

# EPBD.wise

BRINGING EUROPEAN BUILDING POLICY TO LIFE

## Development of Article 9: Policy guidelines for Poland

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# ABOUT EPBD.wise

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



# EXECUTIVE SUMMARY

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This report provides policy guidelines to support Poland in the implementation of Article 9 of the Energy Performance of Buildings Directive (EPBD, 2024/1275). Article 9 introduces two major obligations for Member States: (1) the establishment of minimum energy performance standards (MEPS) for non-residential buildings, requiring renovation of the 16% and 26% worst-performing segments by 2030 and 2033 respectively; and (2) the development of a national trajectory for reducing the average primary energy use of residential buildings by 16% by 2030 and 20–22% by 2035, with progressive improvement until 2050. This report outlines the methodological foundations, data requirements, modelling insights and governance considerations needed to fulfil these obligations.

The analysis employs a hybrid archetype-based and statistical approach using the Invert/EE-Lab modelling framework, calibrated against national energy statistics. Building stock analysis reveals significant variation in primary energy use, with the non-residential health sector exhibiting the highest specific consumption.

Scenario modelling demonstrates that strong regulatory approaches are most effective in achieving both MEPS and national trajectory targets as defined in Article 9. The Regulatory+ scenario – combining MEPS implementation, a CO<sub>2</sub> price of €75/t and fossil fuel boiler bans – delivers approximately 80–85% energy reduction in the health sector by 2033. In contrast, purely economic instruments (€300/tCO<sub>2</sub> carbon pricing without regulatory obligations) achieve only modest reductions, leaving significant portions of the building stock above 2033 thresholds.



The deliverable also compiles policy needs and best practice insights gathered through extensive stakeholder engagement. For Poland, the most critical challenges include the following:

1. There is no comprehensive energy classification system for the existing building stock, as EPCs are primarily required only for new buildings and transactions.
2. Deep renovation would require approximately 6% of GDP – far exceeding available public resources.
3. The requirement that 55% of residential sector improvements come from worst-performing buildings is extremely challenging without systematic identification mechanisms.
4. Vulnerable populations require not only financial support but comprehensive technical assistance.
5. There is a shortage of qualified professionals across multiple disciplines.

Achieving Article 9 targets, MEPS and national trajectories in Poland requires strong regulatory frameworks combined with substantial financial support, comprehensive technical assistance, and coordinated governance. While purely economic and mixed instruments yield partial improvements, only robust regulatory pathways deliver the depth of energy savings needed. Success depends on addressing critical data gaps, building institutional capacity, ensuring social acceptance, and coordinating implementation across the national building renovation plan, energy performance certificates and renovation passports.

The report's key recommendations for Poland are:

- **Align MEPS with data availability**, prioritising public buildings initially given current gaps in the non-residential segment
- **Design realistic renovation trajectories** explicitly linked with coal phase-out timelines (complete by 2040) and accounting for the €9 billion already invested through the Recovery and Resilience Facility
- **Develop comprehensive support mechanisms**, including targeted grants up to 50% for worst-performing buildings, genuine one-stop shops integrating technical and financial support, and coordinated funding across multiple sources
- **Strengthen governance** through clear inter-ministerial coordination mechanisms
- **Ensure social acceptance** through clear communication campaigns and accessible guidance materials



# LIST OF

# ABBREVIATIONS

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<b>ETS2</b>	<b>Emissions Trading System 2</b>
<b>EPBD</b>	<b>Energy Performance of Buildings Directive</b>
<b>EPC</b>	<b>Energy performance certificate</b>
<b>EU</b>	<b>European Union</b>
<b>MEPS</b>	<b>Minimum energy performance standards</b>
<b>NBRP</b>	<b>National Building Renovation Plan</b>
<b>PEF</b>	<b>Primary Energy Factor</b>
<b>RED</b>	<b>Renewable Energy Directive</b>
<b>ZEB</b>	<b>Zero-emission building</b>



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# INTRODUCTION

## 1.1 Scope and objectives of the deliverable

This document provides guidelines to policymakers for implementing Article 9 of the Energy Performance of Buildings Directive (EPBD 2024/1275) into the national context for two selected countries, Poland and Romania. It builds on the policy needs and good practice examples identified in a previous phase of the project (see Deliverable 3.1 – Article 9: MEPS and trajectories for progressive renovation [1]). That report includes advice on how to set up the required database of buildings, define worst-performing buildings, derive the related thresholds for minimum energy performance standards (MEPS) for non-residential buildings, and define the reduction of the primary energy use in the national trajectory for residential buildings.

This draft document intends to initiate discussion among stakeholders and policymakers on developing the national building renovation plans (NBRPs) and how EPBD.wise can effectively support this process. In particular, the document is intended to identify those parts in the NBRP template provided within the EPBD 2024/1275 Annex II, to which the final policy guideline documents should provide specific inputs.

The implementation of Article 9 is closely connected to the development of other policy elements specified in the EPBD 2024/1275. In particular, there is a strong link between the provisions in Article 9 and NBRPs, since the trajectories of progressive building renovation for residential buildings and MEPS for non-residential buildings form an integral part of the projections to be presented in the NBRP. The scenarios shown in this document build on the general scenario outline, framework and modelling approach described in the policy guideline document for NBRPs.

Both documents refer to each other, and some elements, like the description of the scenario assumptions and modelling approach described in this document, are also relevant for Article 9. Table 1 provides an overview of how the content is organised across the two reports. For a full understanding, we recommend reading both.



Table 1: Distinction of content regarding policy guideline documents for NBRP and Article 9.

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

## 1.2 Structure of the deliverable

This report begins with an introduction to the **Article 9 framework** in accordance with the EPBD 2024/1275 (Section 2), providing a foundational understanding of the legislative context.

Section 3 outlines the **policy needs identified earlier in the project**, detailing the specific requirements in Poland and highlighting good practices.

Section 4 delves into the **development of policy recommendations**, with sub-sections focusing on building stock data, identification of worst-performing buildings, and a detailed methodology using the Invert/EE-Lab Model Approach to set up the trajectory for reducing primary energy use. This section also includes scenario assessments and policy measures for achieving energy efficiency goals.

Section 5 presents **strategies for monitoring, evaluation and continuous improvement**, ensuring ongoing assessment of the implemented policies.

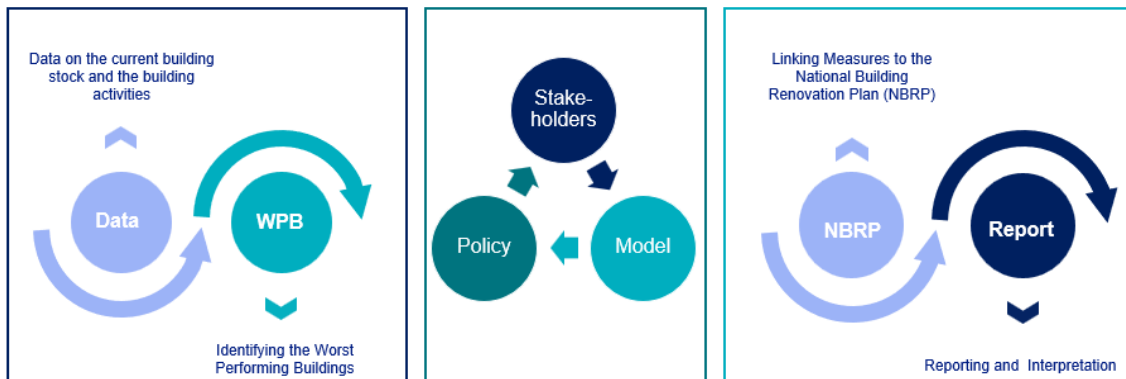
Section 6 introduces the compliance, monitoring and enforcement framework needed to effectively implement MEPS for non-residential buildings.

Section 7 positions Article 9 alongside other policy instruments established by the Directive, which are essential for its successful implementation.

Section 8 presents the necessary requirements for the effective implementation of Article 9 based on the scenario results and discussion with national stakeholders.

## 1.3 Methodology and approach

The methodology and approach for drafting this guidance follows a three-step process:



Overview of the process linking building performance, policy and reporting for renovation planning

### Step 1: Identification of data sources and worst-performing buildings

The first step involves identifying **relevant data sources** and characterising the **current state of the residential building stock**. This ensures a clear understanding of the existing conditions and energy performance across the building sector. In the next step we **identify the worst-performing buildings**, which are characterised by high energy consumption, low energy efficiency ratings or older construction years. This identification process is supported by a continuous cycle of data analysis and worst-performing building classification, allowing for the prioritisation of the most critical buildings for renovation. Reliable data sources for this process may include energy performance certificates (EPCs), renovation rates and historical consumption patterns.

### Step 2: Policy modelling and stakeholder engagement

This phase involves defining and designing policy measures that will support and enable the reduction in average primary energy use. The workflow follows three steps:

- Discussion with **stakeholders** from Poland and integration of their feedback into the policy design.
- Setting up **policy measures**, which include financial incentives, regulatory frameworks, and other strategies designed to promote energy efficiency in residential buildings.
- Using **data-driven models** to assess renovation scenarios, predict energy savings and optimise investment strategies.

### Step 3: Linking the measure to Article 9

The final step is to integrate identified measures into the implementation of Article 9. A feedback loop between Article 9 and the reporting process ensures continuous monitoring and assessment. The **reporting and monitoring** phase helps policymakers evaluate the effectiveness of implemented measures and make adjustments to improve outcomes.



# DESCRIPTION OF THE ARTICLE 9 FRAMEWORK IN ACCORDANCE WITH EPBD (2024/1275)

Article 9 of the EPBD (2024/1275) [3] focuses on accelerating building renovations to achieve a fully decarbonised building stock by 2050. It introduces MEPS for non-residential buildings and a national trajectory for residential buildings.

- 1 9(1) Non-residential buildings (MEPS):** Member States must renovate the **16% worst-performing non-residential buildings by 2030** and **26% by 2033**. They can set energy performance thresholds based on **primary or final energy use** and may define additional energy indicators. Certain buildings, like historical and religious structures, may be exempt under clear criteria.
- 2 9(2) Residential buildings (national trajectory):** Member States must ensure a **16% reduction in average primary energy use by 2030, 20-22% by 2035**, and further progressive reductions until 2050. This trajectory must align with national building renovation plans and identify the number of buildings/units or floor area to be renovated annually, prioritising the worst-performing buildings. Addressing energy poverty is a key aspect, requiring financial and technical support for vulnerable households.

Member States must also implement monitoring and enforcement mechanisms, including penalties, to ensure compliance with the new standards.

New buildings and demolished buildings are not counted in the calculations for renovation targets and energy performance improvements.

# COMPILATION OF THE POLICY NEEDS IN POLAND



The key policy needs related to developing and implementing Article 9 were identified through a structured research approach. Our methodology began with extensive desk research, analysing existing European and national initiatives, projects and reports to establish a comprehensive understanding of the challenges and best practices related to implementing Article 9 requirements – including both policy transposition mechanisms and practical barriers to executing building renovations. To refine our findings, we engaged directly with Polish representatives based on a targeted questionnaire and bilateral meetings. Additionally, the policy forums and stakeholder roundtables organised provided a platform for in-depth discussions on policy needs, implementation barriers and potential solutions. This multilayered approach allowed us to identify country-specific challenges while ensuring that the findings remain broadly applicable to other EU Member States. While structuring our recommendations to address the specific policy needs of Poland, we also aim to provide a replicable framework for supporting the effective implementation of Article 9 across the EU, facilitating progress in building renovation and energy efficiency goals.

Policy need	Challenges identified	Proposed solutions
<b>Building stock data</b>	Lack of an up-to-date and detailed database on energy performance.	Establish a national database to track building energy performance and renovation progress.
<b>Definition of worst-performing buildings</b>	No clear methodology for non-residential buildings; EPC classifications vary in quality.	Define worst-performing buildings based on EPCs and primary energy use, ensuring consistency.
<b>Financial support</b>	Insufficient public financing for deep renovations; lack of private investment.	Develop a comprehensive financial ecosystem, including tax incentives, subsidies and private investment mechanisms.
<b>Qualified workforce</b>	Shortage of trained professionals in energy-efficient renovations.	Expand training programmes and certification schemes for construction workers, architects and energy auditors.
<b>Compliance and enforcement</b>	Weak enforcement of renovation obligations and unclear penalties.	Introduce stronger compliance mechanisms, including fines, rental restrictions and penalty point systems.
<b>Technical assistance</b>	Limited access to guidance on renovation processes and funding options.	Expand one-stop shops to provide advisory services for building owners.

For a more detailed description of the identified policy needs and good practice examples, see D3.1.



# 4



# ASSESSING THE IMPACT OF ARTICLE 9-RELATED POLICIES

This chapter outlines the methodology for addressing the implementation of EPBD Article 9. It begins by providing an overview of the Polish building stock, including the identification and analysis of worst-performing buildings based on their current energy consumption. The first section emphasises the importance of accurate building stock data, examining key data sources and the current status of buildings and building activities.

The second section focuses on setting up a trajectory to reduce primary energy use in residential buildings. Particular emphasis is given to establishing a sub-target for the worst-performing buildings. This provides a clear path for achieving meaningful reductions in energy use. Finally, this chapter explores the development and assessment of different scenarios, outlining potential policy measures to drive improvements and evaluating their impact through scenario analysis.

## 4.1 Building stock data

Building stock data is fundamental to assessing the achievement of targets set by Article 9. The analysis requires a detailed description of the building stock based on two key dimensions: conditioned floor area and primary (or final) energy use per floor area, for



both residential and non-residential buildings. The distribution curve derived from this data enables the identification of the worst-performing buildings and the establishment of performance thresholds mandated by the Directive<sup>1</sup> to target the bottom 43% of the building stock [1]. It is important to note that in Poland, “primary energy” refers specifically to non-renewable primary energy rather than total primary energy. This distinction is critical when comparing primary energy indicators (e.g., defining the 16% and 26% of buildings with the worst performance) across different EU countries [4].

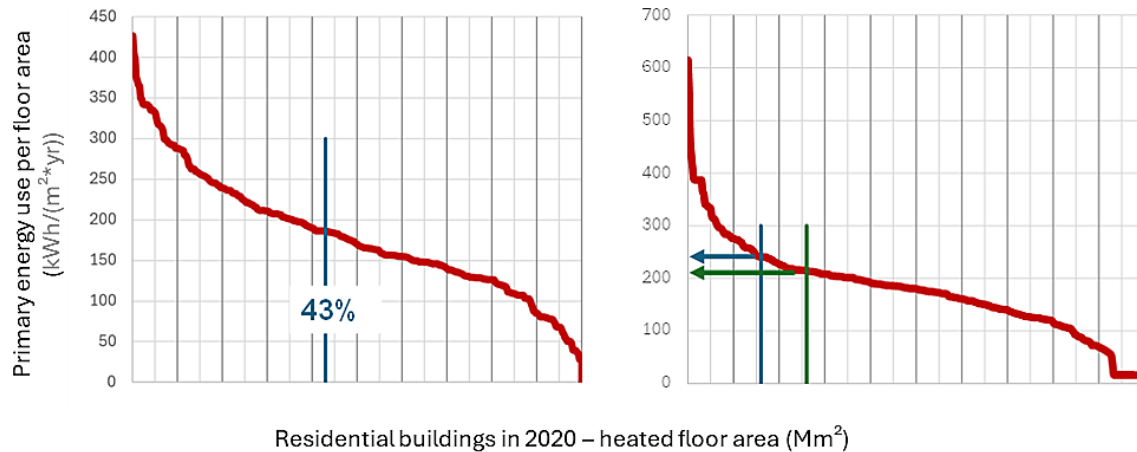
There are four main methodologies to **derive primary energy use data** for buildings:

1. **Archetype-based modelling** – This bottom-up approach relies on reference buildings with predefined geometries, U-values and installed technologies. It uses data from sources such as the EU Building Stock Observatory, national building statistics and initiatives like TABULA/EPISCOPE. However, it often lacks key details like the impact of past retrofitting efforts or heating system distribution among different building segments. This approach may underestimate real-world variance, as seen when comparing modelled distributions with actual measured energy consumption.
2. **Measured energy consumption** – This method uses actual consumption data from a representative sample of buildings. It accounts for real-world factors such as user behaviour, refurbishment status and climatic conditions. While gas or district heating consumption data is often available from grid operators, electricity consumption data is more fragmented. Additionally, secondary heating systems (e.g., biomass, oil) are difficult to incorporate, and privacy regulations may limit data access. A key concern is the potential for bias if measured gas consumption is used to represent total energy consumption.
3. **Energy performance certificates** – EPC databases contain structured and standardised data based on a well-defined methodology. Many countries centralise EPC data in a single or a few databases. However, a significant issue is that EPC-reported energy use often does not align with national energy balance statistics. Additionally, EPC datasets may be biased toward refurbished buildings, leading to potential distortions in energy performance assessments.
4. **Statistical approaches** – Some countries, like Austria, use statistical models to estimate energy consumption. Here, climate-corrected energy data is divided by gross floor area, with adjustments based on volume-to-surface ratios to reflect variations in building efficiency. A normal distribution is assumed, ensuring that the most energy-efficient buildings align with the latest building code standards. This method provides a systematic link between energy performance, EPC classifications and regulatory frameworks.

For a more exhaustive description, see D2.2 “Development of NBRP: Policy Guidelines for Poland” [2].

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1 The Directive requires that Member States renovate the 16% worst-performing non-residential buildings by 2030 and the 26% worst-performing by 2033.



**Figure 1:** Relationship between primary energy use per floor area (kWh/(m<sup>2</sup>·year)) and the heated floor area of residential and non-residential buildings in 2020 (Mm<sup>2</sup>) (X country)

For Poland, we used a hybrid approach combining archetype-based and statistical methodologies to address specific data validation challenges encountered during the analysis. The approach uses the Invert/EE-Lab model, which is built on building archetypes representing different construction periods, building types and energy performance characteristics, calibrated against national energy statistics to ensure alignment with real-world consumption patterns. However, initial validation against the TABULA database revealed systematically lower primary energy demand values in Invert, prompting further investigation. To validate our modelling approach, we conducted a statistical analysis of Poland's EPC database, examining eight cities of varying sizes (including Warsaw, Kraków, Łódź, and Gdańsk) selected based on EPC data availability. This multi-city approach was essential to capture the diverse building portfolio across Poland, where larger cities are dominated by multi-family buildings while smaller cities have more single-family houses. The EPC distribution analysis confirmed that Invert's archetype-based estimates aligned more closely with real-world certificate data than TABULA, validating our hybrid methodology that combines model-based archetypes with statistical verification from actual building performance data.

### Derived distribution of primary energy use of the national residential building stock

The variation in primary energy use per heated floor area ([kWh/(m<sup>2</sup>·year)]) for residential buildings is calculated using three distinct methodological variants, all based on the Invert/EE-Lab archetype framework but differing in key normalisation and behavioural parameters.

1. The first method is based on **standard usage profiles** combined with the **heated floor area** of buildings (Figure 2 and Figure 3). This approach uses average data for energy consumption patterns across the country, which are then applied to the total heated floor area of the building stock.

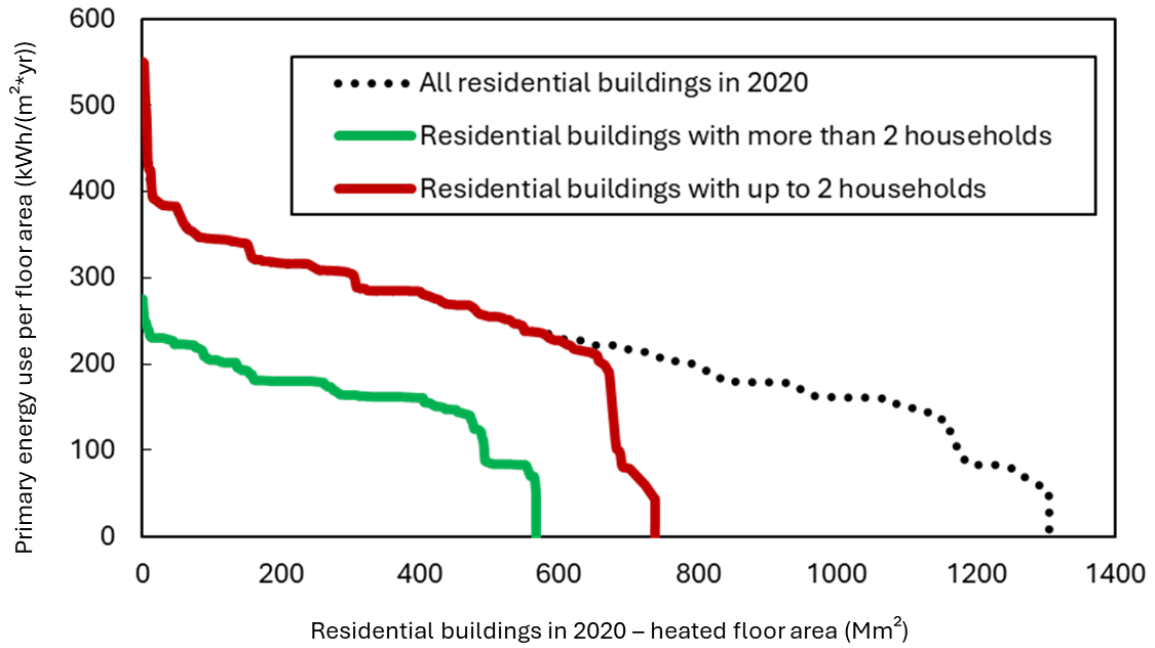


Figure 2: Distribution of primary energy use per heated floor area for residential buildings in 2020, differentiated by number of households

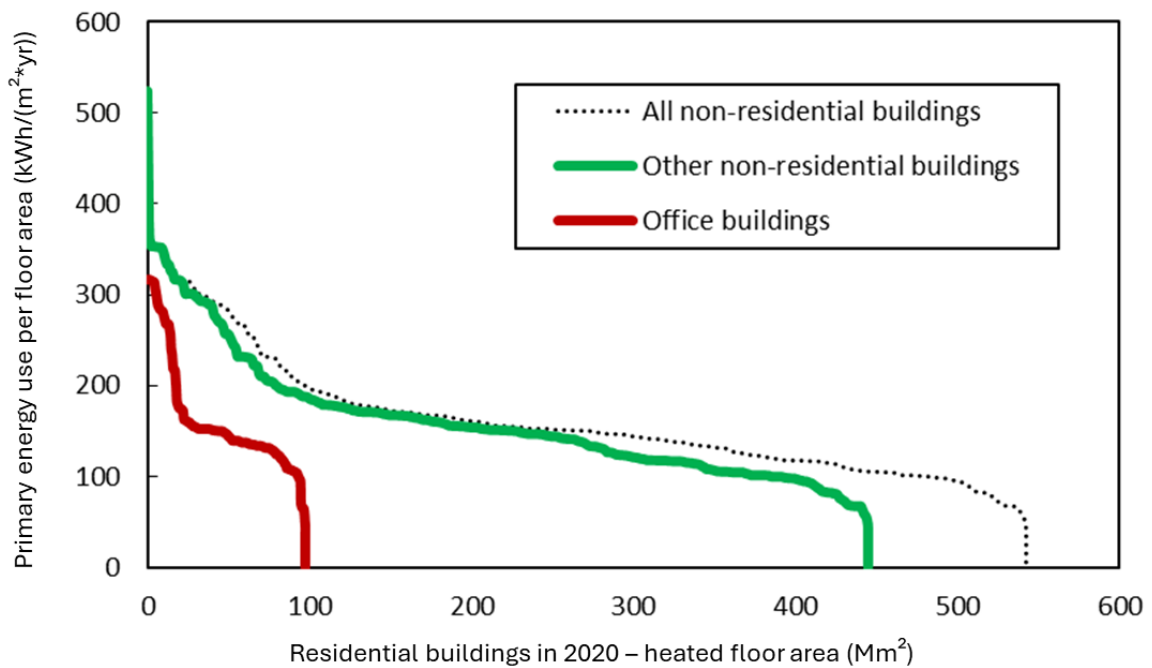


Figure 3: Distribution of primary energy use per heated floor area for non-residential buildings in 2020

2. The second approach uses a more refined calculation, where **energy use is corrected for user-specific behaviour** (Figure 4). This method accounts for individual variations in energy consumption based on the heated floor area, offering a more personalised estimate of energy use. By factoring in how users interact with their spaces, this method aims to provide a closer reflection of actual energy consumption patterns.

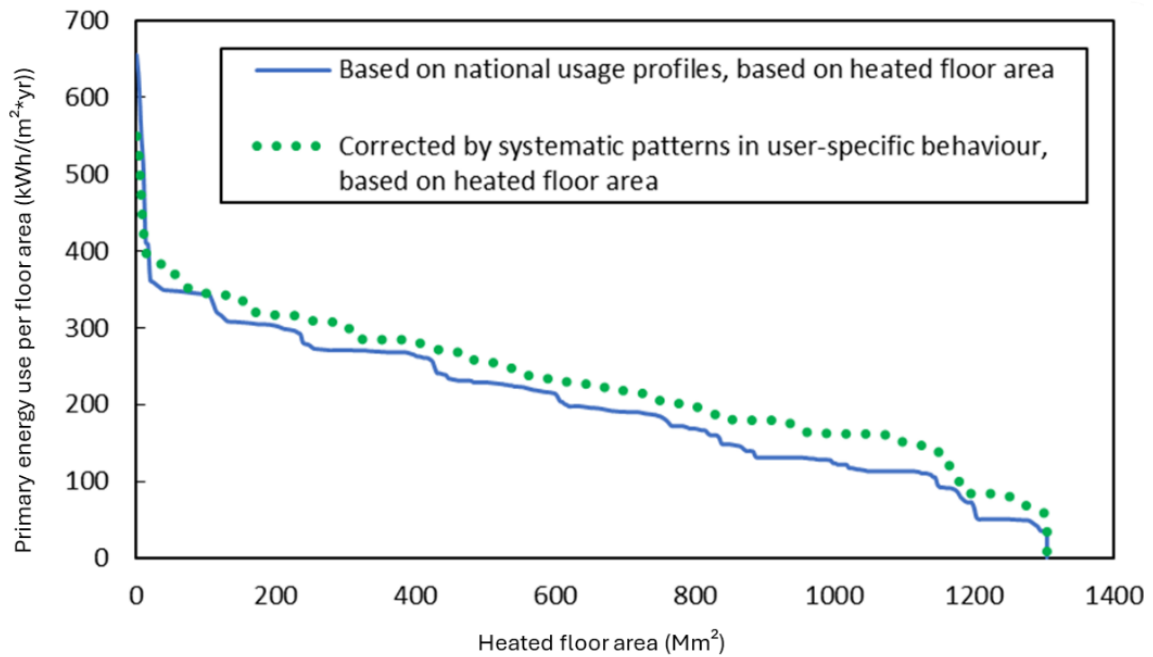


Figure 4: Primary energy use per heated floor area ( $[kWh/(m^2 \cdot year)]$ ) for residential buildings in 2020

3. The third method draws on **national usage profiles**, but calculates results according to the **number of buildings** (Figure 5) rather than total floor area (Figure 2). This method helps to understand energy consumption from a broader perspective, focusing on the building count as a variable that influences overall energy use.

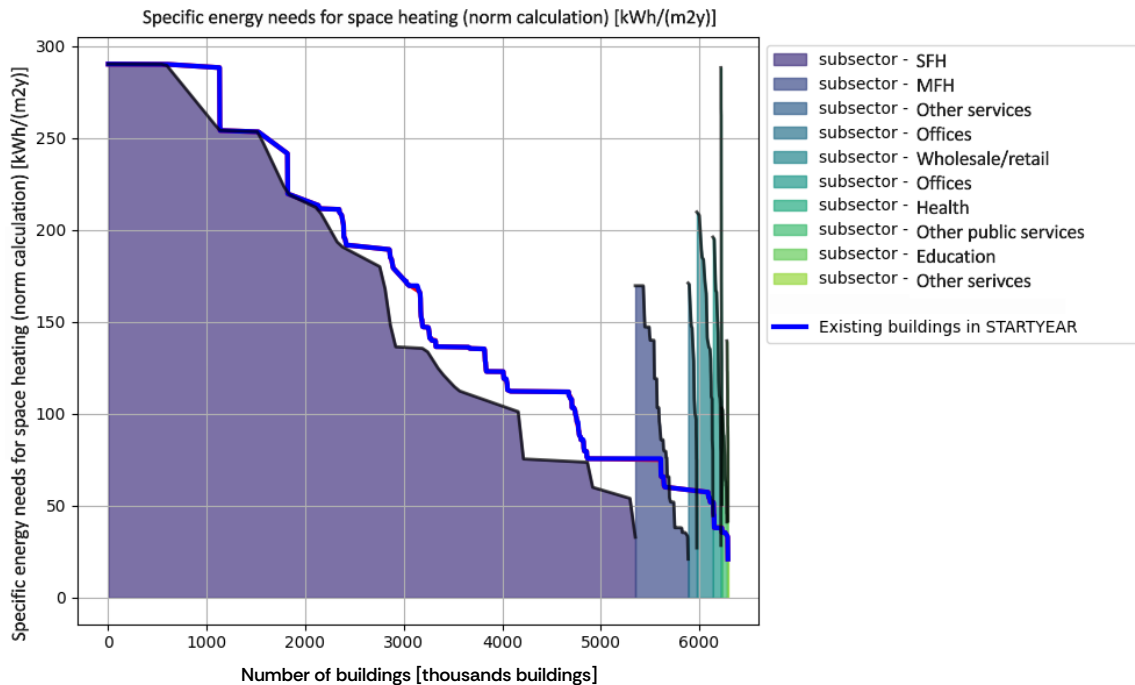


Figure 5: Specific energy needs for space heating by number of buildings per building category

## 4.2 Identification of worst-performing buildings based on primary energy use

To assess and identify the worst-performing buildings within the Polish national building stock, we used an **archetype-based modelling approach** as presented in the previous chapter, integrating various data sources, as listed below. The analysis is based on key indicators that influence energy performance, supporting targeted renovation strategies and policy interventions.

The primary dataset includes information on the number of buildings and total floor area categorised by construction periods. This data is sourced from the **Building Stock Observatory** and enriched with additional **national** and **regional datasets**. Key parameters defining building performance, such as geometry, thermal transmittance values (U-values) and envelope characteristics, are derived from national building typologies. Data on the distribution of energy carriers and heating systems per building type enables the identification of inefficient heating systems and high-emission energy sources.

However, **critical gaps** remain in the available data, particularly regarding the share of refurbished buildings per construction period and building type, which is often estimated rather than directly measured. Similarly, information on the distribution of different energy carriers across various construction periods is limited, requiring further refinement through estimation techniques and complementary data sources.

A key aspect of understanding the energy performance of buildings is the relationship between the heated floor area and primary energy use per square metre categorised by the number of households. Usually, smaller residential buildings exhibit higher energy consumption per floor area, potentially due to factors such as lower insulation efficiency, higher surface-to-volume ratios or outdated heating systems (Figure 6).

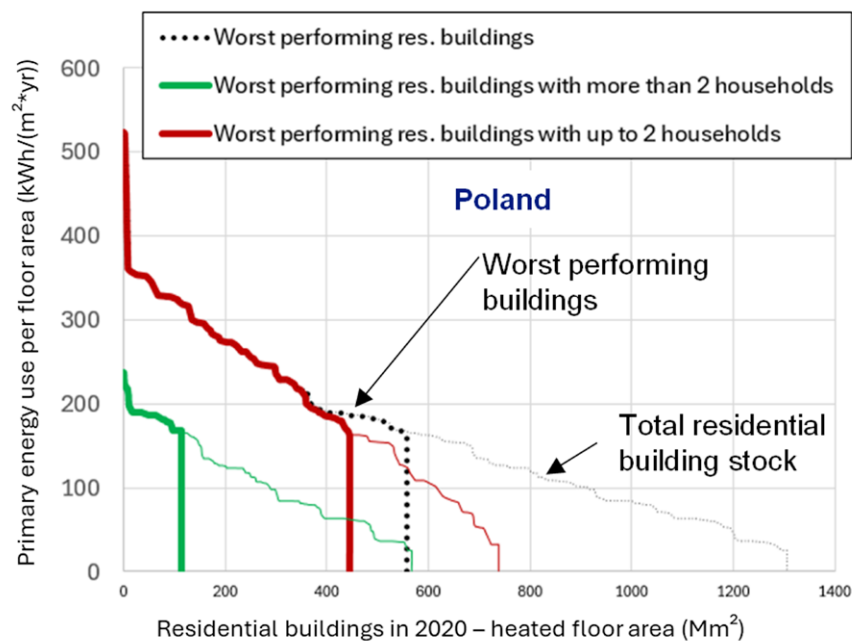


Figure 6: Distribution of specific primary energy use over heated floor area of worst-performing buildings (residential sector) by size in 2020

### 4.3 Definition of thresholds based on primary energy use

An essential step for implementing MEPS is the definition of the threshold value for the 16% and 26% worst-performing buildings based on the primary energy use per heated floor area.<sup>2</sup> According to the Invert/EELab simulation, in 2020, the primary energy use ranged from 50 kWh/(m<sup>2</sup>\*yr) to a maximum of 525 kWh/(m<sup>2</sup>\*yr) in the health sector, while the 2033 threshold varies between 175 and 310 kWh/(m<sup>2</sup>\*yr) across building categories (Figure 7). This shows that the baseline consumption in most sectors remains high, suggesting the need to introduce policy regulations to achieve the EPBD targets.

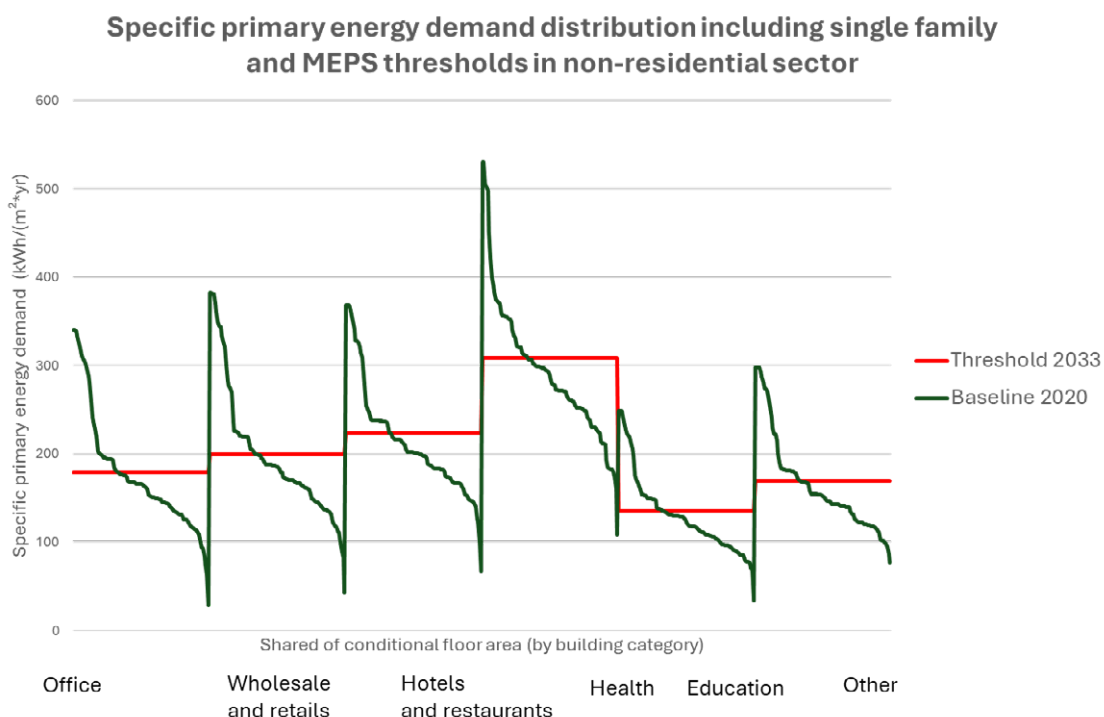


Figure 7: Specific primary energy use of buildings in 2020 by building category, shown as a share of conditioned floor area, compared with the proposed 2033 threshold values

### 4.4 Methodology: Invert/EE-Lab model approach

To outline and explore scenarios for the transformation of the building stock, we used the **Invert** modelling framework. This provides a comprehensive understanding of how energy performance in buildings evolves under different policy scenarios (see below), capturing both economic efficiency and realistic decision-making dynamics.

For a detailed description of the modelling, see Annex A: Model documentation.

The Invert model was run under scenarios that simulate different policy pathways for phasing out worst-performing buildings (Table 2). The scenarios combine varying levels of regulatory stringency, economic instruments and technological ambition to reflect alternative policy approaches. Five main scenarios are assessed:

<sup>2</sup> The 16% and 26% can also be translated as the 16th and the 26th percentile of the primary/final energy use.



1. **Regulatory+** scenario, representing a strong top-down approach with a ban on fossil boilers and stringent MEPS.
2. **Regulatory** scenario with moderate standards, but no fossil ban,
3. **Mix** scenario combining high CO<sub>2</sub> prices (€300/t) and generous subsidies with partial regulatory measures limited to the non-residential sector.
4. **Moderate** scenario having moderate subsidies, limited regulation and a CO<sub>2</sub> price of €75/t.
5. **Pure economic** scenario relying solely on market-based instruments such as CO<sub>2</sub> pricing and subsidies.

Each scenario is defined by specific assumptions on **CO<sub>2</sub> prices**, **subsidy budgets** and the presence or absence of **regulatory instruments** for both the residential and non-residential sectors. This design allows assessment of the interactions between policy tools, their effectiveness in driving renovation and fuel switching, and their overall impact on energy demand, emissions and investment needs in the European building stock.

Table 2 Overview of policy scenarios used in the modelling

Scenario name	CO <sub>2</sub> price	Subsidies	Ban fossil-based boilers	Residential	Non-residential
Regulatory+	75€/t	Moderate	Yes	MEPS	MEPS
Regulatory	75€/t	Moderate	No	MEPS	MEPS
Mix	300€/t	High	No	No MEPS	MEPS
Moderate	75€/t	Moderate	No	No MEPS	MEPS
Pure economic	300€/t	High	No	No MEPS	No MEPS

## 4.5 Scenario results for non-residential buildings

Article 9.1 of the EPBD requires that all non-residential buildings remain below defined maximum primary energy threshold values by 2033, ensuring the progressive phase-out of the worst-performing stock. This section presents modelling results that illustrate how different policy scenarios influence the distribution of primary energy demand across building categories and assesses the extent to which Poland can meet the required thresholds under each framework.

The **2020 data** provides a clear baseline: many building categories currently exhibit high levels of primary energy use, with a considerable share of the conditioned floor area lying above the 2033 threshold values (Figure 8). The two strong regulatory policy scenarios (Regulatory+ and Regulatory) – MEPS implementation, a CO<sub>2</sub> price of €75/t and a ban on fossil fuel boilers for Regulatory+ – drive substantial improvements across all building types. The distribution curves shift significantly downward compared to the 2020 baseline, with most buildings approaching or falling below the 2033 thresholds. The largest improvements are observed in the health sector, dropping from a peak of approximately 500 kWh/(m<sup>2</sup>/year) down to around 70–100 kWh/(m<sup>2</sup>/year), which is equivalent to a reduction of roughly **80–85%** compared with the 2020 baseline.

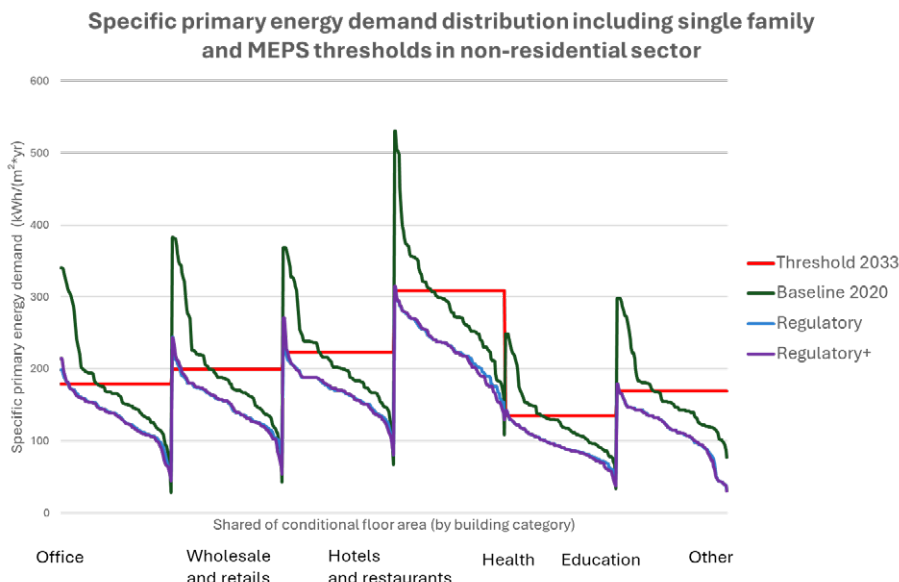


Figure 8: Primary energy use distribution of the Regulatory+ (with MEPS and a ban on fossil-based boilers) and Regulatory (MEPS without a ban on fossil-based boilers) scenarios

In contrast, the **Pure Economic scenario** – a CO<sub>2</sub> price of €300/t without additional regulatory obligations – brings a more modest reduction of primary energy use across all building categories (Figure 9). In the health sector, the divergence between the Pure Economic and Renovation+ scenarios is particularly pronounced. Under the Pure Economic scenario, reductions are modest, bringing peak values down only to roughly 400 kWh/m<sup>2</sup>/year, still well above the 2033 threshold of ~310 kWh/m<sup>2</sup>/year. In contrast, the Renovation+ scenario lowers the peak to approximately 300 kWh/m<sup>2</sup>/year, effectively cutting primary energy use by about 43% compared to the baseline.

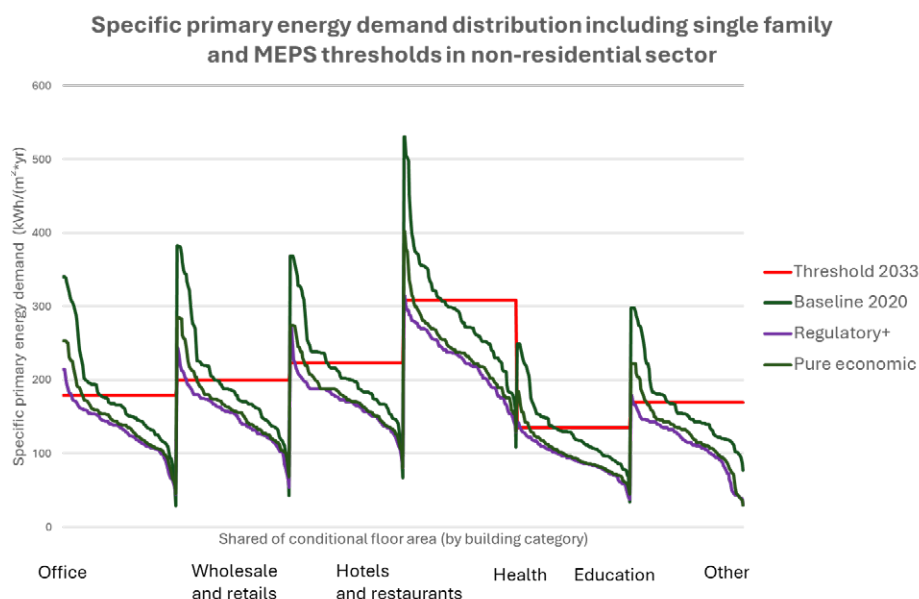


Figure 9: Economic policy scenario with high CO<sub>2</sub> price (€300/t) and no MEPS implementation

These differences across scenarios are closely linked to the underlying **energy-carrier transitions** (Figure 10). Poland's non-residential sector currently relies heavily on **coal and natural gas**. Under the regulatory scenarios, the introduction of MEPS and, in the case of Regulatory+, the ban on fossil-fuel boilers drive a sharp decline in coal use with a phase-out by 2050. Also, natural gas consumption substantially reduces from 2035 onwards. District heating and electricity increase under both scenarios, reflecting the shift toward lower-carbon supply options and the electrification of heating through heat pumps. Under the Pure Economic scenario, however, fuel switching remains limited despite the high CO<sub>2</sub> price, resulting in continued reliance on fossil fuels and smaller reductions in overall primary energy demand.

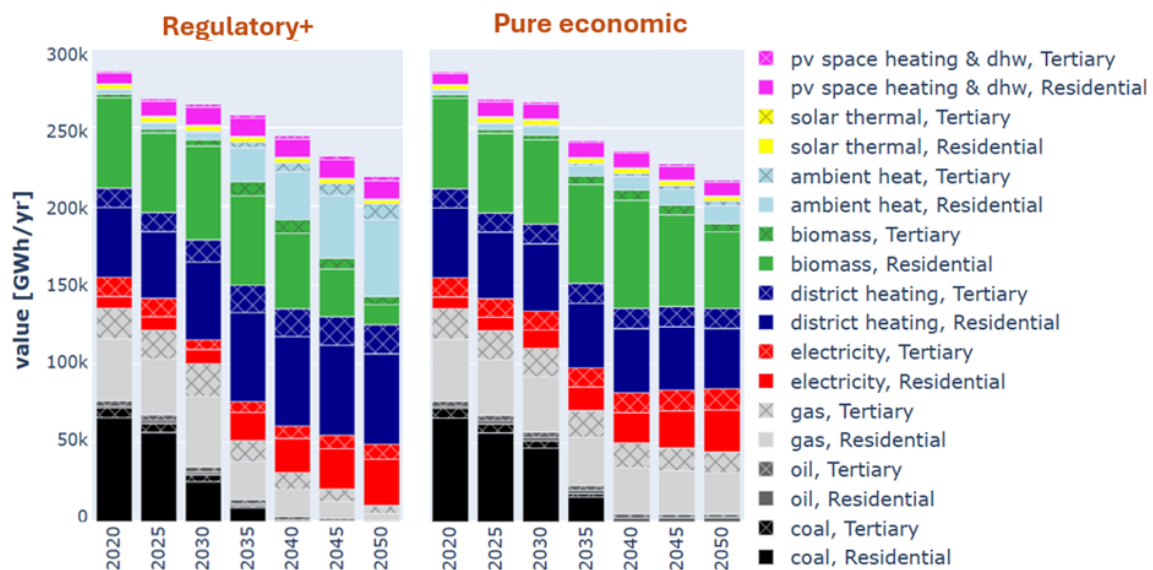


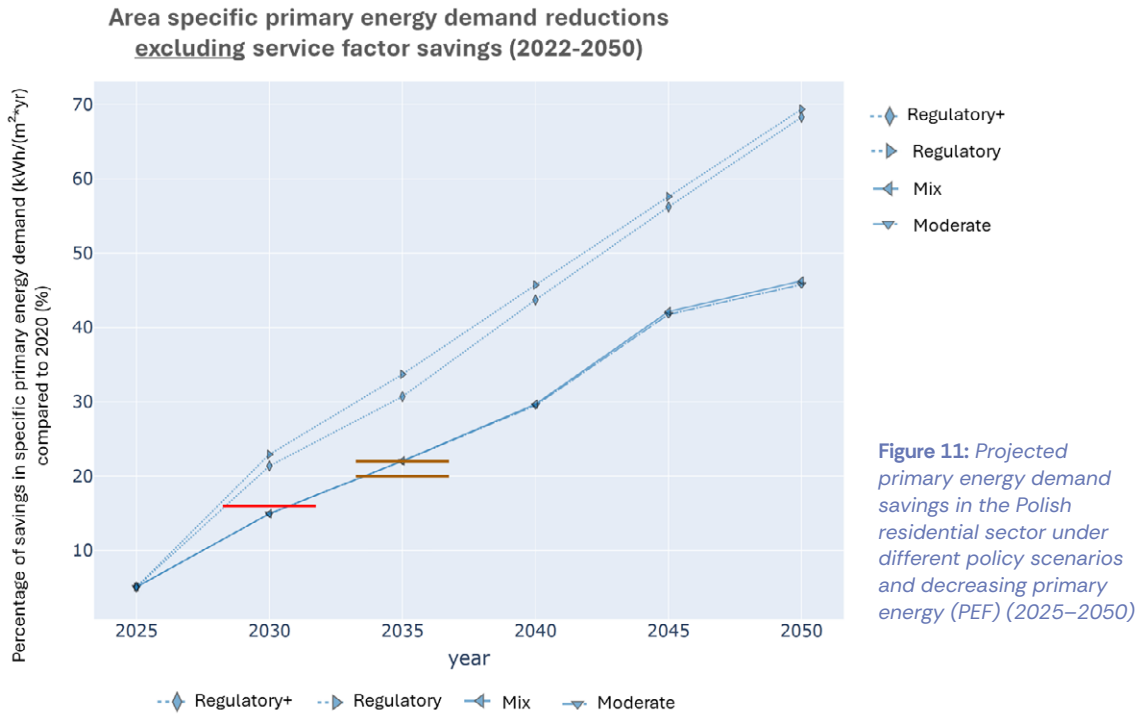
Figure 10: Comparison of final energy use across sectors and carriers under two policy scenarios Regulatory+ (MEPS and ban on fossil boilers) and Pure economic (no MEPS and €300/tCO<sub>2</sub>)

Overall, the modelling shows that only the stronger regulatory pathways – particularly Renovation+ – deliver the depth of energy savings needed for Poland to meet Article 9.1 requirements. While economic incentives alone yield partial improvements, they leave a significant share of the building stock above the 2033 thresholds.

## 4.6 Scenario results for residential buildings

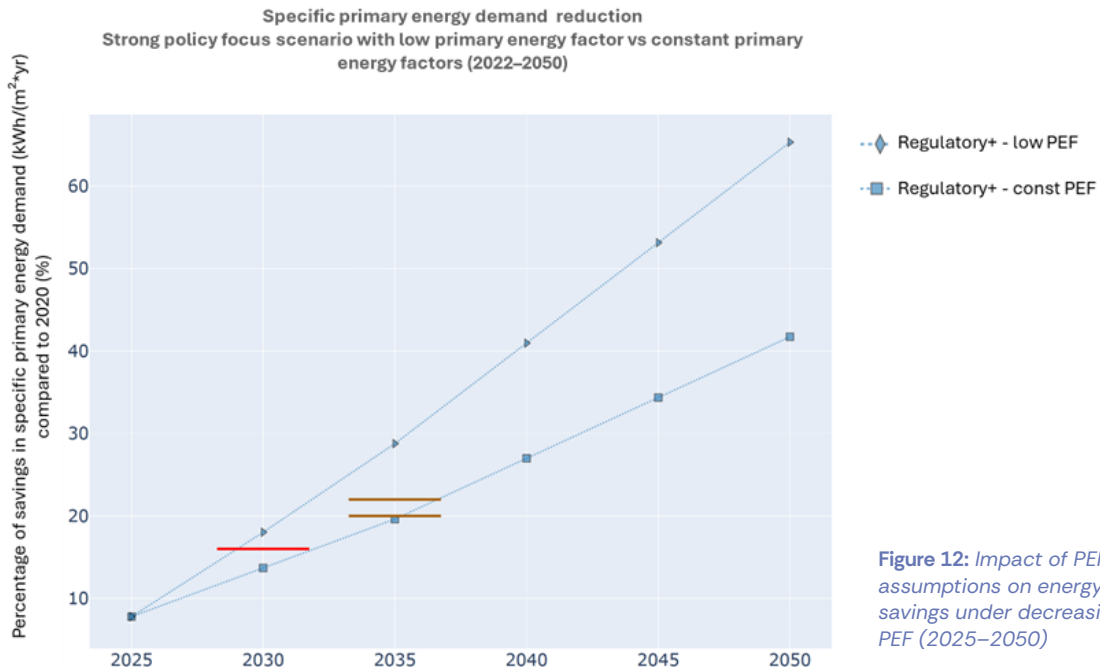
Meeting the EPBD's residential sector targets – 16% average primary energy reduction by 2030 and 20–22% by 2035 – depends on two interconnected factors: the ambition of building renovation policies and the pace of energy supply decarbonisation. This section presents scenario modelling results that assess Poland's compliance pathway under varying policy frameworks, exploring how targets can be met and methodological choices regarding primary energy factors.

The modelling clearly shows that the pace and depth of energy demand reduction depend strongly on the regulatory intensity and on the structural decarbonisation of the energy system. In all cases, tightening policy measures significantly accelerates the decline in primary energy demand, with the Regulatory and Regulatory+ pathways consistently outperforming the more market-oriented Moderate and Mix ones (Figure 11). The **Regulatory+** scenario delivers the fastest reduction in primary energy demand, reaching approximately **70% by 2050**. This is driven by ambitious standards, high renovation rates and strong policy alignment. The **Regulatory** pathway follows a similar trend, achieving around **46% reduction by 2050**. This suggests that once robust frameworks target the worst-performing stock, additional tightening yields diminishing returns as savings depend on deeper, costlier retrofits. The **Moderate** and **Mix** scenarios progress more slowly, but maintain a comparable trajectory. This indicates that market dynamics contribute to long-term efficiency gains.



**Figure 11:** Projected primary energy demand savings in the Polish residential sector under different policy scenarios and decreasing primary energy (PEF) (2025–2050)

A closer look at the **primary energy factor (PEF) sensitivity** highlights another dynamic (Figure 12). When the primary energy factor declines over time (“low PEF”), reflecting a cleaner electricity mix and more renewable inputs, energy demand reductions appear sooner and reach higher absolute values – **approximately 67% by 2050 compared to 42% under constant PEF assumptions**. Maintaining a **constant PEF** dampens apparent progress, as efficiency improvements in the building stock are not amplified by systemic decarbonisation of supply. This confirms that **building policy and energy system decarbonisation must evolve in tandem**.

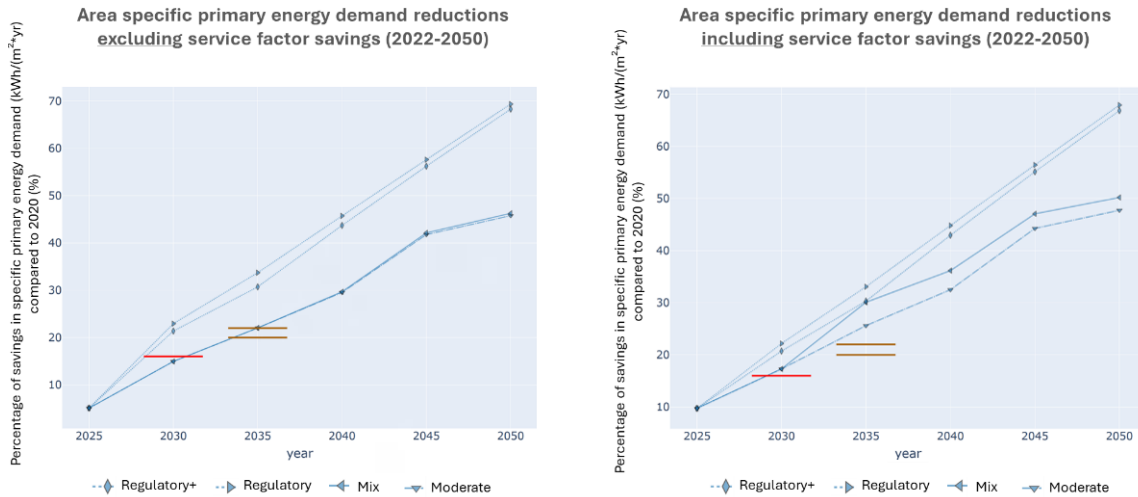


**Figure 12:** Impact of PEF assumptions on energy savings under decreasing PEF (2025–2050)

Finally, the distinction between **including or excluding service-factor improvements** reveals the significance of end-use and operational efficiency (Figure 13). When service factors – such as improved control systems, user behaviour and equipment efficiency – are considered, overall savings increase markedly, particularly in the medium term. Excluding these effects



leads to slower and more linear progress, suggesting that the technical renovation of the envelope alone cannot deliver the full potential envisaged by the EPBD. This points to the need for **integrated renovation strategies** that combine building fabric upgrades with smart systems, behavioural measures and renewable integration.



**Figure 13:** Effect of service-factor (with/without) improvements on primary energy demand reduction under decreasing PEF (2025–2050)

In this context, the evolution of primary energy factors becomes central to interpreting progress and assessing compliance. Table 3 below summarises the projected PEF<sup>3</sup> trajectories for Poland from the base year to 2050, illustrating how decarbonisation of electricity and district heating progressively lowers their primary energy factors, while fossil-based carriers remain unchanged.

**Table 3:** Primary energy factors for Poland for the base year and the years 2027–2050

Poland								
	Base	2027	2030	2033	2035	2040	2045	2050
Gas				1.1				
Oil				1.1				
Biomass				1.1				
Electricity	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2
District heating	1.2	1.15	1.1	1.05	1	0.95	0.9	0.85

Overall, the results suggest:

- **Regulatory frameworks** accelerate progress, especially in the first two decades (2030–2040).
- **Energy system decarbonisation (low PEF)** amplifies these gains, demonstrating the importance of coordinated policy across sectors.
- **Service-factor improvements** act as an additional lever for energy-demand reduction.

3 District heating PEF values are assumed to decrease over time without detailed technology modelling. Values below 1.0 reflect expected integration of waste heat and heat pumps. The specific PEF for waste heat and technology contributions have not been explicitly modelled.



5



# STAKEHOLDER ENGAGEMENT FOR ARTICLE 9 TRANSPOSITION

## Transposition strategy and timeline

The Ministry of Development and Technology outlined that the NBRP will be subject to public consultation, with the objective of establishing a clear roadmap for building renovation and modernisation. However, officials acknowledged that meeting the transposition deadline may be challenging. A critical milestone was set for 30 June 2025, when technical conditions linked to the calculation methodology must be finalised. This review will establish total primary energy – divided into renewable and non-renewable components – as the basis for energy classification, requiring a comprehensive reopening of discussions on energy class definitions and thresholds.

The draft NBRP includes ambitious scenarios ranging from complete coal phase-out by 2040 to achieving zero-emission buildings by 2050. Preliminary modelling suggests that the overall trajectory targets for residential buildings – 16% energy performance improvement by 2030 and 20–22% by 2035 – are achievable, particularly given the anticipated phase-out of coal heating systems accelerated by the implementation of the new emissions trading system (ETS2).

## Critical challenges

### **1. EPCs and data availability**

Poland faces a fundamental challenge in that it currently does not have a comprehensive system of energy classes for existing buildings. EPCs are primarily required only for new buildings and those undergoing transactions, not for the entire building stock. This creates a critical data gap for identifying and prioritising worst-performing buildings. The Ministry indicated that there are no immediate plans to mandate EPCs for all buildings, as such a



requirement would likely face significant social resistance. However, establishing energy classes remains essential for implementing Article 9 effectively.

Local government representatives highlighted the scale of this challenge, noting that approximately 3,000 public buildings alone would require complex analysis to assign energy classes. Without comprehensive building-level data, implementing a targeted approach that prioritises buildings with the highest energy consumption becomes extremely difficult.

## **2. Worst-performing buildings sub-target in the residential sector**

The requirement that at least 55% of the energy performance improvement must be achieved through renovations of worst-performing buildings emerged as a particularly contentious issue. Meeting this criterion depends on whether separate sub-targets are defined for single-family houses versus multi-family houses. With a single aggregated target, the requirement is more readily achievable since single-family houses dominate the worst-performing building category in Poland. Stakeholders described this sub-target as “mathematically impossible” to achieve by 2050 given current conditions. The primary obstacles include:

- Inability to systematically identify and prioritise worst-performing buildings without mandatory EPCs across the building stock
- Uncertainty about which building segments should be targeted first
- Challenges in defining and operationalising the worst-performing buildings category in the Polish context
- Technical and financial barriers to renovating the most degraded buildings, where neglect of maintenance has resulted in conditions that may not be economically viable to remediate.

## **3. Social and economic feasibility**

Stakeholders emphasised that the scale of modernisation envisioned in the Directive represents a significant challenge given the resources required. Estimates suggest that approximately 6% of GDP would be needed for deep renovation of the existing building stock – a level of investment that far exceeds available public finances. The Ministry acknowledged that while the Polish state can provide support, there are realistic limits to public funding capacity.

Beyond financial constraints, the challenge extends to social acceptance and implementation capacity. Vulnerable populations, including the elderly and disadvantaged households, require not only financial support but also comprehensive technical assistance and hands-on guidance through the renovation process. Many building owners cannot independently manage complex renovation projects, creating a need for support systems that go beyond mere financing. The question of temporary relocation during renovations – and associated costs – adds another layer of complexity for individual building owners.

## **4. Energy sources and transition pathways**

The role of biomass and the pace of coal phase-out generated substantial discussion. While modelling assumes a trend toward phasing out low-efficiency coal stoves, this transition is intrinsically linked to social questions affecting the most vulnerable households. Poland's heavy reliance on coal for heating – particularly in rural and lower-income areas – means that rapid transitions could create significant hardship without adequate support mechanisms.



Stakeholders questioned how biomass should be factored into renovation strategies, noting its currently favourable PEF in calculations. In the modelled scenarios, biomass maintains a constant PEF of 1.1 throughout the projection period; if PEF reduction becomes a strong policy focus, biomass would be phased out in favour of more efficient energy carriers. There is concern that changes to PEF values for biomass could significantly alter the economic calculus of renovation decisions. The interconnection between decarbonising the electricity sector, district heating networks and individual buildings was recognised as critical, with stakeholders concluding that purely economic and mixed instruments would be insufficient without coordinated policy measures across these sectors.

### **5. Institutional and administrative capacity**

The Ministry of Development and Technology identified the shortage of qualified human resources as a major implementation barrier. The Directive requires expertise not only in energy efficiency but also in building physics, financial mechanisms, social policy and project management. Building this capacity while simultaneously implementing large-scale renovation programmes represents a significant challenge.

Stakeholders noted that previous long-term renovation strategies suffered from lack of effective execution and inadequate coordination across government bodies. There is consensus on the need for a centralised coordination mechanism to ensure alignment between ministries responsible for construction, sustainable development, social policy, climate action and regional funds. Without such coordination, there is risk of fragmented implementation and inefficient use of resources.

### **6. Economic uncertainty and planning challenges**

Officials emphasised that economic factors create substantial uncertainty for long-term planning due to disruptions such as COVID-19, the war in Ukraine and supply chain breakdown. This uncertainty affects material costs, labour availability, financing conditions and household economic capacity – all critical variables for achieving renovation targets.

## **Enabling measures and support framework**

To address these challenges, stakeholders identified several essential enabling measures:

### **1. Policy and economic instruments**

- Targeted grants for worst-performing buildings
- Green loans and mortgage products with long repayment terms
- Tax incentives for energy-efficient renovations
- Coordination with the Social Climate Plan to address energy poverty while supporting renovations

### **2. Technical and advisory support**

- One-stop shops providing integrated technical and financial advice
- Building professional capacity among energy auditors and renovation specialists
- Standardised assessment methodologies and tools



### 3. Communication and social acceptance

- Clear, accessible communication campaigns explaining the rationale and benefits of renovations
- Transparency about energy class definitions and their implications
- Engagement with building owners to understand renovation processes and available support

### 4. Governance and monitoring

- A designated authority responsible for implementing and monitoring progress toward targets
- Robust data collection systems to track renovations and energy performance improvements
- Inter-ministerial coordination mechanisms

### Path forward

Poland's approach to implementing Article 9 reflects an attempt to balance the Directive's ambitious targets with practical feasibility and social equity considerations. The Ministry has indicated that activities included in the NBRP will be limited to those that are economically viable, with final decisions subject to public consultation.



# 6



# COMPLIANCE, MONITORING AND EVALUATION

To ensure effective implementation of MEPS for non-residential buildings and the national trajectory, Poland must establish clear frameworks for compliance, monitoring and enforcement. These elements are essential to track progress, engage building owners, and achieve national energy and climate targets.

## Compliance mechanisms for Article 9:

1. Initial efforts regarding enforcement and verification may focus on sectors with stronger administrative control and better data availability, such as **public or large commercial buildings**, as recommended in Deliverable D3.1.
2. Where data coverage is incomplete, **simplified compliance methods** (e.g. modelled estimates, statistical proxies) may be required in the short term, alongside efforts to improve EPC and building logbook coverage. These methods are particularly relevant given our findings on insufficient baseline data and the need to develop practical, scalable interim solutions.
3. **Enforcement mechanisms** should include proportionate sanctions and clearly defined exemption criteria. Penalty revenues could be reinvested to strengthen administrative capacity or support renovation efforts. Compliance tracking should also be aligned with the long-term renovation strategies and trajectories defined in the NBRP.

Guidance on monitoring and evaluation of the national trajectory can be found in D2.2 “Development of NBRP: Policy Guidelines for Poland” [2]<sup>4</sup>.

<sup>4</sup> For an enhanced monitoring, reporting and enforcement framework to complement EPBD implementation, please see the [EPBD wise report](#) on this.



1. Poland should **designate competent authorities** and define transparent procedures to verify compliance with MEPS.
2. Building owners must be informed early about the applicable energy thresholds (2030, 2033, 2040, 2050) and supported with appropriate technical and financial assistance.
3. It should be assessed whether compliance can primarily be demonstrated through updated **EPCs** or whether alternative approaches should be considered – such as compliance based on a defined list of renovation measures linked to national energy performance standards. This reflects a key policy to reduce overreliance on EPCs due to data gaps and limited coverage, particularly in the private sector. Even if EPCs are used as the main tool, issuing an EPC for every individual building may not be necessary. Targeted spot checks could be prioritised in segments with a high likelihood of non-compliance, reducing administrative burden while ensuring credible enforcement (as recommended in D3.1)
4. Where data coverage remains incomplete, simplified compliance methodologies – such as modelled estimates or statistical proxies – may be applied in the short term. These interim measures should be complemented by continued efforts to improve EPC data quality and expand building logbook coverage. Such approaches are particularly relevant given the Deliverable’s findings on insufficient baseline data and the need for practical, scalable solutions to ensure consistent progress in the early implementation phase.
5. Enforcement mechanisms should include proportionate sanctions and clearly defined exemption criteria. Revenues from penalties could be reinvested to strengthen administrative capacity or to support renovation measures targeting the most affected segments. Compliance tracking should be closely aligned with the long-term renovation strategies and trajectories established in the NBRP to ensure coherence and transparency across reporting frameworks.

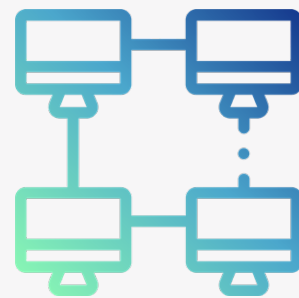
### Suggested first steps

- Appointing national and regional authorities for MEPS oversight.
- Defining the data sources and methods for compliance verification.
- Setting out compliance rules and publishing clear guidance for building owners.
- Launching early communication and outreach campaigns, especially for public and commercial building owners.
- Piloting compliance checks and digital monitoring tools in selected municipalities.

Clear roles, transparent procedures and accessible data systems will be essential to ensure that MEPS drive large-scale, cost-effective renovations.



# 7



# CONSISTENCY AND INTERACTION WITH OTHER POLICY INSTRUMENTS

The requirements of Article 9 are not developed in isolation but are closely linked to other policy instruments established under the EPBD. Ensuring consistency and synergies between these instruments is crucial for achieving a highly energy-efficient and decarbonised building stock by 2050.

## 7.1 National building renovation plan

The **NBRP** is the **central coordination and reporting framework** within which Article 9 mechanisms must be planned, quantified and monitored. The two are therefore deeply interdependent: while Article 9 provides the regulatory engine for achieving measurable reductions in energy demand, the NBRP provides the **strategic roadmap** that integrates those targets into a coherent national policy framework.

Each Member State must include in its NBRP the thresholds for non-residential MEPS and the national trajectory milestones for residential buildings (2030, 2035, 2040, 2050). The plan must also identify the number and floor area of the worst-performing buildings, the policy measures to address them, and the financing and administrative resources required. This ensures that Article 9's quantitative obligations are embedded in a transparent, long-term strategy subject to Commission review.



The **interaction** is therefore **cyclical**: the NBRP informs Article 9 by supplying baseline data on the building stock (often derived from EPC databases) and implements Article 9 by translating thresholds into concrete programmes and investments. Conversely, the milestones in Article 9 structure the NBRP's timeline and provide measurable indicators of progress. A coherent link between the two avoids fragmentation, guarantees consistency with national energy and climate plans, and facilitates the assessment of compliance at both national and EU level.

To maximise effectiveness, Member States should synchronise the development of their Article 9 trajectories with the first draft NBRP due by December 2025, enabling early feedback from the European Commission. Integrating MEPS and trajectories within the NBRP transforms the latter from a descriptive plan into a dynamic governance tool that tracks the transition toward a zero-emission building stock.

## 7.2 Energy performance certificates

The **EPC** system is both a **compliance and a monitoring instrument** for Article 9. For non-residential buildings, EPCs provide the data required to identify the 16% and 26% worst-performing segments and to verify renovation compliance with MEPS. For residential buildings, EPC databases underpin the statistical overview needed to establish and monitor national trajectories of average primary energy demand reduction.

The EPBD strengthens this link by requiring recalibration of EPC classes (A–G) by 2026, aligning class A with the zero-emission building (ZEB) standard and class G with the worst-performing stock – precisely the segment targeted by Article 9. This creates a consistent reference scale across the EU, allowing Member States to express MEPS thresholds and trajectory milestones either in absolute (kWh/m<sup>2</sup>) or relative (EPC-class) terms.

An EPC thus serves three complementary functions:

- **Data foundation:** it generates harmonised, verifiable information on energy use, emissions and renovation progress.
- **Compliance mechanism:** it enables building-level verification of MEPS compliance and facilitates enforcement.
- **Policy feedback loop:** aggregated EPC data feeds into NBRP monitoring and helps evaluate the effectiveness of Article 9-driven measures.

The interaction also extends to **communication** with building owners. Updated EPCs issued after major renovations document the improvement achieved under Article 9 schemes, reinforcing transparency and consumer confidence. To ensure reliability, Member States must strengthen quality control and align EPC issuance cycles with MEPS milestones. The more robust and comparable EPC systems become, the more effectively Article 9 can function as a measurable and enforceable driver of renovation.



## 7.3 Renovation passports

The **renovation passport** complements Article 9 by providing a **building-level roadmap** that guides owners through staged deep renovations consistent with national trajectories and MEPS targets. While Article 9 defines aggregate energy-reduction milestones, renovation passports translate these into actionable steps for individual buildings, turning regulatory obligations into practical renovation pathways.

For Member States that choose to meet their national trajectory targets through **staged deep renovations**, renovation passports are indispensable. They allow each building to plan a sequence of interventions – envelope upgrades, system replacements, integration of renewables – that cumulatively achieve the deep-renovation depth required to reach the average reduction targets of 16% by 2030 and 20–22% by 2035. Issuing renovation passports jointly with EPCs ensures technical coherence between assessment and planning, reduces costs, and provides a direct feedback mechanism for policy evaluation.

Within the broader governance framework, renovation passports support the implementation of Article 9 in three ways:

- **Operationalisation:** translating national targets into tailored building-level actions.
- **Monitoring:** creating a digital record of renovation progress, feeding into national databases used to assess Article 9 compliance.
- **Social acceptance:** improving homeowner understanding and engagement, mitigating resistance to mandatory performance standards.

To ensure coherence, NBRPs should explicitly reference the renovation passport scheme as a supporting instrument for achieving national trajectories and MEPS, including provisions for quality control, data integration, and financial incentives linked to renovation passport milestones. Together, renovation passports and Article 9 create a **micro–macro link** between individual renovation pathways and national decarbonisation trajectories.



8



# POLICY GUIDELINES AND RECOMMENDATIONS

The successful implementation of Article 9 requires a comprehensive and coordinated approach across multiple dimensions. This section outlines the key actions and strategic considerations necessary to achieve the Directive's objectives.

1

## Establishment of minimum energy performance standards

Given that data availability represents a significant bottleneck, a pragmatic approach is essential. The implementation should align threshold definitions with available data by using the 290kW and 70kW installed power thresholds specified in the EPBD as the foundation for data collection and reporting systems. Energy performance standards should be established by building category, such as offices, schools and warehouses, to reflect the diverse characteristics of the building stock. These categories should be determined on the basis of the building inventory and data gathered for the NBRP.

Modelling results demonstrate that regulatory approaches combining mandatory energy performance standards with supporting measures prove most effective in achieving the target of renovating worst-performing buildings within the 2033 deadline. Strong regulatory frameworks that establish MEPS, coupled with carbon pricing (€75/t) and restrictions on fossil fuel boilers, drive substantial improvements across all building types, with most buildings approaching or falling below the 2033 thresholds. This is especially critical in the health sector, which represents the highest energy consumption among public building categories, reducing from a peak of approximately 525 kWh/(m<sup>2</sup>-year) down to around 300 kWh/(m<sup>2</sup>-year) – a reduction of around 43% compared with current baseline levels. In contrast, relying solely on economic instruments such as high carbon pricing (€300/t) without mandatory standards brings only modest reductions, with health sector peak values reaching only 400 kWh/(m<sup>2</sup>-year), still well above the 2033 threshold of ~310 kWh/(m<sup>2</sup>-year). These differences stem from energy source transitions: mandatory standards drive a sharp decline in coal use with complete phase-out by 2050 and substantial reduction in natural gas



consumption from 2035 onwards, while purely market-based approaches show continued reliance on fossil fuels despite high carbon costs.

Other European countries have already enacted legislation on MEPS and targeting worst-performing buildings. **France** has introduced strict measures for buildings exceeding 450 kWh/(m<sup>2</sup>\*y) and requires homes to reach EPC class E by 2028[5]. **Scotland** established minimum energy efficiency standards for private rented domestic properties, requiring new tenancies to meet EPC E from October 2020, extended to all properties from April 2022 with a higher standard of D required from April 2025[6].

2

## Progressive renovation trajectories

The establishment of progressive renovation trajectories requires a top-down prioritisation approach that targets buildings with the highest energy consumption first. This prioritisation should be developed by the government within the NBRP, which should distinguish between single-family buildings and multi-family buildings within the worst-performing buildings category.

However, this strategy must acknowledge the reality that some severely degraded buildings may not be economically viable candidates for renovation. Renovation strategies should be explicitly linked with broader climate policy objectives, including coal phase-out timelines with complete phase-out targeted by 2040 and zero-emission building goals by 2050. Throughout this process, particular attention must be paid to the social implications for vulnerable households.

Trajectories must account for renovations already funded through existing programmes, most notably the €9 billion allocated from the Recovery and Resilience Facility for energy renovations. Additionally, the design of these trajectories should integrate the anticipated impact of the second phase of the emissions trading system (ETS2) on accelerating coal heating phase-out, recognising this mechanism as a key driver of energy performance improvements.

**France** targets worst-performing buildings (EPC classes F and G) with progressive deadlines: no class G buildings by 2025, class F renovated by 2028, and all buildings achieving at least EPC D by 2034, with penalties for non-compliance. For large commercial buildings over 1,000 m<sup>2</sup>, France mandates final energy consumption reductions of 40% by 2030, 50% by 2040 and 60% by 2050[5]. Similarly, **England and Wales** established progressive deadlines for rented properties, requiring residential buildings to achieve EPC class E by 2020 and C by 2028, while rented non-residential properties must meet EPC class E by 2021, D by 2025 and C by 2028[7]. **Brussels'** phased renovation obligation model represents another progressive approach, requiring homeowners to implement selected EPC measures incrementally every five years toward a 2050 performance target of 100 kWh/(m<sup>2</sup>\*y)[8].

3

## Financial and technical support mechanisms

Effective implementation requires targeted financial support that recognises the varying challenges across the building stock. For worst-performing buildings and vulnerable households, higher-level grants – potentially reaching up to 50% of the cost of renovation – should be provided, acknowledging that standard support levels may prove insufficient for the most challenging renovations. Beyond financial assistance, comprehensive one-stop shops should be developed that integrate technical advice, financial guidance, project management support and administrative assistance – moving beyond information provision



to active facilitation. While Poland currently lacks an official nationwide one-stop-shop system, the National Fund for Environmental Protection and Water Management (NFOŚiGW) has piloted an “Operators” programme in Małopolska voivodeship as part of the “Clean Air” programme, which could serve as a foundation for scaling up such services nationally.

Coordination of financial instruments across multiple funding sources is essential, including national programmes such as Clean Air and the Social Climate Plan, as well as EU cohesion funds, to create coherent support packages. While the Clean Air programme has been instrumental in supporting low-income households, there is a need for discussion in Poland about expanding support mechanisms – including repayable instruments such as green loans and favourable financing schemes – to address the needs of middle-income households who fall outside the current programme’s primary focus. Given that Social Climate Fund resources will not become available until 2027, it is critical to front-load investment and enable advanced payment mechanisms to bridge this gap. The approach should combine economic instruments such as grants, green loans and tax incentives with non-financial supportive measures, recognising that purely economic instruments are insufficient to drive the required transformation.

**The Netherlands** has one of the most comprehensive support schemes, combining tax reductions and exemptions, VAT rates and refunds, investment cost deductions, green loans and favourable interest rates. Online tools assess investment costs and carbon savings, while an approved register of energy advisors helps building owners navigate compliance and make informed decisions. **Belgium’s Flanders** region provides interest-free energy loans up to €15,000 for a 10-year duration, targeting priority groups, alongside green bonds for building renovation. The **Brussels** region offers subsidies covering approximately 20% of renovation costs based on income eligibility, combined with low-interest loans for lower-income households. Additionally, Brussels created IRISbox, a one-stop shop designed to standardise and simplify administrative procedures for grant applications. Scotland offers robust support through Home Energy Scotland, providing free nationwide advice, with interest-free loans available up to £38,500 (€42,789) for homeowners.

## 4

### Compliance and monitoring mechanisms

Clear governance structures are fundamental to successful implementation. A single designated working group should be responsible for implementing and monitoring progress toward Article 9 targets to avoid fragmented accountability. Monitoring capacity must be built in collaboration with local administrations, developing expertise in both technical energy performance tracking and the social dimensions of implementation. Drawing from international experience, such as England’s regulatory framework, trigger points for building renovation should be introduced to create clear compliance pathways.

**England and Wales** use transactional trigger points, prohibiting rental of properties not meeting minimum EPC E standard since 2018 for domestic properties and 2023 for non-domestic properties. Local authorities can impose financial penalties up to £4,000 for renting non-compliant properties for three months or more, £2,000 for shorter periods, and £1,000 for providing misleading information[9]. **Belgium’s Flanders** region employs a penalty point system where rental homes not meeting minimum insulation standards accrue penalty points, with homes accumulating 15 points banned from rental as of January 2020[10]. **The Netherlands** uses EPCs as a compliance verification tool, with penalties ranging from pecuniary fines to prohibition of rental for non-compliant buildings[11].



## 5

### Stakeholder engagement

Effective stakeholder engagement requires more than initial consultation. A central coordination centre should be established involving all relevant ministries, including those responsible for construction, sustainable development, social policy, climate and infrastructure. This multi-ministerial approach is essential to ensure coherent implementation and avoid the execution failures that have undermined previous strategies. Ongoing dialogue mechanisms should extend beyond initial consultation phases, allowing stakeholders to provide continuous feedback on implementation challenges and contribute to iterative policy refinement.

**Scotland** provides comprehensive support through Home Energy Scotland, offering free impartial energy advice nationwide alongside interest-free loans up to £38,500 (€42,789) for energy efficiency improvements. Government grants and schemes specifically target low-income and fuel-poor households, while local authorities manage area-based initiatives to reach hard-to-engage households and challenging properties, demonstrating the effectiveness of multi-channel approaches reaching diverse populations.

Transparency must be prioritised around key decisions, particularly regarding energy class threshold definitions and worst-performing building selection criteria. Draft proposals should be made available for stakeholder review before formal adoption, fostering trust and enabling constructive input from affected parties.

## 6

### Developing a qualified workforce

The success of Article 9 implementation depends fundamentally on having a qualified workforce capable of delivering the required services. Professional capacity needs to be built through structured training programmes for energy auditors, ensuring they can deliver reliable, high-quality assessments. This capability is essential for building public trust in the EPC system, which serves as the foundation for identifying and prioritising buildings for renovation.

Several countries have enhanced their EPC systems to better support renovation planning. **Brussels** upgraded its EPC to function as a renovation passport, listing specific measures that building owners must implement in their phased renovation obligation model. This approach requires all buildings to have an EPC by 2025, which then guides the selection of five mandatory measures to be implemented between 2030 and 2050. France uses EPCs to identify worst-performing buildings (classes F and G) that require priority renovation.

## 7

### Fostering social acceptance

Social acceptance of renovation requirements is critical for smooth implementation. Clear communication campaigns should be developed that explain not only the requirements themselves but also the underlying rationale and broader benefits. Accessible information materials, including infographics and simplified guidance, should be specifically tailored for building managers and owners who require practical support rather than technical documentation. Efforts should focus on creating user-friendly EPCs that are easily understood by non-technical audiences. These communication efforts should be coordinated with findings and recommendations from related deliverables focused on EPC system improvements (for more details see D3.2[12]).

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# ANNEX A:

## MODEL DOCUMENTATION

### A.1 Invert EE-Lab

Invert/EE-Lab is a comprehensive bottom-up techno-socio-economic building stock model that simulates energy-related investment decisions in buildings, specifically focusing on space heating, hot water generation and space cooling end-uses[13]. 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 10 years, supporting policymakers, researchers and industry professionals in energy efficiency and building technology assessment [11], [12].

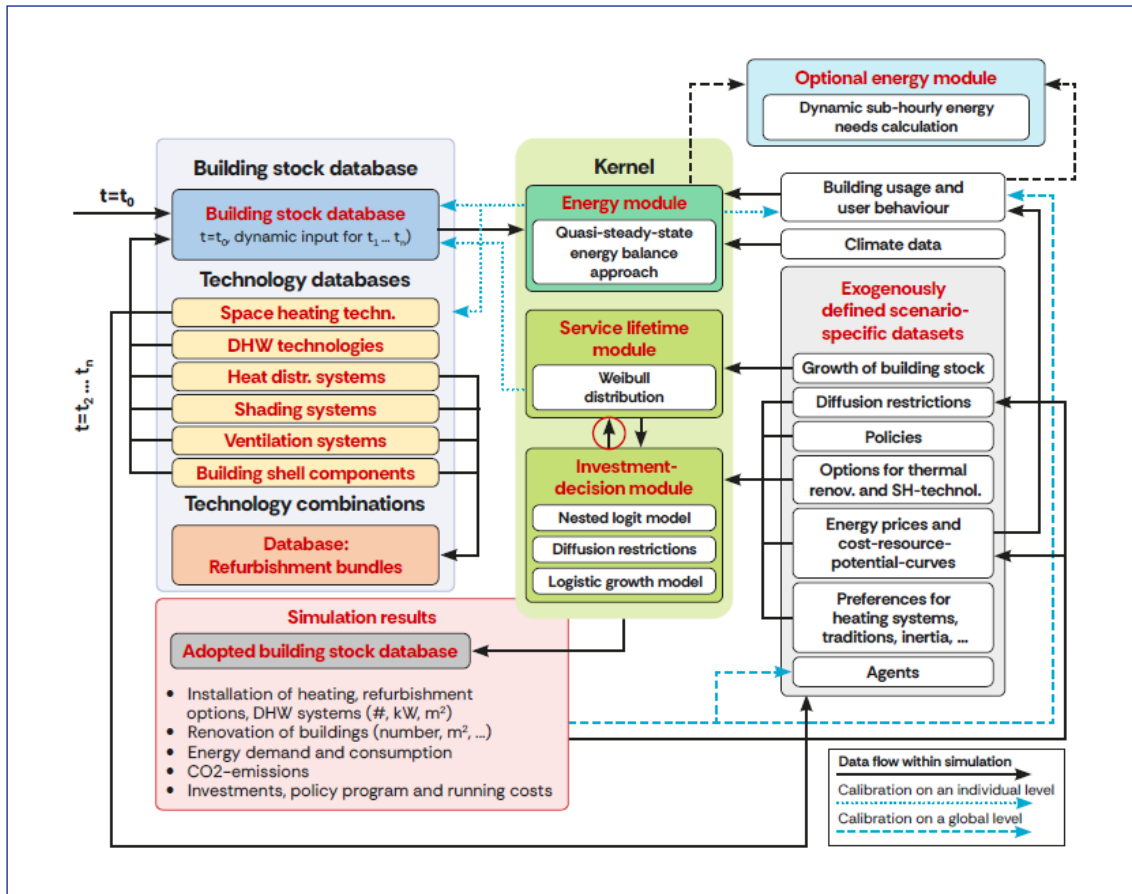


Figure 14: Overview of the structure of Invert/EE-Lab

The figure 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 + 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)

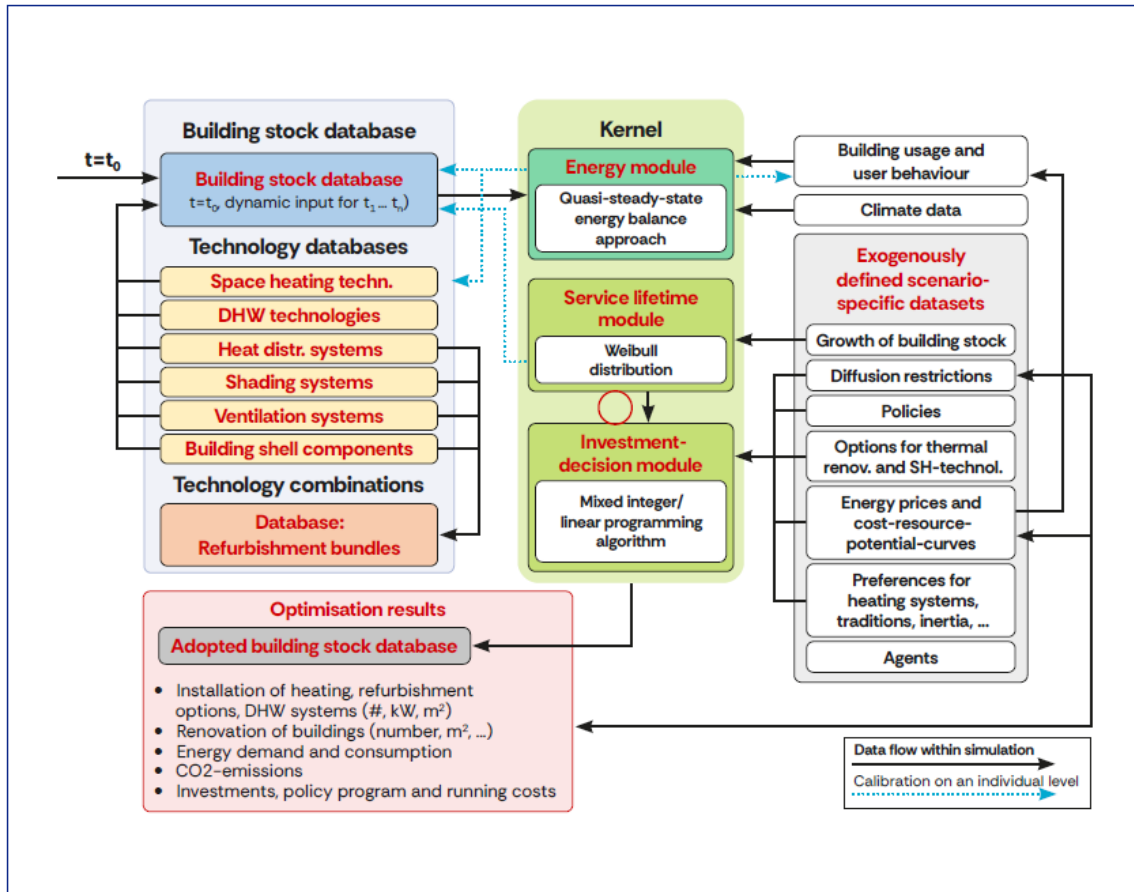


Figure 15: Overview of the structure of the Invert/Opt

The figure 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.

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