CEB
COUNCIL OF EUROPE DEVELOPMENT BANK
BANQUE DE DEVELOPPEMENT DU CONSEIL DE L'EUROPE

EVALUATION PERSPECTIVES

Improving energy efficiency in housing: Why evaluation matters

October 2024

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ISSN 2710-0081 (print)
ISSN 2710-009X (online)

Evaluation Perspectives Series

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Issues of this series consist of working papers aimed at communicating the result of an analytical work with the objective of fostering further discussions on the papers' topics.

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Please cite this publication as:
CEB Office of Evaluation (2024). Improving energy efficiency in housing: Why evaluation matters. Evaluation Perspectives Series, Council of Europe Development Bank, Paris, France.
https://coebank.org/en/news-and-publications/ceb-publications/CEB-Improving-energy-efficiency-in-housing/

Acknowledgements
The authors gratefully acknowledge the contribution of Marine Juster, former EVO intern, and the valuable comments received from the CEB's Executive Office, Loans & Social Development Directorate and Technical Assessment & Monitoring Directorate.

Layout and editing
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Executive summary

The buildings sector is a major contributor to greenhouse gas emissions, including in Council of Europe Development Bank (CEB) member states. While new buildings meet higher energy standards, the Paris Agreement targets are unachievable without improving the energy efficiency of the existing building stock at significantly accelerated rehabilitation rates.

Political commitment to this goal is reinforced by United Nations resolutions, European Union regulations and national legislation, especially in a context of energy shortages and price spikes. Achieving the required rehabilitation rates requires massive investments beyond public funding capacity. It necessitates leveraging public financing with private investments.

The low energy performance of housing entails an important social dimension, as low-income households are the most vulnerable to energy poverty. Energy-poor households see their living standards decline due to their lack of access to essential energy services. This has led governments and European institutions to allocate considerable amounts of funding to support the renovation of private homes or public social housing facilities occupied by low-income tenants.

The needs for energy efficiency in residential buildings are often well identified, but it is less common that these savings are verified. This issue of the CEB's *Evaluation Perspectives* series focuses on the importance of systematically evaluating publicly funded energy efficiency programmes in order to gain knowledge of the results achieved and use these findings to improve the design, technical specifications and implementation of future programmes. This helps to distinguish underperformance for technical reasons from rebound effects due to behavioural changes, i.e. residents increasing heating because it is no longer lost. At a time when public authorities throughout Europe are making considerable policy and budgetary efforts for energy efficiency investments, better knowledge of which programme aspects achieve the greatest energy efficiency gains offers an untapped potential to do more with scarce resources.

Many European countries have launched national housing renovation programmes, and the CEB, along other multilateral development banks, have contributed financing to accelerate rehabilitation rates. Nonetheless, these rates and the depths of renovations remain far below the requirements to reach targets in time and on a sufficient scale. Independent evaluations underline the importance of ensuring that publicly funded energy efficiency-oriented housing renovation programmes are duly assessed for realised energy savings, rather than merely relying on modelled energy savings projections. This would not only satisfy accountability needs, but also enhance the learning from these programmes' actual environmental and social results.

Better knowledge about the realised energy savings would equally serve policy makers, public financiers, rehabilitation programme commissioners, implementers and technical experts. Public authorities and stakeholders would thus gain evidence, beyond mere reporting of incurred public spending, on the actual contribution of that spending to achieving progress towards public policy objectives.

This should contribute to avoiding the fallout of inefficient policies, such as the untargeted subsidisation of rehabilitation expenses, that undermines the possibilities to reach the scale of investment necessary to achieve climate objectives. The gathered information would also allow to appreciate the extent to which public expenditures achieved social effects for vulnerable population groups.

Acronyms and abbreviations

€	euro
$US	United States dollar
BDB	Bulgarian Development Bank
BISE	Bank for Socio-Economic Initiatives (Poland)
CEB	Council of Europe Development Bank
CO_2	Carbon dioxide
EU	European Union
GHG	greenhouse gas
HOA	homeowners' association
KfW	KfW Development Bank (Germany)
MDB	multilateral development bank
MFB	multifamily building
MRDPW	Ministry of Regional Development and Public Works (Bulgaria)
MSME	micro, small and medium-sized enterprise
NDC	Nationally Determined Contribution
NPEE	National Programme for Energy Efficiency (Bulgaria)
TMF	Thermo-Modernisation Fund (Poland)
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

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Introduction

The Council of Europe Development Bank (CEB) supports social cohesion within its 43 member states in view of balanced and environmentally responsible socio-economic development. Improving access, in particular of vulnerable populations, to adequate, safe and affordable housing, as spelt out under the UN's Sustainable Development Goal 11, has remained at the core of the Bank's mission.

In this context, improving energy efficiency in housing is viewed as an important yet highly challenging objective to attain not only in view of enhancing housing conditions and affordability, but also of addressing CEB member states' commitments to limit global warming under the Paris Agreement on Climate Change adopted in 2016. This objective gained further relevance and urgency throughout Europe following Russia's military aggression against Ukraine and subsequent spike in energy prices, bringing further to light the financial and social costs of energy dependency and the low energy performance of older housing in most European countries.

The sheer scale of energy efficiency investments needed to rehabilitate the housing stock across CEB's member states requires long-term public support and leaves little room for wasteful use of public funds. Unfortunately, in many instances, it has been difficult to prove the extent to which public support programmes actually reduced real energy consumption and whether the incurred public expenditure matched the expected benefits. The sharing of experience from successfully designed and implemented renovation projects may in this regard be particularly useful to help scale up public support programmes that generate positive outputs and outcomes in terms of enhanced energy-efficient housing conditions.

This issue of the Evaluation Perspectives series is inspired by evaluations of housing renovation investments aimed at improving energy efficiency carried out by the CEB's independent Office of Evaluation. The paper makes the case for more systematically assessing the actual energy efficiency gains obtained through housing rehabilitation programmes, rather than merely relying on modelled extrapolations of expected reductions in energy consumption. Systematically incorporating an evaluative stance into the design, implementation and monitoring of such public support programmes would allow policy makers, implementers and their financing partners to gain evidence on what works in order to deliver more impactful and sustainable environmental and socio-economic results.

Chapter 1 points to the importance of improving the energy efficiency of the housing stock in the CEB member states. Chapter 2 underlines the need for publicly supported housing rehabilitations to deliver tangible results. Chapter 3 summarises findings from two CEB evaluations aimed at improving energy efficiency of buildings. Finally, Chapter 4 distils lessons in view of enhancing the efficiency, effectiveness and impact of future similar programmes.

The importance of energy efficiency in buildings

Energy efficiency in the context of the climate crisis

The buildings sector (residential, commercial and public buildings) is the largest energy consumer in the European Union, accounting for 40% of total energy consumption and 36% of total greenhouse gas (GHG) emissions (European Commission 2020).

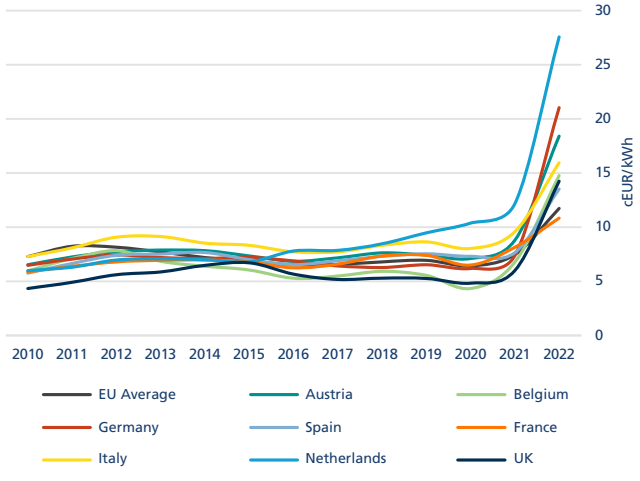
Improvements in construction technology and the compliance with updated building regulations make it possible today to conceive and build housing with very high energy performance standards, including passive house standards.[1] Given the low annual rate of new constructions, the greatest potential for energy savings lies within the existing housing stock. Improving energy efficiency in existing buildings is thus essential for the CEB member states to deliver their Nationally Determined Contributions (NDCs)[2] to the United Nations Framework Convention on Climate Change (UNFCCC) as well as for the EU to achieve its objective of reducing GHG emissions by 80-95% by 2050 compared with the 1990 level. In fact, improving energy efficiency in housing would generate multiple socio-economic benefits that go beyond reduced energy demand and GHG emissions.

Energy efficiency first appeared on the EU agenda during the 1970s oil crises and has since then gained impetus as a driver to help achieve the EU's climate ambitions. The European Commission has recently revised its Energy Efficiency Directive as well as other energy and climate rules with the aim of ensuring that the EU's target of reducing GHG emissions by at least 55% below 1990 levels by 2030 can be met. The revised directive adopts "energy efficiency first" as a legally binding principle of EU energy policy entailing that energy efficiency must be considered by EU countries in all relevant policy and major investment decisions.[3] The directive points to the huge energy savings potential of buildings considering that 75% of the EU's building stock has a poor energy performance. The challenge remains to turn these policy commitments into effective action.

Growing constraints on energy access

Russia's war against Ukraine shed a light on many European countries' overdependence on external energy sources. This situation has put severe pressure on energy access, especially gas, and related electricity prices, reaching record levels across Europe in 2022 (Figure 1).

Figure 1 Household natural gas prices in the Eurozone



Source: Allianz Research (2022).

Note: cEUR = euro cents; kWh = kilowatt-hour.

1. The passive house or Passivhaus concept developed in the 1990s by, among others, Dr Wolfgang Geist is a building and certification process that ensures the construction of sustainable housing structures that require very low levels of energy to achieve comfortable temperature levels all year round without the need for conventional heating and/or air conditioning.
2. NDCs are climate action plans submitted by countries outlining their efforts to reduce national emissions and adapt to the impacts of climate change. These plans are submitted to the UNFCCC.
3. Ref. Directive (EU) 2023/1791 on Energy Efficiency, September 2023. This directive was first adopted by the European Parliament and the European Council in 2012; it was updated in 2018 and 2023, setting rules and obligations for achieving the EU's energy efficiency targets. This directive is part of a broader policy framework of energy efficiency policies addressing energy efficiency potentials in specific policy areas, including buildings (Directive 2010/31/EU). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023L1791&qid=1702308603325

Energy market disruptions and price hikes required public intervention to support populations that risked not being able to meet basic energy needs.

In such a context, aiming for energy efficiency in housing buildings was not driven so much by environmental concerns, but mostly by efforts to alleviate energy poverty and dependency on foreign energy sources.

Vulnerability to energy poverty is increasing due to rising energy prices, the effects of the economic recession and the substantial share of homes with low energy efficiency.

Energy poverty in Europe

Energy shortages and rising energy prices have amplified the existing energy poverty and pushed additional population groups into that category. A recent study estimated that the number of households in energy poverty in the EU increased by more than 50% until June 2022 (Allianz Research 2022). Many governments have been trying to alleviate the increase in energy poverty by providing energy price subsidies. But such subsidies are particularly costly and offer only short-term relief without addressing the root of the problem.

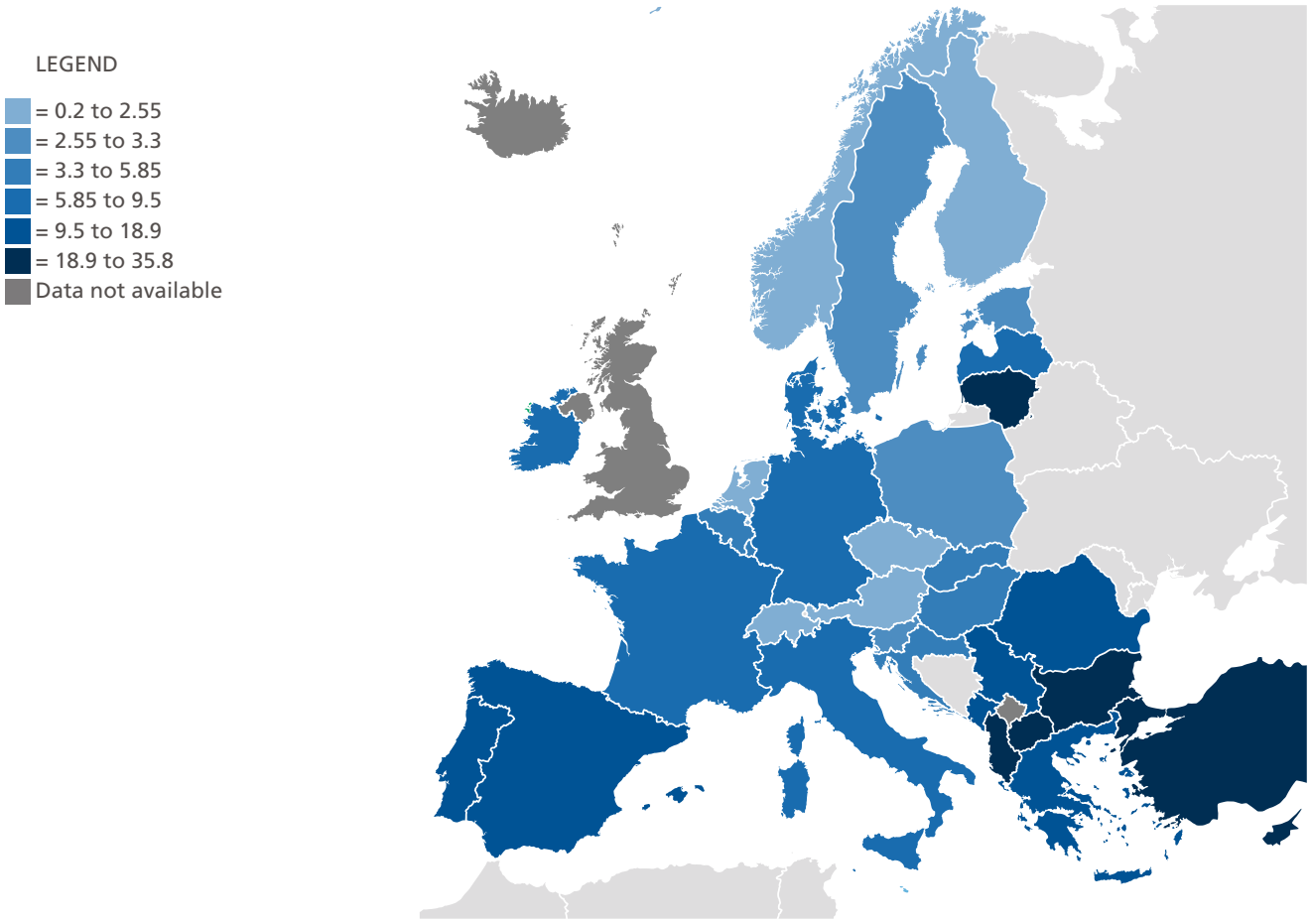
Box 1 Definition of energy poverty

Energy poverty is defined by the EU as "a household's lack of access to essential energy services, where such services provide basic levels and decent standards of living and health, including adequate heating, hot water, cooling, lighting, and energy to power appliances, in the relevant national context, existing national social policy and other relevant national policies, caused by a combination of factors, including at least non-affordability, insufficient disposable income, high energy expenditure and poor energy efficiency of homes."
Source: EU Directive 2023/1791, 13 September 2023
https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023L1791

Fifty million households in the EU are estimated to live in energy poverty (ODYSSEE-MURE 2021a), with the highest energy poverty rates being found in southern and central-eastern Europe (Figure 2).

In this context, fighting energy poverty has become a top priority for the EU and the CEB member states in order to enhance their resilience and social cohesion. Supporting energy efficiency of buildings could, alternatively, provide a longer-term solution by helping reduce households' energy bills and need for subsidies while improving their overall living conditions.

Figure 2 Inability to keep home adequately warm (% of population) 2020



Source: Greens/EFA (2022)

A challenging scope of rehabilitation needs

The need for deep renovation of the residential building stock

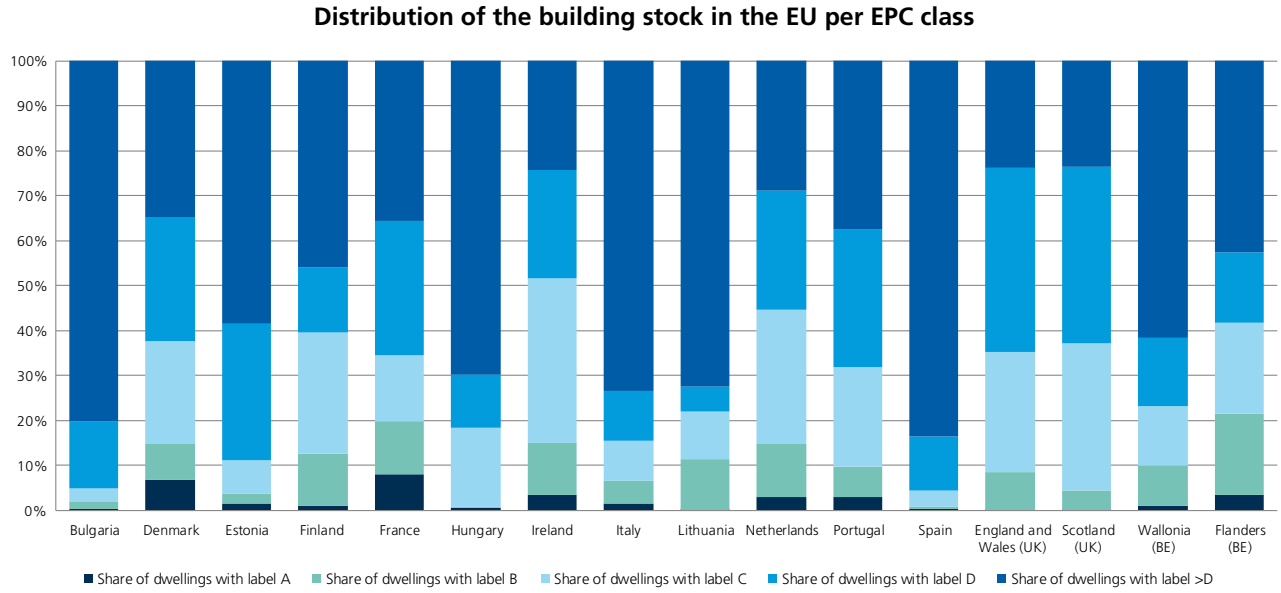
Box 2 The concept of 'deep renovation'

The EU often refers to 'deep renovation' in its policy documents. However, there is no official definition of deep renovation as state-of-the-art standard for a building's rehabilitation to achieve the highest possible level of energy savings. Independent experts consider deep renovation as a rehabilitation process that captures "the full potential of a building to reduce its energy demand, based on its typology and climatic zone. It achieves the highest possible energy savings and leads to a very high energy performance, with the remaining minimal energy needs fully covered by renewable energy. Deep renovation also delivers an optimal level of indoor environmental quality to the building occupants". *Source: BPIE (2021)*

Substantially reducing energy expenditures requires comprehensive improvements of older buildings. Such deep renovation (defined in Box 2) is of critical importance for reaching the EU's climate goals and sustainably lifting people out of energy poverty, since small-scale individual measures have modest effects for the energy performance of buildings. Referring to the data from the European Building Stock Observatory, 38% of residential buildings across EU member countries were built before 1970 (RICS 2020). It shows the significant level of renovation needed for the EU building stock to reach the agreed energy efficiency

targets. The same source estimated that only 12% of the EU's residential building stock has been renovated to meet climate change targets, while 35% of buildings have an energy performance certificate rating between D and G, with class G being the least efficient.[4] Figure 3 illustrates the distribution of energy performance classes for a selection of European countries that paints an even more negative picture (BPIE 2017). Research from 2016 estimated that annual major renovation rates for buildings ranged from less than 0.5% for Spain, Poland and Belgium to above 1.5% for Germany, France and Norway ("ZEBRA 2020" 2016:13), and the current definition of 'major renovations' is less ambitious than what is considered a 'deep renovation'. In order to reach emissions reduction targets, the deep renovation rates would have to be increased to 3% per year; they stand at about 0.2% annually at present (BPIE 2021).

Figure 3 Distribution of the building stock of selected European countries per energy performance certificate class



Source: see BPIE (2017)

Increased incentives for consumers to reduce energy consumption and to renovate buildings are crucial demand-side measures. Parallel investments in clean energy and innovations to expand the supply of green energy can moderate energy price increases in the long term. This transition requires funding substantial upfront investments, though. The combination of both measures may help reduce energy poverty in the long term, while demand-side measures may provide more efficient short-term relief.

Energy efficiency investment needs

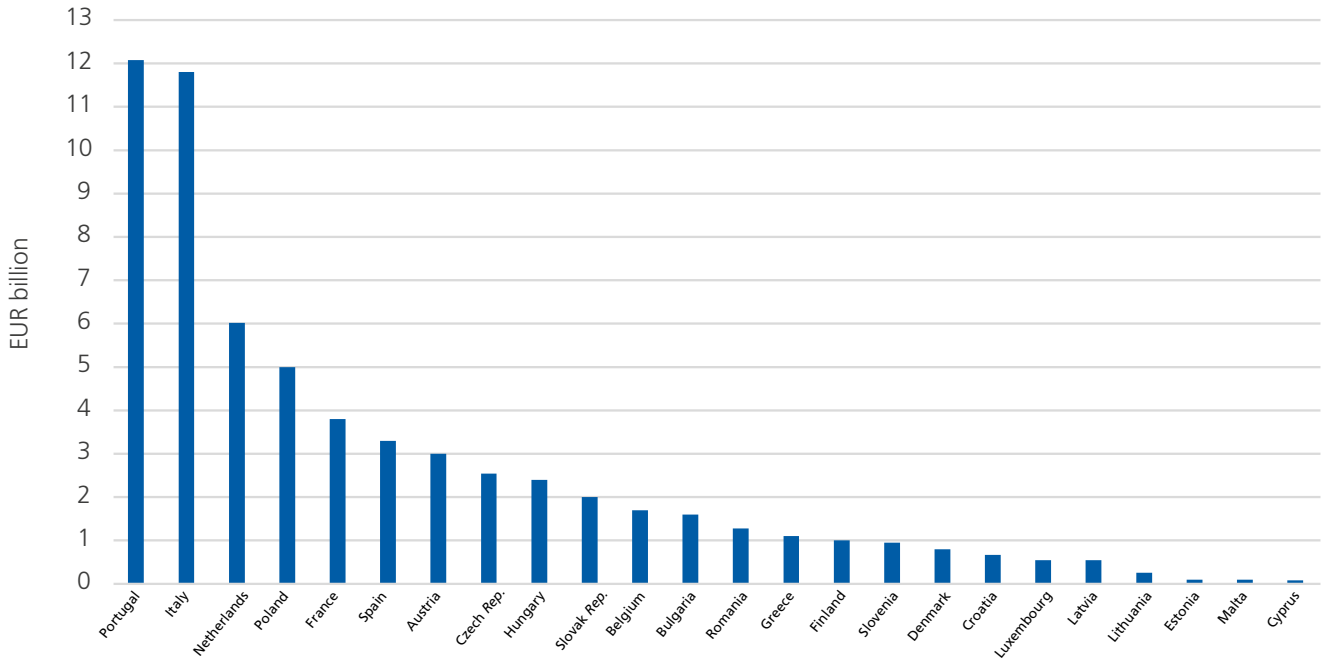
Carrying out renovations to high energy performance standards (insulation and greening of facades, high insulation levels, efficient windows, efficient cooling, solar photovoltaic, etc.) – so-called deep renovation – requires appropriate investments. Energy efficiency measures generally encompass improvements in the building envelope (external walls and roof), though its potential depends on the building type. Improvements are limited, or at least costly, in the case of many historic buildings. Investing in the technical building systems (space heating and cooling) likewise generally increases energy efficiency, though when rehabilitation introduces new cooling systems, the net energy demand may even increase. Through the installation of renewable sources for energy production (thermal energy and electricity), carbon dioxide (CO_2) emissions will directly decline, while the GHG savings benefit from improved building insulation by itself will be reduced (compared with similar insulation in buildings remaining on fuel-based energy provision). The energy efficiency-related investment costs for Europe to comply with the 2030 framework of 40% GHG reduction has been estimated by EIB at €1.1 trillion, of which 75% is for building rehabilitation.

4. A recent study modelled how closely the predicted energy use between different dwelling sizes matched those predicted by the building energy performance classes in France, by combining them with bank-provided anonymised energy bill information. See: Astier et al. (2024).

Figure 4 presents the annual energy efficiency investment needs of various EU countries over the 2021-2030 period.

The non-EU CEB member states are not considered in most comparative analyses, but some studies confirm a large-scale renovation deficit. About one-third of energy consumption in Türkiye stems from public, commercial and residential buildings, whereby residential buildings account for the largest share of this demand. Given the mix of the energy supply system, nearly 76% of the energy demand is covered by fossil fuels. One study estimated an additional investment potential of €3.2 billion over the estimated current levels of €6.2 billion for energy efficiency technologies in Türkiye (GIZ 2018). Three-quarters of this investment gap concerns the residential sector, and around 60% would need to be invested in renovating the existing building stock.

Figure 4 Annual energy efficiency investment needs in EU countries over the 2021-2030 period



Source: see fi-compass (2020)

Georgia committed in its NDC to a 15% reduction of GHG emissions by 2030. The National Energy Efficiency Action Plan estimated gross investment needs for energy efficiency at $US 8.3 billion between 2017 and 2030 (OECD 2018 and GREEN Action Task Force 2016). To implement its Low Emission Development Strategy, an additional $US 10.6 billion is needed for energy efficiency and non-energy related GHG emissions, among others.

In the Republic of Moldova, 70-75% of the existing stock of energy infrastructure assets are in poor condition (Energy Strategy 2030 Moldova), and about 60% of final consumption is related to the buildings sector. A national action plan has been developed in response, aimed at increasing the number of near-zero energy buildings (see www.energy-community.org/). The National Energy Efficiency Project budgeted €75 million for the renovation of public buildings across the country by 2022.

CEB engagement to improve energy efficiency

Development finance institutions can play a major role in financing emissions reductions in multiple sectors and trigger multiplier effects compared with their own lending activities. Multilateral development banks' (MDBs) climate finance in 2020 exceeded $US 65 billion and thus represented nearly 30% of their total financing (IEA 2021).

In recognition of the social dimension of improved housing, the CEB has been supporting investments aimed at improving the energy efficiency of residential buildings for many years. In the last decade, the CEB has approved about €10 billion in favour of projects targeting energy efficiency improvements.

The need for delivering energy efficiency results

Public programmes to improve energy efficiency in housing

The residential housing sector varies across CEB member states, as it was historically influenced by either market economy or state economy systems. This legacy still shapes the diverse characteristics in the housing supply. Many former Central and Eastern European states, for example, have experienced their residential housing evolving from predominant state ownership to extremely high rates of owner-occupancy.

This is important in the context of energy efficiency rehabilitation, since it gives a very different role to the occupants in the decision-making process and responsibilities. Owner-occupants derive direct benefits from improving the energy performance of their residence in terms of an asset value increase and the reduction of energy expenditures. In the case of rented housing, tenants generally benefit from reduced energy expenditures and owners from the asset value increase. As owners finance costs, the decision whether to undertake the rehabilitation is influenced by diverging interests and perceptions of urgency between both parties.

The energy price crisis made residents more interested in the rehabilitation of their dwellings. However, rehabilitation rates still remain insufficient to match national policy expectations or international obligations for GHG reductions. The current higher interest rates counterbalance former incentives with increased funding costs for rehabilitation investments, hence the continued justification for public support programmes to complement private rehabilitation incentives.

Public financial support can be in the form of grant payments, soft lending terms (interest rate subsidies/grace periods) or the reduction of collateral standards.

First, public support can serve to bridge affordability gaps for financing rehabilitation costs, thus helping vulnerable populations benefit from decent housing that require lower energy expenditures on a long-term basis. This would constitute a sustainable social effect while alternative transfer payments through energy cost subsidies are unlikely to be sustained.

Second, public support can help accelerate decisions for homeowners to undertake rehabilitation works. It can indeed serve as a catalyst to increase rehabilitation rates in the case of owners who have the capacity to finance their buildings' renovation costs on commercial terms. Rehabilitation rates can be reduced for various non-financial reasons such as owners' uncertainty about the stability of public support commitments, technological uncertainties, supply disruptions or the shortage of skilled construction labour.

The third reason to improve energy efficiency of buildings is not based on the energy savings intention, but focuses on the policy objective of GHG reductions as a national contribution to the global climate change mitigation targets. These policy objectives are beyond the scope of energy cost calculations of homeowners. The increasing use of 'CO_2 pricing' as an environmental economic instrument provides incentives to internalise GHG-related environmental externalities into private decision making. They may accelerate to some extent homeowners' investment decisions. However, the time horizon until such prices will reach homeowners is too long compared with the time horizon of international GHG reduction targets.

Suitably targeted public support can accelerate and boost GHG reductions by bridging the gap between homeowners and the general public's interests in rehabilitation.

The owners of rental housing differ in their rehabilitation interests compared with owner-occupants who would directly benefit from their homes' renovation. This therefore presents the additional challenge of how to trigger the interest of rental homeowners in renovation works that will primarily benefit their tenants (as reduced heating expenditures do not affect rental homeowners). In Germany, for example, private owners were encouraged to invest in improved energy performance by allowing an increase in rents to compensate for investment costs. However, a debate ensued whether rent increases should be permitted in a market where affordable housing is in permanently scarce supply. The increased asset value and improved rental value after rehabilitation may materialise only in the long term and thus be an insufficient incentive to accelerate rehabilitation rates. The different response mechanisms between private and public owners (cooperatives, municipal or national public housing) affect which support mechanisms are likely to accelerate rehabilitation decisions.

This paper focuses specifically on the rehabilitation challenges for the existing housing stock. In this regard, the particular challenge that applies to buildings of historic and cultural value must be underlined: these buildings are often characterised by external features such as decorative elements on facades, elaborate windows or roof designs that render improvements of energy efficiency particularly costly and technically complex. In these cases, individual designs may improve energy performance somewhat. However, they will not achieve a final performance that is feasible for buildings with simple architectural features (such as large prefabricated buildings). For example, the most cost-efficient external facade insulation is technically unfeasible for buildings with stucco or other decorative elements. Policy support measures need to consider in these cases the higher investment costs to reduce energy consumption, in order to protect the aesthetic values that are also in the public interest.

The role of evaluation

At MDBs, such as the CEB, independent evaluation is an important accountability tool that serves, among others, to establish or verify the results achieved through lending operations. At the same time, it provides an important learning opportunity to contribute to lessons and issue recommendations for future operations. Energy efficiency rehabilitations are often undertaken under large-scale public support schemes that are co-financed through various national and international funding channels. In this context, independent evaluation assesses results with a primary focus on the provided investment loan, while also reflecting on how the framing policies and procedures favoured or hindered the effectiveness and efficiency of achieving results. The purpose is to determine results, while also examining possible improvements to implementing arrangements or assessment frameworks.

Depending on the evaluation's targeted user, it may also aim to raise awareness of policy makers on the need to enhance the design of public policies and programmes; to inform policy implementers about practical constraints that hinder or delay implementation; to suggest adjustments to design features or technical specifications; to improve stakeholder interaction; or to help identify possible solutions to remedy suboptimal use of public funds.

Policy makers and implementers generally establish their own monitoring systems in order to keep track of the operational delivery and assess whether a policy or project is running effectively. In addition, the self-evaluation process may look for evidence of causality, through the specific methodology of 'impact evaluation'.[1] However, independent evaluation processes go beyond this by also assessing their larger impact and from a longer time horizon, thus being able to draw on a stronger evidence basis.

1. The assessment of 'impact' as the ultimate development result of an intervention – defined by the Organisation for Economic Co-operation and Development as the higher-level, long-term and final results – is not to be confused with the search for evidence of a cause-effect relationship between a support measure and the expected results. See Duflo and Kremer (2003).

Box 3 European Court of Auditors' call for increased cost-effectiveness of energy efficiency investments in buildings

'We assessed whether EU co-funded energy efficiency investments in buildings had cost-effectively helped the EU toward its 2020 energy saving target. We concluded that the operational programmes and the project selection were not driven by a cost-effectiveness rationale. While Member States required buildings to be renovated to save a minimum of energy and improve their energy rating, this sometimes happened at a high cost. Because of a lack of comparative assessment of project merits and of minimum/maximum thresholds for cost-effectiveness, projects delivering higher energy savings or other benefits at lower cost were not prioritised. We recommend improving the planning, selection and monitoring of the investments to improve the cost-effectiveness of the spending.'

Source: European Court of Auditors (2020).

Evaluation can provide targeted lessons for various stakeholders in view of their different roles in designing, implementing and reporting about results. Ultimately it is national governments and institutions that are accountable for showing results of their policy support measures. At times of crises, these institutions are under pressure to quickly implement support measures that can imply a trade-off with achieving long-term results. One such example are publicly financed energy price subsidies, as they affect the financing possibilities for programmes aimed at reducing energy consumption in the longer term.

Range of benefits from energy efficiency investments

In order to improve energy efficiency investments, the designers of policy measures need to consider that two beneficiary groups differ in their motivating factors for programme participation. The deep renovation of buildings always requires some complementary works that constitute aesthetic improvements equivalent to general building maintenance, such as facade renovation. The frames below list such types of benefits for residents compared with the general public, with energy-related and environmental benefits shown in blue and general benefits in black. To some extent, low rehabilitation rates can be explained by divergences in priority concerns driving rehabilitation decisions and differences in perception of urgency (in economic terms 'time preferences') between residents and public actors.

Note: blue text indicates direct energy/environmental benefits, black colour indicates general rehabilitation benefits. Some benefits, such as those for public health and air pollution, are highest when energy provision is based on coal or wood.

Source: adapted from European Commission, Directorate-General for Energy (2022)

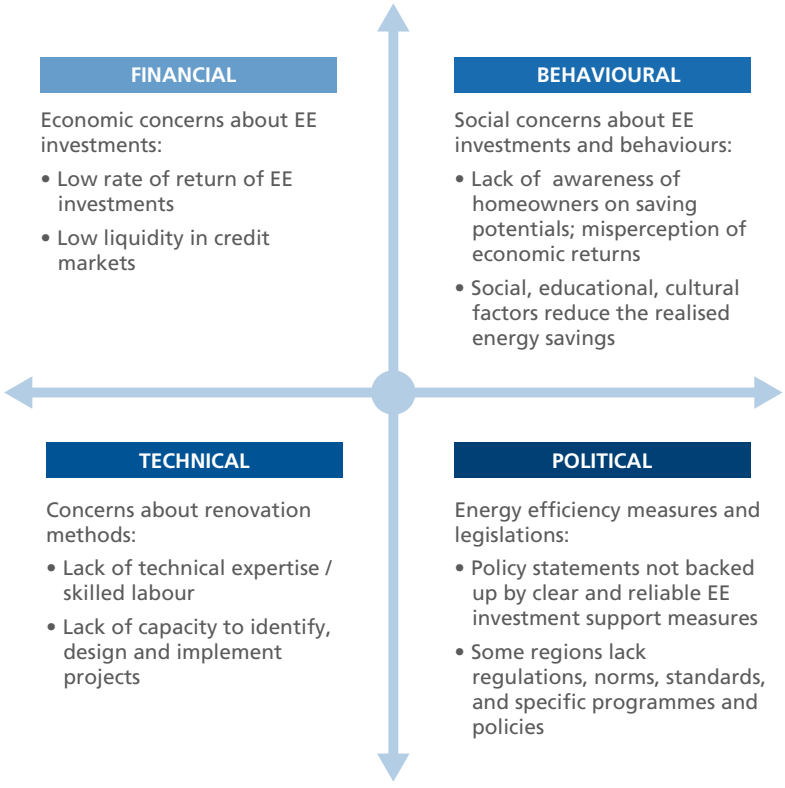
Barriers to undertaking energy efficiency investments

The mere fact that the above-cited high share of residential buildings remains at low energy performance levels indicates that the situation is not amenable to improvement through market forces alone. Low energy performance might have been rational in past decades for building owners due to low energy prices and high levels of public intervention in rental as well as energy markets. However, increased awareness of the global climate challenge and energy market turmoil have jointly rendered the need for accelerated rehabilitation evident. Understanding the different types of barriers is needed to design effective policies.

Public policy actors need to directly consider the financial and political barriers in the design of their support instruments, while identified behavioural factors need inclusion of complementary measures such as improved public awareness and communication strategies. The technical barriers require measures to increase and adapt the professional skills at enterprise level and encourage innovation in the construction sector. These barriers result in energy efficiency renovation rates below the social optimum and require appropriate public policy interventions (Figure 5).

These potential barriers can be studied in a hierarchical manner:

Figure 5 Main barriers to accelerated energy efficiency investments



Source: Adapted from Bagaini et al. (2020)

Note: EE = energy efficiency

SHOULD an energy efficiency rehabilitation measure be carried out from a financial perspective? Dwelling owners can be expected to implement rehabilitations only if expected energy savings justify the investment costs. If they are financially unviable, only support measures that bridge this financing gap will trigger a positive rehabilitation decision.[2]

2. Energy price subsidies and other types of induced energy market distortions can in fact create disincentives for privately financed rehabilitations.

COULD a dwelling owner afford to invest in rehabilitation measures? This dimension addresses liquidity constraints of owners that could prevent measures despite being financially rational. Apartment owners in large buildings could also face barriers to implement their rehabilitation preference due to financial or organisational constraints in their co-ownership.

WOULD a dwelling launch rehabilitation measures, if financial and liquidity constraints have been resolved? This dimension captures a diversity of behavioural factors that need to be identified *ex ante* through sociological analysis or through the evaluation of motivational factors behind slow implementation of support programmes. They could range from misbelief in the effectiveness of renovation methods, short-term consumption preferences (or needs) preventing agreements to rehabilitate, or simply, for instance, elder people fearing excessive disturbances from the renovation process compared with a short-lived expected benefit.

Various buildings and their ownership structures will affect their placement in the above three categories, also influenced by the intended designs of rehabilitation measures. Rehabilitating large panel buildings and their economies of scale will be much easier to justify from a private investor perspective than historic buildings requiring technically complex and costly rehabilitation designs. Obviously, the non-financial benefits in terms of energy cost savings, such as the aesthetic improvement of buildings, the increase in building value or local environmental benefits, will facilitate a positive rehabilitation decision. These will depend on the level of environmental awareness of owners, and whether their financial means allow them to make these the decisive factor to sign up for rehabilitation programmes.

Two case studies from CEB evaluations

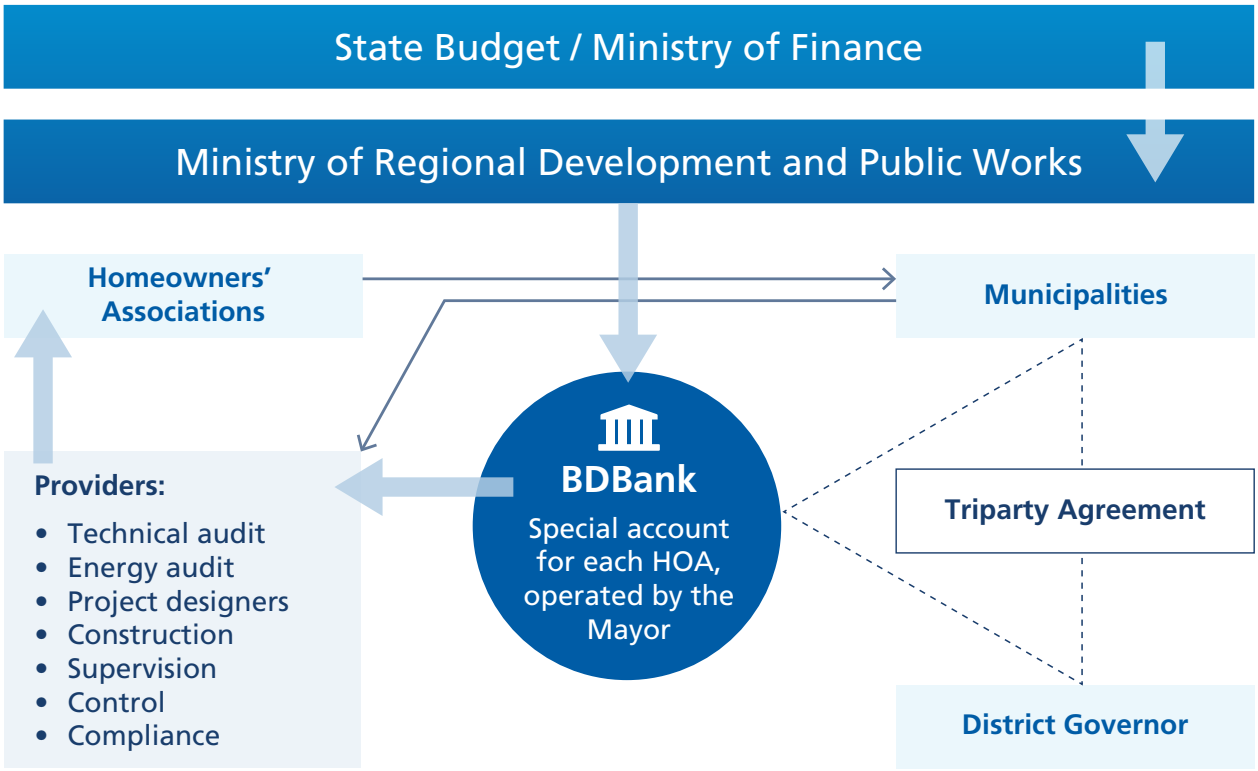
Bulgaria: The Bulgarian Development Bank and the National Programme for Energy Efficiency

Context of the evaluated rehabilitation programme

At the time of launching of the National Programme for Energy Efficiency (NPEE) in 2015, Bulgaria was the most energy-intensive economy in Europe, and the buildings sector contributed around 25% of the final energy consumption. The building stock includes an estimated 65 000 multifamily buildings (MFBs) constructed pre-1990. The Ministry of Regional Development and Public Works (MRDPW) showed in 2017 that an overwhelming share of non-renovated buildings (91%) had very low energy performance. In addition, these MFBs were in poor conditions due to a substantial maintenance backlog. The lack of organisation of homeowners' associations (HOAs) was identified as an important barrier for launching energy-focused renovation works.

The NPEE was the first large-scale programme to improve the energy efficiency in residential buildings, with an initial budget of €500 million that was doubled in 2017. The Bulgarian Development Bank (BDB) was the paying agent for the programme, and accepted applications from the HOAs through the municipalities. As the national development bank, BDB contracted loans from international development banks, such as the CEB and the German Development Bank KfW, to support the NPEE.

Figure 6 The role of the Bulgarian Development Bank in implementing the NPEE



Source: Bulgarian Development Bank (2022)

Box 4 The National Programme for Energy Efficiency – Bulgaria

Target beneficiary group and type of buildings concerned

All multifamily residential buildings of a minimum size in 256 Bulgarian municipalities were eligible to participate on a first-come, first-serve basis, provided owners submitted the required application documents.

Grant support mechanism

The Bulgarian state budget financed the €1 billion NPEE costs as grants, with no owner contributions required. This programme fully paid for the rehabilitation of privately-owned residential buildings.

Description of external programme support

The CEB and KfW provided loans to BDB to finance contractor payments until reimbursement from the MRDPW. The CEB's lending objectives were to improve energy efficiency, generate environmental benefits and reduce energy poverty. KfW's loan to the same programme was aimed at supporting employment in the construction sector of micro, small and medium-sized enterprises (MSMEs). Both international lending institutions contributed to improving energy efficiency through the same public support programme.

Specific implementation challenges

The NPEE mainly benefited owner-residents in large apartment buildings. Practical constraints included the lack of professional building administrations and maintenance funds. Residents had to register through an HOA which could not legally sign contracts or manage rehabilitation works. Municipal authorities thus acted as trustees in charge of works procurement and contract oversight. BDB was in charge of advancing and managing the cash flow of rehabilitation works.

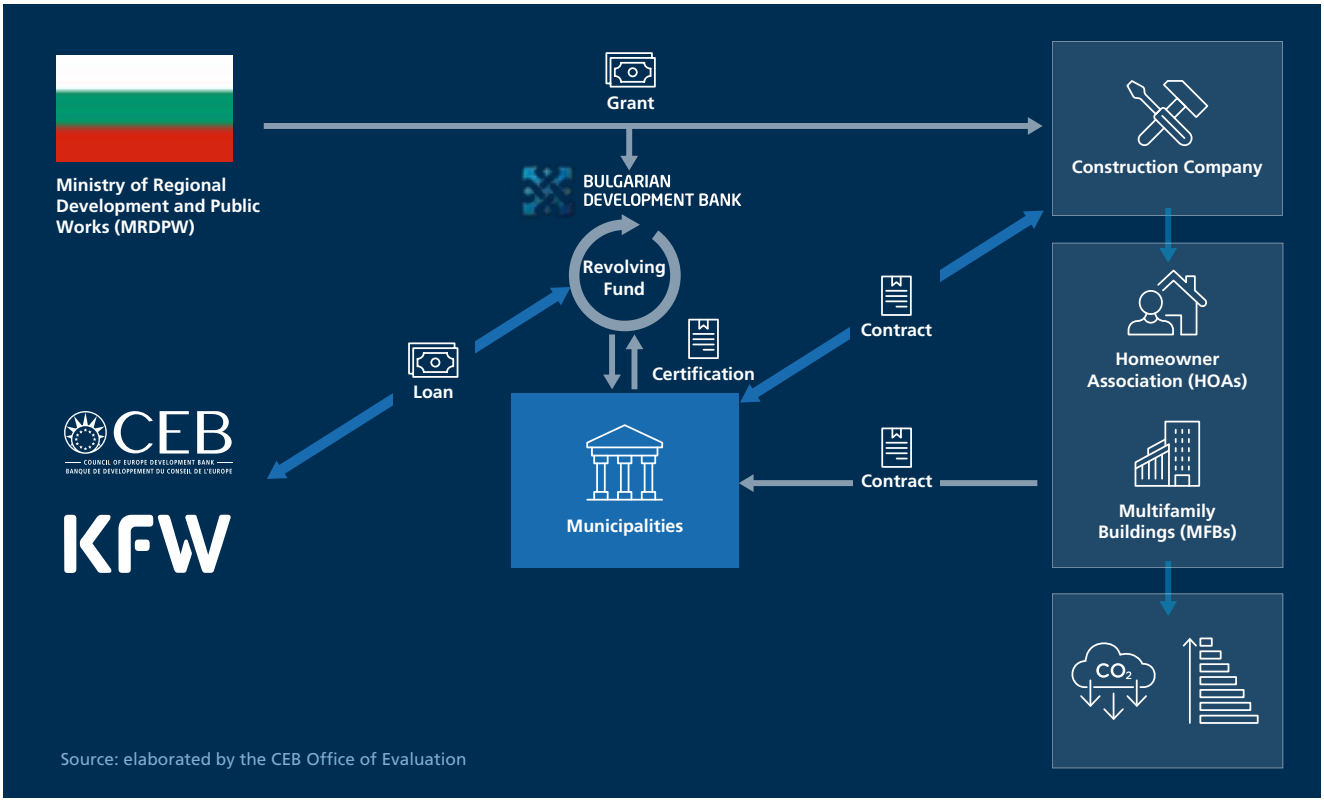
Type of expenses eligible for public funding

Eligible works, based on technical and energy audits, aimed for at least energy performance class C. Public sector stakeholders managed implementation, ensuring compliance with safety norms and financing necessary structural stability measures, electric installations and other modifications, such as raising balcony parapet levels.

CEB evaluation findings

In 2022, the CEB Office of Evaluation assessed the CEB's contribution to the NPEE. Detailed technical and financial data for 263 buildings assigned to the CEB loan of €150 million were available. The NPEE aimed to rehabilitate over 2 000 multifamily buildings. The BDB managed separate accounts for each building, based on cost estimates from energy and technical audits, with works contracts managed by municipalities. This system generated building-level data reported to the CEB.

Figure 7 The role of international loans to facilitate implementation of the NPEE in Bulgaria



The evaluation used this data and conducted a detailed analysis of 26 buildings, including a review of technical and energy audit documents, design of rehabilitations and inspection of works quality. A resident survey provided perceptions of the rehabilitation process and results. Owners were satisfied with the rehabilitation, noting significant improvements without incurring costs. Some warranty concerns were reported to municipal authorities which were continuing to mediate with contractors.

The evaluation lessons may assist national stakeholders in designing future programmes and policies. A novel financing model was launched, involving contributions from apartment owners pre-financed by energy service company loans, repaid through energy cost reductions. This new programme, transitioning from fully public financing to a market-oriented model, warrants close observation. Concurrently, EU-funded grant mechanisms continue, with the EU planning to invest over €800 billion through 2026, including €924 million in grants for improving energy efficiency in Bulgarian buildings.

Building level and technical issues

- All buildings were rehabilitated to meet energy class C specifications, though no *ex post* audits confirmed this. The achieved energy performance was however almost impossible to verify for residents, except the subjective perception affected by weather variations.
- Energy rehabilitation works need skilled labour. In a labour-scarce environment, improved verification at project completion should be considered. Thermal bridge verification through thermo-photography could enhance future work quality.
- Programme monitoring typically ends with the completion of works, failing to provide data on energy savings for future programme designs. Measured savings and cost reductions are necessary to study the effectiveness of technical specifications, requiring access to energy bills, especially in buildings with centralised heat distribution.

- Advanced financing models, such as on-bill schemes, include data collection systems for financing partners' benefit. However, the information gathered being usually confidential, it does not inform public administration for future programme improvements.
- The environmental impact of the NPEE was estimated only through *ex ante* energy audits, with no measured savings. Obligations for record-keeping and data sharing would help generate evidence on retrofit cost-effectiveness.
- A second, post-rehabilitation audit should certify the final energy class of buildings. This could be financed through public funds and included in renovation contracts.
- Improved data on how different designs affect energy savings could help focus funding on buildings with high cost-effectiveness, considering the marginal costs per unit of energy saved. This could help to define the optimal depths of rehabilitation works.

Policy and implementing agency dimension

- The NPEE renovated many large buildings, a significant achievement given the weak capacity of building administrations and inadequate legal framework for proper maintenance.
- Municipal authorities administered rehabilitation works and certified the use of public grant funds. Implementing the NPEE helped municipal staff learn to engage in contract specifications and renovation works supervision.
- Regulatory reforms should empower HOAs to raise maintenance funds and reduce subsidies, facilitating more extensive rehabilitation works.
- International loans provided BDB with the liquidity it needed to manage the rehabilitation accounts and pre-finance rehabilitation works. The CEB loan aligned with national priorities and facilitated NPEE implementation; it did not however influence programme design and implementation in a way that would have impacted efficiency and effectiveness.
- Rehabilitation works were 100% grant-financed. Replicating and upscaling rehabilitation works with such a support model is unlikely due to the extreme fiscal burden. Even with seemingly generous EU funds, the scale of outstanding rehabilitations should prompt stakeholders to seek more efficient use of public resources.

Residents or building owners dimension

- Municipal stakeholders and awareness-raising activities contributed to the successful rehabilitation of over 2 000 buildings, demonstrating the programme's positive impact without negative repercussions for owners.
- The NPEE provided residents and apartment owners with numerous benefits: energy savings, increased asset value, resolved maintenance backlogs and modernised technical installations. These benefits were extended without specific social targeting to a wide array of individuals, including pensioners and vulnerable families, but also better-off households and owners of vacant apartments.
- The lack of pre- and post-rehabilitation energy consumption and expenditure data makes calculating financial returns impossible. Record-keeping obligations and data access would help create evidence of retrofit benefits and cost-effectiveness. International financiers could support improved data collection by including incentives for results-oriented monitoring and evaluation systems in their appraisals and reporting requirements.

Poland: The Bank for Socio-Economic Initiatives and the national Thermo-Modernisation Fund

Context of the evaluated rehabilitation programme

In Poland, the CEB supported the Bank for Socio-Economic Initiatives (BISE, Bank Inicjatyw Spoleczno-Ekonomicznych) with three multi-sector loan programmes approved between 2000 and 2003 and implemented over one decade. BISE's mission is to promote the development of the Polish economy by supporting MSMEs as well as local infrastructure. The case study relates to a component of the CEB loan programmes focused on the energy efficiency-oriented renovation of 165 buildings for a total of €28 million. The CEB lending coincided with a period of intense regulatory reforms undertaken by the Polish authorities in the context of EU accession in 2004. Energy efficiency in the residential sector improved by a modest 0.4% annually, one-tenth of the improvement in industry between 2000 and 2018 (ODYSSEE-MURE 2021b), which confirms the continued relevance of improving the energy performance of residential buildings.

Box 5 The National Thermo-Modernisation Fund – Poland

Target beneficiary group and type of buildings concerned

Energy efficiency investments concerned private residential buildings, private health establishments and public buildings (mostly health and educational facilities). The majority of buildings were built before 1978.

Grant support mechanism

The dwelling owners were required to cover at least 25% of the total renovation project cost as owner contribution. The CEB loan refinanced up to 50% of the incurred rehabilitation costs to BISE which complemented the CEB funds with its own financing.

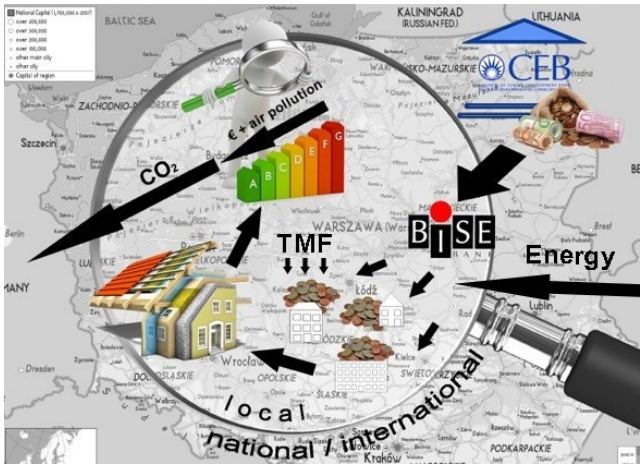
The energy efficiency loans were subsidised through a national mechanism, the Thermo-Modernisation Fund (TMF), which operated since 1998. For buildings' works deemed eligible following an energy audit (by a qualified firm that determined the required works and the expected energy savings), the TMF reimbursed homeowners up to 25% of the eligible investment costs after completion of the works. Eligible energy-saving investments included the thermal insulation of facades, roofs and basements as well as window replacements to reduce energy loss, but also central heating modernisation to improve energy provision. At completion, the TMF had provided funding for over 13 000 individual renovation investments.

CEB evaluation findings

The evaluation assessed the results of energy efficiency rehabilitations. It included desk-based analysis of the buildings' characteristics, scope and description of works, and financial data. This review was complemented by stakeholder interviews in Poland, site visits to building administrators and owner representatives, and gathering beneficiaries' views on improving future programmes. The evaluation aimed to show how building-level information can assess the financial and environmental efficiency of these investments.

Figure 8 illustrates the local and broader economic and environmental benefits. The primary gain for beneficiaries was future energy cost savings. Modernisation was generally due or overdue, improving comfort, aesthetics and asset value. Lower energy use reduces local air pollution and CO_2 emissions, depending on the heating energy source. Renewable energy sources are considered carbon-neutral, except for processing and transport-related emissions. Nationally, Poland relies heavily on coal and imported gas.

Figure 8 Local and national/international dimension of energy efficiency investments – Poland/BISE



Source: CEB Office of Evaluation
Note: TMF = Thermo-modernisation Fund

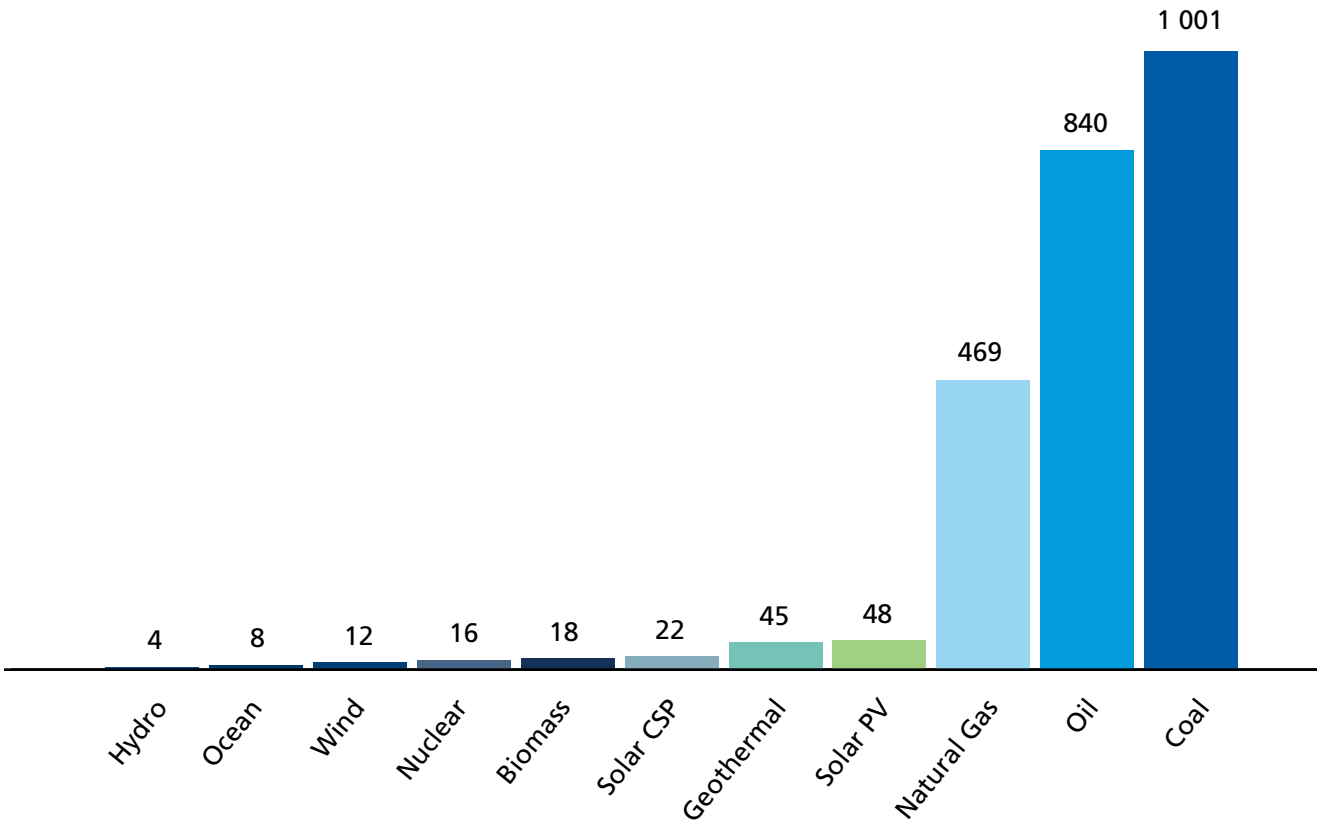
Understanding the link between energy efficiency and emissions reductions involves considering emissions from different energy sources. Of the buildings evaluated, 40% used coal, 30% gas, and 30% a combination of biomass and gas. Reducing energy consumption from lignite-based sources saves twice the CO_2 compared with natural gas. Avoiding biomass-based energy saves emissions only from the supply chain. Investment costs per avoided ton of CO_2 varied significantly between buildings, showing different environmental benefits from public transfers.

Reducing CO_2 emissions has little local benefit, but improved local air quality is noticeable if polluting fuels are avoided. Nationally, increased energy efficiency reduces energy import bills and dependency, justifying public grants to speed up energy-efficient renovations.

It is also important for a social development bank like the CEB to consider the social benefits of publicly funded energy efficiency investments. The evaluation recommended social targeting for selecting beneficiaries in future programmes, balancing environmental objectives with social and distributional considerations. The following list ranks arguments for public support from a mere environmental objective towards social and distributional considerations.

- Accelerate private decisions to 'modernise' buildings to maximise public benefits of energy efficiency through public funding, even if these investments also yield profits for private owners. Social targeting is a secondary concern.
- Shift the economic rationale of private owners in favour of energy modernisation with grant support. This is focused on 'borderline decisions' where energy cost savings are too low or slow to prompt private investment. Public grants can bridge the gap between negative and positive returns, speeding up modernisation.
- Provide direct transfer payments to low-income households for energy-saving investments. Some residents may be unable to finance renovations, even if they are profitable.
- Address energy poverty by offering public grants to vulnerable households that are struggling to pay energy bills. Households in precarious socio-economic situations are difficult to reach without substantial transfer-based support.

Figure 9 Carbon intensity of electricity generation (g CO_2e/kwh)



Note: *Solar CSP = concentrated solar power; g CO_2e = grammes of carbon dioxide equivalent.*
Source: Lauer (2024).

The programme design raises questions about balancing social and environmental benefits and preventing the 'leakage' of public funds to owners who would have invested without subsidies. The monitoring system tracked buildings and investments, establishing characteristics such as rehabilitation costs per square metre. However, these figures varied widely due to different building types. Expected energy reductions from *ex ante* audits ranged from 36% to 60%, but the programme did not record *ex ante* and *ex post* energy use or expenditures. Data from eight buildings showed energy savings between 12% and 51%, with only one meeting the *ex ante* expectations.

The data helped estimate the payback period for renovations from both financial and economic perspectives. For owners, post-TMF grant payback was 10.7 years for residential buildings, over 15 years for schools and offices, and 5 years for large hospitals. Without grants, payback periods would be 20% longer. Recent energy price increases have shortened these periods.

These findings, limited by self-selection bias, underscore the need for better data collection in future programmes. This would allow for more reliable analysis of benefits and complement energy audit estimates. Improved documentation of energy savings and environmental benefits could enhance understanding of the fiscal efficiency and distributional effects of investments aimed at improving energy performance.

Building level and technical issues

- The design of energy efficiency rehabilitations must involve well-trained energy auditors that identify adapted works packages. Their services should be mandatory for public support programmes and include certification after completion of works.
- Owners of private buildings can be more easily convinced of deep renovation, if incentives are combined with sound information on the effectiveness of measures.

- Larger buildings and simple architectural features offer considerable economies of scale for rehabilitation investments that render owner-financed investments more likely to occur.
- Energy savings data must be available and analysed to allow transparent documentation and evidence of the effectiveness of energy efficiency investments.

Policy and implementing agency dimension

- The investments financed with the CEB loans rehabilitated buildings in alignment with national policy objectives to reduce energy consumption.
- The Polish support mechanism contained a modest subsidy level (20% of investment costs) so that private leveraging enhanced the reach of public funds.
- The climate change mitigation benefit is measured by the avoided CO_2 emissions. Their correct estimation needs to consider the different energy provision systems, in addition to the reduction in energy consumption, but requires advanced data systems.
- The payback period of investment costs from energy savings can provide a simple financial indicator of results, if suitable data collection arrangements can be established.
- The systematic collection of energy use data after the completion of thermo-modernisation investments could provide comfort that countries make real progress against their international commitments. MDBs could promote such systems as part of their lending.

Residents or building owners dimension

- Residents need to provide energy use data to establish definite information on savings, which requires voluntary agreements or provisions built into support programmes. Grant instruments allow for leverage to ensure provision of data-sharing agreements.
- It was easier for public building managers to share data than residential building managers, as they also have fairly good management information and reporting systems. Public authorities can play an exemplary role in documenting rehabilitation benefits.
- Administrators of large associations could use well-documented cases of energy efficiency rehabilitations to illustrate the benefits (increase in asset value of buildings, aesthetic improvements and the economic benefit obtained from energy cost reductions) and thus facilitate programme replication.

Key evaluation lessons

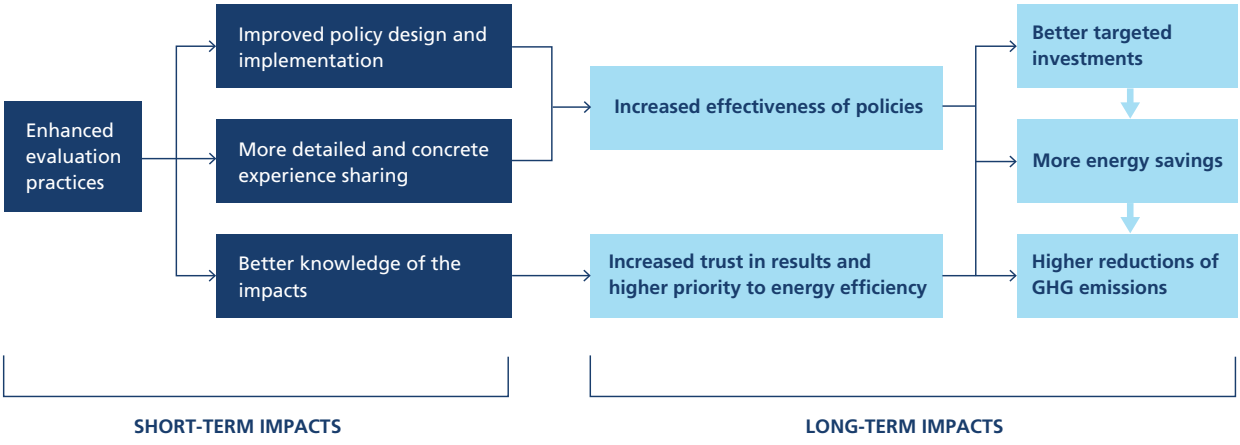
While energy efficiency programmes are highly relevant, evaluations often struggle to generate evidence of their long-term benefits. Most programmes showcase impressive before-and-after pictures, reflecting immediate outputs such as improved building appearances and expanded living spaces. However, higher-level benefits, such as energy savings and distributional effects across residents, are harder to evaluate due to data confidentiality and varying impacts across large buildings.

Some findings from these programmes' monitoring or completion reports can help adjust implementation and refine processes. However, these reports are mostly descriptive and rarely identify unrealised potential or inefficiencies. Understanding contributions to environmental goals, such as reducing GHG emissions, requires detailed information on energy systems and their ecological footprints. Programme promoters often focus on outputs unless clear incentives or requirements demand evidence of environmental and social results. Such evidence is essential for policy makers aiming for efficient public fund use, especially when pursuing environmental and social objectives.

The lessons below focus on large apartment buildings, which pose significant challenges, as shown in the case studies. These lessons also apply to public building rehabilitation, where data access is easier, but literature on realised benefits is still scarce. Public authorities would benefit from knowledge about which rehabilitation depths and support designs yield the best environmental and financial outcomes. Evaluability must be considered in programme design to better establish the effectiveness, efficiency, and sustainability of energy efficiency measures.

Many programmes support energy efficiency investments, but there are limited *ex post* evaluations of such programmes. A meta-analysis on residential energy efficiency found only 16 studies meeting stringent inclusion criteria (randomised control trials and quasi-experimental studies) out of 13 629 published by late 2020 (Berretta et al. 2021). The findings highlight the challenge of identifying commonalities across diverse investments. Even established frameworks often close before measuring changes in energy consumption.

Figure 10 Impact of improving evaluation practices



Source: see Broc, J.-S. et al. (2018)

If *ex post* evaluations had access to such data, they could help policy makers learn from realised energy savings and the full implementation process. Systematic communication of evaluation findings would improve accessibility and help enhance policy and project design, ultimately increasing their effectiveness. The short- and long-term impacts from enhanced evaluation practices are illustrated in Figure 10.

Key lessons from *ex post* evaluations of publicly funded programmes for rehabilitating residential buildings, drawing on the work of the CEB Office of Evaluation and other entities, can be summarised as follows:

Lesson 1

Public actors must be conscientious of the potential trade-off between speed of programme implementation and efficient use of public funds.

- Rehabilitation funds should target criteria such as potential energy savings and GHG reduction, but public support should also consider social criteria and means testing.
- Current programmes often provide similar support to buildings with different uses, energy performance and sizes. More differentiated eligibility criteria and financial mechanisms, based on performance improvements, are needed. To improve environmental efficiency, programmes should target (i) homogeneous building types; (ii) the most energy-intensive buildings, especially those using the most polluting fossil fuels; and (iii) large buildings for economies of scale and reduced administrative costs.
- To be efficient and effective, financial instruments for energy efficiency-oriented rehabilitation should be made visible, transparent and competitive, and have clear eligibility criteria. These should be based on robust diagnoses combining qualitative and quantitative data on buildings' *ex ante* performance, along with awareness-raising and advisory services to users and beneficiaries (lessors and owners).
- Excessive administrative burdens in applying for support may hinder the realisation of potential energy savings.

Lesson 2

Assessing realised energy savings enhances transparency and clarifies private versus societal benefits of publicly funded energy efficiency investments.

- Knowing the realised energy savings versus estimated performance improves future programme designs and savings estimates. This can be achieved through robust baseline studies while safeguarding residents' data confidentiality.
- *Ex post* evaluations based on measured energy use are rare, with most relying on estimated savings. The case studies highlighted the potential of and the need for credible evidence on the scale of savings to encourage investment in energy renovation.
- Reporting of government support programmes mostly focuses on outputs and outcomes such as the number of rehabilitated buildings and related costs, often ending before performance evidence is available. Real-life impact assessments are scarce, and differing indicators and metrics complicate comparative analyses between government programmes or countries.
- Monitoring and evaluation reports should consider potential rebound effects in energy consumption to avoid misinterpretations when savings fall below expectations. This would allow to distinguish between suboptimal works' quality and behavioural factors.
- Transparency in the monitoring and evaluation mechanisms put in place to track the performance of publicly funded energy efficiency programmes should be improved.

Lesson 3

Social, behavioural and institutional factors must be systematically considered in policies and projects aimed at reducing energy poverty and CO_2 emissions.

- The energy and environmental crises have spurred research and innovation in the construction sector. Ensuring this knowledge is correctly applied in rehabilitation works requires suitable training programmes from public and industry bodies.

- Early involvement of lessors, owners and resident representatives can facilitate decision-making during the design and supervision of renovation programmes.
- Raising awareness and providing technical support, such as through energy experts, increases end-users' and owners' readiness to participate in rehabilitation programmes and boosts investors' confidence in higher-quality interventions.
- Tenants benefit from higher use value after energy renovations, but rental price effects need assessment to ensure fair monetary gains sharing with landlords.
- Energy efficiency programmes should comply with environmental, social and governance criteria, ensuring subcontracting and labour laws are followed, and performing effective quality checks on materials used.
- Involving national and regional promotional banks and mobilising funding from commercial banks can improve national coverage of energy efficiency programmes.
- National policy makers' commitment and long-term financial and legislative support are critical for these programmes' success.
- Policy makers should promote increased professional training and suitable certifications for companies engaged in rehabilitation works through competent national bodies.

Lesson 4

MDBs should encourage public entities to commission *ex post* evaluations of energy efficiency programmes and use the findings to improve future programmes' design and implementation.

- MDB funding helps national governments improve housing sector energy performance and leverage investment volumes. However, rehabilitation rates are below those needed under NDCs for climate mitigation targets, requiring efficient resource use as well as increased commitment.
- MDB appraisal processes and results frameworks should ensure that supported national programmes include social and environmental targeting.
- Programme designs should establish baseline data and generate *ex post* information on energy usage, not just programme outputs. Financing requirements should include mechanisms ensuring anonymised information analysis that allows researchers to analyse performance and thus help to improve future designs.
- MDBs should aim at balancing their loan disbursement targets with generating specific results in improved energy efficiency and reduced energy poverty. By doing so, they would also encourage public policy makers and implementers to assess higher-level effects beyond physical rehabilitation.

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ISSN 2710-0081 (print)
ISSN 2710-009X (online)