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OUR-CEE

(Overcoming Underperforming Renovation in Central and Eastern Europe)

National baseline assessment on underperforming renovations

Poland

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The opinions put forward in this study are the sole responsibility of the author(s) and do not necessarily reflect the views of the Federal Ministry for Economic Affairs and Climate Action (BMWK).

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1. EXECUTIVE SUMMARY

Under the existing Energy Performance of Buildings Directive, all new buildings in EU countries must be nearly zero-energy buildings by 31 December 2020 (public buildings by 31 December 2018). The majority of existing buildings were constructed prior to introducing any formal energy performance requirements, resulting in a building stock quality that is considerably below modern standards. Consequently, these buildings require appropriate modernisation, specifically the improvement of existing technical features to significantly reduce energy demand.

This report presents a comprehensive national baseline assessment focusing on the underperforming renovations in Poland. It addresses the following key points: Poland has approximately 14.2 million buildings, nearly 40% of which are single-family dwellings. A significant proportion of these buildings are characterized by low energy efficiency and will require thermal efficiency improvements in the coming years. Buildings commissioned in the 21st century have relatively high energy efficiency, while older buildings have high energy demand, necessitating modernisation.

The assessment covers both national and local levels, identifying that more than 70% of the building stock in Poland has a primary energy ratio higher than 150 kWh/(m²·year), indicating energy inefficiency. The analysis of energy savings and cost savings from shallow and deep energy renovations demonstrates that deep renovations generate higher energy savings but also involve longer payback times.

Factors contributing to underperformance include inadequate project development, lack of specialized knowledge, non-compliance with regulations, and lack of awareness among building users and managers. Legal and regulatory challenges, such as insufficient ambition in national laws and lack of comprehensive approaches to renovations, further exacerbate the issue.

To overcome these challenges, the report recommends introducing unified and ambitious guidelines for public building modernisation, implementing a robust data management system for tracking renovation needs, and providing greater support for renovating historic buildings. Promoting alternative financing methods, such as public-private partnerships in ESCO arrangements, is also suggested to enhance the effectiveness and scope of thermal efficiency improvements.

This summary highlights the urgent need for strategic and comprehensive approaches to improve the energy performance of Poland's building stock, aligning with EU directives and contributing to broader climate and energy goals.

2. INTRODUCTION

Renovating both public and private buildings was singled out in the European Green Deal as a key initiative to drive energy efficiency in the sector and deliver on objectives. To pursue the dual ambition of energy gains and economic growth following the COVID-19 pandemic, the Commission published in 2020 the strategy "A Renovation Wave for Europe – Greening our buildings, creating jobs, improving lives" along with an action plan and a document presenting available EU funding. The Renovation Wave initiative builds on the national long-term building renovation strategies of Member States, other aspects of the Directive on Energy Performance of Buildings, and building-related aspects of each EU country's national energy and climate plans (NECPs). The Renovation Wave aims to at least double the EU's annual energy renovation rate by 2030.

Despite several good attempts to increase the energy performance of Europe's building stock, according to the BPIE's 2023 publication[1] "Buildings climate tracker – 2nd edition", the actions taken since 2015 have not been effective enough to decarbonize the EU building stock at the rate and depth required. In particular, countries in the Central and Eastern Europe (CEE) region are far from being on track; the region has gone backwards and requires a "better implementation of legislative requirements and more ambitious and inclusive strategies" (especially in view of the high share of people experiencing energy poverty) to decarbonize the building stock.

In order to meet 2050 decarbonisation goal in the buildings sector and to catch the full speed of the renovation wave, the CEE region should learn from its previous experiences and mistakes. In particular, it is of utmost importance to manage underperforming energy renovations (i.e., renovations which have not resulted in their projected energy savings) and to identify the possible reasons behind them. The OUR-CEE project addresses the issue of underperforming renovations in public buildings and how to overcome it, focusing on four CEE countries traditionally challenged by low renovation ambitions and poor quality of the building stock. Public buildings, which are expected to lead the way in deep renovation, have been undergoing renovation for many years in CEE – but a significant proportion of this renovation is not achieving appropriate energy savings. The findings of the project will support the acceleration of deep renovation in CEE and achievement of the EU's energy efficiency targets.

This study is the first step of this project, aiming to provide insights into the magnitude of the problem of underperforming renovations in the OUR-CEE project countries, though national baseline studies as well as a regional study of CEE. At the same time, these studies will present the possible reasons that might be behind underperforming energy renovations. Finally, the baseline studies will offer a series of policy recommendations which, if implemented, can significantly improve the performance and impact of future public building renovations in CEE region. The main goal of baseline studies is thus to improve the understanding of underperforming renovations among decision-makers.

[1] BPIE, EU buildings climate tracker 2nd edition, 2023

3. OVERVIEW OF THE NATIONAL BUILDING STOCK AND RELATED POLICIES

There are 14.2 million buildings in Poland, almost 40% of which are single-family dwellings. A significant proportion of buildings are characterised by low energy efficiency and will require thermal efficiency improvements in the coming years. The data show a wide variation in the energy efficiency of buildings both in terms of their purpose and the year they were put into use. Buildings commissioned in the 21st century are characterised by relatively high energy efficiency, but older buildings have high energy demand and require thermal efficiency improvements. This is particularly true of single-family buildings, for which solid fuel boilers remain the primary source of heat. In the case of multi-family residential buildings, the most recent surveys indicate that 30 per cent will still require thermal efficiency improvements after 2020. This proportion may increase further under the influence of the upward trend in the price of energy carriers. A review of the national building stock confirms that a significant proportion of it is characterised by low energy efficiency and will require thermal efficiency improvements in the coming years[1].

Most of Poland's multi-family residential buildings were constructed several decades ago, during a period when energy prices were low and did not accurately reflect their economic value under the conditions of a centrally planned economy. The technical solutions implemented at that time paid less attention to thermal insulation compared to contemporary standards. Heating systems of that era relied extensively on relatively high energy consumption to maintain suitable indoor temperatures. Buildings erected before 2002 exhibit notably higher levels of primary energy ratio compared to those currently under construction.

As of 31 December 2020, Poland will have legislation in place to achieve a state in which all buildings designed, constructed and subject to reconstruction or buildings with a change of use should be near-zero energy buildings. In the case of historic buildings, the aim should be to achieve the greatest possible energy savings.

The primary energy ratio for new residential buildings in Poland is 70 kWh/(m2-year), which is at the upper end of the 50-70 kWh/(m2-year) range recommended by the European Commission for a continental climate. On the other hand, the Polish requirements for non-residential buildings are 45 kWh/(m2-year), which is much lower than the range of 85-100 kWh/(m2-year) recommended by the EC, being among the most ambitious in the EU. On the other hand, when it comes to the share of renewable energy in primary energy supply, the new Building Act does not specify such a requirement, making Poland one of the worst performing EU countries in this respect[2].

3.1. Overview of the national building stock

As already mentioned, there are 14.2 million buildings in Poland. The structure of buildings by type in Poland is shown in Table 1.

Table 1 Structure of buildings by type in Poland at 1 January 2020

Category	Number of buildings (in thousands)
Multi-family residential buildings	553
Single-family residential buildings	5,604
Collective accommodation buildings	3.9
Public utility buildings	420
Industrial, agricultural, and warehouse buildings	5,116
Other non-residential buildings	2,491
Total	**14,189**

Residential buildings account for 43% of all buildings in Poland, while non-residential buildings account for 57%. Single-family detached houses and multi-family buildings account for 88% of the housing stock in Poland, and 94% in terms of net floor area. Office buildings account for approximately 26% of the non-residential stock. The above three building types account for about 77% of the building stock in Poland[3].

As at the end of 2019, the total area of residential buildings was 1,101,686 thousand m^2 and non-residential buildings were 464,730 thousand m^2.

Primary energy ratio ranges of the buildings in Poland are shown in Figure 1.

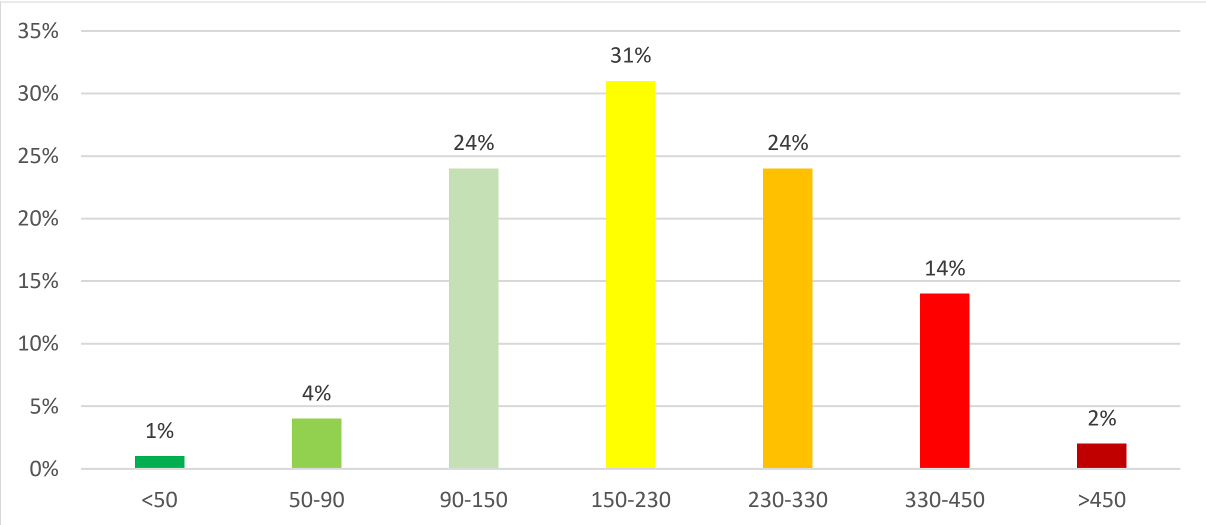

*Figure 1 Primary energy ratio of residential and public buildings in Poland [kWh/(m2*year)]*[1]

More than 70% of the building stock is characterised by a primary energy ratio higher than 150 kWh/(m2-yr), which is considered energy inefficient, with more than 15% in the two worst efficiency ranges. These will mainly be old, unmodernised detached houses and hospitals, which have a high energy demand (much of it for domestic hot water preparation). In contrast, buildings considered to have an primary energy ratio <90 kWh/(m2-yr) represent little more than 4% of the total stock considered. Buildings with primary energy ratio <50 kWh/(m2-year) account for barely half a percent of buildings. This state of affairs is due to the fact that energy-efficient construction started to develop in Poland relatively recently[1].

Age structure of the housing stock in Poland and energy ratios of the buildings as well as the median primary energy consumption for residential buildings depending on the building's purpose and the year of commissioning are shown in Table 2 and Table 3.

Table 2 Age structure of the housing stock in Poland built before 2002 and its initial unit energy ratios

Period of Building Construction	Single-family buildings	Apartments (within multi-family buidings)	Primary energy ratio (EP)	Final energy ratio (EK)
years	*thousands*	*million*	*kWh/(m²·year)*	*kWh/(m²·year)*
before 1918	404.7	1.18	> 350	> 300
1918 – 1944	803.9	1.45	300-350	260-300
1945 – 1970	1363.9	3.11	250-300	220-260
1971 – 1978	659.8	2.07	210-250	190-220
1979 – 1988	754.0	2.15	160-210	140-190
1989 – 2002	670.9	1.52	140-180	125-160

Table 3 Median primary energy consumption for residential buildings depending on the building's purpose and the year of commissioning

	<1994	1994-1998	1999-2008	2009-2013	2014-2016	2017-2018	2019-2020
	[kWh/(m²·year)]						
Single-family	263.7	147.9	143.5	126.3	109.1	94.0	89.3
Multi-family	258.9	139.0	110.0	142.7	97.5	87.0	84.9

As shown in the tables, buildings built before 1994 have the worst energy standard, with a primary energy ratio of more than 150 kWh/(m2-yr).

According to the strategy, approximately 7.5 million thermal efficiency improvements investments are estimated to be carried out by 2050, of which 4.7 million deep thermal efficiency improvements, including staggered thermal efficiency improvements in phases. The 7.5 million renovations on approx. 750,000 buildings planned by 2050 will be relatively equally distributed across decades, with slightly more planned for 2030-2040. The strategy assumes an average annual rate of thermal efficiency improvements of around 3.8%, with the assumption that 65% of buildings will achieve a primary energy ratio of no more than 50 kWh/m2-yr by 2050[1].

3.2. Overview of the national public building stock

According to the buildings database (the EU Building Stock Observatory) published by The European Commission to track the energy performance of buildings across all Member States, most of the floor area belongs to residential buildings. The remaining floor area belongs to non-residential buildings, with the biggest shares being public office and education buildings, and commercial buildings.

Figure 2 below shows the structure of energy use in households and non-residential buildings in Poland in 2012.

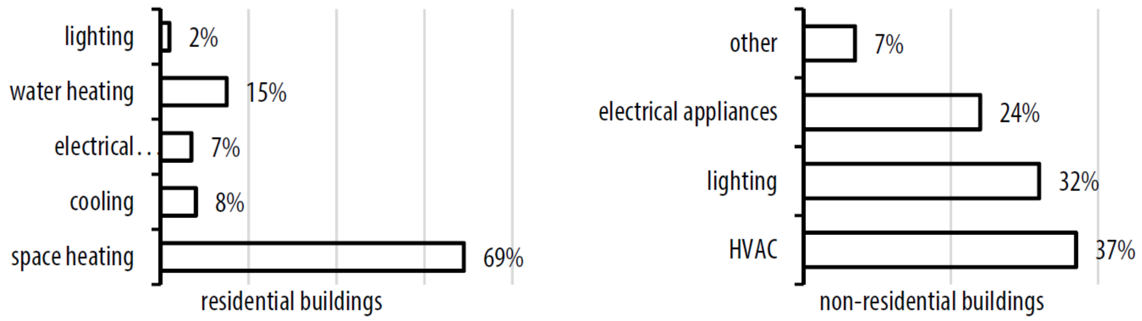

Figure 2 Structure of energy use in buildings in Poland in 2012[4]

In Polish non-residential buildings most of the energy is consumed by heating, ventilation and air conditioning (HVAC) (37%), followed by lighting (32%) and electrical appliances (24%). This is in contrast to residential buildings, where energy is used mainly to meet space heating requirements (69% of total energy consumption)[4].

One of the most significant types of public buildings are schools, where energy is used for heating, cooling, hot water production, lighting and electrical appliances, but the overall energy distribution depends greatly on the climate and in Poland, heating accounts for more than 70% of the energy supplied[5].

Given that the area of buildings owned by the public or occupied by public institutions constitutes a significant percentage of Poland's building stock,[2] and given the significant role of the public sector in spreading good practice and pointing out new directions in the area of energy efficiency, support for the thermal efficiency improvements of public buildings should continue, so that at least 3% of the total area of buildings owned and occupied by government institutions is thermal efficiency improved every year, in accordance with at least minimum energy performance. At the same time, measures should be taken to support local governments in achieving a similar rate of renovation[6].

In the case of public buildings, the Polish LTRS states that around 45% of buildings had been thermally improved by 2019[3]. Taking into account the projects currently being carried out and those planned by public institutions, the percentage of buildings where improvements in thermal efficiency will have been made is estimated to increase to around 55-60% by 2025.

New buildings must meet the energy performance requirements set out in the Regulation of the Ministry of Infrastructure of 12 April 2002 on technical conditions to be met by buildings and their location. These requirements are at the same time the limit values for nZEB buildings - this means that all new buildings constructed after 31 December 2020 will be nearly zero-energy, and in the case of buildings occupied and owned by public authorities, after 31 December 2018[7].

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[2] The exact percentage is not mentioned in Poland's Long-Term Renovation Strategy.
[3] In accordance with Article 2a(1)(b) and (g) of the Energy Performance of Buildings Directive, each Member State shall identify cost-effective refurbishment approaches appropriate to the building type and climate zone, taking into account, where appropriate, possible relevant trigger points in the life cycle of the building, and provide fact-based estimates of expected energy savings and wider benefits, such as in terms of health, safety and air quality.

According to the Polish Regulation of the Minister of Infrastructure on technical conditions to be met by buildings and their location[8], the maximum value of the annual non-renewable primary energy ratio (EP) is calculated as follows:

$$EP = EPH + \Delta EPC + \Delta EPL \, [\frac{kWh}{m^2 * year}]$$

where:

EPH+W – partial EP value for heating, ventilation and domestic hot water preparation

ΔEPC – partial EP value for cooling

ΔEPL – partial EP value for lighting.

Table 4 shows the partial primary energy ratio (EP) for heating, ventilation and domestic hot water preparation.

Table 4 Partial values of the primary energy ratio (EP) for heating, ventilation and hot water preparation EPH+W [kWh/(m2-year)] according to the Regulation of the Minister of Infrastructure on technical conditions to be met by buildings and their location[8]

Type of building	Partial values of the primary energy ratio (EP) for heating, ventilation and hot water preparation EPH+W [kWh/(m²-year)]	
	from January 1,2017	from December 31,2020*
Residential building: a) single-family b) multi-family	 95 85	 70 65
Collective residence building	85	75
Public building: a) health care b) other	 290 60	 190 45
Outbuilding, warehouse and production building	90	70
* From January 1, 2019 in the case of a building occupied and owned by a judicial body, prosecutor’s office or public administration body.		

3.3. Overview of the current state of related policies

Poland's long-term energy policy is outlined in strategic framework documents, including the Poland’s Energy Policy 2040 adopted on February 2, 2021, and the National Energy and Climate Plan for 2021-2030, mandated by EU regulations and adopted by the European Affairs Committee on December 18, 2019. These documents, alongside the Long-Term Renovation Strategy, shape Poland's energy transition framework.

3.4. Poland's Energy Policy 2040

This document establishes the framework for Poland's energy transition. It includes strategic measures for selecting technologies to build a low-carbon energy system. PEP2040 supports the implementation of the Paris Agreement, emphasizing a fair and solidarity-based transition. The policy addresses the challenges of aligning the national economy with EU regulatory conditions related to the 2030 climate and energy targets, the European Green Deal, the post-COVID economic recovery plan, and achieving climate neutrality within national capabilities. PEP2040 is one of nine integrated sectoral strategies stemming from the Strategy for Responsible Development until 2020, with a perspective until 2030, adopted in 2017. It aligns with the National Energy and Climate Plan 2021-2030, focusing on three pillars and eight specific objectives. The Polish Energy Policy until 2040 (EPP2040) emphasizes the importance of renovating buildings to enhance energy efficiency as a critical part of Poland's energy transition strategy. This policy outlines a comprehensive approach to reducing energy consumption in buildings and improving overall energy performance. The policy includes also measures such as modernizing heating systems, promoting high-efficiency cogeneration, and using renewable energy sources for heating.

3.5. The National Energy and Climate Action Plan 2021-2030

This national policy outlines objectives and actions to achieve the Energy Union's five dimensions: internal energy market, energy efficiency, decarbonisation, research, innovation, and competitiveness. It specifies measures for enhancing energy efficiency that public organisations can adopt, including the option to enter into energy efficiency contracts. Under this law, large enterprises within the private sector are obligated to conduct energy audits every four years. These regulations integrate EU directives (Directive (EU) 2018/2002 of 11 December 2018 amending Directive 2012/27/EU on energy efficiency) into Polish law, aiming primarily to achieve a 20% increase in energy efficiency across the EU by 2020. The 2020 amendment incorporated provisions from Directive (EU) 2018/2002, aligning with climate and energy targets for 2030, such as a 7% reduction in greenhouse gas emissions from sectors not covered by the ETS, and aiming for a 21-23% share of renewable energy sources in gross final energy consumption. The objectives for the long-term renovation of the national housing stock have been set out in the National Housing Programme:

- the share of insulated residential buildings in the total housing stock will be 70% in 2030 (compared to 58.8% in 2015),
- reducing the number of people living in sub-standard conditions due to overcrowding, poor technical condition or lack of technical installations to 3,300,000 in 2030 (from 5,360,000 in 2011).

3.6. Polish Long-Term Renovation Strategy

This policy includes the recommendations for shaping policies in building renovation and presents three scenarios for thermal efficiency improvements of the building stock until 2050 and also presented plans for the thermal efficiency improvements of the stock of residential and non-residential buildings, both public and private, which will aim to ensure the improvement of energy efficiency and low-carbon building stock, by enabling a cost-effective transformation of existing buildings into nearly zero-energy buildings

According to the proposed scenario, by 2050, 66% of buildings will achieve passive standard, and 21% will reach energy-saving standards. The remaining 13% of buildings, due to technical or economic constraints, will achieve an efficiency level defined by primary energy ratio values of 90-150 kWh/(m2·year). The scenario forecasts an average annual renovation rate of approximately 4%, with **deep thermal upgrades to the highest standards not exceeding 3% significantly before 2035**. Until then, efforts will focus on developing necessary competencies and technological solutions among suppliers. Economically feasible thermal efficiency improvements could potentially lead to final energy savings in residential buildings of up to 147 TWh, equivalent to about 75% of current final energy demand. In the case of public buildings, as mentioned above an estimated 45% underwent energy renovation by 2019, projected to rise to 55-60% by 2025.

3.7. Energy Performance of Buildings Directive (EPBD) transposition

In Poland, the commitments from EPBD are enclosed in the Energy Performance of Buildings Act, which sets the stage for assessing the energy performance of buildings, including renovated public buildings. The revision of the EPBD requires introducing a uniform scale of energy performance classes from A to G to provide clear benchmarks, with class A representing zero-emission buildings and class G covering the worst-performing 15% of the building stock. For public and non-residential buildings, the revised EPBD sets ambitious targets for energy performance improvements. Member states must ensure that these buildings achieve at least energy performance class E by 2027 and class D by 2030. This incremental approach aims to drive continuous improvements in energy efficiency, ultimately contributing to the broader goal of climate neutrality by 2050.

In Poland, the energy performance of buildings is assessed through mandatory energy performance certificates (EPCs). These certificates evaluate buildings based on their annual primary and final energy use, expressed in kWh/m²/year. There are two primary methodologies for calculating energy performance: one based on standard building use and another on actual energy consumption. This dual approach ensures a comprehensive evaluation of energy efficiency, accounting for both theoretical and practical energy usage patterns. In preparation for the implementation of the revised EPBD, Poland is developing a draft bill to amend the existing Energy Performance of Buildings Act. Poland is one of the last EU countries that has not yet introduced the division of residential buildings into classes. The Ministry of Development and Technology is working on this and has developed a methodology for practical division based on building databases, statistics, and historical data. They have outlined a concept for division and are planning to present this methodology for further debate. Additionally, the Ministry is establishing a new registry to integrate building information due to the absence of a comprehensive and accurate record of such data nationwide, currently relying on estimates.

In 2023, The Polish Energy Conservation Agency (KAPE) has proposed a new scale of energy performance classes tailored to residential buildings[9]. This scale serves as a preliminary framework that could be extended to public buildings, ensuring consistency in energy performance assessments across different building types (Table 5).

Table 5 Proposed values of the non-renewable primary energy ratio for introducing building energy classes - not approved by legislation[9]

Class	Single-family buildings	Multi-family buildings
A	0-63 kWh/m²/year	0-59 kWh/m²/year
B	63-157 kWh/m²/year	59-141 kWh/m²/year
C	157-250 kWh/m²/year	141-223 kWh/m²/year
D	250-344 kWh/m²/year	223-305 kWh/m²/year
E	344-438 kWh/m²/year	305-387 kWh/m²/year
F	438-531 kWh/m²/year	387-469 kWh/m²/year
G	over 531 kWh/m²/year	over 469 kWh/m²/year

The proposed classifications and legislative changes underscore the importance of energy performance in public building renovations. By adhering to these standards, Poland aims to enhance the energy efficiency of its building stock, reduce operational costs, and contribute to environmental sustainability. The rigorous assessment and certification process ensures that renovated public buildings not only meet current standards but are also positioned to achieve higher energy performance levels in the future.

3.8. Overview of existing financial schemes

Poland is the largest recipient of EU Cohesion Policy Funds and dedicates a significant portion to energy efficiency (approximately €3 billion was allocated for this purpose for the period 2014-2020)[10]. Several financing schemes in Poland support the enhancement of energy efficiency in residential buildings. The National Fund for Environmental Protection and Water Management (NFOŚiGW) and the Voivodeship Funds for Environmental Protection and Water Management (WFOŚiGW) administer several programs for residential buildings[4]. Many of these programs are detailed below:

Dom z klimatem - The project aims to increase the number of zero-energy buildings, 3 million replaced heat sources in households by 2030 and 1,000 low-carbon public buildings by 2030.

FEnIKS - The main goal of the program is to improve the country's development conditions through the construction of technical and social infrastructure in line with sustainable development. Implementation of the program aims to increase the energy efficiency of housing, public buildings and businesses, and increase the share of green energy from renewable sources in final energy consumption. Investments in energy infrastructure are intended to improve the quality and operational security of electricity grids, as well as the development of smart heat grids and their increased importance in a modern, green energy system.

Czyste Powietrze (Clean Air) - The main objective of the programme is to improve air quality by reducing emissions of particulate matter and other pollutants into the atmosphere and to improve energy efficiency and the use of renewable energy sources in single-family buildings, as well as to enable the widest possible local access to financial support for residents, including the eradication of fuel poverty.

Stop Smog - The 'Stop Smog' programme is aimed at energy-poor people living in single-family houses. The programme is aimed at all municipalities that can demonstrate poor air quality in their area, i.e. concentrations of air pollutants exceeding EU standards.

Mój Prąd (My Power) - The programme is one of the largest European funding programmes for micro photovoltaic installations for individuals. The aim of the programme is to reduce CO2 emissions and increase the electricity generation capacity of domestic photovoltaic installations.

Energy Consultancy Project - The project 'Nationwide system of advisory support for the public, housing and business sectors in the field of energy efficiency and RES' is a project implemented by the National Fund for Environmental Protection and Water Management (NFOŚiGW) and Partners in 16 regions across the country.

The Thermo-renovation and Repairs Fund – this fund is administered by the National Economy Bank (BGK), offers grants for the renovation and reparation of existing buildings and targets mostly multi-family and public buildings. The primary objective is to provide financial assistance to investors carrying out thermal efficiency improvements, renovation or refurbishment projects of existing residential buildings with the help of loans taken from commercial banks.

Regional Funds supplied from Poland's recovery and resilience plan – these funds for thermal efficiency improvements of residential buildings are intended for comprehensive, deep energy modernisation of multi-family residential buildings, with a preference for measures aiming for a 60% energy saving rate only in specific regional cases.

The thermo-modernisation allowance - an instrument aimed at a wide group of taxpayers who own single-family buildings and have sufficiently high incomes to make the deduction an attractive incentive. In other words, this instrument probably does not contribute to reducing fuel poverty levels, but it should stimulate renovation and thermal efficiency improvements spending among the Polish middle class.

4. ASSESSMENT OF ENERGY PERFORMANCE OF RENOVATED PUBLIC BUILDINGS

4.1. Assessment of energy performance of renovated public buildings at national level

Key elements of Polish regulations concerning building energy efficiency include:

- Energy certification of buildings: every newly constructed building or building undergoing major renovation must possess an energy certificate that informs about its energy efficiency based on calculated energy consumption.
- Minimum energy efficiency requirements: there are specific minimum energy efficiency standards that new buildings must meet. These requirements vary depending on the type of building (e.g., residential, public utility) (see chapter 3.2.)
- Financial support programs: Poland implements various financial support programs such as grants and preferential loans aimed at supporting investments in improving the energy efficiency of buildings, including public buildings.

4.2. Energy performance of buildings in Poland

In Poland, a central registry of the energy performance of buildings is maintained and overseen by the Minister of Development and Technology, who is responsible for construction, spatial planning, and housing. This public database collects information regarding the energy performance certificates of buildings located in Poland. The central registry of the energy performance of buildings includes the following listings:

- individuals authorized to issue energy performance certificates;
- individuals authorized to inspect heating or air conditioning systems;
- energy performance certificates;
- inspection reports of heating or air conditioning systems;
- buildings with a usable floor area of over 250 m² occupied by judicial bodies, prosecutors, and public administration bodies where public services are provided, including information about their energy performance and floor area.

The registry can be accessed by:

- building owners and managers, which must ensure the timeliness and availability of their buildings' energy certificates in the registry.
- state institutions to monitor and evaluate the energy efficiency of buildings and to develop energy policies and strategies.
- energy consultants, which use the registry to analyze data on the energy performance of buildings to provide energy efficiency advice.

There is no possibility of accessing aggregated data regarding public and residential buildings in Poland. The database contains many errors and inaccuracies related to data entry and the quality of energy audits performed. These issues are well-known and have been raised by the Association of Energy Certifiers and Auditors.

4.3. Data available on national level

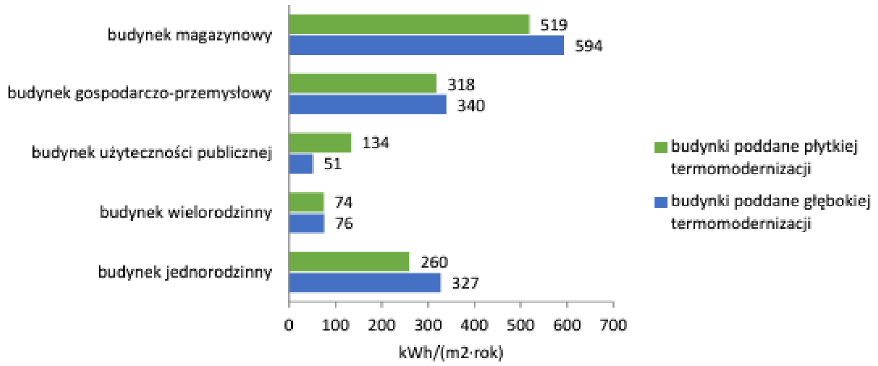
From research conducted in 2019 as part of the research project (included in Polish LTRS)*: Development of methodology and implementation of a study on the scale of thermal efficiency improvements actions in multi-family residential buildings to improve their energy efficiency and assessment of needs and planned actions in this direction* by the Central Statistical Office (GUS), in which respondents (owners or managers of buildings) owning or managing 189,289 buildings participated, it appears that:

- 60.7% of multi-family residential buildings do not require thermal efficiency improvements, including 29.7% due to previous thermal efficiency improvements work completed by 2016, and 31.0% due to lack of necessity for thermal efficiency improvements (e.g., buildings constructed using energy-efficient technologies).
- 39.3% of multi-family residential buildings require thermal efficiency improvements to bring their technical condition up to contemporary energy standards, including 9.4% of buildings where thermal efficiency improvements is underway or planned for the years 2017-2020, and 29.9% where it is not planned.

In Polish Long-Term Renovation Strategy presented the scope of shallow and deep thermal efficiency improvements actions using real building examples and two types of modernisation (deep and shallow) for five types of buildings:

- Single-family homes,
- Multi-family residential buildings,
- Public utility buildings,
- Commercial-industrial buildings,
- Warehouse buildings.

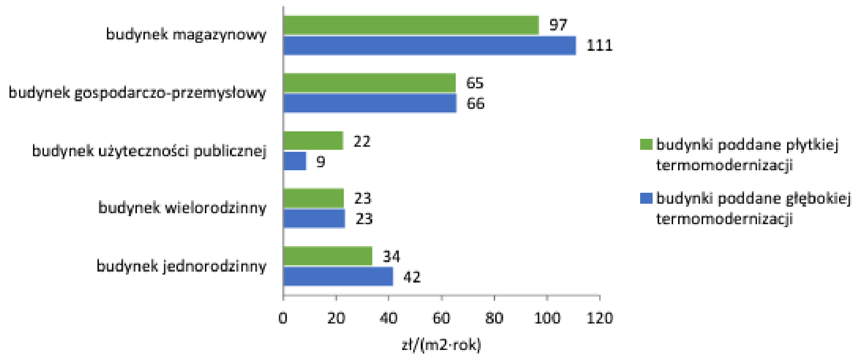
One of the most important analyses carried out for these buildings is the calculation presented in Figures Figure 3, Figure 4 and Figure 5 below.



Source: 'Ekspertyza w zakresie określenia opłacalnych podejść do modernizacji właściwych dla danego typu budynków i strefy klimatycznej', KAPE 2020.

budynek magazynowy	warehouse building
budynek gospodarczo-przemysłowy	utility-industrial building
budynek użyteczności publicznej	public building
budynek wielorodzinny	multi-family building
budynek jednorodzinny	single-family building
kWh/(m2·rok)	kWh/(m2·year)
budynki poddane płytkiej termomodernizacji	buildings which have undergone shallow energy renovation
budynki poddane głębokiej termomodernizacji	buildings which have undergone deep energy renovation

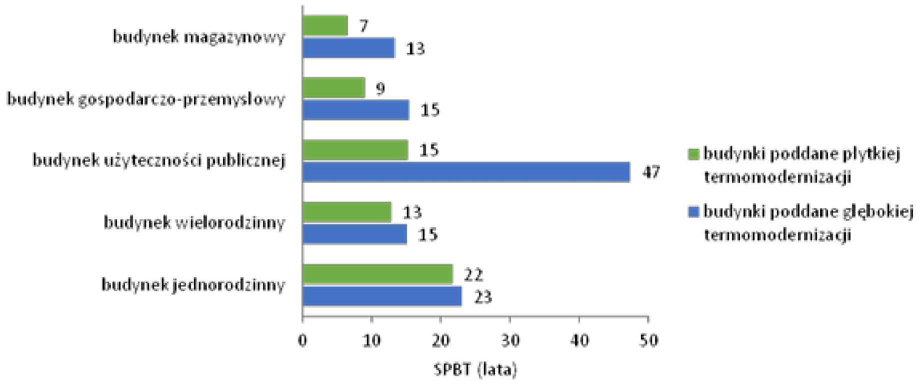
Figure 3 The final energy savings in the buildings analysed after shallow and deep energy renovation



Source: 'Ekspertyza w zakresie określenia opłacalnych podejść do modernizacji właściwych dla danego typu budynków i strefy klimatycznej', KAPE 2020.

budynek magazynowy	warehouse building
budynek gospodarczo-przemysłowy	utility-industrial buildings
budynek użyteczności publicznej	public buildings
budynek wielorodzinny	multi-family buildings
budynek jednorodzinny	single-family buildings
zł/(m2·rok)	PLN/(m2·year)
budynki poddane płytkiej termomodernizacji	buildings which have undergone shallow energy renovation
budynki poddane głębokiej termomodernizacji	buildings which have undergone deep energy renovation

Figure 4 Cost savings in the buildings analysed after shallow and deep energy renovation



Source: 'Ekspertyza w zakresie określenia opłacalnych podejść do modernizacji właściwych dla danego typu budynków i strefy klimatycznej', KAPE 2020.

budynek magazynowy	warehouse building
budynek gospodarczo-przemysłowy	utility-industrial buildings
budynek użyteczności publicznej	public buildings
budynek wielorodzinny	multi-family buildings
budynek jednorodzinny	single-family buildings
SPBT (lata)	SPBT (years)
budynki poddane płytkiej termomodernizacji	buildings which have undergone shallow energy renovation
budynki poddane głębokiej termomodernizacji	buildings which have undergone deep energy renovation

Figure 5 Simple payback times (SPBT) for shallow and deep energy renovation as exemplified by the buildings analysed

This analysis show that:

- Deep energy renovation generates higher energy savings (10%) than shallow thermal efficiency improvements. The public buildings, namely primary school (shallow energy renovation) and hospital (deep energy renovation), are specific cases in this analysis. Given the relatively late year when the hospital was erected (2002), the savings per square metre gained are much lower than in the primary school (1974), which has only undergone shallow energy renovation. The above shows that a greater energy effect can be achieved for older buildings. It follows from the analysis that potential for energy savings exists not only in residential buildings, but also in commercial-industrial buildings.
- The relations between cost savings generated by shallow energy renovation and deep energy renovation and cost savings from one building to another are similar as in the case of energy savings. This reveals a close relationship between energy savings and savings on the costs of energy purchase.
- Simple payback time for renovation will vary strongly depending on the type of building, its location, year of erection, technical condition, amount of CAPEX, current and future prices of energy carriers. However, it can be assumed that for residential buildings, energy renovation will pay off after 10-25 years, and for industrial and utility buildings after about 5-15 years. As can be seen in the charts above, for some public buildings the SPBT can be up to 50 years.

In the Polish LTRS, energy renovation (investment) is considered as cost-effective if the cost of 1 GJ (277.78 kWh) of final energy savings, assuming that the outcomes of the energy renovation investment last fifteen years and that the prices on the investment completion date remain stable, is lower than the cost of 1 GJ (277.78 kWh) of final energy consumed before the renovation. The cost of energy savings gained as a result of energy renovation, depending on its scope and existing heat source, may be lower than the energy price, which makes energy renovation economically viable. However, in some cases (in fact, only when buildings use cheap energy), despite the achievement of high energy and environmental efficiency, the viability of the investment may be questionable. The efficiency of energy renovation is much higher when its scope includes replacement of the heat source and of the central heating system (of course, if it is technically or economically viable).

According to the LTRS, the deep thermal efficiency improvements of these buildings will include at least:

- insulation of the envelope, together with the removal of asbestos-containing products and the selection of materials used in such a way as to reduce the built-in emissions generated during their manufacture,
- replacement of window and door joinery.

In the case of electrically heated buildings, deep thermal efficiency improvements include the replacement of the heat source with a heat pump.

For district heating and electrically heated buildings, as a result of deep thermal efficiency improvements, the target final energy rate for heating, ventilation and domestic hot water preparation should be no more than 60 kWh/(m2 -year). In contrast, for heat pump buildings and buildings which have a heat pump installed as a result of deep thermal efficiency improvements, the target final energy rate for heating, ventilation and domestic hot water preparation shall be no more than 30 kWh/(m2-year). Table 6 shows the difference in pre-renovation final energy benchmarks for buildings with these two different types of heating supply, as per the Polish LTRS.

Table 6. Pre-renovation final energy (FEF) for the buildings analysed in LTRS

Pre-renovation condition	Pre-renovation FEFs for the buildings analysed	
	Buildings supplied by a district heating network and electrically heated	Buildings supplied by heat pumps
Critical	300 kWh/(m²·year)	150 kWh/(m²·year)
Very poor	250 kWh/(m²·year)	125 kWh/(m²·year)
Poor	200 kWh/(m²·year)	100 kWh/(m²·year)
Average	150 kWh/(m²·year)	75 kWh/(m²·year)

The data available at the national level in Poland does not allow an analysis at a deeper level of detail. Existing databases on energy consumption in buildings or their energy performance are not ideal or complete. The relevant authorities are working on the development of a new solution/tool that could improve the collection and analysis of data on this topic, while at the same time allowing the Polish state to implement a scale of energy classes for buildings, which is still awaited.

4.4. Deeper analysis of energy renovated public buildings on a local level to address the underperforming energy renovations issue

Given the lack of data on renovation performance at national level, an approach to assessing the magnitude of the challenge in Poland is to use case studies of specific municipalities or buildings. For this analysis, energy consumption data from a public utility building located in Czasław, Raciechowice municipality, were utilized. Detailed information regarding energy consumption before and after the modernisation, as well as its impacts, are presented below. These data have been compiled to provide a comprehensive assessment of the building's energy efficiency based on the consumption of various types of fuels used before and after the modernisation.

The building owned by the Volunteer Fire Department (OSP) in Czasław serves as a typical example of public utility buildings commonly found in towns and cities across the region. These facilities are integral to community safety and emergency response, embodying a standard usage profile for such establishments. Throughout the different phases of modernisation, the building continued to house the same fire service unit, ensuring that the usage profile remained consistent.

The OSP Czasław building originally utilized an oil boiler installed in 1996. As part of the comprehensive modernisation efforts, a high-efficiency condensing gas boiler was installed. During the initial year of operation, liquefied gas cylinders were used, and following the completion of the gas network connection, the system was transitioned to natural gas supply. Despite the deployment of a boiler with superior efficiency (currently achieving 109% efficiency compared to 91% when the oil boiler was new), there has been an unexpected increase in energy consumption.

All renovation activities aimed to enhance the energy performance and operational reliability of the heating system. The new condensing gas boiler is designed to recover additional heat from the exhaust gases, significantly improving overall energy efficiency. The shift from oil to gas not only aligns with contemporary environmental standards but also reduces the carbon footprint of the facility.

Initial observations and above analysis indicate that while the system's efficiency has markedly improved, further analysis is required to understand the factors contributing to the increased energy usage. Potential areas of investigation include the operational settings of the new system, changes in building usage patterns, or possible inefficiencies in the existing infrastructure that may need addressing. This modernisation activities underscores municipality’s commitment to sustainable practices and the continual improvement of their facilities.

The above case study shows that it is necessary in Poland to examine the case of unaffected renovations of public buildings in more depth, using data gained from more detailed analyses. This should involve a comprehensive evaluation of current renovation practices, an assessment of the efficiency and cost-effectiveness of these projects, and an understanding of the potential benefits and challenges associated with them. Due to the lack of a nationwide database to determine the status of the effectiveness of renovations carried out in buildings (even more so in public buildings) and available to the public, it will be necessary to carry out an in-depth analysis during the assessment of the buildings selected for the preparation of building renovation roadmap as part of the subsequent activities foreseen in the OUR-CEE project.

In Poland, the following approach will be used to make the necessary analysis:

1. Identify public buildings at the municipal level that have undergone the energy renovation process.
2. Compare the energy savings calculations from their respective master project documentation with the building code requirements for the specific type of building (mostly educational buildings such as schools and kindergartens).
3. Use primary energy as the main indicator for comparison.
4. If the calculated primary energy of renovated buildings is lower than the maximum allowed primary energy defined by the building code, conclude that the energy renovations are underperforming.
5. Conduct a detailed analysis of specific buildings to compare their calculated energy savings with real consumption data in the years following the renovation.
6. To avoid climate impact (different number of heating days), adjust the number of heating degree days in the years after the renovation to the number of heating degree days in the reference year before the renovation, allowing for a comparison of consumption values without climatic influences.
7. First, compare the calculated energy consumption with the real energy consumption for the reference year before the energy renovation to detect if there are any significant differences between these two values (determining possible reasons for not achieving expected savings).
8. Then compare the calculated energy consumption with the real energy consumption in the years after the renovation.

5. IDENTIFICATION OF POSSIBLE REASONS BEHIND UNDERPERFORMING RENOVATIONS IN PUBLIC BUILDINGS

Due to the variety of reasons, the renovation process of buildings can be carried out inefficiently. We can distinguish two main types of causes: **execution-related and regulatory issues.** Each of these carries potential risks and challenges that can lead to failure in achieving energy efficiency goals.

5.1. Human factors - inadequate quality of project development and insufficiently conducted research on the energy status of the building.

Before starting a renovation project, it is essential to prepare an appropriate energy model of the building that accurately reflects current energy consumption by its users and appliances. Improper energy modelling during the design phase is one of the primary issues. Lack of precise energy simulations and analyses, as well as neglecting the building's occupancy schedule by its users, can lead to erroneous assumptions about energy savings. For instance, incorrect modelling may result in planned heating, ventilation, or cooling systems being insufficiently effective under real operational conditions and peak energy consumption hours. In Poland, for example, when funds are made available to support renovations, often there is no energy audit conducted or it is hastily prepared, especially in smaller regional funds where such audits have not been a requirement so far.

Another problem is the improper authorisation of prepared projects. Projects may be approved without sufficient verification of compliance with regulations and technical requirements, potentially accepting projects that do not meet energy efficiency standards. Due to time pressure, research or projects are often conducted by inexperienced individuals and are not adequately verified or verified at all.

5.2. Human factors - lack of specialized knowledge and non-compliance with regulations during execution.

Errors during construction can significantly reduce the energy efficiency of the building. Improperly selected construction teams without experience may lead to improperly installed thermal insulation or heating systems, resulting in substantial energy losses. On the other hand, due to cost reduction concerns, decisions affecting the selection of materials and systems not in line with the project specifications can also affect the final energy efficiency of the building. Moreover, non-compliance with the project and building regulations, such as ignoring thermal insulation thickness regulations, can also result in failure to achieve the expected energy savings. Lack of proper supervision from relevant units or investors further exacerbates these problems.

5.3. Human factors - lack of awareness among building users and building managers.

Despite many years of education promoting ecological efficiency, many people are unaware of how much their behaviour affects energy consumption levels. Daily habits and behaviours of users, such as leaving lights and electrical appliances on, can increase energy consumption even in buildings designed to be energy-efficient. This lack of awareness can result in increased strain on the system, which was not anticipated in the project, significantly affecting efficiency.

Additionally, the lack of an installed energy consumption monitoring system is a serious issue because without regular monitoring, it is difficult to detect and correct inefficiencies in building use. This issue also contributes to inadequate building management. Without an appropriate management system, administrators cannot improve energy efficiency. Furthermore, the lack of regular inspections and maintenance of heating, ventilation, and cooling systems can reduce their effectiveness, leading to failure to achieve energy targets.

5.4. Legal regulation environment – lack of ambition

Due to the lack of ambition in national law and the absence of appropriate regulations strictly regulating the need to achieve specific energy savings, renovations are often carried out concerning only individual elements of building modernisation, without a comprehensive approach. Unfortunately, deep renovations are not carried out and the verifiability of planned savings is often not checked, so the investor, administrator, or contractor does not feel or is not responsible for the inadequate or poorly designed renovation. Currently, none of the major national wide support programs have assigned requirements that guarantee comprehensive and deep energy modernisation of buildings consistent with EU climate-energy goals for 2030 and 2050. In programs where minimal requirements for improving energy efficiency are applied, they are set at a level of 25-30%, failing to provide additional incentives for deeper or more comprehensive modernisation of buildings. At the same time, some programs do not specify criteria for minimum energy savings or delay decisions in this area until the future.

5.5. Legal regulation environment – lack of holistic approach and matching available funds

Investors responsible for renovating public buildings, mostly municipal offices or municipalities, face the problem of inadequate matching of offered financial support to local needs. This leads them to adjust their needs to currently available financial resources, sometimes conducting modernisations that bring estimated small energy consumption reduction benefits compared to the costs incurred and cannot approach building improvement in a holistic way. They do not have sufficient resources to carry out deep thermal efficiency improvements, start without a plan, and guaranteed funds for further implementation. It sometimes happens that when replacing a heat source, basic thermal permeability conditions for building partitions are not met, and the new thermal system cannot work effectively, and the costs of energy consumption do not decrease at all but rather grows.

6. POLICY RECOMMENDATIONS TO OVERCOME THE ISSUE OF UNDERPERFORMING RENOVATIONS IN PUBLIC BUILDINGS

Several key recommendations for changes have been identified to close gaps in the national system supporting the effectiveness modernisation of public buildings:

6.1. The necessity of introducing unified and ambitious guidelines regarding the standard for public building modernisation is paramount.

Introducing unified and ambitious guidelines for public building modernisation is crucial to ensure consistent and effective improvements across the building stock. These guidelines should establish clear and measurable standards for energy efficiency, specifying the required performance levels for various types of public buildings. They should also include best practices for the design, implementation, and monitoring of renovation projects to ensure that they meet the desired energy performance outcomes. By providing a standardized framework, these guidelines will help streamline the modernisation process, reduce discrepancies in renovation quality, and ensure that all public buildings achieve significant energy savings. Furthermore, the guidelines should be regularly updated to incorporate the latest technological advancements and reflect evolving climate goals, thereby ensuring that public buildings are continuously improved to meet the highest standards of energy efficiency.

6.2. Leveraging private sector resources and alternative financing methods for public building thermal efficiency improvements

Understanding the scale of challenges associated with conducting deep and comprehensive thermal efficiency improvements, it will also be necessary to involve private sector resources. Therefore, attention should be paid to alternative methods of financing public building thermal efficiency improvements. One approach to increase financing accessibility is through investments in energy efficiency utilizing public-private partnerships in ESCO (Energy Service Company) arrangements. While this instrument has not been widely used to date, its promotion could be influenced by initiatives currently being implemented by the NFOŚiGW (National Fund for Environmental Protection and Water Management) and PFR (Polish Development Fund), drawing on experiences from other European countries.

6.3. The need for implementing a data management system to identify public building renovation needs is critical.

The next challenge lies in the absence of a structured process for monitoring the renovation needs of public buildings. While a system for collecting information on heating sources (CEEB) has been introduced, the data gathered under this initiative does not encompass information on energy efficiency. Streamlining the process of collecting, analysing, and utilizing information about energy consumption in public buildings would not only facilitate strategic renovation planning but also simplify the aggregation of projects, thereby enabling easier access to necessary funding. Currently, individual projects face high operational costs due to their small scale and dispersed nature, making it difficult to demonstrate the profitability of proposed actions and garner private investor interest.

Aggregating various thermal efficiency improvements activities for public buildings, including those undertaken by different owners, into a single investment package would increase participation from the financial sector and secure more favourable financing terms. However, effective project grouping depends on the coordinating entity having access to necessary data for aggregating buildings with similar characteristics or investment needs. Therefore, widespread adoption of this solution largely hinges on streamlining the data management process, which is currently not systematically collected and processed.

6.4. Addressing capacity gaps in public building renovations.

A significant challenge in improving the thermal efficiency of public buildings is the limited capacity of public administration employees, for whom energy efficiency is just one of many responsibilities. This lack of dedicated resources and expertise hinders the effective implementation and monitoring of comprehensive energy modernisation projects. Public administrators often lack the necessary knowledge and skills to carry out these renovations, which is particularly problematic in unconventional cases such as historic buildings. While historic buildings do present unique challenges due to their specific construction characteristics and the need to preserve their historical value, they are only a small part of the overall problem. The broader issue lies in the general capacity gaps within public administration to manage and execute energy efficiency improvements effectively. Addressing these gaps requires targeted training and capacity-building initiatives to equip public sector employees with the skills and knowledge needed for successful energy renovations. This approach will ensure that all public buildings, not just historic ones, can achieve significant energy performance improvements.

6.5. Introduction of the energy class system

Recommendations for implementing changes in the energy class system of buildings include cooperation between the Ministry of Development and Technology and the Ministry of Climate and Environment. Initially, it is recommended to prepare a project for the energy class system. Subsequently, immediate implementation of the final version of the energy class system is recommended after incorporating the final shape of the amended EPBD directive and considering national stakeholders' feedback. Work on the national energy class system should commence within the next year, with full implementation targeted within three years. Utilizing own funds of public administration units is recommended as the main source of financing for the initiative. Effective implementation of these recommendations will contribute to increasing the energy efficiency of buildings, which is crucial for achieving sustainable development goals and reducing greenhouse gas emissions.

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