

# Development of NBRP: Policy guidelines for Ukraine

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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                     |
| 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 Ukraine, in accordance with Article 3 and Annex II of the Energy Performance of Buildings Directive (EPBD) 2024/1275. It offers support and recommendations to Ukrainian 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 Russian invasion in Ukraine resulted in severe effects on every sector of the country. In particular, the transformation of the building sector is strongly affected. This concerns the damage and demolition of a large share of buildings and the migration of the population within the country and beyond, creating challenges for the availability and need of housing services and the functioning of energy infrastructure, such as district heating and many more. Additionally, in order to develop an NBRP, the availability of data is crucial, which is challenging under the severe conditions in Ukraine. We could not explicitly consider all aspects in the quantitative modelling of renovation pathways. This would require further work and consideration of other data sources, which were not available for the purpose of this document.

## **BUILDING STOCK ASSESSMENT**

Ukraine's building stock is dominated by residential buildings, with multi-family houses (MFH) and single-family houses (SFH) accounting for the largest share of the total floor area. Older buildings, particularly those constructed during the Soviet era, demonstrate the highest energy demands due to inadequate insulation and outdated heating systems. The document presents the distribution of specific energy needs across building categories, which forms the basis for identifying the worst-performing buildings (WPB) and setting renovation priorities. Building stock data was derived from multiple sources, including national statistics, the Ukrainian long-term renovation strategy (LTRS), and the Invert/EE-Lab database.

## **SCENARIO ANALYSIS AND MODELLING**

The document presents five policy scenarios analysed using the Invert/EE-Lab building stock model, examining different combinations of policy instruments including Minimum Energy Performance Standards (MEPS), CO<sub>2</sub> pricing, and investment subsidies. Key findings include:

- **Regulatory+ scenario** (comprehensive MEPS combined with fossil boiler bans) achieves the fastest phase-out of fossil fuels and the most significant reductions in energy demand, with final energy demand declining from approximately 165 GWh/yr to 85 GWh/yr by 2050.
- All scenarios project renewable energy shares increasing from approximately 21% in 2020 to 97–100% by 2050, demonstrating Ukraine’s strong potential for renewable heating deployment.
- Final energy savings range from 12–22% by 2050, depending on the policy scenario, with the Regulatory+ and Mix scenarios achieving the highest savings. Savings in delivered energy and primary energy in some scenarios are substantially higher due to the shift to heat pumps.

### POLICY RECOMMENDATIONS

The document provides targeted policy recommendations for Ukraine across several key areas:

- **Data infrastructure:** Strengthened building stock data systems, achieved by developing comprehensive building registers, improving EPC database coverage, and establishing robust data collection mechanisms for renovation monitoring, taking into account the challenges posed by the ongoing conflict.
- **Regulatory framework:** Implementation of MEPS for non-residential buildings and progressive renovation trajectories for residential buildings, aligned with Article 9 of the EPBD and adapted to Ukraine’s EU accession pathway.
- **Financial mechanisms:** Development of targeted subsidy programmes and financial instruments to support building renovation, with particular attention to war-damaged buildings, energy-poor households, and post-war reconstruction priorities.

### MONITORING AND EVALUATION

Continuous monitoring of renovation activities is essential for tracking progress toward NBRP targets. In Ukraine, where data systems have been disrupted or delayed due to the ongoing war, a phased approach is essential. Initial monitoring efforts should focus on low-effort, scalable methods such as macro-level assessments and utility data analysis, while gradually building capacity for more comprehensive EPC-based tracking as conditions stabilise.

### ALIGNMENT WITH EU FRAMEWORK

The NBRP guidelines presented in this document are closely linked to other EPBD provisions, particularly Article 9 (MEPS and renovation trajectories). As Ukraine progresses toward EU membership, alignment with the Fit for 55 framework, including the Energy Efficiency Directive (EED) and Renewable Energy Directive (RED III), will be essential for ensuring policy coherence and access to EU funding mechanisms for building renovation.

# 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 Ukraine. 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.

The document also 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. 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)  |
|--|--|--|
| <b>Building stock data</b>                       | Data collection and description of building stock data, including its distribution regarding energy consumption levels | How to derive the worst-performing buildings and 16 <sup>th</sup> /26 <sup>th</sup> quantile thresholds for minimum energy performance standards |
| <b>Modelling assumptions and scenario design</b> | 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                       |
| <b>Scenario results</b>                          | 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                                 |
| <b>Checking target achievement</b>               | 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  |
| <b>Stakeholder engagement</b>                    | Included   | Not included   |
| <b>Monitoring, evaluation</b>                    | 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) [2]. Chapter 2 summarises the policy needs identified through consultations with stakeholders and good practices relevant to Ukraine. Chapter 3 provides an overview of the building stock data for Ukraine 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 and presents the modelling and scenario results. Chapter 5 outlines strategies for monitoring and evaluation of renovation activities. Chapter 6 discusses the consistency and interaction with other policy elements. Chapter 7 is the main section of the document, where country-specific policy guidelines and recommendations are presented for Ukraine.

## 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.<sup>1,2</sup>

### 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<sub>2</sub> 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<sub>2</sub> 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.

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

<sup>2</sup> For Ukraine, 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.

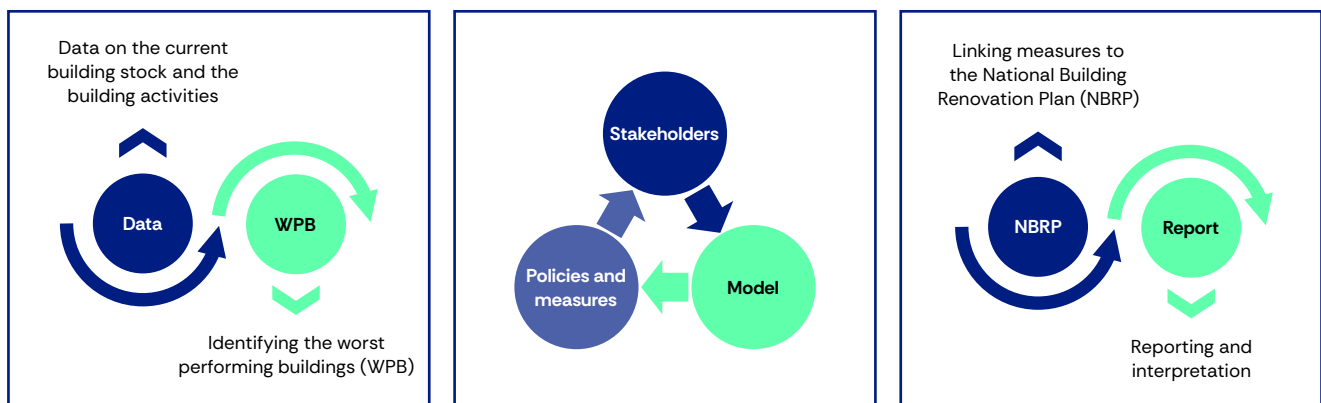
The results of this report were discussed with stakeholders in the framework of dedicated policy forums. More detailed guidelines for framing this stakeholder engagement process are discussed in Chapter 7. For comprehensive guidance on monitoring, reporting, and evaluation of NBRP implementation, see 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 [2]. 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 ZEB 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<sup>2</sup>.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

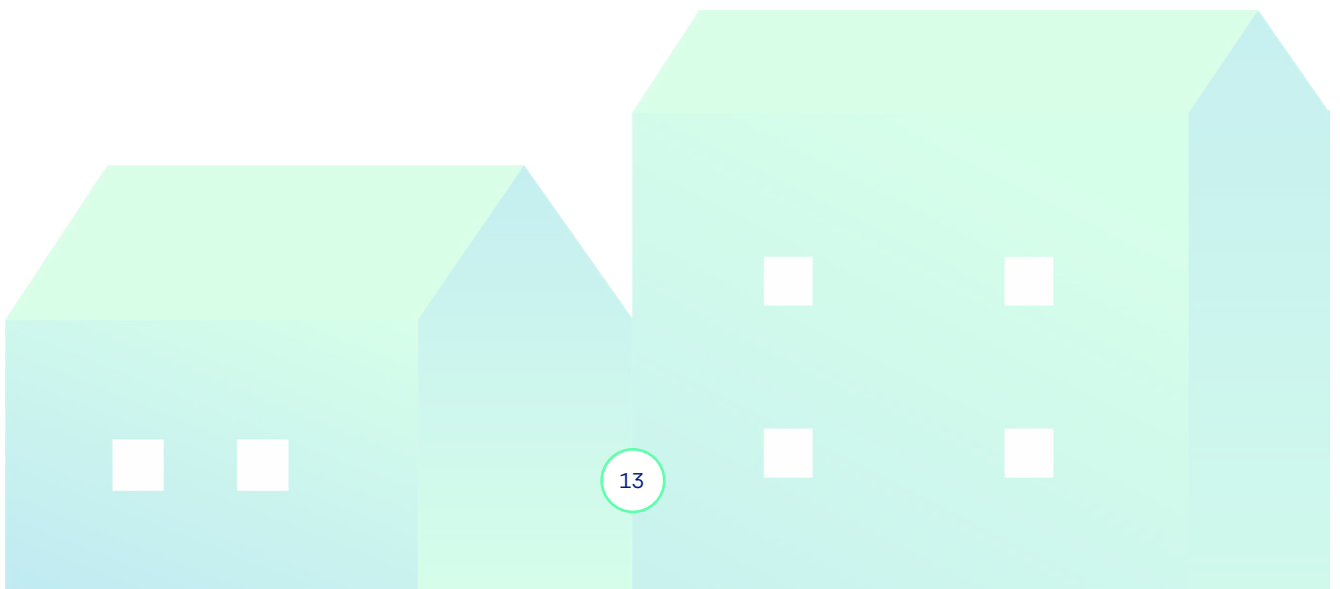
# STATUS OF PREVIOUS LTRS AND SCENARIO WORK

This chapter provides an overview of the LTRS, including its status and main elements, for Ukraine. 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.

Ukraine's LTRS, officially titled the Long-Term Strategy for Thermal Modernisation of Buildings until 2050, outlines its strategic vision for transforming its building stock into a climate-resilient, energy-efficient, and low-carbon sector. The document provides a detailed overview of the current status of the Ukrainian building stock, its energy consumption patterns, and technical characteristics, highlighting significant efficiency gaps compared to EU averages. It identifies the key challenges to large-scale thermal modernisation, including outdated buildings, insufficient financing mechanisms, and limited data availability. It also sets strategic goals and scenarios for achieving deep renovation and decarbonisation by 2050.

The following section summarises the available data presented in the Ukrainian LTRS, including structural and energy indicators of the building stock, requirements for energy performance, and projections of renovation activities, energy savings, and emission reductions under different scenarios.



Available data includes:

- Main indicators of the Ukrainian building stock.
- Total energy consumption of the Ukrainian building stock.
- Energy consumption in the residential sector by building category.
- Structure of the building stock by the construction and size.
- The most common types of apartment buildings.
- The main characteristics of the external walls of multi-apartment buildings according to typical design series.
- Average indicators of energy efficiency of buildings in Ukraine.
- Requirements for the specific energy consumption values for the 1<sup>st</sup> temperature zone of Ukraine.
- Requirements for the specific energy consumption values for the 2<sup>nd</sup> temperature zone of Ukraine.
- Specific consumption of electrical and thermal energy in residential buildings.
- Total floor area of the building stock.
- Total floor area of the non-residential buildings.
- Specific consumption of the electric and thermal energy in public buildings.
- Share of thermally modernised buildings according to scenarios.
- Annual energy savings within scenarios for residential and non-residential buildings.
- Annual goals for thermal modernisation of residential and non-residential buildings until 2030 under scenarios.
- Projected energy consumption and greenhouse gas emissions in the residential and non-residential sectors until 2030 for different scenarios.
- Projected energy indicators of the building stock until 2030 under different scenarios.

The LTRS defines two main modelling scenarios for the thermal modernisation of residential and public buildings, complemented by a variant approach considering different renovation depths. These scenarios were modelled for the period up to 2030, with results for 2040 and 2050 extrapolated based on the same trends and dynamics.

### SCENARIO 1: BASELINE (NORMAL) SCENARIO

The baseline scenario assumes a low level of thermal modernisation, with around 10% of buildings (or 17% of total floor area) renovated by 2030. This corresponds to an annual renovation rate of 1–1.3%, aligned with the current national targets for public and residential buildings.

This scenario reflects the continuation of existing government programmes and current funding and institutional capacity levels. It focuses on bringing buildings up to minimum energy efficiency requirements but does not achieve the full potential of deep renovation.

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### SCENARIO 2: AMBITIOUS SCENARIO

The ambitious scenario assumes a significant acceleration of thermal modernisation, achieving 35–40% renovation coverage by 2030, corresponding to an annual renovation rate of 3.6%. This aligns with the EU's indicative goals set under the European Green Deal, the Fit for 55, and REPowerEU.

The scenario envisions a transition toward deep renovation and the integration of renewable energy sources, aiming to ensure that at least 50% of the energy consumed in renovated buildings comes from renewable sources. By 2050, it envisions the full or near-full decarbonisation of the building stock, with most buildings meeting nearly zero-energy buildings (NZEB) standards.

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### SCENARIO VARIANTS: NORMAL AND NZEB OPTIONS

During the first stage (up to 2030), two variants of implementation were considered within the main scenarios:

- Normal option: Modernisation to meet minimum compliance levels for energy efficiency.
- NZEB option: Modernisation achieves nearly zero-energy building performance.

The subsequent stages (2031–2040 and 2041–2050) are expected to scale up the ambitious/ NZEB trajectory, leading to widespread deep renovation, energy independence, and ultimately the decarbonisation of the national building stock.



# 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 Ukraine and other focus countries within the EPBD.wise project. Subsequently, we organised workshops with focus country contact points (FCCPs) and policy forums in Ukraine to better understand national needs and the specific situation.

This multi-faceted research approach enabled us to identify specific policy needs for Ukraine. From this analysis, countries prioritised some policy elements based on their unique needs; for Ukraine, 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                 |
|  | Public consultation   | -                  | Slovakia              |
| Good governance  | 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     |

In Ukraine, the primary obstacle to a comprehensive understanding and implementation of the NBRP is the significant gap in building stock data, particularly for single-family homes. This sector represents a substantial and crucial part of Ukraine's building stock, yet lacks comprehensive strategies, coherent policy support, and data. Ukraine requires tailored support in drafting and operationalising these plans, as well as fostering sector-specific integration, developing methods for building stock data collection, exploring funding and financing mechanisms, and establishing a methodology for cost calculations. This should primarily focus on decarbonising the building sector, where targeted initiatives could include incentivising energy-efficient technologies and practices. Enhancing expertise and resources dedicated to these areas would improve Ukraine's alignment with EPBD mandates and its overall energy efficiency targets.

For Ukraine, the policy support areas focus on:

1. Improving building stock data collection and quality.
2. Assessing policies and measures required to set and achieve specific targets.
3. Understanding investment needs and required financing programmes.
4. Identifying and collecting data on worst-performing buildings.
5. Developing measures to enhance energy performance in public buildings.
6. Policies and actions on deep renovations.
7. Analysing broader impacts and measures to address energy poverty.



Table 2 provides an overview of these policy needs alongside good practice examples from other Member States.

# BUILDING STOCK DATA AS A STARTING POINT<sup>3</sup>

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.

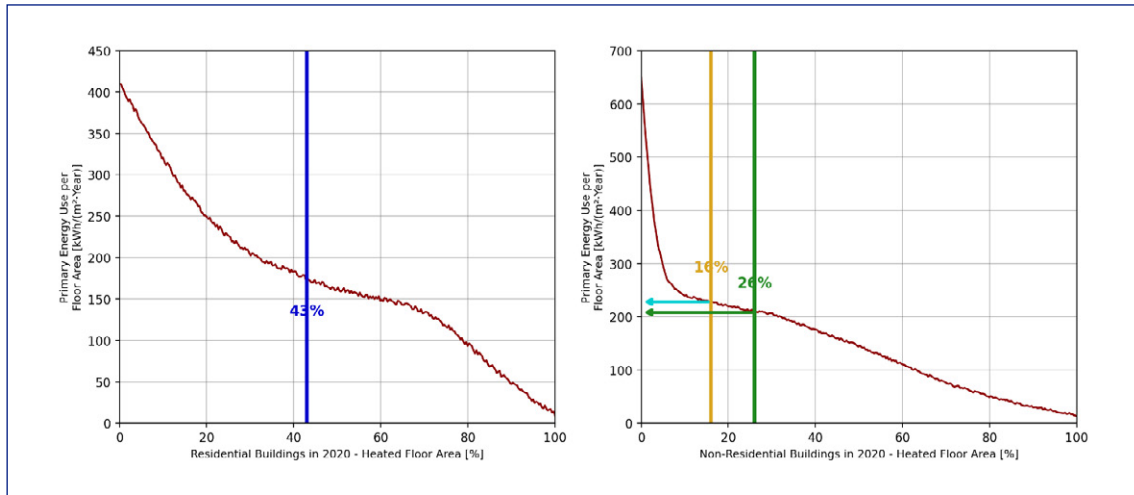
## THE NBRP CONTAINS THE FOLLOWING THREE MAIN PARTS:

- 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 4.3% share of WPB on the one hand and the 16<sup>th</sup> and 26<sup>th</sup> 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 Article 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

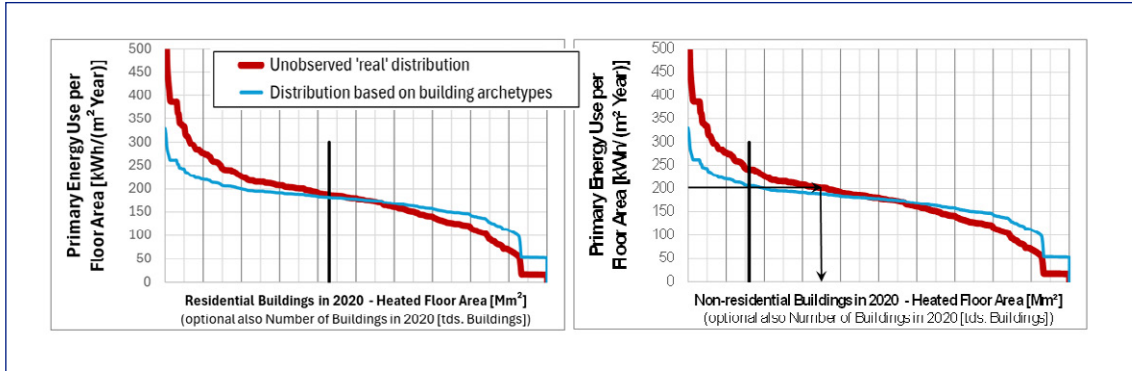
# METHODS FOR COMPILING BUILDING STOCK DATA AND RELATED ENERGY USE

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/Episcopo [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 16<sup>th</sup> and 26<sup>th</sup> 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.

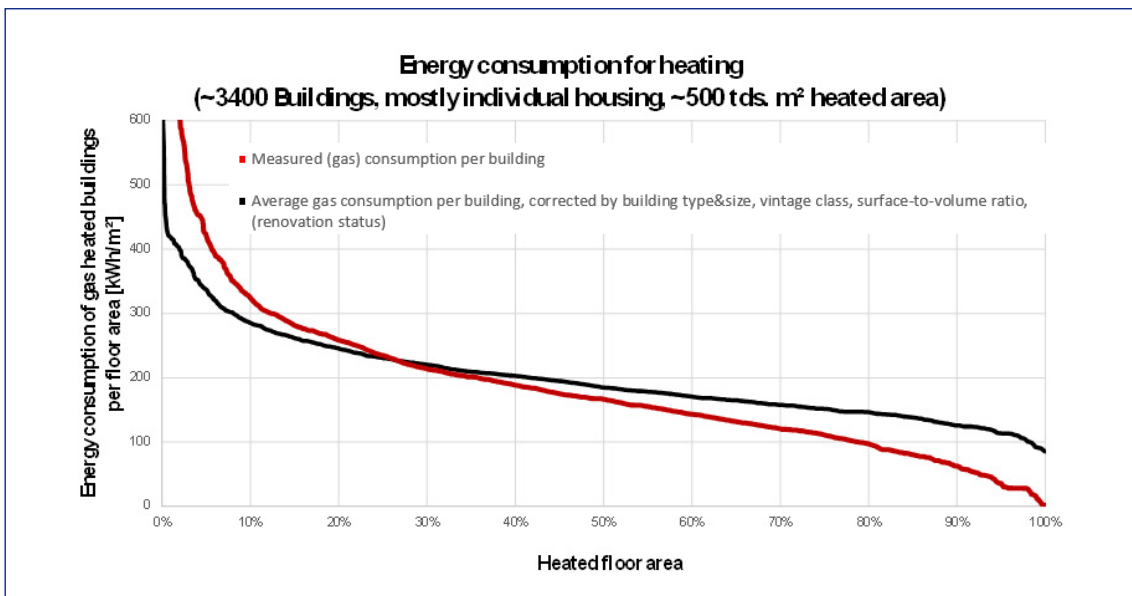
► **FIGURE 3: POSSIBLE BIAS IN THE USE OF THE ARCHETYPE-BASED BOTTOM-UP APPROACH FOR RESIDENTIAL BUILDINGS (LEFT) AND NON-RESIDENTIAL BUILDINGS (RIGHT)**



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.

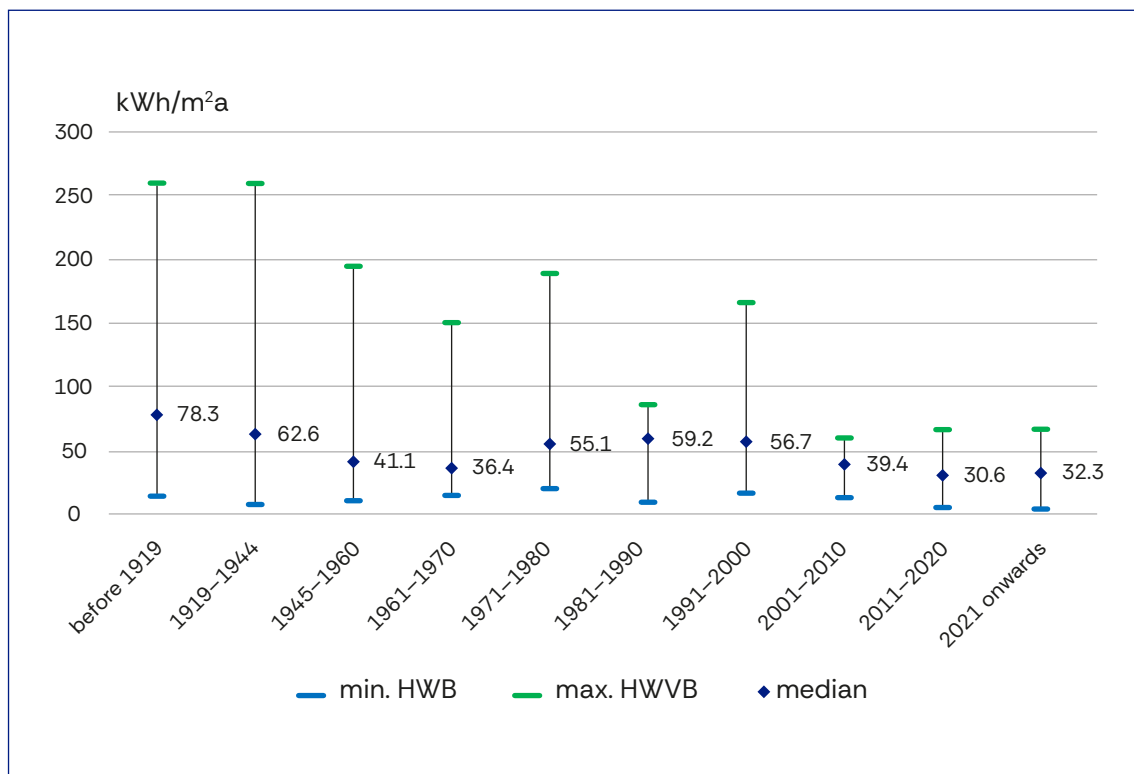
The figure illustrates the potential error associated with this approach, where measured energy consumption (in this case, gas consumption) is used to derive the distribution curve of energy consumption.

► **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

The building stock data presented in this section is derived from multiple sources, including the EU Building Stock Observatory (BSO), Ukrainian national statistical databases, and the Invert/EE-Lab database maintained by TU Wien. Data has been validated against national energy balances and updated to reflect the most recent available statistics (as of 2023).

Acquiring comprehensive data on the Ukrainian building stock presents significant challenges. The information was primarily sourced from Ukraine’s LTRS report and the national statistical agency. While these sources provide some insights into the residential sector, data on the non-residential sector remains scarce.

It is essential to emphasise that obtaining reliable and up-to-date information on the building stock is extremely challenging, particularly in the context of the ongoing war. The conflict has led to territorial occupations, large-scale destruction of buildings, and the rapid construction of temporary shelters to accommodate displaced populations. These factors introduce significant uncertainties, making a systematic assessment of the building stock highly challenging, if not impossible, under current conditions.

### BUILDING STOCK RESIDENTIAL DATA

The total Ukrainian housing stock was 1,079.5 million m<sup>2</sup> in 2023. When excluding the temporarily occupied territories (Donetsk, Luhansk, Crimea), the housing stock is reduced to 984.8 million m<sup>2</sup> [6].

Figure 6, from the LTRS, shows the structure of the housing stock by year of construction, as well as the size of the units by number of rooms.

► **FIGURE 6: STRUCTURE OF HOUSING STOCK BY YEAR OF CONSTRUCTION AND SIZE [6]**

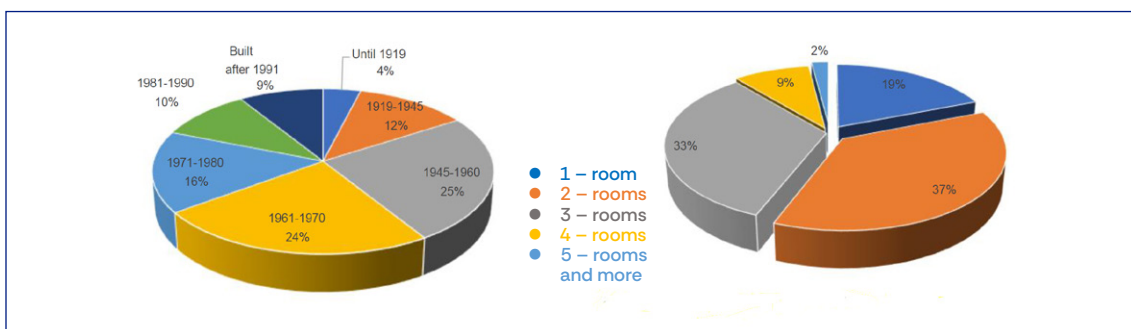


Table 3 provides an overview of the Ukrainian residential building stock, detailing the distribution of built-up areas across different construction periods and the corresponding average area built per year. The total housing stock is approximately 1,079.5 million m<sup>2</sup>, with the largest shares constructed between 1946 and 1960 (25%) and 1961 and 1970 (24%). The annual construction rate varied significantly, peaking between 1961 and 1970 at approximately 25.9 million m<sup>2</sup> per year, followed by a sharp decline after 1991 to just over 3 million m<sup>2</sup> per

year. Notably, early periods such as pre-1919 and 1919–1945 contributed smaller portions, with the former accounting for only 43.18 million m<sup>2</sup> in total. The data illustrate how Ukraine’s residential construction activity surged in the mid-20<sup>th</sup> century but has slowed considerably in recent decades. As can be seen, the table refers to the total building stock, including temporarily occupied areas; if these were subtracted, a different value would result for the respective construction periods.

► **TABLE 3: HOUSING STOCK AREA FOR EACH BUILDING PERIOD AND THE AVERAGE AREA BUILT PER YEAR FOR EACH PERIOD [6]**

| Year         | Building period |                                | Average area built per year |                                |
|--------------|-----------------|--------------------------------|-----------------------------|--------------------------------|
|              | Percentage      | Area [million m <sup>2</sup> ] | Period in years             | Area [million m <sup>2</sup> ] |
| until 1919   | 4               | 43,18                          |                             |                                |
| 1919–1945    | 12              | 129,54                         | 27                          | 4,798                          |
| 1946–1960    | 25              | 269,88                         | 25                          | 10,795                         |
| 1961–1970    | 24              | 259,08                         | 10                          | 25,908                         |
| 1971–1980    | 16              | 172,72                         | 10                          | 17,272                         |
| 1981–1990    | 10              | 107,95                         | 10                          | 10,795                         |
| after 1991   | 9               | 97,16                          | 32                          | 3,036                          |
| <b>Total</b> |                 | <b>1079,5</b>                  |                             |                                |

► **TABLE 4: RESIDENTIAL BUILDING STOCK; PUBLIC BUILDINGS [7]**

| Building category        | Period      | Building type                                  | Average living area (m <sup>2</sup> ) | Share of total housing stock per type | Thermal performance level |
|--------------------------|-------------|--|---------------------------------------|---------------------------------------|---------------------------|
| Multi-apartment building | before 1919 | Pre-revolutionary buildings (Tsarsky)          | 130                                   | 8                                     | Poor                      |
|                          | 1919–1950   | Stalin-era buildings (Stalinkas)               | 78                                    | 14                                    | Poor                      |
|                          | 1951–1970   | Post-Stalin soviet buildings (panel buildings) | 30                                    | 36                                    | Poor                      |
|                          | 1971–1990   | Modern high rises                              | 113                                   | 10                                    | Standard                  |
|                          | 1991–2000   | Modern low rises                               | 61                                    | 18                                    | Standard                  |
|                          | 2001–2010   | Townhouses                                     | 78                                    | 14                                    | Performing                |
| Individual housing       | before 1919 | Single-family house                            | 52                                    | 32                                    | Poor                      |
|                          | 1919–1950   | Terraced house                                 | 95                                    | 17                                    | Poor                      |
|                          | 1951–1970   | Cottage  | 121                                   | 14                                    | Standard                  |
|                          | 1971–1990   | Single flat                                    | 43                                    | 38                                    | Performing                |

## BUILDING STOCK NON-RESIDENTIAL DATA

The non-residential building stock data was extremely scarce, with limited information available. However, Table 5, from the LTRS, provides some insights into public buildings, while no data were found for private non-residential properties. The table categorises public buildings into preschool institutions, schools, health protection institutions, and other buildings, presenting their quantity and total area [6].

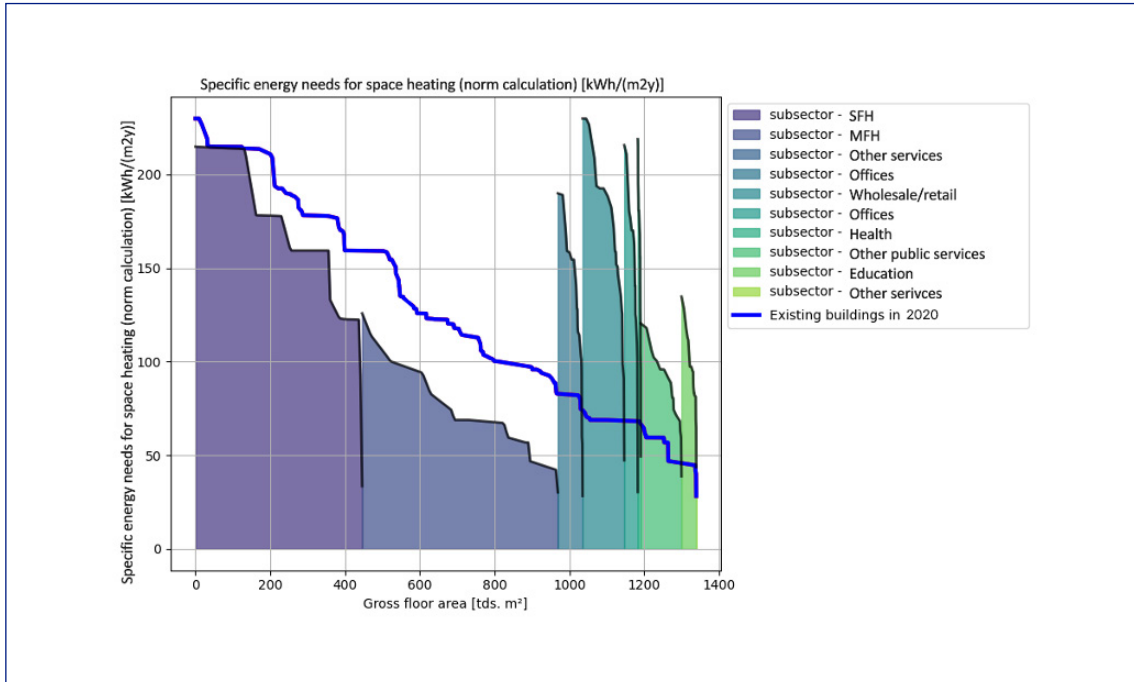
The table indicates 255,344 public buildings, covering a combined area of approximately 320.16 million m<sup>2</sup>. Schools constitute a significant portion, with 16,143 units occupying 81.89 million m<sup>2</sup>. Preschool institutions number 12,983, covering 27.11 million m<sup>2</sup>, while health protection institutions are the least numerous, with 2,442 units and a total area of 9.77 million m<sup>2</sup>. The *Others* category, which includes a wide range of public buildings, dominates in both number (223,776 units) and total area (201.4 million m<sup>2</sup>).

► **TABLE 5: NON-RESIDENTIAL BUILDING STOCK; PUBLIC BUILDINGS [6]**

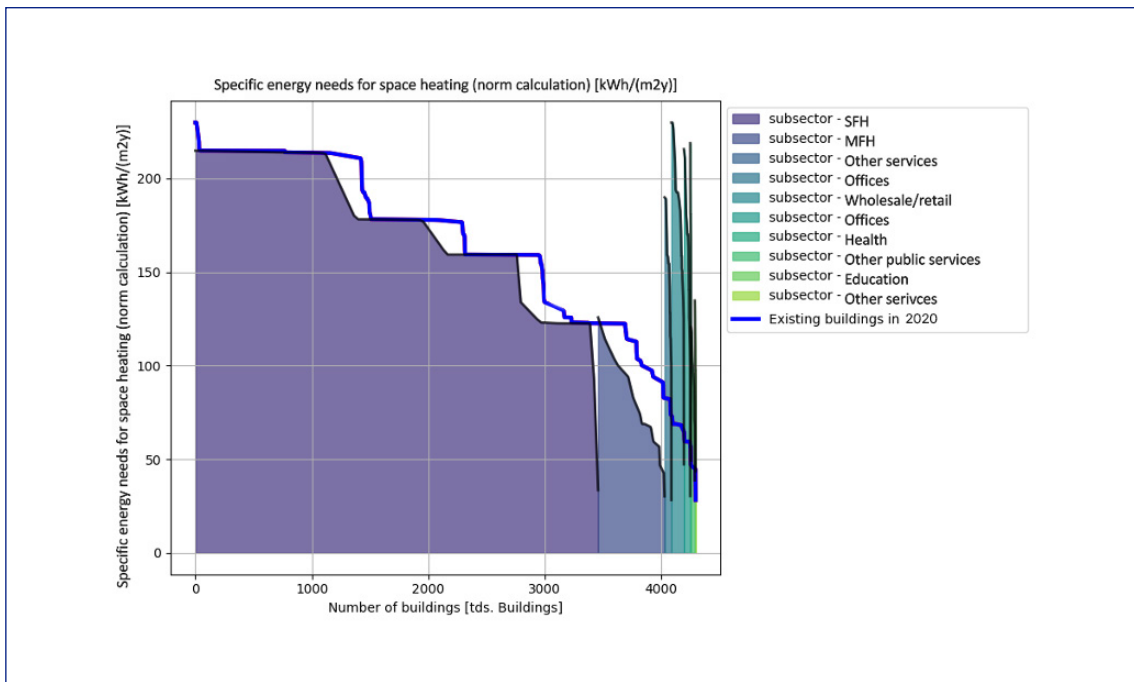
|   | Quantity (units) | Area (million m <sup>2</sup> ) |
|---|------------------|--------------------------------|
| Preschool institutions                    | 12,983           | 27.11                          |
| Schools                                   | 16,143           | 81.89                          |
| Institutions for the protection of health | 2,442            | 9.77                           |
| Others                                    | 223,776          | 201.4                          |
| <b>Total</b>                              | <b>255,344</b>   | <b>320.16</b>                  |

The following figures illustrate the specific energy requirements for space heating in Ukraine, plotted against the gross floor area (Figure 7) and the number of buildings (Figure 8), based on calculations. The graphs show that SFH and MFH account for the largest share of the total building stock, as evidenced by the significant portions of the graphs occupied by these subsectors. The distribution of energy needs across building types highlights the residential sector's higher energy intensity than other subsectors. The curves representing existing buildings at the start and end years enable a comparison of changes over time, indicating potential shifts in energy efficiency resulting from renovations or improvements. The data provides insights into overall energy demand and the impact of different building typologies on space-heating requirements.

► **FIGURE 7: SPECIFIC ENERGY NEEDS FOR SPACE HEATING OVER GROSS FLOOR AREA PER BUILDING CATEGORY**



► **FIGURE 8: SPECIFIC ENERGY NEEDS FOR SPACE HEATING OVER THE NUMBER OF BUILDINGS PER BUILDING CATEGORY**



# DRAFT NBRP SCENARIO ANALYSES: METHOD AND SCENARIO DESIGN

This chapter examines how various policy packages can achieve national building renovation objectives in Ukraine. 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<sub>2</sub> 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:

1. **Scope of minimum energy performance standards (MEPS):** in both sectors / in non-residential only / none.
2. **Fossil boiler ban:** Present/absent.
3. **Carbon-price level:** Illustrative ~75€/t vs. ~300€/t.
4. **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 Ukraine'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.

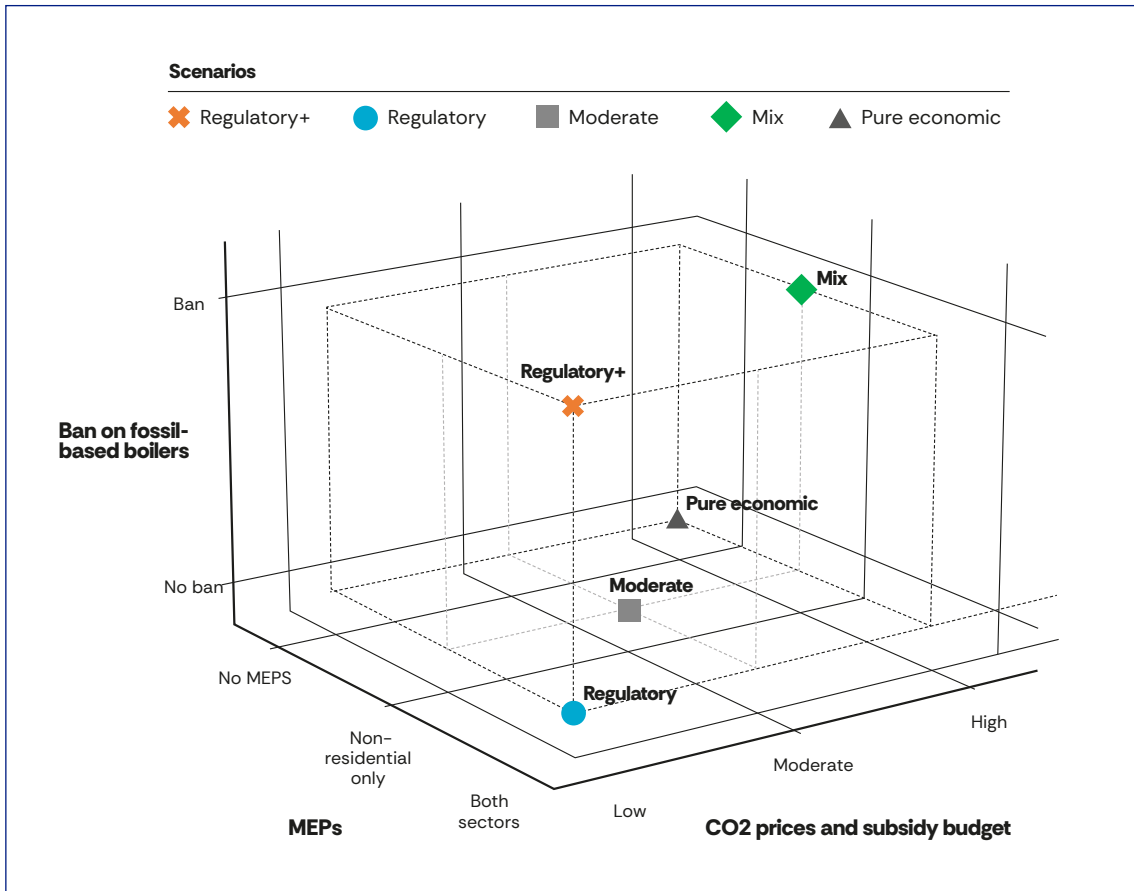
The scenario results inform the development of Ukraine's NBRP by providing quantitative inputs for the roadmap (Annex II, Section (b)) and evidence for selecting policy measures (Annex II, Section (c)).

## 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 9).

► FIGURE 9: SCENARIO GROUPING



► TABLE 6: 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 <sub>2</sub> price                      | 75€/t                           | 300€/t          | 75€/t                           | 300€/t        | 75€/t           |

## 4.3

## SCENARIO FRAMEWORK DATA

The energy prices shown in Table 7 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<sub>2</sub> costs, which are added separately according to the scenario specifications.

► **TABLE 7: ENERGY PRICES FOR UKRAINE FOR THE YEARS 2020, 2030, 2040, AND 2050 IN €/MWH**

|                  | 2020 | 2030 | 2040 | 2050 |
|------------------|------|------|------|------|
| Electricity      | 166  | 166  | 166  | 166  |
| Gas              | 47   | 59   | 59   | 59   |
| Oil              | 75   | 94   | 94   | 94   |
| District heating | 56   | 71   | 71   | 71   |
| Coal             | 40   | 50   | 50   | 50   |
| <b>Biomass:</b>  |      |      |      |      |
| Wood logs        | 29   | 32   | 32   | 32   |
| Wood chips       | 25   | 32   | 32   | 32   |
| Pellets          | 35   | 44   | 44   | 44   |

Sources: EU Building Stock Observatory (BSO), European Commission, [https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/eu-building-stock-observatory\\_en](https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/eu-building-stock-observatory_en); State Statistics Service of Ukraine (Ukrstat), Housing Stock Statistics 2021, <https://ukrstat.gov.ua/>; State Statistics Service of Ukraine (Ukrstat), Energy Balance of Ukraine 2022, <https://stat.gov.ua/en/explorer?md5=504a23ce52eb4e6165d41d653e08bc>

## 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 [11], [12].

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 assessment of policy scenarios against EPBD requirements, including residential energy reduction trajectories, worst-performing building thresholds, and non-residential MEPS compliance. Detailed model descriptions and structure diagrams are provided in Annex A.

## 4.5

## ALTERNATIVE RENOVATION PATHWAYS

Figure 10 presents the final energy demand (FED) projections for Ukraine'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 165 GWh/yr in 2021 to 85 GWh/yr and 130 GWh/yr by 2050, respectively, representing reductions of 48% and 21%. The Regulatory+ scenario, featuring a 75€/t CO<sub>2</sub> 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 largely phased out by 2035. This scenario shows dramatic growth in biomass heating, which becomes the dominant energy carrier by 2050 (approximately 30 GWh/yr), alongside substantial increases in district heating (approximately 30 GWh/yr) and electricity (approximately 15 GWh/yr).

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 to minimal levels by 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 15–20 GWh/yr by 2050, though district heating expansion is particularly pronounced in Ukraine compared to other focus countries, reflecting the country's extensive existing district heating infrastructure.

The Mix, Pure economic, and Moderate scenarios exhibit more gradual energy demand trajectories, all reaching approximately 125–140 GWh/yr by 2050, representing reductions of roughly 15–24% from 2021 levels. The Pure economic scenario, driven by high carbon pricing (300€/t) with substantial ETS<sub>2</sub>-linked subsidies but no MEPS, shows the strongest electricity growth reflecting heat pump adoption, reaching approximately 25 GWh/yr by 2050. However, the absence of regulatory mandates results in a slower phase-out of fossil fuels, with coal persisting at approximately 10 GWh/yr until 2045 and gas maintaining a substantial share (approximately 45 GWh/yr) throughout the projection period.

The Mix scenario (300€/t, high subsidies, MEPS only in the non-residential sector) achieves intermediate results, reaching approximately 140 GWh/yr by 2050, with balanced growth across electricity, district heating, and biomass. The Moderate scenario (75€/t, moderate subsidies, MEPS only in non-residential sector) demonstrates the slowest transformation among policy scenarios, reaching approximately 125 GWh/yr by 2050, with gas remaining the dominant energy carrier at approximately 50 GWh/yr and coal persisting at 10–15 GWh/yr through 2045.

The convergence of outcomes in Mix and Moderate scenarios, despite different carbon price levels, suggests that in Ukraine’s context, non-residential MEPS, combined with moderate economic instruments, can partially compensate for the absence of residential mandates; however, comprehensive MEPS coverage remains essential for achieving a deep transformation of the residential sector. The slower residential transformation in scenarios without residential MEPS reflects Ukraine’s building stock characteristics, including extensive multi-family housing with complex ownership structures, aging building fabric, and the prevalence of district heating systems that require coordinated rather than individual decision-making for heating system transitions.

► **FIGURE 10: FINAL ENERGY DEMAND (FED) RESULTS FOR UKRAINE FOR THE YEARS 2021–2050**

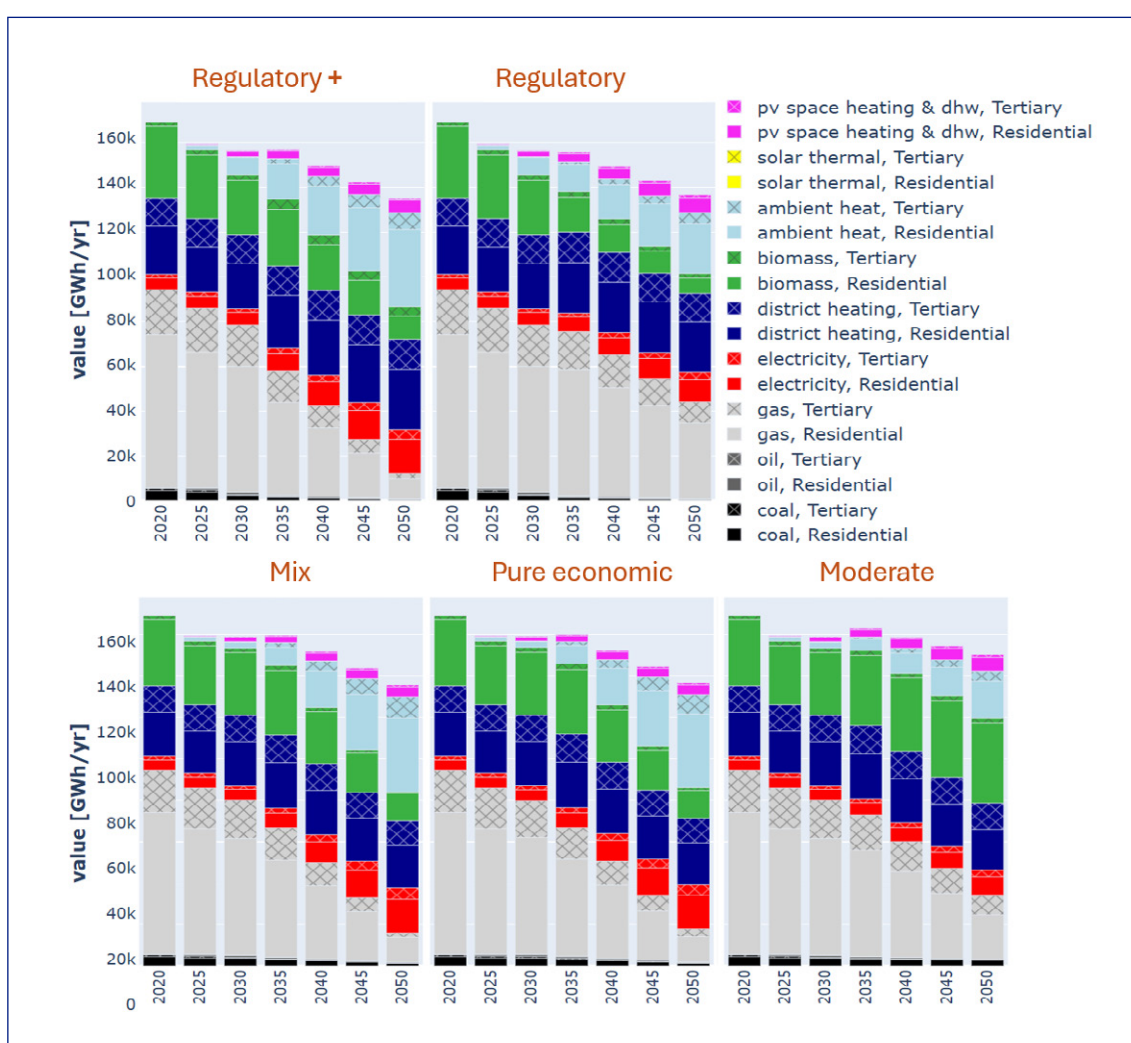


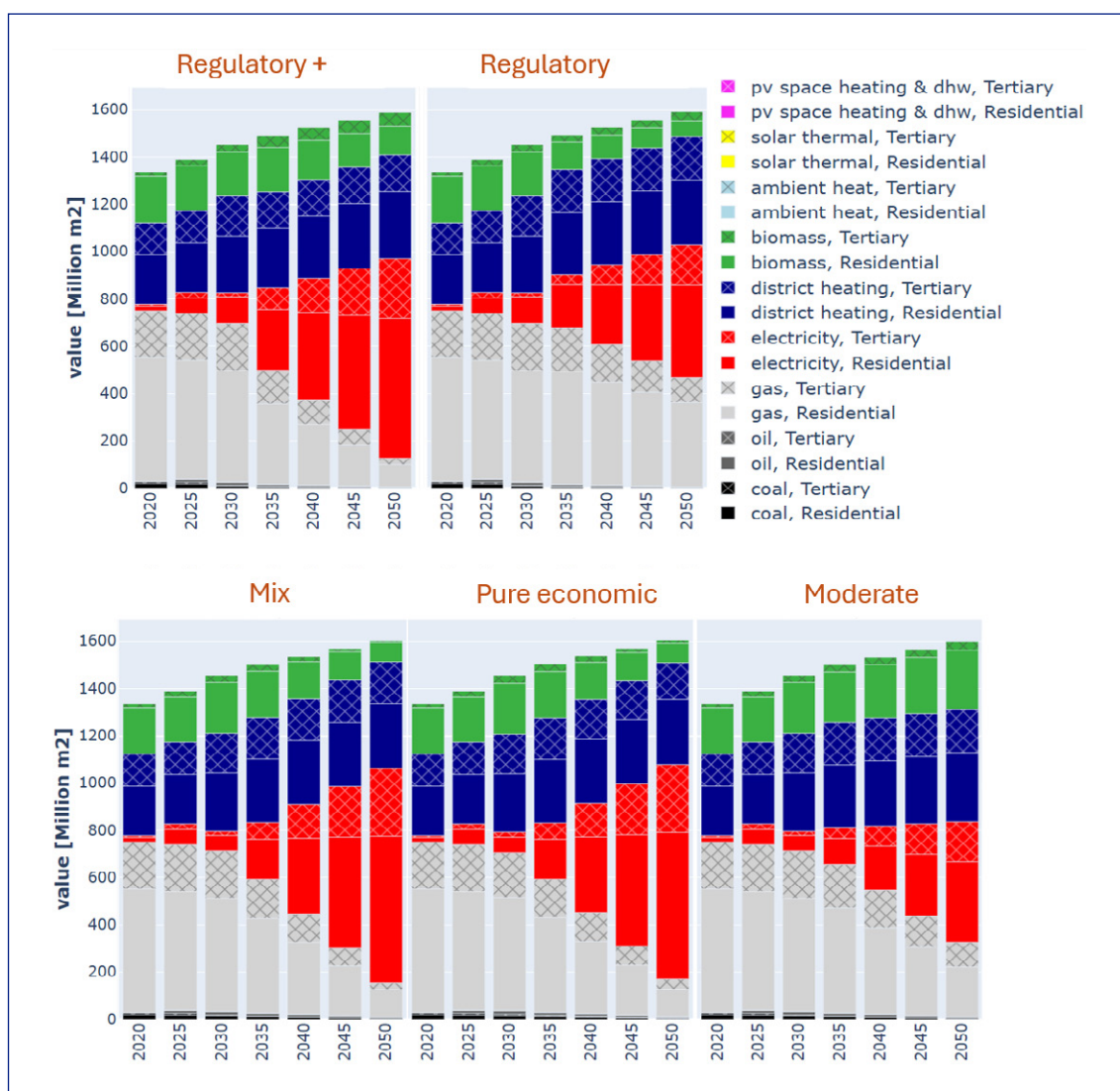
Figure 11 presents the projections for the heated gross floor area in Ukraine by heating system type across the five policy scenarios from 2021–2050. All scenarios show overall growth in heated floor area from approximately 1,300 million m<sup>2</sup> in 2021 to 1,500–1,600 million m<sup>2</sup> by 2050, reflecting natural building stock expansion despite energy efficiency policies. The Regulatory+ and Regulatory scenarios exhibit the most dramatic transformation in heating system composition. In Regulatory+, coal-heated floor area declines precipitously from approximately 50 million m<sup>2</sup> 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 substantial growth in district heating coverage, expanding from approximately 450 million m<sup>2</sup> in 2021 to 600 million m<sup>2</sup> by 2050, making it the dominant heating system and reflecting Ukraine's extensive district heating infrastructure that can be progressively decarbonised. The electrically heated floor area is expected to grow substantially to approximately 250 million m<sup>2</sup> by 2050, while biomass heating is projected to expand to approximately 200 million m<sup>2</sup>. The gas-heated floor area, initially at approximately 700 million m<sup>2</sup> in 2021, is projected to decline to 200 million m<sup>2</sup> by 2050. The Regulatory scenario follows a similar but more gradual pattern, with coal and oil heating declining steadily to minimal levels by 2045 and gas maintaining a larger presence at approximately 400 million m<sup>2</sup> by 2050. Both regulatory scenarios show notable growth in renewable heating technologies, including PV-integrated systems, solar thermal, and ambient heat, collectively serving approximately 100–150 million m<sup>2</sup> by 2050.

The Mix, Pure economic, and Moderate scenarios demonstrate more gradual heating system transitions with total heated floor area reaching approximately 1,500–1,600 million m<sup>2</sup> by 2050. The Pure economic scenario, driven solely by high carbon pricing (300€/t) without regulatory mandates, exhibits the strongest growth in electrically heated floor area among the three intermediate scenarios, reaching approximately 300 million m<sup>2</sup> by 2050, reflecting economically driven heat pump adoption. However, coal-heated areas decline more gradually, persisting at approximately 30 million m<sup>2</sup> until 2045. District heating coverage is expected to expand moderately to approximately 500 million m<sup>2</sup>, while gas heating is projected to remain substantial at approximately 450 million m<sup>2</sup> by 2050. The Mix scenario (300€/t, high subsidies, MEPS only in the non-residential sector) exhibits similar patterns, with a slightly faster coal phase-out and district heating expansion, reaching approximately 520 million m<sup>2</sup> by 2050.

The Moderate scenario demonstrates the slowest transformation, with coal heating persisting at 40 million m<sup>2</sup> through 2045, gas maintaining dominance at approximately 550 million m<sup>2</sup>, and district heating expanding only moderately to 450 million m<sup>2</sup> by 2050. The persistence of gas heating across all three intermediate scenarios, representing 30–35% of total heated floor area by 2050, highlights that economic instruments alone or partial MEPS coverage are insufficient for a comprehensive fossil fuel phase-out in Ukraine's context. The slower transformation in residential heating systems in scenarios without residential MEPS reflects the unique challenges of Ukraine's building stock, including extensive Soviet-era multi-family housing with centralised heating systems, complex ownership structures involving both individual apartments and shared building infrastructure, and the need for coordinated building-level decisions rather than individual household actions for many heating system transitions, particularly in the large district heating-connected building segment.

► FIGURE 11: HEATED GROSS FLOOR AREA RESULTS FOR UKRAINE FOR THE YEARS 2021–2050



## 4.6

# ALIGNMENT WITH EU DIRECTIVES AND LONG-TERM POLICY GOALS

Figure 12 presents the share of renewable energy in Ukraine’s residential sector from 2020 to 2050 across the five policy scenarios, all calculated using RED III-compliant methodologies. The residential sector demonstrates substantial renewable energy growth across all policy pathways, increasing from approximately 21% in 2020 to 82–99% by 2050, depending on the scenario. Ukraine’s relatively low baseline renewable share reflects the dominance of natural gas and district heating systems in residential buildings, requiring more extensive transformation to achieve high renewable penetration. The Regulatory+ scenario achieves near-complete renewable penetration of approximately 99% by 2050, while the Regulatory scenario reaches approximately 87%, demonstrating that comprehensive MEPS implementation

drives significant decarbonisation. The fossil boiler ban in Regulatory+ provides a substantial 12 percentage point advantage in the final renewable share. The Mix, Pure economic, and Moderate scenarios cluster more closely together, reaching an 82–84% renewable share by 2050, indicating that economic instruments alone or partial MEPS coverage can achieve a substantial but incomplete renewable transition in Ukraine’s residential sector. All scenarios exceed the RED III’s indicative 49% renewable energy benchmark for buildings by 2035, reaching 50–55% by that milestone year, representing more than doubling of the renewable share within a decade. The transition shows relatively modest growth between 2020 and 2030 (from 21–32%), followed by accelerating progress between 2030 and 2050 with annual increases of approximately 2–3 percentage points as policy instruments fully phase in, carbon pricing intensifies, and cumulative building stock renovations materialise. This trajectory demonstrates that achieving Ukraine’s residential sector contribution to the NBRP’s zero-emission building stock target by 2050 is feasible but requires comprehensive policy packages, with the significant gap between Regulatory+ and other scenarios emphasising the critical importance of fossil fuel phase-out measures to complement MEPS and economic instruments in contexts where gas heating infrastructure is deeply embedded in the building stock.

► **FIGURE 12: SHARE OF RENEWABLES IN UKRAINE’S RESIDENTIAL SECTOR FROM 2020–2050**

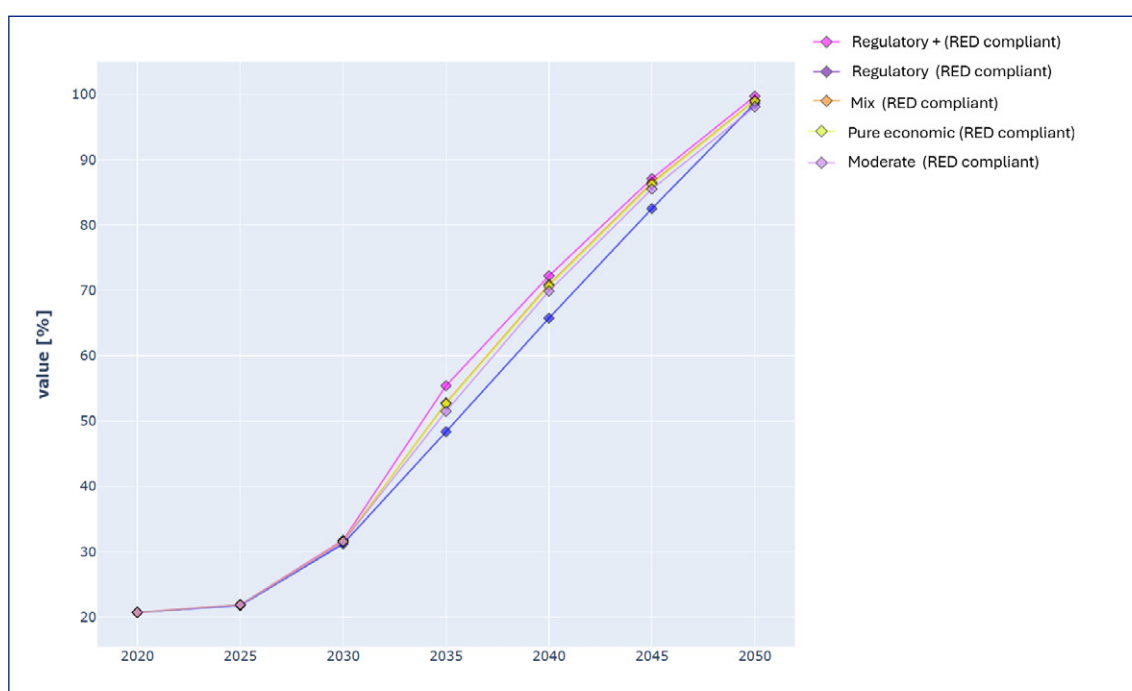


Figure 13 presents specific primary energy demand reductions in Ukraine’s residential sector from 2025 to 2050, expressed as percentage reductions relative to a baseline trajectory. The horizontal lines indicate the EPBD trajectory targets for 2030 (red) and 2033 to 2040 (orange).

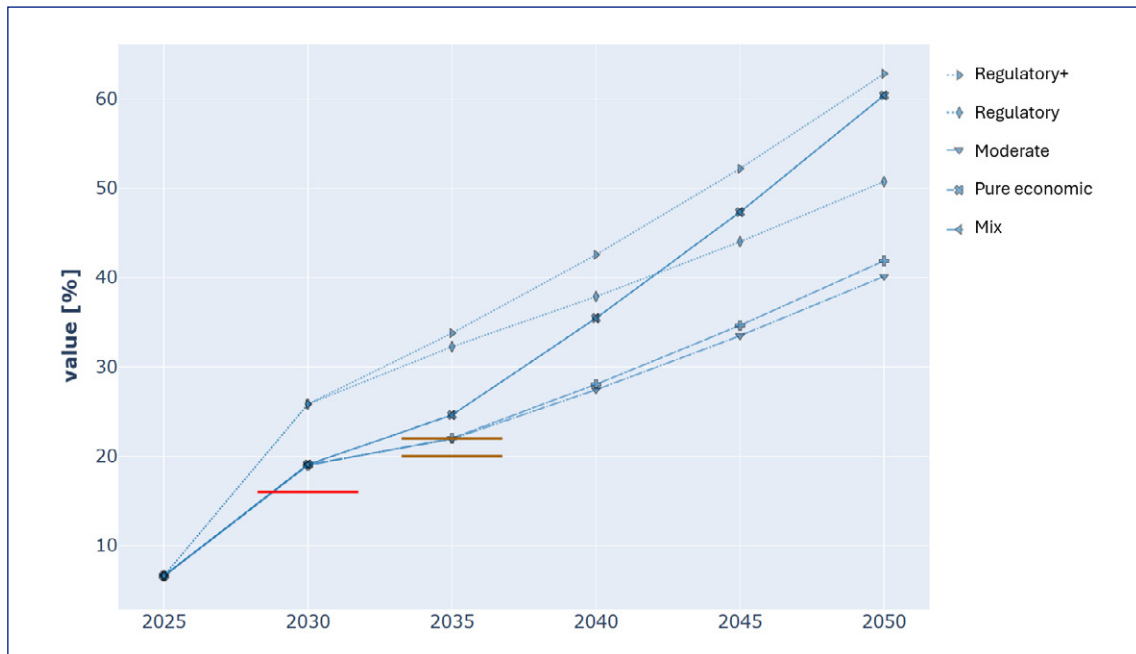
The residential sector shows divergent energy demand reduction trajectories across policy scenarios, with savings ranging from approximately 40–63% by 2050, depending on policy design. The Regulatory+ scenario achieves the highest savings at approximately 63% by 2050, driven by the comprehensive implementation of MEPS in both residential and non-residential sectors, combined with a fossil boiler ban that eliminates inefficient heating systems and

triggers deep building envelope renovations. The Pure economic and Mix scenarios follow closely, achieving approximately 60% savings by 2050, demonstrating that high carbon pricing (300€/t) combined with substantial subsidies can stimulate significant voluntary efficiency improvements through market mechanisms. The Regulatory scenario achieves lower savings at approximately 51% by 2050, indicating that MEPS without the fossil boiler ban delivers more moderate energy efficiency improvements. The Moderate scenario shows the lowest savings at approximately 40% by 2050, reflecting the limited impact of moderate carbon pricing (75€/t) combined with MEPS only in the non-residential sector, leaving the residential building stock largely dependent on market-driven improvements.

All scenarios converge around 19–26% savings by 2030, meeting or exceeding the EPBD 2030 trajectory target. After 2030, the trajectories diverge significantly as policy instruments take full effect. By 2035, all scenarios except Moderate meet the subsequent EPBD targets, with savings ranging from 25–32%. The acceleration continues through 2050, with consistent annual increases as renovation measures accumulate and policy effects compound.

These results demonstrate that achieving Ukraine’s contribution to the EED’s binding energy efficiency targets and the EPBD’s national trajectory requirements for progressive residential building stock renovation requires sustained policy commitment. The significant gap between Moderate and all other scenarios highlights that strong policy instruments, whether regulatory mandates or robust economic incentives, are essential for delivering substantial energy demand reductions in the residential sector.

► **FIGURE 13: SPECIFIC PRIMARY ENERGY DEMAND SAVINGS IN UKRAINE’S RESIDENTIAL SECTOR FROM 2020 TO 2050**



# 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 the progress of Member States 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 8 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 8: EVALUATION OF DATA SOURCES FOR BUILDING RENOVATION MONITORING BY EFFORT, RELIABILITY, AND KEY CHARACTERISTICS**

|               | Reliability low   | Reliability medium   | Reliability high   |
|---------------|---|--|--|
| Effort low    | EPC databases ● – ●<br>Machine learning-based assessments ● – ● | EPC databases ● – ●<br>Market data ● – ●<br>Building permits ● – ●<br>Machine learning-based assessments ● – ● | Financial support databases ●<br>EPC databases ● – ●<br>Market data ● – ●<br>Building permits ● – ●<br>Survey among professionals ●<br>Model-based assessments ● – ● |
| Effort medium | Machine learning-based assessments ● – ●                        | Machine learning-based assessments ● – ●   | Survey among professionals ●<br>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 [9]. 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 Ukraine, 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.

A phased approach is essential in Ukraine, where data systems have been disrupted or delayed due to the ongoing conflict. Initial monitoring efforts should focus on low-effort, scalable methods such as market proxies, public procurement data, and satellite-based assessments. These tools can provide early insights into the dynamics of reconstruction-related renovation and regional disparities. At the same time, Ukraine could invest in building databases, such as EPC registries and digital cadastres, as part of its long-term governance renovation. International support and cooperation will be essential for developing data-sharing protocols and establishing a national coordination unit for monitoring and evaluation.

Across all three countries, 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. Ukraine'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

Ukraine's NBRP presents a strategic opportunity to accelerate building decarbonisation while addressing the urgent need for post-war reconstruction. The policy framework must balance two imperatives: rebuilding damaged assets and aligning reconstruction with the long-term objectives of the EPBD 2024/1275. The scenario analysis in Chapter 4 demonstrates that Ukraine can achieve up to 22% energy savings by 2050 through comprehensive policy packages combining regulatory measures (MEPS, fossil boiler phase-out) with financial support. The Regulatory+ scenario consistently outperforms purely economic approaches, highlighting the essential role of regulatory backstops. All scenarios project renewable energy shares increasing from approximately 21% in 2020 to 97–100% by 2050, demonstrating Ukraine's strong potential for renewable heating deployment.

## 7.1

### KEY RECOMMENDATIONS BY ACTION AREA

#### LEGISLATIVE AND REGULATORY FRAMEWORK:

- Embed MEPS as a central regulatory lever, initially focusing on non-residential and public buildings with gradual extension to the residential sector as data and institutional capacity improve.
- Define and operationalise ZEB thresholds aligned with EPBD requirements and Ukraine's EU accession pathway.
- Establish consistency checks across MEPS, ZEB, and renewable energy trajectories to support fossil fuel phase-out and energy independence.
- Implement a phased compliance framework with re-baselining mechanisms to account for the evolving reconstruction context.

### **INSTITUTIONAL ARRANGEMENTS AND GOVERNANCE:**

- Establish a national coordination unit for building renovation, connecting the Ministry of Communities and Territories Development, the State Agency on Energy Efficiency, and regional administrations.
- Create an integrated monitoring platform connecting the EPC registry, building cadastre, permits, and funding mechanisms.
- Develop data-sharing protocols with international partners and donor-funded reconstruction projects.
- Institutionalise conflict-aware and inclusive stakeholder consultations throughout NBRP cycles.

### **TECHNICAL AND ANALYTICAL INFRASTRUCTURE:**

- Implement a layered monitoring approach combining market proxies (insulation/heating equipment sales), public procurement data, and satellite-based assessments in the near term.
- Improve EPC and building cadastre data quality as systems mature; cross-reference with building registers to identify worst-performing buildings.
- Employ mixed analytical methods (EPC data, measured consumption, archetype modelling) aligned with energy balance statistics.
- Maintain scenario development as a central NBRP element for policy evaluation and investment planning.

### **FISCAL AND FINANCIAL MEASURES:**

- Link MEPS enforcement with targeted subsidies and preferential financing, prioritising war-damaged buildings, energy-poor households, and public infrastructure.
- Develop a national financing roadmap integrating EU pre-accession funds, international reconstruction support, bilateral donors, and private capital.
- Design financial incentives to reward deep renovations over shallow measures, ensuring reconstruction meets high energy performance standards.
- Sequence financial instruments geographically, starting with regions with highest administrative capacity to create early success stories.

### **INFORMATION, AWARENESS, AND CAPACITY BUILDING:**

- Implement one-stop shops providing integrated information on funding, standards, and renovation steps.
- Connect energy-efficiency communication with reconstruction and resilience objectives, making renovation part of the national recovery narrative.
- Launch targeted training programmes for local authorities, building owners, and construction professionals.
- Encourage voluntary data reporting by installers and contractors to close information gaps.

## 7.2

## SUGGESTED IMPLEMENTATION ROADMAP

To support coordinated implementation, Table 9 maps key actions to responsible institutions and timelines. In Ukraine, building energy efficiency responsibilities are distributed across the Ministry of Communities and Territories Development (Minregion), the State Agency on Energy Efficiency (SAEE), and regional/local administrations. The Energy Efficiency Fund and international donors play crucial roles in financing. Effective NBRP delivery requires these institutions to work as a coordinated team, with particular attention to coordination with post-war reconstruction programmes.

► **TABLE 9: IMPLEMENTATION ROADMAP FOR UKRAINE'S NBRP**

| Action area           | Key actions                                   | Lead institution | Supporting institutions             | Timeline     |
|-----------------------|---|------------------|-------------------------------------|--------------|
| Legislative framework | Define ZEB thresholds and MEPS framework      | Minregion        | SAEE, parliament                    | 2025–2026    |
| Legislative framework | Adopt MEPS for non-residential buildings      | Minregion        | SAEE                                | 2027–2028    |
| Legislative framework | Establish residential renovation trajectories | Minregion        | SAEE, local authorities             | 2028–2030    |
| Data infrastructure   | Develop national EPC registry                 | SAEE             | Minregion, State Statistics Service | 2025–2027    |
| Data infrastructure   | Create digital building cadastre              | Minregion        | Local authorities                   | 2026–2028    |
| Data infrastructure   | Implement layered monitoring system           | SAEE             | Minregion, donors                   | 2025–2026    |
| Financial mechanisms  | Align reconstruction funding with NBRP        | Minregion        | EEF, donors                         | 2025–2026    |
| Financial mechanisms  | Develop blended finance instruments           | EEF              | IFIs, private sector                | 2027–2029    |
| Capacity building     | Launch one-stop shops (pilot regions)         | SAEE             | Local authorities                   | 2026–2027    |
| Capacity building     | National training programme                   | SAEE             | Professional associations           | 2025–2028    |
| Monitoring            | Establish biennial evaluation cycle           | Minregion        | SAEE, State Statistics Service      | 2026 onwards |

Minregion = Ministry of Communities and Territories Development; SAEE = State Agency on Energy Efficiency; EEF = Energy Efficiency Fund; IFIs = International Financial Institutions

## 7.2.1 COORDINATION MECHANISMS

Effective implementation requires the following coordination structures:

- **Inter-ministerial working group:** Chaired by Minregion, meeting quarterly to ensure policy coherence. Members: SAEE, Ministry of Energy of Ukraine, Ministry of Finance of Ukraine, Ministry of Social Policy of Ukraine.
- **Reconstruction-NBRP coordination committee:** Joint body ensuring that post-war reconstruction programmes align with NBRP energy performance requirements and avoid lock-in of carbon-intensive solutions.
- **Data governance platform:** Technical body ensuring interoperability between EPC databases, building cadastre, permits, and funding records, with protocols for international data sharing.
- **Donor coordination forum:** Aligning eligibility criteria and reporting requirements across international reconstruction funds, EU pre-accession support, and bilateral programmes.
- **Stakeholder advisory council:** Biannual consultations with industry, housing associations, local governments, civil society, and representatives of war-affected communities.

## 7.2.2 IMPLEMENTATION PHASES

### PHASE 1 (2025–2026) – FOUNDATION:



Establish coordination mechanisms and national coordination unit; define ZEB thresholds and prepare MEPS framework; launch layered monitoring system using available data sources; align reconstruction funding programmes with NBRP objectives; initiate pilot one-stop shops in selected regions; launch public awareness campaign linking renovation with recovery.

### PHASE 2 (2027–2028) – ACCELERATION:



Implement MEPS for non-residential and public buildings; roll out one-stop shops nationally; deploy digital building cadastre and strengthen EPC registry; introduce blended finance mechanisms; conduct first biennial evaluation and policy adjustment; expand training programmes for construction professionals.

### PHASE 3 (2029–2030) – CONSOLIDATION:



Achieve 2030 MEPS milestone for non-residential buildings; verify residential trajectory progress (16% reduction target); refine policies based on evaluation results; prepare for 2033/2035 targets; assess EU accession alignment and adjust framework as needed; scale up private sector engagement and market-based instruments.

By implementing this coordinated roadmap, Ukraine can transform its NBRP into a dynamic, evidence-based instrument that links regulatory standards, financial mechanisms, and technical data systems. This approach ensures that post-war reconstruction contributes to – rather than undermines – long-term decarbonisation objectives, while advancing Ukraine’s path toward EU membership and energy independence.

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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 [8]. 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 [15].

► FIGURE 14: OVERVIEW OF THE STRUCTURE OF INVERT/EE-LAB

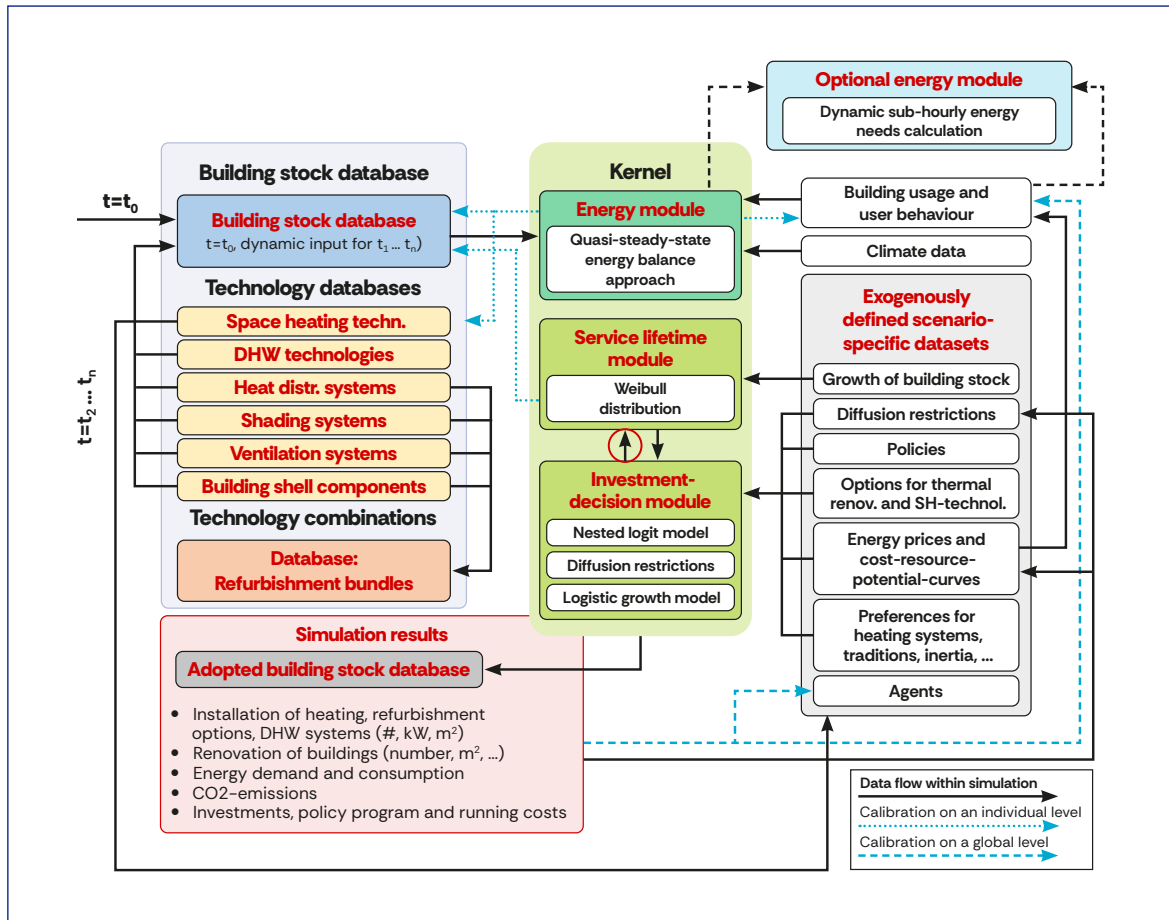


Figure 14 illustrates the model’s structure, showing the interaction between building stock characterisation, policy inputs, investment decision modules, and output indicators. The discrete choice module determines renovation and heating system decisions based on economic factors, policy incentives, 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 15: OVERVIEW OF THE STRUCTURE OF THE INVERT/OPT

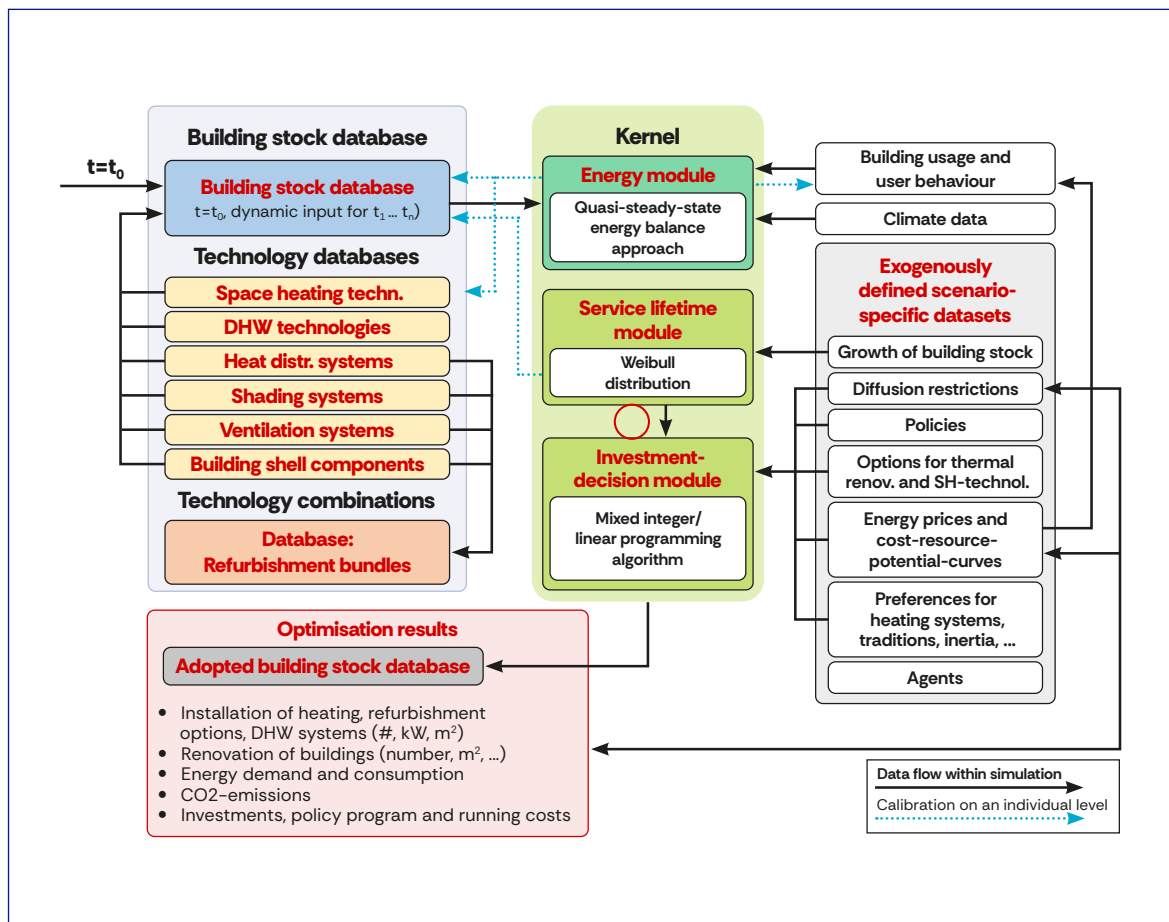
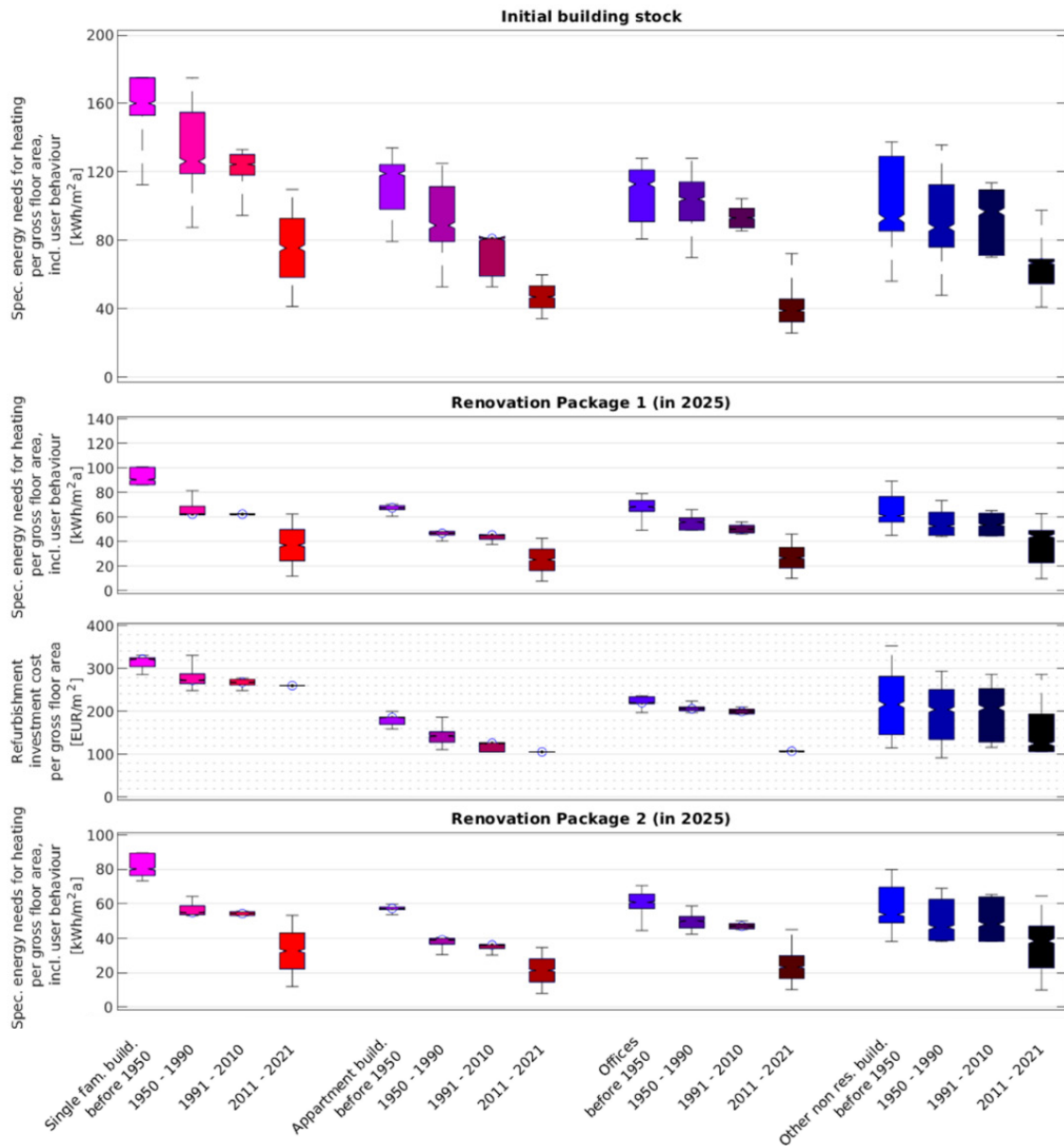


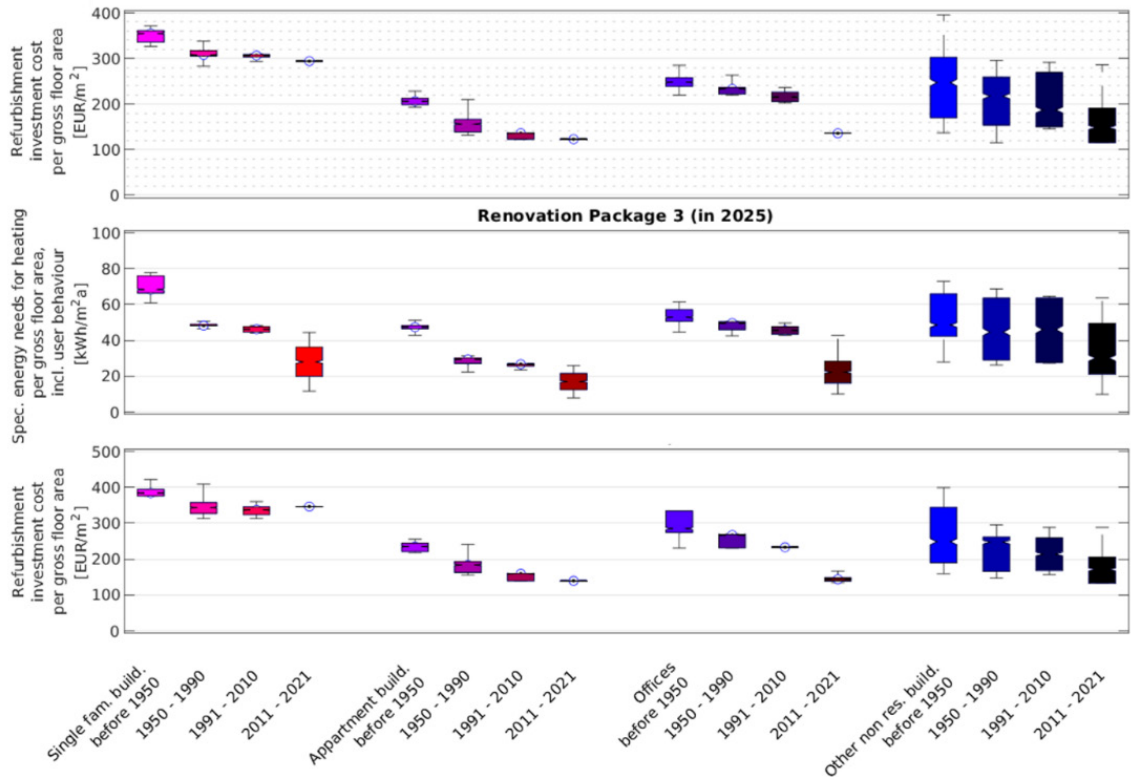
Figure 15 shows the optimisation framework, illustrating how building stock segments, technology options, cost parameters, and constraints feed into the optimisation algorithm to produce cost-optimal renovation pathways.

# ANNEX B: ASSUMPTIONS REGARDING BUILDING RENOVATION MEASURES

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

► **FIGURE 16: 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**





## 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) [2]. 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 10 shows that the list of Annex II indicators can be supported by the EPBD-wise modelling approach.

► TABLE 10: 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 <sup>2</sup> ): <ul style="list-style-type: none"> <li>per building type</li> <li>per energy performance class</li> <li>nearly zero-energy buildings</li> <li>worst-performing buildings</li> <li>The 43% worst-performing residential buildings</li> </ul>  | Number of buildings and total floor area (m <sup>2</sup> ): <ul style="list-style-type: none"> <li>per building age</li> <li>per building size</li> <li>per climatic zone</li> </ul>  |
|  | Annual renovation rates: number and total floor area (m <sup>2</sup> ) <ul style="list-style-type: none"> <li>per building type</li> <li>per renovation depth (weighted average renovation)</li> <li>public buildings</li> </ul>   |   |
|  | Primary and final annual energy consumption (ktoe): <ul style="list-style-type: none"> <li>per building type</li> <li>per end use</li> </ul> Energy savings (ktoe): <ul style="list-style-type: none"> <li>residential buildings</li> <li>non-residential buildings</li> <li>public buildings</li> </ul> Average primary energy use in kWh/(m <sup>2</sup> .y) for residential buildings<br>Share of renewable energy in the building sector (MW installed or GWh generated): <ul style="list-style-type: none"> <li>for different uses</li> </ul> | 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<br>Share of heating systems in the building sector per boiler/heating system type<br>Share of renewable energy in the building sector (MW installed or GWh generated): <ul style="list-style-type: none"> <li>on-site</li> <li>off-site</li> </ul> |
|  | Annual operational greenhouse gas emissions (kgCO <sub>2</sub> eq/(m <sup>2</sup> .y): <ul style="list-style-type: none"> <li>per building type</li> </ul> Annual operational greenhouse gas emission reduction (kgCO <sub>2</sub> eq/(m <sup>2</sup> .y): <ul style="list-style-type: none"> <li>per building type</li> </ul>   |   |
|  | Primary energy factors: <ul style="list-style-type: none"> <li>per energy carrier</li> <li>non-renewable primary energy factor</li> <li>renewable primary energy factor</li> <li>total primary energy factor</li> </ul>  |   |
| (b) Roadmap for 2030, 2040, 2050   | Targets for annual renovation rates: number and total floor area (m <sup>2</sup> ): <ul style="list-style-type: none"> <li>per building type</li> <li>worst-performing buildings</li> <li>The 43 % worst-performing residential buildings</li> </ul>   | Targets for expected share (%) of renovated buildings: <ul style="list-style-type: none"> <li>per building type</li> <li>per renovation depth</li> </ul>  |
|  | Targets for expected primary and final annual energy consumption (ktoe): <ul style="list-style-type: none"> <li>per building type</li> <li>per end use</li> </ul> Expected energy savings: <ul style="list-style-type: none"> <li>per building type</li> </ul>   | 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 | <ul style="list-style-type: none"> <li>total investment needs for 2030, 2040, 2050 (million EUR)</li> <li>budgetary resources</li> </ul>   |   |

# EPBDwise

## CONSORTIUM



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