split between building owner and tenants. Here, benefits like energy savings and reduction of maintenance costs can be attractive arguments for renovation, as these cost types are usually higher in non-residential buildings than in residential buildings.

In cases where commercial buildings are part of a real estate portfolio and managed like financial assets, the tenure status of owner-occupied or rented plays a minor role in the decision-making process. As in these categories, the decision for deep renovation will depend on different factors, such as real estate decision maker profile, actual state and use of the buildings, size of the building portfolio, tenants' interest, etc. Another important factor is the tenant's interest for splitting the costs. In this context, choosing the step-by-step approach is less probable than in the other three categories.

	Strength	Weakness
Opportunity	More market attractive objects to be rented	Higher rental prices
Threats	Owner-tenant split costs	Short-term investment strategy

Table 4: Category 3 - Non-residential commercially rented

Category 4: Non-residential, public owner occupied

In category 4, the building is owned and occupied by a public authority. In this category, there is political commitment to exemplary energy efficiency according to EED art. 5. These self-obligations require deep renovations, which enable both energy and non-energy related benefits, like energy savings, indoor air quality and productivity, thermal and acoustic comfort. In contrast to commercially used buildings, the short-time horizon is not a major concern. Here, additional support on technical aspects might be necessary, especially if in-house facility managers with useful technical expertise are not available. Support from energy auditors and energy experts should be foreseen in the planning.

The main possible hindrance for deep renovation is the internal bureaucratic procurement procedure in public services (EEFIG 2015). To avoid additional bureaucratic procedures, renovation is most likely to be performed in one-stage. The chances of choosing the step-by-step renovation approach are directly related to how bureaucratic procedures are administratively set. Where bureaucratic procurement procedures are more cumbersome, the chances of performing step-by-step renovation are lower.

	Strength	Weakness
Opportunity	Interest on perceiving both energy savings and non-energy related benefits	Quality assurance
Threats	More bureaucratic procurement procedures	Lack of technical expertise. Lack of specialised energy and renovation advisors.

Table 5: Category 4 - Non-residential publicly owned

Conclusion

This chapter presents an analysis, in a matrix format, of the opportunities, threats, strengths and weaknesses which aims at identifying important aspects that should be covered when replicating the individual building renovation roadmaps to four categories:

1) Residential (single and multi-family houses), rented from one owner;
2) Multi-family houses, mixed tenure status (owner occupied and private rented);
3) Non-residential commercially rented; and
4) Non-residential occupied by public owner.

The analysis considers general aspects in regard to energy performance, non-energy related benefits, technical assistance, responsibility share and chances for performing the step-by-step renovation approach.

Categories 1 and 2 were identified as being more likely to benefit from a plan for stepwise renovation. In non-residential, commercially-used buildings, the renovation approach strongly depends on the real estate owners´ profile and on financial aspects. The analysis also shows that in non-residential public buildings the chances of performing the step-by-step renovation approach are directly related to the degree of bureaucratic procedures administratively set (where bureaucratic procurement procedures are more cumbersome, the chances of performing step-by-step approach are lower).

VI. REPLICABILITY OF THE IBROAD ROADMAP AND LOGBOOK

Based on the analysis above, additional features for the iBRoad Renovation Roadmap and Logbook are suggested. These can extend the iBRoad tools for single-family houses to other building types. At first, general suggestions that should be implemented independently from the building category are shown.

Then, key points to extend iBRoad to the four identified building categories are presented in the form of four individual factsheets. The main objective is to concisely emphasise which relevant issues should be addressed in the individual renovation roadmaps according to the different categories. The main conclusions of both chapters V and VI should serve as guidelines for public authorities who want to implement the individual renovation roadmaps as a political instrument for deep renovation.

Additional content for the iBRoad Renovation Roadmap

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.

Format

In the area of non-residential buildings and large multi-family houses, a roadmap has to offer sufficient flexibility to cater for various requirements. The range of the technologies deployed is wider and challenges in long-term planning are more diverse than in single-family houses. On the other hand, a Roadmap should be standardised to a certain degree. Standardisation specifies the format, provides brand recognition and structures the content. If no specific format is provided, auditors and owners can easily feel lost in the handling of the report given its complex content.

The iBRoad Roadmap for non-residential buildings and multi-family houses should follow the existing structure of the Roadmap for single family houses:

- Analysis of the present building state
- Presentation of the renovation steps
- Notes on the connections between the steps

The length of the text fields should not be limited so that all important information can be given in the required depth even though this does not allow for specifying a fixed layout or a fixed number of pages. Yet, there should be a standardised overview in which the central results are shown, similar to the Roadmap page for single-family houses.

	F	D	C	A
When?				
What to do?				
Total Investment				
Costs for maintenance				
Incentives				
Energy bill				

Table 6: Sketch of the standardised overview table for non-residential and multifamily buildings

For this flexible format, assistance software such as the Roadmap Assistant is not absolutely necessary. A template document that the auditors can download is also possible.

Motivating for laymen vs. dense information

To ensure that the iBRoad Renovation Roadmap is fit for many of the categories described in Chapter V, the Roadmap must be adapted to the user or contact person. Each roadmap can start with a standardised introductory text that includes notes for saving energy and a glossary. This can ensure that all recipients receive the same level of knowledge and motivation.

As explained earlier, each category has specific requirements for technical information. The roadmap must therefore allow the energy auditors to design the report flexibly when more information needs to be given. The auditors have to balance between the depth of the technical information and their comprehensibility for the recipients. They must make this decision individually for each customer. The technical understanding of the customers ranges from the layman's knowledge of a private small landlord to the professional understanding of technical departments of real estate companies. The depth of information cannot be specified in a standardised way.

Portfolio Management

Especially with categories 2-4 it can occur that the energy auditor does not only look after only one building, but after several buildings of similar kind, size and use. Usually each building requires an individual renovation recommendation. Nevertheless, it can happen that same renovation recommendations can be adopted for similar buildings. Through portfolio management, roadmaps for several buildings with similar technical features may be issued in parallel.

Portfolio management also helps owners create an overview of their building stock. The example in **Table** provides the property owner with an overview of the main energy related criteria for their building stock at a glance.

	Building 1	Building 2	Building 3
Living space area in m²			
Location			
Renovation measures			
Energy saving			
Invest volume			
Number of renovation steps			
Time horizon			

Table 7: Example table for a portfolio management

iBRoad Principles

Five guiding principles were defined for the iBRoad Renovation Roadmap for single family houses:

- 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

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 need to be pursued differently depending on the specific customer.

Prefabricated recommendations

Prefabricated recommendations are offered to the auditors in the iBRoad tools for single-family houses. They support the auditors by standardising frequently occurring content. They also help to remember many important contents. For multi-family and non-residential buildings, additional standard text blocks may need to be offered, as additional technologies are used and customers need to be addressed in a different way.

Non-energy benefits

Owners, residents 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, in school or in hospitals[3]. The renovation roadmap for single-family houses lists non-energy benefits for each renovation step. Not all benefits are suitable for the additional building categories described in chapter V. For example, 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. 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. The iBRoad Renovation Roadmap should include a separate page describing economic and financial aspects.

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[3] http://bpie.eu/publication/building-4-people-valorising-the-benefits-of-energy-renovation-investments-in-schools-offices-and-hospitals/

Also, the national calculation standards define whether building performance of non-residential buildings is calculated differently than that of residential buildings. The calculation for non-residential buildings may require some additional data such as zones of operation, lighting zones, floor area, net floor space or operation profiles.

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 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, technical building systems are installed more often than in 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.

The auditors have to take these additional triggers into account when drawing up a long-term renovation roadmap.

Auditor Trainings

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

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 planning service. It provides an overview and is intended to avoid connection errors between the individual components. The detailed implementation planning must be provided by a specialist planner in the course of implementation.

Specific adjustments linked to building typology

Having shown, in the previous section, adjustments to the individual building renovation roadmap that apply to all additional building categories, specific adjustments for each category are presented below. The relevant aspects are summarised in factsheets and classified according to their relevance for the respective category. This classification aims at increasing awareness about possible barriers that should be overcome as well as highlighting the aspects that the individual renovation roadmap should focus on. Therefore, the factsheets go beyond technical issues, and include also economic, financial, legal and individual aspects.

The general factsheet structure is divided in two parts:

1) light blue is the information relevant to specific characteristics of each category. In this part, decision makers are defined as target group to whom the content of the Roadmap will be addressed;

2) dark blue is the relevant content information, that should be delivered in the individual renovation roadmap. The content categories go beyond technical aspects, and also include economic, financial, legal and individual aspects (see also ANNEX I for detailed explanations). They are classified from *very important,* through *important* to *less important*. Along with the classification, the choices are briefly explained.

Category 1: Residential (single and multi-family houses), rented from single owner

Relevant information for iBRoad			
Building characteristics	Building category	Single and multi-family	
	Decision maker target group	Private person, company or public authority	
	Exemplary building type	Single and multi-family houses (small and large)	
Deep renovation individual issues	Singularity of this group	One party responsible for decision making and financing issues	
	Main challenges	Formal agreements between building owner and tenants about the renovations and the amount of the rent increase	
	Likelihood of step-wise renovation	It must be weighed whether a one-off high investment is better or a distribution of individual posts over several years. Financing and funding programmes can have an influence on the decision, depending on which is economically better.	
Content of the Roadmap			
Pre-fabricated recommendations	Technical recommendations	Important	Technical recommendations must be understandable for laypersons. In this target group, facility managers are not always involved.
	User behaviour recommendations	Important	Tenants are the principal users of the buildings. Standardised recommendations for users' behaviour should be included. The landlords can be given recommendations for the efficient operation of the building.
Economic indicators	Energy cost savings	Less important	Roadmap recipient does not benefit directly from savings. However, energy cost savings may provide competitive advantages and help to convince tenants to deep renovation so that the tenants do not oppose against renovations.
	Payback time	Important	Economic indicators like payback time or capital value are important to support the decision-making process to implement deep renovations. The indicator weighs short-term investments against long-term profits.
	Real estate value	Important	The real estate value increase is an important indicator to support owners in the decision process. It increases the chances to get a profit in case of sale and provides competitive advantages.

Non-energy benefits	Thermal comfort	Important	Decision makers do not benefit from increased comfort. However, thermal comfort is a quality indicator for buildings, and it provides competitive advantages. It prevents moisture and mould and provides healthy living.
	Indoor air quality	Important	Decision makers do not benefit from increased comfort. Indoor air quality is another quality indicator for buildings. It provides competitive advantages.
Legal aspects	Shared responsibility	Less important	As only one party is responsible for deep renovation, this issue is less relevant for this category.
	Bureaucratic procedures	Important	The bureaucratic effort for coordination with tenants, building authorities and subsidy providers can become very high and involves high risks for the owner. The roadmap can be used to point out these risks with specific notes.
Financial aspects	Available incentives	Very Important	Subsidies can play a decisive role. In addition to the type and amount of the subsidy, specific information on the legally correct handling of the subsidy with regard to the tenants is also important.
	Risk assessment	Important	In addition to technical connection errors, special attention must be paid to risks in the rental relationship.
Trigger points	Technical	Important	Technical triggers are always the starting point for a roadmap. In rented buildings, however, there are many other triggers such as change of tenant.
	Individual/personal	Less important	Personal triggers for the landlord can be, for example, changes in the financial situation. They are not always predictable.

Category 2: Multi-family houses, mixed tenure status

Relevant information for iBRoad			
Building characteristics	Building category	Multi-family houses	
	Decision maker target group	Private persons and/or companies	
	Exemplary building type	Multi-family houses (small and large)	
Deep renovation individual issues	Singularity of this group	Different parties involved in the decision-making process and legal and practical responsibilities	
	Main challenges	High complexity due to the number of parties involved, who may have conflicting interests and different financial capabilities	
	Likelihood of step-wise renovation	High, common agreement is easier for smaller and step-by-step successive renovation measures	
Content of the Roadmap			
Pre-fabricated recommendations	Technical recommendations	Important	Technical recommendations are addressed to building professionals. Usually, property management companies are involved in the decision-making process. Users of the buildings are owners.
	User behaviour recommendations	Important	Standardised recommendations for users' behaviour should be included. The property management companies can be given recommendations for efficient operation of the building.
Economic indicators	Energy cost savings	Important	Some roadmap recipients benefit directly from savings. For them savings can be a major motivation for renovation measures. In rented units, roadmap recipients do not benefit directly from savings. However, energy cost savings may provide competitive advantages for a new renting.
	Payback time	Very Important	Economic indicators like payback time or capital value are important to support the decision-making process to implement deep renovations. The indicator weighs short-term investments against long-term profits.
	Real estate value	Important	The real estate value increase is an important indicator to support owners in the decision process. It increases the chances to get a profit in case of sale.
Non-energy benefits	Thermal comfort	Important	Some decision makers benefit directly from increased comfort. It can motivate them for deep renovations. Decision makers with rented units only have indirect benefits.
	Indoor air quality	Important	Some decision makers benefit directly from increased comfort. It can motivate them for deep renovations. Decision makers with

			rented units only have indirect benefits, e.g. a better occupancy.
Legal aspects	Shared responsibility	Very Important	As many parties are responsible for deep renovation, this issue is very relevant. The roadmap must contain the basis for the decision-making process.
	Bureaucratic procedures	Important	The bureaucratic effort for coordination with the ownership community, the property management companies, building authorities and funding agency can become very high and can endanger the entire renovation process. The roadmap must contain respective standardised notes.
Financial aspects	Available incentives	Very Important	Subsidies can play a decisive role for the owners. In addition to the type and amount of the subsidy, specific information on the legally correct handling of the subsidy with regard to ownership community and the property management company is also important.
	Risk assessment	Less important	The roadmap must pay special attention to risks in the ownership community. Possible changes of owners in the future must not endanger the implementation of the roadmap.
Trigger points	Technical	Very important	Technical triggers are always the starting point for a roadmap. In buildings with multiple owners they can form the basis for a common decision on the roadmap.
	Individual/personal	Less important	Personal triggers have only little influence on the roadmap for an ownership community. The roadmap cannot be based on these triggers.

Category 3: Non-residential, commercially used

Relevant information for iBRoad			
Building characteristics	Building category	Non-residential	
	Decision maker target group	Private companies i.e. real estate companies, individual investors	
	Exemplary building type	Office buildings (rented or owner occupied), wholesale and trade	
Deep renovation individual issues	Singularity of this group	The decision to deep renovate is strongly related to a short-time horizon and financial risks	
	Main challenges	Focus on economic building operation	
	Likelihood of step-wise renovation	It must be weighed whether a one-off high investment is better or a distribution of individual posts over several years. Financing and funding programmes can have an influence on the decision, depending on which is economically better.	
Content of the Roadmap			
Pre-fabricated recommendations	Technical recommendations	Important	Technical recommendations are addressed to building professionals. Usually, facility managers are involved.
	User behaviour recommendations	Less important	Users of the buildings are those who are in the building. In office buildings they are e.g. employees. Standardised recommendations for user behaviour should be included. The facility manager can be given recommendations for efficient operation of the building.
Economic indicators	Energy cost savings	Less important	Information about energy cost savings is important, however energy costs mostly account for only a small proportion of business costs.
	Payback time	Important	Payback time and/or net present value are indicators commonly used in the decision-making process in companies. Many companies expect payback periods of less than three years. The roadmap must explain why this is often not achieved for renovations and why investing in step-by-step renovation could benefit owners even if pay-back time is shorter than usual.
	Real estate value	Important	An outline of the real estate value increase can support the companies´ decision-making process.

Non-energy benefits	Thermal comfort	Important	Thermal comfort is important for many non-residential buildings, e.g. for offices, hotels and restaurants. The roadmap should highlight the benefits of increased productivity, reduced sick leave and absenteeism, ….
	Indoor air quality	Important	Indoor air quality is import for many non-residential buildings. Nevertheless, the roadmap should highlight the improvements, especially those related to increased productivity, reduced sick leave and absenteeism, ...
Legal aspects	Shared responsibility	Less important	As only one party is responsible for deep renovation, this issue is less relevant for this category.
	Bureaucratic procedures	Important	The bureaucratic effort for coordination with tenants, building authorities and subsidy providers can become very high and involves high risks for the owner. The roadmap must contain respective standardised notes.
Financial aspects	Available incentives	Important	Subsidies can motivate the decision makers for deep renovation. In addition to the type and amount of the subsidy, specific information on the legally correct handling of the subsidy with regard to the tenants is also important.
	Risk assessment	Very Important	Risk assessment is a commonly used indicator to support real estate companies´ decision-making process. Special attention must be paid to risks in the rental relationship.
Trigger points	Technical	Important	Technical triggers are always the starting point for a roadmap. In rented buildings, however, there are many other triggers such as a change of tenant. Technical trigger points address the facility management and maintenance activities.
	Individual/personal	Less important	Individual/personal aspects, such as the distribution of life insurance and thus the gain of new financial resources, are not part of the scope for non-residential buildings.

Category 4: Non-residential publicly owner occupied

Relevant information for iBRoad			
Building characteristics	Building category	Non-residential	
	Decision maker target group	Public authorities	
	Exemplary building type	Public administration buildings, public education buildings (schools, universities, etc.)	
Deep renovation individual issues	Singularity of this group	Commitment for leading by example and performing deep renovations, EED obligation of renovating 3% of government owned buildings	
	Main challenges	Procurement procedures, budget restrictions	
	Likelihood of step-wise renovation	Medium, step-wise renovations can enable deep renovation despite restricted budgets as it spreads the high costs over several small investments	
Content of the Roadmap			
Pre-fabricated recommendations	Technical recommendations	Important	Technical recommendations are addressed to building professionals. Usually, facility managers are involved.
	User behaviour recommendations	Less important	Users of the buildings are employees, students and the general public. Standardised recommendations for user behaviour should be included. The facility manager can be given recommendations for efficient operation of the building.
Economic indicators	Energy cost savings	Important	Information about energy cost savings are important, however energy costs mostly account for only a small proportion of public costs.
	Payback time	Less important	Economic indicators should be displayed in the roadmap but might not play a decisive role.
	Real estate value	Less important	Economic indicators should be displayed in the roadmap but might not play a decisive role.

Non-energy benefits	Thermal comfort	Important	Importance to the decision makers depends on building type and usage. Comfort improvements should be highlighted in the roadmap.
	Indoor air quality	Important	Importance to the decision makers depends on building type and usage. Comfort improvements should be highlighted in the roadmap, especially for non-residential buildings such as hospitals or old people's homes where vulnerable persons live. Here the non-energy related benefits are particularly decisive.
Legal aspects	Shared responsibility	Less important	As only one party is responsible for deep renovation, this issue is not so relevant.
	Bureaucratic procedures	Very Important	Internal bureaucratic procedures can be cumbersome but decisive in the decision-making process. The Roadmap must provide the relevant information for a smooth process.
Financial aspects	Available incentives	Important	Subsidies can motivate the decision makers for deep renovation (also grants and dedicated loans from EIB, EU funds or other financiers). In addition to the type and amount of the subsidy, specific information on the legally correct handling of the subsidy is also important.
	Risk assessment	Important	Risk assessment is a commonly used indicator to support public administrations´ decision-making process. Special attention must be paid to budget risks. If, for example, it cannot be assessed whether it would be more economical to tear the building down.
Trigger points	Technical	Important	Technical triggers or regulatory requirements are always the starting point for a roadmap. Technical trigger points address the facility management and maintenance activities.
	Individual/personal	Important	Individual/personal aspects are important for non-residential publicly owner-occupied buildings as, e.g., hospitals.

Content of the iBRoad Logbook

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 tools structure

As with the roadmap, it depends on the national calculation standard 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, net floor space or operation profiles.

If additional data are required for the calculation of non-residential buildings, they 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. If the non-residential building data in the logbook is to be evaluated (for example for statistics), additional data fields are required. This requires a similar procedure for defining the data fields as for residential buildings. Here the required amount of data from the individual member states is collected and compared. Due to the flexible data structure of the logbook, national versions can be created which contain only the relevant data fields.

VII. CONCLUSION

This report shows how iBRoad methods can be useful for deep stepwise renovation in multi-family and non-residential buildings. It describes how the iBRoad renovation roadmap and the logbook can be adapted to meet the requirements of different target groups. Political and funding instruments available for non-residential and multi-family buildings and existing European renovation roadmaps or logbooks are examined to demonstrate if the replication of the iBRoad tools to other building typologies can be supported and what adjustments are necessary.

The specific features and requirements of the different target groups are identified with respect to the renovation roadmap. Based on this analysis four relevant categories are identified for residential and non-residential buildings:

- Category 1: Residential buildings (single and multi-family houses), rented from single owner;
- Category 2: Multi-family houses, mixed tenure status (owner occupied and privately rented);
- Category 3: Non-residential buildings commercially used;
- Category 4: Public non-residential buildings.

In order to adapt the existing roadmap for single-family houses to these categories, adjustments are proposed on two different levels. Adjustments that are independent from the building category and apply to all identified building types, and adjustments that refer to one specific category.

In general, a long-term renovation perspective is helpful for all types of buildings. The analysis shows that the iBRoad roadmap and the iBRoad logbook for single-family houses can be used as a basis for other building types. They can be adapted to meet the specific requirements of multi-family houses and non-residential buildings. For iBRoad tools to be adapted to multi-family and non-residential buildings in the pilot countries in the future, policy instruments would ideally have to be rearranged to specifically support stepwise renovations for these types of buildings.

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ANNEX I

The possible analysed categories of the Roadmap content:

1. Building characteristics:
   1.1. Building category: building typology (multi-family houses or non-residential)
   1.2. Decision maker target group: main decision maker group to which the Roadmap should be addressed – private person, private company and/or public authority
   1.3. Exemplary building type: example of a possible building type for the analysed category – multi- apartment buildings (small or large), private office building, public school etc.
2. Deep renovation individual issues:
   2.1. Singularity of this group: main single aspect of this category, relevant for planning the deep renovation
   2.2. Main challenges: main challenge to be overcome during deep renovation planning
   2.3. Likelihood of step-wise renovation: how high (or low) are chances to perform the step-by-step approach
3. Content of the Roadmap:
   3.1. Pre-fabricated recommendations
      3.1.1. Technical recommendations: pre-fabricated texts with recommendations about technical aspects that should be considered when performing a specific measure
      3.1.2. Recommendations of user behaviour: pre-fabricated texts with recommendations about building user behaviour, which aim at reducing energy costs and/or optimising the use of the building
   3.2. Economic indicators
      3.2.1. Energy cost savings: possible energy cost savings led by the deep renovation
      3.2.2. Payback time: amortisation time until when initial investment costs will be paid back.
      3.2.3. Real estate value: real estate value adjustment due to increased building performance after deep renovation
   3.3. Non-energy benefits
      3.3.1. Thermal comfort: improvements related to the thermal sensation in the building
      3.3.2. Indoor air quality and productivity: improvements related to the air quality and its effect on productivity of building users
   3.4. Legal aspects
      3.4.1. Responsibility share: complexity of legal responsibility share between the parties involved
      3.4.2. Bureaucratic procedures: complexity bureaucratic procedures that can be a barrier not to perform the deep renovation
   3.5. Financial aspects
      3.5.1. Available incentives: the availability of incentives can be a decisive factor to perform the deep renovation. For example, owner-tenant split incentives could increase the interest of tenants on deep renovation
      3.5.2. Risk assessment: detailed assessment about the risks related to the deep renovation
   3.6. Trigger points: Relocation/disruption logistic

3.6.1. Technical: timing the deep renovation according to maintenance activities and/or material life cycles

3.6.2. Individual/personal: relocation (time, availability) or disruption (combine with other non-energy measures) generate individual motivation to perform (or not) the deep renovation

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