EPBD.wise

Bringing European Building Policy to Life

Development of NBRP:

Policy guidelines for Romania

Ece Özer, Irma Imamovic, Lukas Kranzl, Paul Söder, Andreas Müller, Francesca Conselvan, Sara Ortner

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Authors

Ece Özer, Irma Imamovic, Lukas Kranzl, Paul Söder – TU Wien

Andreas Müller, Francesca Conselvan – e-think

Sara Ortner – ifeu

Reviewers

Bettina Sticher, Susanne Geissler – SERA Global

Denisa Diaconu – BPIE

Romane Faure – Efficient Buildings Europe

Design

Publishing Bureau

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EPBD.wise aims to kickstart action to bring Europe's buildings directive to life and make our climate goals a reality. Over the course of three years, project partners work with public authorities (such as municipalities, energy agencies, etc.) in six European countries (Bulgaria, Greece, Hungary, Poland, Romania, and Ukraine) for the design, implementation, and evaluation of key provisions to ensure our buildings are in line with our climate goals. Starting with the six focus countries, EPBD.wise builds a replicable model to support the widespread implementation of these measures across Europe.

Focus country reviewers
Mihai Moia – ROENEF

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LIST OF ABBREVIATIONS

BSO	Building Stock Observatory
DH	District heating
EC	European Commission
EED	Energy Efficiency Directive
EPBD	Energy Performance of Buildings Directive
ETS2	Emissions Trading System 2
EPC	Energy performance certificates
FCCP	Focus country contact point
FED	Final energy demand
GHG	Greenhouse gas
JRC	Joint Research Centre
LTRS	Long-term renovation strategy
MEPS	Minimum energy performance standards
MFH	Multi-family house
MR&E	Monitoring, reporting, and evaluation
NBRP	National building renovation plan
NECP	National energy and climate plan
NZEB	Nearly zero-energy buildings
PED	Primary energy demand
PEF	Primary energy factor
PNIESC	Romania's Integrated national energy and climate plan
PNRR	Romania's Recovery and Resilience Plan
RED III	Renewable Energy Directive
RES-H	Renewable energy sources for heating
RP	Renovation passport
SFH	Single-family house
SME	Small and medium-sized enterprises
V/A	Volume/surface
WPB	Worst-performing buildings
ZEB	Zero-emission building

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EXECUTIVE SUMMARY

This document provides policy guidelines for implementing the national building renovation plan (NBRP) in Romania, in accordance with Article 3 and Annex II of the Energy Performance of Buildings Directive (EPBD) 2024/1275. It offers support and recommendations to Romanian stakeholders and policymakers for developing a comprehensive NBRP that aligns with EU decarbonisation objectives and the goal of transforming the national building stock into zero-emission buildings by 2050.

The NBRP is a strategic policy instrument that requires Member States to establish a clear roadmap toward achieving a highly energy-efficient and decarbonised building stock. This document addresses Romania's specific challenges by providing guidance on building stock data collection, scenario development, policy measure design, stakeholder engagement, and monitoring frameworks. It builds on Romania's existing long-term renovation strategy (LTRS) and the policy needs identified through stakeholder consultations conducted under the EPBD.wise project.

BUILDING STOCK ASSESSMENT

Romania's building stock presents significant data challenges, particularly for the non-residential sector where comprehensive information on energy performance remains limited. The document recommends a multi-method approach to establishing the required building stock data foundation, combining EPC databases (where available), measured consumption data, archetype-based modelling, and statistical distributions. Given Romania's current data limitations, priority should be given to establishing a comprehensive national building stock database that integrates EPC data, building permits, public funding records, and market information such as sales of insulation materials and heating systems. Remote sensing and georeferencing techniques should be piloted to visualise renovation patterns and identify unreported activities.

SCENARIO ANALYSIS AND MODELLING

Using the Invert/EE-Lab building stock model, this report assesses five policy scenarios for Romania's building sector from 2021–2050, examining how different combinations of regulatory measures, carbon pricing, and financial support affect energy demand, emissions, and renovation activity.

Key scenario findings for Romania:

- Final energy demand reduction: The scenario based on strong regulatory measures (Regulatory+) achieves the most substantial reductions, with final energy demand declining from approximately 90 GWh/yr in 2021 to 45 GWh/yr by 2050 – a reduction of approximately 50%. Scenarios without comprehensive regulatory measures (Mix, Pure economic, Moderate) achieve more modest reductions of 17–22%.
- Renewable energy share: Romania demonstrates strong potential for renewable energy growth in the residential sector, with all scenarios projecting increases from approximately 45% in 2020 to 88–100% by 2050. This reflects both new renewable heating installations and the phase-out of fossil fuel systems.
- Heating system transformation: Under the Regulatory+ scenario, coal-heated floor area is virtually eliminated by 2050, while electricity (primarily heat pumps) and renewable district heating expand significantly. Biomass heating remains dominant, reflecting Romania's traditional reliance on wood-based heating systems.

Based on the scenario analysis and stakeholder consultations, the following **key recommendations** emerge for Romania's NBRP:

- **Legislative and regulatory framework:** It is important to anchor the NBRP in the Article 9 trajectories of the EPBD and establish clear, enforceable MEPS. Implementation should begin with the non-residential sector, then expand to the residential stock using a staged approach with milestones for 2030 and 2035. The NBRP should define and operationalise ZEB thresholds, incorporating them into the national compliance framework.
- **Institutional arrangements:** A national EPC database governance framework should be established to improve data quality, coverage, and interoperability. Romania should establish a standing stakeholder forum comprising ministries (MDLPA, ME, MIPE), local authorities, energy agencies, and professional associations to facilitate coordination and policy co-creation. This can build on existing structures such as the CIC PNRR (Interministerial Coordination Committee for the National Recovery and Resilience Plan).
- **Technical and analytical infrastructure:** The NBRP should prioritise developing a comprehensive building stock database integrating multiple data sources. Romania should pilot remote sensing techniques to validate renovation statistics and identify gaps between urban and rural areas.
- **Financial measures:** Financial instruments should be designed to support deep renovations, with targeted subsidies for envelope measures and renewable heating systems. Priority should be given to energy-poor households and public buildings. The NBRP should align with Romania's PNRR Component 5 – The Wave of Renovation (€2.9 billion) and Modernisation Fund allocations.

Effective NBRP development requires inclusive public consultations engaging local and regional authorities, building owners, construction professionals, financial institutions, and civil society organisations. While Member States were required to submit draft NBRPs by December 2025, public consultations remain essential for the final NBRP submission in December 2026.

NBRPs serve as both planning instruments and frameworks for monitoring, reporting, and evaluation (MR&E). The document recommends combining multiple complementary data sources: EPC databases, financial support programme records, building permits, and professional surveys. For Romania, establishing reliable EPC infrastructure and systematically expanding data collection, both by increasing coverage rates and conducting regular surveys among construction professionals and building owners, will be crucial for effective monitoring.

The NBRP must ensure consistency with the broader Fit for 55 framework, including the Energy Efficiency Directive (EED) and Renewable Energy Directive (RED III). It should also align with Romania's Integrated national energy and climate plan (PNIESC), which provides the overarching framework for national energy and climate policy coordination.

Romania faces significant but manageable challenges in developing an effective NBRP. The scenario analysis demonstrates that achieving the EPBD's energy reduction targets requires a mix of policy instruments, including regulatory measures in both the residential and non-residential sectors. Scenarios relying solely on economic instruments achieve substantially lower energy savings, according to the analysis in this study. By combining robust regulation, institutional coordination, targeted financial support, and practical implementation mechanisms, Romania can accelerate its progress toward a decarbonised, energy-efficient, and socially inclusive building sector aligned with the 2030 and 2050 EU targets.

INTRODUCTION

1.1 SCOPE AND OBJECTIVES OF THE DELIVERABLE

This document provides guidelines for policymakers on setting up national building renovation plans (NBRPs) according to EPBD Article 3 and Annex II in Romania. It builds on the existing long-term renovation strategies (LTRS) introduced by the amending Directive (EU) 2018/844 (see Chapters 1.4 and 1.5) and the policy needs and good practice examples identified in a previous phase of the project [1]. A relevant part of the report focuses on developing scenarios for renovating building stocks and establishing the necessary database.

This document provides support and recommendations to stakeholders and policymakers for the development of NBRPs. In particular, it identifies the specific parts in the NBRP template provided in EPBD Annex II to which the policy guidelines provide targeted inputs. The drafting of the NBRP is closely connected to the development of other policy elements specified in the EPBD. In particular, there is a strong link between NBRPs and the provisions in Article 9 of the EPBD, since the trajectories of progressive building renovation for residential buildings and minimum energy performance standards (MEPS) for non-residential buildings form an integral part of the projections to be presented in the NBRP, namely in terms of targets to be achieved and the policy measures required to reach them.

Thus, both documents – the policy guidelines for Article 9 and the one for NBRP – refer to each other in specific points [2]. Additionally, certain elements, such as the description of scenario assumptions and the modelling approach outlined in this document, are also relevant to Article 9. Table 1 provides an overview of how the content is organised across the two reports. Reading both policy guideline documents together is considered helpful for a complete understanding.

TABLE 1: DISTINCTION OF CONTENT REGARDING POLICY GUIDELINE DOCUMENTS FOR NBRP AND ARTICLE 9

	Policy guideline NBRP (D2.2)	Policy guideline Article 9 (D3.2)
Building stock data	Data collection and description of building stock data, including its distribution regarding energy consumption levels	How to derive the worst-performing buildings and 16th/26th quantile thresholds for minimum energy performance standards
Modelling assumptions and scenario design	Overall modelling approach, scenario design, and scenario framework data (e.g. energy prices)	Specific elements affecting the effectiveness of the Article 9 instrument, such as the evolution of primary energy factors
Scenario results	Overall pathway results, e.g. in terms of final energy demand by energy carrier	Specific results showing the target achievement of Article 9, split by residential and non-residential buildings
Checking target achievement	Overall evaluation of target achievement, including ZEB consistency, RED III consistency, and fossil fuel phase-out	Article 9 targets, in particular, focus on the compliance of the trajectories for residential buildings
Stakeholder engagement	Included	Not included
Monitoring, evaluation	Monitoring of renovation activities and establishing a continuous feedback and evaluation mechanism	Focus on the compliance with MEPS (non-residential buildings)

1.2 STRUCTURE OF THE DELIVERABLE

This deliverable is structured to provide a comprehensive framework for implementing NBRP according to the Energy Performance of Buildings Directive (EPBD) (2024/1275) [3]. Chapter 2 summarises the policy needs identified through consultations with stakeholders and good practices relevant to Romania. Chapter 3 provides an overview of the building stock data for the three countries and explains how to use this data to evaluate the target achievements outlined in the EPBD. Chapter 4 conducts scenario analyses to examine the potential effects of varying policies. Chapter 5 presents the strategies for monitoring and evaluation. Chapter 6 discusses the interaction with other policy elements. Chapter 7 is the main section of the document, where country-specific policy guidelines and recommendations are presented for Romania. The final chapter summarises the key findings and provides practical advice to policymakers.

1.3 METHODOLOGY AND APPROACH

This chapter outlines the general approach and main steps required for setting up the NBRP. Figure 1 illustrates a three-step methodology, starting with assessing the data on the current building stock, which is also used for identifying the worst-performing buildings (WPB). This provides the input for modelling projections of building renovation, based on the assumption of policy measures. Policy measure assumptions and modelling results must be considered iteratively in the stakeholder discussion process. Integrating this with the complete set of policy instruments and components of the EPBD needs to be collected in the NBRP report.

STEP 1: BUILDING STOCK DATA COLLECTION AND IDENTIFYING THE WPB

The first step of the process consists of collecting data on the current building stock and ongoing building activities. Reliable and comprehensive data collection is essential for evaluating a building's energy performance and overall condition. The key objective is to identify the **WPBs:** buildings with high energy consumption, low energy class, or a certain construction period and renovation status.

This is facilitated by a cyclical interaction between **data** and **WPB classification**, ensuring the most critical cases are prioritised for renovation. Accurate data sources may include energy performance certificates (EPCs), renovation rates, and historical consumption patterns.[1,2]

STEP 2: MODELLING, POLICIES AND MEASURES, AND STAKEHOLDER ENGAGEMENT

Once the data on the building stock is set up and WPBs have been identified, the process moves toward designing policies, measures, and related decision-making. This step involves three key elements:

1. **Modelling:** Using data-driven models to assess renovation scenarios, predict energy savings, and optimise investment strategies. In this study, we use the building stock model Invert, described in more detail in Chapter 4.5.
2. **Policies and measures:** Developing regulatory frameworks, financial incentives, and renovation guidelines to support energy efficiency improvements. In particular, measures in line with Article 9 of the EPBD must be considered. Within this study, we focus on the role of minimum energy performance standards (MEPS), CO_2 prices, investment subsidies, and different development pathways of primary energy factors (see Chapter 4). These policy instruments were selected because they represent the core mechanisms available to Member States for driving building renovation: MEPS provide regulatory requirements that mandate action on the worst-performing buildings; CO_2 pricing creates economic incentives for fuel switching and efficiency improvements; and subsidies address financial barriers that often prevent building owners from undertaking renovations. The interaction between these instruments determines the pace and depth of building stock transformation.

1 For the building stock data analysis in this project, we rely on existing data sources and proven approaches, as described in Chapter 3.

2 For Poland, additional details on building stock data and worst-performing building identification are provided in Deliverable D3.2.

3. **Stakeholders:** Collaboration among policymakers; local, regional, and national authorities; researchers; building owners; civil society; financial institutions; and other partners listed in Article 3 of the EPBD is essential to ensure the feasibility and effectiveness of renovation strategies.

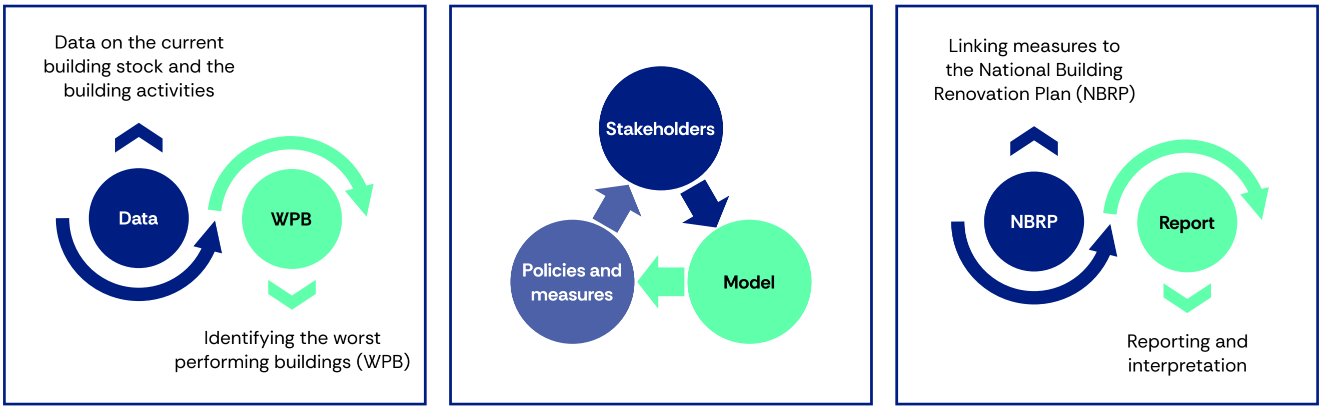
The results of this report were discussed with stakeholders in the framework of dedicated policy forums. More detailed guidelines for framing this stakeholder engagement process are discussed in Chapter 7. For comprehensive guidance on monitoring, reporting, and evaluation of NBRP implementation, see Deliverable D6.3 An integrated monitoring, reporting and evaluation framework for effective EPBD implementation.

The interplay between these three components ensures that renovation efforts are achievable and aligned with national and European climate goals.

STEP 3: LINKING MEASURES TO THE NBRP AND RELATED TARGETS

The final step is to integrate the identified measures into the NBRP. A feedback loop links the proposed renovation measures to the specific targets and milestones defined in the EPBD, including the 2030 and 2035 trajectories for residential buildings and MEPS compliance for non-residential buildings. A feedback loop should be established in the drafting phase of the NBRP to ensure continuous monitoring and policy evaluation, and to maintain this link with long-term goals. This will help policymakers evaluate the effectiveness of implemented measures and make necessary adjustments to improve outcomes.

FIGURE 1: STEPWISE APPROACH TO DERIVE TRAJECTORIES FOR A PROGRESSIVE DECREASE IN THE AVERAGE PRIMARY ENERGY USE



1.3.1 INTERFACE WITH ARTICLE 9

The development of NBRPs is closely linked to the implementation of Article 9 of the EPBD, which establishes minimum energy performance standards (MEPS) for non-residential buildings and progressive renovation trajectories for residential buildings. Both instruments share common data requirements, particularly regarding building stock characterisation and the identification of worst-performing buildings. The scenario analyses and modelling approaches presented in this document are directly relevant to Article 9 implementation, as they inform the feasibility and impact of different MEPS trajectories. For detailed guidance on Article 9 implementation, see the companion policy guideline in Deliverable D3.2.

1.4 DESCRIPTION OF THE NBRP FRAMEWORK UNDER EPBD (2024/1275)

NBRPs are introduced with the Directive (2024/1275) in Article 3, under which each Member State shall establish a plan to ensure the renovation of the national stock of residential and non-residential buildings, both public and private, into a highly energy-efficient and decarbonised building stock by 2050, and transform it into zero-emission buildings (ZEBs) by 2050 [3]. The NBRPs are not just a reporting obligation under the EPBD; they are a strategic policy tool essential in steering the long-term evolution of the national building inventory. Buildings account for a large share of the EU's total energy use and greenhouse gas emissions. Consequently, NBRPs present an essential tool for Member States to synchronise their national initiatives with the EU's goal of achieving climate neutrality by 2050. Through establishing specific objectives, recognising investment requirements, and aligning policy efforts across various sectors and governance tiers, NBRPs act as a detailed guide for achieving a highly energy-efficient and emission-free building stock. Additionally, they assist in incorporating broader societal objectives, such as reducing energy poverty, fostering job creation, and enhancing indoor environmental quality, making them essential tools for achieving a fair and inclusive energy transition. Article 3 outlines that each NBRP must include:

- An overview of the national building stock for different building types, including their share in the national building stock, construction periods, and climatic zones; an overview of market barriers and market failures; an overview of the capacities in the construction, energy efficiency, and renewable energy sectors; and the share of vulnerable households.
- A roadmap with nationally established targets and measurable progress indicators, including the reduction of the number of people affected by energy poverty, with a view to achieving the 2050 climate neutrality goal, in order to ensure a highly energy-efficient and decarbonised national building stock, and the transformation of existing buildings into ZEBs by 2050.
- An overview of implemented and planned policies and measures.
- An outline of the investment needs for the implementation of the NBRP, the financing sources and measures, and the administrative resources for building renovation.

- The thresholds for the operational greenhouse gas emissions and annual primary energy demand of a new or renovated ZEB.
- Minimum energy performance standards (MEPS) for non-residential buildings.
- National trajectory for the renovation of the residential building stock, including the 2030 and 2035 milestones for average primary energy use in kWh/(m^2.y).
- An evidence-based estimate of expected energy savings and wider benefits, including those related to indoor environmental quality.

Annex II of the Directive (2024/1275) provides additional information on the mandatory and optional indicators to be included in the NBRP. For example, it specifies that Member States must report on primary and final energy consumption, annual operational greenhouse gas (GHG) emissions, and the annual renovation rate of the national building stock. Optional indicators include aspects such as the number of EPCs per construction period, the reduction in energy costs per household, and the number of jobs created in the renovation sector.

Member States must submit the first draft of NBRPs to the Commission by 31 December 2025. To support Member States in this process, the European Commission has published guidance and provided an NBRP template, which consists of an Excel sheet for targets, indicators, and measures, as well as a Word template for the NBRP narrative. The final guidelines were published in June 2024.

1.5 STATUS OF PREVIOUS LTRS AND SCENARIO WORK

This chapter provides an overview of the LTRS, including its status and main elements, for Romania. The chapter summarises the available data, including information on the building stock, energy performance characteristics, and renovation needs, as well as the scenarios and modelling assumptions used to project renovation pathways up to 2050.

Although the level of detail and structure varies across countries, all three strategies aim to identify cost-effective renovation trajectories that align with national climate and energy goals while addressing technical, financial, and institutional challenges.

The following sections summarise the content of Romania’s LTRS.

Romania’s LTRS presents a comprehensive overview of the national building stock and energy consumption patterns, outlining key data and projections relevant to the residential and service sectors. The document provides a detailed foundation for assessing renovation needs and identifying potential pathways toward a more energy-efficient building stock.

The available data in Romania's LTRS cover both structural and energy performance aspects of the building sector, including:

- Energy consumption (primary, final, residential sector, and services) comparison between 2010 and 2016.
- Primary and final energy consumption in Mtoe, including allocation by sector, from 2005–2017.
- Energy consumption in buildings in Romania, from 2013–2016 (Mtoe).
- Share of buildings by building categories (SFH, MFH, education, health, administration and offices, commercial).
- Building stock – main characteristics and shares of the renovation pace, estimated until 2020.
- Breakdown of building stock by year of construction.
- Final energy consumption by sector in Romania.
- Final energy consumption by building category (commercial buildings, administrative, health, education, residential SFH).
- Annual building renovation rates per scenario.
- Comparison of renovation benefits per scenario by 2030.
- Renovated building area, number of beneficiaries, and value of investments per scenario.
- Energy savings for scenarios.
- Reduction of CO_2 emissions for scenarios.
- Increased share of renewable energy for scenarios.
- Results, impact indicators, and milestones of building renovation.

Based on these datasets and analyses, the Romanian LTRS develops three renovation scenarios reflecting different levels of ambition, implementation pace, and market readiness:

SCENARIO 1:

Scenario 1 considers renovations with a staggered increase of 0.53–1.56% per year (above the reference value of approximately 0.5% per year). This scenario initially projects only a modest increase in the pace of renovation, which can be useful in the first decade to design and introduce new financial mechanisms, develop a consolidated national programme, assign new responsibilities to various public authorities, and establish market capacities. However, this will require a more substantial increase in the coming decades (i.e., from 2030–2050) to achieve the 2050 target.

SCENARIO 2:

Scenario 2 corresponds to a more ambitious increase in the renovation pace for the first decade aiming to achieve greater savings by 2030 and a higher share of the worst-performing buildings. This scenario focuses more on multi-family buildings (approximately 40%) as they offer the highest potential for energy savings and CO_2 emission reductions.

SCENARIO 3

Scenario 3 reflects renovation rates equally distributed over each decade. Such a scenario would be challenging to implement in the first decade, as the market might not be ready for such a high renovation pace, and funding would be more difficult to mobilise. However, this would reflect more accurately the pace needed to achieve the 2050 targets and interim targets.

SUMMARY OF THE POLICY NEEDS AND BEST PRACTICE EXAMPLES

The key policy needs related to developing and implementing NBRPs were identified in the scope of Deliverable D2.1. Our approach consisted of comprehensive desk research, analysing existing projects and related reports to establish a baseline understanding of policy needs in focus countries. We conducted a detailed questionnaire in Romania and other focus countries within the EPBD.wise project. Subsequently, we organised workshops with focus country contact points (FCCPs) and policy forums in Romania to better understand national needs and the specific situation.

This multi-faceted research approach enabled us to identify specific policy needs for each focus country. From this analysis, countries prioritised some policy elements based on their unique needs; for Romania, NBRPs were identified as one of the priorities. Moreover, our findings must not only cater to the immediate needs of these focus countries but also remain applicable and replicable for other EU countries. This broader vision ensures that the strategies and policy recommendations developed can serve as a model for harmonised building renovation policies across the entire European Union (EU).

The identification of policy needs was complemented by the identification of good practice examples. This process included quantitative and qualitative analysis, stakeholder engagement, legal and administrative screening, and evaluation techniques. Based on the Joint Research Centre's (JRC) report, good practice examples were compiled for Deliverable D2.1. The report assessed each LTRS, evaluated the strategies' compliance with the Directive, and checked if all the requirements were adequately addressed in each national strategy [3]. Table 2 provides an overview of the policy needs identified across the focus countries, along with corresponding good practice examples from other Member States.

TABLE 2: OVERVIEW OF POLICY NEEDS

General challenge addressed	Specific challenge addressed	Policy needs (1–7)	Good practice example
Data availability, accessibility, and quality for effective policymaking	Building stock overview (residential and non-residential)	1	Italy
Good governance	Public consultation	–	Slovakia
	Policies and actions on public buildings	2	Wallonia, Belgium
	Implementation details on the latest LTRS	2	Spain
	Policies and actions on deep renovations of buildings, including staged deep renovation and RPs	2, 6	Wallonia, Belgium
	Policies and actions on WPB and energy poverty	2, 4, 6	Spain
Construction industry and labour and skill shortages	An overview of national initiatives to promote smart technologies, as well as skills and education in the construction and energy efficiency sector	–	Wallonia, Belgium
Clear presentation of co-benefits	Expected energy savings and wider benefits	6, 7	Lithuania
Estimation of the impacts, in particular, of the broader benefits of energy efficiency	Roadmap with indicative milestones (decarbonisation, renovation rate, renovation of building stock, energy savings)	7	Finland
	Cost-effective approach to renovation (identification of trigger points)	2, 7	Lithuania
Financing	The mechanisms for mobilising investments (the aggregation of projects under single or multiple ownership to make them more attractive to investors, the reduction of the perceived risk of energy efficiency financing for investors and the private sector, the use of public funds to leverage private investment, the guidance of investments into an energy-efficient public building stock, the provision of better advice in the market, such as one-stop shops)	3	Wallonia, Belgium

There is a lack of comprehensive data on Romania's existing building stock. The country would significantly benefit from dedicated support in developing a comprehensive NBRP that aligns with the objectives outlined in the EPBD. This entails developing robust data collection and analysis methodologies essential for identifying priority renovation areas and allocating resources efficiently. Furthermore, Romania would benefit from guidance on integrating these plans with broader economic and environmental policies, ensuring a holistic approach to building renovation that supports sustainable development.

3

BUILDING STOCK DATA AS A STARTING POINT[3]

This chapter addresses Section (a) of the NBRP template in Annex II of the EPBD, which requires Member States to provide an overview of the national building stock. The data and methods presented here directly support policymakers to complete sections of the template related to building stock characteristics, energy performance distribution, and identification of worst-performing buildings.

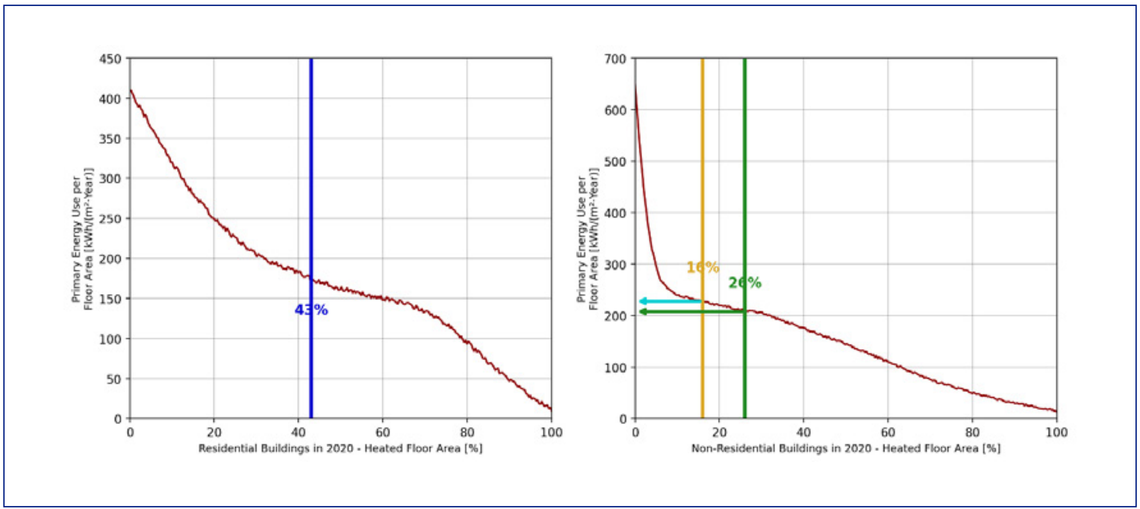
THE NBRP CONTAINS THE FOLLOWING THREE MAIN PARTS:

1. **Overview of the national building stock.**
2. **Roadmap for 2030, 2040, 2050.**
3. **Overview of implemented and planned policies and measures.**

In this regard, building stock data is a key starting point for developing the NBRP, particularly for assessing the target achievements laid out in the EPBD. The development of NBRPs requires a description of the building stock, among others, along two dimensions: ① conditioned floor area and ② primary (or final) energy use per floor area, each for both residential and non-residential buildings. The resulting distribution curve is needed to derive the 43% share of WPB on the one hand and the 16th and 26th quantiles for non-residential buildings on the other hand.

3 As described in Chapter 1.1, there are links between the policy guideline documents of NBRP and Art 9. In particular, regarding building stock data, the analyses regarding Article 9 build on the concepts and data described here.

FIGURE 2: DISTRIBUTION CURVE OF THE BUILDING STOCK (PRIMARY ENERGY USE OVER CONDITIONED FLOOR AREA OF THE BUILDING STOCK) AS A KEY REQUIREMENT



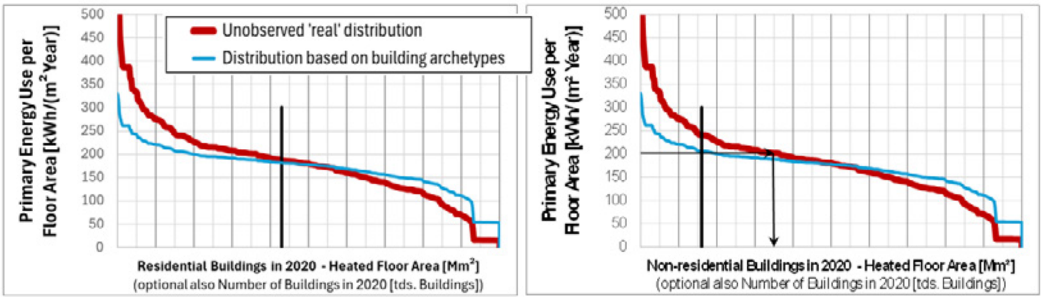
3.1 METHODS FOR COMPILING BUILDING STOCK DATA AND RELATED ENERGY USE

There are four main approaches to derive the primary energy use data needed:

1. Archetype-based (reference buildings) bottom-up modelled results based on geometries and U-values, installed technology (e.g. EU Building Stock Observatory (BSO)).
2. Measured energy consumption data for a representative sample of buildings.
3. EPCs (from a representative sample for the whole building stock).
4. Statistical approach (applying distribution functions).

The archetype-based approach can build on reliable data sources such as the BSO [4], national building stock statistics, or other sources such as Tabula/Episcope [5]. However, essential data elements are often missing, such as the share of previously performed building renovation activities for the split of heating systems on different building segments or vintage classes (construction periods). Here, expert opinions or additional data may be necessary. By comparing data from measured energy consumption of buildings (red line), which is typically unobserved, with the distribution based on the archetype approach (blue line), Figure 3 shows that the actual distribution might be steeper, i.e., the archetype-based approach might underestimate the variance of the distribution. If the actual implementation and measurement of achievements for non-residential buildings were based on actual energy consumption (i.e., the red curve), while the setting of the 16th and 26th percentile thresholds is based on the archetype approach, this could lead to a significant deviation in the case of non-residential buildings. In the case shown on the right-hand side of the figure, it would mean that not 16% but rather 35% would need to be renovated. Such a distortion obviously should be avoided.

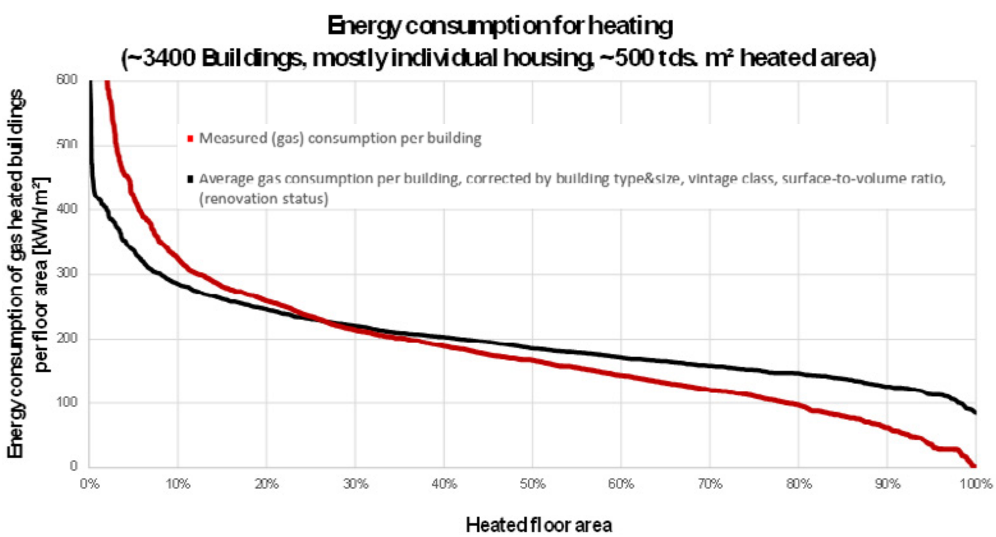
FIGURE 3: POSSIBLE BIAS IN THE USE OF THE ARCHETYPE-BASED BOTTOM-UP APPROACH FOR RESIDENTIAL BUILDINGS (LEFT) AND NON-RESIDENTIAL BUILDINGS (RIGHT)



The approach based on measured energy consumption for a representative sample of buildings benefits from the fact that the measured energy consumption data explicitly consider the actual building usage, refurbishment status, climatic conditions, and other relevant factors. Also, if the building stock is heated by a high share of gas or district heating, a few grid operators or companies typically own the consumption data. However, in the case of electricity, the consumption counted in the EPBD is usually not directly measured. Secondary heating systems are also often difficult to consider. In particular, if larger shares of electricity, heating oil, and biomass are used for heating or if there is a high cooling demand, the approach typically has its limitations. Additionally, it is crucial to note that the use of consumption data must comply with data protection regulations.

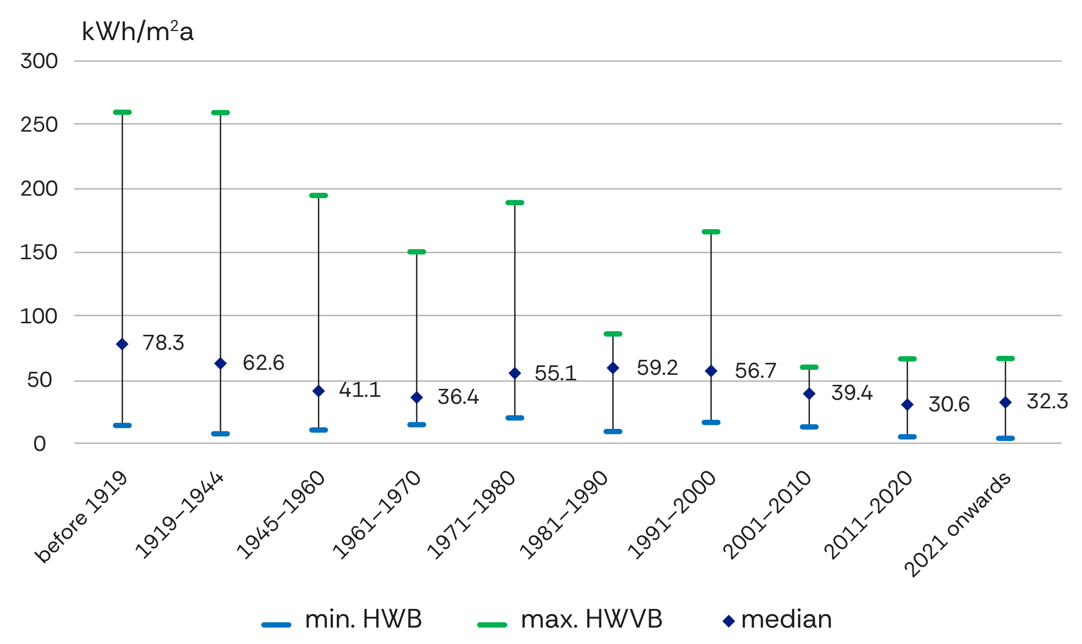
The figure illustrates the potential error associated with this approach, where measured energy consumption (in this case, gas consumption) is used to derive the distribution curve of energy consumption.

FIGURE 4: MEASURED ENERGY CONSUMPTION AND THE BIAS TO GAS CONSUMPTION CORRECTED BY CERTAIN BUILDING-RELATED DATA



The approach based on EPC databases benefits from the fact that EPCs typically include the required information based on an established, clearly defined, and agreed-upon methodology. In many countries, the data is stored in one or a few databases. However, as a downside, it is worth noting that the total sum of primary energy use reported by EPCs is generally inconsistent with the energy use data in energy balances. Also, in many countries, there is a bias in the buildings represented in EPC databases. The distribution of energy needs for space heating in residential buildings in an exemplary city, as shown in Figure 5, illustrates that there is likely an overrepresentation of refurbished buildings, which can be observed, for example, from the low mean value in the 1961–1970 period. Also, in this city, EPCs are only available for 12–15% of all buildings.

FIGURE 5: DISTRIBUTION OF ENERGY NEEDS FOR SPACE HEATING IN RESIDENTIAL BUILDINGS, FOR EXAMPLE, IN AN AUSTRIAN CITY WITH A POPULATION OF ABOUT 130,000



Source: Behmann: Statistische Quartalsblätter, Stadtmagistrat Innsbruck, Referat Statistik und Berichtswesen, Heft 2/2023.

The approach is based on a standard distribution chosen in the Austrian NBRP. Here, energy consumption data from the energy balances and the useful energy analysis for different building categories have been considered from 1990–2020. The total energy consumption is climate-corrected and divided by the gross floor area. This represents the average building. By describing this building with the V/A (volume/surface) ratio and considering this ratio, the value is adjusted by the mean V/A value. In addition to this mean value, a normal distribution is assumed, so that the lower range of the 99% quantile aligns with the building code for the most efficient buildings in 2021 (NZEB standard). Since the building codes and EPCs in Austria refer to the V/A (volume/surface ratio, also known as characteristic length), these values can be directly linked to the results in EPCs and building codes.

3.2 BUILDING STOCK DATA

Romania's building stock data presents specific challenges that must be addressed in developing the NBRP. While the LTRS provides foundational information, comprehensive data on energy performance, particularly for non-residential buildings, remains limited. This section summarises the available data and identifies the methods used to establish the building stock baseline for scenario modelling.

The building stock characterisation for Romania draws on multiple sources:

- Romania's long-term renovation strategy (LTRS), which provides building stock structure, construction periods, and baseline energy consumption data.
- Energy performance certificate (EPC) data, where available, though coverage remains incomplete.
- National Institute of Statistics data on housing stock and construction activity.
- Eurostat Building Stock Observatory data for cross-validation.
- Model-based estimates using the Invert/EE-Lab framework calibrated to national energy balances.

Due to limited EPC coverage, the building stock distributions presented in this section rely substantially on model-based estimates using archetype approaches, supplemented by available measured data and cross-validated against national energy balance statistics. This approach ensures consistency between building-level performance estimates and aggregate national energy consumption figures. The following figures present the specific energy needs for space heating across building categories, illustrating the distribution by both gross floor area (Figure 6) and the number of buildings (Figure 7). These distributions serve as the basis for identifying the worst-performing buildings and establishing MEPS thresholds.

FIGURE 6: SPECIFIC ENERGY NEEDS FOR SPACE HEATING OVER GROSS FLOOR AREA PER BUILDING CATEGORY

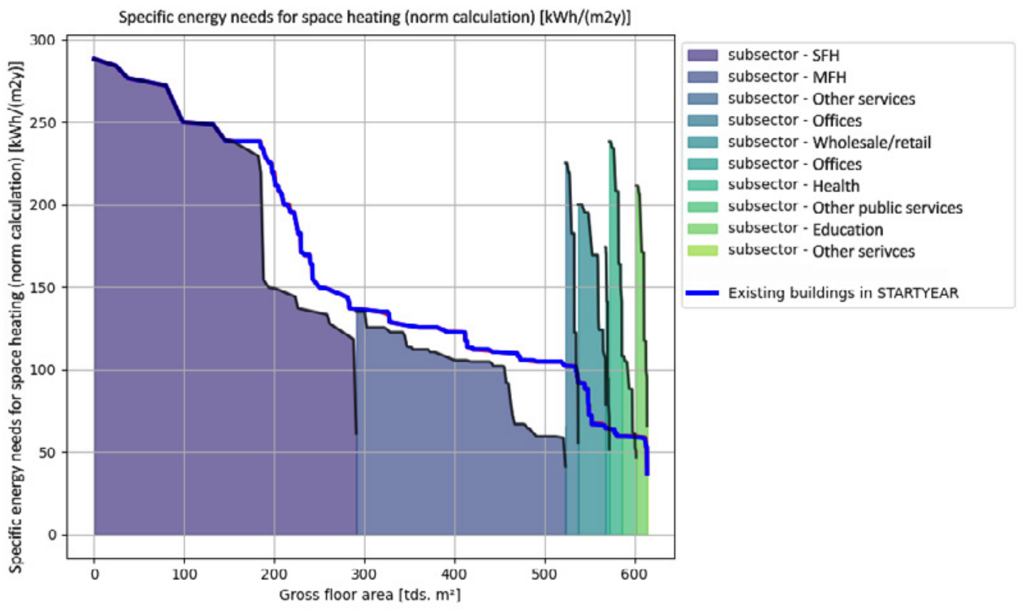
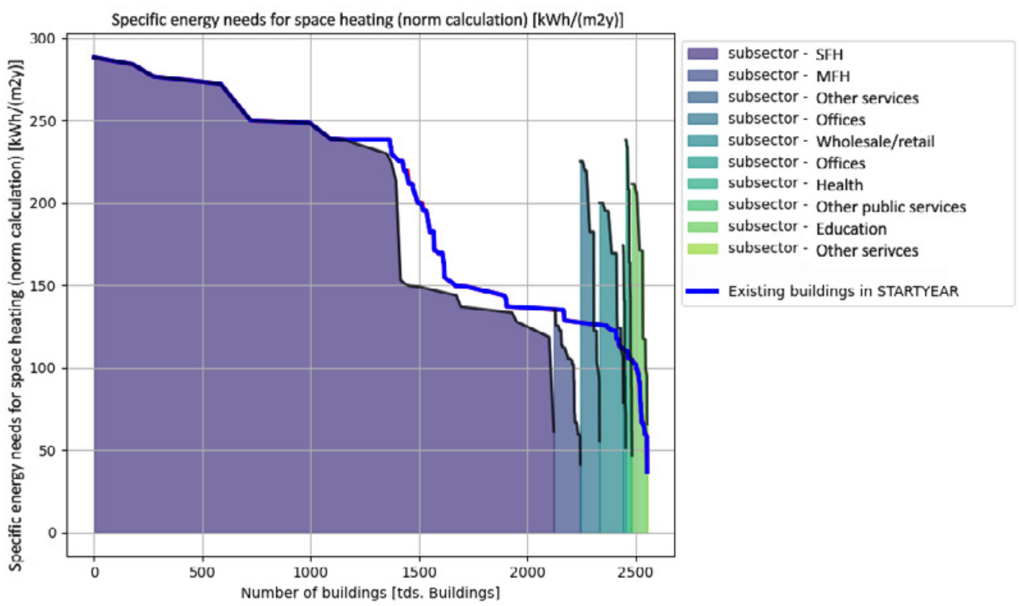


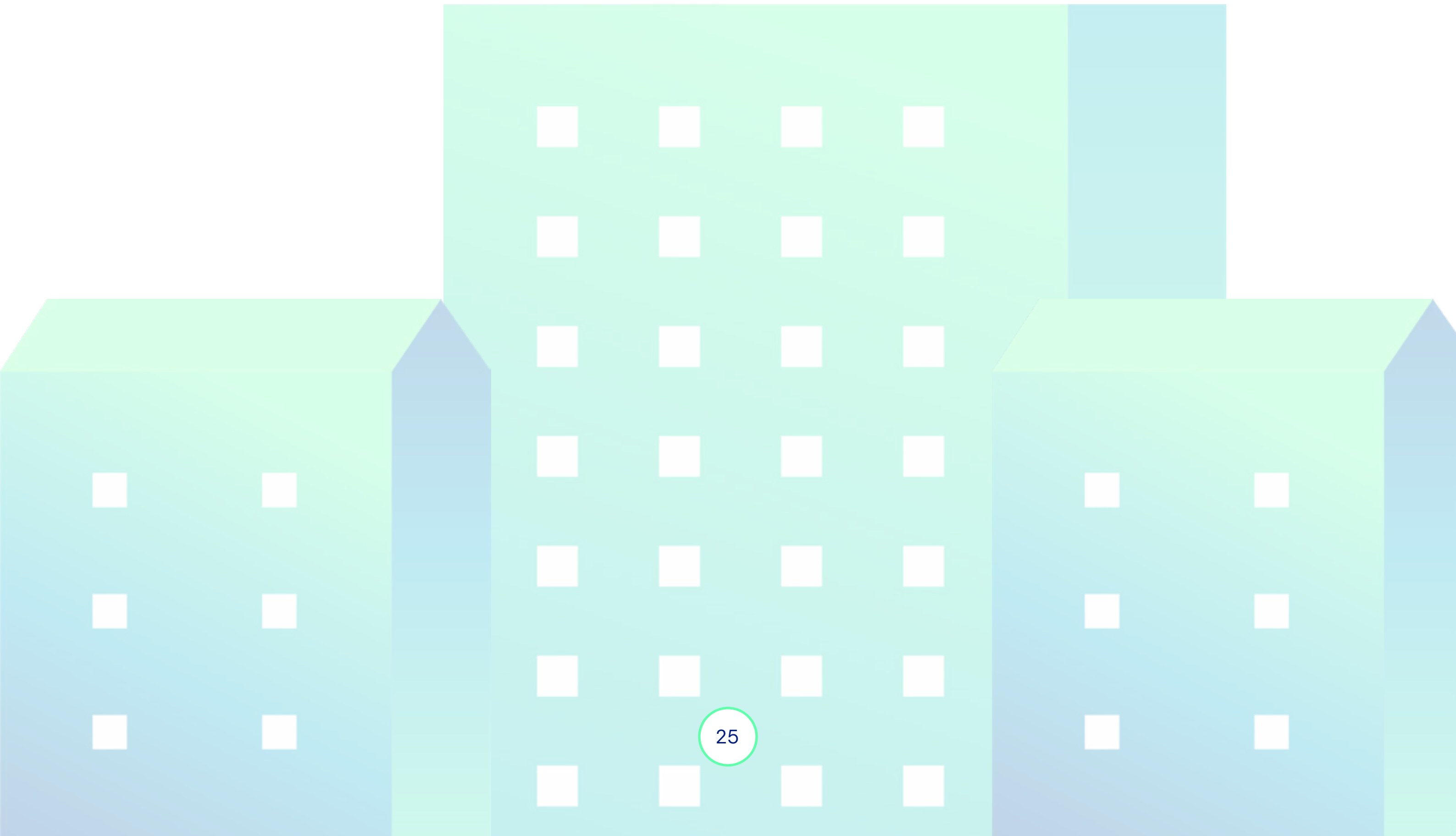
FIGURE 7: SPECIFIC ENERGY NEEDS FOR SPACE HEATING OVER THE NUMBER OF BUILDINGS PER BUILDING CATEGORY



The distribution curves for Romania reveal several key characteristics relevant to NBRP development:

- **Residential sector:** Single-family houses (SFH) dominate the building stock in terms of both number of buildings and total floor area. Average specific energy needs for space heating range from approximately 100–250 kWh/(m^2.year) depending on construction period and renovation status, with pre-1990 buildings showing significantly higher consumption.
- **Non-residential sector:** Education, health, and administrative buildings show wide variation in specific energy needs, reflecting diverse building types, ages, and usage patterns. Data quality for non-residential buildings is notably lower than for residential buildings, requiring additional data collection efforts.
- **Worst-performing buildings:** Based on the distribution analysis, the worst-performing 16% of buildings (relevant for the 2030 MEPS threshold) correspond approximately to buildings with specific energy needs above 200–220 kWh/(m^2.year). The 26% threshold (relevant for 2033) corresponds to approximately 180–200 kWh/(m^2.year).

These thresholds will require validation and refinement as Romania's EPC database coverage improves. The scenario analysis in Chapter 5 uses these distributions to model the impact of MEPS implementation on renovation activity and energy demand reduction.



DRAFT NBRP SCENARIO ANALYSES: METHOD AND SCENARIO DESIGN

This chapter examines how various policy packages can achieve national building renovation objectives in Romania. Using the Invert/EE-Lab building stock model parameterised for each country, we assess final/primary energy, operational GHG emissions, renovation activity by depth, uptake of heating options, and outcomes for worst-performing buildings.

4.1 POLICY DIMENSION

The policy dimension describes the types of policy instruments considered in the scenario design. These instruments represent the main levers available to Member States for driving building renovation under the EPBD framework. Each scenario combines different settings of these instruments to explore alternative renovation pathways.

The scenario design developed for this analysis addresses several key policy elements outlined in Annex II (c) of the recast Energy Performance of Buildings Directive (EPBD 2024/1275), which specifies the required content for national building renovation plans (NBRPs). Two elements are fully incorporated into the modelling framework. Element (b), concerning national minimum energy performance standards (MEPS), is explicitly modelled through a dedicated policy axis that varies across three levels: ① No MEPS, ② Non-residential sector only, and ③ Both sectors, allowing for systematic comparison of regulatory stringency and its impact on building stock transformation. Element (f), regarding the decarbonisation of heating and cooling and the phasing out of fossil fuels, is directly addressed through the **Ban on fossil-based boilers** axis, which differentiates scenarios based on whether such a ban is implemented, aligning with the EPBD's objective of complete fossil fuel boiler phase-out by 2040. Several additional elements are partially addressed: element (d), concerning the protection of vulnerable customers and alleviation of energy poverty, is indirectly considered through the **Subsidy budget** dimension, where scenarios with higher subsidy levels linked to Emissions Trading System 2 (ETS2) revenues can provide greater financial support for households, though targeted measures for vulnerable groups are not explicitly modelled; element (h), on the promotion of renewable energy sources in buildings, is implicitly addressed, as both the fossil boiler ban and carbon pricing mechanisms create economic incentives for switching to renewable heating systems; and element (n), regarding market barriers and failures, is partially captured through CO_2 pricing, which addresses carbon externalities, and subsidies, which help overcome upfront investment barriers that often prevent building owners from undertaking energy renovations.

Instruments are grouped into regulatory, economic, and non-financial measures:

- **Regulatory:** Minimum energy performance standards (MEPS) by sector; an optional ban on installing new fossil-fuel boilers.
- **Economic:** Public grants (with higher rates for worst-performing buildings and low-income households), zero-interest/guaranteed loans, on-bill repayment where applicable, tax relief/green mortgages, and targeted top-ups (e.g. envelope depth, heat-pump/DH connection). Budgets vary between moderate and high; where relevant, "high" assumes recycling of ETS2-type revenues or equivalent national sources.
- **Non-financial:** One-stop shops for advice/applications, skills, and quality-assurance programmes, and facilitation tools for homeowner associations/multi-family decision making.

4.2 SCENARIO SPECIFICATION

The scenarios vary across four levers in a harmonised way across countries:

- **Scope of minimum energy performance standards (MEPS):** In both sectors / in non-residential only / none.
- **Fossil boiler ban:** Present/absent.
- **Carbon-price level:** illustrative ~75€/t vs. ~300€/t.
- **Public-support budget:** Moderate vs. high (the latter assuming, where relevant, recycling of ETS2-type revenues or equivalent national sources).

EPBD ALIGNMENT AND THRESHOLDS USED FOR EVALUATION:

- Residential trajectory: Average primary energy of the whole residential stock reduced by ≥16% by 2030 and ≥20–22% by 2035, with further decline toward 2050 along a progressive path.
- Worst-performing share (WPB): ≥55% of the total reduction to 2030/2035 achieved by renovating the bottom 43% of the stock (defined by national distribution of primary energy).
- Non-residential MEPS: percentile thresholds such that no more than 16% of floor area is above the national threshold by 2030, and no more than 26% by 2033.

THRESHOLD DERIVATION AND WPB IDENTIFICATION

- Percentiles and WPB cut-offs are read from country-specific distributions of specific primary energy vs. conditioned floor area by category.

- Distributions combine EPC samples, measured data (where available), model-based adjustments, and light statistical smoothing to avoid archetype bias, ensuring defensible thresholds.

The five scenarios are designed to explore how different combinations of policy instruments affect Romania's transformation of its building stock toward decarbonisation. Each scenario represents a coherent policy package that could be realistically implemented. The scenarios are not predictions but rather illustrative pathways that help policymakers understand:

- Which policy combinations are most effective for achieving EPBD targets.
- The trade-offs between regulatory and economic instruments.
- The expected pace of fossil fuel phase-out under different conditions.

The scenario results inform the development of Romania's NBRP by providing quantitative inputs for the roadmap (Annex II, Section (b)) and evidence for selecting policy measures (Annex II, Section (c)).

FIVE SCENARIOS:

1 **Regulatory+** – Moderate carbon price; MEPS in residential and non-residential; ban on new fossil boilers; moderate subsidy budget.

2 **Regulatory** – Moderate carbon price; MEPS in both sectors; no boiler ban; moderate subsidy budget.

3 **Moderate** – Moderate carbon price; MEPS in non-residential only; no boiler ban; moderate subsidy budget.

4 **Mix** – High carbon price; high subsidy budget; MEPS in non-residential only; no boiler ban.

5 **Pure economic** – High carbon price; high subsidy budget; no MEPS; no boiler ban.

Outputs assessed per scenario: final and primary energy (by carrier and segment), operational GHG, renovation activity by depth, outcomes for the worst-performing share, heating-system uptake (e.g. heat pumps and low-carbon district heating). Scenarios are policy-sensitive (not forecasts) and are compared against the residential trajectory, WPB contribution, and non-residential percentile thresholds above (refer to Figure 8).

FIGURE 8: SCENARIO GROUPING

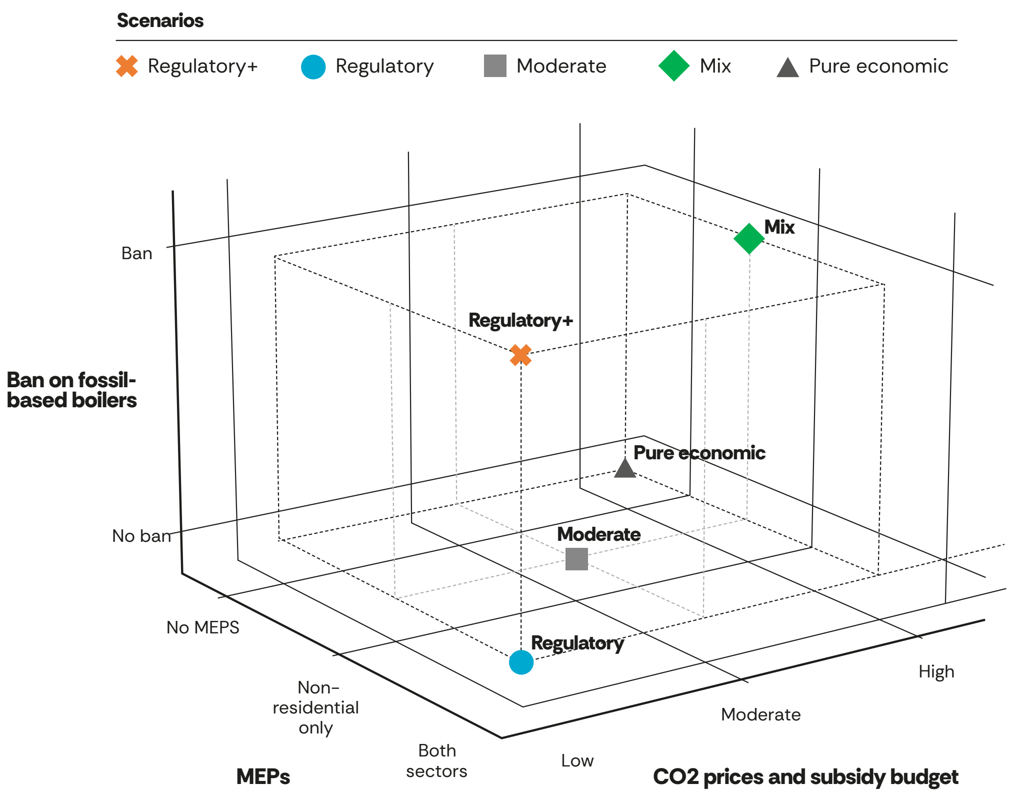


TABLE 3: SCENARIO DESIGN

	Regulatory+	Mix	Regulatory	Pure economic	Moderate
MEPS	Residential and non-residential	Non-residential	Residential and non-residential	No	Non-residential
Ban on fossil-based boilers	Yes	No	No	No	No
Subsidies for building envelope renovation	Moderate	High	Moderate	High	Moderate
Subsidies for RES-H systems	Moderate	High	Moderate	High	Moderate
CO_2 price	75€/t	300€/t	75€/t	300€/t	75€/t

4.3 SCENARIO FRAMEWORK DATA

The energy prices shown in Table 4 are input assumptions to the Invert model, derived from multiple sources, including IEA World Energy Outlook projections, Eurostat historical data, and national energy price statistics. They represent retail prices including taxes but excluding CO_2 costs, which are added separately according to the scenario specifications.

TABLE 4: ENERGY PRICES FOR ROMANIA FOR THE YEARS 2020, 2030, 2040, AND 2050 IN €/MWH

	2020	2030	2040	2050
Electricity	135	165	149	149
Gas	35	47	47	47
Oil	99	124	124	124
District heating	78	98	98	98
Coal	34	43	43	43
Wood logs	25	31	31	31
Wood chips	22	27	27	27
Pellets	30	38	38	38

Sources: EU Building Stock Observatory (BSO), European Commission, https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/eu-building-stock-observatory_en; National Institute of Statistics, Population and Housing Census 2021 (published 2023), https://www.recensamantromania.ro/; National Institute of Statistics, Energy Balances 2023, https://insse.ro/cms/en/content/energy-statistics.

4.4 USED MODELS: INVERT/ EE-LAB AND INVERT/OPT

The scenario analyses in this report are based on two complementary building stock models developed by TU Wien: Invert/EE-Lab and Invert/Opt.

Invert/EE-Lab is a techno-socio-economic simulation model that projects energy-related investment decisions in buildings, covering space heating, hot water, and cooling. The model uses a highly disaggregated building stock description (by type, age, renovation state, heating system, and regional infrastructure availability) and simulates investment decisions through discrete choice and technology diffusion approaches. It has been applied in over 40 EU projects and is parameterised for EU-27+ countries [8].

Invert/Opt is a cost-optimisation variant that calculates cost-optimal renovation pathways by combining available technology options for building envelope and heating systems, subject to constraints such as biomass availability, infrastructure access, and suitable roof areas for solar technologies. Both models enable the assessment of policy scenarios against EPBD requirements, including residential energy reduction trajectories, thresholds for the worst-performing buildings, and non-residential MEPS compliance. Detailed model descriptions and structure diagrams are provided in Annex A.

4.5 ALTERNATIVE RENOVATION PATHWAYS

Figure 9 presents the final energy demand (FED) projections for Romania's building sector across five policy scenarios from 2021 to 2050. The Regulatory+ and Regulatory scenarios achieve the most substantial energy demand reductions, declining from approximately 90 GWh/yr in 2021 to 45 GWh/yr and 67 GWh/yr by 2050, respectively, representing reductions of 50% and 26%. The Regulatory+ scenario, featuring a 75€/t CO_2 price, moderate subsidies, MEPS in both sectors, and a fossil boiler ban, demonstrates the most aggressive decarbonisation trajectory with coal virtually eliminated by 2030 and oil disappearing by 2035. This scenario shows dramatic growth in biomass heating, which becomes the dominant energy carrier by 2050 (approximately 20 GWh/yr), alongside substantial increases in electricity and district heating.

The Regulatory scenario, identical except for the absence of a fossil boiler ban, achieves significant but more gradual fuel switching, with coal and oil declining steadily but persisting at low levels through 2045. Both regulatory scenarios exhibit notable deployment of renewable heating technologies, including photovoltaic (PV) space heating, solar thermal, and ambient heat systems, collectively contributing approximately 8–10 GWh/yr by 2050, reflecting Romania's favourable climate conditions for solar technologies.

The Mix, Pure economic, and Moderate scenarios exhibit intermediate energy demand trajectories, all of which reach approximately 70–75 GWh/yr by 2050, representing roughly 17–22% reductions from 2021 levels. The Pure economic scenario, driven by high carbon pricing (300€/t) with substantial ETS2-linked subsidies but no MEPS, shows strong electricity growth reflecting heat pump adoption, reaching approximately 20 GWh/yr by 2050. However, the absence of regulatory mandates results in a slower phase-out of fossil fuels, with coal persisting until 2040 and gas maintaining a substantial share (approximately 25 GWh/yr) throughout the projection period.

The Mix scenario (300€/t, high subsidies, MEPS only in the non-residential sector) and the Moderate scenario (75€/t, moderate subsidies, MEPS only in the non-residential sector) produce remarkably similar outcomes, suggesting that in the Romanian context, higher carbon prices without residential MEPS yield comparable results to moderate carbon prices with non-residential MEPS. Both scenarios exhibit balanced growth across electricity, district heating, and biomass; however, the absence of residential MEPS hinders the pace of transformation in the dominant residential sector. Gas remains the largest single energy carrier in all three intermediate scenarios by 2050, highlighting that comprehensive MEPS coverage in both sectors is essential for achieving deep decarbonisation in Romania's building stock, where residential heating accounts for the majority of energy demand and is characterised by diverse ownership structures and varying capacity for investment in heating system upgrades.

FIGURE 9: FINAL ENERGY DEMAND (FED) RESULTS FOR ROMANIA FOR THE YEARS 2021–2050

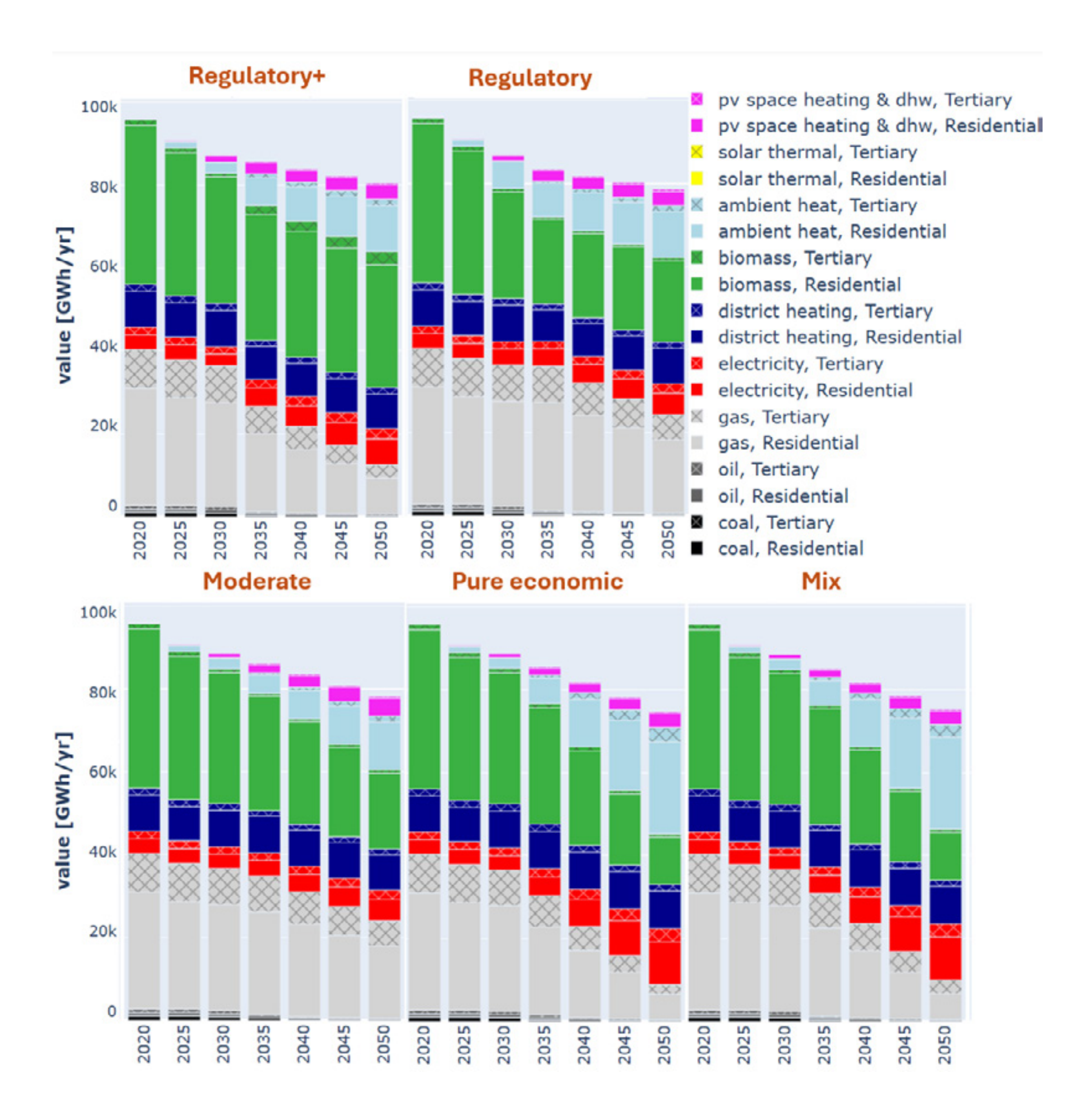
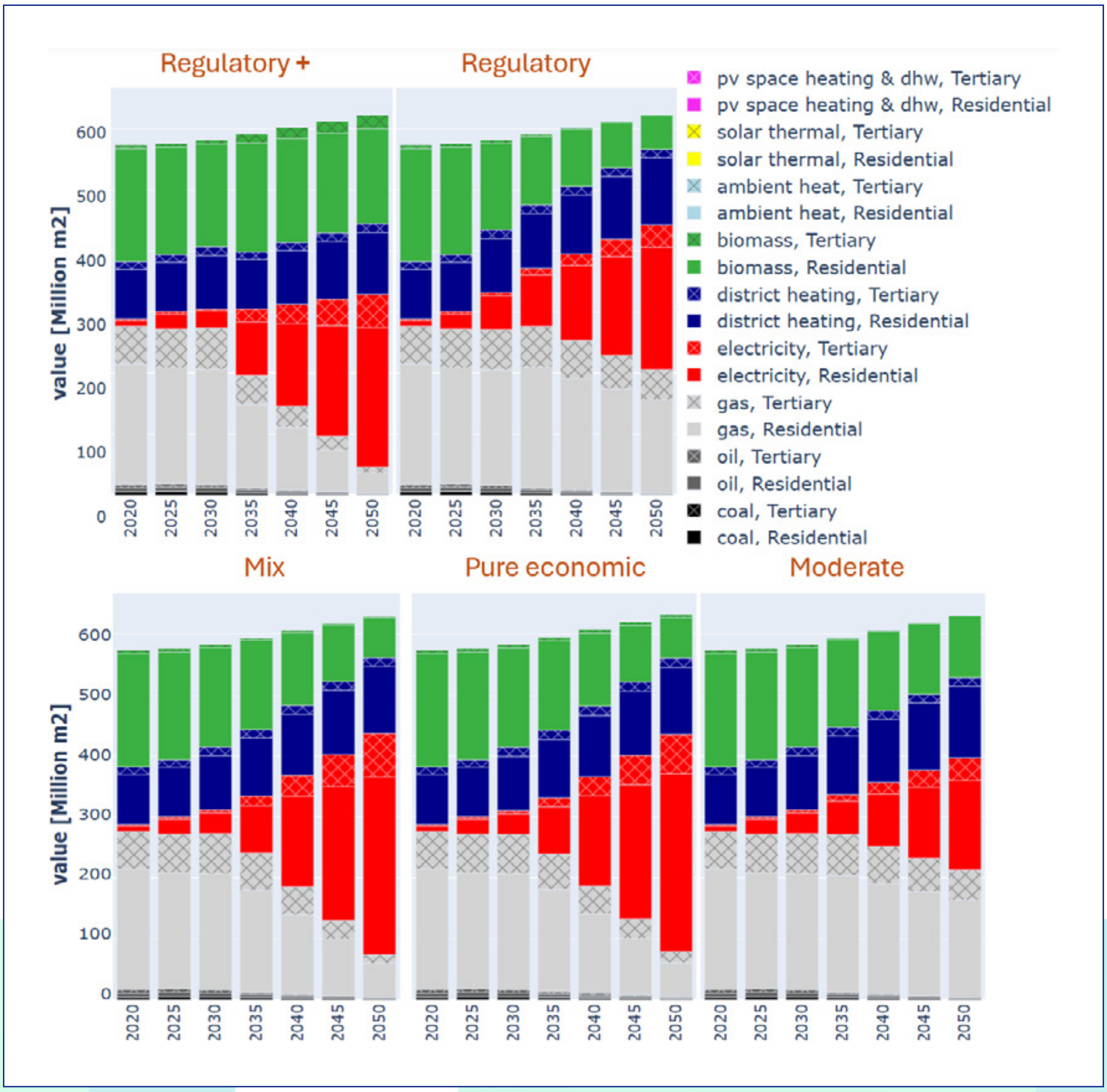


Figure 10 presents projections for the heated gross floor area in Romania by heating system type across the five policy scenarios from 2021–2050. All scenarios project overall growth in heated floor area from approximately 580–600 million m² in 2021 to 620–650 million m² by 2050, reflecting the natural expansion of the building stock. The Regulatory+ and Regulatory scenarios exhibit distinctly different trajectories in heating system composition. In Regulatory+, coal-heated floor area declines precipitously from approximately 50 million m² in 2021 to near-zero by 2030, while oil-heated areas are eliminated by 2035 due to the fossil fuel boiler ban. This scenario shows dramatic growth in biomass-heated floor area, expanding from approximately 180 million m² in 2021 to 250 million m² by 2050, making it the dominant heating system. The electrically heated floor area is expected to grow substantially to approximately 150 million m² by 2050, while district heating is projected to expand moderately from 100 million m² to 120 million m² by 2050. The Regulatory scenario follows a similar but more gradual pattern, with coal and oil heating declining steadily to minimal levels by 2045. Both regulatory scenarios show notable growth in renewable heating technologies, including PV-integrated systems, solar thermal, and ambient heat, collectively serving approximately 30–40 million m² by 2050.

The Mix, Pure economic, and Moderate scenarios demonstrate more gradual heating system transitions with total heated floor area reaching approximately 620–640 million m² by 2050. All three scenarios show similar overall patterns but differ in transition speeds and final heating system compositions. The Pure economic scenario, driven solely by high carbon pricing (300€/t) without regulatory mandates, exhibits the strongest growth in electrically heated floor area, reaching approximately 180 million m² by 2050, reflecting economically driven heat pump adoption. However, coal-heated areas decline more gradually, persisting at approximately 20–30 million m² until 2045.

The Mix and Moderate scenarios exhibit nearly identical trajectories, despite differing carbon price levels (300€/t versus 75€/t), with both achieving similar outcomes by 2050: coal heating is reduced to approximately 20 million m², biomass expands to 200 million m², and electricity reaches 150–160 million m². This convergence suggests that, in Romania's context, MEPS in the non-residential sector, combined with moderate subsidies, can achieve comparable results to those of high carbon pricing alone. Gas heating maintains a stable presence across all three intermediate scenarios at approximately 200–220 million m² throughout the projection period, highlighting its persistence as a transitional fuel. The slower transformation in residential heating systems in the Mix and Moderate scenarios, evident in the continued presence of coal and stable gas consumption, underscores the critical importance of extending MEPS to the residential sector to achieve comprehensive decarbonisation of Romania's building stock, where traditional heating systems and varied building quality present significant barriers to voluntary system replacement.

FIGURE 10: HEATED GROSS FLOOR AREA RESULTS FOR ROMANIA FOR THE YEARS 2021–2050



4.6 ALIGNMENT WITH EU DIRECTIVES AND LONG-TERM POLICY GOALS

Figure 11 presents the share of renewable energy in Romania's residential sector from 2020–2050 across the five policy scenarios, all calculated using RED III-compliant methodologies. The residential sector demonstrates steady renewable energy growth across all policy pathways, increasing from approximately 43% in 2020 to 79–80% by 2050, with scenarios converging significantly by the end of the projection period. Romania's relatively high baseline renewable share reflects the widespread use of traditional biomass heating systems in residential buildings, providing a favourable starting point for further decarbonisation.

All scenarios show a slight dip to approximately 42–43% around 2025 before beginning their upward trajectories. The Regulatory+ scenario consistently leads throughout the projection period, reaching approximately 80% renewable share by 2050, while the other scenarios converge to 79–80%. The differentiation between scenarios is most pronounced during the 2035–2045 period, with Regulatory+ maintaining a 5–8 percentage point advantage over other scenarios around 2040, before this gap narrows substantially by 2050.

The Pure economic scenario performs notably well, tracking closely with regulatory approaches and reaching approximately 79% by 2050, demonstrating that strong carbon price signals can achieve outcomes comparable to regulatory mandates. The Mix, Moderate, and Regulatory scenarios follow similar trajectories throughout, with minimal differentiation between them.

All scenarios approach or exceed 45–46% renewable energy share by 2030, positioning Romania close to the RED III's indicative 49% renewable energy benchmark for buildings. The transition trajectory shows acceleration after 2030, with consistent annual increases of approximately 1.5–2 percentage points across most scenarios between 2035 and 2050, reflecting the steady replacement of remaining fossil fuel heating systems and the continued expansion of renewable technologies.

FIGURE 11: SHARE OF RENEWABLES IN ROMANIA'S RESIDENTIAL SECTOR FROM 2020–2050 IN DIFFERENT SCENARIOS

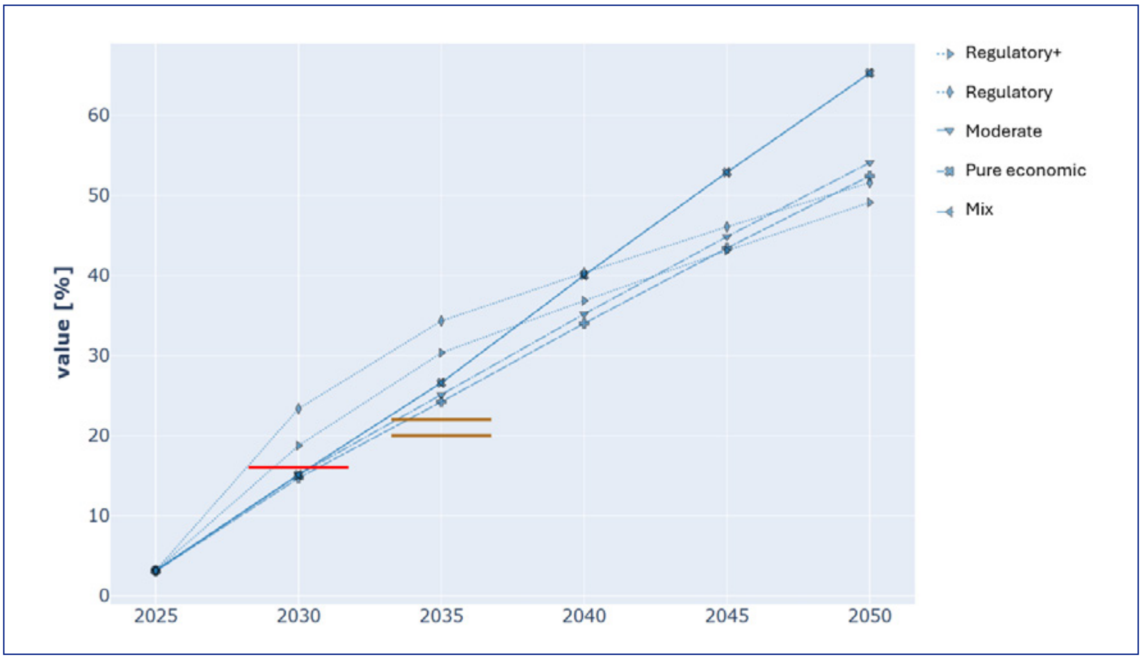
Figure 12 presents specific primary energy demand reductions in Romania's residential sector from 2025–2050, expressed as percentage reductions relative to a baseline trajectory. The horizontal lines indicate the EPBD trajectory targets for 2030 (red) and 2033 to 2040 (orange).

The residential sector shows gradually diverging trajectories across policy scenarios, with savings ranging from approximately 49–65% by 2050 depending on policy design. The Regulatory+ and Pure economic scenarios achieve the highest savings at approximately 65% by 2050, though through different mechanisms: Regulatory+ relies on comprehensive MEPS implementation combined with a fossil boiler ban, while Pure economic drives efficiency improvements through high carbon pricing (300€/t) and substantial subsidies. The Regulatory scenario follows at approximately 54% by 2050, with Mix achieving similar results at approximately 52%. The Moderate scenario shows the lowest savings at approximately 49% by 2050, reflecting the limited impact of moderate carbon pricing (75€/t) combined with MEPS only in the non-residential sector.

All scenarios start at similar levels around 3% in 2025 and converge around 15–24% by 2030, with every scenario meeting the EPBD 2030 trajectory target. Regulatory+ shows the earliest divergence, reaching approximately 24% by 2030 compared to 15% for Moderate. By 2035, all scenarios exceed the subsequent EPBD targets, with savings ranging from 24% to 34%. The trajectories continue to diverge through 2050, with consistent annual increases across all scenarios.

These results demonstrate that Romania can achieve its energy efficiency targets through multiple policy pathways. Both strong regulatory instruments (Regulatory+) and robust economic incentives (Pure economic) can deliver equivalent long-term outcomes, while Moderate consistently shows the lowest savings, confirming that ambitious policy drivers are necessary for deep residential energy demand reductions.

FIGURE 12: SPECIFIC PRIMARY ENERGY DEMAND SAVINGS IN ROMANIA'S RESIDENTIAL SECTOR FROM 2020–2050, CONSIDERING DECREASING PRIMARY ENERGY FACTORS



STRATEGIES FOR MONITORING, EVALUATION, AND CONTINUOUS IMPROVEMENT

National building renovation plans serve a dual function: they are both strategic planning instruments and frameworks for monitoring, reporting, and evaluation (MR&E) of renovation policies. Article 3 of the EPBD 2024/1275 establishes that NBRPs shall include measurable progress indicators and be subject to regular updates based on implementation experience. The European Commission will assess Member State progress through the NBRP reporting cycle, with updates required every five years. This chapter outlines strategies for establishing effective MR&E systems, drawing on the detailed guidance provided in EPBD.wise Deliverable D6.3 An integrated monitoring, reporting and evaluation framework for effective EPBD implementation.

Various approaches exist for tracking renovation activity, differing in terms of data quality, effort, and coverage. Table 5 evaluates key data sources for monitoring renovation activity across three criteria:

1. **Effort:** The administrative and financial resources required to collect and analyse data from each source. This assessment focuses on ongoing operational costs for data analysis, rather than initial infrastructure setup costs (e.g. for EPC databases, these reflect analysis costs rather than database establishment costs).
2. **Reliability:** The quality and trustworthiness of the data for policy evaluation purposes, considering factors such as data verification, standardisation, and consistency.
3. **Completeness:** The extent to which the data source captures the full range of renovation activities in the building stock. For example, financial support databases provide highly reliable information but only cover subsidised renovations, leaving non-subsidised activities untracked – hence the medium (●) completeness rating.

Overall, the table highlights that no single method provides full coverage, but that multiple complementary sources can provide a solid foundation:

TABLE 5: EVALUATION OF DATA SOURCES FOR BUILDING RENOVATION MONITORING BY EFFORT, RELIABILITY, AND KEY CHARACTERISTICS

	Reliability low	Reliability medium	Reliability high
Effort low	EPC databases 🔴 – 🟢 Machine learning-based assessments 🔴 – 🟢	EPC databases 🔴 – 🟢 Market data 🟠 – 🟢 Building permits 🔴 – 🟠 Machine learning-based assessments 🔴 – 🟢	Financial support databases 🟠 EPC databases 🔴 – 🟢 Market data 🟠 – 🟢 Building permits 🔴 – 🟠 Survey among professionals 🟠 Model-based assessments 🔴 – 🟢
Effort medium	Machine learning-based assessments 🔴 – 🟢	Machine learning-based assessments 🔴 – 🟢	Survey among professionals 🟠 Machine learning-based assessments 🔴 – 🟢
Effort high		Survey among building owners 🟠 – 🟢	Surveys among building owners 🟠 – 🟢

🔴 – Completeness low; 🟠 – Completeness medium; 🟢 – Completeness high

A. CONTINUOUS TRACKING OF EPC DATABASE AND BUILDING LOGBOOK

- This approach provides real-time, standardised data on renovation activities and energy efficiency improvements. It offers up-to-date insights but requires strong infrastructure and raises privacy concerns.

B. DOCUMENTATION OF FINANCIAL SUPPORT INSTRUMENTS AND PROGRAMMES

- These are databases from funding programmes and financial support schemes, such as the French Observatoire National de la Rénovation Énergétique (ONRE), established in 2019 by the Ministry of Ecological Transition to monitor all components of public policy on energy renovation (Ministère de la Transition Écologique, 2019). This approach provides comprehensive economic and regional data, making it highly valuable for evaluating policies and tracking public investment in renovations. By only capturing renovations that receive financial support, this approach may miss some activities in the private sector.
- Another approach is using data from programmes offering financial or technical support for renovations to a specific sector, such as the SHAERE database (Sociale Huursector Audit en Evaluatie van Resultaten Energiebesparing) for the Dutch non-profit housing sector, which contains energy performance data for approximately 60% of all social housing dwellings [6]. However, this approach fails to provide insights into renovations in other sectors, such as the private sector.

C. BUILDING PERMITS

- Building permit data can track major renovation works that require formal approval, such as structural modifications, extensions, or changes to building use. This data source provides direct, verified records of formal renovation activities and enables geographically specific analysis at the municipal level. However, coverage is limited because many energy efficiency measures, including insulation upgrades, window replacements, and heating system changes, typically do not require building permits in most Member States. Building permits are, therefore, most useful as a complementary source for tracking deep renovations involving structural changes, rather than as a primary indicator of overall renovation activity.

D. SURVEY AMONG BUILDING OWNERS AND PROFESSIONALS

- These surveys gather industry professionals' data on renovation practices and market trends. They offer technical accuracy but may not capture small-scale renovations, as their results depend on the sample size.

E. MACHINE LEARNING-BASED ASSESSMENTS

- This approach uses large datasets (e.g. satellite images, energy use data) to identify renovation activities and trends through predictive models. It enables scalable, automated monitoring and can flag likely renovations or compliance gaps. However, it requires high-quality, standardised data and raises concerns about transparency, accuracy, and potential bias if used without human oversight.

Given the diversity of national contexts and capacities, countries must tailor their monitoring systems to suit their specific needs. The following section provides country-specific guidance for Romania, building on the policy needs identified in Deliverable D2.1. It outlines priority data sources, innovative methods, and institutional measures for reliable, actionable, cost-effective renovation monitoring and continuous policy improvement.

For Romania, the existing EPC infrastructure and permitting systems can be a strong foundation for monitoring renovation activities. The country should focus on improving the completeness and reliability of EPC and logbook data, while gradually integrating market indicators and cross-referencing them with building registers. Surveys among building professionals can complement this system by providing sectoral insights, especially for private, unsubsidised renovations. Given the deliverables' finding of inconsistent baseline data and fragmented sources, Romania should prioritise the development of an integrated monitoring platform that links EPCs, financial support data, and permits. The use of machine learning for spatial trend detection could be piloted in metropolitan regions where data quality is higher. These actions address Policy Needs 1 (data availability), 4 (identification of WPBs), and 7 (renovation pathways).

Monitoring must be closely linked to regular evaluation and revision cycles of the NBRPs. Progress indicators should go beyond energy performance alone, including social impact, public investment leverage, and renovation depth metrics. Transparent reporting, data sharing across governance levels, and continuous stakeholder engagement are key to transforming monitoring into a tool for policy learning, not just compliance. Monitoring frameworks could also consider mechanisms for voluntary or incentivised data reporting from market actors, such as installers, contractors, or energy advisors.

CONSISTENCY AND INTERACTION WITH OTHER POLICY INSTRUMENTS

The NBRPs are not developed in isolation but are closely linked to other policy instruments established under the EPBD and related EU legislation. Ensuring consistency and synergies between these instruments is crucial for achieving a highly energy-efficient and decarbonised building stock by 2050.

In addition to their role under the EPBD, NBRPs must also remain consistent with the Fit for 55 framework, including the Energy Efficiency Directive (EED) and the Renewable Energy Directive (RED III). NBRPs should also align with national energy and climate plans (NECPs), which, although not part of the Fit for 55 package, provide the overarching national framework for coordinating energy and climate policy. This alignment ensures that the renovation targets, scenario assumptions, and policy measures within NBRPs contribute coherently to EU-wide energy efficiency and GHG reduction objectives.

6.1 ZERO-EMISSION BUILDINGS (ZEBS)

NBRPs are designed to guide the progressive transformation of the building stock into ZEBs by 2050. This includes defining thresholds for operational greenhouse gas emissions and annual primary energy demand for new and renovated buildings.

The scenario development and target-compliance assessments within NBRPs explicitly verify whether the renovation pathways align with the ZEB definition and long-term decarbonisation objectives. In this context, NBRPs should:

- Ensure that the national targets for renovated floor area and energy-use reduction are consistent with the performance levels required to reach the ZEB standard by 2050.
- Integrate intermediate milestones (2030, 2040) to demonstrate steady progress towards achieving ZEB compliance.

- Reflect the gradual replacement of fossil-fuel-based heating and cooling systems with renewable and low-emission alternatives.
- Incorporate the deployment of renewable energy solutions, electrification trends, and improved energy-system integration into the scenario assumptions.

Thus, the ZEB requirements act both as a benchmark and an endpoint for evaluating NBRP trajectories, ensuring that long-term objectives are embedded in the planning, modelling, and implementation framework.

6.2 MINIMUM ENERGY PERFORMANCE STANDARDS (MEPS)

MEPS serve as a regulatory backbone for building stock decarbonisation. For non-residential buildings, the EPBD establishes mandatory MEPS requiring the 16% worst-performing buildings to be renovated by 2030 and 26% by 2033. For residential buildings, Member States must define national trajectories to progressively reduce average primary energy use, targeting a reduction of 16% by 2030 and 20–22% by 2035 compared to 2020 levels.

The NBRPs integrate both MEPS (for non-residential buildings) and national trajectories (for residential buildings), directly linking them to the Article 9 provisions of the EPBD. Romania's scenario analysis indicates that achieving these targets requires comprehensive regulatory measures in both sectors; the Regulatory+ and Regulatory scenarios demonstrate that MEPS applied to residential buildings significantly accelerate energy savings compared to scenarios relying solely on economic instruments.

Scenario development supports these regulatory requirements by quantifying their potential contribution to energy savings, renovation uptake, and emissions reduction under different pathways. To ensure consistency, NBRPs should:

- Define a clear phase-in timeline for non-residential MEPS implementation with milestones for 2030 and 2033.
- Establish the national trajectory for residential buildings, specifying the 2030 and 2035 primary energy reduction targets.
- Include enabling measures such as financial support schemes, advisory services, and technical assistance to facilitate compliance and ensure a socially fair transition.
- Use scenario modelling to estimate the expected impact of MEPS and trajectories on renovation rates, energy demand, and emissions.
- Align implementation with the overall decarbonisation pathway and energy-efficiency targets set under national planning frameworks.

This integration ensures that regulatory requirements are part of an evidence-based, scenario-driven renovation pathway, not isolated mandates.

6.3 ENERGY PERFORMANCE CERTIFICATES (EPCS)

EPCs form the essential data backbone for NBRPs, identifying the least energy-efficient buildings and tracking the progress of renovations over time. While EPC data may vary in completeness and quality across countries, they provide a harmonised methodology and an established national database for assessing building performance.

Scenario modelling within NBRPs relies on EPC data to define baseline conditions, classify buildings by energy performance, and evaluate the outcomes of implemented measures. Therefore, strengthening EPC systems is crucial for enhancing the accuracy and reliability of policy evaluation and model-based projections. To ensure consistency, NBRPs should:

- Promote full digitalisation and interoperability of national EPC databases, enabling data exchange with building cadastres, renovation funding programme records, and building permit systems.
- Update EPC calculation methodologies to incorporate the new ZEB and MEPS definitions from the EPBD recast, ensuring that energy performance ratings accurately reflect compliance requirements and enable meaningful comparisons across building types.
- Integrate EPC data into the monitoring and reporting cycles of the NBRP to continuously assess progress toward national and EU objectives.

A more holistic and flexible EPC framework, one that accommodates different building types, usage patterns, and regional climate conditions, allows scenario analyses and compliance checks to be grounded in reliable, verifiable data, supporting transparent tracking of renovation outcomes.

6.4 RENOVATION PASSPORTS (RPS)

Renovation passports are complementary instruments that provide building-level renovation roadmaps. They aim to help building owners plan staged renovations that align with national long-term targets and the overall decarbonisation pathway.

Within the NBRPs, RPs are a practical link between scenario-based national projections and individual renovation actions. To strengthen their contribution, NBRPs should:

- Promote the gradual roll-out of RPs, beginning with the worst-performing and public buildings, where data availability and support mechanisms are strongest.
- Incorporate information from RPs into national monitoring systems and use these data to validate model projections on renovation uptake and performance improvements.
- Integrate RPs into one-stop shops and advisory services, making them accessible to households and SMEs as tools for stepwise deep renovation.

- Link RPs with available financing instruments to support the implementation of identified renovation measures.

By connecting national-level modelling with building-specific action, RPs ensure that scenario outcomes translate into real, measurable progress on the ground.

6.5 POLICY COHERENCE AND ALIGNMENT

Consistency checks across all instruments are embedded into the scenario modelling and policy-assessment processes within NBRPs. These checks ensure that the strategic, regulatory, and financial components of building decarbonisation work harmoniously.

Key principles of alignment include:

- Ensuring that renovation pathways are compatible with ZEB thresholds and the long-term fossil-fuel phase-out.
- Embedding MEPS implementation into NBRP scenarios, allowing their impact to be monitored and evaluated against national targets.
- Using EPC data as the common reference for performance tracking, model validation, and policy evaluation.
- Integrating RPs as supporting instruments for building-level implementation, ensuring that long-term renovation planning aligns with NBRP objectives.
- Maintaining coherence with national energy and climate frameworks, ensuring that energy-efficiency and renewable-energy contributions are mutually reinforcing and not overlapping.

By systematically embedding these consistency principles into the NBRP scenario development and monitoring processes, Member States can ensure coherence, avoid duplication, and enhance the credibility and effectiveness of their long-term renovation strategies.

DEVELOPMENT OF POLICY RECOMMENDATIONS

This chapter presents consolidated policy recommendations for Romania's national building renovation plan (NBRP), drawing on the scenario analysis, stakeholder consultations, and policy framework assessment presented in preceding chapters. The recommendations are organised into five action areas, followed by an implementation roadmap with institutional responsibilities and phased timelines.

7.1 KEY RECOMMENDATIONS BY ACTION AREA

Romania's NBRP should build on existing national instruments, including PNRR Component 5 – The Wave of Renovation (€2.9 billion allocation), the national energy and climate plan (PNIESC), and existing EPC infrastructure. The scenario analysis in Chapter 5 demonstrates that combining regulatory measures (MEPS, fossil boiler restrictions) with targeted financial support achieves the strongest decarbonisation outcomes. The Regulatory+ scenario consistently outperforms purely economic approaches, underscoring the importance of regulatory frameworks alongside incentives. The following recommendations focus on implementation priorities that go beyond minimum EPBD transposition requirements.

LEGISLATIVE AND REGULATORY FRAMEWORK

- Operationalise MEPS thresholds and residential renovation trajectories under Article 9, with clear exemption criteria for heritage buildings based on documented assessment of character impact (see Austrian and Irish guidance for heritage-energy balance).
- Define national ZEB thresholds aligned with EPBD Annex I and integrate into building codes, ensuring coherence with EPC methodologies and MEPS definitions.
- Align NBRP objectives with PNIESC targets, EED public building requirements, and RED III renewable heating trajectories.
- Establish structured policy review cycles to adjust targets based on implementation experience.

INSTITUTIONAL ARRANGEMENTS AND GOVERNANCE

- Establish EPC database governance under MDLPA with interoperability to e-Terra cadastre, PNRR funding databases, and building permits; implement data quality protocols including validation checks and sampling audits.
- Build on CIC PNRR structures to create a standing NBRP coordination forum with thematic working groups (data/monitoring, financing, skills, energy poverty).
- Implement structured monitoring cycles with clear indicators (energy performance, renovation rates, investment volumes, social impacts) and transparent reporting to stakeholders and the Commission.

TECHNICAL AND ANALYTICAL INFRASTRUCTURE

- Develop a comprehensive building stock database integrating EPC data, building permits, and funding records, prioritising coverage of the non-residential sector where data gaps are largest.
- Implement building logbooks to track renovation history at individual building level.
- Maintain scenario modelling capacity with regular updates to assess policy effectiveness; publish assumptions and results transparently.

FISCAL AND FINANCIAL MEASURES

- Develop an investment roadmap quantifying annual needs by building category, identifying funding sources (PNRR Component 5, Modernisation Fund, Cohesion Fund, national budget), and mechanisms to mobilise private capital.
- Design subsidy programmes prioritising deep renovations and worst-performing buildings, with differentiated support rates for vulnerable households; combine grants with zero-interest loans and on-bill repayment.
- Address split incentives in rental housing through measures linking rent adjustments to documented energy savings or mandatory EPC ratings for rental properties.
- Identify and map energy-poor households using harmonised criteria; ensure MEPS implementation includes safeguards preventing negative impacts.

INFORMATION, AWARENESS, AND CAPACITY BUILDING

- Expand one-stop shops to national coverage, with specialised support pathways for homeowner association decision-making in multi-family buildings (see France's Accompagnateurs Rénov model).
- Conduct regular surveys among construction professionals to monitor capacity and skills gaps; support training programmes for energy auditors and installers.
- Implement awareness campaigns explaining NBRP objectives and available support; publish regular progress reports accessible to stakeholders.

7.2 SUGGESTED IMPLEMENTATION ROADMAP

7.2.1 INSTITUTIONAL RESPONSIBILITIES

To support coordinated implementation, Table 6 maps key actions to responsible institutions and timelines. In Romania, building energy efficiency responsibilities are distributed across MDLPA (building regulations, EPCs), the Ministry of Energy (energy policy), MIPE (EU funding coordination), and ANRE (energy regulation). Effective NBRP delivery requires these institutions to work as a coordinated team.

TABLE 6: IMPLEMENTATION ROADMAP FOR ROMANIA'S NBRP

Action area	Key actions	Lead institution	Supporting institutions	Timeline
MEPS implementation		MDLPA	ME, ANRE, local authorities	2025–2033
ZEB standards		MDLPA	ME, URBAN-INCERC	2025–2030
EPC database governance		MDLPA	INS, ANRE	2025–2027
Financial programmes		MIPE, Ministry of Finance	MDLPA, ME	2025–2030
Stakeholder forum		MDLPA	All ministries, agencies	2025 onward
One-stop shops		MDLPA	Local authorities, ANRE	2025–2028
Professional training		Ministry of Labour	MDLPA, professional associations	2025–2030
Monitoring and evaluation		MDLPA	INS, ME, MIPE	Continuous

MDLPA: Ministry of Development, Public Works and Administration; ME: Ministry of Energy; MIPE: Ministry of Investments and European Projects; ANRE: National Energy Regulatory Authority; INS: National Institute of Statistics; URBAN-INCERC: National Institute for Research and Development in Constructions, Urbanism, and Sustainable Spatial Development

7.2.2 COORDINATION MECHANISMS

Effective implementation requires the following coordination structures:

- **Inter-ministerial working group:** Chaired by MDLPA, meeting quarterly to ensure policy coherence. Members: Ministry of Energy, MIPE, Ministry of Finance, Ministry of Labour, ANRE.
- **Data governance platform:** Technical body ensuring interoperability between EPC databases, e-Terra cadastre, permits, and funding records.
- **Funding coordination committee:** Chaired by MIPE, aligning eligibility criteria across PNRR, Modernisation Fund, and national programmes.
- **Stakeholder advisory council:** Biannual consultations with local authorities (AMR), professional associations (OAR), financial institutions, and civil society.

7.2.3 IMPLEMENTATION PHASES

PHASE 1 (2025–2026) – FOUNDATION:

Submit draft NBRP (December 2025) and final NBRP (December 2026); establish coordination mechanisms; define MEPS and ZEB thresholds; align PNRR Component 5 with MEPS timeline; launch stakeholder consultations.

PHASE 2 (2027–2028) – ACCELERATION:

Implement non-residential MEPS with compliance support; scale one-stop shops to national coverage; establish a comprehensive building stock database; conduct the first biennial evaluation.

PHASE 3 (2029–2030) – CONSOLIDATION:

Achieve 2030 MEPS milestone (16% non-residential floor area); verify residential trajectory progress (16% primary energy reduction); conduct first NBRP revision; prepare for 2033/2035 targets.

By implementing this coordinated roadmap, Romania can transform its NBRP into a dynamic, evidence-based instrument linking regulatory standards, financial mechanisms, and technical data systems, ensuring the building stock contributes fully to EU 2030 and 2050 climate objectives.

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ANNEX A: MODEL DOCUMENTATION

A.1 INVERT EE-LAB

Invert/EE-Lab is a comprehensive techno-socio-economic bottom-up building stock model that simulates energy-related investment decisions in buildings, specifically focusing on space heating, hot water generation, and space cooling end-uses [7]. The model is based on a highly disaggregated description of building stocks across EU-27+ countries (including Iceland, Norway, Switzerland, and the UK), incorporating:

- Building characteristics: Type, construction period, renovation state, existing heating systems.
- User structure: Ownership patterns, occupancy types, decision-making behaviour.
- Regional elements: Availability of energy infrastructure (district heating, natural gas) at the sub-country level.
- Climate zones: Heating and cooling degree days by region.

The model simulates investment decisions in building envelope improvements and heat supply/distribution systems through a combination of discrete choice approaches and technology diffusion theory. As a myopic simulation tool, it evaluates the effects of different policy interventions – including economic incentives, regulatory measures, and technology development programmes – on total energy demand, energy carrier mix, emission reductions, and costs.

Key model capabilities include:

- Simulation of renovation decisions under different policy frameworks.
- Assessment of heating system replacement choices.
- Projection of energy demand by carrier and end-use.
- Evaluation of policy cost-effectiveness.

Analysis of technology diffusion patterns

Invert/EE-Lab has been applied in over 40 projects across EU-27+ countries over more than ten years, supporting policymakers, researchers, and industry professionals in energy efficiency and building technology assessment [8].

FIGURE 13: OVERVIEW OF THE STRUCTURE OF INVERT/EE-LAB

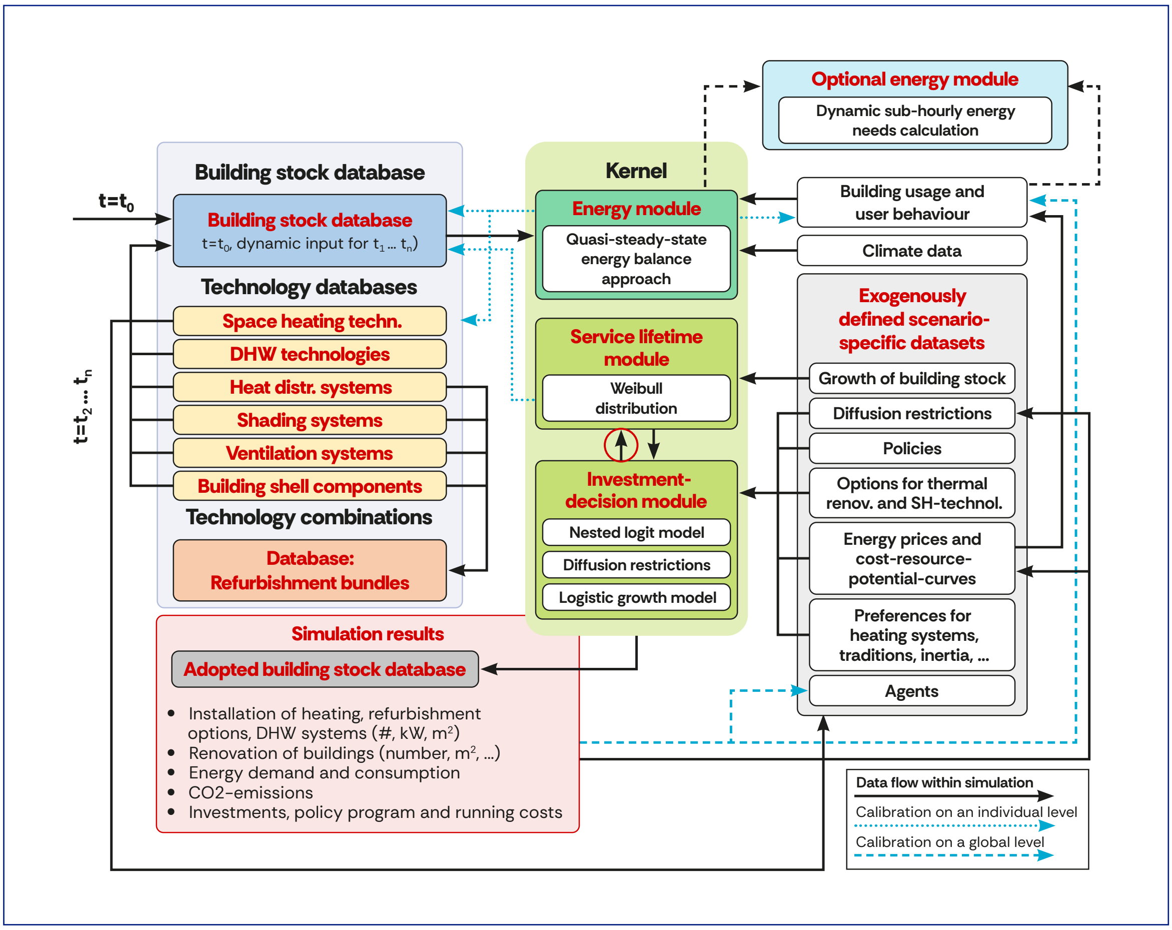


Figure 13 illustrates the model's structure, showing the interaction between building stock characterisation, policy inputs, investment decision modules, and output indicators. The discrete choice module determines renovation and heating system decisions based on economic factors, policy incentives, and behavioural parameters. Technology diffusion constraints ensure realistic deployment rates for new technologies.

A.2 INVERT/OPT MODEL

Invert/Opt is a derived model version specifically designed to calculate cost-optimal renovation scenarios. Unlike the simulation-based Invert/EE-Lab, Invert/Opt uses optimisation algorithms to identify the most cost-effective combination of technology options for both heat savings (envelope measures) and heat supply (heating systems) across different time periods.

Key features of Invert/Opt include:

- Cost-optimality calculation: Identifies renovation measures that minimise total costs (investment and operating) while meeting energy or emission targets.
- High disaggregation: Varies by country from several hundred to several thousand building segments, split across multiple climate regions.

- Diffusion constraints: Accounts for limited availability of tradeable biomass, energy infrastructure constraints, and suitable roof areas for solar technologies.
- Technology mix outputs: Produces diverse technology portfolios even in optimisation mode, reflecting real-world constraints.

The model calculates cost-optimality for:

- Building envelope retrofitting (insulation of walls, roofs, floors; window replacement).
- Heating and hot water supply system replacement.
- Integration of renewable energy technologies (solar thermal, heat pumps, biomass).

FIGURE 14: OVERVIEW OF THE STRUCTURE OF THE INVERT/OPT

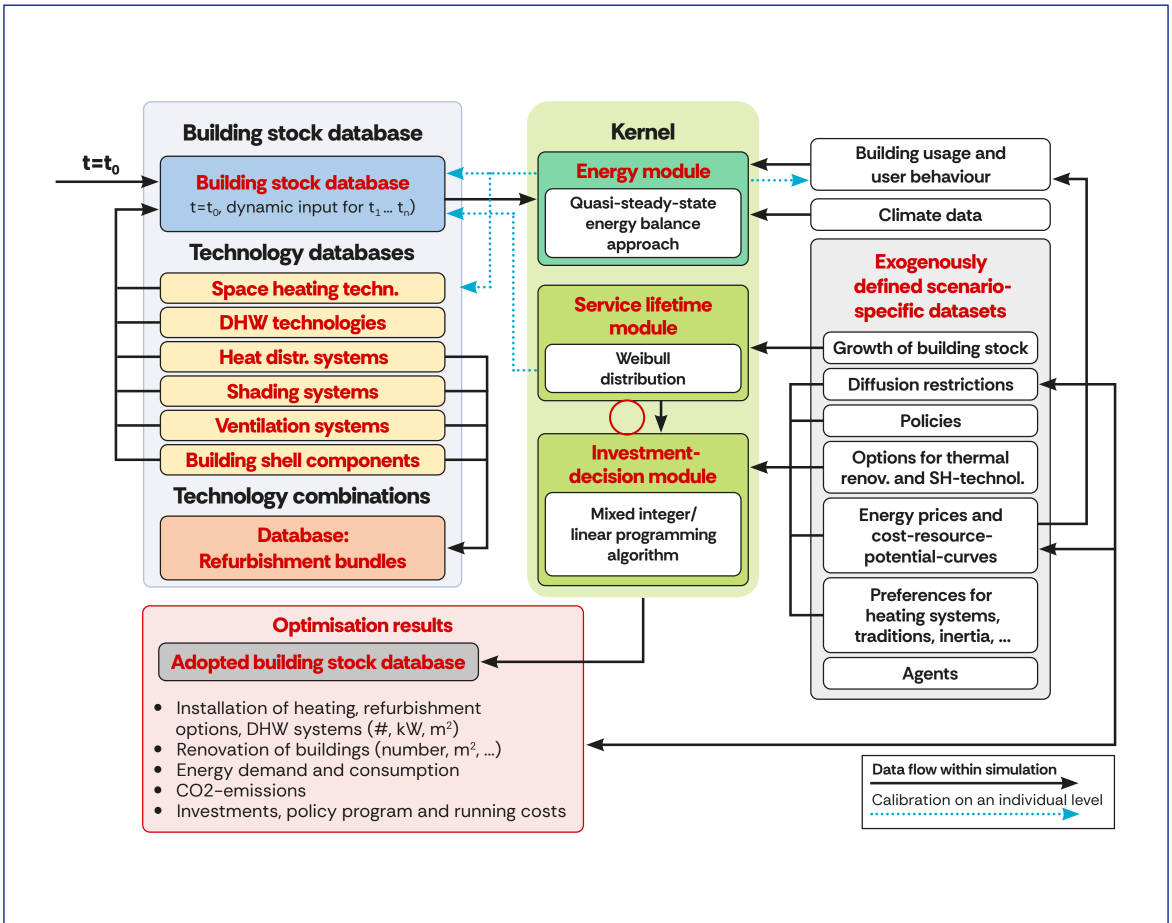
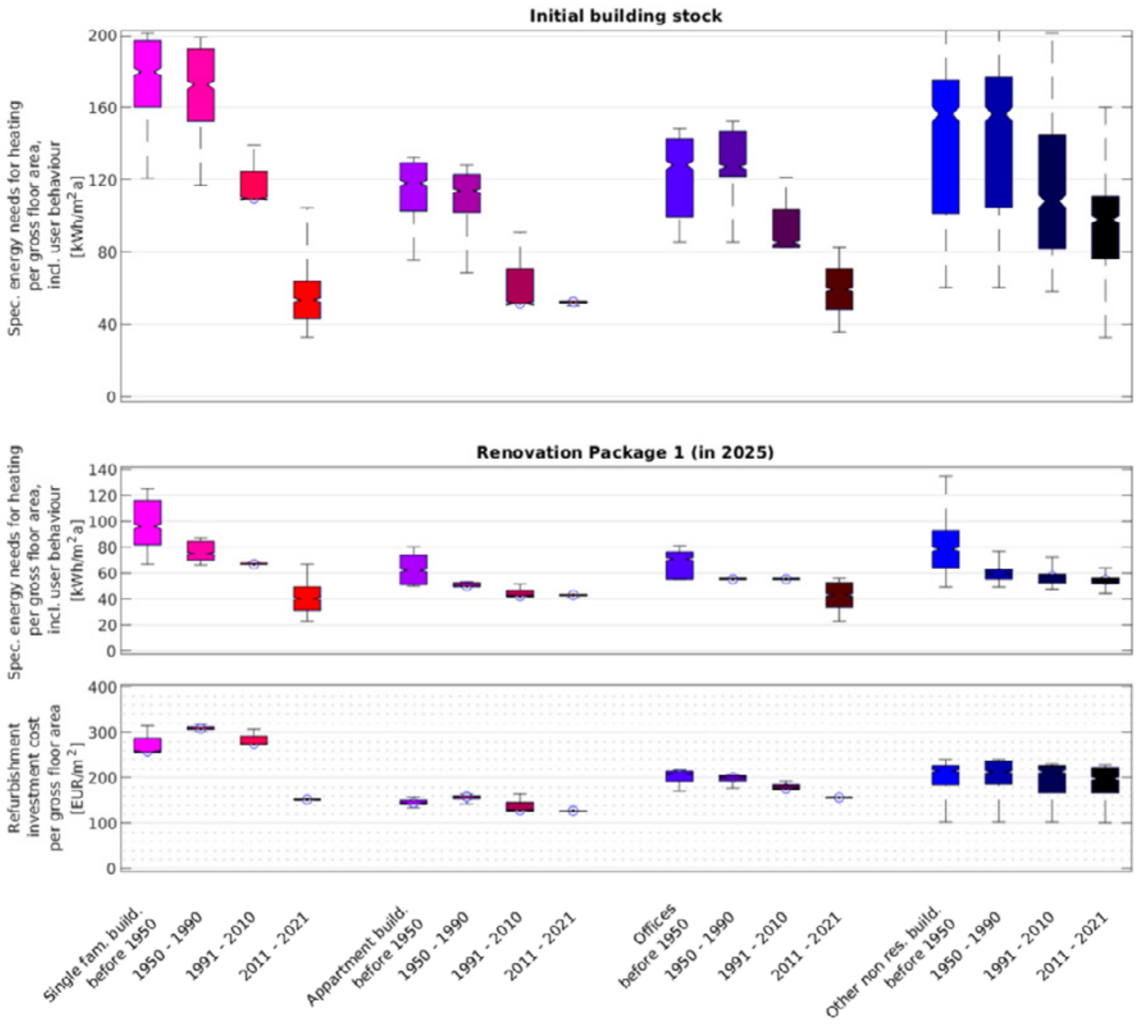


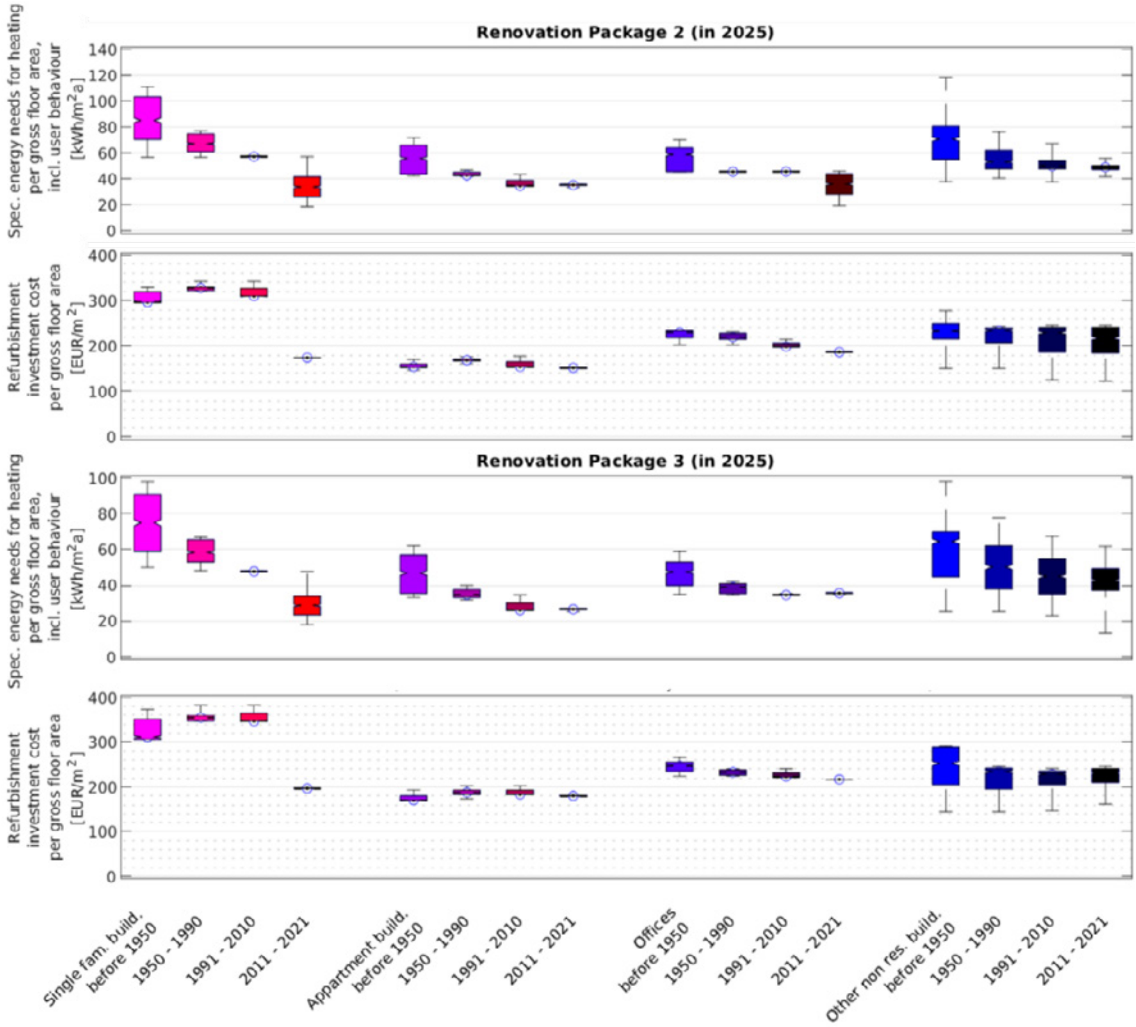
Figure 14 illustrates the optimisation framework, showing how building stock segments, technology options, cost parameters, and constraints are integrated into the optimisation algorithm to produce cost-optimal renovation pathways.

ANNEX B: ASSUMPTIONS REGARDING BUILDING RENOVATION MEASURES

The following figure provides an overview of the specific energy needs and renovation investment costs for Romania's residential building stock. Romania is assessed across three renovation packages reflecting varying depths and scopes of energy renovation.

FIGURE 15: DISTRIBUTION OF SPECIFIC ENERGY NEEDS AND INVESTMENT COST FOR REFURBISHMENT BEFORE AND AFTER RENOVATING BUILDINGS WITH THREE DIFFERENT TYPES OF RENOVATION PACKAGES OF THE BUILDING ENVELOPE IN DIFFERENT BUILDING CLASSES FOR ROMANIA




Renovation Package 2 (in 2025)
Spec. energy needs for heating per gross floor area, incl. user behaviour [kWh/m²a]
Refurbishment investment cost per gross floor area [EUR/m²]
Renovation Package 3 (in 2025)
Spec. energy needs for heating per gross floor area, incl. user behaviour [kWh/m²a]
Refurbishment investment cost per gross floor area [EUR/m²]
Single fam. build. before 1950
1950 - 1990
1991 - 2010
2011 - 2021
Appartment build. before 1950
1950 - 1990
1991 - 2010
2011 - 2021
Offices before 1950
1950 - 1990
1991 - 2010
2011 - 2021
Other non res. build. before 1950
1950 - 1990
1991 - 2010
2011 - 2021

ANNEX C: CONTRIBUTION TO THE NBRP DOCUMENT

This section aims to show that the list of indicators can be supported by the EPBD.wise modelling approach. The NBRP is a strategic planning tool mandated under Article 3 of the EPBD (2024/1275) [3]. Its purpose is to guide Member States in establishing a clear roadmap toward achieving a highly energy-efficient and decarbonised building stock by 2050. The NBRP outlines national targets for 2030, 2040, and 2050 and sets measurable progress indicators to monitor compliance with EPBD provisions.

The European Commission developed an annotated template document and an Excel sheet to facilitate the development of harmonised NBRP documents. In line with the EPBD, the document covers a broad spectrum of quantitative and qualitative indicators that reflect the national building stock's status, evolution, and renovation needs. These include:

1. Overview of the national stock.
2. Roadmap for 2030, 2040, and 2050.
3. Overview of planned and implemented policies and measures.
4. Outline of the investment needs, the budgetary sources, and the administrative resources.
5. Thresholds of new and renovated ZEBs.
6. Minimum energy performance standards for non-residential buildings.
7. National trajectory for the progressive renovation of the residential building stock.

The Commission has prepared an Excel-based indicator mapping tool to support the development and operationalisation of these indicators. This tool provides a structured overview of all mandatory and optional indicators, their grouping, and their relevance to different parts of the NBRP template. It is intended to assist focus countries and stakeholders in identifying data gaps and aligning their national reporting with EPBD requirements. Table 7 shows that the list of Annex II indicators can be supported by the EPBD.wise modelling approach.

TABLE 7: ANNEX II INDICATORS THAT CAN BE SUPPORTED BY EPBD.WISE

Annex II	Mandatory indicators	Optional indicators
(a) Overview of the national building stock	Number of buildings and total floor area (m^2): • per building type • per energy performance class • nearly zero-energy buildings • worst-performing buildings • The 43% worst-performing residential buildings	Number of buildings and total floor area (m^2): • per building age • per building size • per climatic zone
	Annual renovation rates: number and total floor area (m^2) • per building type • per renovation depth (weighted average renovation) • public buildings	
	Primary and final annual energy consumption (ktoe): • per building type • per end use Energy savings (ktoe): • residential buildings • non-residential buildings • public buildings Average primary energy use in kWh/(m^2.y) for residential buildings Share of renewable energy in the building sector (MW installed or GWh generated): • for different uses	Primary energy use of a building corresponding to the top 15 % (substantial contribution threshold) and the top 30 % (do no significant harm threshold) of the national building stock, as per Delegated Regulation (EU) 2021/2139 Share of heating systems in the building sector per boiler/heating system type Share of renewable energy in the building sector (MW installed or GWh generated): • on-site • off-site
	Annual operational greenhouse gas emissions ($kgCO_2eq/(m^2.y)$): • per building type Annual operational greenhouse gas emission reduction ($kgCO_2eq/(m^2.y)$: • per building type	
	Primary energy factors: • per energy carrier • non-renewable primary energy factor • renewable primary energy factor • total primary energy factor	
(b) Roadmap for 2030, 2040, 2050	Targets for annual renovation rates: number and total floor area (m^2): • per building type • worst-performing buildings • The 43 % worst-performing residential buildings	Targets for expected share (%) of renovated buildings: • per building type • per renovation depth
	Targets for expected primary and final annual energy consumption (ktoe): • per building type • per end use Expected energy savings: • per building type	Share of energy from renewable sources in the building sector (MW installed or GWh generated)
(d) Outline of the investment needs, the budgetary sources, and the administrative resources	• total investment needs for 2030, 2040, 2050 (million EUR) • budgetary resources	

EPBDwise

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