OUR-CEE
Overcoming Underperforming Renovations in Central and Eastern Europe

Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag
European Climate Initiative EUKI

OUR-CEE

(Overcoming Underperforming Renovation in Central and Eastern Europe)

National baseline assessment on underperforming renovations

Romania

Author(s): Energy Policy Group

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).

July 2024

EPG EnEffect Regional Energy Agency North POLSKA SIEĆ Energie Cités

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. EXECUTIVE SUMMARY

The renovation of the building stock is one of the key target sectors for energy and CO_2 reduction at the EU level. Despite policy efforts, the wide range of regulatory measures, financial instruments, and initiatives that have resulted in notable technical improvements to the building stock, the energy consumption, in both public and residential sectors, has not yet experienced the dramatic reduction necessary to achieve set targets. One of the cornerstone policies aimed at reducing the energy consumption of the building stock, the Energy Performance of Buildings Directive (EPBD), introduced the requirement for Member States to establish certification (energy performance certificates) and energy labeling schemes for existing buildings to indicate their energy performance, as well as a common framework for the calculation of buildings' energy performance.

In Romania, the Long Term Renovation Strategy is the main document aiming to transform the national building stock to meet energy efficiency standards by outlining specific actions and targets for both public and residential buildings. It introduces the cost-optimal renovation packages to ensure economical viability of energy efficiency renovation measures, for all types of public buildings, educational, healthcare, administrative, commercial buildings, all of which would be able to achieve deep renovation standards.

The performance of the building stock in Romania has been steadily, albeit slowly, improving, and some progress has been made in achieving renovation targets. However, there are significant challenges for the Romanian renovation sector to achieve the energy savings potential. Although the Romanian policy landscape and legal frameworks have established specific standards and measures for energy performance in the renovation sector, achieving these standards has encountered various barriers, related to national energy performance calculation methodologies, knowledge gaps about the national building stock, monitoring and evaluation practices, and certification processes, poor management and use of buildings post-renovation. To overcome these barriers and accelerate the rate and quality of the energy efficiency renovations, it is essential to improve the national building stock knowledge base, establish robust monitoring and evaluation frameworks to ensure that energy performance targets are met and that the actual energy savings align with predicted outcomes, enhance the administrative capacity at both national and local levels. Finally, increasing awareness and knowledge about energy efficiency among building occupants will help mitigate issues related to occupant behavior that impact energy consumption.

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[i] "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 decarbonization 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.

3. OVERVIEW OF THE NATIONAL BUILDING STOCK AND RELATED POLICIES

This section provides an overview of the Romanian building stock, detailing building types and their characteristics in terms of age, energy consumption, and carbon emissions. It examines the relevant national policies, legislative frameworks, and financing programs that impact energy efficiency renovations. Furthermore, it assesses the effectiveness of these policies and programmes in addressing national specificities and realizing the energy-saving potential at the building stock level, with a particular focus on public buildings.

3.1. Overview of the national building stock

In Romania, there is no comprehensive, publicly available, and up to date database at the national level which can offer an in-depth picture of the building stock and its performance. Essential information such as construction materials, occupancy rates, energy consumption, a status of renovation activities as well as implementation of energy-saving measures, the share of Near Zero Energy Buildings (nZEB)[1] in the total construction market are outdated, missing, or fragmented across several authorities.

The information below has been retrieved from several sources: the 2020 National Long Term Renovation Strategy (LTRS), Building Stock Observatory (BSO), Eurostat, and National Institute of Statistics. LTRS and BSO provide information about the number of buildings, construction periods, building categories, and built areas, while Eurostat offers information on the building stock energy consumption.

3.1.1 Total gross floor area

According to LTRS, the Romanian building stock totals 5.6 million buildings, of which 5.3 million are residential buildings, covering a total gross area of 582.27Mm^2, and 242.5 thousands are public and commercial buildings, covering a total gross area of 62Mm2.[ii] Somewhat similar numbers of the building stock are provided by the Building Stock Observatory which reports a total floor area of 584.4 Mm^2 of which 567.9Mm^2 are residential areas and 82.5Mm2 are non-residential (public and commercial buildings) areas. These numbers are expected to increase, considering the general trends in construction activities. Between 2016 and 2022, new builds, renovations, and capital refurbishments have increased in Romania, with the most significant growth observed in new builds activities, as illustrated in Figure 1.

[1] The nZEB buildings, as defined in the Energy Performance of Buildings Directive (EPBD) are very high energy performance, where the nearly zero or very low amount of energy required should be largely met by renewable sources, including those produced on site or in the vicinity.

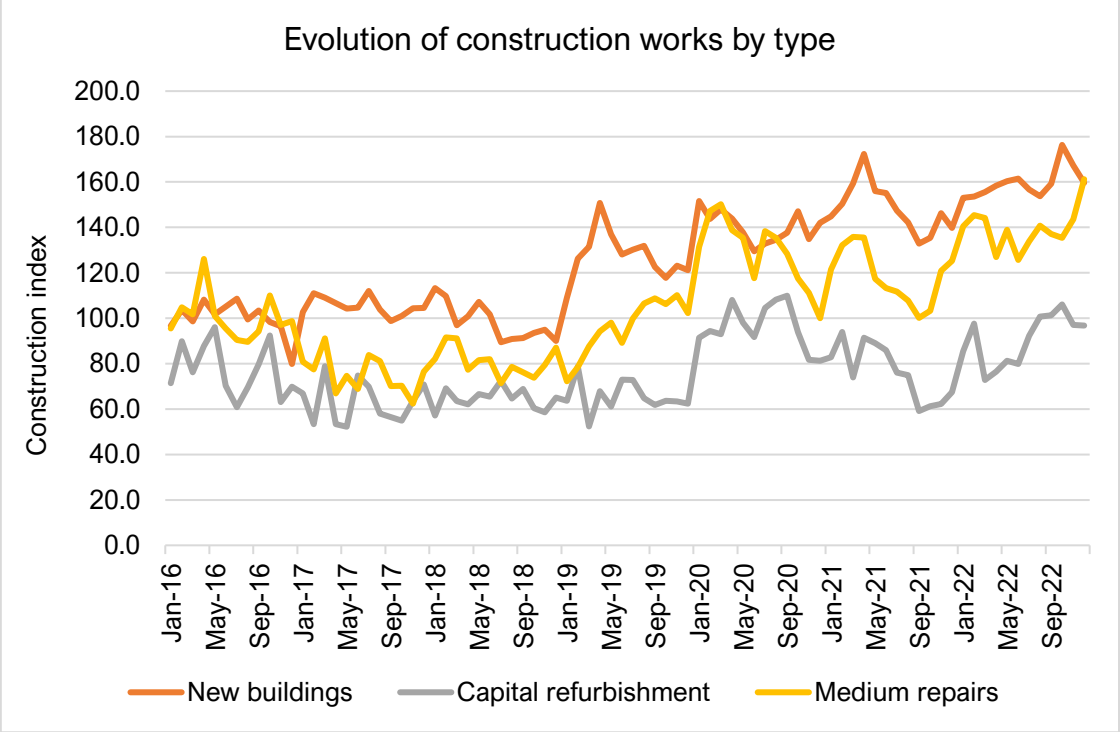

Figure 1: Evolution of construction works by type
Source: National Institute of Statistics, 2022

3.1.2 Building stock categories by purpose

The building stock is grouped into residential, which includes single family houses (rural and urban), multi-family dwellings, and non-residential, which includes educational buildings, hospitals, health establishments and social housing, offices, warehouses, hotels, restaurants and shops. Residential buildings cover 90% of the building stock, with the Single Family Houses (SFM) being by far the most dominant building type. The public building sector, with a total share of 9.62% of the building stock, consists of commercial (4.17%), education and healthcare (4.15%) and offices, which have the lowest share, as shown in Table 1.

Table 1: Number of buildings, floor area, and share in the building stock, per building type

	Building types	No. of buildings	Floor area (Mm2)	Areas share in the building stock (%)
Residential	Total	5 318 886	582.27	90.38%
	Single Family Houses	5 165 00	372.26	58%
	Multi Family Houses	153 866	210.02	33%
Public buildings	Total	242 455	62.01	9.62%
	Public (education, healthcare, social housing)	69 313	26.77	4.15%
	Offices	7 500	8.36	1.3%
	Commercial[2]	165 642	26.88	4.17%

Source: Romanian Government, LTRS, 2020

[2] The Romanian Long Term Renovation Strategy includes in the commercial building type the following categories: hotels, restaurants, cafes, and shops

3.1.3 Building stock categories by year of construction

The building stock is old and in need of renovation, with the largest part being built between 1960 – 1989. 31% of the building stock is built before 1961[iii], and considered for listing in the national preservation acts. Only a portion of this building stock is designated as national heritage assets and, therefore, exempt from the general energy efficiency regulations for renovations. Furthermore, one of the characteristics of the Romanian building sector is its exposure to seismic risk.

Both the residential and the public buildings sector have been considerably expanded during 1945 – 1969 with a total covered area constructed that is more than triple than the average in other time periods, in the overall timespan frame of 1850-2021, as shown in Figure 2.

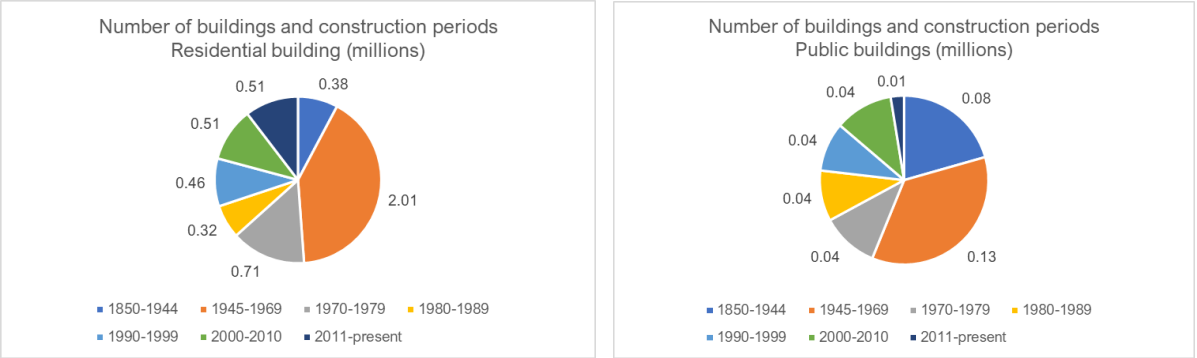

Figure 2: Number of buildings and their construction periods
Source: Building Stock Observatory, 2023

3.1.4 Building stock energy consumption and energy performance

Buildings play a critical role in contributing to greenhouse gas (GHG) emissions at the national level, with a share of 42% of the total final energy consumption, equivalent to 9.52 million tonnes of oil equivalent (Mtoe) out of a total of 22.86 Mtoe. The residential and public buildings sectors together account for 40% of Romania's gas demand, 50% of electricity demand and 74% of district heating demand. The sector study in the LTRS shows that the final energy consumption for residential buildings accounts for 81% of the aforementioned number, while public and commercial buildings are accountable for 19%.

As illustrated in Figure 3, data on energy consumption between 2015-2021 shows that the residential energy consumption, significantly increased during COVID -19 pandemic, compared to pre-pandemic levels, mainly as a result of people working and studying from home. By contrast, public and commercial buildings experienced a decrease in energy consumption during the same period, most likely due to decreased occupancy and operational hours. Overall, final energy consumption in buildings has increased in Romania from 2016 until 2021.

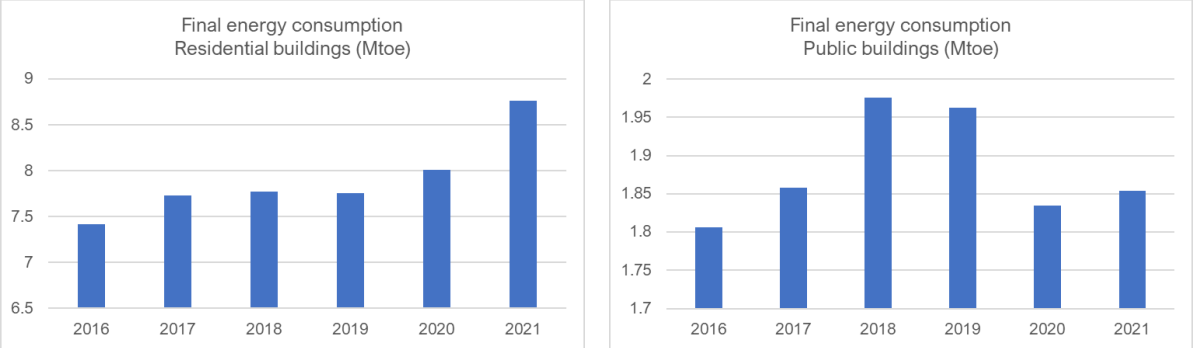

Figure 3: Final energy consumption in public and residential buildings
Source: Building Stock Observatory, 2023

Buildings' energy performance, however, is measured in terms of primary energy consumption and carbon emissions, and further categorized into energy classes, based on the national calculation methodology. The national energy class labeling scheme, introduced in 2023, differentiates between building typologies, residential and public. On the public buildings category, the rating values for each energy class are different for office buildings, education, healthcare, commercial, tourism, and sport, further detailed in Table 2.

Table 2: Energy classes ratings per building typology

Building typology	Primary energy, kWh/m2,year							
	A+	A	B	C	D	E	F	G
Single family houses	≤91	91-129	129-257	257-390	390-522	522-652	652-783	>783
Collective housing	≤73	73-101	101-198	198-297	297-396	396-465	495-595	>595
Office	≤68	68-97	97-193	193-302	302-410	410-511	511-614	>614
Educational	≤48	48-68	68-135	135-246	246-358	358-447	447-536	>536
Healthcare	≤117	117-165	165-331	331-501	501-671	671-838	838-1005	>1005
Commercial	≤88	88-124	124-248	248-320	320-393	393-492	492-591	>591
Tourism	≤67	67-93	93-188	188-321	321-452	452-565	565-678	>678
Sport	≤75	75-104	104-206	206-350	350-494	494-617	617-741	>741

Source: MDPWA, Mc-001-2022, 2023

3.1.5. *Share of nZEB*

As of 2016, there is no publicly available or relevant and up-to-date data regarding the number of nZEB buildings in Romania. Based on the latest reports[iv], submitted in 2016, the nZEB development within the total construction market in the country, was registered as the

one of the lowest among the Member States, with 13% share of nZEB buildings, as shown in Figure 4.

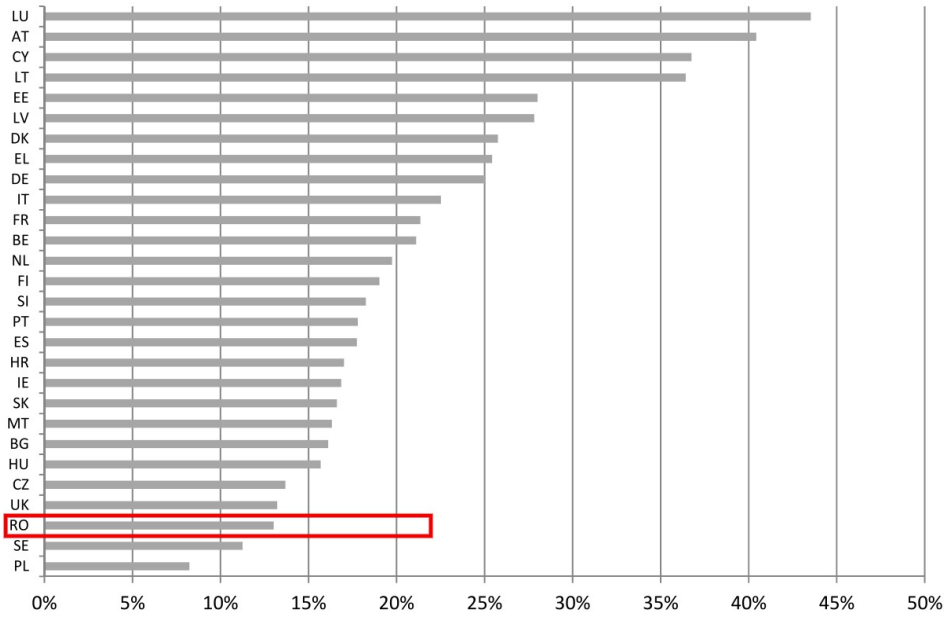

Figure 4: Share of nZEBs in the total construction market of Member States
Source: D'Agostino, Delia, et al., 2021[v]

However, there is a considerable number of new buildings and refurbishments that have been certified as "green buildings", under voluntary certification schemes, such as BREEAM, LEED or Passive House. In 2022 the number of BREEAM or LEED certificates reached a peak number of 154 buildings, and 128 buildings in 2023, ranking third in Central and Eastern Europe region, in terms of the total certificates issued[vi]. The most predominant types of developments that were certified were industrial, commercial and office buildings[vii]. In 2023, the first certificates for public buildings were issued, for both new buildings and refurbishments. Furthermore, by 2024, 28 buildings, including refurbishments, received the Passive House certificate. [viii]

3.2. Overview of the national public building stock

3.2.1 Characteristics of the public building stock

Romania has a total of almost 90000 public buildings that are owned by central and local administrations, of which most are healthcare and education, as shown in Table 3. Central government owns 3087 and local administration more than 80000 buildings. The highest rate of achieved renovation is for education buildings (15% by 2020). There is no available data for cultural and sports public buildings.

Table 3: Breakdown of public buildings by branches and share of renovations by 2020

Destination	Number of buildings [units]	Renovated by 2020 [%]
Central government buildings	3087	5%
Local administration	3271	5%
Education	23031	15%
Healthcare	51269	1%
Culture	4342	-

Sport	4700	-

Source: MDPWA, 2021

Among the various building types presented in Table 3, only central government buildings have a published registry. This registry includes detailed information on their construction year, construction materials, height, heating equipment, energy carriers, and final energy consumption[ix].

Table 4 below outlines key energy performance indicators and U-values for different types of public buildings in Romania, highlighting significant variations in energy consumption and thermal performance across building types. The thermal transmittance (U-value), which quantifies the rate of heat transfer through building materials, indicating how well a building retains heat, for both vertical and horizontal surfaces are consistent across all building types, with the vertical U-values ranging from 0.70 to 1.50 W/m²K and horizontal U-values ranging from 0.35 to 1.30 W/m²K. Offices have the lowest energy consumption, ranging from 120 to 250 kWh/m² per year, while healthcare buildings and educational buildings have the highest range of energy consumption, 200 – 400 kWh/m2 year for healthcare facilities and 200 – 350 kWh/m2 year, for education and cultural.

Table 4: Energy performance characteristics of the public building stock

Building type	Energy Performance Indicator		Energy consumption [kWh/m2 year]
	U value [W/m2K]		
	Vertical	Horizontal	
Offices	0.70 – 1.50	0.35 – 1.30	120 – 250
Education, cultural	0.70 – 1.50	0.35 – 1.30	200 – 350
Healthcare	0.70 – 1.50	0.35 – 1.30	200 – 400
Tourism	0.70 – 1.50	0.35 – 1.30	150 – 300
Commercial	0.70 – 1.50	0.35 – 1.30	150 - 300

Source: MDRAPFE, 2017

In Romania, public buildings primarily rely on natural gas and electricity, as shown in Figure 5. Natural gas, used for heating and sometimes electricity generation in public buildings, is a prevalent energy source in the country, due to its relatively lower cost, efficiency, and extensive pipeline infrastructure that supports its distribution. Additionally, since 2018, there has been a gradual increase in the use of renewable energy sources and biofuels in public buildings, as shown in Figure 6. Since 2021, however, Romanian authorities have focused more on diversifying energy systems by increasing the use of solar energy and installing photovoltaic panel systems on both public institutions and households. The total value of public acquisition contracts for alternative energy sources was 4.5 times higher in 2021 and 8 times higher in 2022 compared to 2020[x]. Most contracts were concluded by territorial administrative units, and various public institutions, including schools, social services, and universities, have shown interest in installing solar panels.

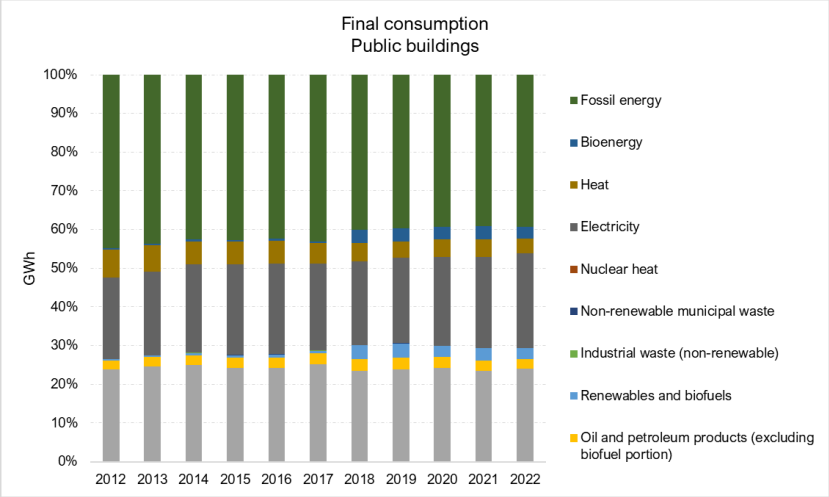

Figure 5: Final energy consumption in public buildings, based on energy carrier
Source: Eurostat, 2024

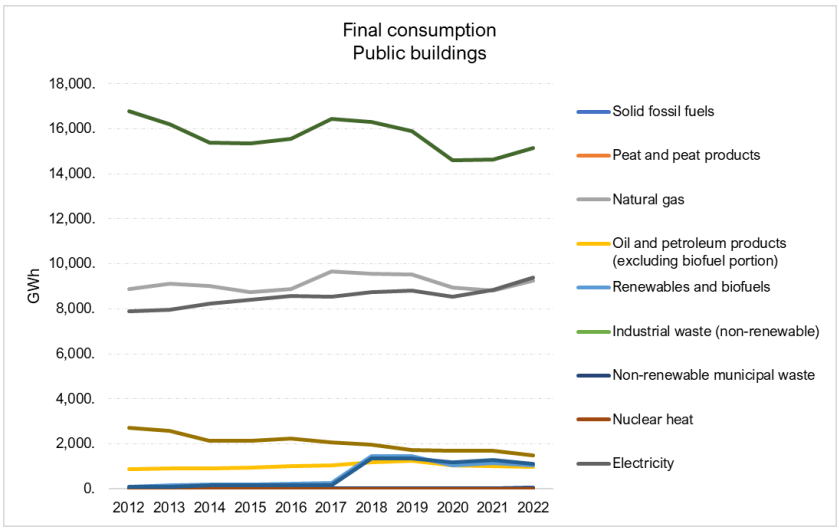

Figure 6: Trends in energy carriers and final energy consumption in public buildings
Source: Eurostat, 2024

3.2.2. Renovation targets for the public building stock

The Romanian LTRS includes specific actions for public buildings, which are envisioned to lead the energy renovation efforts. By 2030, the Strategy aims at renovating an area of 8.25 Mm², equating to 26% of the public building stock, achieving energy savings of 0.05 Mtoe and reducing CO_2 emissions by 0.25 Mt between 2021-2030. This encompasses public buildings owned and used by the public administration and those rented or leased by local or regional administrations and buildings owned but not necessarily used by these administrations.

To achieve these goals, two dedicated programs are suggested in LTRS: a long-term national programme for state-owned buildings and a similar program for municipality-owned buildings. Significant energy savings are expected to stem from deep renovations and the achievement of nearly Zero Energy Building (NZEB) standards in public buildings, along with improved lighting and renewable energy installations. The proposed cost-optimal renovation packages (described in section 3.3) aim for public buildings to achieve at least an 'A' rating on the Energy Performance Certificate (EPC), reducing specific energy consumption to below 150 kWh/m²

per year. This target covers heating, domestic hot water, lighting, mechanical ventilation, and air-conditioning.

Additionally, the LTRS outlines an implementation roadmap, detailing targets and milestones for 2030, 2040, and 2050, focusing on energy savings, CO_2 emission reductions, increases in nZEB buildings, and the reduction of buildings with the lowest energy classes. These targets are benchmarked against 2020 values. For public buildings, these milestones are expressed as shown in ***Table 5***.

Table 5: LTRS Public buildings renovation targets

Implementation roadmap Targets and milestones	**2030**	**2040**	**2050**
Final energy savings (total)	9%	35%	65%
Final energy savings (public buildings)	0.05%	0.09%	0.16%
CO_2 emissions reduction (total)	24% 2.34(Mtoe)	50% 4.91(Mtoe)	80% (7.85Mtoe)
CO_2 emissions reduction (public buildings)	0.25 (Mtoe)	0.49 (Mtoe)	0.82 (Mtoe)
Percentage of public buildings renovated	26%	52%	100%
Equipped with BEM (Building Energy Modelling) or similar) (units)	20 384	40 768	67 947

Table 6: LTRS associated costs for the renovation scenario and 2030 expected outputs

Public building - type	Category	Area [m2]	Buildings [number]	Investments [EUR million]	Energy savings [Mtoe]	CO_2 reduction [Mtonne]	Increased share of RE [Mtoe]
Education	Schools	4.24	4 361	874.84	0.03	0.14	14.81
Health	Hospitals	1.61	161	318.33	0.01	0.06	5.28
	Others	1.07	14 324	192.52	0.01	0.02	3.11
Administrative offices		1.35	1 539	236.55	0.01	0.03	4.41
Commercial		1.47	10 153	305.83	0.01	0.06	5.71
Total		**9.74**	**30538**	**1928.07**	**0.07**	**0.31**	**33.32**

3.3. Overview of the current state of related policies

3.3.1 National energy and climate policy framework

In Romania, the key strategic documents that guide and provide the policy framework for the building renovation sector are **the National Energy and Climate Plan (NECP)**, the **National**

LTRS, **National Recovery and Resilience Plan (NRRP)**, and two main legislative instruments, that form the basis to enact policy documents and national commitments, namely **Law no. 372/2005** and **Law no. 121/2014**, which transpose the Energy Efficiency Directive (EED) and the Energy Performance of Buildings Directive (EPBD), respectively.

The Romanian NECP currently in force was approved by Government Decision no. 1076/2021[xi]. It sets national emission reduction goals and strategies to achieve them, aligning with the EU-wide collective climate and energy targets for 2030. As outlined in the plan, the targets for 2030 on energy efficiency, decarbonization and renewable energy sources are: 32.3 Mtoe for primary energy and 25.7Mtoe for final energy, a 21.6% reduction of greenhouse gas emissions, and a 30.7% share of renewable energy in gross final energy consumption. The contribution of the building renovation sector to the overall energy saving targets to be achieved following the recommended scenario put forward in the LTRS and referenced in NECP is 30 % reduction in the final energy consumption target, 108 % for reduction of CO_2 emissions and 87 % for renewable energy targets by 2030.

However, considering the EU revised climate and energy legislation, namely the objectives of 'Fit for 55 package' and Effort Sharing Regulation, and to accelerate the implementation of European Green Deal, the Romanian NECP has been criticized for being too modest. The shortcomings in terms of efficacy[xii] and ambition[xiii] on the current NECP against the revised EU legislation, are expected to be addressed in the updated plan, to be submitted by June 30, 2024. At the time of writing, the updated plan had not yet been submitted.

The National LTRS is the key national policy and planning instrument to support the renovation of the national stock of both residential and non-residential buildings, public and private, towards an efficient and decarbonized building stock by 2050. It provides a roadmap to achieve the milestones and targets, measures and indicators for 2030, 2040, and 2050. Some of the key measures proposed in the strategy are outlined below.

Energy efficiency renovation measures:

1. <u>Recommended renovation packages for building types.</u>
   - Single Family Houses: For single-family houses, the LTRS recommends a minimum renovation package (P1). This involves meeting the national technical regulations on the energy performance of buildings, achieving an energy performance certificate (EPC) rating close to class 'C'.
   - Multi-Family Buildings: For multi-family buildings, an average renovation package (P2) is advised. This package includes deep renovations to prevent future reworks to meet near-zero energy building (NZEB) requirements, along with the minimal use of renewable energy solutions.
   - Social Housing, Educational, and Health Establishments: These buildings are recommended to undergo maximum renovation packages (P3), aiming for deep renovations or NZEB standards. The measures include all possible renewable energy options, such as rooftop photovoltaic panels, solar domestic hot water preparation, and geothermal heat pumps.
   - Office and Commercial Buildings: Similar to social housing, educational, and health establishments, office and commercial buildings should also follow the maximum renovation package (P3). This involves deep renovations or NZEB standards, incorporating renewable energy solutions like rooftop photovoltaic panels, solar domestic hot water systems, and geothermal heat pumps.

2. Addressing seismic risk: introduces mandatory requirements to reduce building seismic risk as complementary measures in energy efficiency renovations, based on the cost-benefit analysis results.
3. Elaboration and approval of the methodology to calculate energy performance of buildings
4. Project pipeline and development assistance: to ensure the renovation of at least 26% of public buildings by 2030, 52% by 2040, and 100% by 2050, the LTRS calls for the development of a project pipeline and assistance system for priority public building projects.
5. Building Renovation Passport (BRP): the strategy suggests including the Building Renovation Passport (BRP) in the technical book of the building.
6. Support for local authorities: Local authorities will receive technical and procedural support for preparing project documentation and accessing funding. This support aims to enhance the capacity of local governments to undertake comprehensive renovation projects.
7. Standard Tender Documentation: the development of standard tender documentation with performance indicators, specific requirements, and technical and economic evaluation procedures is crucial. This includes frameworks for centralized procurement and energy efficiency renovation services for central government-owned and municipal buildings.

Financing measures

1. Promotes the development of a regulatory framework for energy service companies - ESCOs
2. Proposes the institutional framework for financial mechanisms, including a national or regional institution, the `Fund`, responsible for mobilising all funds and managing flows, identify financial needs, help mobilise and deploy funding, including through financial mechanisms to manage, act as lender or paying agent for grant schemes / revolving loans
3. Provide financing scheme options for central government buildings, local government buildings, local multi-family buildings, single-family houses, commercial buildings
4. Addresses the issue of split-incentive dilemmas issue specific cu public building renovations proposing that budgetary rules should be revised to allow savings from energy efficiency improvements to be retained until renovation debts are repaid, or the central government should provide budgetary support for renovations.

Monitoring measures

1. The LTRS implementation roadmap contains indicators and milestones for the deployment of Building Energy Management (BEM) systems for public and commercial buildings, offering target values for 2030, 2040, 2050.
2. Assigns responsibility of Ministry of Development, Public Works and Administration (MDPWA) to develop, manage, and maintain a national building database with information about the entire building stock: typologies, construction periods, energy performance certificates, energy consumption, energy carriers, seismic building characteristic.

Although these are some of the key measures that the Romanian LTRS proposed in 2020, the implementation of many of them are progressing slowly, such as the approval of the energy

performance calculation methodology, and the development of the national database with comprehensive information on the building stock.

Furthermore, the LTRS renovation targets must be further enhanced according to the latest NECP assessment by the European Commission, focusing on both the rate and depth of renovations. Increasing the renovation rate from the current baseline of 0.5% to beyond 3-4% is crucial for achieving national energy efficiency and decarbonization goals. Additionally, there is an increasingly pressing need to collect and analyze data on current energy consumption and renovation outcomes to inform and review the target numbers against a more accurate overview of the current state.

Several measures proposed in the Romanian LTRS and its action plan, such as defining financing objectives and an investment strategy for the renovation of public administration buildings, are to be supported through the National Recovery and Resilience Plan.[xiv]

The **National Recovery and Resilience Plan (NRRP),** approved in 2021[xv] and further amended[xvi] comprises of a series of reforms and structured investments, divided across several components. The NRRP has an important section regarding buildings, specifically Component 5 – Renovation Wave which aims at increasing the number of renovations to improve the energy efficiency of public buildings, to reduce overall dependence on fossil fuels, and to increase the pace and level of ambition in renovations.

In Romania, as in many EU countries, the programme has had the second highest share of energy related investments in the NRRP, after sustainable mobility, and a significant role providing with the financing programmes, targeting deep and medium renovations for both residential and public building stock, as well as the construction of new energy efficient buildings.

3.3.2 National programmes for financing building renovation

The main financing programmes dedicated to energy efficiency renovations for public buildings are the **Energy efficiency in public buildings programme**, implemented by Environmental Fund Administration (EFA), and **Regional Operational Programme (ROP) 2021-2027.**

The Energy efficiency in public buildings, which is a multi-annual financing programme, aims to increase energy efficiency of public buildings, reduce greenhouse gas emissions, reduce primary energy consumption, as well as to promote the use of renewable energy sources. Standalone renovation works are listed, such as thermal wall insulation on the external walls, floors and installing new higher performing windows and doors; upgrading technical equipment for heating, cooling, ventilation, hot water; replacing lighting system with higher performing LED systems; implementing Energy Management Systems (EMS) for energy consumption monitoring; installing energy supply system based on renewable energy sources etc.

Although the guide indicates energy consumption and carbon emissions as performance indicators and provides guidelines on their calculation, it does not specify the consumption or emission reduction targets that projects must achieve to qualify for financing, merely requiring the inclusion of these figures in the application.[xvii]

The funding is provided by revenues generated by the ETS certificates, and the total sum allocated in 2023 to energy efficiency renovations of public buildings is 120 mil euro (600 mil

RON). The amount of financing granted to municipalities differs based on the type and size of the local administration.

Regional Operational Programme 2021-2027 (ROP) Energy efficiency for both public buildings and residential buildings, as well as the reduction of GHG emissions are among the activities and targets that are eligible for funding, under the Regional Operational Programme. The funds are divided among 8 regions in Romania[xviii]. The previous Regional Operational Programme, which ran between 2014-2020 dedicated to improve energy efficiency in buildings, offered financing for *light, medium,* and *deep renovations*.

National Programme for the consolidation of buildings at seismic risk (NPCBSR)[xix], implemented by MDPWA which provides integrated financing for both renovations works to reduce buildings' seismic risk and to improve energy performance. There are two sub-programmes, one dedicated to residential buildings and the second to public buildings owned or occupied by central and local administrations.

Complementing the above financing programmes, the Ministry of Energy runs another programme, part of the Modernisation Fund, that **supports the investments in new renewable electricity generation capacity for self-consumption in the public sector[xx].** Financial support is offered for procuring equipment for renewable electricity generation from wind, solar, or hydro sources, aiming to reduce energy consumption in public buildings through renewable energy sources.

Despite the diversity of financing programmes available, that to a certain extent address both the specificities of the national building stock (for example, the exposure to seismic risk), and the variety of renovation measures to improve its energy efficiency, overall eligible works and activities make no reference to the renovation packages mentioned in the Romanian LTRS, requirements, or recommendations on how these activities can be coupled in order to ensure a cost-optimal, staged renovation, leading to deep a renovation. In this case the risk of lock-in is typically greater. Low-efficiency measures from earlier stages can impede the implementation of more efficient elements later on, as opposed to a staged deep-renovation.[xxi]

Moreover, energy efficiency renovation funds are currently dispersed across various ministries, each with distinct management and implementation responsibilities. Despite the numerous benefits associated with the development and operationalization of a 'Fund' dedicated to energy efficiency to streamline public funds, as proposed in the Romanian Long Term Renovation Strategy (LTRS), this measure has not yet been implemented. The Fund would streamline both EU and national funds, optimising the allocation of resources towards energy efficiency renovations. As a result, financing terms and subsidies may remain fragmented, leading to confusion and competition between different programmes. This is hindering the complementarity of funding sources and performance indicators, ultimately compromising the achievement of energy-saving targets. The reportedly poor collaboration between state institutions responsible for efficiency financing programmes and despite mechanisms intended to facilitate systemic data exchange and collaboration between these key institutions, the fragmented structure hinders the potential for more complex and comprehensive analysis on achieving energy efficiency targets.

3.3.3 Legal framework

The Law no. 121/2014 and **Law no. 372/2005** are the primary national normative acts in the field of energy performance, which transpose the Energy Efficiency Directive (EED) and the Energy Performance of Buildings Directive (EPBD), respectively.

EED is transposed in the Romanian legislation in Law nr. 121/18.04.2014 with the regulatory scope and objectives of creating the legal framework for the implementation of national energy efficiency policy in order to achieve the target of increasing energy efficiency. The provisions are set to improve energy efficiency at all stages of energy chain (including the supply sector): primary resources, final consumption, production, distribution, supply, transport.

The law provides the organizational infrastructure, reporting standards and requirements as well as standards for reporting on energy consumption for public buildings, the regulatory framework for energy audits and energy auditors in Romania. Some of the key aspects of the law include establishing the organisation the Energy Efficiency Directorate. The Energy Efficiency Directorate, a division under the Ministry of Energy, is responsible for developing policy and legislation on energy efficiency, monitoring progress towards national targets, and certifying energy auditors and managers. Local administrations must submit yearly reports on the energy consumption of public buildings, detailing total heated area, electricity consumption, heating energy consumption, and energy bills.

Law nr. 121/2014 on energy efficiency is complemented by Law nr. 372/2005 on building energy performance and Government Decision nr. 219/2007 on promoting cogeneration based on heat demand.

The Law no. 372/2005, which provides the national legislative framework for energy performance of buildings, has been well established since 2007 and consistently amended to comply with the provisions of EPBD recasts over the years. Since it first entered into force, the law provided a general framework for minimum energy performance requirements for buildings renovations, certification and inspection schemes. However, despite the early implementation of EPBD provisions in the national legislation, particularly regarding the nzeb obligations for energy performance of building renovations, the development and implementation of a calculation methodology lagged behind with approximately 4 years since the introduction of new regulations. The said methodology (Mc-001-2022) was only approved and came into force in January 2023.

Based on the new energy performance calculation methodology, Mc-001-2022, which replaces the previous Mc-001-2006 methodology, significant changes have been introduced to the energy classification system for buildings. The updated methodology requires more stringent energy performance values for primary energy (kWh/m² per year) across eight different classes and an additional assessment of a building's environmental impact and a classifications system based on pollution levels by measuring CO_2 emissions (kg CO_2/m² per year).

The timespan between, on the one hand, the launch of the LTRS, in 2020 and the implementation of financing programmes and tools, and on the other hand the approval of energy performance calculation methodology (Mc-001-2022) indicates an important gap which has prompted significant challenges for the renovation sector. The existence of legal obligations for energy performance of buildings without a framework for assessing, calculating, and verifying the energy performance of buildings impacted the design and execution of renovation projects creating inconsistencies in the energy performance outcomes, and in ensuring

accurate evaluation of energy savings in practice. During this time, without a standardised approach and clear performance indicators, architects, energy auditors, buildings owners and local authorities faced difficulties in ensuring that the renovation works met the required energy efficiency standards at the time the projects were finalized, resulting in a performance gap between projected and actual energy savings required by the revised regulations and performance indicators.

Law 372/2005 also provides the inspection framework for energy efficiency projects, assigning responsibilities and standardised control procedures. According to the law, State Inspectorate in Constructions (SIC) is the public institution operating under the authority of MDPWA, tasked with (on and off building site, on all project stages) inspection responsibilities to ensure quality and compliance with urban planning standards requirements and professional conduct, with regulatory frameworks for obtaining building permits, and the application of legal provisions in the construction field. Since 2013, the institution has the additional tasks of verifying the application of legal provisions of energy performance of buildings for both new-build and renovation projects, and of inspecting the heating and cooling systems.[xxii]

4. ASSESSMENT OF ENERGY PERFORMANCE OF RENOVATED PUBLIC BUILDINGS

The observed inconsistencies in fully addressing the characteristics of the building stock in policies and financing programmes and their dispersed governance, the misalignment in terms of national commitments of energy savings and GHG emissions reduction targets and actual progress, as well as the difficulty in keeping up with EPBD revisions highlight that there are certain challenges for the renovation sector to reach its share of energy savings. These issues are exacerbated by the lack of comprehensive and reliable data on the building stock, which hampers the ability to accurately examine buildings' energy performance, its gradual development, the effect of policies, financing programmes, and measures.

Energy Performance Certificates (EPC) are a crucial data source on the development of energy performance of buildings and in the EU, and while Romania mandates EPCs for newly constructed and renovated buildings since 2013, in line with EPBD provisions, it lacks a comprehensive national database of these certificates. Energy performance classification is included in the Energy Performance Certificates (EPC) which are mandatory for energy efficiency renovations on public buildings, that is buildings owned and/or managed by public authorities or institutions providing public services where a total useful floor area of more than 250 m2 is occupied by a public authority and frequently visited by the public.[xxiii]

Besides the indication of label category (A+ to G), the current Romanian EPCs contain information about the building type, year of renovation, area, and the annual total primary energy consumption. Given that EPCs display the specific annual energy consumption as indicative of buildings' energy performance, the indicator is being widely used in national policy goals for energy reduction and recognized as a reliable measure of actual energy usage. However, there is an important gap between this indicator (primary energy consumption) and the actual, measured energy consumption. Reducing final energy consumption is a key objective of energy efficiency renovations, as it directly translates to costs and economic viability.

Accordingly, the following analysis draws upon energy consumption data, the Romanian context of energy class ratings and their development, cost optimal renovation packages, control procedures and independent reports on energy efficiency renovation works, supplemented by information obtained from workshops with central and local authorities as well as experts in the field.

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

4.1.1. Discrepancies between renovation targets and actual achievements

As renovation targets have become more ambitious at EU level, and Romania struggling to keep up with the EPBD revisions and other relevant policies, the current pace and depth of renovations no longer leads to significant energy savings and CO_2 reduction. According to a study by EPG on tracking the implementation progress of NECP and assessing the achievability of its objectives on the buildings sector, Romania will need to significantly enhance the depth of renovations to meet the revised EU objectives. It would require reaching 1.5 million m2 medium-high renovations and 1 million m2 of deep renovations in a scenario compatible with

'Fit for 55' goals. Yet there have been and are ongoing financing programmes for renovations that focus on single measures renovations. Additionally, a study conducted in 2021 by the MDPWA on the status of achieving nZEB status in energy efficiency renovations in Romania[xxiv] showed that often the results at the completion of the renovation works did not fully match the forecasts in the energy performance calculations. Experts and local administrations that were interviewed as part of the aforementioned study reported that the monitoring of energy consumptions after the renovation works were completed revealed that none of the renovated buildings achieved the expected energy savings.

The Romanian LTRS takes into account four typologies of buildings, as reference, to propose three cost-optimal renovation packages. The cost-optimal level is the energy performance level that can be achieved with the lowest cost over the building's expected economic life. The lowest cost is calculated by considering the building's use and type, as well as costs related to energy investments, maintenance, energy consumption, and operations. Using the common EU methodology framework for calculation, the Romanian LTRS uses as reference buildings the following categories, as representative of the national building stock: collective housing; single-family building; social housing, health and educational establishments, office and commercial buildings.

Except for single family houses, for which the P1 Package (achieving class B or C after renovation) is recommended as being cost-optimal, all other building categories, both P2 and P3 packages would be considered as deep renovations, leading to more than 60% reduction of energy consumption. While P2 involves deep renovation which is to be done in order to avoid redoing to meet future nZEB requirements (staged renovation) with minimal use of renewable sources, the P3 involves deep renovation at nZEB standard including all renewable energy options. Accordingly, in both P2 and P3 renovation packages the reference buildings could achieve an energy class rating A.

The observed energy performance gap may be partly attributed to methodological challenges in establishing and assessing energy efficiency performance. During the drafting and approval of the Romanian LTRS and the associated renovation packages, the calculation methodology in effect at that time, Mc-001-2006, provided lower performance standards for energy classes than the current one, Mc-001-2022. The timespan between, on the one hand, the launch of the LTRS, in 2020, the implementation of financing programmes and tools, and on the other hand the approval of energy performance calculation methodology (Mc-001-2022) indicates an important gap which has prompted significant challenges for the renovation sector. The existence of legal obligations for energy performance of buildings without a framework for assessing, calculating, and verifying the energy performance of buildings impacted the design and execution of renovation projects creating inconsistencies in the energy performance outcomes, and in ensuring accurate evaluation of energy savings in practice. During this time, without a standardised approach and clear performance indicators, architects, energy auditors, buildings owners and local authorities faced difficulties in ensuring that the renovation works met the required energy efficiency standards at the time the projects were finalized, resulting in a performance gap between projected and actual energy savings required by the revised regulations and performance indicators.

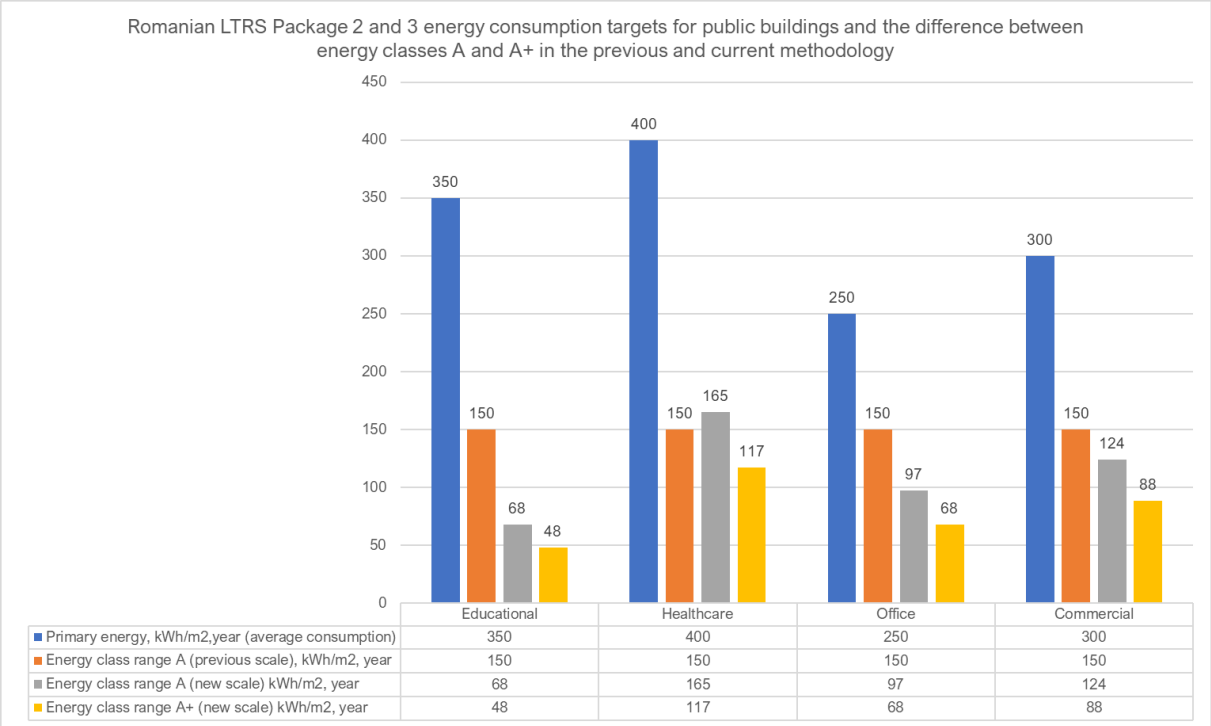

Figure 7: Energy class targets for public buildings in LTRS and differences between the previous and new classification systems
Source: MDPWA, Mc-001-2006 (revised in 2017) and MDPWA, Mc-001-2022, 2023

As illustrated in Figure 7, for most building types, the energy performance levels in the current methodology are much higher than those in the previous methodology, by an average of 27% in class A, and 46% in the newly introduced class A+, the recommended class ratings after the renovation of public buildings. An exception to this general tightening of performance standards in energy classes is healthcare facilities, where the new limit values in each class have increased. For example, in class A, the previous scale had a limit of 150 kWh/m², while the current scale ranges from 117 to 165 kWh/m² per year, representing approximately a 10% increase in the upper limit values. As the only type of public building that operates continuously throughout the year, healthcare facilities, particularly hospitals, have a higher average energy consumption than any other building type, as shown in Figure x.

Furthermore, although the energy classes provide some indication of how much energy a building consumes for heating, cooling, ventilation, and lighting, as well as the associated carbon emissions, they have several shortcomings in accurately predicting actual consumption during the building's operational stage. The rating scale is an asset energy rating, focusing on the building itself and its systems, rather than an operational rating based on measured consumption. It relies on general assumptions about building types, independent of how energy is actually used. For instance, the number of occupants is estimated based on floor areas, and heating and cooling patterns are assumed to be uniform across all building types.

The implications of this are that the predicted energy consumption values, assessed prior to an energy efficiency renovation, often differ from the actual consumption values post-renovation, with the predicted values frequently being higher than the measured outcomes.

4.1.2 Onsite inspections of energy efficiency renovation projects

The State Inspectorate for Construction (SIC), the national authority responsible for ensuring compliance with the energy efficiency legal framework for both new construction and renovation projects, is tasked with verifying the application of legal provisions related to the energy performance of buildings and with inspecting heating and cooling systems. According to the specific SIC control procedure, the inspection priorities are centered on verifying energy performance certificates, conducting energy audits, and reviewing the associated technical documentation. Depending on the type of irregularities found, the measures can be to redo energy audit reports, cancellation and re-issuance of the building's EPC, requiring technical re-evaluation of energy audits and EPC.

Since 2015, the State Inspectorate in Constructions collaborated with MDPWA for developing a quality themed inspection on the development of projects within the Ministry-led investment programmes. An overview of SIC annual reports on inspections carried out specifically for energy renovations, since 2015, illustrates high numbers of deficiencies found and remedial measures taken, primarily in the 2015 – 2020 time interval[xxv], as shown in Figure 8. The SIC reports do not specify whether the inspected projects were energy efficiency renovations or new builds at nZEB standard. Additionally, there is no correlation provided between the number of inspections conducted and the number of irregularities identified. For instance, a single project inspection may uncover multiple irregularities, leading to several corrective measures being implemented.

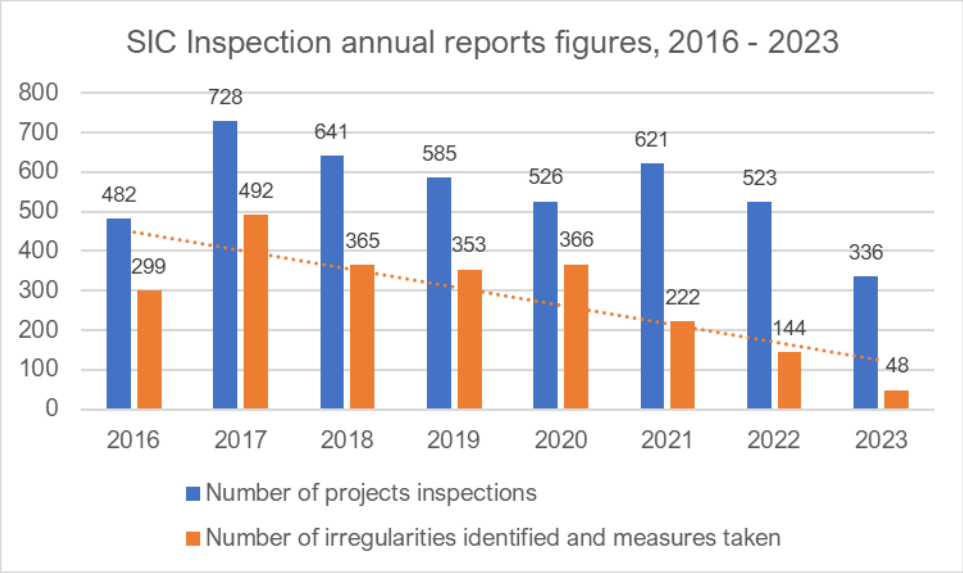

Figure 8: SIC Inspection annual reports, 2016-2023
Source: SIC

Inspection activities involve verifying that construction projects adhere to regulations and possess all required documentation and building permits. However, there are several shortcomings in fully addressing the quality of work. During the construction stage, compliance with project design is assessed solely through visual inspection, which may not adequately ensure the integrity and quality of the work performed. Due to a lack of equipment, the inspection does not currently allow for an assessment in detail, comparing the type of materials,

processes and systems specified in the project design with the ones used onsite, during construction.

4.1.3. Post-renovation issues

Occupants' behaviour and building energy performance are closely intertwined. Specific behaviors and cultural practices influence energy consumption patterns significantly, in both residential and public buildings[xxvi]. The occupants' behaviour refers to the way individuals interact with the building's systems in response to internal and external environments. Factors such as psychological, physiological, social, and cultural norms play a role in this interaction, directly impacting energy consumption and indoor environmental quality. Energy consumption behaviours factors differ based on buildings typologies. Studies on energy consumption behaviors focused on domestic settings, explored how household practices influence energy use, while those focused on public buildings, such as offices, schools, and hospitals, explored different usage patterns, management practices, or working hours that can impact energy performance.

Studies focusing on the role of occupants' behaviour consumption patterns in public buildings, showed several common factors influencing discrepancies between predicted and measured energy use. In the case of office buildings these factors can be related to night-time energy use by leaving office equipment on, which can be associated to both occupants not turning the equipment off and operational schedules, or extended hours[xxvii]. Modeling studies by Hong and Lin demonstrate that different work styles, such as austere or wasteful, can result in energy consumption variations of up to 50% less or 90% more, respectively, compared to typical behavior[xxviii]. In environments that are not extensively monitored, it is challenging to isolate the precise impact of these factors.

In Romania, many occupants prefer natural ventilation and tend to use windows and doors to regulate indoor temperatures, often resulting in increased energy use for heating and cooling when outdoor temperatures are extreme.[xxix] Romanians living in urban areas prefer to maintain an indoor temperature of approximately 22° Celsius during winter. This preference is notably higher than that of most other EU countries, but comparable to the indoor temperatures in Poland[xxx]. Additionally, Romania is one of the countries with the longest working weeks in the EU, averaging 40.2 hours per week[xxxi].

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

To identify the obstacles of energy efficiency renovations at the local level, a workshop was conducted on May 27, 2024. Together with local administrations, energy efficiency experts, inspection and control bodies at the local level, and architects, the workshop aimed to validate and establish a comprehensive baseline of the current status of the energy efficiency renovations carried out, monitoring and evaluations practices at the local level, as well as blockages in achieving the expected energy savings after the renovations.

The municipalities participating in the workshop have undertaken energy efficiency renovations on public buildings through various financing programmes, including the Regional Operational Programme and the National Recovery and Resilience Plan. The types of buildings that have been renovated or are planned for renovation include town halls, kindergartens, and schools. However, none of the municipalities present at the workshops reported having established practices for monitoring energy consumption post-renovation, with only a few local

administrations use energy management systems (EMS) or engage in comprehensive measuring and monitoring energy efficiency renovations and their energy use. Due to the absence of monitoring practices at the local level, the evaluation of energy savings and the effectiveness of energy efficiency renovation measures was further limited.

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

Desk research and workshop consultations with central and local authorities, architects, and energy efficiency experts outline that the issue of underperforming renovations in Romania has varied causes. These causes can be regulatory, collaborative, economic, socio-cultural, and psychological in nature and can be distributed throughout the buildings' energy efficiency renovation process, from the initial stages of planning and design through to the construction and operational stages.

Planning and design stage:

- The current energy performance modeling and labeling frameworks, which are primarily based on the asset energy rating, fail to address the post-occupancy energy consumption. This rating focuses on the building itself and its systems, and not on an operational rating based on actual measured consumption. While design-stage predictions based on energy audits and planned renovation measures are often optimistic, forecasting significant energy savings and low consumption post-renovation, do not necessarily guarantee that the building will consume less energy than anticipated. Such optimism can lead to a performance gap from the outset, where the actual energy consumption of the building post-renovation is higher than expected.
- A common issue in renovation projects is the lack of a thorough and comprehensive analysis of the buildings before the renovation. Often, technical assessments of the buildings conducted before the commencement of renovation works fail to identify all the problems that require improvements, leading to the discovery of additional issues only once the work has begun. This can result in significant project disruptions, including improper budgeting and the need for additional funds to cover unforeseen renovation and repair works. Consequently, project timelines are either extended, and the overall costs escalate beyond initial estimates, or there are compromises in the renovation works and energy efficiency measures, to fit in with the initial budget.
- With part of Romania's building stock being exposed to high seismic risks, there is a legal requirement that energy renovations be coupled with complementary seismic risk measures, such as structural reinforcements. This demands additional investments, which often pose significant financial challenges. In cases where budgets are restricted, costs may be redistributed, leading to compromises in energy efficiency renovation works or technical equipment. Consequently, developers and investors may abandon projects altogether due to the prohibitive costs of comprehensive renovations. An example is found in one of the schools initially selected for renovation under the România Eficientă programme, developed by the Energy Policy Group (EPG) with private investments. The project was halted due to the combined cost of energy efficiency improvements and necessary seismic reinforcements. Similar financial roadblocks are likely in other public

building renovations, where national energy efficiency financing programmes do not cover the extra costs associated with seismic risk mitigation. As a result, additional funding from private entities or local budgets is necessary to complete such projects without compromises to the building's energy efficiency after the renovation.

- In Romania, energy renovations in the building sector have long been associated primarily with thermal rehabilitation, often sidelining the holistic architectural understanding necessary for a comprehensive energy efficiency renovation project. This perspective has led to energy renovations being seen as isolated technical interventions rather than integrated projects. As a result, design documentation submitted for obtaining building permits was, reportedly, often incomplete and failed to incorporate energy-saving measures comprehensively[3]. This lack of coordination could be caused by a lack of common goals, asymmetric information, or split incentives between energy efficiency experts, engineers, and architects[xxxii].
- The misalignment between on the one hand changing policy goals, financing programmes and their different energy performance indicators, at the national level, and the practicalities and delays of renovation projects authorisation at the local level, on the other hand, is a significant contributor to the performance gap. Obtaining the necessary permits for renovation projects is often a complex and lengthy procedure in Romania and exacerbated by limited administrative capacities and technical expertise at the local level. The procedural slowdowns due to bureaucratic hurdles involved in project approvals have caused confusion for energy efficiency renovation projects, with many projects receiving financial support at a time certain calculations and indicators were in force but were finalized when the said indicators were outdated.
- The competitive tendering process is often based on the lowest price, which poses challenges in ensuring the quality and efficiency of energy efficiency renovation projects. Contractors and design professionals may cut corners in project design and planning in order to meet the low budget criteria, leading to both substandard work in the implementation stage and non-compliance with energy efficiency standards and cost-optimal solutions. This cost-driven approach can lead to multiple problems and design errors, to lower-quality materials and equipment being proposed in the project design. It can also make it difficult to withstand market crises and disruptions in the construction sector[4][xxxiii], further complicating efforts to keep the renovation works and energy performance targets within the planned budget during the execution stage.

Execution stage:

- Onsite, during the execution stage, some of the most frequently mentioned issues were non-compliance with project designs and technical specifications, improper assembly, use of substandard materials and equipment, and inadequate oversight during construction. According to the State Inspectorate for Construction (SIC), deviations from approved project designs often included unauthorised alterations to materials, construction methods, and equipment, such as heating, cooling and ventilation systems. Romanian legislation

[3] Information obtained at workshop with central authorities, energy efficiency experts, and energy efficiency organizations held on 27.06.2024, and at workshop with local authorities, energy efficiency experts, and energy efficiency organizations held on 27.05.2024.

[4] The COVID 19 pandemic in 2021, the war in Ukraine, inflation, and rising prices in energy and transportation triggered an unprecedented surge in construction material costs in Romania during 2022, resulting in an almost 50% increase from 2020 levels

mandates that all project alterations occurring during execution must be documented by the responsible architect and approved by the site manager, constructor, and project owner.

- During workshop consultations, the non-compliance with project design and poor execution has also been attributed to the lack of workers' skills in carrying out energy efficiency renovation projects.

Operational stage:

- Despite the objectives of energy and operational costs savings behind energy-efficient building renovations, actual consumption often deviates due to occupants' behavior. This deviation is largely attributed to the so-called "rebound effect," where occupants overconsume energy under the assumption that the building's improved efficiency offsets higher usage[xxxiv]. Conversely, the "pre-bound effect" refers to the tendency of occupants in less energy-efficient buildings to strictly control energy consumption[xxxv]. In the case of energy efficiency renovations of public buildings (see section 4.1.3.) the rebound effect may be more prevalent as there are less incentives for occupants to save on energy bills.
- As reported by local administrations during workshop consultations, occupants' lack of knowledge about operating energy-efficient buildings and utilizing energy-efficient equipment also contributes to the failure of achieving post-renovation energy savings. In Romania, this lack of knowledge is further compounded by a general reluctance to adopt energy-saving behaviors[xxxvi]. However, as one of the most frequently attributed causes of the occurrence of energy performance gaps in building renovations[xxxvii], there is a need to better understand the particularities of occupants' behavior in Romania. Most of the local administration staff participating in the consultation workshops do not have a monitoring procedure in place for public buildings' energy efficiency renovations, and most of the claims indicating the role of occupants' behavior are solely based on observations. Therefore, there is a need for more empirical evidence to support these claims and understand the impact of occupants' behavior on the performance gap.

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

Improving energy efficiency of public buildings in Romania and achieving the anticipated energy savings through renovations involves navigating a complex array of challenges: in aligning energy efficiency policy frameworks and renovation measures with the actual state and characteristics of the building stock, in guiding energy efficiency building renovation by using a strictly technical and economic prediction model, focused on technologies and cost savings, but overlooking human behaviour and its impact, and ensuring accurate project implementation in the construction stage. Addressing the underachievement in energy savings through renovations, and the energy savings targets overhaul in the revised Energy Performance of Buildings Directive (EPBD), would require tackling the current shortcomings through comprehensive policy adjustments around data collection and management, monitoring, evaluation, and certification processes, coordination of financing programmes, capacity building, and awareness raising.

6.1. Building stock data management

The Romanian policy landscape and financing programmes are falling short in fully addressing the characteristics of the building stock. The lack of an in-depth knowledge about the needs and conditions of the national building stock steered the development of ineffective, and essentially abstract renovation policy measures, such as the cost-optimal renovation packages proposed in the Romanian Long Term Renovation Strategy, which failed to translate into practical, on the ground cost effective solutions, and reaching a long term cost-efficient equilibrium between final energy consumption and investments. In order to identify the cost-efficient energy renovations, a comprehensive and detailed assessment of the current energy efficiency state of the building stock is essential. Yet, buildings registries containing detailed information about built areas, energy consumption, renovation measures, technical information, and energy performance certificates (EPCs) at the national level are yet to be elaborated. As such, Romania urgently needs a coherent, up-to-date database of its building stock. Renovation programs should make data publicly available on renovation rates, depth, measures taken, and energy consumption achieved to ensure transparency. A comprehensive overview of the national building stock and its performance would track the progress towards energy efficiency renovation goals, inform future policies in the renovation sector, and help evaluate the impact and effectiveness of various policy measures, such as energy certification processes.

6.2. Monitoring and evaluation

In parallel, the adoption of Energy Management Systems (EMS) can play a transformative role for local administrations, in monitoring and managing energy consumption, particularly in public buildings. EMS can provide real-time data on energy usage, identify inefficiencies, and suggest corrective actions, thereby optimizing energy consumption. Local authorities may require more specific guidelines and policy actions to facilitate the adoption of such monitoring systems. This could include providing financial incentives, training programmes and technical support to ensure successful implementation. Furthermore, making energy consumption

monitoring mandatory for public buildings can significantly advance the role of public institutions in leading the energy renovation sector.

Introducing monitoring and evaluation requirements from the planning and design stages of renovation projects would address barriers from these early phases. This could be achieved in the building renovation tendering processes, by mandating subcontractors to conduct both pre- and post-renovation monitoring of actual energy consumption. Moreover, to address the causes of underperforming renovations arising during the construction stage, inspection activities could be enhanced to identify potential issues early in the renovation process. Implementing appropriate technologies and improving evaluation methodologies would be beneficial to gain better insights into the quality of the work, particularly concerning energy efficiency aspects such as air-tightness and the quality of installation of insulation and heating/cooling equipment.

6.3. Capacity building

The slow processing of funds, combined with bureaucratic hurdles at the central administration level, has caused confusion and setbacks in many renovation projects, leading to delays in the implementation of renovation projects. To address this issue, the administrative capacity must be enhanced for evaluation, approval of financing requests and allocation of funds. Monitoring the results of the renovation projects and analysing the effectiveness of the programme, particularly in achieving energy efficiency targets, must be conducted thoroughly and transparently. Currently there are no official data available on the contributions the programmes have made, on energy savings and CO_2 emissions reduction.

Local administrations are pivotal in delivering energy efficiency renovations and achieving energy savings targets. Local administrations play a crucial role in delivering energy efficiency renovations and achieving energy savings targets. They bear significant responsibility to lead by example in the renovation sector, including efficient energy planning at the local level, securing financing sources for public buildings, and ensuring responsible procurement practices. Additionally, local administrations must ensure compliance with energy efficiency renovation processes, legal frameworks, and various financing programme requirements. Finally, local administrations are also responsible for the management and monitoring of public buildings in their area, including energy consumption for renovated buildings. However, in Romania local administrations face challenges in terms of administration, funding and technical capacity in fulfilling these roles, with many local administrations in Romania seeking the necessary extra capacity, expertise, and financing elsewhere, for examples Urbact, NGO partnerships, Horizon etc.

Given the current status and quality of energy efficiency renovations in Romania, the activities of inspecting and controlling are crucial to ensuring that the expected energy savings are achieved after renovations. This can be done through thorough verification processes, rather than relying solely on visual inspections and compliance with legal frameworks and document verification. This capacity gap stems from a lack of equipment for properly assessing the quality and performance of renovation works, insufficient skills to evaluate these works on-site and at project completion, and a shortage of staff dedicated to these specific inspection and control activities. Consequently, quality assessments remain superficial, failing to ensure the renovations meet the desired energy performance targets. This highlights a pressing need for institutional strengthening and capacity building to enhance the effectiveness of inspection and control activities across the country.

6.4. Financing instruments

Although proposed in the Romanian LTRS, but not created an integrated financial instrument to consolidate national and EU funds destined for energy efficiency and renovations would bring multiple benefits to the sector. A unified management framework would ensure consistent monitoring, common performance indicators and requirements across different financing programmes for energy performance renovations for public buildings, and a streamlined process which would ease the administrative burden for central administration and the application process for local administrations.

Similarly, given the external pressure for faster and better-quality renovations and the particularities of the Romanian building stock, specifically related to its age and energy performance, it would require large investments that EU or national funding alone may not be able to cover. Leveraging private capital to bring the public building stock to the required energy performance standards and developing the necessary legislative and regulatory basis (ESCO framework), would alleviate the pressure on public funding[xxxviii].

6.5. Awareness raising

As occupants' behaviour have a major impact on achieving energy savings during buildings' operational stage, post-renovation, there is a need for better information for occupants as to how the renovated buildings and their equipment should be used, along with general awareness raising about energy-efficient practices and the benefits of reducing energy consumption. Similarly, given the scale and urgency of improving energy efficiency of the building stock, it requires coordinated efforts from different professions involved in the construction process, pooling of extra resources, and knowledge. This can be tackled through awareness raising campaigns, funding joint projects that bring different professions to work on innovative solutions, establishing collaborative interdisciplinary platforms, developing educational programmes.

7. REFERENCES

[i] BPIE, EU buildings climate tracker 2nd edition, 2023
[ii] Government of Romania, 2020, Long Term Renovation Strategy
[iii] National Heritage Institute, 2022, Metodologia de intervenție pentru abordarea non-invazivă
[iv] European Commission, 2019, Comprehensive Study of Building Energy Renovation Activities and the Uptake of Nearly Zero-Energy Buildings in the EU, – Final report, Publications Office.
[v] D'Agostino, D., Tzeiranaki, S. T., Zangheri, P., & Bertoldi, P. (2021). Assessing nearly zero energy buildings (NZEBs) development in Europe. *Energy Strategy Reviews*, 36, 100680.
[vi] Build Green, 2023, Decarbonisation to become the new era
[vii] Agenda Construcțiilor, 2024, ADP: 128 de cladiri din Romania au fost certificate BREEAM sau LEED in 2023
[viii] Passive House Institute, Database
[ix] Ministry of Development, Public Works and Administration, 2020, Inventarul clădirilor încălzite și/sau răcite cu suprafețe utile de peste 250 mp deținute și ocupate de administrația publică centrală.
[x] Ciobotea, M., Dobrotă, E. M., Stan, M., Bălăcian, D., Stanciu, S., & Dima, A. (2024). Data–driven analysis of Romania's renewable energy landscape and investment uncertainties. *Heliyon*, *10*(6).
[xi] Guvernul României, 2021, Hotărârea nr. 1076/2021 pentru aprobarea Planului naţional integrat în domeniul energiei şi schimbărilor climatice 2021-2030
[xii] Energy Policy Group (2023), A critical evaluation of Romania's first Integrated National Energy and Climate Plan: implementation progress and the road to 2030
[xiii] European Commission (2022), Assessment of the final national energy and climate plan of Romania
[xiv] Government of Romania, 2020 Plan de acţiune pentru implementarea strategiei naționale de renovare pe termen lung pentru sprijinirea renovării parcului național de clădiri rezidențiale și nerezidențiale, atât publice, cât și private, și transformarea sa treptată într-un parc imobiliar cu un nivel ridicat de eficiență energetică și decarbonat până în 2050
[xv] European Commission, 2021, Council Implementing Decision on the approval of the assessment of the recovery and resilience plan for Romania
[xvi] Council of the European Union, 2023, COUNCIL IMPLEMENTING DECISION amending the Implementing Decision of 29 October 2021 on the approval of the assessment of the recovery and resilience plan for Romania
[xvii] Ministerul Mediului Apelor și Pădurilor (2023) GHID DE FINANȚARE a Programului privind creșterea eficienței energetice și gestionarea inteligentă a energiei în clădirile publice,
[xviii] European Commission, 2022, Decizia CE de aprobare a programului "Dezvoltare Durabilă" pentru sprijin din partea Fondului european de dezvoltare regională si al Fondului de coeziune în cadrul obiectivului „Investiții pentru ocuparea forței de muncă și creștere economică" din România
[xix] Ministry of Development, Public Works and Administration, 2022, ORDIN nr. 2.853 din 7 noiembrie 2022 privind Programul național de consolidare a clădirilor cu risc seismic ridicat (PNCCRS)
[xx] Government of Romania, 2022, Ordinance no. 60, 4 may 2022 to establish the institutional and financial framework for the implementation and management of the funds allocated to Romania through the Modernization Fund, as well as to amend and supplement some normative acts Ministry of Energy, 2024, ORDIN 1013, 27 iunie 2024, privind completarea ghidul solicitantului
[xxi] BPIE (Buildings Performance Institute Europe) (2021). Deep Renovation: Shifting from exception to standard practice in EU Policy.
[xxii] Ministry of Regional Development and Public Administration (currently MDPWA), 2013, ORDIN pentru aprobarea Procedurii de control al statului cu privire la aplicarea unitară a prevederilor legale privind performanța energetică a clădirilor și inspecția sistemelor de încălzire/climatizare – indicativ PCC 001-2013.
[xxiii] Law no. 372/2005
[xxiv] MDPWA, 2021 Analiza Diagnostic privind Stadiul Actual Existent în România pentru Atingerea Nivelurilor NZEB în Renovarea Fondului Construit Existent și în Construirea Clădirilor Noi
[xxv] State Inspectorate in Constructions, 2016-2023, Inspection reports

[xxvi] Mahdavi, A., Berger, C., Amin, H., Ampatzi, E., Andersen, R. K., Azar, E., ... & Verbruggen, S. (2021). The role of occupants in buildings' energy performance gap: myth or reality?. *Sustainability*, 13(6), 3146.
Ebuy, Habtamu Tkubet, et al., (2023), "Occupant Behavior Impact on Building Sustainability Performance: A Literature Review." *Sustainability* 15.3, 2440.
[xxvii] Mulville, M., Jones, K., and Heubner, G. (2014). The potential for energy reduction in UK commercial offices through effective management and behaviour change. *Archit. Eng. Des. Manag*. 10, 79–90.
[xxviii] Hong, T., and Lin, H.,2013, Occupant Behavior: Impact on Energy Use of Private Offices. Report. Berkeley, CA: Ernest Orlando Lawrence Berkeley National Laboratory.
[xxix] News.ro, 2024, România are peste 240 de mii de clădiri publice al căror consum de energie depăşeşte cu mult media recomandată la nivel european. Dacă s-ar respecta standardul european, s-ar obţine o economie de peste 6 miliarde de lei anual
[xxx] Unlock Research, Habits, 2022, Studiu de măsurare ecogesturi
[xxxi] Eurostat, 2023, How much time per week do Europeans usually work?
[xxxii] Palm, J., Reindl, K. Understanding barriers to energy-efficiency renovations of multifamily dwellings. *Energy Efficiency* 11, 53–65 (2018).
[xxxiii] Trading Economics, 2024 Romania - Construction cost index; Arena Construcțiilor, 2023, Multiple provocări pun presiune pe costurile de proiectare şi execuție
[xxxiv] Herring, H. (2004). Rebound effect of energy conservation.
[xxxv] Sunikka-Blank, M., & Galvin, R. (2012). Introducing the prebound effect: the gap between performance and actual energy consumption. *Building Research & Information*, *40*(3), 260–273.
[xxxvi] Bucată, Roxana (2024) Transformări socio-ecologice în România
[xxxvii] Mahdavi, Ardeshir, et al. 2021, "The role of occupants in buildings' energy performance gap: myth or reality?." *Sustainability* 13.6, 3146.
[xxxviii] IEA, 2017, The global ESCO market

OUR-CEE
Overcoming Underperforming Renovations in Central and Eastern Europe

OUR-CEE (Overcoming Underperforming Renovations in Central and Eastern Europe) is part of the European Climate Initiative (EUKI) of the German Federal Ministry for Economic Affairs and Climate Action (BMWK).

EPG
EnEffect
Regional Energy Agency North
POLSKA SIEĆ Energie Cités