MAKING CHOICES FOR HOME RENOVATION

GUIDE FOR AN EFFECTIVE IMPLEMENTATION OF EPBD ARTICLE 9.2

BPIE

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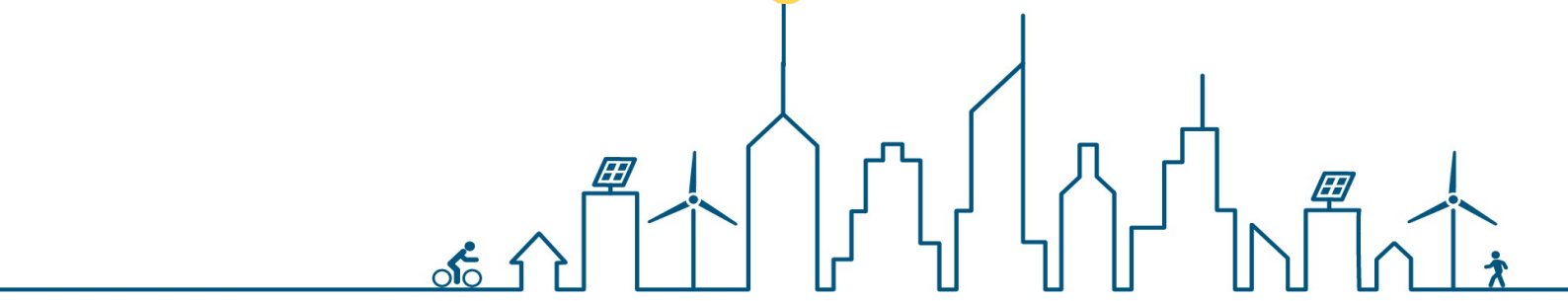


EXECUTIVE SUMMARY

Buildings represent the largest share of final energy consumption in the EU, accounting for around 40% of the total, and are responsible for approximately 36% of energy-related greenhouse gas emissions. The revised Energy Performance of Buildings Directive (EPBD) aims to address this challenge by setting high-level obligations for Member States to upgrade their residential building stock[1]. Article 9 of the EPBD mandates a progressive renovation trajectory with clear energy reduction targets and a focus on the worst-performing buildings.

The key requirements for residential buildings include:

- Reducing the average primary energy use of the entire residential building stock
  - by at least 16% from 2020 levels by 2030,
  - and by at least 20-22% from 2020 levels by 2035,
- Ensuring that at least 55% of the decrease in the average primary energy use is achieved through the renovation of the 43% worst-performing residential buildings.

This report provides a practical roadmap for Member States to design and implement renovation trajectories. It aims to support the trajectory design process by providing a practical, policy-oriented interpretation of Article 9.2 of the EPBD. The report complements other guidance documents by translating legal requirements into actionable, operational terms.

Central to this approach is the accurate assessment and segmentation of the residential building stock and distribution of buildings in each segment across energy performance levels. This would enable policymakers to identify buildings in greatest need of renovation and define targeted, effective policies to meet the energy reduction goals.

[1] Directive (EU) 2024/1275

Developing a national renovation trajectory hinges on three key steps:

1. **Segmenting the building stock** and **distributing buildings** in each segment per energy performance, ensuring a clear identification of the worst-performing buildings at the building stock level;
2. **Designing renovation scenarios** with policy instruments that would balance cost effectiveness with social equity and specifying energy renovation thresholds, depths, rates and support measures;
3. **Identifying an optimal renovation scenario** including policy instruments that meets EPBD targets on energy savings and focuses on worst-performing buildings.

Segmentation is a vital step in designing targeted renovation policies. Grouping buildings by their performance, structural and architectural characteristics, renovation suitability, or broader socio-economic considerations ensures consistent and predictable policy effects. After segmenting the building stock, each segment should be further distributed across energy consumption intervals using various data sources, such as Energy Performance Certificate (EPC) databases or utility sales records.

Once robust segmentation and distribution have been established and verified against national statistics, the worst-performing buildings should be identified at the building stock level. Furthermore, policymakers should develop renovation scenarios and policy instruments for each segment to specify renovation triggers, rates, depths, and support measures. Scenarios should be economically and technically feasible for various stakeholders, such as homeowners and financiers, and include social benefits, such as lower healthcare costs and productivity gains. Well-designed renovation support should motivate homeowners to consider and initiate renovation projects.

Following the identification of an optimal renovation scenario and relevant policy measures, Member States must translate these into a clear implementation strategy, in line with EPBD requirements — particularly those addressing the worst-performing segment of the building stock. The optimal scenario should identify renovation depths as well as renovation support that would achieve targeted renovation rates and primary energy reductions. By applying the same methodology across all EPBD milestones[2] and building stock segments, Member States can establish a robust, progressive renovation trajectory.

Finally, because the EPBD sets multiple interim benchmarks (e.g., for 2030 and 2035), Member States should adopt a multi-year perspective that integrates workforce capacity, financing, and political constraints to deliver the lasting reductions in primary energy use required by the directive.

[2] 2030, 2035, 2040, and every 5 years thereafter.

To effectively implement the approach outlined in this report and meet the EPBD Article 9 targets, Member States are advised to adopt the following measures:

Strengthen national data infrastructure

- Establish or improve centralised databases (e.g., national EPC databases) to gather detailed and reliable data on categories such as building stock size, performance, past renovation, and ownership. Draw on all relevant national and European data sources, such as national statistics offices and the EU Building Stock Observatory.
- Structure data sources for effective building stock segmentation according to its unique characteristics such as age, use, socio-economic criteria, location, climate, or ownership.
- Encourage standardised data collection methods across regions and property types to ensure consistency, accuracy, and comparability.
- Implement regular data quality checks by cross-referencing official statistics with other data sources to maintain an up-to-date overview of the building stock.

Develop flexible and well-informed renovation scenarios

- Thoroughly assess and use the potential of building renovation when designing renovation trajectories, ensuring it is not neglected in favour of building construction.
- Recognise and quantify the social benefits of renovation—such as improved health and reduced energy poverty—and integrate them into the design of support mechanisms.
- Clearly establish the relationship between renovation targets and renovation thresholds, depth, and support measures.
- Introduce well-structured renovation support mechanisms to:
- Ensure that renovation benefits are clearly communicated, and that renovation is made attractive to homeowners thanks to stable and consistent renovation support, and
- Support effective delivery of EPBD targets.

Carefully consider the worst-performing buildings

- Define clear policy instruments (e.g. mandatory renovation requirements, EPC rules for rentals[3], targeted subsidies, tax incentives, advisory services) to address the 43% worst-performing segment of the residential building stock.
- Couple financial support with regulatory measures, for instance by associating the share of subsidies in renovation costs with achieved energy performance improvements.
- Promote social equity by ensuring lower-income and vulnerable households in this segment receive sufficient financial and technical assistance to carry out deep renovations.

Consider and integrate the role of different stakeholders

- Work with financial institutions to clarify their role in easily accessible loan schemes, low-interest financing, and other mechanisms that reduce cost barriers in the various segments, and include these into renovation scenarios.
- In renovation scenarios, plan renovation rollouts that match the construction and financial sectors' capacity, gradually shifting the focus to medium- and long-term planning.

[3]As in the case of France.

INTRODUCTION

The Energy Performance of Buildings Directive (EPBD) is a key legislative tool designed to boost the energy efficiency and environmental performance of Europe's buildings. The EPBD recognises the severe impact buildings have on EU energy consumption and GHG emissions and therefore seeks to decarbonise the building stock and support the achievement of EU climate objectives.

In its efforts to renovate and decarbonise EU buildings, ***EPBD Article 9 sets out targets*** requiring EU Member States to develop a quantifiable national trajectory for the progressive renovation of the residential building stock and significantly reduce primary energy use in residential buildings before 2050.

This long-term approach includes interim benchmarks – anchored in 2030 and every five years thereafter – that set strict ***targets on primary energy use reduction*** relative to 2020 levels: a 16% decrease in the average primary energy use of the national residential building stock by 2030, and a 20–22% decrease by 2035.

In addition to setting overall energy savings targets, the directive clearly identifies parts of the residential building stock that must achieve them. It focuses on the least efficient buildings, defined as the worst-performing 43% of the residential sector. Under the ***worst-performing buildings target***, Member States must ensure that these buildings deliver at least 55% of the total residential energy use reductions. By prioritising renovations in buildings with the poorest performance, the directive is intended to drive significant energy savings and enhance living conditions in areas most affected by energy poverty.

The implementation of Article 9 requirements will require an in-depth examination of multiple renovation-related factors. These include the current performance of existing buildings, renovation costs and financing options, and ensuring that the national construction industry has the necessary skills and capacity to meet the directive's goals. Member States need to prepare to address this complex challenge in a timely and coordinated manner.

The report aims to support Member States in meeting the targets set by Article 9 (2) of the EPBD and in designing their national progressive renovation trajectories. It outlines the key steps involved in this process and explains the initial stages in detail. To enhance clarity and practical relevance, the final chapters present a concrete example and illustrate how these initial steps can be applied to a hypothetical residential building stock.

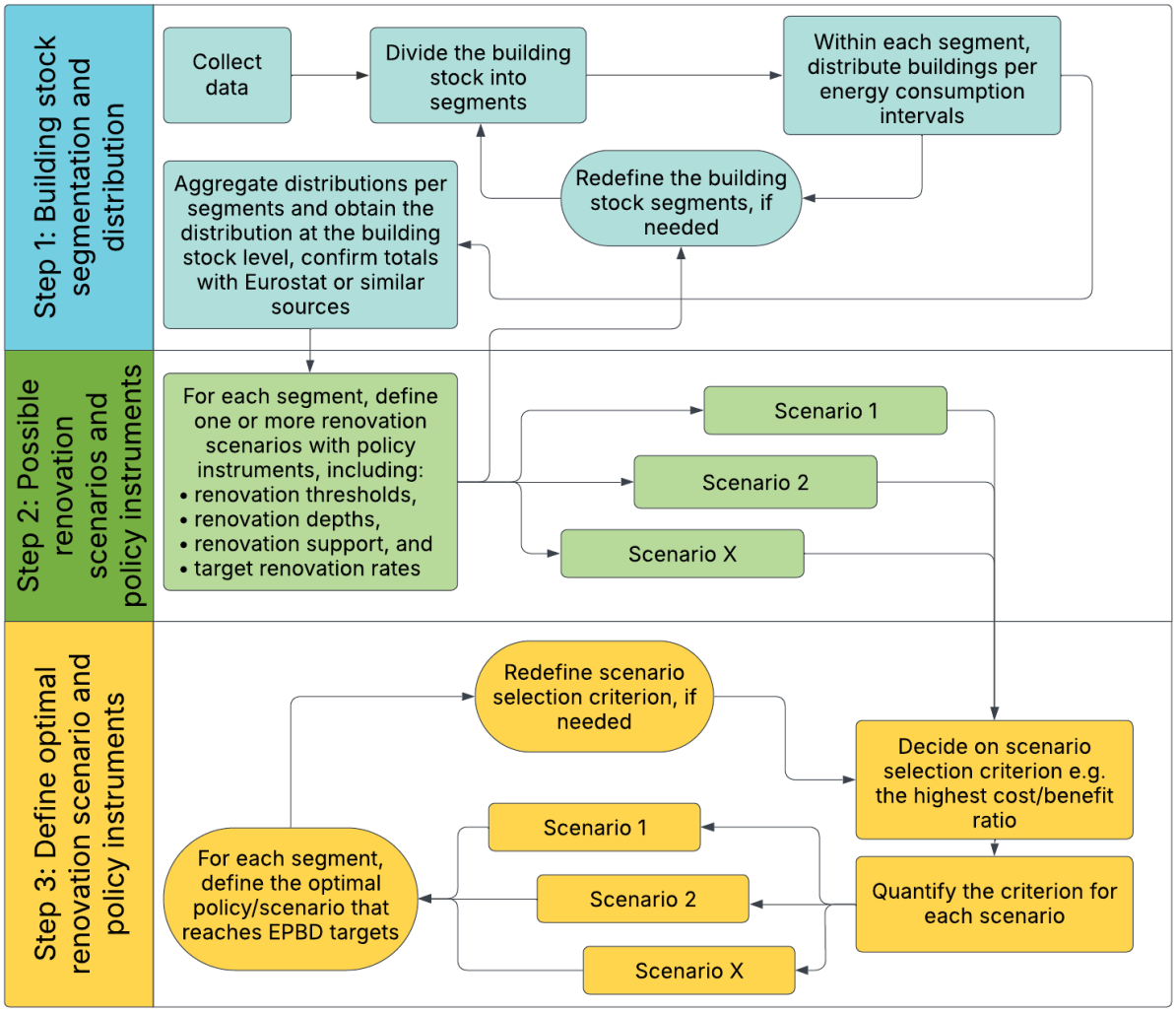
In explaining how national renovation trajectories can be designed, the report focuses exclusively on existing buildings. It does not account for reductions in average primary energy use achievable through new buildings or energy supply system interventions. As such, the report is intended to support Member States prioritising the renovation of their existing building stock as the approach to reducing energy use at the building stock level.

STEPS FOR DESIGNING NATIONAL RENOVATION TRAJECTORIES

This section outlines the process for designing a renovation trajectory for residential buildings tailored to a specific country. To enhance clarity and simplicity, the steps below focus on achieving one annual energy use reduction target, such as the 2030 target. When these steps are applied to all annual targets – while factoring in considerations like the capacity of the national construction industry and available financing – a comprehensive national renovation trajectory can be developed. The focus of the approach explained below is the renovation of existing buildings, excluding the impact of construction and demolition.

Figure 1 provides an overview of the three key steps in the process.

Figure 1: Steps for reaching EPBD targets



STEP 1: BUILDING STOCK SEGMENTATION AND DISTRIBUTION

The first step in creating a national renovation trajectory is to collect data and systematically organise the building stock into well-defined segments. This could draw on sources such as national statistical offices and the EU Building Stock Observatory. The segmentation should group buildings with similar characteristics, such as primary energy consumption, to ensure design and implementation of targeted policies. After segmentation, buildings within each segment should be distributed across energy consumption intervals, using useful floor area or number of buildings. This distribution can be represented graphically, with the horizontal axis indicating energy consumption levels and the vertical axis displaying either the number of buildings or the total floor area.

After generating segment-level distributions, they can be aggregated to produce a comprehensive distribution at the residential building stock level. This serves as the foundation for defining the threshold for the worst-performing buildings.

Step 1 is the primary focus of this report and is detailed further below.

Segmentation

Building stock segmentation involves grouping buildings based on key characteristics to ensure that specific policies have consistent and predictable effects across the building stock. For instance, achieving a specific renovation depth within a segment may require similar investments per square meter, yield comparable payback periods, and require similar financial support per square meter of floor area.

Buildings within the same segment should share similar energy and greenhouse gas performance, architectural and structural features, and renovation suitability from both economic and technical perspectives. To incorporate socio-economic parameters, additional information such as building occupation (primary or secondary residence, or vacant building), ownership status (rented or owner-occupied), and availability to vulnerable groups (e.g., social housing or occupied by people in energy poverty) can also be included.

Construction period[4] and building use are the most logical and practical criteria to start with. These factors significantly influence building performance, architecture, and renovation potential while being relatively easy to obtain and widely available for most residential buildings. An example of a building segment would include apartment buildings built in the 1980s used for social housing.

Once the building stock is segmented, the number of buildings or useful floor area within each segment should be distributed into energy consumption intervals. This distribution is crucial for several reasons. First, it helps refine the segmentation by identifying groups of buildings that are likely to respond similarly to renovation policies. Second, it is essential to accurately determine the threshold for the worst-performing buildings.

A balance must be maintained between accuracy and complexity when determining the size and number of energy performance intervals. Increasing the number of intervals enhance the precision of renovation scenario design and the definition of the worst-performing buildings threshold.

[4]Such as buildings built between 1981 and 1990.

Distribution

Distribution of buildings within a segment can be derived from various sources, such as national Energy Performance Certificate (EPC) databases, utility company sales records, or similar datasets.

A typical national EPC database may include detailed records of individual buildings, such as their age, size, geometry, construction materials, installed energy systems, energy consumption levels (e.g., energy need, final energy, or primary energy), and greenhouse gas (GHG) emissions. If the EPC database is sufficiently large, it can be used to determine the distribution of buildings or floor areas across different energy consumption levels and energy consumption intervals. This distribution can then be applied to the corresponding building stock segment.

When using EPC databases, it is crucial to provide a representative view of the building stock. Member States could distinguish between the events that triggered the production of an EPC and to select records that accurately represent the existing building stock. Given that only a small proportion of the EU building stock consists of new or energy-upgraded buildings, EPCs issued after construction or energy renovation will overestimate the performance of the existing building stock and should therefore be excluded. Instead, triggers such as the rent or sale of a building are more appropriate for providing a representative view of the building stock segments.

EPC and other databases can also be valuable in confirming or refining previous building stock segmentation approaches. For example, an analysis of an EPC database might reveal that geographic location significantly influences building characteristics. It could become evident that two buildings with the same use and construction period, but located in different regions of the same country, differ substantially in geometry and building envelope features, or can be exposed to different weather profiles. In such cases, building segmentation could be adjusted to include location as a criterion.

Upon completion of building stock segmentation and distribution of buildings within each segment distributed, quality checks should be performed to ensure accuracy and consistency. Quality checks should confirm that, when aggregated, the building stock segments match national statistics on the number of buildings, floor area, and energy consumption. National statistics are typically available from sources like national statistics offices, Eurostat, or similar organisations and may serve as a starting point for designing renovation trajectories.

Once the quality checks are finalised, the segmentation and distributions should be accurate and ready for use in developing the renovation trajectory.

DEFINING THE WORST-PERFORMING BUILDINGS AND THRESHOLDS

For the purpose of establishing national progressive renovation trajectories, the EPBD requires that the 43% worst-performing residential buildings be renovated. Accordingly, the worst-performing buildings are defined as those in the bottom 43% of the residential building stock when sorted by energy performance. The threshold for worst-performing buildings is, therefore, the energy consumption value, expressed in kWh/m²/year, above which 43% of the building stock is located.

While the threshold can be defined for each building stock segment, the EPBD specifies that worst-performing buildings are identified at the building stock level. In other words, the EPBD target—allocating 55% of the reduction in average primary energy use to the worst-performing buildings—does not necessarily have to be achieved at the segment level.

Determining the exact threshold for the worst-performing buildings to match precisely 43% of the building stock can be challenging. The primary reason for potential mismatches is the limited number of energy consumption intervals used in distributions.

The threshold for the worst-performing buildings will fall within a specific range, and the size of this range significantly affects the threshold's accuracy. If the threshold lies within the 170-180 kWh/m²/year range, it can be approximated as the midpoint of these values.

The worst-performing buildings are defined based on their energy performance *before renovation*. The EPBD targets are set with reference to the pre-renovation worst-performing buildings threshold and must be achieved accordingly. However, as the building stock undergoes renovation, the threshold for the worst-performing buildings, i.e. the threshold that would define the worst performing 43% of the building stock, shifts toward lower energy consumption values and better performing energy classes

BUILDING STOCK SEGMENTATION AND DISTRIBUTION EXAMPLE

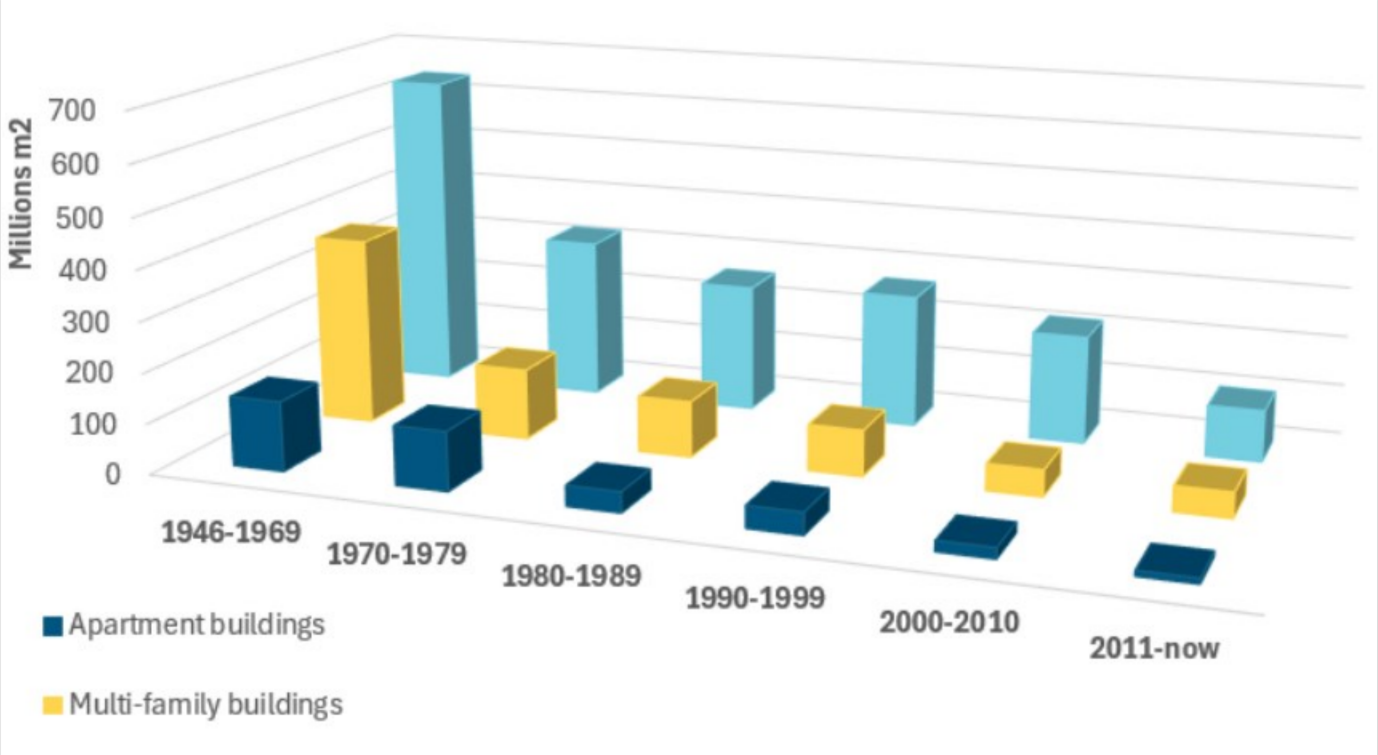
This section provides a practical example of segmenting a hypothetical residential building stock, distributing buildings within each segment, and determining the threshold for the worst-performing buildings. The hypothetical building stock used is not representative of any specific EU country.

Building stock segmentation

The example in Figure 2 explains how a hypothetical building stock can be segmented per construction period and building use. The segmentation is defined by seven construction periods and three building purposes[5], resulting in a total of 21 building stock segments. For each segment, statistics such as the number of buildings, useful floor area, or energy consumption can be provided.

Figure 2 shows useful floor area values for each of 21 segments in our hypothetical building stock. While the total useful floor area of the entire building stock equals 1.36 billion m^2, values obtained at the segment level vary from 10.7 million m^2 for apartment buildings built after 2011 to 172.7 million m^2 for single-family buildings constructed before 1945.

Figure 2: Useful floor area per construction period and building use



[5]The distinction between single-family, multi-family, and apartment buildings varies across different Member States and may depend on the number of dwellings and floors. More detailed information can be found in national building typologies available at https://episcope.eu/building-typology/.

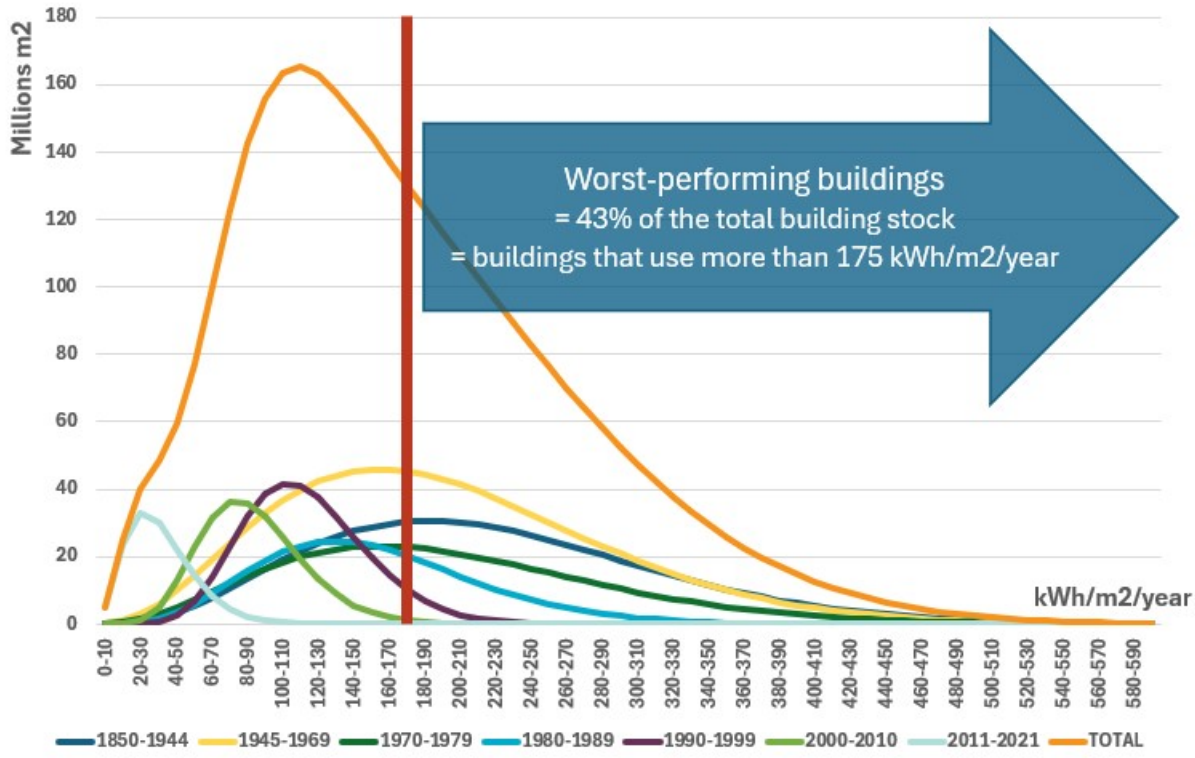
Building stock distribution and the worst-performing building threshold

Figure 3 explains how, within each segment of the hypothetical building stock, buildings can be distributed per energy performance intervals. For the sake of simplicity, distribution ignores the distinction between building uses and is applied to seven segments obtained per construction period only. Introducing segmentation per building use (or any other criterion) would follow the same approach and result in one graph per building use.

The example from Figure 3 illustrates the total useful floor area of 1.36 billion m², represented as the area under the curve marked as 'TOTAL.' This line depicts how the total building stock area is distributed across energy consumption intervals shown on the horizontal axis.

The threshold for the 43% worst-performing buildings is set at an annual energy use of 175 kWh/m², as marked by the red line. This indicates that the 43% worst-performing buildings are those consuming more than 175 kWh/m²/year.

Figure 3: Distribution of building stock and buildings stock segments per energy consumption intervals



[5]The distinction between single-family, multi-family, and apartment buildings varies across different Member States and may depend on the number of dwellings and floors. More detailed information can be found in national building typologies available at https://episcope.eu/building-typology/.

As shown in Figure 3, similar distributions can be generated for individual building segments, with each segment represented by one distribution line. As expected, older buildings have a higher energy consumption compared to newer buildings. For example, the majority of buildings constructed between 1970 and 1979 consume between 135 and 185 kWh/m²/year, whereas the majority of buildings constructed between 2000 and 2010 consume between 55 and 105 kWh/m^2/year.

While the threshold for worst-performing buildings can technically be determined at the segment level, it should be calculated and applied at the building stock level (i.e., the 'TOTAL' line). This approach ensures consistency and coherence with ***EPBD Article 9 targets***.

STEP 2: POSSIBLE RENOVATION SCENARIOS AND POLICY INSTRUMENTS

While this paper focuses on providing guidance on how to define building segment targets for policy design, it is important to understand the sequencing of next steps. The development of potential renovation scenarios with policy instruments will show how targets for primary energy use reduction and renovation of the worst-performing buildings can be achieved. To meet these targets at the residential building stock level, scenarios should determine renovation rates and depths for each previously defined building stock segment.

The granularity of inputs used for defining and quantifying policy scenarios will have a direct impact on their design and application. A granular overview of the residential stock, such as concerning ownership structure or building use will be essential to define renovation scenarios for each building stock segment. In addition to building stock segmentation elements, indicators listed under Annex II of the EPBD (such as the evaluation of the capacities in the construction, energy efficiency and renewable energy sectors, or the percentage of people affected by energy poverty) should be used as inputs or reflected upon in order to design scenarios.

In addition to other policy instruments, each renovation scenario must include key scenario elements:

- **Renovation thresholds**, expressed in primary energy consumption (kWh/m^2/year), used to identify buildings to be renovated,
- **Renovation depths**, to be applied to buildings above the renovation thresholds,
- **Renovation support measures**, such as financial support, and
- **Targeted renovation rates**, i.e. the rates expected to be achieved by implementing the key scenario elements and scenario policy measures.

An effective definition of renovation scenarios and the associated policy instruments must consider the links between the key scenario elements. For example, targeted renovation rate will be strongly linked to renovation threshold and depth, which should be properly reflected when designing each scenario. While some policy instruments can be defined in step 3, all scenario-dependent policy instruments must be identified in step 2.

Key scenario elements must align to ensure the feasibility of the renovation scenario, taking into account the perspectives of homeowners, occupants, financial institutions, and other stakeholders. For instance, the targeted renovation rate for a specific building stock segment will most likely depend on the economic performance of the renovation as perceived by the homeowners and financial institutions, as well as on the easiness of undertaking and completing renovation projects. Renovation support measures, such as financial support to homeowners, should therefore be developed alongside renovation thresholds and depths to make targeted renovation rates possible. Well-structured renovation support to homeowners can encourage homeowners to initiate renovation projects early on, reducing the need for significant government efforts, such as marketing campaigns.

In their attempt to encourage renovation, effective policies should benefit from identifying, quantifying and monetising social benefits of energy renovation, such as reduced public spending on healthcare or productivity increase. Extensive literature about such benefits is available and should be used as guidance for scenario development[7].

Renovation scenarios and their policy packages should be designed through a consultative process involving key stakeholders. Among others, this includes stakeholders directly impacted by the policy decisions and those who can contribute with valuable insights to support the design of scenarios. This will also satisfy the EPBD requirement for national consultations in the process of preparing the national building renovation plans and use the consultations to inform political decisions.

Ultimately, the renovation rates and depths for each building stock segment will determine energy use reductions at the residential building stock level and their share allocated to the worst-performing buildings.

[7] E.g. Building 4 People - Quantifying the benefits of energy renovation investments in schools, offices and hospitals, and Healthy Buildings Barometer 2024: How to deliver healthy, sustainable, and resilient buildings for people

STEP 3: THE OPTIMAL RENOVATION SCENARIO AND POLICY INSTRUMENTS

Several renovation scenarios can achieve or exceed the EPBD targets. The optimal renovation scenario including its set of policy instruments can be determined by maximising cost-effectiveness and/or renovation depth or minimising initial investments and/or required renovation subsidies.

The optimal renovation scenario should consistently reflect the societal benefits of renovating the building stock. It is therefore essential to incorporate societal impacts into the earlier steps of scenario development to ensure they are fully captured in the final assessment of different scenarios.

Stakeholder consultations remain essential in step 3. The optimal renovation scenario and policy package should be selected and confirmed in close collaboration with stakeholders to ensure informed and supported decisions.

Following the three steps we have described should deliver the optimal renovation scenario that achieves the EPBD targets while maximising the likelihood of success.

OUTCOME OF THE STEPS

Once the steps are implemented and the optimal renovation scenario is selected, Member States should have a clear strategy for (a) achieving the annual energy use reduction targets and (b) meeting the requirements for the worst-performing buildings.

As the final outcome, one renovation scenario including policy instruments should be defined for each building segment identified in Step 1. The renovation scenario may outline:

- Required number of buildings or floor area to be renovated[8],
- Renovation depth, and
- Type and size of renovation support, where applicable.

When aggregated, these values provide the overall figures for the entire residential building stock. The values obtained at the building stock level should then be used to validate compliance with the ***EPBD Article 9 targets***.

Applying the same steps to all annual energy use reduction milestones, while accounting for the worst-performing buildings, establishes a national trajectory for the progressive renovation of the residential building stock.

[8]Or indirectly, the renovation rate.

CONCLUSIONS AND RECOMMENDATIONS

To effectively design national renovation trajectories that meet EPBD Article 9 requirements, policymakers should adopt a clear, data-driven strategy. This is especially critical given the central role of buildings in realising the climate and energy transition and the key role of associated targets, which encompasses not only the size of energy reductions but also how these should be allocated to the worst-performing buildings and the rest of the building stock.

Trajectory design begins with a meticulous building stock segmentation. By defining energy consumption intervals and thresholds, policymakers can answer both elements – energy reductions and the contribution of the worst-performing buildings. Reliable segmentation and distribution depend on **consistent and representative data** so that realistic renovation scenarios can be developed.

While more granular segmentation yields greater precision, it also adds complexity to policy design and implementation. **Policymakers must therefore ensure that segmentation remains practical for local authorities, building owners, and the construction sector.** A step-by-step scenario-building process – eventually specifying which buildings and by how much they should be renovated, as well as adequate support measures — should drive actions toward required renovation rates and overall EPBD targets.

Finally, because the EPBD sets multiple milestones (e.g., for 2030 and 2035), **Member States need to adopt a multi-year perspective that integrates workforce capacity, financing, and political constraints.** This longer-term view helps avoid short-term strategies that might fail to deliver the lasting reductions in energy consumption the directive demands.

To effectively implement the approach outlined in this report and meet the targets set forth in EPBD Article 9, Member States are advised to adopt the following measures:

Strengthen national data infrastructure

- Establish or improve centralised databases (e.g., national EPC databases) to gather detailed and reliable data on key categories such as building stock size, performance, past renovation, and ownership. Draw on all relevant national and European data sources, such as national statistics offices and the EU Building Stock Observatory.
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- Encourage standardised data collection methods across regions and property types to ensure consistency, accuracy, and comparability.
- Implement regular data quality checks by cross-referencing official statistics with other data sources to maintain an up-to-date overview of the building stock.

Develop flexible and well-informed renovation scenarios

- Thoroughly assess and use the potential of building renovation when designing renovation trajectories, ensuring it is not neglected in favour of building construction.
- Recognise and quantify the social benefits of renovation—such as improved health and reduced energy poverty—and integrate them into the design of support mechanisms.
- Clearly establish the relationship between renovation targets and renovation thresholds, depth, and support measures.
- Introduce well-structured renovation support mechanisms to:
  - Ensure that renovation benefits are clear, and renovation is attractive to homeowners thanks to stable and consistent renovation support, and
  - Support effective delivery of EPBD targets.

Carefully consider the worst-performing buildings

- Define clear policy instruments (e.g. mandatory renovation requirements, EPC rules for rentals[9], targeted subsidies, tax incentives, advisory services) to address the 43% worst-performing segment of the residential building stock.
- Couple financial support with regulatory measures, for example, by associating the share of subsidies in renovation costs with achieved energy performance improvements.
- Promote social equity by ensuring that lower-income and vulnerable households in this segment receive sufficient financial and technical assistance to carry out deep renovations.

Consider and integrate the role of different stakeholders

- Work with financial institutions to clarify their role in easily accessible loan schemes, low-interest financing, and other mechanisms that reduce cost barriers, in the various segments, and include these into renovation scenarios.
- In renovation scenarios, plan renovation rollouts that match the construction and financial sectors' capacity, gradually shifting the focus to medium- and long-term planning.

[9]As in the case of France.