

Residential energy renovations: benefits and enablers for a just transition



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Summary

To achieve GHG emission reduction targets of the EU for the entire building sector, estimated investment need amounts to EUR 200 billion yearly until 2030. Observed investment in 2023 was 73 billion, computing to a current yearly investment deficit of EUR 127 billion (I4CE, 2025). This underscores the need to accelerate investment in this sector and secure public funding to leverage private sector investments.

Housing prices, energy prices and the cost of capital play a critical role in shaping investment dynamics and affordability in the building sector. For energy renovations and heating electrification, relative competitiveness of electricity vis-à-vis fossil generation is particularly important. Recent developments in these issues have hindered fast progress in energy renovation activity.

This project was initiated to address the decarbonisation of existing residential buildings by exploring the often-overlooked socioeconomic dimensions of energy-efficient renovation efforts.

Building on a brief analysis of the social context, stakeholder landscape as well as EU policy framework of energy renovation, this report explores the social, economic, and environmental impacts of energy renovation. The report furthermore analysed key barriers and enablers for decarbonisation of existing residential buildings, including equity-focused innovative financing as well as country case studies, and examines how a just transition can be achieved across diverse regional and socio-economic contexts.

The analysis was informed by targeted literature reviews and expert interviews, conducted through an iterative participatory process with continuous exchange with relevant voluntary experts from the EEA-EIONET network and from key EU level institutions. Key steps included workshops to refine the scoping note and validate the report's conclusions, written feedback on the intermediary draft report and scoping note as well as expert interviews with national experts from EIONET and from relevant institutions.

Financial and economic challenges, benefits and enablers

At individual project level, high upfront costs, long payback periods, split incentives (e.g. lessors bear costs, tenants benefit from savings) and limited access to suitable financing are key financial obstacles, especially for low-income households. Country case studies confirm these barriers, including a lack of financial resources and savings, insufficient and poorly targeted funding schemes, and a general lack of effective incentives.

Whereas Member States increasingly acknowledge the need to integrate distributive, procedural, and recognitional justice into financing instruments, implementation often falls short. Their financing mixes are strongest on distributive justice (grants/loans), weaker on procedural justice (co-design, transparent rules), and thinnest on recognitional justice (tenure, disability, digital exclusion). The Affordable Housing Initiative can learn from examples of good practice such as Estonia that targets worst 43% stock to prioritise vulnerable households (BUILD UP, 2025), Finland that engages advocacy groups for older adults, disabled, migrants (BUILD UP, 2025) and Spain that dedicated energy-poverty panel in consultation (BUILD UP, 2025).

To realize the full potentiality of innovative financing instruments, such as On Bill Schemes (OBS), regulators may adapt the existing framework, in which agents operate, including measures related to capital lending requirements, risk assessment approaches as well as the tightening of Minimum Energy

Performance (MEPS) (BPIE, 2022) as well as coordination and combination of private financing instruments and public funding schemes, which are linked to direct energy efficiency improvements (Oeko-Institut e.V., 2023).

Although the need to improve the targeting of funding is widely acknowledged, in practice this often proves to be the greatest challenge. Integrating Justice Principles into policy design and implementation is particularly difficult, as it requires finding a balance between simple measures, prone to misallocation, and more sophisticated targeting mechanisms that demand considerable administrative effort. These demands frequently collide with limited national administrative capacities and the absence of integrated data (AK Europa, 2025; Jüngling et al., 2025).

Continuous monitoring and impact assessment of distributional outcomes are crucial. Current frameworks often miss this, calling for better targeting, continuous evaluation, and monitoring of who actually benefits from subsidies.

While economic incentives for private households and other demand-side stakeholders are crucial to drive energy renovations, policy makers must also account for the social cost effectiveness, including the substantial economic benefits both in short and long term. The Healthy Homes Barometer 2022 by RAND Europe estimates that improving poor indoor climates in residential and public buildings across Europe could generate over EUR 600 billion in economic benefits by 2050, mainly through productivity gains (RAND Europe, 2022). A very central economic co-benefit of energy renovation is that it strengthens Europe's security and sovereignty by reducing energy dependence and vulnerability to geopolitical shocks.

Behavioural and social challenges, benefits and enablers

BPIE (2024a) notes that while all EU Member States acknowledge energy poverty in their renovation strategies, less than half have established clear targets for reducing it, and only 35% of long-term renovation strategies include proper financing provisions for vulnerable categories.

At the same time key socioeconomic obstacles for energy renovation lie in behavioural and social factors as many homeowners lack awareness, trust, and motivation, often favouring short-term affordability over long-term savings, even when support is available. Moreover, country case studies highlight the importance of consistent policy frameworks and institutional trust as critical enablers for successful renovation programs.

To overcome behavioural barriers to energy renovation, confidence and trust must be strengthened through the provision of clear, tailored information and support from reliable sources. Trusted intermediaries such as local installers, non-profit organisations, and one-stop shops that offer comprehensive advice and coordination services are essential in reducing perceived risks and guiding homeowners through the renovation process.

Scaling One-Stop Shops (OSS) for a Just Transition works best for low-income households when they are proximity-based and embedded in municipal social services (Cattaneo et al., 2024; Habitat for Humanity International, 2024; OpenGela, 2022; Ramboll, 2022). A coherent, inclusive, and context-sensitive approach is needed to advance effective and just energy renovations in Europe.

The social benefits emerge mostly for the inhabitants, mainly in terms of better health, sustainable cities and communities and reduced inequality due to lowering of energy poverty, which underlines

the potential of awareness and communication campaigns to boost motivation for the uptake of energy renovations. Vulnerable groups (like low-income households, the elderly, or people living in poor housing) are the main beneficiary from relief from high energy costs (EC, 2025c), health and well-being improvements from energy renovation (O'Connor et al., 2024; EEA, 2023), greater climate resilience (EEA, 2025). Besides the social benefits, social safeguards are critical as without attention to equity, renovations risk increasing displacement, inequality, and social exclusion.

A just energy renovation strategy must simultaneously address distributional (e.g. subsidies effectively targeting low-income households), procedural (ensuring all stakeholders, including tenants, have a meaningful role in planning renovation programs), and recognition justice (adapting programs to the specific needs of vulnerable groups, as detailed in the following paragraph).

Holistic policy design

A holistic assessment of environmental, social (including health), and economic costs and benefits can shift the focus from mere short-term cost-effectiveness of energy renovation to broader long term social cost-effectiveness, while ensuring that public support is allocated efficiently.

The revised Energy Performance of Buildings Directive (EPBD/2024) emphasizes the consideration of environmental and health externalities of energy use and the comparative methodology framework for cost optimality has been recently revised by the Commission. While the Commission Delegated Regulation 2025 provides a well-designed methodology, it can't be seen as a fully holistic assessment tool as it lacks consideration of wider societal benefits such as reducing energy poverty and touches behavioural aspects and social vulnerabilities only to very limited extent. Therefore, it should be applied as part of multi-criteria decision-making together with other types of Life Cycle Assessments (LCAs) for buildings, such as Social LCA.

To effectively steer the distributive impacts of renovation, it is important that all relevant costs and benefits, social, economic, and environmental, are systematically and mandatorily considered in policy design and implementation, while avoiding double counting and capturing reinforcing effects. More integrated governance, linking tax ministries, regional governments, and local authorities, as well as energy building experts, economists, environmentalists, social policy specialists, and city planners, is essential to avoid fragmentation and deliver fair outcomes. Where data is already available, a stronger integration is needed, particularly through the digitalisation of archives. To relevantly target the right households, data on income level, energy consumption, energy bill and CO₂ emissions need to be used as joined criteria for support eligibility.

Policy design should explicitly account for the heterogeneity among target users. Addressing Just Transition in renovation policies implies an intersectional approach and ensure that vulnerable groups are explicitly included in eligibility, targeting, and delivery design: Low-income tenants, homeowners without mortgages, marginalized communities, elderly & persons with disabilities, women-headed households, uncontracted tenants, middle-income households and rural households. Going beyond a just funding of energy renovations, energy renovation should be made an integral part of social protection benefits to increase societal resilience. While affordability is the primary goal of the Affordable Housing initiative, co-benefits of energy renovation such as energy poverty reduction, decreased vulnerability, and reduced inequality have value in their own right, as they directly improve people's well-being, while also supporting uptake of renovation measures and enhancing societal resilience.

1 Context, policy relevance and objective of the work

Decarbonising residential heating and cooling remains a climate imperative. The building sector is a key contributor to greenhouse gas (GHG) emissions, representing around one third of energy related EU emissions and a large energy consumer, using around 40% of the final energy in the EU. Around two-thirds of the total EU energy consumption in buildings is for residential buildings (EEA, 2023b). Meeting targets for 2030 and beyond requires a doubling of the annual reduction in greenhouse gas emissions achieved between 2005 and 2020. The EU's 2030 and 2050 climate goals cannot be met without a significant acceleration in building energy renovations (EEA, 2023b). Additionally, a significant gap between effective investment and investment that would be compatible with the needed path in building renovation is observed (Keliauskaite, U. et al., 2024). Volatility in heat pump demand is driven by factors such as consumer scepticism that current electricity prices will make fossil fuels like gas less economically attractive, but also by a combination of factors that vary across national markets, including high installation costs, limited financing options, long and complex customer journeys amid installer shortages, and, in some cases, policies that discourage deployment. This undermines the shift toward decarbonised heating in the context of energy renovation.

In the context of financial constraints, the energy crisis, social tensions, and the housing crisis, the economic, financial, and social viability of energy renovation, as well as its social impacts, are important factors in the sustainable decarbonisation of housing. In 2023, 10.6% of the European Union's population were unable to keep their homes adequately warm (EC, 2024c). At the same time, the need for cooling is emerging as a growing challenge: in the EU, the number of days with temperatures above the comfort threshold, measured as cooling degree days, increased from 37 in 1979 to 140 in 2022, nearly quadrupling over this period (Eurostat, 2023a). This issue is exacerbated by an aging building stock, with over half of residential structures in EU-27 countries built before 1970, prior to modern energy efficiency standards (EC, 2014) as well as by a rise in EU housing prices, which have increased on average by 48% between 2015 and 2023 (European Parliament, 2025). Home energy renovation can deliver multiple economic, environmental, health and social benefits to be considered when designing policies.

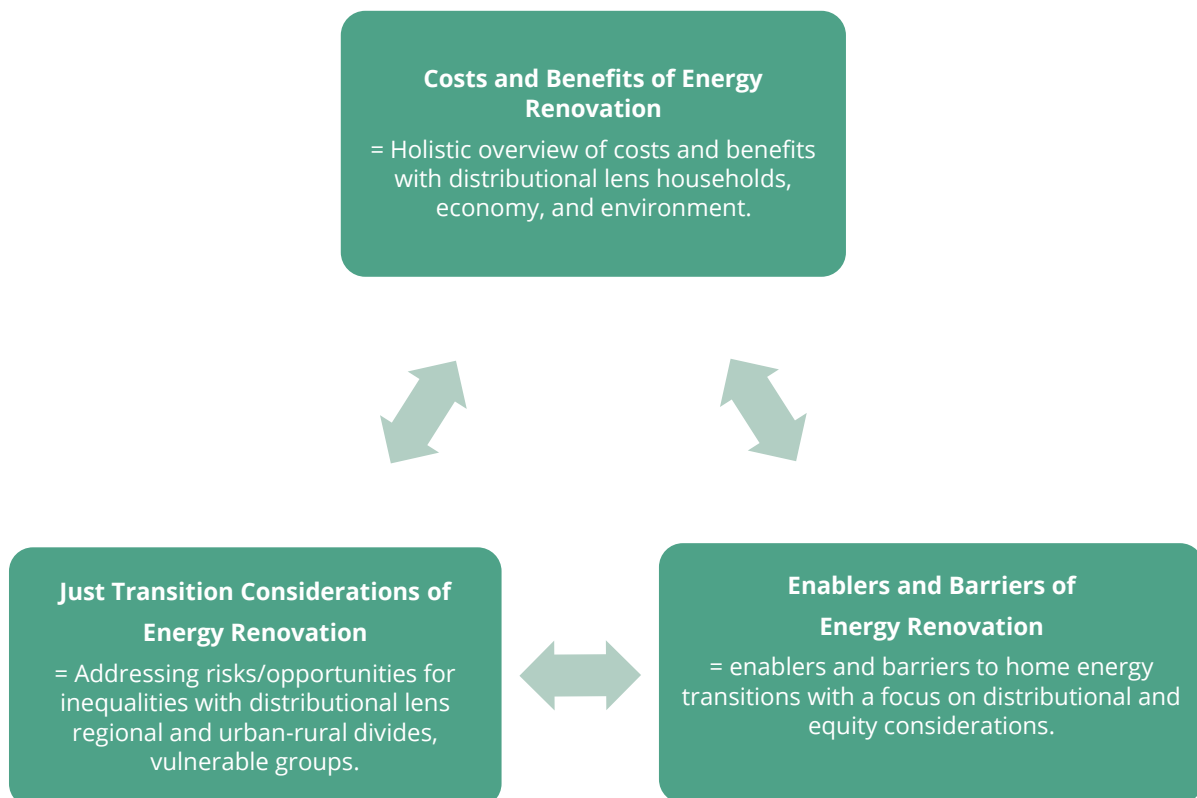
At both the household and business levels, where deployment decisions are made, weak economic incentives are one key barrier (Keliauskaite, U. et al., 2024). Beyond, the peculiarity of energy renovation manifests in institutional and behavioural barriers that hinder progress. The transition to sustainable heating and cooling presents unique challenges, particularly for investors - including individual households - who must integrate various technical measures or energy systems, coordinate specialized craftsmen and companies, and tailor solutions to specific local contexts and building users. Additionally further challenges are information asymmetries between stakeholders, uncertainties in key variables such as energy prices, conflicting interests (e.g., between lessors and tenants), and dependencies on external decisions made by banks, insurers, public regulators, and energy providers. To address these challenges, policymakers must design policies that effectively leverage public funds to attract private investment and target specific societal groups to minimize regressive distributional effects while maintaining energy and climate objectives.

1.1 Focus and objective

In this study, the following elements of the **Energy Renovation of Residential Buildings** are considered: building design, material choice, insulation (walls, ceilings, roofs, and windows), and heating systems, as well as climate adaptation measures like cooling systems and shadowing strategies, nature-based solutions, bio architecture practices, passive options, and improvements to building surroundings. Integrating renewable energy sources into residential buildings is also essential to enhance sustainability. Furthermore, user's needs, user preferences, optimisation of space use, and behaviour are also considered. As this task focuses mainly on the renovation of existing residential buildings, new construction and non-residential buildings are considered in a very limited manner and only when relevant.

The focus of this project is placed on **decarbonisation of existing residential buildings** since (i) energy consumption in residential buildings represents the largest share of energy consumption in buildings, (ii) households have a direct connection between their energy efficiency decisions/ behaviour and the consequences of their decisions (both financial and non-financial) and (iii) because the renovation of existing buildings is the priority target of the energy renovation wave. Over the past four years, the EEA has published numerous data sets, reports, and briefings on buildings and climate-related issues (available via EEA Data (EEA, 2024c), Indicators (EEA, o. J.-b), Briefings (EEA, o. J.-a), Reports (EEA, o. J.-c)). However, the socioeconomic aspects - including costs, benefits, financing and the just transition - have not been explored in detail.

Figure 1. This Study's Analytical Perspective on the Socio-Economic Impacts of Energy Renovation



Source: Own visualisation

1.2 Methodology and approach

The research project combined targeted literature reviews (with review questions outlined in the introductions of the respective chapters) and expert interviews to inform its analysis. The project followed an iterative and participatory process involving continuous exchange with relevant voluntary national experts from the EEA-EIONET network and from key EU level institutions. An online workshop in February 2025 was held to present, discuss, and refine the project's scoping note. Between April and June, five expert interviews were conducted with relevant experts to address specific research questions relevant to their expertise on country case studies, innovative finance and just transition considerations (see Appendix for interview guidelines and Acknowledgement section for further details on interview partners). Written feedback on the first draft of the ETC Report was collected between July and August 2025. Finally, a concluding online workshop was held in October 2025 to review the key messages and agree on final adjustments to the report's conclusions.

The actionable dimension of the project in supporting the implementation of energy renovation materializes through national level case studies on Germany, Spain and Slovakia and by a specific topic assessment in the field of innovative financing schema. The focus lies on key knowledge required by policy makers, specifically the socio-economic and environmental rationale for intervention, barriers inhibiting the wider uptake of key solutions, along with enablers to accelerate the transition. The report also assesses Just Transition considerations of energy renovation policies to avoid negative unwanted social impacts of the energy renovation.

Following this introductory chapter, **chapter 2** explores the social context, stakeholder landscape, as well as EU policy landscape of energy renovation of residential buildings. It examines housing market inequalities, social vulnerabilities, and the roles of key actors involved in or impacted by renovation efforts in the EU. In addition, it provides an overview of the EU policy framework shaping energy renovation in the building sector. Chapter 2 provides the necessary foundation for next chapters. **Chapter 3** focuses on the social, economic, and environmental costs and benefits of energy renovation, addressing both climate change mitigation and adaptation - and examines their distribution from the perspectives of households, businesses, and the public sector. In **chapter 4**, the analysis turns to key barriers and enablers for energy renovation. This includes a high-level synthesis of existing (grey) literature on socio-economic factors, a country-level examination of economic barriers and enablers in three selected countries with a focus on equity and distributional aspects, and a deep-dive into innovative financing solutions. **Chapter 5** addresses Just Transition considerations, analysing distributive, procedural, and recognitional justice dimensions. This chapter also accounts for differing regional and urban-rural contexts and explores opportunities to mitigate inequalities during the transformation process.

2 Social context and stakeholder landscape in energy renovation

Key Messages:

Rising housing costs are exacerbating income inequality across all Member States, disproportionately burdening low-income households, many of whom spend over 40% of their income on housing. (Ozdemir & Koukoufikis, 2025). Targeted policy responses are needed to address regional, urban-rural, and socioeconomic divides, as well as essential service poverty, the latter being especially prevalent among single-parent households, elderly women, and residents of multi-family apartment blocks in Central and Eastern Europe (Petracco et al., 2024).

The energy renovation process involves multiple stakeholder groups, including demand-side actors (e.g. homeowners, lessors, tenants) who initiate and fund projects, enabling and regulatory actors (e.g. governments, financial institutions) who provide the legal and financial framework, supply-side actors (e.g. architects, builders, installers) who implement the measures and advisory and intermediary stakeholders (e.g. One-Stop-Shops, neighbours) who provide guidance or influence the renovation process in other ways (Camarasa et al., 2021; Ramboll, 2022).

Owners are central actors in energy renovations. They make key decisions, bear the financial burden and associated risks, and interact with nearly all other stakeholders. The diversity of ownership structures, property types, and living arrangements means that owners take on different roles and responsibilities throughout the renovation process, resulting in varied motivations and constraints to undertake renovations. Supply-side, as well as advisory and intermediary, stakeholders play a crucial role in guiding and influencing owners' renovation decisions. Especially peers, such as neighbours, friends and family, can have a significant impact on private owners' choices (Ramboll, 2022).

Energy renovation is a cornerstone of 2019 European Green Deal and a key strategic priority under the EU Competitiveness Compass. Through an integrated policy framework - including the Renovation Wave strategy and its Affordable Housing Initiatives as one of its key measures, the new Emission Trading System (ETS2), the Social Climate Fund (SCF), the revised Energy Performance of Buildings, Renewable Energy and Energy Efficiency Directives - the EU aims at least doubling the current annual energy renovation rate - from 1% to 2% until 2030 - with a strong focus on deep renovations (EC, 2020a).

To set the stage for the analysis in the following chapters, this section outlines the broader social context in which the energy renovation wave is taking place. It first examines key dynamics in the housing market, with a focus on inequalities and social vulnerabilities that shape exposure to and capacity for renovation. This is followed by an overview of the main stakeholder groups involved in or affected by building renovation efforts, highlighting their roles, interests. The section concludes with an analysis of the current EU policy framework governing energy renovation in the building sector.

2.1 Current housing market context, inequalities and social vulnerabilities

The energy transition in the building sector unfolds against a backdrop of deep-seated social inequalities and vulnerabilities that risk being exacerbated if not carefully addressed. Energy poverty¹ remains a widespread challenge across the EU, highlighting the unequal access to essential energy services among households. Persistent energy² poverty affects millions of people across the EU, with the highest rates concentrated in Southern and Eastern European countries, creating an urgent need for targeted renovation policies that prioritize vulnerable households (Petraçco et al., 2024). Ozdemir & Koukoufikis (2025) highlight the interconnectedness of the crisis of housing affordability and energy poverty, stating that ‘rising housing costs increase disposable income inequality in all Member States, disproportionately affecting low-income households who often spend more than 40% of their income on housing’. Summer energy poverty (SEPOV) disproportionately affects vulnerable populations, including renters, women, the elderly, and those living in urban heat islands or poorly insulated buildings. Summer energy poverty (SEPOV) is considered the inability to maintain comfortable indoor temperatures during summer. In France, 70% of renters reported feeling too hot in their homes compared to 54% of homeowners, illustrating a tenure-based divide in thermal comfort (EC, 2025d). By contrast, winter energy poverty tends to affect households in rural and colder regions, where older or poorly insulated dwellings and reliance on expensive fossil fuels make heating unaffordable.

Escalating living costs and the renovation divide

Between 2015 and 2024, house prices in the EU rose by an average of 51.3%, with Hungary seeing the highest increase at 177%. Rental prices also rose steadily, averaging a 16.8% increase between 2015 and 2024 (Eurostat, 2024b). However, these nominal figures should be understood in light of broader macroeconomic trends. Over this period, the EU’s Harmonised Index of Consumer Prices (HICP), a standard measure of inflation, increased by 30.2%, reflecting the cumulative impact of the post-pandemic recovery, energy price shocks, and broader cost-of-living increases (Eurostat., 2025; Eurostat, 2024). Although rental prices remained below the cumulative EU inflation rate, housing purchase prices outpaced general inflation by a considerable margin, especially in parts of Central and Eastern Europe (Eurostat, 2024a).

Wage growth varied significantly by Member State and often lagged behind both housing and consumer price increases, particularly in countries with lower GDP per capita. In several countries, real wage growth (i.e. adjusted for inflation) was stagnant or negative, exacerbating affordability concerns. However, affordability is influenced by more than just the relationship between wages and housing costs, it is also shaped by access to essential services such as healthcare, public transport, and education. Inequalities are often greater within countries than between them, with certain population groups experiencing wage growth that falls far short of rent or mortgage increases, placing new market entrants, especially younger and economically vulnerable households, under disproportionate financial stress (Eurofound, 2023; Ozdemir & Koukoufikis, 2025).

¹ Energy poverty is defined as a household's lack of access to essential energy services, such as heating, hot water, cooling, lighting and energy to power appliances (EP, 2023).

² Persistent energy poverty refers to a situation where a household experiences energy poverty over a prolonged period, typically measured over several years. It indicates a chronic inability to meet basic energy needs rather than a temporary.

However, this average shows significant variation across EU Member States. The steepest increases in housing rents were recorded in Hungary, where prices surged by 87.1%, followed by Lithuania at 73.3%, reflecting broader affordability pressures in parts of Central and Eastern Europe. In contrast, some southern countries experienced far more moderate changes; Greece, for instance, recorded only a 2.9% increase over the same period (Eurostat, 2024b). These regional variations reflect broader socioeconomic inequalities and uneven market dynamics. As a result, even in Member States with relatively stable nominal rent prices, rising energy and food costs, combined with limited income growth, have contributed to growing household precarity.

In addition to broader housing affordability pressures, the cost of implementing energy renovations has risen sharply in recent years. Construction producer prices and overall building costs across the EU have followed a consistent upward trajectory since 2000, with a marked acceleration after 2021, largely driven by rising input-material prices and supply-chain disruptions. Although growth slowed in 2023–2024, construction costs remain at historically high levels, significantly affecting the affordability of both building renovations and new housing (Eurostat, 2024b).

Since 2020, the price of key construction materials, such as insulation, timber, steel, and heating system components, has increased sharply due to supply chain disruptions, energy price volatility, and inflationary pressures linked to the post-COVID recovery and geopolitical instability. Labour costs have also risen, amplified by persistent skill shortages and potentially low productivity in the construction sector, further driving up project expenses. These combined factors have directly raised the overall cost of renovation projects. Compounding this, the European Central Bank and national authorities raised interest rates from historically low levels in 2022–2024 to counter inflation, making credit more expensive and harder to access, particularly for lower-income households and first-time borrowers. While these upfront costs present a major barrier, it is important to note that well-designed energy renovations can reduce the operational costs of buildings, primarily through lower energy bills, over the long term, helping offset initial investments, especially when combined with targeted financial support and consumer protections.

According to the latest Eurostat statistics, in 2024, 93.3 million people in the EU (21.0% of the population, or approximately 1 in every 5 individuals) were at risk of poverty or social exclusion (Eurostat, 2024b). This high figure underscores the widespread financial strain on households. In the second half of 2024, average electricity prices for households in the EU remained largely stable, with a slight decrease to EUR 0.287/kWh from EUR 0.289/kWh in the first half of the year. Nevertheless, these prices remain well above pre-2022 energy crisis levels, still largely due to higher gas prices driving up electricity prices (Eurostat, 2024b). The recent shock has highlighted the EU's vulnerability to external fossil fuel price volatility, particularly given its limited domestic oil and gas reserves. To mitigate this exposure and advance its climate targets, it is critical for the EU to accelerate both energy efficiency and renewable energy deployment, thereby reducing reliance on imported fossil fuels and improving energy price stability.

The ongoing cost-of-living crisis, fueled by escalating energy and food prices, has made it increasingly difficult for many households to afford essential expenses. For lower-income and vulnerable groups, who often live in the worst-performing buildings and already struggle to pay their energy bills, the upfront investment required for critical home improvements, like energy renovations, is often out of reach. The combination of tighter financial conditions and persistently high renovation costs has impacted the progress enabled by subsidy schemes or tax incentives. Due to a surge in construction costs, since trade restrictions were imposed during the COVID-19 pandemic in 2020, and recent interest

rate increases in Germany, renovation efforts are at risk, with new construction rates down 30% from last year. In addition the renovation rates also slumping as the cost of insulation works rose by 12.7% and upkeep costs increased by 11.7% (Euractiv, 2023).

Recent research further illuminates the complex factors contributing to energy poverty beyond the general cost-of-living crisis. A strong link exists between income levels, household composition, and geographical location and the incidence of energy poverty. Low-income households and lone-parent families emerge as particularly vulnerable. For instance, among households reporting an inability to keep their homes adequately warm or experiencing arrears in utility bills, 62% belong to the two lowest income groups, a stark contrast to only 19% found in the two highest income groups. This vulnerability is further pronounced among lone parents with children, where over 20% report experiencing inadequate warmth or utility bill arrears, a figure 6 percentage points above the EU average of 14% (Hormigos Feliu et al., 2025).

For the EU, enhancing housing energy efficiency represents a powerful lever for simultaneous climate action and social betterment. Upgrades such as better insulation and renewable heating systems while reducing utility costs and emissions, have the potential to simultaneously improve living conditions and alleviating energy poverty, especially by making homes more affordable for low-income households (Ozdemir and Koukoufikis, 2025). Recent evidence shows that 39% of private tenants in the bottom half of the income distribution live in energy-inefficient housing, underscoring how tenure and income combine to heighten vulnerability (Eurofound, 2023).

Eurofound (2023) identifies four broad types of housing problems (exclusion, insecurity, problematic costs, and inadequacy) that are also highly relevant to the context of energy renovation. When adapted to the renovation wave, these categories capture how decarbonisation measures in the housing sector can inadvertently deepen vulnerabilities:

- **Renovation-driven housing exclusion** – when renovation costs or ‘renoviction’ policies cause rent increases beyond affordability thresholds, forcing low-income tenants to leave their homes.
- **Renovation-related housing insecurity** – where renovation processes or outcomes increase the risk of arrears on rent, mortgages, or utilities, for instance due to temporary relocation expenses or post-renovation bills that remain high despite efficiency gains.
- **Renovation-induced problematic housing costs** – when repayment schemes for renovation loans or higher rents to cover investments lead households to cut back on other essentials such as food, healthcare, or education. Even with energy savings, the net financial effect can be negligible or negative for vulnerable groups.
- **Persisting housing inadequacy despite renovation programmes** – when households are excluded from schemes (e.g., ‘hard-to-reach’ owners, informal dwellings, uncontracted tenants), leaving them in inefficient, uncomfortable homes. This also occurs when upgrades focus on aesthetics or partial works without resolving insulation and energy efficiency deficits.

These categories reveal how different forms of vulnerability may be shaped or worsened by the renovation wave, with varying implications across **regions (2.1.1)**, **urban–rural settings (2.1.2)**, and **socioeconomic groups (2.1.3)**.

2.1.1 Regional divides

Significant disparities exist between EU member states in terms of building stock quality, energy efficiency levels, and economic capacity to finance renovations. These regional variations often lead to uneven exposures to energy poverty and differing capacities to undertake necessary renovations. **Regional divides** are further intensified by the inadequate reach of public transport. Because public transport largely serves urban centers, those in rural or low-density areas are forced to depend on other means (EAPN, 2022).

Without targeted support, less affluent regions risk falling further behind, undermining the Renovation Wave's objectives. Policy measures, including regionally tailored financing schemes, technical assistance, and social support programs, are essential to ensure that energy renovation benefits are equitably distributed and that regional inequalities are not exacerbated.

2.1.2 Urban-rural divides

Access to renovation technologies, expertise, and financing options varies substantially between urban and rural areas. Physical isolation limited economic diversity, and high rates of vulnerable populations due to lower incomes and higher poverty rates, combined with lower educational and employment opportunities and an ageing population are some of the characteristics that increase the vulnerability of rural communities (RENOVERTY, 2024). While a simple urban-rural split is often cited, the spatial dimension of energy vulnerability is more complex and remains inadequately addressed empirically (Mashhoodi et al., 2019). Analysis highlights that energy poverty does not necessarily align with common patterns of broader deprivation, such as urban–rural divides, but instead tends to be highly regionalized and shaped by local-specific factors (Robinson et al., 2019). These territorial inequalities thus require tailored approaches that recognize the specific challenges of different settlement types and detailed, high-resolution spatial analysis.

Moreover, the urban-rural divide plays a significant role in energy poverty prevalence. The results indicate that rural areas consistently experience higher levels of energy poverty. This is especially evident in Member States such as Bulgaria, Romania, and Greece. In fact, across all EU Member States where overall energy poverty levels exceed the EU average, rural areas are generally the most affected territorial typology, while cities consistently demonstrate the lowest incidence (Hormigos Feliu et al., 2025). This can partly be attributed to the finding that rural households tend to spend a larger proportion of their income on energy compared to their urban counterparts, due to larger, less-efficient homes, reliance on costlier heating fuels, limited access to modern energy infrastructure, and lower average incomes. When examining the EU's building stock in conjunction with climate conditions and the local implementation of rooftop photovoltaics, analysis reveals that rural areas are likely to face greater challenges in terms of energy efficiency and needs compared to towns, suburbs, or cities. In some Member States, such as Latvia and Lithuania, these building-related challenges coincide with other high energy poverty indicators, notably elevated at-risk-of-poverty rates (Hormigos Feliu et al., 2025).

2.1.3 Socioeconomic divides

The most pronounced vulnerability relates to economic capacity. Ozdemir & Koukoufikis (2024) emphasize an inequitable pattern where those facing financial constraints are more likely to inhabit inefficient housing but are simultaneously excluded from energy improvement programs due to cost

barriers, despite being the population that would gain the most from such interventions. The middle class, recognised as a key stakeholder in the renovation of the EU building stock, also faces challenges, with many middle-income households fall into a support gap, earning too much to qualify for targeted assistance programs but lacking sufficient disposable income to finance significant renovation costs upfront. Middle-class households, while crucial actors in the energy transition, often face structural barriers due to limited access to tailored financial instruments. As Svobodová (2019) notes, tapping into these potential demands hybrid solutions that enable participation without overburdening households financially. Recent studies show that for these households, the cost of deep energy renovations often equals or exceeds their annual income, limiting their ability to take action without external support (Bruegel, 2023). This financing bottleneck has made them a critical—yet underserved—target group in achieving large-scale building decarbonisation.

The evidence indicates significant disparities across population groups and housing tenures. As the interviewed FRA expert noted, ‘low-income groups not living in social housing would be worse off, usually’, due to limited access to subsidies and high upfront costs. Further, the expert noted that approximately 37% of people living in poorly insulated dwellings and struggling to make ends meet are private tenants, a group that remains particularly hard to reach with current energy efficiency measures. These households face a dual burden: unaffordable energy bills and limited legal or financial capacity to initiate renovations. The landlord-tenant split incentive describes the situation that lessors bear the investment costs of refurbishment, but tenants benefit from lower operating costs. This means that the financial benefit does not accrue to the party that made the investment (Ramboll, 2022).

The EU housing crisis affects different groups of people in different ways, with particularly severe impacts on vulnerable population (FRA, 2025). Vulnerable groups such as Roma communities, migrants, older adults, and persons with disabilities face compounded risks, many live in informal or substandard housing that is excluded from renovation programmes or energy benefits, as illustrated in the case of Cañada Real, near Madrid, where entire communities were disconnected from electricity (FRA, 2024b). Energy poverty also displays distinct spatial patterns across the EU, with a dynamic that risks being worsened by ‘universal renovation policies that fail to account for regional economic disparities’. To ensure no one is left behind during Europe's environmental transition, a comprehensive, integrated approach is therefore needed, particularly emphasizing targeted policy responses to address these disparities and essential services poverty. Single-parent households, elderly women, and those in multi-family apartment blocks in Central and Eastern Europe are particularly exposed to essential services poverty (Petracco et al., 2024). The concept of essential services poverty is defined as a household's inability to access or afford services like water, sanitation, energy, and transport, helps sharpen our understanding of recognitional justice (Petracco et al., 2024). This understanding is further built on the EEA assessment of essential services poverty across the EU and social impacts of low carbon energy policies. Gendered vulnerabilities also emerge with relation to the SEPOV, with women facing specific risks due to physiological heat sensitivity and social norms around dress codes or personal safety in public spaces (EC, 2025d; Staab et al., 2024).

Box 1. Defining vulnerability in the context of energy renovation

According to the EPBD (2024), “vulnerable households” means households in energy poverty or households, including lower middle-income households, that are particularly exposed to high energy costs and that lack the means to renovate the building that they occupy’. To effectively address social equity in energy renovations, it is crucial to define the criteria that characterize vulnerability. Vulnerability encompasses multiple dimensions including economic, health-related, social, and demographic factors. Economic vulnerability is often measured by income poverty thresholds and energy poverty indicators, such as the inability to keep a home adequately warm or cool. Health vulnerabilities include elderly populations, persons with chronic illnesses, or disabilities who may be more sensitive to inadequate housing conditions. Social vulnerabilities also arise from factors like social isolation, migrant status, or minority ethnic backgrounds that can limit access to information and support services. Energy efficiency measures help alleviating energy poverty, however, barriers to accessing renovation schemes are often faced by the most vulnerable (EC, 2024e).

Energy vulnerability and energy poverty are closely related but distinct concepts within the EU policy framework. While energy poverty primarily refers to the affordability of essential energy services, energy vulnerability encompasses a broader range of factors that limit consumers’ ability to benefit from the energy market. According to the (EC, 2020b), energy vulnerability includes situations beyond income-related poverty, such as critical dependence on electrical equipment for health reasons, or socio-demographic factors like age and education. Market-related challenges, such as complex contracts, biased comparison tools, or aggressive commercial practices, can further exacerbate consumer vulnerability. The Electricity and Gas Directives require Member States to define ‘vulnerable customers’, a concept that may include energy poverty but also other dimensions of vulnerability, including protections like bans on disconnection during critical times. Thus, consumer vulnerability can be broadly understood as limitations on accessing the full benefits of the internal energy market (EC, 2020b). In general, **vulnerability in the context of energy renovation** could be defined as the state of households that are particularly at risk of being unable to afford essential energy services due to a combination of low-income, high energy costs, and the poor energy performance of their homes.

Source(s): EC 2020b, EC 2024

2.2 Stakeholder overview

This chapter provides an overview of the most common stakeholders involved in the energy renovation of residential buildings, discussing their respective roles, as well as their relationships and interactions. Such an overview is important for understanding who is involved in the renovation process and ensuring that no relevant stakeholders are overlooked and that their perspectives are taken into account when policy decisions are made. This helps to better anticipate the impact of decisions on different stakeholders and supports more holistic and inclusive planning and implementation. It should be noted that not all possible stakeholders and connections are depicted, rather, the focus is on the most relevant and frequently involved actors. In practice, additional stakeholders and more complex interrelations may exist.

Different groups of stakeholders can be identified in the energy renovation process. A key group is the demand-side actors, who are central to the entire process (Camarasa et al., 2021; Ramboll, 2022). They initiate renovations and make crucial decisions regarding the scope and choice of measures or

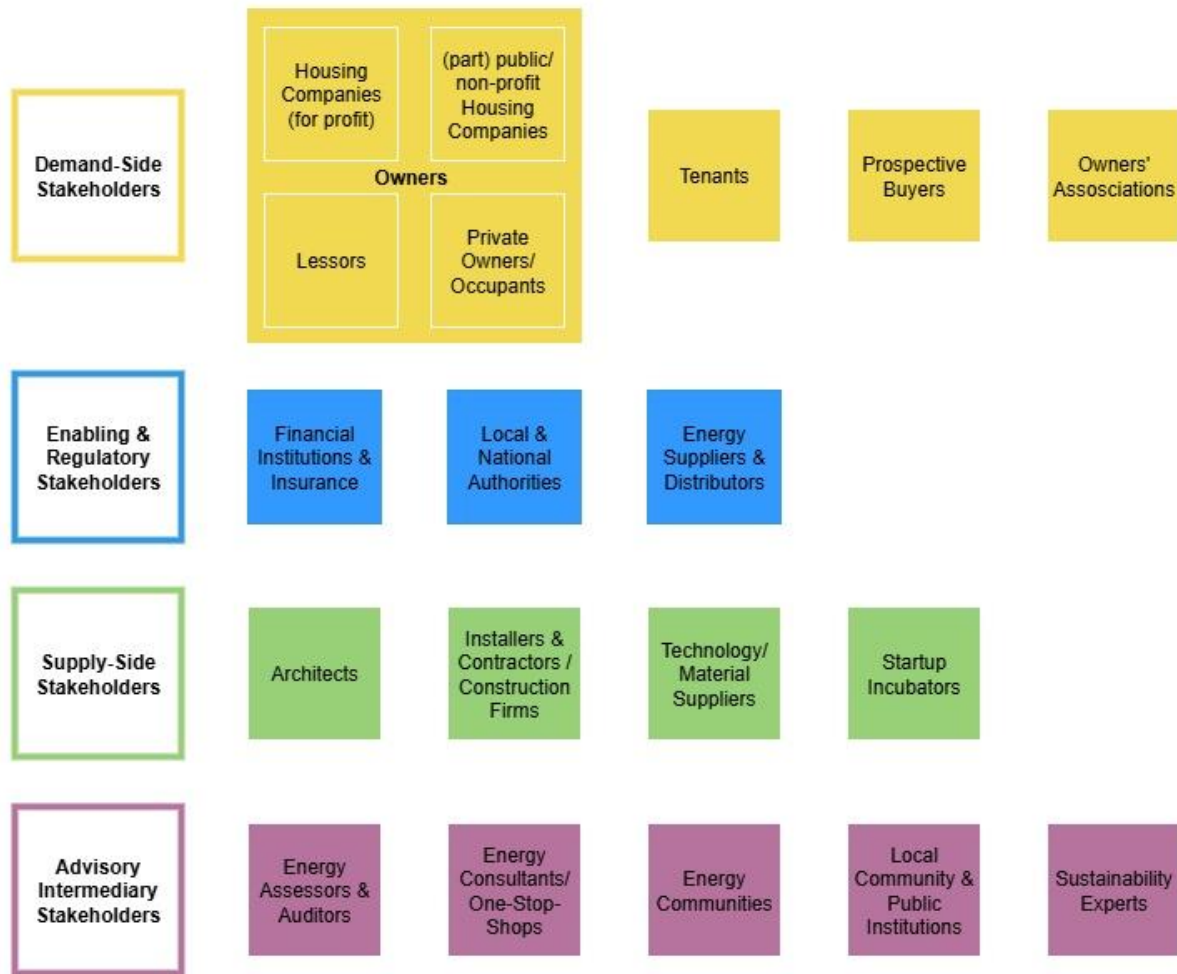
technologies. They also bear the financial burden and are the ones that benefit from the outcomes. This group includes private homeowners and lessors, profit-oriented and non-profit housing companies, tenants, owner associations, and prospective buyers.

Another group of stakeholders comprises enabling and regulatory actors (Camarasa et al., 2021; Ramboll, 2022). They establish the legal and institutional framework for energy renovations by setting laws, regulations, standards and norms. They also facilitate the process by offering financial support in the form of grants, subsidies, tax incentives or similar mechanisms, and by providing insurance to cover potential risks and ensure project success. The energy supply side also falls within this group, as they determine the type and source of available energy (e.g. fossil versus renewable), set energy prices and manage grid access and supply infrastructure. This group includes financial institutions, insurers, local and national authorities, energy suppliers and energy service providers.

The supply-side stakeholders are responsible for delivering the energy renovation measures. These stakeholders plan, design, permit, build and implement the necessary technologies and improvements. In addition, many of them also provide advice and technical guidance throughout the renovation process. This group includes architects, engineers, installers, construction companies, technology providers, contractors, material suppliers and start-up incubators. Finally, there is the group of advisory and intermediary stakeholders, which includes actors who provide guidance or influence the renovation process in various ways (Ramboll, 2022). Members of this group include energy assessors and auditors, the local community and public institutions, energy consultants, one-stop shops and the general public and civil society.

Figure 2 shows the various groups and stakeholders. The individual stakeholders and their roles in the energy renovation process are described in more detail below, along with a discussion of their relationships with other stakeholders.

Figure 2. Stakeholder overview for energy renovation of residential housing



Sources: Awonuga, Kehinde Feranmi et al., 2024; Barbosa & Almeida, 2025; BPIE, 2022; Camarasa et al., 2021; EEA, 2022; Giraudet & Lucas Vivier, 2024; Prieto et al., 2024; Ramboll, 2022; expert judgement

Private owners are individuals who own residential property, such as a house or apartment, and use it as their main or secondary residence. Ownership can take various forms, including sole ownership, multi ownership, and ownership of different property types, such as single-family homes, flats, or multi-unit buildings. These properties can be found in both urban and rural areas, ranging from detached and semi-detached houses to apartments in larger complexes (Ramboll, 2022). Due to the diversity of ownership structures, property types and contexts, private owners take on different roles and responsibilities in decision-making and throughout the entire renovation process.

In addition to private owners who live in their own property, there are also lessors who exclusively rent out their property. Furthermore, owners are distinguished from housing companies, which can be profit- or non-profit oriented, and private or (partly) government-owned. Despite their different structures and objectives, all these groups have similar connections with other stakeholders in the renovation process. They are therefore analysed together from the perspective of owners.

Owners are key actors in the renovation process and are connected to nearly all other stakeholders. As they are responsible for covering the energy costs, they have a direct incentive to improve energy

efficiency. They select their energy supplier/distributor and pay the bills, giving them a direct connection to energy suppliers. In recent years, this relationship has evolved alongside the emergence of prosumers. These are homeowners who produce energy (e.g. via rooftop solar panels), consume it and sell any surplus electricity back to the grid. This creates new contractual and financial interactions between owners and energy suppliers and distributors, thereby increasing owners' involvement in the energy system (EEA, 2022c).

However, this direct connection and incentive usually applies only to owners who live in the property themselves. In cases where owners rent out their property, such as private lessors or housing companies, they are often not directly affected by energy costs. Instead, it is usually the tenants who bear these expenses and are directly impacted by the benefits or shortcomings of energy efficiency measures. This can lead to conflicting interests between owners and tenants, particularly with regard to renovation decisions. This situation is commonly referred to as the landlord-tenant dilemma, and will be explored in more detail in a later chapter (Ramboll, 2022).

Property owners are also affected by regulatory measures, such as legal requirements for heating systems (e.g. bans on oil heating), minimum energy performance standards for rental properties, public incentives for renovations (e.g. subsidies) or other financial instruments (e.g. carbon pricing), which links them to local and national authorities. As they usually have to cover the cost of renovations themselves, they also often have to interact with banks and financial institutions to take out loans, as well as with insurance providers to cover potential risks or unexpected outcomes (Barbosa & Almeida, 2025; Giraudet & Lucas Vivier, 2024; Ramboll, 2022).

Owners may also decide to renovate in order to increase the property's value, especially if they are considering selling it in the future. In this context, potential future buyers may influence owners' decisions (Barbosa & Almeida, 2025; Ramboll, 2022). In cases of shared ownership, multi-unit buildings or properties with jointly owned common areas, owners' associations play an important role, too. Reaching a joint decision in such settings is often challenging and requires coordination among all parties involved (Barbosa & Almeida, 2025; Ramboll, 2022). Their connection to energy assessors and auditors is based on assessing the energy performance of buildings. These professionals issue energy performance certificates, thereby influencing renovation decisions and the property's potential future value (Barbosa and Almeida, 2025).

Energy consultants and One-Stop-Shops (OSS) advise homeowners on suitable renovation strategies and available support schemes. OSS are centralised service platforms that provide integrated support for energy renovations (BPIE, 2022). They offer technical, financial and administrative assistance, through a single point of contact³. Their advice has a significant influence on owners' decisions about whether and how to proceed with energy renovations (Barbosa and Almeida, 2025). Energy communities⁴ can also support the renovation process. As citizen-driven initiatives, they promote collective action, raise awareness, and enable joint investments in energy efficiency at the local level. A recent example is the Support Service for Citizen-led Renovation, an EU initiative that fosters bottom-

³ Examples of established One-Stop-Shops in EU Member States include [France Rénov'](#) (France) and [Oficina Rehabilitación](#) (Spain), among others.

⁴ Energy communities are citizen-led legal entities that enable local groups to collectively produce, consume, share, or sell renewable energy (European Commission, forthcoming).

up renovation efforts by helping emerging energy communities plan and implement collaborative renovation projects (European Commission, forthcoming).

Through their planning and consultancy services, architects shape the technical scope and strategic direction of the project. They also guide and advise owners toward more comprehensive and energy-efficient solutions (Camarasa et al., 2021; Ramboll, 2022).

Installers and construction are responsible for carrying out the renovation work, making them key players in determining the overall quality and success of the project (Camarasa et al., 2021; Ramboll, 2022). They also provide advice during the planning and practical implementation phases. Most installers and construction firms are small businesses employing only a few people. Their choices are often shaped by prevailing market standards, social norms and established practices within their professional networks. Strong ties to material and technology suppliers can also significantly influence their decisions regarding which products and technologies to adopt (Ramboll, 2022). In practice, architects, installers, contractors and suppliers must work closely together to ensure coherent planning and smooth implementation. At the same time, they must operate within the regulatory framework set by the authorities, complying with applicable building codes, performance standards, safety regulations and other legal requirements.

Sustainability experts, such as environmental and resource economists, specialists in renewable energies, energy price and billing schemes, circular economy, air quality, nature conservation and biodiversity, also play a role in the context of energy-efficient renovations. Their expert assessment and advice can influence public perception and the evaluation of technologies and measures. They also contribute to political decision-making by providing scientifically sound insights (Ramboll, 2022). In this way, they help align strategies with climate targets, environmental protection, macro and micro economic constraints and social justice.

On the supply side, startup incubators also play a role as relevant stakeholders. They are stakeholder organizations that support startups and primarily smaller companies in developing and scaling innovative solutions. By providing access to funding, expert guidance, and industry connections, incubators can accelerate the growth of businesses focused on innovative planning, financing, or implementing energy efficiency renovations. Startups supported by these incubators can challenge traditional market actors by introducing novel solutions, disrupting established industry models, and promoting new business approaches that drive transformation across the renovation sector (Awonuga, Kehinde Feranmi et al., 2024)⁵. Although incubators typically do not have a direct relationship with property owners, they contribute significantly to driving innovation in processes and products, reducing costs and environmental footprints and pushing existing stakeholders toward greater efficiency and sustainability.

Finally, it is also important to recognise the often underestimated influence of peers. Neighbours, friends and family can have a significant impact on private owners' decisions. Studies have shown that

⁵ An example of a startup incubator is [PropTech Denmark](#), a non-profit association that fosters collaboration between the real estate sector and technology innovators to drive digital and sustainable transformation in Danish real estate. Another example is the [Climate Lab](#) in Vienna, an innovation hub promoting, amongst others, circular economy principles within the construction sector.

renovation choices are influenced by a person's social networks even more than by expert advice (Ramboll, 2022).

2.3 EU level policy landscape for energy renovation of buildings

Energy renovation is a cornerstone of the 2019 European Green Deal, which aims to decarbonize the EU's energy system and achieve climate neutrality by 2050. A key legislative tool of the EU Green Deal is the 'Fit for 55 package' that was introduced in July 2021 to help the EU achieve a 55% reduction in greenhouse gas emissions by 2030.

For the building sector, the revision of the Energy Performance Directive, the Renewable Energy Directive, the Energy efficiency Directive and of the EU ETS (ETS 2) are central in the EU level legal framework. To achieve the EU's target of a 55% emissions reduction by 2030, compared to 1990 levels, the building sector must, compared to 2015 levels, cut its emissions by 60%. This requires at least doubling the current annual energy renovation rate - from 1% to 2% until 2030 - while prioritizing deep energy renovations (EC, 2020a). In addition, the revised EPBD targets a 14% reduction in final energy consumption and an 18% reduction in energy consumption for heating and cooling in buildings by 2030 compared to 2015 levels (EU, 2024). The Renovation Wave Strategy (EC, 2020), published in 2020, aims to renovate 35 million buildings by 2030, at least doubling the annual rate of energy renovations in the EU. At the heart of this vision is the EU's Renovation Wave strategy aims to improve energy efficiency and support a fair and sustainable transition. It seeks to reduce energy consumption, alleviate energy poverty, and boost economic growth, job creation, and living standards across the EU. By focusing on affordable, inclusive solutions, the strategy also promotes the development of Small and Medium-sized Enterprises and addresses vulnerabilities in inefficient buildings, ultimately enhancing citizens' health and quality of life. The Renovation Wave Strategy furthermore emphasizes the need for 'deep renovations' as renovations that reduce energy consumption by at least 60%.

Box 2. Concept and Policy Background of Deep Renovation

In contrast to individual renovation measures and standard renovations, which combine several simple individual measures, deep renovations are based on integrated renovation concepts that result in zero or near-zero energy buildings (Ramboll, 2022). Although ‘deep renovation’ currently lacks a uniform, legally binding definition under Union law, the revised Energy Performance of Buildings Directive (EPBD) introduces a proposed conceptual framing. According to the revised directive, deep renovation should be understood as ‘a renovation that transforms buildings into zero-emission buildings but, as a first step, as a renovation that transforms buildings into nearly zero-energy buildings.’ This stepwise approach is intended to avoid lock-ins by ensuring that initial renovation measures align with the longer-term objective of achieving zero-emission buildings. [...] ‘A deep renovation for energy performance purposes may also be a prime opportunity to address other aspects such as indoor environmental quality, living conditions of vulnerable households, increasing climate resilience, resilience against disaster risks including seismic resilience, fire safety, the removal of hazardous substances including asbestos, and accessibility for persons with disabilities’ (Official Journal of the European Union, 2024). More generally, the BPIE has defined deep renovation as the process of capturing in one or a few steps the full potential of a building to reduce its energy demand, based on its typology and climate zone. Due to the lack of EU-wide guidelines defining the criteria for deep renovation in the past, the minimum qualifying standard may differ between Member States. However, Member States typically require a building to have a certain minimum EPC level after renovation to qualify as deep renovation, usually set out in their Long-Term Renovation Strategies (LTRS) required under the EPBD (BPIE, 2021).

Currently, the annual deep renovation rate in the EU averages just 0.2%, while the overall building renovation rate stands at around 1% (BPIE, 2021). Although the EU aims to double the total annual renovation rate to 2% by 2030, it has not set a specific target for deep renovations. The Buildings Performance Institute Europe (BPIE) advocates for a significantly more ambitious approach: increasing the deep renovation rate to 3% annually by 2030 and maintaining that level through 2050 (BPIE, 2021). This reflects the scale of transformation deemed necessary to meet long-term climate goals. Meeting these targets demands a combination of more ambitious energy efficiency measures and a faster phasing out of fossil fuel-based heat boilers in buildings, with a transition to efficient, renewable and waste energy-based heating and cooling solutions, such as heat pumps and district energy systems (EEA, 2023b). Achieving this will necessitate substantial investment efforts (EEA, 2023a).

Sources: Ramboll 2022, Official Journal of the European Union 2024 Own visualisation, BPIE 2021

Further important elements of the policy background include the Electricity Directive and Regulation, the Renewable Energy Directive, and the Energy Efficiency Directive. The Electricity Directive and Regulation (EU, 2019) revised the rules for the EU internal electricity market aiming to empower consumers with more tools to actively participate in the energy system, recognising that access to consumption data can foster positive behavioural changes. The Renewable Energy Directive (EU, 2023c) sets the EU-wide target for the share of renewable energy is set to rise at least 42.5% to achieve a target of 45% for renewable energy sources in the EU’s energy mix by 2030. As part of this framework, each Member State is required to raise the share of renewable energy used for heating and cooling by at least 0.8 percentage points annually between 2021 and 2030, reflecting the crucial role of buildings in achieving the Union’s climate and energy objectives.

The Energy Efficiency Directive (EU, 2023b), the main EU law for promoting energy efficiency, highlights consumer behaviour as a key factor in implementing energy-saving measures and mandates consumption-based billing - such as for heating - to increase awareness and encourage energy savings. The revision of the Energy Performance of Buildings Directive (EPBD) (EU, 2024), adopted in 2024, aims to achieve a zero-emission building stock by 2050 by improving both new and existing buildings through strengthened renovation requirements, particularly targeting the worst-performing buildings, mandating zero-emission buildings by 2028 (public) and 2030 (general), and promoting energy performance standards, renewable energy integration, smart technologies, and renovation planning in all Member States.

Long-Term Renovation Strategies (LTRS) were national strategies required under Article 4 of the 2012 Energy Efficiency Directive (Directive 2012/27/EU) and reinforced in the 2018 revision of the Energy Performance of Buildings Directive (EPBD). Their objective was to support the decarbonisation of the national building stock by outlining pathways and measures for mobilising investment in the renovation of residential and non-residential buildings, both public and private. LTRS have since been replaced by National Building Renovation Plans (NBRPs) under Article 3 of the revised EPBD (2024/1275/EU). NBRPs build on the foundation of LTRS but introduce more comprehensive, enforceable, and measurable planning frameworks aligned with the EU's climate-neutrality and building decarbonisation targets (EC, 2024c). The first draft must be submitted by December 2025, with the final version to be completed by the end of 2026. The new plans include national targets for 2030, 2040 and 2050, progress indicators, an overview of investment needs, planned policies and measures for financing, technical support, advice tools, and tackling energy poverty. They form part of the integrated National Energy and Climate Plans (NECPs) and will be monitored and evaluated through the integrated national NECP Reporting.

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investment in the renovation of residential and non-residential buildings, both public and private. LTRS have since been replaced by National Building Renovation Plans (NBRPs) under Article 3 of the revised EPBD (2024/1275/EU). NBRPs build on the foundation of LTRS but introduce more comprehensive, enforceable, and measurable planning frameworks aligned with the EU's climate-neutrality and building decarbonisation targets (EC, 2024c). The first draft must be submitted by December 2025, with the final version to be completed by the end of 2026. The new plans include national targets for 2030, 2040 and 2050, progress indicators, an overview of investment needs, planned policies and measures for financing, technical support, advice tools, and tackling energy poverty. They form part of the integrated National Energy and Climate Plans (NECPs) and will be monitored and evaluated through the integrated national NECP Reporting.

The Affordable Housing Initiative (EC, 2021a) is a key measure within the Renovation Wave and ensures that social and affordable housing is also contributing to the Renovation Wave. The initiative is in line with the New European Bauhaus, the European Pillar of Social Rights, the Cohesion Policy Objectives 2021-2027, the REPowerEU plan and the revised Energy Efficiency Directive and the revision of the Energy Performance of Buildings Directive.

From 2027 a new emissions trading system (ETS2) will be introduced in Europe alongside the existing EU ETS (European Commission, 2023). This new system will include emissions from fuels used for combustion in buildings. Part of the revenue from the ETS2 will go to the Social Climate Fund, which was set up specifically for this purpose. Social climate fund (SCF) (European Commission, 2024): Member States will be able to use SCF to directly support vulnerable households by investing in home energy renovation amongst others. EU Member States have been revising their National Energy and Climate Plans (NECPs) in 2024 and corresponding strategies for the building sector, while facing several challenges. In its recent assessment of the updated National Energy and Climate Plans (NECPs), the European Commission identified several key shortcomings that require urgent attention. Firstly, information on the Social Climate Plans included in the NECPs often lacks sufficient guarantees to ensure social fairness, raising concerns about the equitable distribution of climate policy impacts. Secondly, while around half of the final NECPs acknowledge the importance of phasing out fossil fuel subsidies, only a few provide a comprehensive overview of existing subsidies or a clear timeline and concrete measures for their phase-out. Lastly, 5 out of the 23 NECPs assessed project a gap in achieving their Effort Sharing Regulation (ESR) national targets, highlighting the need for stronger and more immediate action in those Member States to stay on track for the EU's 2030 climate goals (EU, 2025).

Member states were supposed to submit the drafts of the National Social Climate plans in June 2025. According to Politico, the European Commission confirmed that only Sweden submitted its Social Climate Plan by the June 30, 2025 deadline (Guillot, 2025; Swedish Environmental Protection Agency, 2025). As of end of August 2025 it is still the only EU country that officially submitted the Social Climate Plan to the Commission, though several countries are in the final stages of the drafts.

The new priorities of the EU, through the EU Competitiveness Compass, also emphasize the macro level strategic importance of the decarbonization of the building sector. The EU Competitiveness Compass reflects growing public interest in sustainable growth and industrial resilience. It focuses on three priorities: closing the innovation gap, aligning decarbonisation with economic growth, and reducing strategic dependencies. In line with citizens' concerns - such as those highlighted in recent Eurobarometer surveys - it aims to strengthen Europe's economy by supporting startups, scaling clean technologies, and securing key resources. Decarbonisation of Buildings is a key element of 'Joint road

map for Decarbonisation and Competitiveness', which is one of the three Core Areas for Action in the Competitiveness Compass for the EU (EC, 2025a).

A central element of this strategy is the Clean Industrial Deal, which turns the green transition into a competitive advantage. It promotes industrial decarbonisation, supports the uptake of clean tech, and works to ensure affordable energy through the Action Plan for Affordable Energy, published on 26 February 2025 (European Commission, 2025a). While it does not detail the exact costs and benefits of energy renovations, it clearly emphasizes their value - boosting competitiveness, lowering energy bills, creating jobs, and contributing to climate goals. This positions energy efficiency not just as a climate measure, but as a smart economic investment aligned with the broader megatrend of competitiveness (EC, 2025b).

Building on this analysis of the social context, stakeholder landscape, and EU policy framework for residential energy renovation, the following chapter offers a detailed assessment of its social, economic, and environmental costs and benefits.

3 Social, economic and environmental costs and benefits of energy renovation

Key messages:

Maximizing long-term value of energy renovation should begin with environmental impacts, recognizing that society is embedded within the environment, and economic systems within the social. A holistic assessment of costs and benefits needs to also take into account potential reinforcing dynamics and potential adverse effects, such as social displacement or affordability issues.

The distributive effects of energy renovation span social benefits for inhabitants, environmental gains for both residents and society (including future generations), and complex but wide-reaching economic impacts for stakeholders. Vulnerable groups are the main beneficiary from relief from high energy costs (EC, 2025c), health and well-being improvements from energy renovation (O'Connor et al., 2024; EEA, 2023) and greater climate resilience (EEA, 2025). These findings highlight that energy renovation is not only a climate and energy policy tool but also a powerful instrument for advancing social equity, public health, and climate resilience, provided it is effectively targeted.

The revised Energy Performance of Buildings Directive (EPBD) emphasizes the consideration of environmental and health externalities of energy use, as well as the extension of the emission trading system and carbon prices, for determining the cost-optimal level of energy performance over the estimated economic life cycle (Official Journal of the European Union, 2024). The comparative methodology framework has been recently revised by the Commission (Directorate-General for Energy (European Commission), 2025; available [here](#)). While the Commission Delegated Regulation 2025 provides a well-designed methodology and improved the scope compared to 2010, it can not be seen as a fully holistic assessment tool as it lacks consideration of wider societal benefits e.g. reducing energy poverty and considers behavioural aspects and social vulnerabilities only to very limited extend.

As part of multi-criteria decision-making, additional Life Cycle Assessments (LCAs) for buildings should be considered to ensure a comprehensive evaluation of the economic, social, and environmental benefits of energy renovation, e.g. Life Cycle Sustainability Assessment (LCSA) frameworks developed under EU research programmes such as Horizon 2020 provide a structured way to combine environmental LCA (including the full carbon life cycle), Life Cycle Costing (LCC), and Social LCA (S-LCA) (Rodrigo A. F. Alvarenga, n.d.).

To achieve the EPBD goals for the building sector (both residential and non-residential buildings) the investment need amounts to EUR 200 billion yearly until 2030, creating a current investment deficit of EUR 127 billion each year (I4CE, 2025). This investment gap underscores the importance of gaining a balanced understanding of not only the costs but also the benefits of energy renovation.

This chapter aims to explore existing evidence based on multiple impacts of energy renovations, including potential adverse effects, synergies and distributional consequences. The costs and benefits

of energy renovation (including decarbonization and resilience, as defined in this project) of residential buildings are grouped into three categories: (i) social (incl. health), (ii) purely economic/financial and (iii) environmental. For each category of impact, the assessment examines the distribution of these impacts, identifying who benefits, who bears the costs, and at what point in time. Additionally, the section on economic costs and benefits also covers two exploratory questions on cost dynamics:

- How do the timing and execution of renovation projects influence their overall costs and benefits?
- What efficiency gains and cost reductions can be achieved by scaling up renovations from individual housing units to the district level?

The study follows an integrative review methodology, primarily based on qualitative assessment, complemented by quantitative elements where appropriate. The studies identified as most central during the literature scan were used to cluster costs and benefits within a structured matrix. This matrix organizes impacts across key dimensions economic, social, and environmental while also identifying the main affected stakeholders, potential adverse effects, the time horizon of the impact and the related Sustainable Development Goals (SDGs). A condensed form of this table is presented in chapter 2.2 (Table 1). To complement the matrix, a graph was developed to illustrate the dynamics and interconnections among the different types of costs and benefits (Figure 3). It combines both private and public perspectives and is designed to provide a holistic overview while highlighting key drivers and interconnections. Chapter 3.5 further places these findings in the context of current EU policy developments, underscoring their practical implications for decision-makers.

3.1 Economic effects of energy renovation and cost determinants

Typically, the first consideration for a decision maker pertaining to an energy renovation is its whole economic viability and effect. In addition to the costs and benefits accruing to the decision maker, there are various direct and spillover effects that energy renovations induce in the whole economy. Moreover, various determinants strongly influence economic cost effectiveness such as timing and scaling of the renovation process.

3.1.1 Main economic effects of energy renovation

Economic costs and benefits are numerous, and their nature differs at least in the following attributes: scale, timing, magnitude, certainty, impact channels and directness. The Healthy Homes Barometer 2022 by RAND Europe estimates that improving poor indoor climates in residential and public buildings across Europe could generate over EUR 600 billion in economic benefits by 2050, mainly through productivity gains (RAND Europe, 2022). In this section, we explore economic costs and benefits of energy renovation that evolve for the various stakeholders discussed in chapter 2.2 to the following five categories: Household Finance, Firm, Growth and employment, Public Finance and Energy system level costs and benefits. The primary distinction between private investment, firm-level and growth and employment is scale. Public finance and energy system level changes take place as a result of the decision taken on different scales (RAND Europe, 2022).

Household Finance costs and benefits (micro-level) start with the purchase required to finance the energy renovation. We call these acquired materials and services household renovation investments including financing. Financing costs associated with energy renovations include both direct and indirect expenses. These encompass the cost of credit - such as consumer loans, mortgage loans, and zero-

interest eco-loans - as well as the opportunity costs incurred when using personal savings to finance part of the investment. The latter reflects the potential returns that could have been earned had those funds been allocated elsewhere.

The individual project investment cost for households will depend on the local context, building type and the chosen renovation measure and can range from single-digits to more than EUR 20,000 in detached houses and considerably more than that in apartment buildings (see for e.g. Palma et al., 2022). The primary impacted stakeholder is the owner and impacts are immediate in case of direct financing or can be deferred in full or in part with financing instruments (Giraudet and Lucas Vivier, 2024).

The primary variable (operating) cost saving from energy renovation is reduced energy bills. We label the variable costs household operating costs. When an energy upgrade is carried out as part of a general renovation and includes improvements to the building envelope or other measures with energy use impact, the resulting reduction in energy bills often offsets the investment costs over time (Copenhagen Economics, 2018). However, the current and future price of energy type (e.g.: electricity, gas, etc) used for heating and cooling is a crucial variable in the calculation result. Additionally, there may be changes for necessary repair and maintenance costs and loan financing.

In the purest cost-benefit analysis and perfect information setting, a renovator would consider investment costs to expected future variable costs savings and invest if net present value is positive. In practise, the benefits from energy savings benefit the entity who pays the bills. They accrue over a longer time horizon and are likely increasing in nature as energy prices particularly from fossil generation become more expensive. Individual decision maker heterogeneity (e.g. life situation, age, house condition) leads to different priorities, tolerances for risk and discount rates on future savings, complicating the decision-making context (also see chapter 4.1.3). The economic viability of deep energy renovation is also strongly influenced by financing conditions, electricity prices and carbon pricing (see also Keliauskaitė et. al (2024) for a sensitivity analysis from Germany).

It is important to recognize that actual energy savings achieved through building renovations may be up to 50% lower than those projected by simulation models, based on findings from multiple renovation projects (Giraudet and Lucas Vivier, 2024). This energy performance gap can be attributed to an overestimation of both pre-renovation energy consumption (prebound effect) and the achievable energy savings, often due to cost-saving behaviours like under-heating of low-income households before the renovation. Beyond, post-renovation energy consumption may turn out to be higher than simulated due to the rebound effect, which refers to increased use of the heating system after renovation, e.g. by raising the indoor temperature (Giraudet et al., 2018; Giraudet and Lucas Vivier, 2024) as well as due to quality defects in the implementation and installation phases of the renovation process (Giraudet and Lucas Vivier, 2024). Part of the effect may also originate from incorrect technical assumptions in simulation models (Hajian et al., 2024). However, the extent of the rebound effect attributed to behaviour can vary significantly by building type and user group.

An energy renovation may also yield induced private monetary costs & benefits to the owner of the dwelling (for different owner types see also

Figure 2). Benefits for owners appear via higher rents and capitalization of the energy renovation into property value, where a recent literature review finds historical price premiums of 3-15% but with considerable variation among different markets and energy efficiency improvement specifications for

energy-efficient buildings (IEA, 2025b). This can be partly explained by comfort gains that lead to utility benefits and the capitalization of energy savings into property value (Giraudet & Lucas Vivier, 2024). From the tenants' perspective, however, higher rents represent an additional cost. Such rent increases carry the risk of exacerbating social inequality, an issue that was introduced in chapter 2 and will be discussed in more detail in the following chapters.

There are also other induced costs that are often overlooked. These include expenses related to removal, demolition, and interior finishes, which are difficult to attribute solely to the energy-relevant portion of the renovation. Additionally, expansions in surface area can drive up costs for non-energy and non-thermal elements, while intellectual services - such as energy audits, architectural design, and project management - further contribute to the overall investment (Giraudet and Lucas Vivier, 2024).

The climate crisis and the ambitious environmental objective in the building sectors necessitate reshaping of the linear-economy and in short-term energy transition create challenges and opportunities for companies involved in construction and renovations. We label these impacts, which mostly take place on the meso level firm costs and benefits. They can result in productivity gains and the business case for construction companies improves, though activity in general may shift more toward renovation activities compared to newbuilding segment. The business case for fossil industries on the other hand is weakened as there is an efficiency gain or abolishment of fossil generation. There are also positive impacts for innovation & competitiveness (industrial productivity) through R&D spending, competitiveness race and turnover on energy efficiency goods. The cost effects of technological and organisational innovations will be discussed further in chapter 3.4. As discussed in chapter 2.2 startup incubators further accelerate innovation by supporting early-stage solutions and business models that advance energy renovation technologies, real estate management optimisation and financing schema. Typically, increased renovation activity yields immediate impacts for companies and longer-term economic effects take place as a result of innovations. Simultaneously some of these innovations can end up benefiting building owners as the use of buildings becomes more optimized.

Private household finance and firm-level activities project to macro level costs and benefits as Growth and employment. These macroeconomic structural impacts include economic growth from the activity which has positive GDP impacts, reshaped construction activity and positive spill overs on other industries. There are also employment effects through direct jobs, subsidized jobs and opportunities for internships. A BPIE (2020) literature review synthesized that every EUR 1 million investment in energy renovations created between 15 - 29 local long term EU jobs in the Member States. A growing number of examples shows that hiring workers from vulnerable groups can also be an effective social policy in the context of energy renovation (Copenhagen Economics, 2018). Most of the macroeconomic impacts have some time lag, as organizations usually take some time to adjust their business scale such as personnel until they have certainty over the persistence of the change and will utilize measures such as subcontracting and overtime in the short-time frame. The supply and demand shocks continue to influence the economy longer term.

Advancing energy renovations has impacts on public finance. The public budget balance is affected via tax income for instance via changes in energy consumption taxes and property taxes on individuals, value added taxes on material purchases or income taxes on corporate profits and newly hired workers. Furthermore, if there are existing support schemes in place, tax credits and subsidies directly influence public finances. Should public sector be performing renovation activities in buildings owned by public bodies, there are also public investment costs. While economic costs are typically a consideration for decision makers, social costs and benefits need to not be adequately accounted for as well. An example

of the potentially significant impact of social costs on public finances—particularly on social security budgets—is the reduction of healthcare expenditures (Heidenreich et al., 2024; RAND Europe, 2022). The healthcare cost impacts are discussed in more detail in chapter 3.2.

The public sector also faces administrative costs since different renovation activities will need to be added to official records and similarly handling of taxes and subsidies causes administrative burden. Cases of fraud may also require monitoring and punishment actions. Our experience from personal communications with ministry officials has highlighted that inability to include sufficient administrative costs can sometimes be a meaningful deterrent for public funding.

Finally, energy renovations influence the energy system layer. Energy system impacts include impacts on import dependency and supplier diversity. According to Eurostat, roughly 2.63 million TJ of natural gas and 0.912 million TJ of oil and petroleum products were used for household space and water heating in 2023 (Eurostat, 2023b). These implicate a market valuation of approximately EUR 35 billion annually as of July 2025.⁶ With most of this being imported from outside the EU and calculated over a heating system lifetime, potential import savings from phasing out fossil-fuels in European Union residential space heating can reach hundreds of billions of Euros highlighting the importance of the energy transition.

An important energy system impact driver is the integration of renewables. The energy demand profile of renovated buildings directly influences the renewable energy share in the building sector's energy mix. Renovation activities that reduce heating and cooling demand or replace fossil-fuel systems with electrified or district heating solutions firmly relate energy efficiency renovations to the EU's Renewable Energy Directive targets (Directive (EU) 2018/2001). A particularly drastic change to the demand profile takes place when residential solar photovoltaic (PV) generation is introduced through energy renovations. Increased penetration of small-scale solar PV and solar thermal can be anticipated as EPBD recast mandates optimization of solar energy generation potential on new buildings. Adding solar PV turns buildings into energy suppliers and consumers into prosumers⁷, which in turn feeds into utilities' business case and the operation of regional energy distribution (DSO) networks. Solar PV can also be a catalyst for energy communities' formation.

On the other hand, electrification of heating and cooling via heat pumps and other electricity-based heating modes increases electricity generation needs and electrification of the society likely means more large-scale wind and solar energy and other renewables get added to the production mix, since these are already often viewed as least cost way to produce energy (see for e.g., Kabeyi & Olanrewaju (2023)). Wind and solar generation exhibit lower operating costs meaning they are typically run whenever its sunny or windy but are intermittent by nature. The intermittency of production means transmission system and other balance responsible parties need to invest in gridlines, backup power and new balancing market methods. In electricity and heat generation, peaking plants and other generation may need to create their breakeven profits from those times when renewable generation is scarcer, and this may increase price volatility as less traditional marginal generation units are

⁶ Using Dutch August 2025 natural gas futures as of 8 July 2025 with settlement at roughly EUR 9.8/MMBtu and conversion of 1 TJ to 947,817.12 cubic feet and an oil price of EUR 60 per barrel and BOE to TJ conversion of 1 BOE = 0.00586152 TJ. We used price of crude oil instead of heating oil and a conservative timing and level for natural gas futures, which by nature are very volatile.

⁷ This also changes the consumers' relationship with energy and can alter everyday practices of the inhabitants and influence the economics of electricity using equipment such as electric vehicles.

economically viable to cover balancing needs to bid in the scarce production periods. Any such impacts may be mitigated or even improved when renovation actions include consideration for demand flexibility. Potential ways to address this include heat-pump optimization and different storage solutions. Finally, security of maintenance, energy efficiency, production capacity and the overall functionality of the energy system are also highly important energy system considerations. The shift away from fossil fuels and burning generation leads to a green fuel and energy supplier transition. Fuel and energy supplier changes points to both individual level change of energy supplier for instance when shifting from gas to electricity and the increasing impact on renewables producers. Additionally, there will be impacts on energy prices as well as the price volatility, the direction of which will depend on the new supply and demand balance. Overall, it can be said that energy system impacts associated with the clean energy transition impacts all involved stakeholders, with impacts on household owners and occupants being more immediate though lasting in nature and system-level impacts realisation on Energy Suppliers and Distributors taking place particularly in the medium and long-term.

3.1.2 Determinants of economic cost dynamics

In the context of energy renovation projects, both the timing and scaling of execution processes are critical determinants of their overall economic costs and benefits. Effective management of these aspects can significantly influence the financial outcomes and the long-term value derived from the renovation. The following paragraphs aims to explore the impact of timing and execution on renovation projects, focusing on how these factors shape the cost-effectiveness and benefits realized throughout the process. Furthermore, this section will investigate the potential efficiency gains and cost reductions that can be achieved when scaling up renovation efforts from individual housing units to a district-wide level. By examining these dynamics, the section seeks to offer insights into how strategic planning, and the scale of execution can optimize resource utilization and enhance the economic sustainability of renovation projects. Giraudet and Lucas Vivier (2024) examine the cost dynamics associated with the coordination of energy renovation actions, emphasizing three scales of intervention: individual homes, multiple homes, and technological progress.

At the scale of a single home, Giraudet and Lucas Vivier (2024) highlight the significant benefits of comprehensive renovation approaches compared to step-by-step strategies in achieving high energy performance at a lower overall cost (ADEME et al., 2020; Maia et al., 2024; Observatoire BBC, 2021). Several underlying factors explain this including:

- **Interface issues in step-by-step renovations:** Fragmented renovations often neglect the careful coordination of construction interfaces, which can result in air leakages and thermal bridges, both of which undermine energy efficiency goals.
- **Neglect of Ventilation Systems:** Incremental renovations frequently omit the installation of mechanical ventilation systems. This omission forces reliance on manual window opening for air renewal, which is less efficient and may conflict with thermal comfort and energy savings.
- **Lack of integration between insulation and heating systems:** Effective energy renovation requires a coordinated approach to insulation and heating (thermal envelope and building systems). Insulation upgrades should be matched with the installation of appropriately sized heating systems. Conversely, installing systems such as heat pumps without sufficient insulation can result in suboptimal performance and higher energy consumption.
- **Duplication of fixed costs:** Step-by-step renovations often lead to the repetition of fixed costs such as those for protective measures, scaffolding, and site cleaning, which would only be incurred once in a comprehensive renovation project.

In addition to individual homes, Giraudet and Lucas Vivier (2024) emphasize the potential benefits of coordinating renovation efforts across multiple dwellings. When projects are organized at a larger scale - particularly by property management companies or housing cooperatives - they can harness economies of scale, resulting in substantial cost savings. Michelsen (2015) and Deutsche Energie-Agentur (2022) (dena) provide empirical evidence for this, showing that energy efficiency outcomes significantly improve when renovations are executed at a broader scale, which underscores the importance of regional planning and social innovation.

Beyond coordination, the authors highlight the role of technical and organizational innovations in driving down renovation costs. While technological progress can lead to more efficient materials and systems, the impact of any single innovation on overall renovation costs often remains limited (Giraudet & Lucas Vivier, 2024). This is primarily due to the non-standardized and labour-intensive nature of deep energy renovations. Though modular and prefabricated solutions represent a promising technological approach to increase labour productivity in renovation and reduce on-site time as well as related inconveniences, their successful deployment often depends on complementary organizational innovations. Such innovations, including new coordination models, streamlined processes, and integrated planning, can enhance the effectiveness of technical advancements and unlock further cost efficiencies (Giraudet and Lucas Vivier, 2024).

Industry experts expect that continuing innovation will bring down the cost of heat pumps by 40% by 2030 (Agora Energiewende, 2023). Recognizing their decarbonization potential, the EU aims to install at least 60 million new heat pumps by 2030 as part of the REPowerEU strategy. At the same time, clean-tech innovation in the construction sector (for example, prefabricated 'plug-and-play' retrofit components and digital design tools) can accelerate the learning curve and boost productivity, thereby improving unit economics of renovations over time (EC, 2021).

A major cost driver in deep renovations is the installation of a heat pump, with, for example, average upfront costs for air-to-water systems in Germany ranging from EUR 20,000 to EUR 30,000 per unit depending on capacity and complexity (Meyer et al., 2024) and a large diverge of costs across European countries. According to the IEA (2024), replacing a gas boiler with a heat pump can reduce energy use by 60-70% without insulation, and by up to 90% when combined with insulation improvement. Despite the high initial investment, heat pumps can deliver energy cost savings of 60-90% in countries where gas and electricity prices are similar (depending on the level of insulation).

The reduction of the energy bill depends strongly on the relative prices of gas and electricity. If electricity is significantly more expensive than gas, the financial benefit is smaller, though this loss can be partly offset by improving building insulation. In countries where gas is up to four times cheaper than electricity, switching from gas to a heat pump can even result in higher energy bills (IEA, 2024). In the EU, electricity excise duties exceed gas taxes and this is only partially address with the introduction of ETS2 and creates a disincentive for investments in clean technology (Sgaravatti, 2024).

Additional emerging organisational and technological innovations such as digitalisation, off-site modular construction, novel materials, and circularity principles are also gaining relevance and may lead to cost reductions. Although these aspects fall outside the core scope of this study, they merit further investigation and should be considered in future research and policy design. Startup incubators are a central driver for emerging innovations and cost reduction, as they support early-stage solutions and business models.

In addressing economic costs and benefits of energy renovation, systemic thinking is required and issues such as sector integration should be considered. The analysed cost dynamics underscore the importance of strategic planning and coordination in residential energy renovation to maximize performance and minimize costs from both a private cost-effectiveness and a social costs-effectiveness point of view. The results of a sensitivity analysis for Germany by Keliauskaitė et. al (2024) indicate that policy measures such as public grants, reduced electricity tariffs and access to low-interest financing can significantly improve the economic case for renovation, particularly for more costly projects. A frequent pitfall in accounting for economic costs and benefits is partial optimization, where a decision maker only takes the view of one segment. This phenomenon coupled with unaccounted positive and negative externalities conceptually also happens on a wider scale if social and environmental benefits that we will introduce in the next two sections are not considered.

A holistic assessment of environmental, social, and economic costs and benefits with a long-term perspective can shift the focus from mere cost-effectiveness to broader social cost-effectiveness, while ensuring that public support is allocated efficiently.

3.2 Social costs and benefits

This chapter addresses the social costs and benefits of residential energy renovation, noting that greater social effectiveness may require linking policies to broader housing quality improvements (European Foundation for the Improvement of Living and Working Conditions., 2023). Social costs and benefits of energy renovation can be broadly divided into five key areas:

- indoor comfort and space quality
- alleviation of energy poverty
- improved health and overall well-being
- climate resilience and climate preparedness of buildings, occupants, and communities
- creating attractive cities with social responsibility

Indoor comfort encompasses a range of factors that directly impact the quality of life of inhabitants: thermal conditions (protection from cold, heatwaves and temperature fluctuations etc.), indoor air quality, acoustic conditions, daylight/ lighting conditions, humidity and dampness, inconvenience during adaption and ease of use/ ease of maintenance (Ruiz-Valero et al., 2025; Giraudet and Lucas Vivier, 2024). The EPBD defines indoor environmental quality and includes requirements in indoor environmental quality focusing mostly on air quality and thermal comfort (EU, 2024). The effect of several of those aspects of indoor comfort on health and overall well-being will be discussed in more detail below.

While almost all of the effects of energy renovation on indoor comfort are clearly positive, inconvenience during the renovation phase has a negative effect on indoor comfort. Factors such as the duration of works, space required for construction, adaptability of existing structures, and disruptions to daily routines can temporarily reduce comfort and create stress for inhabitants, representing a significant, often overlooked cost of renovation.

All the mentioned effects of energy renovation on indoor comfort influence demand-side stakeholders, particularly benefiting tenants, occupant private homeowners as well as potential future buyers of the

building. While the cost of inconvenience during the renovation process is mostly short-term, the benefits related to indoor comfort are expected to manifest in the short-, medium-, and long-term.

Space quality, in the context of energy renovation, refers to the physical and functional improvements made to a dwelling. These enhancements include more efficient use of space, improved aesthetics, increased safety and accessibility, and the creation of additional usable areas (Ruiz-Valero et al., 2025). Better internal and external spatial layouts can enhance the compatibility of space use, allowing for greater flexibility and comfort. The visual appeal of renovated spaces contributes not only to personal enjoyment but also to satisfaction derived from knowing others perceive the environment positively. Safety improvements, such as the installation of handrails and fire hazard mitigation, reduce the risk of accidents and can lower liability for all owners in multi-unit buildings (Heidenreich et al., 2024). Improved accessibility features enable smoother transitions between spaces, benefiting individuals with impairments and increasing the likelihood of aging in place.

Renovations may also unlock previously underused or uncomfortable areas, increasing usable living space such as by adding a balcony and thereby enhancing well-being and offering greater freedom in how the home is used. Such upgrades may also enhance shared spaces and together these upgrades contribute to a more comfortable, functional, and attractive living environment, enhancing both subjective satisfaction and the objective value of the property (Ruiz-Valero et al., 2025). These improvements in space quality benefit demand-side stakeholders such as tenants, homeowners, and prospective buyers, beginning immediately after renovation and continuing to provide value over the long term.

As discussed before, energy poverty is defined as a household's lack of access to essential energy services, such as heating, hot water, cooling, lighting and energy to power appliances (EP, 2023). It arises most commonly at the intersection of low household income and poor energy performance of dwellings, resulting in an inability to maintain adequate indoor temperatures and meet basic energy needs (Copenhagen Economics, 2018). Energy poverty is often associated to winter and heating needs yet it needs to be differentiated from summer energy poverty (see also chapter 2.1), that refers to the inability to maintain comfortable indoor temperatures during summer (EC, 2025d), which become more and more relevant as climate change increase the frequency and intensity of heat waves. Energy renovations can play a critical role in reducing the risk of (summer) energy poverty by improving the energy efficiency of buildings, thereby reducing energy bills. However, the extent of this impact depends on future developments in energy prices, overall living costs, and the broader state of income inequality. Whether a renovation also comes with adverse effects like gentrification and displacements depends largely on the presence of social safeguards, such as tenant protections, low-income subsidies, rent-control floors, and targeted financing, to prevent evictions and ensure affordability (EC, 2023b).

The reduction of energy poverty resulting from energy renovations can be observed in the short, medium, and long term. In the short term, renovations can alleviate the burden of high energy costs, particularly for vulnerable populations in urban areas with inadequate housing and high energy expenses (EC, 2025d), thereby contributing to greater equity and social inclusion. Going further, the reduction of energy poverty has broader societal impacts, including decreased public spending on social aid and improved social stability.

Enhancing indoor comfort and addressing energy poverty plays a critical role in improving both public health and overall well-being. A systematic review of 45 academic studies found that 90% reported positive health outcomes resulting from energy efficiency measures in buildings, including

improvements in respiratory health, general physical health, mental well-being, and life satisfaction (Wang et al., 2022). Improved thermal comfort and indoor air quality are associated with reduced incidence of respiratory and cardiovascular conditions. For instance, lower exposure to humidity, particularly when combined with cold, has been linked to a decreased risk of such illnesses (Dervaux & Rochaix, 2022). A Eurofund (2016) study estimated that improving indoor climates through energy renovations could generate savings in the health sector of approximately EUR 167 billion in the EU-27, due to fewer sick days and hospital visits.⁸ Recent analysis indicates that air pollution still causes EUR 600 billion in losses each year in the European Union, which is equal to 4% of its annual GDP (Mejino-López & Oliu-Barton, 2024).

Thermal discomfort and fuel poverty are furthermore linked to adverse mental health effects such as anxiety, stress, and depression. Efficiency improvements can mitigate these issues, particularly when complemented by financial support mechanisms and strong community engagement (IEA, 2025b). Also, utility arrears can contribute to poor mental health and energy renovations can contribute to reducing arrears (European Foundation for the Improvement of Living and Working Conditions., 2020).

In addition to positive health effects, energy renovation contributes to overall well-being as greater control over energy expenses fosters a sense of financial security, while visible home improvements can enhance social status and self-esteem. These psychosocial benefits highlight the broader social value of energy renovation, beyond technical and economic dimensions. A key yet often overlooked effect of energy renovation on well-being is the diverse and unobserved utility households associate with energy efficiency. This idiosyncratic value is shaped by preferences for specific technologies and contextual life events, such as equipment breakdown, relocation, or family growth, which influence both the perceived benefits and timing of investments (Giraudet and Lucas Vivier, 2024).

An analysis by RAND Europe (2022) indicates that, using a computable general equilibrium model, the projected economic benefits are substantial if current and future cohorts of children and adults across the European Union, the United Kingdom, Switzerland, and Norway are not exposed to damp and mould and do not experience a lack of daylight. The model estimates that the macroeconomic cost of such exposure in residential buildings over the next 30 years could amount to approximately EUR 53 billion, mainly because of effects on labour productivity and mortality. Additionally, they find that the aggregated monetised well-being losses⁹ of the climate risk factors damp, lack of light, noise in dwellings and inability to keep the house adequately warm amounts to EUR 258 billion per year (RAND Europe, 2022).

Energy renovation contributes to improved outdoor air quality by reducing emissions of pollutants like particulate matter (e.g.: PM_{2.5}), SO₂, and NO_x, which are closely linked to heating technologies and fuel types (Buchmayr et al., 2021; Bulle et al., 2019). For example, in the EU, around 60% of PM_{2.5} emissions are from buildings heating systems in 2022 (EEA, 2025). Exposure to concentrations of fine particulate matter above the 2021 World Health Organization guideline level resulted in 238,000 premature deaths in the EU-27 in 2020 alone (EEA, 2022a). Moreover, the combination of air pollution

⁸ There is evidence that renovations can lead to higher concentrations of indoor pollutants and increased occupant discomfort or health symptoms if adequate ventilation for comfort is lacking (Bekö et al., 2016). A tendency toward overheating during heat waves has also been reported (Hassan et al., 2024).

⁹ The well-being valuation approach estimates the monetary value of indoor climate hazards by quantifying how much additional income would be needed to offset the loss in life satisfaction associated with exposure, using regression analysis on EU-SILC survey data.

and extreme heat has been shown to increase mortality rates, particularly through cardiovascular and respiratory diseases, underscoring the importance of clean, resilient building technologies (EEA, 2022a).

While greenhouse gas emissions from burning fossil fuels are routinely accounted for in energy and climate policies, the immediate health impacts of air pollution from the same fuels are rarely quantified alongside them (Pei et al., 2025). According to CE Delft (2022), amongst heating technologies non-condensing coal boilers and wood stoves impose the highest health-related social costs, at EUR 29.2/GJ and EUR 17.9/GJ respectively. In contrast, solar thermal systems have no direct emissions and incur no health-related social costs. Other clean options, such as electric and district heating systems, also perform well, though their indirect emissions depend on the energy mix used for electricity generation (CE Delft, 2022).

Importantly, the health and well-being impacts of energy renovation are most pronounced among vulnerable groups, including children, the elderly, and individuals with pre-existing conditions. Research indicates that comprehensive renovations can reduce school absences by 20% among children with asthma and lower the mortality risk by over 30% among adults over 65 with a history of cardiovascular hospitalisation (O'Connor et al., 2024). The EEA emphasizes that, due to children's heightened vulnerability to air pollution, improving air quality around child-focused settings such as schools and kindergartens can reduce their exposure and should be prioritized (EEA, 2023). Some health and overall well-being effects of energy renovation, such as improved indoor air quality and thermal comfort, can be felt in the short term, while others, like reduced respiratory illnesses and better cardiovascular health, tend to emerge over the medium and long term.

Enhancing resilience requires making buildings more robust to withstand escalating heat, variable precipitation, storms, and other extreme weather events (GlobalABC, 2024). Energy renovation strategies must increasingly address not only energy efficiency targets but also the climate resilience and climate preparedness of buildings, occupants, and communities. As temperatures rise and the frequency of extreme weather events such as heatwaves increases, building design and renovation practices must consider thermal comfort under both heating and cooling scenarios.

Between 1980 and 2020, heatwaves were responsible for 86-91% of fatalities caused by climate-related extreme events, causing 77,000–129,000 deaths in the 32 EEA member countries (EEA, 2022). Between 2010 and 2019, exposure to heatwaves was 64.4% higher (1.07 billion person-days per year) than between 2000 and 2009 (0.65 billion person-days per year) among people aged over 65 and children under one year old (van Daalen et al., 2022). The summer of 2022 saw more than 60,000 heat-related deaths in Europe, with Italy, Spain, Germany, France and Greece bearing the heaviest burden (Ballester et al., 2023). Within countries, there is also unequal exposure to the rising number of heatwaves, with low-income households, individuals with health conditions, children, older adults, outdoor workers and people experiencing homelessness being the most affected groups (EEA, 2025). Enhancing indoor thermal protection through energy renovation can therefore be especially valuable for these groups, as it strengthens climate resilience and preparedness in both the short and long term.

Energy renovations, while beneficial overall, may inadvertently deepen social inequalities if not implemented equitably. E.g. Rocha et. al (2024) found that unprivileged groups are less served by green cooling services in major European urban areas. Based on an analysis of 14 major European regions, the study found that lower-income residents, tenants, immigrants, and unemployed individuals consistently receive below-average access to green cooling. In contrast, upper-income residents, nationals, and homeowners benefit from above-average cooling provision. This disparity heightens the

fatality risk during extreme heatwaves, as vulnerable populations are often unable to afford either passive or active cooling solutions.

Well-insulated building envelopes can improve both winter energy performance and summer heat resistance, yet inadequate renovation planning, particularly when passive cooling measures are omitted, can result in overheating risks (Ramboll, 2022). Effective renovation must therefore incorporate climate adaptation strategies, including shading devices, natural ventilation, thermal mass utilization, and integration of climate-responsive materials (Ramboll, 2022). The positive effects of energy renovation on climate resilience and preparedness benefit tenants and private owners, in particularly vulnerable groups as they face higher climate risks and occur short- medium as well as long-term.

Energy renovation initiatives strongly contribute to creating attractive cities with social responsibility by lowering crime rates, diversifying neighbourhoods, and encouraging greater community engagement. Well-maintained, diverse neighbourhoods promote social inclusion by providing shared spaces where people from different backgrounds can connect. These improvements also benefit civil society, local and national authorities by attracting new residents, boosting city budgets through increased residential and business taxes, and enhancing the business environment through access to a broader skill base. This links back to the positive economic effects outlined in chapter 3.1, both for construction company business cases and for public budget balances. Furthermore, energy renovations provide opportunities for citizens to get engaged in their communities (Copenhagen Economics, 2018). A good social environment, e.g. direct engagement, dialogue etc., is central for increasing the acceptance for energy renovations amongst tenants. The resident's acceptance of renovations is furthermore influenced by those previously described benefits that are visible and directly experienced by the tenants (International Energy Agency, 2017).

The main beneficiaries of the creation of attractive cities with social responsibility are demand-side stakeholders such as tenants, private owners that can experience increased safety and improved social mobility for low-income households. Chetty et al. (2016) find that children from low-income families living in higher-income neighbourhoods are more likely to attend college, and will as a result earn 31% more as adults (Chetty et al., 2016). All effects of energy renovation on the creation of attractive cities with social responsibility are estimated to occur in the medium and long-term.

Energy renovations have significant social impacts that go well beyond minor upgrades for the privileged, playing a crucial role in addressing deep inequalities like energy poverty across Europe. The next chapter will examine the equally important environmental costs and benefits of energy renovation to provide a comprehensive view of its overall impact.

3.3 Environmental costs and benefits

According to the nested model of sustainability, the environmental dimension encompasses the economic and social spheres, suggesting that long-term environmental health is foundational to both societal well-being and economic stability (Giddings et al., 2002). This conceptual model emphasizes that strategies aimed at ecological conservation – such as the preservation of natural ecosystems – are not only environmentally beneficial but also instrumental in ensuring a healthy living environment, which underpin secure and habitable living conditions for society (Rockström et al., 2009).

In the context of building renovations, six core domains can be identified for assessing environmental costs and benefits:

- Emissions of GHG (global pollutant) and of local air pollutant
- Resource use and waste management
- Land use and ecosystem efficiency

The accounting of emissions is the most commonly used environmental indicator for evaluating renovation measures (Abbasi et al., 2023). The building sector is a major contributor to greenhouse gas (GHG) emissions in the European Union, accounting for approximately 36% of energy-related GHG emissions (EEA, 2024b). Therefore, improving the energy performance of buildings insulation and the replacement of fossil-fuel-based or inefficient heating systems, is essential for achieving the EU's climate neutrality objective by 2050.

Under the revised Energy Performance of Buildings Directive (EPBD, Directive (EU) 2024/1275), the EU's target has shifted from promoting nearly zero-energy buildings toward zero-emission buildings. This progression signifies a more holistic view that encompasses not only operational emissions but also embodied emissions from construction materials and processes throughout the entire building life cycle. In June 2025, the Commission published guidance documents accompanying the provisions of the EPBD recast, with guidance specifically regarding zero-emission buildings (European Commission, 2025b).

The emissions balance thereby depends on primary energy consumption¹⁰ for operating the building and the supply chains of used materials, components and technologies (embodied carbon emissions). Consequently, life cycle assessment methodologies, such as especially for calculating the carbon footprint, are very well presented for the evaluation of renovation projects (Abbasi et al., 2023; Cabeza et al., 2014; EEA, 2024a). To provide comparability across projects or to use environmental data in economic models, environmental damage can be translated into monetary terms. However, this process requires a careful distinction between market prices and economic damage values. A common, but flawed, approach is to equate the market price of CO₂ emission permits with the actual damage caused by emissions. Instead, more robust monetization methods for LCA midpoint categories follow two main approaches: damage cost and abatement cost methods. Damage-based methods like Ecovalue, EPS, LIME3, and Stepwise estimate impacts on human health, ecosystems, and productivity, while abatement-based methods such as MMG, Environmental Prices, and EVR use exclusively or add the cost of achieving policy targets like the Paris Agreement (Arendt et al., 2020). In the building sector, studies review different methods, highlighting varying approaches to damage evaluation (Durão et al., 2019) and finding a wide variability in coefficients, with values ranging from as low as EUR 7.50 per tonne (LIME3) to as high as EUR 500 per tonne (Dong et al., 2019). The review by Arendt et al. (2020) provides a comprehensive overview of monetization methods and values for a range of environmental midpoint indicators typically included in complete life cycle assessments.

For impact assessment of building renovations, studies mostly focus on life cycle carbon emissions. Renovations can lead to reductions in GHG emissions during operation of around 50%. However, these

¹⁰ As defined in the EPBD, primary energy accounts for the total energy used, including energy losses in conversion and distribution, offering a more comprehensive measure than final energy consumption (Official Journal of the European Union, 2024). This indicator is pivotal in national renovation strategies and long-term building decarbonisation planning.

benefits are partially offset by the embodied lifecycle emissions of the additional materials required for renovation, especially when changes extend beyond energy efficiency improvements. Zimmermann et al. (2023) find that 54% of these embodied emissions are related to modifications unrelated to energy efficiency, such as spatial reconfigurations or interior layout changes. As a result of the wide variability in project scopes, overall GHG emission reductions range between 20% and 65%. In a review of multiple renovation cases, the average operational emissions prior to renovation were 13.5 kg CO₂-eq/m² per year. Post-renovation, the combined operational and embodied emissions averaged 8.7 kg CO₂-eq/m² per year over a fifty-year reference study period (Zimmermann et al., 2023). Trying to monetize these savings of approx. 0.005 t CO₂-eq/m² per year with methods quoted by Arendt et al. (2020) would give a mitigated environmental damage of 3 ct/m² per year to EUR 2.5/m² per year.

Although the emphasis for many renovation studies lies on the mitigation of carbon emissions, there are also other emissions that cause environmental damage such as acidification. Potential monetary valuations for acidification impacts vary widely, ranging from EUR 0.01/kg SO₂-eq to EUR 9/kg SO₂-eq, with abatement cost-based methods like EVR yielding significantly higher values than damage-based approaches (Arendt et al., 2020). Eutrophication damage due to energy and material used during the life cycle ranges from EUR 0.01/kg PO₄-eq to EUR 64/kg PO₄-eq, with the highest estimates based on contingent valuation studies reflecting public willingness to pay in high-income countries like Sweden, while the lowest values derive from global average damage assessments focused on biodiversity and agricultural productivity (Arendt et al., 2020). Calculations of acidification and eutrophication potential are less common, and as such, no comprehensive review studies on these impacts in the context of building renovations were identified.

While GHG emissions and their impact on the climate are experienced globally, other pollutants such as particulate matter, and NO_x have more localized environmental and public health impacts (Buchmayr et al., 2021; Bulle et al., 2019), which were discussed in chapter 3. Accordingly, emissions from the built environment affect different stakeholder groups. Society at large is impacted by global climate change caused by GHG emissions. End-users such as private owners and tenants locally benefit directly from improved air quality when heating systems are decarbonized and building technologies become more efficient.

Energy renovation furthermore impacts resource use and waste management. Key indicators in this area include raw material dependency, reuse and recycling of materials, waste generation, wastewater management, and biomass consumption (Abbasi et al., 2023; Pomponi and Moncaster, 2017). Promoting circular building design, including modular construction, the use of bio-based or recycled materials, and design-for-disassembly principles, can substantially reduce environmental impacts and raw material demand (López Ruiz et al., 2020). This means that while the outcome regarding thermal insulation and comfort and energy efficiency is the same, before mentioned design and material choices will show different cost and benefits in this indicator. Circular practices in the building sector are aligned with European policy objectives, i.e. the EU Circular Economy Action Plan, which seeks to decouple economic growth from resource use. The Action Plan states the aim to double the EU's circular material use rate until 2030. For the construction and buildings sector, the Circular Economy Action Plan emphasizes increasing the durability, reparability, and recyclability of buildings, and developing digital logbooks for buildings. Moreover, it encourages the reduction of soil sealing, and the increase of circular use of excavated soils (European Commission, 2020).

The circularity of products and activities can be described using various circularity indexes, which differ in their scope, both in terms of the materials included and how these are accounted for. Some of these indicators use monetary values; however, in such approaches, the economic value of materials is

counted, rather than the environmental damage caused by extraction or their unavailability to ecosystems. The widely differing methodologies result in a broad range of monetization values from EUR 0 to over EUR 20,000/kg Sb-eq (antimony equivalents). For water use over the life cycle, costs range from < EUR 0.01 to EUR 30/m³.

The transition towards more resource-efficient and circular renovation practices also affects the stakeholder group of installers, contractors and construction firms as suppliers of material and equipment. As sustainability along the supply chain becomes a central criterion, suppliers offering insulation and heating system components made from renewable, recycled, or locally sourced materials gain a competitive advantage. Life cycle considerations and the origin of materials, e.g. the use of regionally available bio-based products, are becoming increasingly relevant in procurement.

In terms of land use and ecosystem impact, building renovation and densification strategies offer a clear advantage over new construction, as they allow for improved energy performance without further land sealing or encroachment on greenfield areas (Häkkinen et al., 2013). Soil restoration and permeability should also be considered in renovation site planning, particularly when surfaces are resurfaced or re-landscaped. By modernizing the existing building stock rather than expanding it, renovations support the dual goals of reducing environmental degradation and optimising urban land efficiency. This was exemplified by a project from Denmark that used life cycle assessment to investigate different renovation options and found that, especially with minimal interventions and biogenic materials, renovations are both more climate-friendly and cost-effective than new construction (Realdania, 2024). However, material sourcing for renovations, particularly in the case of biomass, can introduce land-use conflicts. Assuming there is a shift from fossil fuels to greater use of biomass energy, it could potentially lead to competition between biomass production for construction or energy use and agricultural production or conservation priorities. These pressures underscore the importance of balancing the use of renewable materials with ecological safeguards to prevent adverse outcomes such as forest degradation, biodiversity loss, or the spread of monocultures. Forest ecosystems and biodiversity-rich areas are especially vulnerable unless sustainable forestry and land use strategies are effectively implemented. Consequently, regional planning frameworks must integrate ecological constraints to ensure that material demand aligns with nature conservation and long-term resource stewardship (Wu and Pfenninger, 2023).

To quantify the impacts of land use change, an ecosystem services approach can be employed, capturing the full range of services that ecosystems offer (provisioning, regulating and supporting, and cultural), typically in biophysical terms, with the option of expressing them in monetary terms depending on the assessment goal. This approach assesses how land transformations affect the supply and quality of these services, often using biodiversity indicators such as species richness, functional diversity, and pollination rates to evaluate declines in ecological integrity and ecosystem functionality (Brandão and Milà i Canals, 2013). A central challenge lies in capturing not just the immediate economic benefits of ecosystem use, but also the long-term strategic value of these services for future generations, which are often difficult to monetize (Costanza et al., 2017). The impact of land use change is highly context-dependent and varies significantly based on the type of ecosystem affected, making broad generalizations unreliable.

Land and ecosystem impacts from the built environment concern society at large, as the sealing of land through new construction projects contributes to biodiversity loss, the fragmentation of natural habitats, ecological degradation, and the disappearance of natural areas that provide ecosystem

services such as such as pollination, flood regulation, and heat mitigation as well as cultural ecosystem services. Renovation of existing buildings, by contrast, enables the revitalization of already developed land without further encroachment on greenfield sites, making it a more sustainable alternative. Beyond avoiding ecosystem degradation, building renovation can proactively contribute to biodiversity restoration through urban greening, ecological landscaping, and reconnecting fragmented habitats, supporting the goals of the EU Biodiversity Strategy and Nature Restoration Regulation.

To summarize, energy renovation measures offer several environmental benefits by reducing energy consumption, lowering greenhouse gas emissions and local air pollutants leading to acidification or eutrophication, and improving in many cases resource and land use efficiency. These outcomes result in reduced pressures on the natural environment. Applying circular economy principles, such as prioritising renovation over demolition and reconstruction, promoting the use of renewable and recycled materials, is essential for minimizing raw material use and limiting waste generation. Nature-based solutions provide benefits for biodiversity. To fully realise these benefits, it is important to integrate monitoring frameworks that track environmental co-benefits - such as biodiversity indicators and ecosystem service valuation. These tools help assess and maximise nature restoration outcomes over time.

However, there are also potential costs for the environment such as the shift to biomass energy sources that might lead to increased local emission, particular matter in case of biomass use, and additional requirement to building energy infrastructure. Finally, goal conflicts can arise, e.g. the sourcing of biomass for construction or energy may compete with the preservation of natural ecosystems. Careful planning and stakeholder engagement are essential to maximize co-benefits and trade-offs across environmental, economic and social dimensions.

3.4 Summary and interconnectedness of energy renovation costs and benefits

The primary effects of energy renovation, detailed in previous chapters, are summarized into overarching categories. This streamlined matrix highlights key economic, social, and environmental impacts, affected stakeholders, time horizons and connections to relevant Sustainable Development Goals (SDGs).

Table 1. Energy renovation impacts: main affected stakeholders, time horizon and SDG links

Impacted Factors/ Indicators	Main Affected Stakeholders	short-term (0-5y)	medium-term (5-15y)	long-term (15+y)	Related SDGs
Emissions (GHG, PM, SO₂, NH₃)	General Public /Civil Society + Tenants + Private Owners	yes	yes	yes	Climate Action (SDG 13)
Resource and waste management	General Public /Civil Society + Installers & Contractors/ Construction Firms	yes	yes	yes	Responsible Consumption and Production (SDG 12)
Land use and ecosystem efficiency	Tenants + Private Owners	no	no	yes	Life on Land (SDG 15)
Indoor comfort	Tenants + Private Owners + Prospective Buyers	yes	yes	yes	Good Health and Well-being (SDG 3)
Space Quality	Tenants + Private Owners + Prospective Buyers	yes	yes	yes	Good Health and Well-being (SDG 3)
Energy Poverty	Tenants + Private Owners + Prospective Buyers	yes	yes	yes	Affordable and Clean Energy (SDG 7), No Poverty (SDG 1), Reduced Inequalities (SDG 10)
Health and Overall Well-Being	Tenants + Private Owners + Prospective Buyers	yes	yes	yes	Good Health and Well-being (SDG 3)
Climate resilience & climate preparedness	Tenants + Private Owners	yes	yes	yes	Sustainable Cities and Communities (SDG 11)
Creating attractive cities with social responsibility	Tenants + Private Owners + General Public /Civil Society + National & Local Authorities	no	yes	yes	Sustainable Cities and Communities (SDG 11)

Household Finance	Tenants + Private Owners + Individual Private Lessors	yes	yes	yes	No Poverty (SDG 1), Good Health and Well-being (SDG 3), Affordable and Clean Energy (SDG 7), Reduced Inequalities (SDG 10), Responsible Consumption and Production (SDG 12)
Firm	Housing companies (for profit)	yes	yes	yes	Decent Work and Economic Growth (SDG 8), Industry Innovation and Infrastructure (SDG 9)
Growth and employment	General Public /Civil Society	yes	yes	yes	Good Health and Well-being (SDG 3), Decent Work and Economic Growth (SDG 8)
Public finance	General Public /Civil Society + Local & National Authorities	yes	yes	yes	Industry Innovation and Infrastructure (SDG 9), Sustainable Cities and Communities (SDG 11), Peace, Justice and Strong Institutions (SDG 16)
Energy system	Energy Supplier & Energy Service Providers	yes	yes	yes	Affordable and Clean Energy (SDG 7), Industry Innovation and Infrastructure (SDG 9), Climate Action (SDG 13)

Source(s): Authors' analysis based on multiple sources discussed in this chapter

Going beyond a comprehensive overview of the costs and benefits of energy renovation, the following visualization (Figure 3) gives more insights into key dynamics and interconnectedness of the costs and benefits. It is based on the framework of ecological economics, which conceptualizes the economy as a subsystem of society, and society as a subsystem of the environment, bounded by ecological limits (Daly, 1996). The relationships among key variables (consolidated categories of costs and benefits) were visualized in a diagram inspired by causal loop diagrams (CLDs), where an arrow marked with a plus sign (+) denotes a positive (reinforcing) relationship between two variables.

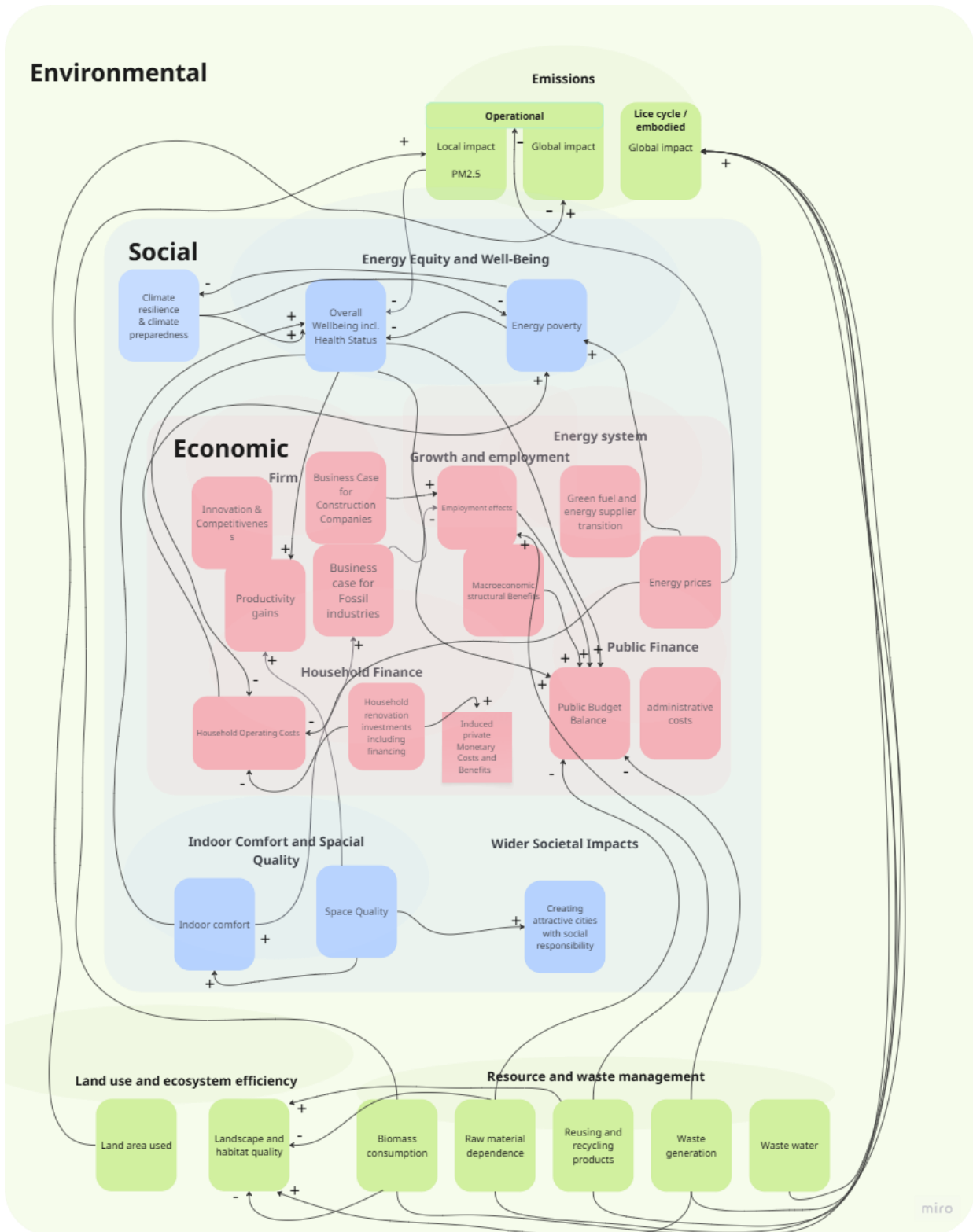
The aim of this visualization is to highlight key costs and benefits of energy renovation while simultaneously demonstrating the interconnectedness of the costs and benefits of energy renovation across different areas. This interconnectedness must be carefully considered to avoid double counting, while providing a holistic assessment of the costs and benefits of energy renovation.

The economy functions as a dynamic system, where changes in one area inevitably ripple through others. Energy renovations, for example, not only improve household conditions but also contribute to structural shifts in labour markets, industrial activity, and public finance. These transformations can reconfigure demand across supply chains, influence fuel choices, and alter the competitive position of firms within and beyond the energy sector. As more households connect to electrified systems, new patterns in energy consumption emerge, which may impact pricing and infrastructure needs. Moreover, the evolving business landscape affects employment and tax revenues, further linking economic change to public service provision. In this context, renovation policies do not operate in isolation - they are embedded within broader economic and social systems.

Energy renovation delivers substantial social benefits that emerge quickly and extend well into the future. One of the most significant advantages is the improvement in health and overall well-being, driven by reductions in energy poverty, enhanced indoor comfort and strengthened climate resilience. These improvements not only elevate quality of life but also lead to increased economic productivity and reduced public spending on health and social aid. Enhanced space quality and greater urban liveability foster stronger community ties and broader societal acceptance of changes in the built environment.

In the context of energy renovation, land use, resource efficiency, and waste management are closely interlinked with emissions, as the sourcing of construction materials, the handling of demolition and renovation waste, and the overall efficiency of resource use directly influence both greenhouse gas and air pollutant outputs. Land use influences emissions balance by determining whether ecosystems can continue to deliver critical services, including carbon sequestration. The environmental impacts of energy renovation indirectly also affect the social sphere. Improvements in indoor thermal comfort are particularly significant for vulnerable groups, such as the elderly. Furthermore, the land areas used as well as landscape and habitat change affect the societal acceptance for changes in local environment. Resource and waste management also impact the local job market and public expenses for waste services. Considering circular economy principles in materials for building renovations offers strong benefits for a localized, specialized economy, supporting both environmental and economic sustainability.

Figure 3. Key dynamics of energy renovation costs and benefits



Source(s): Authors' analysis based on multiple sources discussed in this chapter

While this section explored the interconnections among the various costs and benefits of energy renovation, following provides a summary of the whole chapter and draws conclusions on the costs and benefits of energy renovation.

3.5 Conclusions on the context of current EU policy developments

Energy renovation is fundamentally driven by the presence of sufficient and well targeted economic incentives for decision-makers. Despite this, the broader social spillovers of energy renovations, such as health and well-being improvements or neighbourhood revitalization, are often inadequately accounted for in economic valuations and price signals (Ferreira et al., 2017). These externalities underscore the importance of integrated policy design that aligns economic and social priorities.

Economic benefits include, among others, improved business opportunities for renovation companies, reduced dependence on imported energy, overall economic growth, and the creation of additional jobs (Copenhagen Economics, 2018; IEA, 2025b; RAND Europe, 2022). The economic benefits of energy renovation are closely aligned with broader EU priorities. Energy renovation contributes to the Green Deal Industrial Plan by driving innovation, creating jobs, and improving energy efficiency. It also supports the objectives of the EU Competitiveness Compass by enhancing labour productivity, strengthening social capital, and increasing economic resilience.

As the sector shifts toward widespread renovation practices, a systemic transition is unfolding across all levels, micro (households), meso (industries and communities), and macro (national economies), producing both winners and losers. Energy renovations entail economic costs that extend beyond the private homeowner's initial investment, including financing expenses. Public expenditures amongst other encompass administrative costs and potential economic repercussions for fossil fuel industries, which may or may not be offset through benefits for construction companies. One way to align the direct economic benefits towards broader social policy objectives is the employment of individuals from vulnerable groups in energy renovation (Copenhagen Economics, 2018), which can also support broader social policy objectives.

A comprehensive deep energy renovation approach tends to be more economically efficient than fragmented, step-by-step efforts, which may suffer from coordination failures, neglected ventilation systems, or poor integration between insulation and heating upgrades (Giraudet and Lucas Vivier, 2024; Maia et al., 2024; Observatoire BBC, 2021; ADEME et al., 2020). Moreover, renovating multiple homes in a coordinated manner can generate economies of scale (Michelsen et al., 2015; dena, 2022), increasing the overall net social benefit. Technical and organizational innovations are also crucial in reducing renovation costs, yet significant regional price disparities and market complexity remain persistent challenges.

Energy renovation generates immediate and long-term social benefits, particularly by structurally reducing energy bills, thereby alleviating energy poverty, and by improving health and well-being (Ruiz-Valero et al., 2025; Copenhagen Economics, 2018; Wang et al., 2022; Dervaux and Rochaix, 2022; IEA, 2025a; European Foundation for the Improvement of Living and Working Conditions., 2020; Giraudet and Lucas Vivier, 2024; RAND Europe, 2022). These improvements also support economic productivity and lower public spending on healthcare and social aid. Additionally, renovations strengthen climate resilience (Ramboll, 2022) and contribute to attractive cities with social responsibility (Copenhagen Economics, 2018). These social benefits of energy renovation reinforce the goals of the Competitiveness Compass by building societal resilience and supporting inclusive, sustainable growth.

The EU's Renovation Wave aims to improve building efficiency while protecting vulnerable households. Yet, in some countries energy renovations have led to rent hikes and displacement (EEA, 2022; Leino et al., 2025). Renovations by property owners can accelerate housing price increases and gentrification unless accompanied by safeguards like tenant protections, low-income subsidies, rent-control floors, and targeted financing (Ástmarsson et al., 2013; EC, 2023c). Furthermore, the inconvenience experienced during the renovation process by tenants though noise disturbance etc. (Giraudet and Lucas Vivier, 2024), should be kept minimal to ensure support for renovation measures.

In the context of building renovations, we assessed environmental costs and benefits of energy renovation across three key domains: greenhouse gas and local air pollutant emissions, resource use and waste management, as well as land use and ecosystem efficiency (Abbasi et al., 2023; Giddings et al., 2002). Environmental indicators for building renovation are well-established, with greenhouse gas emissions and life cycle assessments commonly used for benchmarking sustainability (Abbasi et al., 2023; Cabeza et al., 2014; European Environment Agency, 2024). Different accounting methodologies exist depending on the system boundaries, allowing us to differentiate between operational and embodied emissions. Operational emissions are closely linked to energy consumption and energy sources, where reducing energy use and shifting to renewables typically lowers emissions¹¹. In practice, certain types of buildings, such as new constructions, buildings that are sold or rented out, and public buildings, must have an Energy Performance Certificate (EPC). This certificate reflects the building's operational energy performance and thus indirectly captures its operational CO₂ emissions from heating, cooling, and other energy uses. Embodied emissions, on the other hand, include not only those from operation but also from the supply chains of required materials and fuels. They provide information not only about the effectiveness of energy efficiency measures but also about the materials used and the transportation methods involved in the renovation project.

While climate mitigation is a central focus of current impact assessments, renovation strategies must also address climate adaptation, as older, poorly insulated buildings are highly vulnerable to overheating and extreme weather. Measures such as passive cooling, shading, and natural ventilation are often underdeveloped (Ramboll, 2022), and renovations can introduce other pressures, including waste generation, resource competition, and land-use change. Aligning renovation with the Circular Economy Action Plan, one of the key initiatives under the European Green Deal, and integrating mitigation, adaptation, and resource efficiency is essential to avoid goal conflicts and ensure a coherent, systemic sustainability transition, directly supporting the EU's 2050 climate neutrality target. There are provisions on climate adaptation in the EPBD (e.g. addressing the issues of cooling in an increasingly warm climate) (Official Journal of the European Union, 2024).

To effectively support energy renovation, policy-making must be grounded in holistic evaluations of both costs and benefits, taking into account their reinforcing dynamics and potential adverse effects, such as social displacement or affordability issues. This includes mechanisms for compensation and structural support to ensure a just transition. Crucially, evaluations should start with environmental impacts, acknowledging that the economy operates within society, and society itself is embedded within the environment. At the same time the assessment of costs and benefits of sustainability

¹¹ Though, biomass heating may increase local air pollution and requires regulation and emission limits, along with the deployment of modern technologies. Although biomass energy is often regarded as carbon-neutral over its life cycle, this assumption depends on sustainable sourcing and conditions of forestation, which can make its climate benefits uncertain in the short term.

transitions must carefully consider the risk of double counting risks when aggregating benefits across policy areas and sufficiently consider risk assessments and technological progress (Bürger et al., 2024).

To fully harness these benefits, the transition must be managed in a way that ensures fairness and accounts for the broader environmental and social impacts of renovation. The social benefits of energy renovation arise primarily for inhabitants, most notably through improved health, more sustainable communities, and reduced inequality from alleviating energy poverty. The primary beneficiaries of relief from high energy costs are vulnerable populations in urban areas with inadequate housing and high energy expenses (EC, 2025c). Health and well-being improvements from energy renovation are also most pronounced among vulnerable group, including children, the elderly, and individuals with pre-existing conditions (O'Connor et al., 2024; EEA, 2023). Greater climate resilience is also a very relevant benefit, particularly for those most exposed to heat waves such as low-income households, individuals with health conditions, children, older adults, outdoor workers and people experiencing homelessness being the most affected groups (EEA, 2025). However, these measures can fail if poorly targeted: For instance, Rocha et. al (2024) found that unprivileged groups are less served by green cooling services in major European urban areas. Finally, energy renovations can also foster social mobility for low-income households by contributing to more diverse and inclusive neighbourhoods (Chetty et al., 2016)

Taken together, these findings highlight that energy renovation is not only a climate and energy policy tool but also a powerful instrument for advancing social equity, public health, and resilience. Moreover, the transition holds the potential to deliver targeted advantages to vulnerable groups, particularly if revenues are redistributed in a way that supports a just and equitable transformation and thereby help reduce inequality (Tapia et al., 2022; Budolfson et al., 2021).

These benefits underscore the importance of awareness campaigns that emphasize long-term savings and societal value, which can outweigh the initial private costs. Environmental benefits usually emerge equally for inhabitants, for example, through the reduction of primary energy consumption, and for wider society, such as through an increasing share of renewables. The economic impacts involve a wide range of stakeholders including housing providers, lessors, and public authorities. While the distributive effects on this side are more complex to untangle, energy renovation can be a cost-effective means of advancing multiple economic objectives, from job creation and energy savings to long-term public expenditure reduction.

Guided by Just Transition principles, these benefits can reduce inequality by ensuring vulnerable communities have equitable access to clean, energy-efficient, and climate-resilient housing. Targeted, temporary redistribution of revenues can reinforce these outcomes (Budolfson et al., 2021), a priority reflected in upcoming national Social Climate Plans funded through the EU Social Climate Fund (European Commission, 2024).

The revised (2023/2024) Energy Performance of Buildings Directive (EPBD) makes the Minimum Energy Performance Requirements (MEPR) a central tool for Member States. In the context of the EPBD, MEPR are specifications designed to limit the amount of energy used by a building. They can be set and used by Member States to achieve objectives of energy demand reduction in the residential buildings (alongside with other measures and support)¹² and materialise at market level through the Energy Performance Certificate (EPC) known as the energy labelling of buildings. According to the EPBD, when defining MEPR, the cost-optimality principle should apply - although Member States can set MEPR that are more energy efficient than the cost optimal energy efficiency level.

An important innovation of the revised 2024 EPBD is to explicitly broaden the cost optimality calculation from financial variables only to also consider variables representing environmental and health externalities of energy use, as well as the extension of the emission trading system and carbon prices.

The cost optimality calculation of different elements of MEPR is complex and subject to a lot of methodological challenges. This is not a new approach, as Member States have been applying it since 2013. To support definition of economically sound and comparable MEPR across Member States, the revised EPBD recommends that the Commission lays down a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements. It should be used by the Member States to adjust their MEPR if they are less ambitious than the cost-optimal levels (Official Journal of the European Union, 2024).

The comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements has been recently revised by the Commission (European Union, 2025).

It defines the environmental and health externalities of energy use that the Member states are required to integrate in their calculations as the emissions of air pollutants (at least, fine particulate matter PM2.5 and nitrogen oxides NOx) in the macroeconomic calculation of cost-optimal levels. While there are methodological requirements given by the EC for the calculation of environmental and health externalities, including a time horizon for 30 years for residential buildings, those requirements still give room for the application to the national contexts based own sources, own conversion factors, etc.

The Regulation asks member states conduct both a macroeconomic (societal perspective) and a microeconomic calculation (private perspective) of cost-optimal levels and, given the technical peculiarities of the exercise, they should provide sensitivity analysis, e.g. by testing how much the results change according to different assumption and methodological choices (e.g.: projected price of energy, of construction material, of discount rate level, etc.). Furthermore, the accompanying guidelines include recommendations on different parameters, variables and factors to be used.

Whereas member states must carry out both calculations (private and societal cost-optimal level), in the end they can decide which one is used for the identification of the national benchmark. This choice is left to the member states as it is also a political question whether the citizens should pay for societal

¹² *Member States should set minimum energy performance requirements for buildings and building elements with a view to achieving the cost-optimal balance between the investments involved and the energy costs saved throughout the life cycle of the building, without prejudice to the right of Member States to set minimum energy performance requirements which are more energy-efficient than cost-optimal energy efficiency levels. Provision should be made for the possibility for Member States to review regularly their minimum energy performance requirements for buildings in light of technical progress.* (EU, 2024, Article 13)

burden or the extra costs are to be provided by the public. They can potentially also consider the differences between private and societal cost-optimal levels for the minimum energy performance requirements for buildings. While the Commission Delegated Regulation 2025 provides a well-designed methodology and improved the scope compared to 2010, the following challenges to improve are identified: While wider societal benefits such as reducing energy poverty and dependency on import of fossil energy are not required, Member states are still encouraged to integrate them, provided that they have a sound methodology to do so. The Guidelines provide some references in this regard. Member states can consider behavioural aspects, people needs and way of life only indirectly by defining a 'building type' and its typical use representative of specific social/vulnerable aspects and define specific MEPR for them, if they represent relevant percentage of member states' building stock and population. The ambition level depends a lot on how much member states will be able and willing to unfold the exercise. Experts consulted during the preparation of this report recommend that the Commission work closely with Member States to refine the methodology, ensure consistent implementation, and gradually increase ambition levels.

While the current approach represents an improvement, there are natural limits to how far a methodological framework for calculating cost-optimal levels can be extended to capture broader societal impacts such as energy poverty. The MEPS-based framework provides information on what is reasonable from an economic perspective. However, it does not fully address the questions of who benefits, who pays, and how vulnerable groups are considered. These aspects are partly tackled by the more socially oriented components of the Fit for 55 package. For the social dimension, instruments such as the Energy Poverty framework, the Social Climate Fund, the Social Climate Plans, and the requirement to integrate social aspects into renovation strategies provide complementary measures. Effective implementation requires that policies take into account people's needs, lifestyles wishes, and capacities as these are important influence factors for financial and economic optimality at individual project level. Policymakers need to be aware of the limitations of CBA such the lacking of limited consideration of distribution of effects, insufficient inclusion of innovation dynamics and a status quo bias in data used for assessments (Bürger et al., 2024). This is why in this context CBA should be used as one assessment within a wider appraisal framework instead of a major decision criterion.

When deciding for the best policy option, the net-benefit, being the result of a CBA, only represents the aspect of efficiency, whereas in practise a balance between effectiveness, coherence, proportionality, and subsidiarity is needed. Alternative decisions method suitable for the context of sustainability transitions can be for instance, multi-criteria evaluation, a non-monetary approach to ex-ante assessments (Munda, 2019) or risk-opportunity analysis, which moves away from quantifying every possible outcome and focuses on assessing all significant opportunities or risks, whether quantifiable or not (Sharpe et al., 2020). (Bürger et al., 2024) More concrete, other Life Cycle Assessment (LCA) requirements for buildings should considered in decision making for a full consideration of economic, social and environmental benefits of energy renovation.

Recent developments in EU life cycle thinking have significantly expanded the focus from purely environmental metrics to include social and economic co-benefits - especially relevant in the context of building renovation. Notably, Life Cycle Sustainability Assessment (LCSA) frameworks developed under EU research programmes such as Horizon 2020 provide a structured way to combine environmental LCA (including the full carbon life cycle), Life Cycle Costing (LCC), and Social LCA (S-LCA) (Rodrigo A. F. Alvarenga, forthcoming). These are increasingly applied to assess not only energy performance, but also broader outcomes such as job creation, energy poverty reduction, and occupant well-being. A recent example is the Level(s) framework, the EU's core voluntary reporting tool for sustainable buildings, further supports this shift by promoting the lifecycle perspective on buildings

with the following elements whole life carbon, resource efficient material flows, efficient use of water, health and comfort, adaptation and resilience to climate change, life cycle costs and value (EC, 2025e). Building on this foundation of key costs and benefits of energy renovation in residential buildings, the next chapter examines the key barriers and enablers shaping the implementation, providing insight into the practical challenges and opportunities for scaling these sustainable practices.

4 Review of key barriers and enablers of energy renovation in residential buildings

The aim of this sub-task is to first provide an overview of the key enablers and barriers to renovating existing residential buildings in the EU and its Member states. This will then be complemented by a more in-depth assessment of country-level activities, as well as developments relating to innovative finance instruments for energy renovation.

4.1 Synthesis of key barriers and enablers

Key messages:

- The political and legal framework conditions are central to the implementation of energy-efficient renovations. Although the EU sets clear guidelines and targets, their effectiveness depends strongly on implementation at the national level, which is often hindered, for example, by shifts in political power. Strengthening long-term policy commitments and ensuring coherence with other national laws are therefore crucial.
- To effectively promote energy-efficient renovation, targeted economic incentives and the removal of financial barriers (e.g., fossil fuel subsidies, relatively low gas prices compared to electricity) are essential. Clear market signals favouring the use of renewable energies and energy-efficient technologies are needed.
- Behavioural factors influence every aspect of energy-efficient renovations and must therefore be consistently addressed. It is therefore essential to communicate the multiple benefits of renovation, respond to owners' concerns, as well as to train professionals to provide competent and trustworthy advice.
- As technical, economic, legal and social factors are deeply interconnected, they should be addressed together to maximise synergies and avoid trade-offs.

As discussed in chapter 3, despite its many benefits and growing technical possibilities the energy-efficient refurbishment of residential buildings is not progressing at the pace necessary to meet climate targets (Barbosa and Almeida, 2025; Camarasa et al., 2021; Ramboll, 2022). This is due to a number of barriers that hinder both investment and implementation, ranging from a lack of financial support and awareness of the benefits of renovation to shortages of skilled labour. While policies promoting energy-efficient buildings vary across Europe and globally, many countries face similar challenges (Barbosa and Almeida, 2025). The nature and intensity of these barriers, however, may differ depending on the type of renovation, such as incremental upgrades or deep renovations, and the specific technologies involved as well as the country or region (Camarasa et al., 2021).

To better understand these issues, this chapter examines the key barriers currently hindering energy renovation in the EU, followed by an analysis of the factors that enable their implementation. This chapter also explores how existing EU policies and instruments address these challenges and create enabling conditions. A better understanding of the barriers and enablers can help develop targeted solutions and utilise suitable enablers to overcome existing hurdles.

A high-level synthesis of existing literature reviews on barriers and enablers of energy-efficient renovation was conducted to answer the following research questions:

1. What are the key barriers to advancing the energy renovation?
2. What are the key enablers to advancing the energy renovation?
3. How do existing EU policies and instruments address these challenges?

The key findings are summarised in overview tables and then discussed in detail. To systematically analyse and clearly illustrate the numerous influencing factors, the barriers and enablers have been divided into four categories: *legal and political*, *economic and financial*, *social and behavioural* and *technical*. It is important to note that this classification is not rigid, as many factors are interdependent and can fall into multiple categories. Environmental considerations, such as the integration of nature-based solutions or the use of bio-based materials, for example, can serve as both enabler and barrier, depending on the availability of expertise, regulatory clarity, and market access.

Additionally, it is important to acknowledge that barriers and enablers can vary significantly between countries, as they are shaped by national contexts, policy environments, institutional capacities, and specific market conditions. They may also differ within a country, as various stakeholders and subgroups, such as households with different socioeconomic characteristics or income levels, may be affected in distinct ways and have different response capacities. The following sections examine these dimensions in greater detail, structured around the four categories mentioned above.

4.1.1 Legal and political barriers and enablers

Political and legal frameworks often form the foundation for economic, technical and social measures in the renovation of residential buildings. Although stakeholders in the EU mention legal and political barriers and enablers less frequently than, for example, technical or economic aspects (Camarasa et al., 2021), these factors can still be decisive in enabling or hindering action. Without adequate regulations, necessary measures are often neglected, delayed or implemented inadequately. Conversely, comprehensive, well-designed and sustainable policies can create stability, stimulate investment and lead to the effective integration of technical, economic and social considerations. Table 2 presents the political and legal barriers and enablers identified within this project.

Table 2. Legal and political barriers and enablers of energy renovation in residential buildings

legal & political	
barriers	enablers
Political instability at the national level and inconsistent implementation of EU rules across Member States (e.g., frequent national policy changes, varied enforcement of EU directives)	Credible and consistent implementation of existing legal and political frameworks at national, regional and local levels (e.g., EU directives such as EPBD, EED; binding targets; clear long-term strategies)
Contradictory national regulations (e.g., heritage protection laws restricting retrofitting; fossil fuel subsidies)	Standards, labelling and regulatory obligations (e.g., energy labels, smart metering, consumption-based billing, Energy Performance Certificate, Renovation Passport, technical norms, minimum performance requirements)
Regulatory complexity and administrative burden (e.g., bureaucratic procedures)	

Sources: Barbosa & Almeida, 2025; Camarasa et al., 2021; Giraudet & Lucas Vivier, 2024; Prieto et al., 2024; Ramboll, 2022

One of the main legal and political obstacles to energy renovation is, on the one hand, the rapidly changing political conditions at national level and, on the other hand, the fact that the effectiveness of EU requirements depends strongly on the ambition and consistency of their implementation by Member States.

National conditions such as regulations, strategies and funding programs may change quickly, for instance due to elections or shifts in political leadership. This creates uncertainty and a lack of predictability for demand-side and supply-side stakeholders involved in the renovation process. Unclear policy or unstable policy direction can therefore discourage renovation efforts (Barbosa and Almeida, 2025; Ramboll, 2022). A lack of transparent overview of current national and local regulations can make orientation and implementation even more challenging (Prieto et al., 2024).

At the EU level, the numerous policies, such as the Energy Performance of Buildings Directive (EPBD) and the Energy Efficiency Directive (EED) (see chapter 2.3), provide key frameworks, set clear targets, and offer guidance for national and local actors. However, the actual outcomes depend heavily on national circumstances and ambition, given the considerable flexibility in how these regulations can be implemented (Barbosa and Almeida, 2025; Camarasa et al., 2021). For example, the revised EPBD sets a binding target to improve the residential building stock but leaves it to Member States to define a national trajectory. Similarly, while Member States are required to establish a national Renovation Passport scheme, the use of these passports by individual building owners remains voluntary. Linking financial support for renovations to the use of Renovation Passports could, for instance, increase their effectiveness. However, such measures would have to be implemented at the national level (BPIE, 2024). The effectiveness of these provisions will only become clear once the EPBD has been transposed into national law, which must be completed by May 2026. Overall, while EU-level directives provide clear goals and frameworks, their success depends heavily on ambitious and effective implementation at national and local levels.

Renovation efforts can be hindered not only by the transposition of EU regulations into national law, but also by conflicting national legislation. For instance, heritage protection laws may restrict or even prohibit the renovation of older, energy-inefficient buildings. Similarly, rental regulations may permit lessors to increase rents without guaranteeing corresponding efficiency improvements for tenants (Ramboll, 2022). Such provisions can limit the scope for renovations or reduce the incentive to carry them out.

In addition, legal requirements or regulatory instruments may be overly bureaucratic for owners and other stakeholders. If regulatory measures are perceived as too complex or administratively burdensome, they can have a demotivating effect and discourage rather than encourage renovation (Barbosa and Almeida, 2025; Prieto et al., 2024).

Despite the challenges posed by legal and political issues, well-designed measures have been shown to be powerful enablers for energy renovation. In the past standards, regulations and policies in the buildings sector have primarily focused on economic and technical aspects, while social and behavioural dimensions were often overlooked (Ramboll, 2022). Recent updates to key EU directives, such as the Energy Efficiency Directive (EED) and the Energy Performance of Buildings Directive (EPBD), have started to incorporate social considerations (BPIE, 2024). For example, the EPBD now includes definitions of concepts like vulnerable households (EC, 2024a), while Article 24 of the EED deals with empowering and protecting vulnerable customers and alleviating energy poverty (EU, 2023b).

The EPBD also requires Member States to develop National Building Renovation Plans, replacing earlier long-term renovation strategies, to guide the transformation of the building stock towards high energy efficiency and decarbonisation by 2050 (EC, 2024a; Ramboll, 2022). The National Building Renovation Plans are part of the integrated National Energy Plans (NECPs) and thus help to address the previously mentioned barrier by providing planning security and contributing to political stability at the national level.

The revised Renewable Energy Directive (EU, 2023c) sets out an EU-wide indicative target for the building sector to achieve a 49% share of renewable energy by 2030. It also obliges Member States to ensure a consistent annual increase in the proportion of renewable energy used for heating and cooling purposes. The directive thus sends a strong political signal and encourages the adoption of green heating and cooling technologies (Pezzutto et al., 2024).

Similarly, the Energy Efficiency Directive (EU, 2023b) promotes energy savings by raising national targets and introducing consumer-focused mechanisms. These include mandatory consumption-based billing, particularly for heating and hot water, and the promotion of smart metering systems. Such measures increase transparency and encourage energy-efficient behaviour, which could reduce final energy consumption by 5-10% (Ramboll, 2022). Article 21 of the EED also addresses split incentive issue between tenants and lessors, which is often cited as a barrier to renovation, by calling for concrete solutions to share benefits and costs.

Another significant development is the planned creation of an EU ETS 2 market including the building and transport sector (2023a) from 2027 onwards. By internalising CO₂ costs, the ETS is expected to provide further price signals and financial incentives for energy-efficient renovations and cleaner technologies. Other political requirements at EU level include the Ecodesign for Sustainable Products Regulation (ESPR) and the Energy Labelling Directive which set out product-related sustainability and efficiency standards for products (Ramboll, 2022).

Legal measures such as standards, labelling and information obligations, including energy labels, smart meters and consumption-based billing, build on the broader EU directives outlined earlier and are important in promoting energy-efficient renovations. They encourage more responsible consumer behaviour and help reduce the rebound effect. At the same time, they ensure that the technologies used are correctly sized and utilised efficiently. These instruments also help to overcome status quo bias, where people resist change even when it brings long-term benefits. Technical norms, quality standards and legally binding minimum requirements for energy renovations ensure the consistent implementation of renovation measures and boost consumer confidence (Camarasa et al., 2021; Ramboll, 2022).

Energy performance certificates (EPCs) are also important in this context.¹³ They provide information on a building's overall energy efficiency and contain details of energy consumption, operating costs and potential savings (EC, 2024a). EPCs therefore provide owners, tenants and investors with an important basis for making decisions about energy renovation (Barbosa and Almeida, 2025).

In addition, the aforementioned Renovation Passports are becoming increasingly important tool. They provide a structured, customised plan for the comprehensive renovation of a specific building, ideally including costs, benefits and financing options. With an RP, owners and investors can efficiently plan measures and identify and overcome obstacles to future renovations at an early stage (Barbosa and Almeida, 2025).

The EPBD emphasises the combined application of EPCs and RPs, setting uniform standards for both instruments. For these instruments to be widely adopted and accepted, a suitable legal framework and national adaptation are crucial. Similarly, the Renovation Wave strategy underscores the importance of EPCs and building renovation passports as critical tools to drive and accelerate deep renovations (Barbosa and Almeida, 2025).

By establishing this comprehensive legal framework, which Member States are obliged to transpose into national law, the EU has set a clear direction for coordinated action. Ultimately, however, the effectiveness of these measures will depend on ambitions and consistent implementation at the national and local levels.

4.1.2 Economic and financial barriers and enablers

Although energy renovations in the residential building sector are generally economically viable from a societal perspective when properly implemented, they are not yet widely adopted across the EU (Camarasa et al., 2021). This is often due to a range of financial and economic barriers that hinder implementation. In many countries and for most technologies, these are considered the most critical obstacles (Camarasa et al., 2021; Pezzutto et al., 2024). At the same time, well-designed economic instruments and financing mechanisms can be important enablers, reducing upfront costs, improving access to capital and creating incentives for energy-efficient renovations. Table 3 shows the key economic and financial barriers and enablers.

¹³ An energy performance certificate is an official document that indicates the energy efficiency of a building or building unit. The energy performance is calculated using the methodology set out in the EPBD (EC, 2024a).

Table 3. Economic and financial barriers and enablers of energy renovation in residential buildings

economic & financial	
barriers	enablers
High upfront costs (e.g. high initial renovation costs, long payback period)	Long-term cost savings (e.g. lower energy bills and reduced maintenance costs)
Uncertainty about cost-benefit ratio (e.g. difficulty estimating renovation costs, energy savings, and impact on property value)	Energy independence (e.g. reduced exposure to fossil fuel price volatility, supply risks, and geopolitical uncertainty)
Insufficient financial support and inadequate targeting (e.g. subsidies, low-interest loans, and grants often lacking or poorly targeted)	Targeted financial support (e.g. grants, subsidies, tax incentives, low-interest loans tailored especially to low-income households)
Distorted market signals (e.g. low fossil fuel prices compared to electricity, fossil fuel subsidies)	Carbon pricing and subsidy reform (e.g. ETS2, removal of fossil fuel subsidies)
Split incentives (e.g. landlord-tenant dilemma)	Economic solutions for split incentives (e.g. cost-sharing models, rooftop PV leasing)
	Step-by-step renovation (e.g. breaking down renovations into manageable stages to reduce upfront financial burden)

Sources: Barbosa & Almeida, 2025; Camarasa et al., 2021; Giraudet & Lucas Vivier, 2024; Prieto et al., 2024; Ramboll, 2022

One of the key financial challenges is the high upfront cost of renovations (Barbosa and Almeida, 2025). Although energy-efficient measures usually result in lower energy expenses over time, it often takes years for these savings to offset the initial investment. For many individual homeowners, this means that renovations may not be financially viable (Galvin, 2024). As a result, many choose less comprehensive and more affordable improvements over deep renovations (Ramboll, 2022). Consequently, the financial barrier can hinder many from undertaking renovation projects in the first place.

A lack of information, the complexity of the renovation process, and a lack of expertise can lead to uncertainty regarding the expected results (Prieto et al., 2024). The difficulty of estimating both the renovation costs and the potential savings creates a considerable financial risk for owners. Furthermore, while the EPBD states that Energy Performance Certificates should make the energy performance of buildings visible to prospective buyers or tenants, literature still identifies uncertainty over whether renovation investments will increase the property's market value, enabling higher rents or resale prices, as a barrier. As a building's energy performance is often not immediately apparent, many buyers and tenants are unwilling to pay a higher price for energy-efficient properties, which is also why rented properties tend to have lower energy performance compared to owner-occupied homes (Giraudet and Lucas Vivier, 2024). These uncertainties act as a barrier, making many people hesitant to undertake such an investment (Ramboll, 2022). There is also uncertainty surrounding future

developments, such as the long-term impact of climate change on the heating and cooling requirements of buildings (Camarasa et al., 2021).

Another key issue is the so-called 'split incentive' problem. This occurs when the costs and benefits of energy-efficient renovation measures are distributed among different stakeholder groups, which significantly reduces the incentive to undertake such investment. The most well-known example of this is the landlord-tenant dilemma. Lessors bear the investment costs, while tenants benefit from the energy savings. Split incentives also exist when tenants do not pay their energy costs directly, for instance as part of 'warm rent', where heating costs are included in the rent. In such cases, tenants often lack the motivation to reduce their energy consumption (Barbosa and Almeida, 2025; Prieto et al., 2024; Ramboll, 2022). Split incentives can also arise over time. For instance, if owners invest in renovation but then sell or leave the property before the long-term benefits, such as lower energy costs, are realised (Barbosa and Almeida, 2025; Prieto et al., 2024). The age of the property owner is also a factor to consider. Many elderly people own energy-inefficient buildings but are reluctant to renovate, as they are uncertain whether they will personally benefit from the energy savings (Ramboll, 2022).

The cost effectiveness challenges are further exacerbated by low fossil energy prices and insufficient financial support for energy efficiency measures. The lower relative price of gas compared to electricity has discouraged the adoption of heat pumps in several EU Member States in recent years (Letz et al., 2025; European Heat Pump Association, 2024). The continued dependence on fossil fuels heightens the risk of supply shortages and exposes consumers to volatile international prices. While counterproductive and insufficiently targeted fossil fuel subsidies still persist in many EU countries, support instruments such as subsidies, low-interest loans and grants for energy renovation are often lacking or insufficient to make renovations financially viable (Pezzutto et al., 2024; Ramboll, 2022). Moreover, they frequently fail to address the specific needs of different target groups. Consequently, low-income households, who could benefit most from long-term energy savings, are often unable to access these measures (Barbosa and Almeida, 2025; Camarasa et al., 2021; Giraudet and Lucas Vivier, 2024; Prieto et al., 2024; Ramboll, 2022). The same applies to traditional lending practices, such as mortgage approvals, which tend to prioritise income over factors such as a building's energy efficiency or expected savings on operating costs in the future. This disadvantages creditworthy low-income households in particular (Barbosa and Almeida, 2025).

At the same time, some available funding opportunities remain unused, possibly due to a lack of awareness, complex application procedures, or bureaucratic hurdles (Barbosa and Almeida, 2025). This highlights the need for not only additional funding programs, but also well-thought-out, easily accessible and socially fair financing solutions to promote renovation projects.

However, in addition to these barriers, there are also many economic and financial factors promoting energy-efficient refurbishment in the EU. According to Camarasa et al. (2021), economic enablers are among the most important factors facilitating energy renovation in most European countries and for most technologies.

Although energy efficiency measures are often associated with high initial costs, they represent a worthwhile investment if implemented correctly. Reducing energy consumption lowers ongoing operating costs, resulting in significant savings over the lifetime of a building (Camarasa et al., 2021; Giraudet and Lucas Vivier, 2024). Technological innovations also contribute to economic efficiency by reducing repair and replacement costs, as modern systems typically require less maintenance and have

a longer lifespan (Ramboll, 2022). For owners to be willing to make high initial investments, the potential for long-term savings must be clear and certain right from the beginning.

Furthermore, as discussed in chapter 3.1, switching to renewable energies and efficient technologies increases independence from fossil fuels. This significantly reduces the impact of external factors, such as volatile energy prices on international markets, supply bottlenecks, and geopolitical risks and offers an economic advantage in the long term (Pezzutto et al., 2024; Ramboll, 2022). The importance of such independence has grown in the wake of Europe's energy crisis, which was triggered by the war in Ukraine. This has likely led households to place greater value on resilience and protection against future price shocks, even when energy costs are low (Ramboll, 2022).

In order to overcome the initial financial hurdles, targeted support in the form of subsidies, grants, tax incentives or low-interest loans is crucial (Giraudet and Lucas Vivier, 2024; Pezzutto et al., 2024). This is particularly important for households who want to renovate but are discouraged by the high initial costs or uncertain financing conditions. To ensure the broadest possible impact, funding instruments should be carefully tailored to specific target groups, especially low-income households who typically face the greatest barriers, but who would also benefit the most (Barbosa and Almeida, 2025; Ramboll, 2022).

At the same time, phasing out fossil fuel subsidies and introducing carbon pricing instruments, such as the ETS2, are crucial economic enablers to increase the comparative advantage of climate friendly buildings. These measures send a clear price signal, enhancing the economic appeal of climate-friendly solutions and encouraging investment in sustainable technologies. This helps promote fair market conditions between conventional and energy-efficient systems, providing stronger economic incentives to renovate inefficient buildings (Pezzutto et al., 2024; Ramboll, 2022). However, without targeted support mechanisms, such as the Social Climate Fund, higher taxes on fossil fuels could have a disproportionate impact on low-income households, reducing their renovation budget and potentially delaying the transition, thereby placing lower-income households at risk of energy poverty (EC, 2023b).

Another way to make renovations more affordable is to carry them out in phases. Splitting renovations into smaller, more manageable stages can reduce the psychological and financial barriers to entry, particularly for lower-income households (Barbosa and Almeida, 2025; Ramboll, 2022).

The split-incentive problem can also be addressed through economic measures, to ensure that both parties benefit from the energy renovation. One approach, for example, is to allow lessors to recover a portion of renovation costs through rent increases, provided that tenants receive guaranteed, measurable energy savings (Ramboll, 2022). Another promising solution is to rent out roof space to companies that install and operate photovoltaic systems. This allows property owners access to renewable energy without requiring them to make the initial investment.

4.1.3 Social and behavioural barriers and enablers

Social and behavioural barriers also pose a significant challenge to the implementation of energy renovations in Europe. Despite their importance and interaction with other barriers, they are often overlooked and not adequately addressed. Yet, measures targeting social and behavioural aspects can have a considerable impact and act as key enablers of renovation (Ramboll, 2022). Table 4 shows the key social and behavioural barriers and enablers.

Table 4. Social and behavioural barriers and enablers of energy renovation in residential buildings

behavioural & social	
barriers	enablers
Lack of information, knowledge and awareness (e.g. limited understanding of renovation benefits and outcomes, insufficient knowledge about building specifics and energy use)	Access to clear and trustworthy information (e.g. information campaigns, tools like RPs)
Uncertainties and lack of trust (e.g. doubts about the renovation process, experts, funding, political decisions, and new technologies)	Effective communication of multiple benefits (e.g. highlighting benefits like increased comfort, health, aesthetics, climate protection)
Behavioural biases (e.g. preference for immediate over future benefits, rebound effect)	Social and environmental awareness and responsibility (e.g. motivation to contribute to sustainability)
Perceived hassle and inconvenience (e.g. bureaucracy, noise)	Social influence and peer examples (e.g. social norms, best practice examples)
Coordination and communication challenges (e.g. difficult decision-making in multi-owner buildings, unclear responsibilities, poor communication)	Stakeholder cooperation and coordination (e.g. transparent communication, clear roles, early involvement)
	Tailored renovation approaches (e.g. step-by-step renovations, addressing the demands of tenants and building owners)

Sources: Barbosa & Almeida, 2025; Camarasa et al., 2021; Giraudet & Lucas Vivier, 2024; Prieto et al., 2024; Ramboll, 2022

A lack of knowledge and information can be a major barrier to investing in energy efficiency measures (Camarasa et al., 2021). Many homeowners are unaware of their actual energy consumption and related costs, preventing them from recognising the potential savings that energy-efficient renovations could offer. They often lack basic knowledge about their own property, such as the construction materials used or the type of heating and energy systems in place (Prieto et al., 2024). This knowledge gap is particularly pronounced among low-income households, who often have limited access to education and sources of information (Ramboll, 2022).

In addition, there is often a lack of awareness of the many benefits of energy-efficient renovations. While most people are aware of the savings in energy costs and long-term reduction in consumption, this alone is often not enough to prompt renovation. However, many people are unaware that energy efficiency measures offer numerous additional advantages, such as better sound insulation, increased living comfort, enhanced aesthetics and positive environmental and climate effects (see chapter 3.2) (Camarasa et al., 2021; Ramboll, 2022).

As mentioned under economic and financial barriers, uncertainties regarding renovation costs, potential savings and the effect on the building's value can complicate decision-making. Inadequate advice and a lack of information from professionals regarding the different options and technologies available, how they work, and what the renovation process will look like can further increase uncertainty and may even lead to misconceptions (Prieto et al., 2024). For example, concerns may arise

that construction work as part of the renovation could damage the building's structure or pose health risks (Ramboll, 2022).

Another problem is a lack of trust in the renovation process and the stakeholders involved, such as installers, contractors and public authorities managing funding and regulations (Barbosa & Almeida, 2025; Ramboll, 2022). If recommendations from experts or administrative processes, such as funding procedures, are perceived as opaque or unreliable or even 'too good to be true', people are less likely to renovate (Eurofund, 2016). There is also often mistrust of new technologies, particularly green ones, and of change in general (Pezzutto et al., 2024).

Other social barriers arise from certain behavioural patterns and psychological phenomena, such as hyperbolic discounting and the rebound effect. As previously mentioned, energy renovations are often associated with high initial costs that only amortise over time. However, many people favour short-term rewards over higher long-term benefits. This behaviour is known as hyperbolic discounting or present-bias, which results in decisions about renovation measures often not being made purely rationally (Giraudet and Lucas Vivier, 2024; Ramboll, 2022).

The rebound effect (as discussed in chapter 3.1) can act as a barrier to achieving the full energy savings expected from renovations. Although technical measures improve energy efficiency, energy consumption can remain at a similar level to before or even increase. One reason for this is that users may be tempted to increase their consumption due to the increased efficiency and subsequent savings in energy costs. For instance, they may heat and cool rooms more intensively or frequently. While this effect can certainly have positive aspects for low-income households, such as a noticeable improvement in living comfort and health conditions, overall, the rebound effect means that the actual energy savings often fall short of original expectations (Ramboll, 2022).

Another obstacle to renovation decisions is the perceived inconvenience of the work, also known as the hassle factor. The process of gathering information, planning, dealing with bureaucracy and the renovation work itself are often considered stressful and difficult to fit in with everyday life (Prieto et al., 2024; Ramboll, 2022). As outlined in chapter 3, these inconveniences can be seen as a cost of energy renovation and considerably reduce motivation to undertake energy-efficient measures. Additionally, some owners prioritise other aspects, such as aesthetic improvements, over energy savings (Barbosa and Almeida, 2025; Camarasa et al., 2021).

Communication and coordination issues can also present an obstacle. As discussed in chapter 2.2, the various ownership structures, particularly in buildings with multiple owners, can complicate the decision-making process. Reaching agreement on which renovations to carry out, their timing, and scope can be challenging, and coordination among the different stakeholder can slow down the process and cause delays (Barbosa and Almeida, 2025; Giraudet and Lucas Vivier, 2024). Even during the renovation itself, uncertainties often arise regarding responsibilities and liabilities, as well as problems concerning stakeholder involvement and communication between parties, e.g. owners, architects, contractors and authorities (Prieto et al., 2024). Such misunderstandings and coordination difficulties place an additional burden on the process and act as a further barrier.

However, behavioural and social factors can act not only as obstacles to energy renovation but also as drivers, significantly influencing the decision-making of owners and other stakeholders. Access to comprehensive and transparent information is crucial for the success of energy renovations from a social and behavioural perspective. Consumer information and empowerment are central elements of the Energy Efficiency Directive, emphasising the importance of equipping citizens with the knowledge

needed to understand their energy use and make confident renovation decisions (EU, 2023b). This helps to reduce uncertainty and hesitation, build trust in the renovation process, and ultimately increase motivation to act (Ramboll, 2022). Digital tools and databases, such as the aforementioned Renovation Passport or Energy Performance Certificates, can present this information in a clear and accessible way.

Effective marketing of energy-efficient technologies is also important (Camarasa et al., 2021). In addition to energy savings, other benefits such as aesthetic improvements, more comfortable indoor temperatures, better sound insulation, improved air quality and associated health benefits should also be emphasised (see chapter 3.2). These aspects are often more appealing to owners than efficiency arguments alone and can significantly increase motivation to renovate (Barbosa and Almeida, 2025; Pezzutto et al., 2024; Ramboll, 2022). In addition, information on climate change and the role of renovation in climate adaptation should be communicated. This could include details on how insulation protects against heat or how heat pumps can also be used for cooling.

It is also crucial to know how to use energy-efficient technologies correctly to avoid the rebound effect. A targeted information and education strategy can increase overall awareness and environmentally friendly behaviour among everyone involved. Knowing that energy-efficient renovation not only offers personal benefits such as cost savings and greater comfort, but also actively contributes to climate protection, can be an additional motivating factor (Ramboll, 2022).

The source of information is just as important as its content. Government-led information campaigns and trusted institutions, such as one-stop shops, installers and energy consultants, can play a key role in providing guidance and helping households navigate regulatory complexity and administrative burdens (Barbosa and Almeida, 2025). They provide relevant information and foster trust through their expertise and credibility. For low-income households, well-known organisations such as the Red Cross or Caritas can help to reduce hesitation and build confidence in energy-efficient renovations. However, the most powerful influence is the immediate social environment. Seeing neighbours, friends or family members undertake renovations can significantly boost motivation, as social norms and peer influence strongly shape individual decision-making (Ramboll, 2022).

As mentioned before, implementing renovation measures step by step makes it easier for households with limited budgets or time constraints to get started, as the projects are more manageable and less stressful (Barbosa and Almeida, 2025). This approach is particularly suited to younger owners and tenants, who often prefer this approach for financial and practical reasons (Ramboll, 2022).

Effective communication and cooperation between stakeholders is crucial for the successful energy-efficient renovation of buildings (Camarasa et al., 2021). This is particularly important in complex projects involving many stakeholders, such as multi-owner buildings, where good coordination can significantly contribute to success. Transparent information exchange, clear role distribution and early involvement promote trust, reduce conflicts and enable efficient processes (Barbosa and Almeida, 2025; Prieto et al., 2024). In such cases, owners' associations can play a key role as a structuring body by coordinating, mediating and encouraging joint decision-making.

4.1.4 Technical barriers and enablers

Although many technical solutions for the energy-efficient renovation of residential buildings already exist and are generally economically viable, their rapid implementation is still limited by several technical factors. However, technological innovation offers many opportunities to promote energy

renovations in Europe and enhance their effectiveness. Table 5 illustrates the key technical barriers and enablers.

Table 5. Technical barriers and enablers of energy renovation in residential buildings

technical	
barriers	enablers
Complexity of renovation and technology (e.g. multi-phase process with many stakeholders, innovative, rapidly evolving technologies)	Standardised, smart and user-friendly technologies (e.g. standardised components, intuitive systems, automation, Artificial Intelligence (AI))
Shortage of skilled labour and expertise (e.g. lack of skilled workers for advice, planning, design, construction, installation, maintenance)	Research and Development (R&D) and deployment of training (e.g. research for emerging technologies, upskilling of installers, contractors)
Lack of reliable data and monitoring (e.g. limited access to monitoring data, uncertain building energy performance predictions)	Comprehensive data and digital tools (e.g. reliable data on buildings and energy use, tools like Renovation Passports)
Dependence on non-renewable energy and electricity supply (e.g. high share of fossil fuels, unstable grid access in rural areas)	Improved environmental performance and renewable energy (e.g. low-emission technologies, renewable energy systems like PV and heat pumps)
	Affordable high-quality, low-maintenance technology (e.g. durable and reliable systems)

Sources: Barbosa & Almeida, 2025; Camarasa et al., 2021; Giraudet & Lucas Vivier, 2024; Prieto et al., 2024; Ramboll, 2022

A major technical barrier is the complexity of the energy renovation process. It involves several phases and numerous stakeholders (see chapter 2.2) and typically comprises a variety of measures and technologies. The selection of suitable technologies and an appropriate type of renovation that meets the technical requirements, as well as the needs and financial possibilities of the owners, is challenging but crucial to the success of the renovation. To maintain long-term energy efficiency potential, planning is needed to avoid lock-in effects and to ensure that early retrofits do not limit future improvements. This is especially important in the context of step-by-step retrofitting, which is common practice in Europe, where homeowners often renovate their homes gradually over several years (Barbosa and Almeida, 2025). A lack of coordination in the initial stages can significantly restrict the scope or cost-effectiveness of subsequent upgrades (see also chapter 3) (ADEME et al., 2020; Barbosa and Almeida, 2025; Maia et al., 2024; Observatoire BBC, 2021; Ramboll, 2022).

The renovation technologies can also pose a considerable technical challenge. Many of them are based on highly innovative and rapidly evolving solutions that require specialised technical expertise. One example of this is the Renovation Passport¹⁴, which is a useful tool for structured planning of energy-

¹⁴ A Renovation Passport is a document that provides a tailored, long-term, step-by-step roadmap for the deep renovation of a specific building to enhance its energy performance (Barbosa and Almeida, 2025).

efficient renovations. However, it is based on complex digital data sources and technical information, so using it requires specialised knowledge. The complexity of energy renovation is further exacerbated by the fact that each measure must be adapted to the building's specific circumstances (Barbosa & Almeida, 2025; Pezzutto et al. 2024). According to Camarasa et al. (2021), some stakeholders also perceive a lack of reliable and efficient technologies as an obstacle in the EU.

The use of energy-efficient technologies, such as modern ventilation systems and heat pumps, can also be complex and may overwhelm or discourage users. If not used correctly, these systems may fail to reach their full efficiency potential, thereby limiting the overall impact of the renovation (Ramboll, 2022). For instance, a recent study involving over 1,000 heat pumps in Central Europe showed that a considerable proportion of the systems either underperformed or were incorrectly sized. This highlights the importance of post-installation performance monitoring and user guidance to guarantee operational efficiency (Brudermueller et al., 2025).

These barriers are exacerbated by a shortage of skilled professionals, which is a widespread issue across the EU, and by gaps in the knowledge and skills of those involved in the renovation process. This shortage affects the planning, advisory and implementation phases of renovation and is particularly challenging for installers, who play a key role throughout these stages. As many installers are small businesses with few employees (see chapter 2.22.2), their capacity to keep up with technological developments or invest in additional training is limited (Ramboll, 2022). A lack of experience with innovative systems, such as heat pumps, however, can lead to design errors or inadequate implementation of the technology, which reduces its effectiveness. As installers and other specialists have an advisory role, a lack of technical expertise and experience can also result in owners receiving incorrect advice and making poor decisions (Barbosa and Almeida, 2025; Camarasa et al., 2021; Pezzutto et al., 2024; Prieto et al., 2024).

A lack of necessary data and information is also a key barrier, particularly during the planning and implementation of energy-efficient renovations. Reliable information about the building is crucial for experts to be able to select suitable renovation measures and provide owners with sound advice. This includes details such as the building envelope, materials used but also energy consumption and user behaviour. Without this information, it is difficult for installers, construction firms, and other professionals involved in executing the renovation to accurately estimate renovation costs and benefits, or to make reliable predictions about the outcomes and energy savings of planned renovation measures (Prieto et al., 2024).

Important data is also generated after renovation, providing insights into the effectiveness of the measures. In practice, however, follow-up monitoring rarely takes place, often due to unclear responsibilities, lack of incentives, and limited technical or financial capacity among the involved stakeholders. Therefore, data on building performance after the renovation and information on changes in user behaviour are limited (Prieto et al., 2024). Additionally, a clear information gap can be observed across Europe. While comparatively comprehensive data on renovation technologies, their efficiency, and CO₂ intensity is available in Northern and Central Europe, information in many Southern and Eastern European countries is often based solely on expert estimates (Pezzutto et al., 2024).

Another technical barrier is that, regardless of how efficient and sustainable renovation measures and technologies are, their actual performance in reducing emissions depends heavily on the energy source used. Therefore, the dependence on fossil fuels, already discussed as an economic barrier, also represents a technical limitation, as it constrains the effectiveness of energy-efficient renovations. In countries with a high proportion of fossil fuels in their energy mix, such as Poland and Cyprus,

electricity-based systems can still lead to comparatively high emissions (Pezzutto et al., 2024). Consequently, the actual reduction in emissions across Europe can vary considerably. Furthermore, the availability of electricity grid infrastructure itself can become an additional barrier, particularly in rural or structurally weak regions where access to stable electricity grids is not guaranteed (Pezzutto et al., 2024).

While technical barriers can significantly hinder progress, there are also a number of technical enablers that can actively support and accelerate the implementation of energy renovation projects. For example, harmonised technical standards and strengthened product requirements under the Ecodesign Directive and the Ecodesign for Sustainable Products Regulation (ESPR) improve product performance, durability, reparability and energy efficiency, which can increase predictability, reduce market fragmentation and support more reliable renovation outcomes (Barbosa & Almeida, 2025; Camarasa et al., 2021; European Commission, s.a.).

Another key technical enabler is the simple and intuitive usability of technologies, which encourages the adoption of renovation measures by overcoming barriers such as limited technical knowledge, low digital skills, and uncertainty surrounding new technologies. User-friendly systems help reduce hesitation, build trust in technical solutions and ensure effective use, thereby unlocking their full savings potential (Camarasa et al., 2021; Ramboll, 2022).

In this context, automation and artificial intelligence (AI) are playing an increasingly important role. Systems that react independently to environmental conditions enable energy savings without requiring active behavioural changes from users. This can be achieved through operational settings, for example heating systems that lower themselves at night or adapt to the outside temperature, but with advances in AI and automation, these systems can become even more responsive and efficient. This can also counteract the rebound effect by minimising counterproductive behaviour (Barbosa and Almeida, 2025; Ramboll, 2022).

Another crucial aspect is the reliability and longevity of the technology (Camarasa et al., 2021). Systems that require frequent maintenance or repair can quickly become frustrating, reducing acceptance (Ramboll, 2022). Therefore, to ensure long-term satisfaction and trust in refurbishment measures, high product quality, low maintenance requirements and reliable operation are essential. In addition, sustainable heating and cooling technologies typically do not require fuel storage and often take up less space (Pezzutto et al., 2024).

To improve these technological aspects and support broader adoption of energy-efficient technologies, training and upskilling of professionals involved in the renovation process is essential. Specialists such as installers and contractors play a key role as they can act as gatekeepers for energy-efficient measures and influence owners' decisions considerably (Ramboll, 2022). Therefore, practical training and experience in dealing with innovative energy efficiency technologies are essential to motivate owners to renovate and realise the full savings potential (Pezzutto et al., 2024). However, as mentioned before, installers and other supply-side stakeholders, are often small businesses with only few employees, and therefore require support to enable their staff to participate in training programmes. The Recast of the Energy Efficiency Directive also mentions training measures as an important instrument (EU, 2023b).

Alongside training, continued research and development can help reduce reliance on fossil fuels for heating and cooling, while also decreasing costs through efficiency gains and other technological improvements, and promote innovative energy supply technologies, such as standalone photovoltaic

systems and battery storage, which could be especially beneficial for remote regions. Moreover, nature-based solutions, such as green roofs and climate-adapted urban spaces, should be further explored, as they could complement renovation measures, particularly in the context of climate change and biodiversity loss (see chapter 3.3) (Pezzutto et al., 2024).

Furthermore, research should not only focus on energy efficiency, but also on the ecological sustainability of technical solutions. Technologies that use renewable energy sources and avoid environmentally harmful materials, such as certain refrigerants used in heat pumps, can help achieve a more comprehensive and sustainable approach to renovating buildings (Barbosa and Almeida, 2025; Camarasa et al., 2021; Pezzutto et al., 2024).

Data plays a central role in the effective, targeted implementation of energy renovation. As previously mentioned, information gaps and differences in data availability still exist across Europe. These need to be addressed to obtain a comprehensive overview of the building stock. Reliable information on existing buildings and their energy status, as well as the heating and cooling systems used and their consumption, will enable the prioritisation of measures, with particular focus on the most energy-inefficient buildings (Pezzutto et al., 2024). The revised EPBD emphasises the importance of data collection and exchange, highlighting instruments such as the Renovation Passport and Energy Performance Certificates to facilitate the systematic recording of information on renovation steps and energy demand (Barbosa and Almeida, 2025). The digital building logbook is then intended to consolidate all building-related information including data from EPCs and RPs. This is supposed to support information exchange among stakeholders and enable informed decision-making. Furthermore, the EPBD requires the creation of national databases that will contain information on the energy performance of the national building stock and subsequently feed into the EU Building Stock Observatory (EC, 2024a). The EPBD, therefore, lays the groundwork for greater transparency and strengthens the information base for the building sector across the EU.

4.1.5 Conclusion and key recommendations

Although there are already numerous innovative, economically viable technical measures for energy-efficient renovation of residential buildings that receive a wide range of political support, they are not being realised to their full potential. This gap is largely due to a variety of barriers, including technical, economic, financial, social, behavioural, legal and political ones.

While they vary across countries, regions and technologies, economic barriers tend to be the most significant, whereas legal obstacles are generally less prominent (Camarasa et al., 2021). Nevertheless, legal and political frameworks provide an essential foundation for renovation efforts and must not be overlooked. In the EU, important directives such as the Energy Performance of Buildings Directive, the Energy Efficiency Directive and the Renewable Energy Directive play a vital role in establishing the regulatory framework for energy renovations.

In the past, these directives focused primarily on technical and economic aspects, often overlooking the social and behavioural dimensions of energy renovation (Ramboll, 2022). However, recent updates have begun to address this by placing greater emphasis on the social impact of renovations. For instance, the recast of the EPBD focuses on the worst-performing residential buildings, which are often occupied by households experiencing energy poverty, and requires Member States to monitor the social impacts of building renovations. It also established a definition for Renovation Passports and created a common EU framework to harmonise their legal application across Member States. Despite

the numerous improvements made, some argue that the EPBD and the Energy Efficiency Directive are still not ambitious enough to drive sufficient energy renovations across the EU (BPIE, 2024).

EU regulations are also important for providing stability and direction. This is often lacking at a national level. Therefore, stronger and more binding national-level obligations can help drive the expansion of energy-efficient renovations (BPIE, 2024). At the same time, standardisation and labelling promote the harmonisation of instruments across Europe.

For energy renovations to deliver meaningful climate benefits, they must be closely linked to the broader transition from fossil fuels to renewable energy and low carbon sources. This means that the electricity powering buildings should increasingly come from clean, renewable sources rather than fossil fuels. Effective carbon pricing mechanisms, such as the upcoming ETS 2, which will begin pricing emissions from the building sector in 2027, can help to provide coherent price signals. Similarly, gradually removing fossil fuel subsidies is important, as they send the wrong market signals and hinder the transition to sustainable energy (Pezzutto et al., 2024).

Moreover, social and behavioural factors must be considered throughout, as they significantly influence other aspects. This is particularly evident in technical barriers. For example, owners may reject the complexity of modern renovation technologies, their often challenging operability can lead to incorrect use, and missing or uncertain data can make it difficult to reliably estimate costs and potential savings. In this context, educating and training specialists who advise owners directly is of central importance, as they can significantly influence owners' decisions (Prieto et al., 2024).

In order to motivate owners and reduce their concerns about renovations, additional measures must be implemented alongside the aforementioned financial incentives. The many advantages of renovations must be communicated, and customised renovation strategies must be developed. These include, for example, gradual implementation and the use of artificial intelligence and automation to increase user-friendliness and effectiveness (Barbosa and Almeida, 2025; Camarasa et al., 2021; Ramboll, 2022). Ultimately, social and behavioural aspects must be considered in all measures, as they are crucial to the success of renovations.

The barriers and enablers described are often closely interlinked. Rather than occurring in isolation, technical, economic, social and legal factors usually interact and influence one another. Identifying synergies and potential trade-offs is crucial for developing effective, integrated solutions. The challenge for policy makers is therefore to consider barriers and enablers not individually, but in relation to each other and derive the smarter cocktail of responses.

Moreover, existing enablers can often be used to address specific barriers and promote energy renovation. At the same time, it is essential to analyse these barriers and enabling factors within the national and regional context, as they can vary significantly. The following chapter will examine this by taking a closer look at selected country case studies.

4.2 Country-level analysis

Key messages:

- All three analysed countries, Germany, Spain and Slovakia, are in the early stages of clean transition, with the portion of fossil fuels according to Eurostat 2022 gross available energy by fuel exceeding 80% in all 3 countries. Energy renovations and transformation to fossil-free heating and cooling are hindered by elements that continuously foster carbon lock-in.
- Overall, lack of financial means and savings, high upfront cost of renovations, insufficient (and untargeted) funding schemes, lack of incentives, lack of knowledge and awareness are seen as the central barriers to energy renovations in the analysed countries.
- The country experts identified clear and trustworthy information as a central enabler and named successful examples such as one-stop-shops, targeted public funding schemes, local managers and lasting policies as functional ways to respond to information needs.
- Improving social targeting of policies was seen as key enabler in all 3 countries, though the focus of targeting mechanisms differed. In Germany innovative social differentiation and split incentive solutions were highlighted. In Slovakia the experts stress consistency of financial instruments as more important and emphasize the enabling role of state-backed loan instrument. In Spain, the focus is on instruments designed for vulnerable consumers and on neighbourhood-scale renovation initiatives.

To complement the well documented barriers and enablers, the following chapter provides a review of comparative case studies of three EU member with diverse country characteristic discussing the implementation of the decarbonisation of residential housing as well as the socioeconomic challenges those countries are facing in doing so. A comprehensive selection process was conducted that, on the one hand, considered the outcome of the expert engagement workshop in February 2025 and, on the other hand, examined criteria diversity in renter population, diversity in building stock, variations in cost of capital, climatic conditions, stage of transition and energy poverty indices as well as access to information. These criteria were used so that we would get representation across different spectrum of countries in residential building sector in the EU. As an outcome of this process Germany, Slovakia and Spain were selected as case studies. The three countries differ significantly in the selection criteria that we utilized as highlighted in table 6 below.

Table 6. Country selection criteria

Criteria variable	Germany	Spain	Slovakia	EU 27 average
Owner population; Income and living conditions Eurostat 2024	47.2%	73.7%	93.1%	68.4%
Variation in cost of capital; ECB loans for house purchase in April 2025	3.69%	2.74%	3.74%	3.26%

Climatic conditions; Main Köppen-Geiger areas	Cfb	Csa, Csb, BSk, Cfb	Dfb	NA
Energy poverty; Share of households unable to keep house adequately warm in 2023	8.2%	20.8%	8.1%	10.6%

Source(s): (Housing in Europe, 2021), (Loans | ECB Data Portal, 2025), (World Bank Climate Change Knowledge Portal, 2025), (Eurostat, 2023c)

Germany and Slovakia are at the opposite ends of the spectrum for the entire EU 27 in the owner-renter population. There are also significant differences between countries in cost of capital, where mortgage rates in Spain are the lowest among the three. All three analysed countries still face major challenges in stage of the transition, namely in phasing out fossil fuels, with the portion of fossil fuels according to Eurostat 2022 gross available energy by fuel exceeding 80% in all 3 countries.

The climatic conditions differ between the countries so that most of Slovakia falls in continental climate with cold winter and thus has generally the highest heating need whereas Spain has multiple climate types with varying heating and cooling needs in different regions. Germany is primarily within temperate oceanic climate with cold but not severe winters and warm summers.

In energy poverty we used ability to keep home heater metric, but even if a cost-based or income-based metric such as 10% rule, the 2M or LIHC was used, Spain faces a challenging situation. Slovakia's situation appears worse than in household ability to keep home warm metric if income metrics are used instead.

The following chapter builds on previous findings and focuses on concrete challenges and solutions that Germany, Slovakia and Spain are facing in implementing the decarbonisation of residential housing. Our work draws from key messages from the National Energy and Climate Plans (NECP) and other relevant studies, which is cross-referenced with the analysis of insights provided by expert interviews. Given the focus on just transition with this work, special emphasis evolves around inequality, unequal distribution of impacts and the inclusion of vulnerable groups.

Our work is guided by the following research questions:

1. How are Germany, Slovakia and Spain implementing the home energy renovations, and what socioeconomic challenges (including political, social, environmental and economic) are they encountering in the process?
2. What concrete solutions and best practices can be identified in Germany, Slovakia and Spain to address challenges such as policy disputes, diverging interest of stakeholders involved, and affordability for households, and issues of inequality or unequal distribution of impacts?

Experts from each country were respectively interviewed in a joint country-specific interview conducted in Microsoft Teams in May 2025 in order to be able to capture discussion also between the different stakeholders. The semi-structured expert interviews (see Appendix 1 for an interview template) employed experts from the following organisations:

- **Germany:** German Environment Agency (Umweltbundesamt Deutschland) and Institute for Applied Ecology (Öko-Institut e.V.)
- **Slovakia:** Ministry of the Economy and Ministry of Transport
- **Spain:** IDAE (Institute for the Diversification and Saving of Energy)

The primary difference in our interview representation is that Slovakia was represented by government officials whereas Germany and Spain had more research-oriented participation. Each of the case studies are presented by elaborating on the general context the countries residential building stock before providing details on the key measures that each country is implementing to foster energy renovations. Consequently, country specific socioeconomic barriers and enablers for energy renovations are discussed, which is mostly informed by the respective expert interviews. Finally, a comparative review of the findings is conducted seeking to derive broader learnings and best practices applicable to other EU countries.

4.2.1 Country case study Germany

The following chapter provides an overview of the state of Germany's building stock before discussing key policy measures that are implemented to address the uptake of energy renovations on residential buildings as well as country specific challenges and enablers arising in Germany.

Introduction to Germany's residential building stock

Germany's residential building stock includes around 18.8 million buildings. Single- and two-family homes account for the majority (83%) of the residential building stock, while multi-family buildings make up the remaining 17%. At the same time, the majority (56.4%) of individuals resided in flats in 2021 (Eurostat, 2021). Residential buildings have diverse ownership structures varying from private individuals, homeowner associations (Wohnungseigentümergeinschaften), housing cooperatives (Wohnungsgenossenschaften) to municipal as well as private housing companies (RenOnBill, 2020). In 2022, individuals privately own 79% of the residential units in Germany, whereas the remaining 21% belong to housing cooperatives, public institutions or private companies. Within the privately owned homes, 55% of the buildings and 45% of the housing units are owner-occupied accounting for 17.8 million units. In contrast, 23.1 million residential units are rented out (Deutsche Energie Agentur, 2025).

Germany's residential building sector is primarily based on fossil fuelled heating systems, with around 80% of homes being heated with individual gas or oil boilers (Braungardt et al., 2024). In contrast, district heating is used in only 15.1% of residential units and only 6.6% of buildings (Deutsche Energie Agentur, 2025). Overall, the sector is responsible for around 30% of Germany's total energy consumption and accounts for 64% of the energy use within the entire building sector. The CO₂ emissions from residential fuel combustion in 2023 amounted to 79,025kt (Eurostat, 2024a). As the large majority of energy consumed in residential buildings is used for space heating and hot water, energy renovation measures comprising improved heating system efficiency, renewable energy technologies and thermal insulations of buildings are considered most effective in reducing residential energy demand (RenOnBill, 2020).

Two-thirds of Germany's residential building stock was built in the 1970s or earlier, and thus, before thermal insulation regulations were first introduced. Consequently, these buildings have a profoundly higher energy demand compared to the newer building stock, which makes them an important dimension for energy efficiency measures. However, when compared to other building stocks in Europe, Germany appears to be better off in terms of its buildings stock's insulation and energy

efficiency characteristics: A study conducted by a German smart-climate housing technology company analysing the home temperature loss after 5 hours with an inside temperature of 20°C and outside temperature of 0°C indicates that homes in Germany (1°C loss) have a lower temperature loss than most European countries such as Spain (2.2°C) and Belgium (2.9°C) (Tado, 2020).

Regulatory efforts to improve the energy performance of residential buildings were first introduced in the 1970s with the adoption of the Thermal Insulation Ordinance in 1977. Over the years, the legal framework has further expanded including legislations such as the Renewable Energies Heat Act in 2009 and the Energy Savings Ordinance in 2014 (amended in 2016), which were consolidated into the Building Energy Act (Gebäudeenergiegesetz, GEG) in 2019. This act serves as main legal instrument for setting energy efficiency and consumption standards and was updated in 2023 following unprecedented media attention and decreased in ambition compared to the law's first draft amendment (Braungardt et al., 2024; RenOnBill, 2020).

To incorporate just transition considerations, it is important to note that lower-income households in Germany predominantly rent dwellings in multi-family apartments. While only about a quarter of the highest income group rents their homes, the vast majority (90%) of individuals from the lowest income decile occupy rented apartments (Schumacher et al., 2025). At the same time, the number of social housing units has been in steady decline since 2006 dropping from 2.1 million units to just around 1.1 million units in 2023 (Deutsche Energie Agentur, 2025).

Looking at current developments in the residential housing sector, residential buildings approved for construction in 2023 have significantly decreased when compared to previous years (39%) in particular among two-family and single-family homes. Yet, 65% of the newly completed residential buildings were equipped with heat pumps as their main heating system, with those numbers being lowest amongst multi-family buildings and residential complexes. The overall numbers of heat pumps sold increased from approximately 236,000 to 356,000 units in 2023 indicating 51% growth. Yet, only 2.7% of residential units and 4.2% of residential buildings use heat pumps as their heating system (Deutsche Energie Agentur, 2025). To achieve Germany's climate targets for 2030, a yearly renovation rate of around 2% is required. Yet, only 0.7% of buildings were renovated in 2023 even decreasing to 0.69% in 2024 (BuVEG, 2025).

According to Germany's updated Integrated National Energy and Climate Plan (NECP), which was submitted to the European Commission in August 2024 (Federal Ministry for Economic Affairs and Climate Action, 2024), EUR 46.5 billion were invested in energy renovations in 2020. However, investments required for the energy transition in Germany by 2030 is estimated at around EUR 240 billion per year for the renovation and modernization of building envelopes and heating system technology. Thus, the total investment need from 2023 to 2030 amounts to EUR 1,044 billion (EWI, 2023).

Implementation of energy renovation policy and measures in Germany

The following chapter discusses important energy renovation measures implemented in Germany based on the previously mentioned NECP (Federal Ministry for Economic Affairs and Climate Action, 2024). The Buildings Energy Act (GEG) defines key measures in the buildings sector including federal funding for energy-efficient buildings and constitutes an important standard setting instrument. As discussed before – after having been updated in 2023 – the GEG now requires for the use of 65% renewable energy in new heating systems (gradual phase in), which reduces the use of fossil fuels in heat generation. While new buildings located in new development areas (Neubaugebiete) have to use

65% of renewable energy from 2024 onwards, the installation of fossil heating systems is still allowed in existing buildings and new buildings outside new development areas as long as they fulfil the gradual renewable energy phase-in requirements from 2029 onwards (Braungardt et al., 2024). The Act on Municipal Heating Planning (Wärmeplanungsgesetz) further defines when the 65% rule comes into effect depending on whether a heating plan is already in place that e.g., foresees the expansion of district heating, which would require an earlier application of the 65% rule. With the Act on Heat Planning and the Decarbonisation of the Heat Networks (Heat Planning Act), heat planning has been introduced as a key strategic instrument of the heating transition nationwide as of January 2024 including requirements for the decarbonisation of heat networks by 2045.

Federal Funding for Efficient Buildings (BEG) consolidates several funding schemes designed to support funding energy renovations. The BEG is primarily implemented by the Federal Office for Economic Affairs and Export Control (Bundesamt für Wirtschaft und Ausfuhrkontrolle, BAFA) as well as the German state-owned investment and development bank (Kreditanstalt für Wiederaufbau, KfW). The BEG provides funding for singular measures (e.g., external insulation, renewal of heating systems or optimization, replacement of windows) (BEG Einzelmaßnahmen). To support more comprehensive renovation measures, low-interest loans and grants depending on the energy efficiency standard achieved after the renovation are available (BEG Wohngebäude) (BMWE, 2025).

Since 2024, the program further provides funding for heating replacements with an integrated socially differentiated component. In addition to the basic funding rate of 30%, a bonus of 30% is available for owner-occupied properties with lower income (Schumacher et al., 2025). Furthermore, Germany launched a heat pump initiative (Heat Pump Roll-Out) in spring 2022 together with stakeholders, with the aim of installing at least 500,000 heat pumps annually from 2024 onwards. The BEG foresees a funding rate of up to 70% of the eligible investment cost (up to EUR 21,000) as well as additional lending options (energie-experten, 2025). Projected sales numbers of 250,000 heat pumps exceed the 2024 numbers (193,000 heat pumps sold), yet remain far below the initiative's goal (Bundesverband Wärmepumpe e.V., 2025; Der Spiegel, 2025).

Since the last modification of the Modernization Surcharge (Modernisierungsumlage) in 2019, lessors are allowed to add 8 percent of the renovation costs (without capital costs and maintenance costs) to the tenant's rent to refinance their investment, creating incentives for lessors. Additional caps limit the possible rent increase over a period of 6 years depending on the prior rent level. Public subsidies received must be deducted from the amount subject to the surcharge (Verbraucherzentrale Bundesverband, 2022). Ordinary rent increases e.g. to compensate inflation to keep up with the general rent level in the region are prohibited unless this level is reached. With the update of the GEG, a new option was introduced, which allows lessors to pass on 11 percent of the renovation cost to the tenant when making use of public funding schemes. Yet, the amount received from public funding needs to be deducted from the overall renovation cost that can be passed on. In cases, where lessors do not employ public funding, the modernization surcharge remains at former 8 percent (Bundesministerium für Energie und Wirtschaft, 2025).

Under certain circumstances, the GEG legally requires for Energy Performance Certificate (EPC; Energieausweis) indicating the buildings energy efficiency standard on a scale from A+ (best) to H (worst). Thus, they enable future buyers or tenants to consider respective information in their decision making. Two types of certificates exist: Whereas the demand certificate (Verbrauchsausweis) is based on the actual energy demand of the building, the projected demand certificate (Bedarfsausweis) indicates the projected energy demand. As specified in the GEG, EPCs are required for newly

constructed buildings, after major renovations as well as when renting out or selling a building or unit (exemptions apply) (Bundesanzeiger, 2020)

The Fuel Emissions Trading Act (Brennstoffemissionshandelsgesetz, BEHG) introduced a national emission trading system starting in 2021 in the heating (buildings) and transport fuels sector for emissions from fossil fuels sold in Germany (BMJV, 2019). By applying a CO₂ price to emissions coming e.g., from fossil heating systems in buildings, energy renovations are incentivized. Once, the EU ETS2 for buildings is starting to operate in 2027, it will replace national emission trading systems like the Germany system.

Country specific challenges and enablers in Germany

In order to identify country specific challenges and barriers to energy renovations in Germany yet discuss the German perspective on good practices and economic enablers, an expert interview including two experts from German Environment Agency and Oeko-Institut e.V. was conducted in May 2025.

As pointed out above, the German housing market is characterized by a high share of renters, which is highest amongst low-income individuals. Especially in some large cities, rental markets become increasingly tight exposing renters to gentrification related challenges such as modernizations where primary goal is to enable rent increases over contributing to the decarbonization of the building.

A specific market challenge is related to the current design of the modernization surcharge, which seeks to create an incentive for lessors to conduct energy renovations in rented-out buildings. As argued by the interviewed experts, the modernization surcharge in the context of the current rental law creates split incentives considering that tenants pay a 'base rent' with additional cost e.g., for heating and energy depend on their consumption. In addition, as the lessors is not able to pass on investment cost that were covered by a public subsidy, yet has other possibilities to increase the tenant's rent outside the modernization surcharge, conducting an energy renovation is usually not cost-covering (Henger et al., 2021) and affects the lessor's willingness to conduct the retrofit. The revised GEG seeks to mitigate one extent of the dilemma by introducing differentiated surcharges depending on whether public subsidies were employed or not. At the same time, rental markets in rural areas are inherently different from urban environments, yet the same regulations apply. While the modernization surcharge might provide a sufficiently high incentive for energy renovations in urban areas with dynamic rental markets where the overall rent level is higher, the incentive in rural areas, where markets are less tight and rents relatively lower, might not be enough.

Even though Germany has a well-established public funding scheme for energy renovations, the interviewed experts argue that the subsidy scheme is not sufficiently tailored to promote the overall uptake of energy renovation. Existing research shows that e.g., the funding program for efficient buildings is primarily used by high-income households, in particular for full refurbishment (Braungardt et al., 2023). Yet, the existing funding rates are insufficient to implement retrofits among lower-income groups. Experts further note a correlation between the amount of subsidies available and the price development of heat pump indicating that the current design of the subsidy is potentially inefficient.

Energy renovations in Germany are considered relatively expensive related to both, the cost of material and the labour cost, but also in terms of the overall price level and the high cost of capital for retrofits. Evidence suggests that e.g., heat pump installations in Germany are up to 2.5 times more expensive than in the UK. Part of the higher prices can be attributed to material, labour, and planning costs, as

well as the value-added tax. However, some of the price differences can also be linked to the type of funding available. While Germany provides percentage-based subsidies, the UK relies on fixed grant amounts (Vering et al., 2025). Moreover, the significant shortage of workforce in the renovation sector not only increases renovation costs but also prolongs renovation processes. The lack of general retrofitting obligations for low performing buildings in Germany as in many other countries was pointed out as main barrier towards speeding up energy renovations.

Important challenges identified relate to people's perception of energy renovation measures and their valuation. Evidence from the German housing market revealed that the value of future energy cost savings surpasses tenants' willingness to pay by factor 2.5 (Kholodilin et al., 2017). Furthermore, the interviewed experts identified a general mistrust towards governmental calls to save energy following the energy crisis in the aftermath of the intensified conflict in Ukraine in 2022. In 2024, around 35% of households supported the CO₂ levy, while about 36% opposed it and 29% remained undecided. Despite the annual increase in the CO₂ price, these figures were unchanged compared to the previous year (Kaestner et al., 2024).

In addition, the overall public perception of energy renovations – in particular the benefits of replacing fossil fuelled heating systems – was negatively affected by a campaign by the German tabloid BILD that spread misinformation regarding the planned revision of the GEG in 2023. As argued by the experts, the campaign did not only lead to abandoning the plan of tightening energy efficiency standards but also affected Germany's position in the trilogue negotiations on the EBPD letting aside the damage caused to possible future development in the field energy efficiency policies. It was further argued that by shifting the starting date for the application of requirements for municipal heat planning, many households will postpone their decision to switch to low carbon heating technologies because there is still the potentiality that their area might be connected to district heating as long as heat planning has not been complete. Considering that most areas will not be connected to district heating or ever become a hydrogen heating roll-out area, households face serious carbon lock-ins (Braungardt et al., 2024).

Concerning good practices and enablers for energy renovations, the experts pointed towards positive experiences with One-Stop-Shop (OSS) offers by local energy agencies that were successfully implemented and could be scaled up on the national level. Experience from implementing large subsidy programs revealed that funding schemes like the currently implemented heating replacement scheme, that have integrated socially differentiated components should achieve significantly better uptake rates among lower-income households when compared to untargeted schemes that mostly benefited high income groups. An additional measure, which addresses just transition considerations for energy renovations, is the CO₂ Cost Sharing Act, which went into effect in 2023. Initially, lessors were able to pass on the occurring CO₂ levy for the supply of oil and gas for heating in full to the tenant. With the CO₂ Cost Sharing Act, the cost sharing between lessors and tenant is determined by the emissions performance of the building (in CO₂ per m²). The higher the annual emissions, the higher the share the lessors is to bear creating a financial incentive to retrofit the dwelling (KPMG-Law, 2023).

4.2.2 Country case study Spain

The following section provides an overview of the building stock and the state of energy poverty in Spain. This is followed by an analysis of the current national regulatory frameworks, including the National Energy and Climate Plan and other relevant policies. Finally, Spain's country-specific challenges and opportunities are discussed, drawing on insights from a national expert interview.

Introduction to Spain's residential building stock

Spain's residential building sector presents a significant opportunity for energy renovation, given its aging housing stock and current energy performance. Residential buildings present 62% of the total building stock. Approximately 56% of these buildings were constructed before 1980, a period prior to the implementation of modern energy efficiency standards (RENONBILL, 2020). The energy consumption in the residential sector accounts for 27% of total final energy consumption (EC, 2025c).

While 65.7% of the Spanish population lives in flats (Eurostat, 2021), approximately 80% of the residential building stock consists of single-family homes. In 2021, renters accounted for 24% of the residential population in Spain (Eurostat, 2021), which is a rise of 5 percentage points since 2005 (RENONBILL, 2020). This shift in housing tenure may face barriers to energy renovation due to limited control over property modifications and potential financial constraints. Addressing these challenges requires policies that support renters' involvement in energy efficiency initiatives and ensure equitable access to renovation benefits.

As a net energy importer, Spain's reliance on external energy sources underscores the importance of enhancing domestic energy efficiency. Improving the energy performance of residential buildings can reduce dependency on imported energy, contribute to national energy security, and support Spain's commitments to climate goals (RENONBILL, 2020). Whereas in 2023 Spain had an energy dependency ratio of 68.6% (MITECO, 2024), based on the NECP measures the future energy dependency ratio of Spain is predicted to be 50% in 2030 (MITECO -Ministry for Ecological Transition and the Demographic Challenge, 2024).

In conclusion, analysing the current building stock highlights the need for targeted interventions aimed at the aging housing stock, single-family homes, an increasing share of rental properties and decreasing Spain's reliance on external energy sources.

Implementation of energy renovation measures in Spain

Spain's Integrated National Energy and Climate Plan submitted in 2024 (MITECO -Ministry for Ecological Transition and the Demographic Challenge, 2024) includes the following measures on the built environment:

As part of Spain's National Energy and Climate Plan (NECP), District Heating and Cooling Networks in the residential sector are promoted as a key measure to support energy renovation. These networks aim to increase the use of renewable and waste energy sources, offering efficient and flexible solutions for heating and cooling in both residential buildings and nearby industrial applications. Technologies involved include heat pumps, chillers, biogas systems, solar thermal energy, and electric boilers. To facilitate their deployment, the NECP outlines legislative actions to reduce administrative barriers, economic instruments such as public aid programmes, and communication measures to raise awareness. As part of this a national census of Heating and Cooling Networks 2024 has been conducted (ADHAC, 2024). The deployment of networks will be partly financed through Spain's market-based energy savings obligation scheme CAE (Certificados de Ahorro Energético), complementing public financial support.

All energy efficiency measures in the residential sector outlined in Spain's National Energy and Climate Plan (NECP) are designed to align with Measure 4.2 of the Plan to Combat Energy Poverty, ensuring coherence with broader national efforts. This measure operationalises the National Strategy Against

Energy Poverty (ENPE) 2019–2024, primarily through the provision of social energy vouchers and guarantees of minimum vital supply to vulnerable households.

A key innovation under this strategy is the introduction of a ‘social CAE’ within the national Energy Saving Certificate System (CAE). This mechanism enables companies to finance energy renovation projects specifically targeting vulnerable households. In return, they receive social CAE certificates, which count toward fulfilling their energy efficiency obligations under national targets (ECODES, 2024).

Looking ahead, a new National Strategy Against Energy Poverty (2026–2030) is currently under development and expected to be finalised by the end of 2025. This updated strategy aims to transition from short-term, crisis-driven responses toward more structural, medium- and long-term actions that promote energy equity and social resilience. It is also designed to be coherent with Spain’s broader national strategies for combating poverty and social exclusion (Ministerio de Derechos Sociales Consumo y Agenda 2030, 2024).

As part of Spain’s National Energy and Climate Plan (NECP), a key measure focuses on improving energy efficiency in the existing residential building stock to significantly reduce energy consumption. This measure includes a combination of legislative, fiscal, and financial instruments. Legislative efforts are directed toward the transposition of updated EU requirements on energy efficiency and renewable energy into national law, in line with the latest European directives. In addition, the plan foresees taxation measures, such as personal income tax deductions to incentivise private investment in renovation. These are complemented by public support programmes, which offer both non-repayable aid and financing schemes to further facilitate energy upgrades in the residential sector.

As part of Spain’s NECP, the promotion of energy communities is recognised as a strategic measure to empower citizens and local actors in the energy transition. The aim is to strengthen the role of citizens as active participants and drivers of change by facilitating the equal participation of individuals, small and medium-sized enterprises, and local authorities. To support this goal, a targeted regulatory reform is planned, which includes removing existing legal and administrative barriers, establishing a network of support offices, providing training programmes, and promoting the development and implementation of industrial micro-networks.

In addition to this, the NECP includes further measures such as improving energy efficiency in cold-generating equipment and large air-conditioning systems in the tertiary sector and public infrastructure, as well as strengthening the Energy Efficiency National Fund. However, these latter two measures are only briefly referenced in this paper due to its limited scope and focus on residential sector renovation.

Country specific challenges and enablers in Spain

To gain deeper insights into the country-specific challenges and enablers of energy renovation in Spain, an expert interview was conducted in May 2025 with the Spanish Institute for the Diversification and Saving of Energy (IDAE), which serves as the primary source for the following chapter. IDAE is a public agency under the Spanish Ministry for the Ecological Transition, responsible for promoting energy efficiency, renewable energy, and sustainable energy planning at the national level.

For Spain the affordability of housing is a very central barrier as high upfront costs meet low to average income. According to the latest data from the European Energy Poverty Advisory Hub based on Eurostat SILC, 17.5% of the Spanish population were unable to keep their homes adequately warm in

2024, representing an increase of 6 percentage points compared to 2014. Among individuals living below the at-risk-of-poverty threshold (defined as below 60% of the median equivalised income), this share rises significantly to 31.4% in 2024 (Energy Poverty Advisory Hub, 2025). Whereas Spain has been suffering from high levels of energy poverty for a while already, also summer energy poverty becomes an increasing concern. Most low- and middle-income households in Spain do not have affordable access to air conditioning. The conditions are worsening as Spain is experiencing increasingly frequent high temperatures and extreme weather events like heatwaves, which urban areas are largely unprepared for. This situation is further exacerbated when energy prices rise, as seen during the 2021–2022 crisis, and due to the rise of housing prices in relation to salaries.

A key milestone was the approval of Royal Decree 897/2017 of 6 October, which established the definition of vulnerable consumers, introduced the social electricity tariff, and implemented other protective measures. In 2018, this framework was strengthened by the introduction of the thermal social tariff (*bono social térmico*), a one-time payment to assist with heating costs. Despite these advances, further efforts are required to improve these programs by making them more explicitly income-based and broadly accessible.

One key barrier to a just transition are insufficiently adequate incentives for rental housing, where energy efficiency conditions tend to be poorer. Many local incentives apply to entire buildings, making it difficult for individual tenants or owners to benefit unless the whole building agrees to participate. At the national level, policies tend to focus more broadly on reducing energy demand or improving energy rating certificates. While historically the consideration of residents' income levels has been insufficient, new legislations such as the national housing law (Spanish Government, 2023), are beginning to address this issue. Due to aggravating energy poverty, the government has a strong focus on providing sustainable, affordable and locally adapted solutions for both heating and cooling.

The problem is further complicated as Spain's climate varies greatly across regions - while northern Spain typically has a mild, humid climate, it is the south of Spain that experiences high temperatures almost the whole year. The variance on winter climate zones and summer climate zones is directly connected to variance in building requirements for thermal insulation and strategies to prevent overheating. The National Strategy against Energy Poverty (*Estrategia Nacional contra la Pobreza Energética 2019–2024*, currently under review), acknowledges these regional disparities in energy needs. It highlights more severe cooling requirements in southern areas compared to colder regions, as well as significant differences in winter heating needs across the northern and central parts of the country.

In Spain housing is primarily a regional competency of the autonomous communities, with complementary roles played by local municipalities and the national government. Whereas there is a national Ministry of Housing and Urban Agenda with overall policy, strategic planning and coordination competences, the primary responsibility for housing policy implementation lies with the Autonomous Communities (regions), according to the Spanish Constitution, with municipalities playing a complementary role at the local level (e.g. promotion of public housing, local planning, local taxation of buildings) (Spanish Government, 2023). In the context of the Recovery and Resilience Fund, differing priorities are addressed by designing certain programs to be managed in collaboration with regions to agree on adapted solutions. However, this approach can also contribute to further policy fragmentation. While coordination mechanisms are in place, this multi-level governance structure makes the implementation of housing policies more complex and time-consuming. Regional differences pose challenges not only due to the diverse climatic zones but also because they add

complexity to multi-level governance. Spain's 17 autonomous communities and two autonomous cities vary significantly in economic development, social policies, and housing strategies.

Climate adaptation is included in the different strategies. The national level as well as most medium or large Spanish cities work on integrating natural based solutions or climate resilient technologies, but the implementation of this can be difficult as the sectors are still difficult to merge. In the building sector there is little tradition of working with adaptation and capacity building is needed to reach a holistic approach.

Several further barriers hinder energy renovation efforts. The interview partners point out room for improvement to achieve full interoperability and integration of data across the tax ministry, autonomous communities, and regional governments, complicating coordination and policy implementation. Behavioural and social challenges also play a significant role: many people lack awareness of the benefits of energy renovation and perceive the costs as prohibitive. They often feel overwhelmed by complex bureaucratic procedures and harbour mistrust toward administrative institutions and their commitment to climate and ecological issues. For most, the primary barrier is limited access to clear information and practical support needed to navigate application processes (Pérez-Navarro et al., 2023).

Several successful legal and fiscal reforms have significantly improved the efficiency of the energy renovation approval process. Tax reforms, including targeted tax reliefs, have also played a crucial role, although further efforts would be needed to make these reforms and incentives more accessible and equitable to low and middle-income households. Law 10/2022 of 14 June, introduced within the framework of Spain's Recovery, Transformation and Resilience Plan (PRTR), introduces key measures to support building renovation. It offers three new personal income tax (IRPF) deductions, strengthens the legal framework for owners' associations, enhances their access to credit, and establishes a guarantee scheme to facilitate financing for residential renovation projects (IDAE, 2025). In December 2024, the Spanish Council of Ministers approved a Royal Decree-law extending personal income tax (IRPF) relief for energy efficiency improvement works in residences until 2026. Between 2021 and 2023, these deductions have facilitated the rehabilitation of 122,862 homes thus far, resulting in over EUR 300 million in tax savings (MIVAU, 2024).

Additionally, grants aimed specifically at vulnerable consumers and neighbourhood-wide renovation programs funded through Next Generation EU resources have demonstrated strong potential supporting energy communities and renovation projects in smaller municipalities. Alongside the Next Generation Funds, the Social CAE system that was introduced in chapter 4.2.2 stands out as an innovative socially differentiated finance mechanism.

At the municipal level, one-stop shops provide essential support by building capacity and facilitating collaboration among stakeholders, helping residents navigate complex bureaucratic procedures. The Institute for Diversification and Saving of Energy (IDAE) supports these efforts through tailored programs in collaboration with regions (i.e. PREE5000), thereby promoting specific measures for small municipalities and vulnerable groups, along with other programmes supporting energy communities and community transformation offices (i.e. CE IMPLEMENTA and CE OFICINAS). Moreover, incentive programmes for supporting renewable energy thermal installations in the residential sector (Royal Decree 477/2021) are also available, while not specifically targeted at building renovation. In parallel, MIVAU also promotes energy renovation incentives through six programmes, co-funded by NextGeneration EU funds under the PRTR plan. The first five address the renovation of residential

buildings with actions at neighbourhood, building and dwelling levels. The sixth programme is aimed at the construction of social rental housing in energy-efficient buildings (MIVAU, 2023).

The ARCE 2050 project, launched by Spain's Ministry of Housing and Urban Agenda (MIVAU) in January 2025, promotes a broad, participatory process to revise and update the national energy renovation strategy. It brings together public bodies, professionals, and citizens to decarbonize the real estate sector, improve quality of life, and combat energy poverty, aligned with the new EU Energy Efficiency Directive (ARCE 2050, 2025).

Moreover, energy communities and cooperatives are emerging as vital actors to ensure inclusive access to benefits. To scale these models, intermediaries play a critical role by fostering trust and dialogue among diverse stakeholders, bridging gaps where public administrations may lack credibility. Local engagement is paramount, as municipalities possess nuanced understanding of neighbourhood realities and can facilitate win-win outcomes for residents, administrations, and businesses. Many municipalities already incorporate resident income levels in their tax incentive schemes, yet specific support for tenants and simplification of renovation procedures remain urgent priorities. The second report by the Common Energy Observatory shows that between 2023 and 2024 energy communities have grown by 44%. Whereas the number of energy communities had reached 479 in 2023 this number has grown to 659 in 2024 (ECODES, 2025).

Evidence-based approaches and coordination are essential. Demonstrating tangible benefits to citizens, businesses, local communities, and regions through real data helps build support and drives replication of successful initiatives. Enhancing coordination mechanisms between regions and municipalities is also a key focus area. In this regard, several initiatives focused on awareness raising and behavioural change are currently underway, promoted by various stakeholders, particularly third sector organisations. These actions include guidance on accessing social assistance, empowerment and information campaigns aimed at equipping consumers with the tools and knowledge to manage their energy consumption more efficiently. Furthermore, IDAE is developing a longitudinal study to monitor a panel of vulnerable households over three years, collecting data on energy consumption, expenditures, and key factors affecting energy well-being. It combines the measurement of thermal comfort-related energy use with surveys on housing characteristics, equipment, and behavioural patterns (IDAE, 2022).

Data Interoperability is a strategic priority for the Spanish administration, closely tied to the implementation of the Building Renovation Passport and compliance with evolving European directives.

Public-private partnerships, exemplified by Spain's National Energy Efficiency Platform - which mirrors the European platform and engages various banks - are instrumental in identifying and promoting diverse financing tools such as soft loans and green loans (MITECO, 2025).

Looking ahead, there is cause for optimism: rising energy costs are making renovation benefits more tangible to citizens through lower bills and increased comfort. However, sustained education campaigns are needed to deepen public understanding and accelerate adoption of energy efficiency measures. Building on the insights from Spain's experience, the following case study will explore the context, challenges, and opportunities related to energy renovation and energy poverty in Slovakia.

4.2.3 Country case study Slovakia

Slovakia is an independent country since 1993 and part of EU since 2004. The country has just over 5 million people in an area of above 49,000km². The country is landlocked and in a mountainous territory. It has an affluent economy and established democracy.

Slovakia has four distinct seasons and most of it falls under Köppen-Geiger climate classification of Dfb indicating continental climate with warm summer and coldest month below zero, necessitating space heating in residential homes and increasingly cooling solutions. Especially the southern part of the country has aspects of temperate climate while the mountainous regions in the north are colder on average.

Introduction to Slovakia's building stock

As pertaining to our variables that guided the selection of countries, considering diversity in renter population, Slovakia has a very high rate of home ownership resulting from privatization after the fall of communism in Europe, standing at 93.1% and second to Romania in the European Union according to Eurostat (2024).

The diversity in building stock is pronounced as the country has over 1 million single family homes, which house more than half of the total population. Around two-thirds of these have been built after 1960. According to 2021 census, there is a significant renovation gap in single family houses, with over two thirds not having an insulated envelope, 45% no replaced windows and up to 70% not having an insulated roof. Multi apartment buildings, which represent a single-digit number of total buildings, yet house above 45% of Slovakia's residents on the other hand appear in better condition, with nearly 70% of them having done some renovation measure. It is estimated that only 10% of the energy savings potential is in multi-apartment buildings.

Regarding heating distribution mode, 2021 estimates quoted in Slovakia's final NECP (2025) show that roughly 35% of the households have central heating as they are connected to district heating. Approximately 43% have local heating with 4% having floor heating and the remainder have a separate heating system which is also primarily fossil-fuel powered. Reflecting stage of transition in fossil-fuel phaseout being in its beginning stages in heating and cooling, natural gas is the primary heating fuel representing around 66% of the consumed energy. This is followed by solid fuels at 21% while both electricity and liquid fuels have around 5% share.

Implementation of energy renovation measures in Slovakia

Slovakia has commitment to carbon neutrality by 2050 and national targets for 2030 include 64.3% reduction in GHG emissions vs, 1990 (excluding LULUCF), 22.7% reduction in non-ETS emissions vs. 2005, 25% share of renewables (33.7% in heating and cooling) and Primary Energy Saving of 2.6 % and Final Cumulative Energy Consumption change of -1.8 % respectively from EU 2020 reference scenario for energy efficiency.

Slovakia has submitted its final updated NECP to the European Commission in April 2025 (MHSR, 2025). The document stresses value for money principle, security of supply and affordability of all energy as crucial for the country. It includes the following measures with substantial influence on the residential built environment:

State run Heating aid scheme ('the Heat Scheme') primarily for energy efficiency, energy system modernization including district heating and cooling solutions as well as heat distribution facilities repowering with 1 billion in funds for 2021-2030.

The Recovery and Resilience Plan financed 'Renove House' or 'house recovery' for single-family houses renovation by 2030 targeting renovation of at least 25,164 single family houses with minimum average target of 30% primary energy savings. NECP report states that further financial measures are needed in the single-family houses in addition to existing ones. There is also an ongoing 'renovation Dom mini' scheme funded from REPowerEU that targets two regions suffering from high small particle emissions numbers and can be partially paid in advance, which can support renovation of at least 3,060 single family houses.

In multi-apartment buildings the aim is to stabilize the trend of renovations around 3%, of which it has traditionally been significantly above, with continued use of State Housing Development Fund. The fund provides a 25-year loan with 1-3% interest rate for up to 100% of eligible measures, which are 1) thermal insulation of existing buildings, 2) modernisation (such as modernization of common parts and equipment, RES installation and list modernisation) and 3) removal of systematic faults (mostly prefabricated panel technology). When at least two renovation measures are carried out simultaneously, the applicant is eligible to obtain the lower interest rate, (for example the interest rate for insulation is 1.5% and for RES installation is 1%, then for the full loan the interest rate is 1%. The remission of a part of the loan is possible in case the renovation measures lead to higher ambition achieved in energy savings. EU funds are also important source of funding through State Housing Development Fund.

The most important funding source for all residential single-family house renovations will be the Social Climate Fund. Other listed measures include renewable energy sources installations for multi-apartment buildings and replacement of old gas boilers with new condensing boilers at least for vulnerable households in hybrid systems in combination with solar heating.

Slovakia will deal with energy poverty in the first stage by establishing official definition, identifying the at-risk households and setting up adequate measures. There are estimated 470,000 households with annual savings between EUR 1,000 to EUR 5,000 and another 390,000 with zero or negative savings indicating that the problem could be substantial. Banská Bystrica and Nitra regions are identified as having particularly large portion of households with little savings.

Of particular interest is the Housing policy of the Slovak Republic until 2030 (Ministerstvo dopravy Slovenskej republiky, 2022), which defines the medium-term vision of the Slovak Republic in the field of housing. The document identifies housing affordability as central global challenge and sees the role of the State as a provider of conditions that enables citizens to reach adequate standard of living. In Slovakia development of rental housing and renovation of existing housing is emphasized.

Other existing policies with housing policy relevance include Long-Term Strategy for the Renovation of the Building Stock, Integrated National Energy and Climate Plan for 2021-2030, the Low-Carbon Development Strategy of the Slovak Republic until 2030 with a view to 2050 and the National Emission Reduction Programme.

Country specific challenges and enablers in Slovakia

Detached houses are lagging behind in energy renovations and should be a focal point going forward. The reasons for this are multi-pronged. In apartment buildings there is a long history of successful policies including the ability to obtain state backed loan and inhabitants have learned about benefits of renovations and can still readily get information from legally mandated building manager (either association of owners or professional manager). There is also primarily a good social mix in Slovakian apartment buildings, making decisions easier.

By contrast renovation actions in detached houses have been sparse. A private individual has to bear the entire cost of the renovation, which on average is much higher per person. This manifests in primarily single small-scale renovation actions taking place in detached house stock. Many Slovakian households also lack savings or even the ability to generate significant savings going forward. Thus, for instance the cost of changing gas-powered heating system to heat pumps is particularly prohibitive. This comes on top of an existing lockdown of being connected to gas network. A lot of detached houses are located in economically less developed areas, where house prices are low and renovation costs may even exceed the house value. Already there are a significant number of empty homes as more than 20% of dwellings have no permanent residency according to the Statistical Office of the Slovak Republic (SODB2021 - Dwellings - Basic results, 2021), and it is unclear how many of the currently occupied but unrenovated houses will have future use.

The aging situation overall, where Slovakia faces particularly steep and increasing demographics pressure complicates the housing market picture going forward, also regarding empty dwellings. Nevertheless, it may also be another inflection point to get renovations done. Combined, detached house renovations face the multiple challenges including financial stress of expensive renovations, information gap, existing system lock-in and regional divide. Dissemination of information and awareness raising is mostly covered by Slovak Innovation and Energy Agency, however it is likely, that current capacities and scope will be extended due to new obligations coming from EED and EPBD.

The Roma minority represent a significant minority in the Slovak Republic estimated at 8% of population by the Roma Civil Monitor project (Slovakia – Roma Civil Monitoring, 2025). Their housing conditions have previously been documented to be particularly poor (Filčák et al., 2018). Addressing the issue is very complex and living in informal housing by itself complicates designing policies to tackle the problem. According to Housing policy of the Slovak Republic until 2030 and (Sika et al., 2020)), numerous support schemes have been in place to improve the situation. However, clear data gaps still exist as highlighted by the fact that estimate vary considerably even regarding their population. Further measures that take into account the cultural sensitivities are therefore called for to assist and get a better understanding of their living conditions. The backbone for new policies is provided by the Strategy for Equality, Inclusion and Participation of Roma by 2030 and new Slovak construction legislation from 2025.

While the first wave of renovations in apartment buildings has proven successful, the second wave of renovations may be more difficult to achieve. This is due to diminishing returns from future consecutive energy renovations actions, where the energy saving potential from new actions is smaller than previously. Nevertheless, the most pressing concern for apartment buildings is to speed up the systemic transition in district heating networks towards efficient system based on RES. This work is complicated by a diverse ownership, size and grid-technical situation of the local utilities.

4.2.4 Comparative country review and concluding remarks

It was our assumption, that countries which fall in different ends of spectrum in various housing related aspects would have marked differences in the challenges that the countries face. This was indeed the case in certain aspects, but similarities also arise from the analysis. Table 7 highlights 2-3 key barriers and enablers in reflection to the framework introduced chapter 4.1. These are based on the interview question where the experts were asked to reflect the challenges to the country case as well as our expert interpretation of the interview and subsequent expert communication as well as country specific materials that we have reviewed.

Table 7. Overview of key barriers and enablers in case study countries

Country	Germany	Spain	Slovakia
Most relevant barriers identified	<ul style="list-style-type: none"> • High upfront cost in terms of material, workforce and borrowing of capital • Split incentives particularly due to high share of renters intensifying the presence of the landlord-tenant dilemma, which is insufficiently addressed in some renovation policies (e.g., modernization surcharge, design of the public funding scheme) • Lack of information, knowledge and awareness in light of unfavourable public perception of energy renovations and undervaluation of associated future energy savings 	<ul style="list-style-type: none"> • High upfront costs combined with widespread energy poverty, including increasing risks of summer energy poverty • Limited access to information, knowledge, and awareness, especially among vulnerable groups • Uncertainty and lack of trust, often due to low confidence in public institutions and overly complex bureaucratic procedures 	<ul style="list-style-type: none"> • High upfront costs combined with inability to generate significant savings. The obstacle is especially in relevant among detached house owners. • Dependence on non-renewable energy & electricity supply combined with lock-in in existing gas infrastructure and challenges in cleaning district heating generation
Most Relevant enablers identified	<ul style="list-style-type: none"> • Targeted financial support via integrating socially differentiated components in public funding schemes • Access to clear and trustworthy information with promising experiences from the implementation of OSS on the local level • Economic solutions for split incentives CO₂ levy effort sharing between lessors and tenant as good practice 	<ul style="list-style-type: none"> • Targeted financial support e.g. grants aimed specifically at vulnerable consumers and neighbourhood-wide renovation programs • Access to clear and trustworthy information via intermediaries such as one stop shops and energy communities 	<ul style="list-style-type: none"> • Targeted financial support particularly in terms of long-standing policy in apartment buildings, which includes state-backed loan, • Access to clear and trustworthy information combined with sufficient time for citizens and the industry to learn about the benefits has been especially useful in apartment

		<ul style="list-style-type: none"> • Comprehensive data and digital tools tied to the implementation of the Building Renovation Passport 	sector. Good social mix further helps decisions in apartments.
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Source(s): Authors' analysis based on multiple sources discussed in this chapter

Housing affordability was identified as a central challenge, closely connected to financial incentives of energy renovations and a lack of funding instruments. The high upfront cost of retrofitting was identified as a common barrier across all three countries, though the underlying reasons differ: in Germany, high labour costs are the main factor. In Spain, lower average incomes and widespread energy poverty, including a notable prevalence of summer energy poverty, exacerbate the issue. In Slovakia many individual households' have little ability to generate savings, in some areas, detached house energy renovations are even more expensive than the housing price.

The enabler which may directly tackle the upfront costs are financial instruments. Experiences from financial instruments in the three countries are mixed. The experts raised concerns regarding the efficiency of non-targeted subsidies and the effects on for e.g. heat pump prices. If a financial instrument is non-targeted, the uptake is smaller among vulnerable groups. Regarding targeted policies, more evidence is needed on how their design can improve outcomes. Nevertheless, targeted policies were seen as functional in all three countries, even if their targeting mechanisms differed. In Germany innovative social differentiation and split incentive solutions were highlighted. In Slovakia the experts stress consistency of financial instruments as more important and emphasize the enabling role of state-backed loan instrument. In Spain instruments aimed at vulnerable consumers and neighbourhood scale renovations were highlighted. Among innovative financing mechanisms, the Social CAE system used in Spain stands out, alongside Next Generation funds supporting energy communities and renovation projects in smaller municipalities, although it is too soon to conclude its effectiveness.

Mistrust toward government policies or administrative institutions which is connected to lack of information, knowledge and awareness was either directly identified or implied by numerous experts. In Germany, overall public perception of energy renovations – in particular the benefits of replacing fossil fuelled heating systems – was negatively affected by a campaign by the German tabloid BILD that spread misinformation regarding the planned revision of the Buildings Energy Act (GEG) in 2023. Evidence from Germany further suggested that tenants have a low willingness to pay for future energy savings, which may further affect their perception and support of renovation measures. In Spain the mistrust can be due to low confidence in public institutions and overly complex bureaucratic procedures

The enabler which can influence behavioural barriers including both limited access to information, knowledge and trust as well as and mistrust toward government policies is access to clear and trustworthy information. This underlines the importance of public communication in creating acceptance for climate polices. Each interview session raised good examples from local communication, although they again had their own context specificities. In Spain several initiatives are underway that aim at demonstrating tangible benefits to citizens, businesses, local communities, and regions through real data as this is seen as an important driver to help build support and drives replication of successful initiatives. OSS's have been successful in building trust in both Spain and

Germany. In Slovakia long-term funding instrument and history of renovation in apartment buildings had led to people learning about the benefits.

As analysed using the example of the modernisation surcharge in Germany, split incentives need to be considered when designing policies aimed at incentivising energy renovations. Furthermore, public funding schemes should avoid creating split incentives, and where possible, enable co-sharing of benefits. In Spain, incentives for energy renovations in the rental housing sector have historically been limited but recent legislation such as the National Housing Law (Ley 12/2023, de 24 de mayo, por el derecho a la vivienda, 2023) is beginning to address this gap. Germany's national emission trading system, which includes fossil fuel emissions from building heating, in combination with the CO₂ Cost Sharing Act, which determines the cost sharing between lessors and tenant according to the emissions performance of the building, could create incentive for energy renovations if the CO₂ levy is high enough.

Aging housing stock is a European-wide challenge identified in all three countries. In Spain 56% of these buildings were constructed before 1980, a period prior to the implementation of modern energy efficiency standards and in Germany 2/3 were built in 70s or earlier. On the other hand, older houses can also act as a driver for energy renovations. In Slovakia the long-term housing policy instruments were in part started due to structure and material related concerns.

Similarly, dependence on non-renewable energy & electricity supply is still a problem in all 3 countries. In heating and cooling this can be examined via Eurostat's (Eurostat, 2025) statistics on renewable energy sources share in heating and cooling in 2023, which was only around 21% in Spain, 19% in Slovakia and 17% in Germany, all below EU average of around 26%. At the same time, lock-in in fossil generation exacerbates investment costs, especially in detached houses, as heating system replacements can be even more expensive in such a case. The climate friendly transition within district heating and cooling sector faces challenges related to the companies' different situation locally as well as the solutions and potential competition for alternative heating and cooling generation options.

As shown in Table 7, energy poverty is particularly severe problem in Spain. In response to it, the country is undertaking significant efforts, including the development of a new National Strategy Against Energy Poverty (2025–2030). This strategy places a strong emphasis on structural, medium- and long-term measures aimed at promoting energy equity and strengthening social resilience and builds on Spain's broader national strategies for combating poverty and social exclusion. Regarding gentrification the problem is often connected with share of rental population and consequently in Slovakia, where majority are homeowners, it was mentioned that a good social mix has supported the progress in apartment buildings.

Despite being one of the focus questions, climate change adaptation only came up as part of eligible renovation measures in Slovakian finance instruments and was not specifically mentioned in German interview. In Spain climate change adaptation is included in different strategies but the building sector still faces a learning curve and capacity building needs in adaptation solutions. These facts indicate a wider need in Member States to focus not only on prevention of climate change but to tackle its inevitable impacts, such as heat waves and storms, in building renovations.

Experts highlight the need for regional solutions to energy renovations, noting the strong role of local competencies. In Spain, housing is primarily a regional responsibility, with the Autonomous Communities leading policy implementation, while the national government provides strategic

coordination. Municipalities support implementation through local planning, public housing promotion, and building taxation, in line with the Spanish Constitution and the 2023 Housing Law (Ley 12/2023, de 24 de mayo, por el derecho a la vivienda, 2023). In one of the interviews, there was also a directly expressed scepticism about the benefits of further EU harmonization in policies in this space. The challenges presented above are to some extent shared, which speak to benefits from at least high-level targets, which still leave enough room for local solutions.

In Germany, the Buildings Energy Act (GEG) defines key measures in the buildings sector including federal funding for energy-efficient buildings and constitutes an important standard setting instrument on national level defining. Germany has large funding scheme in place for singular measures as well as more comprehensive renovation measures. Yet, it is argued that socially differentiated components could foster the uptake amongst lower income communities.

The central national regulations and instruments guiding energy renovation in Spain include the CAE scheme (Certificados de Ahorro Energético), the National Housing Law (Ley 12/2023), the National Strategy against Energy Poverty, and initiatives such as public-private partnerships exemplified by Spain's National Energy Efficiency Platform, all of which reflect the country's legislative and strategic response within the broader EU framework. Spain's most central national funding mechanisms for energy renovation include the Energy Efficiency National Fund and a range of targeted programs managed by the Institute for Diversification and Saving of Energy (IDAE), such as PREE5000, CE IMPLEMENTA, and CE OFICINAS, which support actions in small municipalities, vulnerable groups, and energy communities. Additionally, NextGenerationEU funds, allocated through Spain's Recovery, Transformation, and Resilience Plan, play a crucial role in accelerating renovation efforts. This also underscores the importance of identifying future funding opportunities to sustain these initiatives once the current funds are exhausted.

In Slovakia the important policies include housing policy, long-term renovation strategy and the Integrated National Energy and Climate Plan, the Low-Carbon Development Strategy and the National Emission Reduction Programme. The State Housing Development Fund remains the primary vehicle for apartment buildings whilst detached house renovations will be supported from emerging EU instruments including the Social Climate Fund.

As the country cases illustrate, addressing upfront costs through effective financial instruments remains a major challenge. The following chapter explores the potential of emerging innovative financing solutions to accelerate energy renovation of residential buildings.

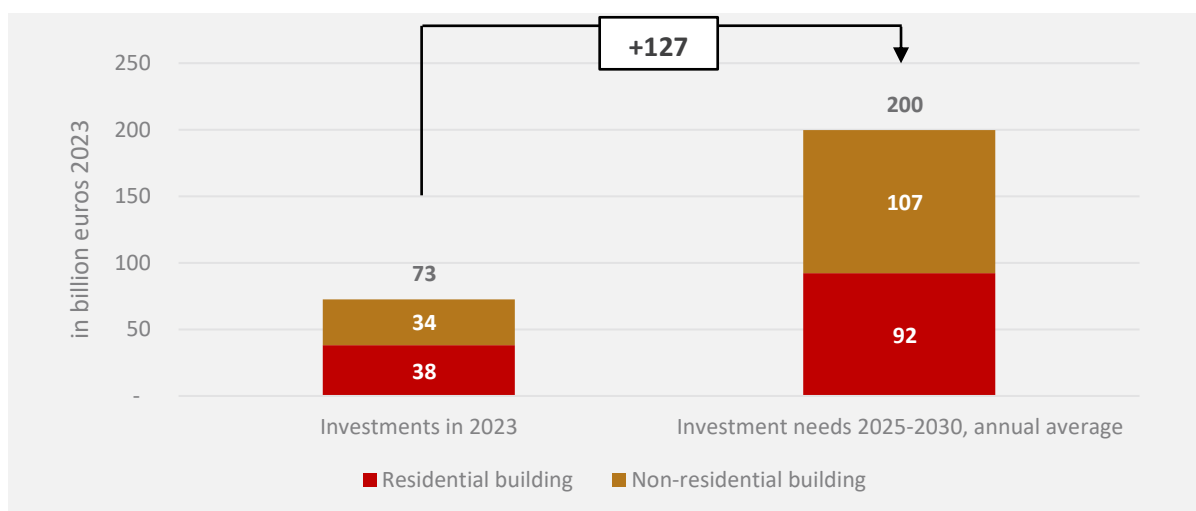
4.3 In-depth topic assessment of innovative financing instruments for energy renovations

Key messages:

- To achieve the goals foreseen in the EBPD for the building sector (both residential and non-residential buildings) the investment need amounts to 200 billion euros yearly until 2030, creating a current investment deficit of 127 billion euros each year (I4CE, 2025). Others even find that EPBD measures require a total annual investment of 297 billion euros leaving an annual investment gap of 149 billion euros (Keliauskaite et al., 2025).
- Innovative financing instruments refer to mechanisms that are either in the pilot stage or under active consideration within EU Member States, though often already operational in other regions such as the United States. Innovative financing instruments like On Bill Schemes (OBS), energy efficient mortgages, Property Assessed Clean Energy (PACE) financing, incremental property tax and crowdfunding have a strong focus on energy efficiency and create a direct link to energy performance improvements.
- OBS offer a degree of novelty by integrating the repayment for energy renovation into the utility billing process. Thereby OBS addresses common barriers such as high upfront costs, owners' reluctance to take on additional personal debt, limited access to traditional financial products as well as the landlord-tenant-dilemma (Barbosa & Almeida, 2025; Bertoldi et al., 2021; Brown et al., 2019; Mundaca & Kloke, 2018).
- To realize the full potentiality of innovative financing instruments, regulators may adapt the existing framework, in which agents operate, including measures related to capital lending requirements, risk assessment approaches as well as overall measures such as tightening Minimum Energy Performance Standards (MEPS) (BPIE, 2022).
- Public funding schemes fulfil the crucial role of not only promoting the overall increase in renovation but to make sure that those most exposed to energy shocks and climate policy induced price rises yet unable to finance energy renovations under market conditions, are given the opportunity to decarbonize their houses (Schumacher et al., 2025). Socially differentiated funding schemes for energy renovation such as MaPrimeRénov' in France have shown to increase the uptake of energy renovations among lower-income household when compared to generalized funding schemes (Oeko-Institut e.V., 2023).

In the context of the EU's energy and climate objectives, directing financial flows towards decarbonizing the heating and cooling sector and more generally building renovations remains a profound challenge. The EU's Renovation Wave Strategy, which was launched in 2022, foresees the energy renovation of 35 million buildings until 2030 (Agir pour le climat, 2021) whereas the EPBD demands an average reduction of primary energy use in residential buildings by 16% in 2030 (2020 baseline) with 55% coming from the 43% worst performing buildings. Yet, this would require doubling current renovation rates of 1%. To achieve the goals foreseen in the EBPD for the building sector (both residential and non-residential buildings) the investment need amounts to EUR 200 billion yearly until 2030, creating a current investment deficit of EUR 127 billion each year (I4CE, 2025). Others even find that EPBD measures require a total annual investment of EUR 297 billion leaving an annual investment gap of EUR 149 billion (Keliauskaite et al., 2025).

Figure 4. Achieving EBPD targets for building renovation will require EUR 200 billion per year on average between 2025 and 2030, leaving a climate investment deficit of EUR 127 billion in 2023.



Source: I4CE (2025). All data are in EUR 2023. 2023 investments in buildings renovation are estimated at EUR 73 billion. The annual average investments needed to meet the EU's climate objectives are estimated at EUR 200 billion between 2025 and 2030. The difference between these two levels of investment corresponds to the climate investment deficit, estimated at EUR 127 billion.

However, calculations of deep renovation cost in EUR per kWh saved show that conducting deep renovations will require fewer total investments to realize the EBPD goals when compared to only medium renovation instead. Whereas deep renovations enable a cheaper reduction of a certain amount of primary energy use on the long term, individual cost for homeowners are a significant barrier considering that the per square meter cost of deep renovations exceed those of medium renovations (I4CE, 2025) and that energy renovations of residential buildings are often self-financed by owners (Agir pour le climat, 2021).

Yet, existing research addressed in our report (see chapter 2.2) shows that the energy renovation market is complex and includes a diverse set of agents such as tenants and multi-family building owners that might not necessarily be eligible for traditional financial instruments such as bank loans (Bertoldi et al., 2021). Furthermore, to address just transition considerations, public funding instruments for energy renovations are required that benefit socially vulnerable groups. Respective groups tend to be most exposed to changes in energy prices, thus are disproportionately impacted by their dwelling's renovation status whilst being unable to finance its energy renovation.

This chapter seeks to address the potentiality of innovative financing instruments and complementary public funding schemes in fostering the uptake of residential energy renovations by following the research question: *How can innovative financing instruments mitigate existing challenges including high upfront costs and the Landlord Dilemma for energy renovations of residential buildings?* The methodological framework of this chapter involves a comprehensive review of existing literature in the field of innovative financing instruments and public funding instruments to contextualise the research problem. Our research is further informed by a semi-structured interview, which was jointly conducted with two experts from Oeko-Institut e.V. and Buildings Performance Institute Europe (BPIE) in May 2025 (see Interview guideline on innovative financing instruments).

4.3.1 Definition of innovative financing instruments and focus barriers to be addressed

In the following, we seek to discuss prevalent financial barriers for the uptake of energy renovations (addressed in 3.1.1) and to create an understanding of ‘innovation’ in the context of financing instruments. From an owner’s perspective, high up-front and overall investment cost as well as long pay-back periods, that are associated with economic risk, remain important barriers to conducting home energy renovations. A closely related barrier evolves around the insufficient availability of suitable financing options such as attractive loan terms, yet traditional financial instruments rarely cater to the needs of multi-family building owners and tenants. At the same time, the underuse of available funding mechanisms and financing instruments due to high information cost e.g., retrieving financing information and complex application processes for subsidies, remain an important challenge. To give an example, only 35% of the owners in Germany, which have conducted a renovation or plan to do so in the future, actually employ public funding possibilities (tagesschau, 2024).

Further barriers that homeowner experience concern the lack of clarity related to the benefits of the energy renovation due to insufficient knowledge about home energy consumption and obtainable financial benefits (Barbosa and Almeida, 2025). Other authors argue that the cost of capital and the instrument’s simplicity are key determinants (Brown et al., 2019) as well as the previously discussed landlord-tenant-dilemma (Reutter, 2025). At the same time financial institutions face several obstacles that affect their engagement in energy renovations. Among the main challenges are high transaction costs, the relatively small scale of projects, and uncertainties surrounding credit risks, a lack to structured data and the reliability of projected energy savings (Barbosa and Almeida, 2025).

Figure 2 provides an extensive overview of relevant stakeholders involved, yet traditional financial institutions including banks and insurance companies are considered the main source of private capital in this context. Given the financial limitations faced by most households and the variation in building types and ownership structures as well as additional barriers discussed above, financing instruments must cater to specific needs of homeowners and occupiers (Barbosa and Almeida, 2025).

Generally, financing instruments for energy renovation vary from grants and subsidies, tax incentives and (green) loans to on-bill financing, energy efficient mortgages, Property Assessed Clean Energy (PACE) financing and crowdfunding (Barbosa and Almeida, 2025; Bertoldi et al., 2021). More specifically, innovative financing instruments refer to mechanisms that are either in the pilot stage or under active consideration within EU Member States, though often already operational in other regions such as the United States. As further argued by the interviewed experts, innovative financing instruments have a strong focus on energy efficiency and create a direct link to energy performance improvements. Thereby, respective instruments aim at addressing key barriers to energy renovations by employing financing models such as those enabling loan repayment through energy cost savings that minimize the requirement for upfront capital investment (Bertoldi et al., 2021; Brown et al., 2019). Bertoldi et al. (2021) distinguish innovative financial instruments from traditional and well-established as well as tested and growing financial instruments and classify them according to the type of financing they employ. Thereby, they differentiate between non-repayable rewards like grants and subsidies, debt and equity financing. Debt financing refers to the borrowing of funds such as loans or bonds, which are repaid over time with interest. Equity financing such as crowdfunding is a type of financing where funds are raised by giving the investor partial ownership as well as a claim to profits. The following table provides an overview on selected financing instruments based on their classification as traditional & well-established, tested & growing or new & innovative.

Table 8. Financing instruments for energy renovation by type of financing and level of establishment in Europe

	<u>Traditional & well-established</u>	<u>Tested & growing</u>	<u>New & innovative</u>
<u>Non repayable rewards</u>	<p>Tax incentives</p> <p>Financial relief for conducting renovation measures in the form of tax credits or rebates is offered to incentivize the implementation of energy renovations.</p>	<p>Energy Efficiency Obligations (EEO)</p> <p>EEOs are financing schemes that require energy suppliers or distributors to achieve specific energy savings targets by supporting or financing energy efficiency improvements in households.</p>	<p>Energy Efficiency Feed-in-Tariffs (EE FITs)</p> <p>The household is rewarded for the operational performance of the investment, namely the energy savings delivered. Consumers are incentivized to reduce energy consumption through financial rewards that supplement the cost savings achieved from lower energy bills.</p> <p>Incremental Property Tax</p> <p>Incremental property taxes are modified property tax schemes that reflect the energy efficiency level of buildings. Thereby, they incentivize property owners to undertake energy renovation measures in order to lower their tax burden. This approach could also be implemented in form of a property purchase tax linked to building efficiency.</p>
	<p>Grants and subsidies</p> <p>Non-repayable grants or partial funding for energy renovations that are not related to the energy performance from governments or other institutional bodies.</p>	<p>Grants and subsidies</p> <p>Non-repayable grants or partial funding for energy renovations that are related to the energy performance of the renovation from governments or other institutional bodies</p>	
<u>Debt financing</u>	<p>Soft loans</p> <p>Soft loans offering preferential terms are specifically designed to finance energy renovations.</p>	<p>Revolving Loan Funds (RLFs)</p> <p>RLFs support energy efficiency projects by offering loans with little or no interest, where repayments are used to sustain the fund and</p>	<p>On-Bill Financing</p> <p>The cost of the renovation is covered by the utility provider and subsequently repaid by households through their utility bills, with repayments commonly offset by the resulting energy savings.</p>

	<p>Leasing</p> <p>A leasing arrangement for energy-efficient equipment or systems, with the associated costs distributed over the duration of the lease term.</p>	<p>finance additional future initiatives.</p> <p>Energy Performance Contracting (EPC)</p> <p>Energy service companies (ESCOs) oversee the full renovation process and link their compensation to the actual energy savings achieved, ensuring performance-based outcomes.</p> <p>Commercial (green) loans</p> <p>Green Bonds</p> <p>Corporate residential owners or regional governments can borrow at favourable terms using the EU Green Bond Standard.</p>	<p>Property Assessed Clean Energy (PACE) financing</p> <p>Energy upgrades are financed through the annual assessment of the property tax bill that is used to repay the loan. The funds for the loans are raised through bonds offered by municipalities.</p> <p>Energy-Efficient/Green Mortgages</p> <p>Green mortgage products provide preferential terms to borrowers who invest in energy efficiency upgrades. The renovation investment can be included in the mortgage without raising the down payments as energy savings are used to repay the renovation cost.</p> <p>Crowdfunding</p> <p>Crowdfunding enables direct financing between investors and borrowers and therefore eliminates the need for traditional financial institutions as intermediaries.</p>
<p>Equity financing</p>		<p>Energy Performance Contracting (EPC)</p>	<p>Third-Party Ownership Models</p> <p>A third party assumes responsibility for financing, owning, and operating energy-efficient systems, while end users benefit from the resulting energy savings. This model is commonly applied in cooperatives or energy communities.</p> <p>Crowdfunding</p>

Sources: Bertoldi et al. (2021) and Babosa & Almeida (2025), own representation

Focusing on innovative financing instruments, the table displays a considerable variety regarding mechanism and type of financing employed. EE FITs for example adapt the mechanism of FIT for renewable energy, which guarantee long-term purchase prices per kWh through public funds for the renewable energy generated. Instead of energy production, EE FITs reward the participant for energy savings related to the energy renovation by treating the savings as ‘theoretical energy production’ that is used to contribute to the repayment of the investment. In contrast, PACE financing, which relies on debt-financing, is already implemented in the United States and based on a voluntary property tax assessment that is used to repay the energy renovation loan over a longer time. More specifically, the PACE assessment is added to the general property tax bill collected by the municipalities. The funds for the loans that finance the renovations are raised through bonds offered by municipalities.¹⁵ In the context of incremental property taxes, Muellbauer (2023) suggest a green land value tax and how it could be designed. Findings from the Netherlands further indicate that introducing an energy-efficiency property tax can incentivise housing renovations (Fernández et al., 2024). In addition, crowdfunding enables direct financing between investors and borrowers, thus eliminating the need for traditional financial institutions as intermediaries. Besides being donor-based, crowdfunding can employ equity financing potentially granting the investor a share of the energy savings revenues as profit, or based on debt-financing also referred to as investment crowdfunding (Bertoldi et al., 2021). When asked about the relevance of the categorized instruments, in particular in respect of the new and innovative instruments, the interviewed experts referred to EE FITs, OBS as well as energy-efficient and green mortgages as highly relevant.

4.3.2 On-bill Schemes as an example of a promising innovative financial instrument

This section takes a closer look at innovative financing instruments by focusing on On-Bill Schemes (OBS). The selection of OBS is based mainly on the fact that it is available for property owner and occupier, thus addressing the landlord-tenant-dilemma. In addition, it directly links to energy performance improvements and can be well combined with public funding schemes offering an innovative approach.

Introduction to On-Bill Schemes (OBS)

The umbrella term OBS, which includes On-Bill Financing (OBF) and On-Bill Repayment (OBR), refers to innovative mechanisms for funding residential energy renovations by integrating repayment into the utility billing process. Thereby, they can address common barriers to energy renovation, such as high upfront costs, owners’ reluctance to take on additional personal debt, limited access to traditional financial products as well as challenges resulting from landlord-tenant-dilemma.

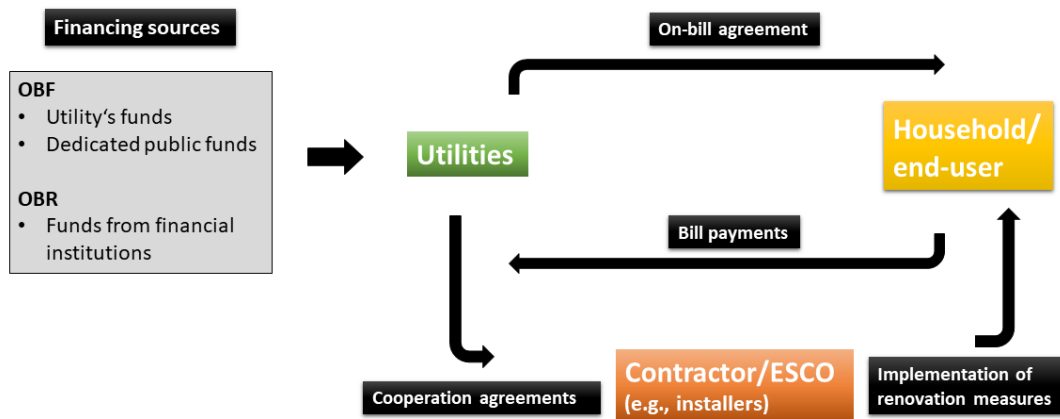
The distinction between OBF and OBR lies primarily in the source of capital:

- OBF is financed by the utility company using their own funds or by relying on dedicated public funding, with the utility company typically overseeing the entire process starting from client engagement to energy audits and monitoring.
- In contrast, OBR involves third-party financing typically coming from financial institutions, with the utility serving as the billing intermediary as they are responsible for collecting the repayments on the bill.

¹⁵ There is an academic debate evolving around the impact of PACE on local house prices in the US (see e.g., Millar and White (2024)).

In principle, OBS can be attached to the utility meters, which enables transferability between occupants, or can be tied directly to the individual user. While meter-based schemes offer greater flexibility, they can carry increased credit risk due to the involvement of multiple potential payers over time (Bertoldi et al., 2021; Bianco and Sonvilla, 2021).

Figure 5. General representation of an OBS and its possible financing sources



Source: Bianco & Sonvilla (2021), own representation

Bianco & Sonvilla (2021) find that the reviewed literature provides limited fundamental analysis of OBS, yet existing analyses of OBS mostly evolves around experiences with particular case studies. OBS have been implemented in multiple states in the US for more than a decade. As first European country, the UK implemented a policy framework seeking to foster the uptake of OBS as part of the 2013 'Green Deal' initiative (Mundaca and Kloke, 2018). In the Netherlands, 'Energiesprong' was introduced as an initiative under which renovations are funded through savings on the energy bill over the next 30 years which the recipient paying a monthly fee corresponding to the difference between the actual and previous bills (Ricardo, 2025). In most EU countries, OBS yet remains at piloting stage including the RenOnBill project (BPIE, 2022).

Challenges and barriers to the implementation of OBS

Despite offering an innovative approach to multiple barriers of energy renovations, OBS may face implementation obstacles related to the owner/tenant, the utilities and financial companies involved as well as the market (Bianco and Sonvilla, 2021; BPIE, 2022).

From an owner/tenant's perspective, negotiating energy renovation agreements in multi-family-buildings can be challenging due to the complexity of the decision-making process. This is in particular true where most of the individual apartments are privately owned while shared spaces (hallways, gardens) are collectively owned. Even though OBS reduce up front cost for energy renovations, another barrier still arises from the owner/tenant's limited capacity to secure credit, e.g., due to low-income levels, which restrains their ability to partner up with financial institutions and utility companies for investments.

In the context of the landlord-tenant-dilemma, both energy and temporal split incentives are relevant for OBS. As discussed before, energy split investments arise when tenants are responsible for the utility payments yet leaving the lessors with little motivation to invest in energy renovations. This is addressed

by OBS as it reduces the need for upfront cost and lessors can simply permit their tenants to enrol in the program. On the other hand, temporal split incentives relate to scenarios where the energy renovation measure may not be profitable, the owner sells, or tenant leaves the dwelling. In case the tenant enrolls in the program while renting, the use of metering allows the next tenant to continue the repayment. However, this could still discourage tenants from subscribing to the scheme as they do not benefit from reduced energy savings when switching homes before the end of the repayment period. Yet, implementing such a scheme is difficult to the extent that new tenants would not be able to choose their energy provider as the OBS contract with a particular energy provider is taken over from the previous tenant. This, however, would be a violation of law based on the Directive (EU) 2019/944 on common rules for the internal market for electricity. In cases, where the owner enrolls in the OBS, the new owner could continue the repayments when metering is installed. This example illustrates that shifting away the focus from purely financial benefits of tenants to other immediate social benefits such as indoor comfort, space quality and improved well-being including health as discussed in chapter 3.2, could help to address the landlord-tenant-dilemma in the context of OBS.

Utilities may face tension between promoting energy efficiency and maintaining their revenue streams, which could be negatively impacted by declining energy consumption. This is particularly true for natural gas providers, whereas electricity providers might offset potential consequences through enabling fuel switches (e.g., installation of a heat pump) that might even increase demand. Yet, Bianco & Sonvilla (2021) argue that OBS could be a transitional activity for natural gas providers that offsets reduced natural gas sales.

An additional hurdle that utilities face evolves around the fact that financial institutions that meet specific standards and operate under close supervision of national authorities usually carry out lending activities. Utilities that engage in credit provision as foreseen in OBF would have to comply with strict legal requirements. OBR might be less challenging in that regard as they foresee that financing institutions carry out the money lending activities. As argued by the interviewed experts, the applied conceptualization of financial risk by lending institutions can be considered a barrier to OBS among other financial instruments. Even though, energy upgrades of buildings are directly associated with a cash flow, i.e., the reduced energy bill, banks' risk assessment tools usually do not allow for adding this to the disposable income of the of the property owner and therefore, increase their credit capacity. For commonly used risk assessment tools, those projected savings might not be considered reliable enough to positively feed in the client's credit capacity.

Furthermore, utilities might lack the required internal expertise as well as service network (to subcontract ESCOs, architects etc.) to conduct comprehensive energy renovations. From a market's perspective, financial institutions do not necessarily prioritize energy renovation projects and the products offered might not be sufficiently attractive for OBS. The lack of accessible financing options can be a significant barrier for lower-income and vulnerable households (Bertoldi et al., 2021; Bianco and Sonvilla, 2021; BPIE, 2022).

4.3.3 Policy recommendations for increasing the uptake of OBS

The RenOnBill project seeks to promote the implementation of OBS in Europe. In addition to scientific analyses, enabling stakeholder dialogues and piloting of OBS, the project developed national roadmaps for its focus countries that propose specific policy measures to increase the uptake of OBS. Addressing some of these barriers, the RenOnBill Project proposed a diverse set of measures to promote the update of OBS, which include the following (BPIE, 2022).

To begin with, decision making for OBS in multi-family buildings could profit from lowering the voting thresholds required for approving those projects in owners' associations. However, such a measure could disadvantage vulnerable residents who have fewer abilities to oppose decisions that might negatively affect them.

An additional measure to increase the uptake of OBS could be to allow the assessment of residents' creditworthiness through their history of utility bill repayments. In addition, calculation tools of financial institutions should better reflect the added value to the asset achieved by the energy renovation, which could e.g., reduce the capital requirements for specific investments. By facilitating the inclusion of the respective data in credit risk assessment models used by banks through regulation, access to finance for residents could be improved. Enhanced regulations could push financial institutions towards adapting their calculation models as argued by the interviewed experts.

In order to implement OBS, utilities need to be able to facilitate investments in form of loans repaid by the residents through their energy bill. In cases where affordable renovation loans are not available, local governments could establish loan guarantee funds that mitigate lending risks for banks and address OBS barriers like loan security concerns and low attractiveness of commercial loans. In addition, grant schemes on local or national level could reduce cost for participants. Funding for such schemes could be raised by environmental taxes on energy consumption or green bonds (BPIE, 2022).

Additionally, the financial sector's engagement in energy renovations can benefit from incorporating Mortgage Portfolio Standards (MPS) as has been conducted as voluntary framework in the recast EPBD and thus, improve the attractiveness of commercial loans. The revised Energy Efficiency Directive (EED) mandating the set-up of individual meters in multi-family buildings under conditions can allow for better energy consumption tracking after being transposed into national law.

Energy Efficiency Obligation Schemes (EEOS) as outlined in the EED require entities including energy distributors and suppliers to meet a part of their efficiency targets through measures that benefit low-income households and residents suffering from energy poverty. These actions may comprise energy renovation measures as well as financial or other incentives for efficiency upgrades that are aligned with national support schemes. An example for such a national support scheme is the 'social CAE' in Spain, that was introduced within the national Energy Saving Certificate System (CAE) (see also chapter 4.2.2 Implementation of Energy Renovation Measures in Spain's NECP). Companies can finance energy renovation projects that benefit vulnerable households and in return receive social CAE certificates in return to better meet their company's energy efficiency targets that are set by the government (ECODES, 2024). An updated EED could include strengthened EEOS that contribute to resolving the tension utilities face between efficiency induced decreases in consumption and maintaining profitability.

Finally, implementing stricter Minimum Energy Performance Standards (MEPS) is considered a way to address the landlord-tenant dilemma. Building on existing EPBD rules that target buildings with low efficiency ratings increasing the standard's level of ambition could further promote the uptake of energy renovations including those facilitate by OBS. While MEPS may be a driver of energy renovations, it is commonly argued that they need to be embedded into a comprehensive policy framework of funding and financing mechanisms as well as practical and technical support. In particular measures to support low-income households, who disproportionately reside in the worst performing buildings, are needed in order to not overburden the vulnerable with the cost of complying with respective minimum standards (Sunderland, 2020).

Table 9. Summary on barriers addressed, policy recommendations, potential benefits as well as risks and challenges of OBS

Barrier addressed	Policy recommendation	Potential benefit	Risk/challenge to be considered
Decision making processes in multi-family houses	lowering the voting thresholds required for approving those projects in owners' associations in the context of OBS	Speedy decision making	disadvantage vulnerable residents
Financial credibility/low attractiveness for financial institutions	allow the assessment of residents' creditworthiness through their history of utility bill repayments	reduce the capital requirements and increased access to finance	Increased financial risk for lending institutions
Low attractiveness for financial institutions	local governments could establish loan guarantee funds	Address loan security concerns and low attractiveness of commercial loans	Local governments need to raise funds
Technical possibilities for consumption tracking	set-up of individual meters in multi-family buildings	allow for better energy consumption tracking	
Financial burdening of vulnerable households	Energy Efficiency Obligation Schemes (EEOS) require entities including energy distributors and suppliers to meet a part of their efficiency targets through measures that benefit low-income households	Address just transition considerations and hold distributors and suppliers accountable	
Landlord-tenant-dilemma	implementing stricter Minimum Energy Performance Standards (MEPS)	Potential driver of OBS facilitated energy renovations	Require a comprehensive policy framework of financing mechanisms, technical support as well as measures supporting vulnerable households

Source: Own representation, based on previously discussed sources.

4.3.4 Where private finance fails to address just transition considerations: the role of public funding schemes

Despite addressing some of the key barriers that affect the uptake of energy renovations, the promotion of innovative financing instruments like OBS is not sufficient in making sure that the energy transition is socially just and vulnerable groups are not left behind as stipulated by multiple EU policies.

Considering that private financing instruments usually do not integrate just transition and social equity considerations but focus on profitability and risk mitigation, public funding schemes are of particular importance to make energy renovation accessible to many households in the middle- and lower-income groups.

Yet, direct income support, as commonly included in measures seeking to mitigate the effects of climate policies on the vulnerable, is not an adequate solution in the long term, because it neither enables vulnerable groups to increase their resilience against fossil fuel prices nor makes sure that respective groups are included in the energy transition (Schumacher et al., 2025). The limitations of direct income support were also highlighted in expert interviews on just transition, which further emphasized that such measures cannot ensure long-term energy security for households, particularly due to the risk of policy shifts with changing governments.

Experiences from multiple public funding schemes implemented across different EU members point towards the importance of public funding options and their combination with private funding in the design of those schemes. Considering the example of Germany with a long history of public funding schemes that were designed as main incentive for energy renovations, the interviewed experts argue that those did not sufficiently promote the uptake of renovations necessary to meet climate targets. Yet, the uptake of funding is particularly low amongst low-income households. Data shows that owner-occupiers with assets and income below a certain threshold, which makes them eligible to housing allowances (Wohngeld-Plus), occupying very inefficient buildings is 40 percent higher than among other owner-occupiers. This indicates greater challenges in this income segment when it comes to carrying out renovations even with public funding (DIW, 2024).

In turn, vulnerable households made increased use of socially differentiated funding schemes for heating replacements both in Germany ('Heizungsförderung') (KfW, 2025) and Austria ('Kesseltausch') (KPC, 2025) that included a significantly higher funding rate for those households with up to 70% and 75%. However, in light of the market price developments e.g., the price increases in heating pumps, the expert interviewed identified some correlation between the amount of funding available and heat pump prices, which suggests that respective subsidies could be to some extent economically inefficient.

Even though Germany has a large public funding scheme for both singular as well as more comprehensive renovation measures in place, this example demonstrates that public funding schemes can create split incentives that need be taken into consideration: In case a lessors applies for energy renovation funding, the amount received need to be deducted from the renovation cost which the lessors can pass on to the tenant in form of a rent increase. This protects tenants to some extent from significant increases yet could reduce the property owner's incentive to conduct the renovation. The renovation still increased the asset's value, however, this only becomes relevant to the owner once the property is sold.

Furthermore, the amount of funding in Germany depends on the achieved efficiency grade at the end of the renovation whereas is the MaPrimeRénov' program (MaPrimeRenov, 2025) in France it relates to the relative efficiency improvement of the building, which increases incentives for the renovation for those buildings categorized as worst performing. In contrast to the German scheme, MaPrimeRénov has an integrated socially differentiated component meaning the economically worst off that achieve

the highest relative efficiency improvement will retrieve the highest funding rate.¹⁶ MaPrimeRénov' also benefits low-income lessors that rent out the dwelling for at least six years, whereas in Germany socially differentiated funding schemes dedicated to vulnerable groups like the heating replacement scheme only apply to the very small group of owner-occupiers.

In addition, under MaPrimeRénov' both owner-occupiers and lessors can finance eligible projects with an interest-free loan of up to EUR 50,000 (Zero-rate eco loan). The loan, repayable over up to 20 years, also streamlines the process with the applicant's bank and positively impacts the renovation's overall cost efficiency. The French example also demonstrates well how public funding schemes can be combined with a One-Stop-Shop (OSS) system, which connects individuals with renovation coaches that support in applying for funding and the development of a renovation plans.

Scientific evidence investigating accessibility of energy renovations in France suggests that funding for middle and low-income households has substantially increased over the last ten year. Recent accessibility improvements to the zero-rate eco loan have significantly improved availability of financing for energy renovations. Considering significant increases in cost for energy renovations including heat pumps in the last ten year of around 30 percent, public funding support is critical in enabling energy renovations across all income groups. Yet, the evidence from France shows that despite the existing support schemes the necessary investments are not fully possible for a French middle income class household leaving aside vulnerable households. In this manner, promoting targeted support measures remains essential and should be made a budgetary priority (I4CE Institute for Climate Economics, 2025).

As pointed out by the International Energy Agency (IEA, 2025c) government-backed programmes for energy renovations in the EU are in declined in terms of funding scope and access to different schemes including economies such as Germany, France and Italy. Even though overall investment in energy renovations has been resilient in 2024 supported by projects from former funding periods, significant decline in investments in energy renovation is expected if budgetary priorities are not reversed and new funding schemes emerge (IEA, 2025b, I4CE, 2025). This risks undermining climate goals, worsening energy poverty, and multiple strategic benefits for the EU.

4.3.5 Conclusions

Innovative financing instruments like OBS provide promising solutions to address long-standing barriers that affect the sufficient uptake of energy renovation for reaching European climate targets. Yet, realizing their full potentiality calls for regulators to adapt the existing framework, in which agents operate, including measures related to capital lending requirements, risk assessment approaches as well as the tightening of MEPS.

Public funding schemes have to fulfil the crucial role of promoting the overall increase in renovation and to make sure that those most exposed or vulnerable to requirements of MEPS, energy shocks and climate policy induced price rises yet unable to finance energy renovations under market conditions, are given the opportunity to decarbonize their houses and improve their energy efficiency. Thus, fostering the coordination and combination of private financing instruments and public funding

¹⁶ In June 2025, the temporary suspension of the program was announced (starting date yet unclear) due to a backlog in processing applications and increased cases of fraud. However, the program shall be reinstalled by the end of 2025 latest (Le Monde, 2025).

schemes, which are linked to direct energy efficiency improvements, remains imperative. Given the variety of experience in housing policies across the EU, member states should make use of existing peer-learning opportunities.

5 Just transition considerations

Key messages:

- To accelerate renovation rates fairly, policies must embed distributive, procedural, and recognitional justice by moving beyond technical solutions toward integrated governance that addresses social and economic equity. This means integrating distributive, procedural, and recognitional justice into governance, not just technical fixes, recognising that women-headed households, older people, minorities, migrants, and persons with disabilities face higher energy-poverty risks, lower access to support, and risks of displacement/green gentrification (EEA, 2024c).
- Policymakers must balance simple measures (risking misallocation) with socially targeted ones (higher admin effort) amid limited national capacities (AK Europa, 2025; Jüngling et al., 2025)
- One aspect of effective targeting is creating the non-take-up of benefits amongst vulnerable via trusted intermediaries. One-Stop Shops, when integrated within municipal social services and supported by local intermediaries, can reach vulnerable groups more effectively. By reducing risks, providing tailored guidance, and supporting households throughout the process, they directly contribute to tackling energy inequality and ensuring a fair transition (EC, 2024b).
- Integrating justice dimensions alongside technical and economic outcomes in renovation program evaluations through targeted financial mechanisms, integrated planning and governance, a human rights-based approach, and efforts to bridge the digital divide strengthens long-term success and enhances social acceptance (EEA, 2024c; FRA, 2024b).

Although there is no single, universally agreed definition, the concept of *just transition* advanced by the International Labour Organization (ILO) is broadly understood as the process of greening the economy in a fair and inclusive way, creating opportunities while ensuring that no one is left behind. The European Environment Agency (EEA) adds that just transitions must deliberately address the interplay between environmental goals and social fairness, with attention not only to outcomes but also to the processes and pathways through which change occurs (EEA, 2024c). Rather than simply adding distributive and procedural elements to existing policies, a just transition demands systemic change in how environmental governance is conceived and operationalized.

Applied to the built environment, this means that renovation strategies must go beyond technical energy efficiency metrics and explicitly incorporate mechanisms for equity, participation, and recognition of diverse needs, ensuring that the burdens and benefits of climate action are fairly shared across society. As discussed in chapter 3, energy renovations can deliver multiple and interconnected economic, environmental, and social benefits, such as improved health outcomes and reduced energy poverty. At the same time, the transition towards climate neutrality also carries significant social risks, which different groups experience in unequal ways, from low-income tenants and elderly residents to rural households and marginalized communities. Embedding justice principles into the design and implementation of renovation strategies is therefore essential to ensure that no one is left behind (EEA, 2024c).

This chapter explores how justice considerations are reflected in building renovation strategies across the EU. The analysis is guided by two key research questions:

1. How are EU Member States designing and implementing policies to advance distributive, procedural, and recognitional justice in building renovation strategies, and how do governance frameworks address related challenges?
2. What can be learned from the experiences of specific vulnerable groups and from different policy instruments to ensure a just transition in energy renovations, and how effective are these approaches in reducing inequalities?

These questions are explored through thematic analysis and expert interviews. This chapter further examines how distributive, procedural, and recognitional justice are reflected in energy renovation policies across the EU. It draws on a literature review and on expert interviews conducted in May 2025 with representatives from Eurofound and the EU Agency for Fundamental Rights (FRA). As noted above, the chapter also integrates insights from chapters 2, 3 and 4 (see Interview guideline on just transition considerations).

The following sections examine the three justice dimensions (5.1), explore how they intersect with the realities of vulnerable groups (5.2), and assess key policy approaches and instruments to operationalize a just transition in practice (5.3.1–5.3.7).

5.1 Justice dimensions in energy renovation

The just transition in energy renovation can be understood through three interconnected dimensions, distributive, procedural, and recognitional justice, that must be addressed together to ensure fairness and inclusion. Considering these dimensions simultaneously is essential to ensure that no one is left behind during the energy transition (Petracco et al., 2024).

The European Environment Agency (EEA, 2024c) defines just sustainability transitions as processes that deliberately address the interplay between environmental goals and social fairness, with justice assessed not only in terms of outcomes but also in the fairness of the processes and the recognition of diverse groups. In this framing, distributive justice concerns the allocation of costs and benefits across society, procedural justice emphasizes equal access to and participation in decision-making, and recognitional justice highlights respect for and fair consideration of diverse needs, cultures, and perspectives.

5.1.1 Distributive justice

Distributive justice concerns how the costs and benefits of the energy transition are shared across society. Williams & Doyon (2019) defines it as ensuring equitable access to affordable clean energy for vulnerable communities and addressing the uneven distribution of environmental impacts across space, time, and species. In the context of energy renovation policies, the central question is who bears the costs and who reaps the benefits.

Unequal distribution of costs and benefits

Energy efficiency retrofits can produce considerable long-term cost savings that have the potential to deliver proportionally greater benefits to economically disadvantaged households since these households spend a larger share of their income on energy bills (EEA, 2024c). Deep renovation not only

cuts emissions but also delivers co-benefits, such as better health and comfort, that can disproportionately help the poorest households, seniors, children, and people with disabilities as they tend to be confronted with worse housing conditions upfront. However, without safeguards, the costs of renovations (e.g., upfront loans or higher rents) can fall on those least able to afford them, even when the cost is partially covered by public subsidies, which are often disproportionately accessed by owners of larger or higher-value properties. Analyses warn that owners of the worst-performing housing, often low-income renters, are especially exposed to market rents and price shocks (EEA, 2024c).

Social safeguards and regulatory measures

The representative from FRA emphasized that if owners renovate with public funds, it should be under the condition that this does not result in rent increases which outweigh the energy savings, highlighting the potential for regressive outcomes even when public support exists.

As discussed in chapter 4.2.1, Germany offers an example of how such concerns can be partially addressed. The German approach highlights the potential for split incentives in public funding schemes: When a lessor receives public funding for energy renovations, the amount granted must be deducted from the renovation costs that can legally be passed on to tenants through rent increases.

Similarly, France's *MaPrimeRénov* scheme exemplifies distributive fairness by targeting income-based renovation grants (MaPrimeRenov, 2025). Vulnerable households also receive state-backed loans of up to 20 years to cover residual costs at zero interest rate.

As discussed before Eurofound (2023) emphasize an inequitable pattern where those facing financial constraints are more likely to inhabit inefficient housing. An example for tackling this is Article 159 of the French 2021 Climate and Resilience Law that prohibits any rent increase for dwellings with an energy performance rating of F or G, whether at the time of a new lease, a renewal, or a silent extension (Légifrance., 2021) .

Financing instruments and equity gaps

As discussed in chapter 4, despite addressing some of the key barriers to the uptake of energy renovations, the promotion of innovative approaches that include robust support services like One-Stop Shops (OSS) or specific financing instruments such as On-Bill Schemes (OBS) is not sufficient to ensure that the energy transition is socially just and inclusive, as emphasized by multiple EU policies (Bertoldi et al., 2021; Bianco and Sonvilla, 2021). Private financing instruments typically prioritize profitability and risk mitigation and often fail to integrate just transition or social equity considerations. As such, public funding schemes remain essential, particularly for those with limited financial assets who are unable to access or benefit from private financing mechanisms.

Governance dimensions

Finally, distributive impacts require consistent attention across governance levels. Chapter 4.2 *Country-Level Analysis* has highlighted that the distributive impacts of energy renovation require consistent attention across all levels of government. As illustrated by the case of Spain, interviewees noted that Just Transition principles are not yet uniformly integrated across governance levels. While many municipalities take residents' income into account when designing support schemes, national-level programmes tend to apply more general criteria, such as overall energy demand reduction or

improvements in energy performance certificates, without systematically addressing social equity concerns.

5.1.2 Procedural justice

While distributive justice highlights who benefits from energy renovations, procedural justice determines how those benefits are decided and delivered. It concerns the processes through which decisions are made, particularly the accessibility, transparency, and inclusivity of renovation policies (EEA, 2024c). Delivering justice in practice requires fair representation in decision-making institutions and ensuring that procedures are inclusive at every stage.

Barriers to participation

According to both experts, meaningful participation of low-income and marginalized populations remains insufficient. The lack of tailored support mechanisms impedes participation. Many programs require high levels of digital literacy, placing them out of reach for the very groups they aim to support. As our interviewed expert highlighted, you need to find your way to make upfront payments, this can be a huge barrier, especially for people with limited time, flexibility, or trust in public institutions. Further noted that the solutions require development on the local level and with involvement with the users, not top-down.

Inclusive governance models

Evidence shows that governance models that involve residents in decision-making processes during the renovation result in higher satisfaction rates, lower decline rates by residents, as well as better technical solutions. In Croatia, the Long-term Renovation Strategy was shaped through an Open Partnership Dialogue that connected local/state actors, academia, and industry experts, facilitating inclusive governance. Poland's Ministry of Climate established a multistakeholder working group to define energy poverty and collect best practices, ensuring cross-sectoral input and local relevance (EC, 2023d). The ARCE 2050 project, launched by Spain's Ministry of Housing and Urban Agenda (MIVAU) in January 2025, exemplifies a broad, participatory process to revise and update the national energy renovation strategy. This initiative brings together public bodies, professionals, and citizens, as discussed in chapter 4.2.2 (ARCE 2050, 2025).

Benefits of participation

As discussed in chapter 3 procedural justice in energy renovation is supported through participatory approaches that empower residents to actively shape their communities, reinforcing local ownership and social cohesion. Early engagement of citizens in planning ensures that their voices are included and that the benefits of renovation are broadly understood and accepted. When residents perceive that the outcomes are equitably distributed and reflect their input, public support for renovations and related urban changes increases significantly.

Financing as procedural justice

While deep energy renovations offer significant long-term cost savings, overcoming high up-front costs remains a critical barrier, especially for vulnerable groups. They are most affected by energy price changes but often lack the means to finance renovations. As explored in chapter 4.3, innovative financing instruments such as On-bill Schemes aim to mitigate these upfront costs and address challenges like the landlord-tenant dilemma. However, private finance often falls short in addressing

just transition considerations, underscoring the crucial role of public funding schemes. These schemes must move beyond simplistic income-based targeting to be truly effective. Instead, they should be socially differentiated based on a more nuanced understanding of vulnerability. This includes prioritizing households experiencing energy poverty, considering specific socio-demographic factors like age, health status, and family situation, and acknowledging geographical disparities in energy access, energy needs and costs (Brand and Fickling, 2020; Douenne, 2021; George et al., 2023; Immervoll et al., 2025; Labrousse et al., 2023).

5.1.3 *Recognitional justice*

Recognitional justice relates to acknowledging and respecting the identities, needs, and rights of different social groups.

Intersecting vulnerabilities

Current policy frameworks often overlook intersecting vulnerabilities, such as the compounded discrimination faced by Roma communities, immigrants, and people with disabilities. FRA's 2023 study *Being Black in the EU – Experiences of people of African descent* highlights disproportionate housing and energy-related challenges: 32% face difficulties making ends meet (EU average: 18%), 14% cannot afford to heat their home (EU average: 7%), 18% are in arrears on utility bills (EU average: 6%), and 45% live in overcrowded housing (EU average: 17%). These figures underscore the urgency of integrating equity considerations into renovation policies (FRA, 2023). Similarly, FRA's *Being Muslim in the EU - Experiences of Muslims* shows that about 35% of Muslim respondents experienced racial discrimination when trying to buy or rent a house (FRA, 2024a).

Exclusion in practice

During the expert interviews it was mentioned Cañada Real, an informal settlement near Madrid, entire communities, largely comprised of Roma residents were disconnected from electricity, raising severe concerns about energy deprivation and human rights. Similarly, national experts from Slovakia highlight the inadequate housing conditions of the Roma community as a significant challenge. The interviewed expert recounted cases in Amsterdam and Riga where well-designed programs failed due to behavioural and trust issues, older adults or migrants did not sign up for renovation schemes they did not fully understand or trust. Tailored, culturally sensitive, and accessible support structures are needed.

Institutional barriers

As discussed in chapter 4.1 *Synthesis of Key Barriers and Enablers* on Barriers and Enablers, lack of awareness and mistrust in institutions can significantly hinder renovation uptake, often compounding discriminatory experiences. Financing tools also miss the most vulnerable: tax incentives, for instance, provide no benefit to households below the tax threshold. Spanish experts noted that relying on tax returns to assess eligibility can exclude low-income households not required to file taxes.

Policy frameworks

EU legislation has begun to embed recognitional justice. Article 24 of the Energy Efficiency Directive (Directive (EU) 2023/1791) requires Member States to 'implement energy efficiency improvement

measures that address those affected by energy poverty, vulnerable customers and, where applicable, people living in social housing’, and to monitor their impact. Similarly, the recast Energy Performance of Buildings Directive (Directive (EU) 2024/1275) specifies that ‘... policy measures should as a priority target vulnerable households, people affected by energy poverty and people living in social housing’.

Emerging practices

Some local initiatives already embody recognitional justice in practice. The Amelio Pro programme in Lille Metropole (France) combines social work, engineering, and legal support to meet the specific needs of low-income households. Since 2014, the integrated advisory service has supported more than 20,000 households, with demand increasing by 38% in 2022 (EC, 2023d).

5.2 Compounding inequalities and justice dimensions in energy renovation: exploration based on selected specific vulnerable groups

Understanding a just energy renovation requires recognizing how social inequalities intersect with distributive, procedural, and recognitional justice (chapter 2.1). Vulnerable groups, including renters, older adults, and marginalized communities, are disproportionately affected by persistent energy poverty, rising housing costs, and regional, urban-rural, and socioeconomic disparities (2.1.1 Regional divides; 2.1.2 Urban-rural divides; 2.1.3 Socioeconomic divides). These interactions often determine whether energy renovation policies help reduce current vulnerabilities or inadvertently worsen them.

The following sections detail how various specific groups, already identified as vulnerable and implicitly acknowledged in stakeholder analyses, experience these justice dimensions in varied and often unequal ways during the energy transition.

5.2.1 Low-income private tenants

The lower income groups consistently spend a higher proportion of their income on essential services, of which energy, compared to the wealthiest (Petracco et al., 2024; EC, 2023b). As a result, measures that lead to increased energy prices, such as carbon taxes, tend to disproportionately affect lower-income households, which often reside in less energy-efficient dwellings, compounding their disadvantages.

They have limited money to respond to the situation and face restricted access to renovation funds. As tenants, they are often excluded from owner-focused schemes. Their procedural rights to influence renovations are weak due to limited access to information, low awareness of available programs, and difficulties in participating in decision-making processes. Consequently, their specific needs are often unrecognized in policy design. When lessors implement energy renovations, tenants may also face renoviction. Renovictions refer to the process where certain retrofitting policies and programs, rather than improving living standards or increasing the availability of quality affordable housing, instead lead to the eviction of vulnerable households due to subsequent rent increases.

Interview partners in the German case study also emphasized that profit-driven retrofits pose a significant issue in the rental market, as they often prioritize high-end renovations that justify rent increases. While policies and financial incentives often drive the adoption of improved building materials and technologies, their high costs can exclude low-income groups. To promote equitable access, these measures must be specifically designed considering the financial capabilities and unique needs of vulnerable populations.

Solutions could include targeted grants or subsidy programs for low-income homeowners and tenants, public-private partnerships for insurance cost-sharing, and facilitated access to innovative technologies like prefabricated renovation materials (EC, 2025d).

5.2.2 Homeowners without mortgages

In many Southern and Central-Eastern European Member States, in particular in rural area, a notable portion of homeowners without mortgages¹⁷ often live in poor-quality, inefficient housing. Although they often face high utility costs, they frequently lack the liquid assets, digital literacy, or institutional trust required to engage in an energy renovation and benefit from subsidy schemes (Eurofound, 2023).

Despite representing a significant share of the housing stock, this group is rarely recognised as a distinct target in renovation policies, creating gaps in both distributive and procedural justice. However, the group of vulnerable homeowners in Slovakia is eligible for targeted financial support schemes launched under the Recovery and Resilience Plan (RRP), such as *Obnov dom* and *Obnov dom mini*. This distinct group has been formally recognized as a priority target within national renovation policies. These programs aim to reduce energy consumption and improve building energy efficiency. Households can obtain up to EUR 15,000 for achieving at least a 30% energy saving, and up to EUR 19,000 for savings exceeding 60%, with the agency funding a maximum of 75% of eligible costs. This includes insulation, window replacement, and the installation of renewable energy systems like heat pumps (SEA - *Obnov dom*, 2024) (SEA - *Obnov dom*, 2024).

5.2.3 Marginalized communities

Marginalized communities (e.g., Roma, informal settlements, homeless) face profound exclusion from energy access and renovation programs, as informal or unapproved dwellings often disqualify them from financial support. Their procedural participation is virtually non-existent, and their identities and unique living situations are largely unrecognized in mainstream policy, leading to systemic neglect. Despite efforts by MS to improve living conditions, long-term impact remains limited due to legal, infrastructural, and social barriers. Recent legislation simplifying dwelling legalization and land acquisition (e.g. in Slovakia) offers new opportunities to enable safe, dignified housing and renovation for these vulnerable groups. Furthermore, marginalized communities, such as Roma communities, often live in areas with poor environmental conditions, lacking access to basic services like water and sanitation (EEA, 2024c; FRA, 2024b). Homeless people also face specific barriers due to the requirement of a fixed address for essential services access (EC, 2023d). Marginalized communities face exclusion in energy renovation, with distributive inequalities arising from a lack of access to financial support for informal housing, and procedural barriers like the absence of policy participation and the requirement of a fixed address for services. Elderly and persons with disabilities

Elderly people and persons with disabilities face multiple burdens in energy renovation. Distributive challenges include exposure to energy poverty and high upfront costs, while procedural barriers arise from digital exclusion and complex application processes. Their specific physical and social needs are often not adequately recognized in standard renovation approaches, leading to low uptake even of beneficial schemes. The interviewed expert highlighted that elderly people are a central focus in their recent research (Eurofound, 2022) on access to essential services and energy poverty. Specifically, he

¹⁷ This group is often described as ‘asset rich but cash constrained’, meaning they own property but lack the financial liquidity or credit access required to undertake substantial renovations.

noted that older adults often face multiple and compounding disadvantages, such as living in energy-inefficient homes, limited digital literacy, and reduced physical mobility, which can all hinder their ability to benefit from renovation schemes or access support programmes. In the same vein, national experts from Slovakia identified the high proportion of retired people as a challenge, noting that older people are generally reluctant to undertake refurbishment projects.

5.2.4 Women-headed households

Women-headed households disproportionately experience energy poverty, highlighting distributive inequities. The absence of gender-sensitive approaches in national strategies points to a lack of recognition of their specific vulnerabilities. Among vulnerable groups, single mothers face particular financial hardship driven by lower wages, higher childcare expenses, and limited access to affordable housing. This combination exacerbates their challenges in undertaking energy renovations, making them a critical target for tailored support measures. Recognizing this, the European Parliament ‘called on the EU and Member States to protect women living in energy poverty by providing a timely and coordinated response to address the long-term impact of the energy crisis, highlighting that access to affordable utilities must be guaranteed to low-income households, in particular older women and single mothers’ (EP, 2023).

Expert insights underscore that it is not enough to just offer funding, it is needed to make sure the people who most need it can and will use it. Further, they state that programs too often focus on owners, but tenants, informal residents, and digitally excluded people are the ones most at risk of being left behind.

5.2.5 Uncontracted tenants (tenants without formal rental contracts)

Another often-overlooked group is *uncontracted tenants*, individuals renting without a direct energy supply contract, often through informal subletting from a property owner. In many European countries, such informal tenancies are either illegal or operate in a legal grey area. This arrangement typically excludes tenants from eligibility for renovation subsidies or energy cost support, reinforcing both distributive and procedural injustices. The recast Energy Efficiency Directive (Directive (EU) 2023/1791) includes such tenants within its broader definition of ‘vulnerable consumers’.

Informal renting remains common in several Member States, partly because rents are lower, but also because formal renting can require the lessors to obtain a business certificate and pay fixed income tax (Delphi, 2020). As a result, certain groups in need of housing or energy benefits, including tenants without formal rental contracts, people without a fixed address, those in shared accommodation, some migrants and mobile citizens, and low-income households just above eligibility thresholds, may be excluded from support. For example, in Lithuania, tenants with informal agreements cannot qualify for rent subsidies. Addressing this gap calls for a mix of preventative measures to reduce informality and targeted enforcement to ensure fair access to housing and energy assistance (Eurofound, 2023).

5.2.6 Middle-income households

Middle-income households, though owning property, often fall into a support gap: they earn too much to qualify for targeted assistance programmes, yet lack the disposable income to afford substantial renovation investments. This gap reflects distributive injustice, as they remain excluded both from subsidy schemes and from high-return private financing instruments.

Their situation is especially acute in Member States with low wage-to-cost ratios, where even moderate renovations are unaffordable. Behavioural factors compound these challenges: reluctance to endure the hassle of renovations, distrust of contractors, or a lack of perceived immediate benefits. Policies need to better recognize and address these constraints, offering tailored measures such as simplified procedures, staged renovations, or targeted credit products through One-Stop Shops (OSS).

5.2.7 Rural households

In rural areas, many families live in large homes but only use a few rooms. For such households, insulating two or three rooms may be the most economically viable solution, yet existing policies tend to focus on whole-building performance rather than actual consumption patterns. Rural residents are disproportionately affected in Member States where energy poverty exceeds the EU average, and they often lack access to advisory services or renovation providers. At the same time, rural areas often have available land for renewable energy production, which could become a long-term competitive advantage despite current socioeconomic challenges (BMWK, 2024).

Individualized support through One-Stop Shops can help identify the most effective and affordable interventions, addressing real energy poverty while minimizing costs. While tailored outreach and simplified application processes, including accessible One-Stop Shops, are important, these alone can only achieve so much. A proactive approach is needed to understand the underlying reasons for not renovating, such as behavioural barriers like reluctance to endure the hassle of renovations or a lack of perceived immediate benefits. Older owner households may be unwilling to disrupt their daily lives for renovation works, they face social and behavioural obstacles including limited information, distrust, perceived inconvenience, and coordination challenges.

Below Table 10 highlights the key barriers different vulnerable groups face in accessing energy renovations, ranging from high costs, limited access to funding, and digital or procedural exclusion, to behavioural and spatial constraints, and identifies targeted solutions such as One-Stop Shops, staged renovations, gender-sensitive programs, and measures to ensure equitable access to support.

Table 10. Specific vulnerable groups, vulnerabilities, and possible targeted solutions in energy renovation.

Group	Vulnerabilities	Possible Solutions
Low-income private tenants	High energy costs, limited access to renovation funds, weak procedural rights, risk of renovation	Targeted subsidies, strengthened tenant protections, public–private partnerships, facilitated low-cost renovation options
Homeowners without mortgages	Lack of liquid assets, limited access to affordable credit, digital literacy gaps, low institutional trust, limited procedural inclusion	Targeted financial support, tailored credit options, simplified procedures, OSS facilitation
Marginalized communities	Exclusion from formal programs due to informal housing, lack of procedural participation, unrecognized identities	Recognition of informal housing, tailored outreach, dedicated support programs
Elderly and persons with disabilities	High upfront renovation costs, limited and fixed incomes, digital exclusion, insufficient recognition of accessibility and social needs	Accessible application processes, targeted financial and technical support, inclusion of accessibility needs
Women-headed households	Lower wages, higher childcare expenses, limited access to affordable housing, insufficient recognition in national renovation strategies	Gender-sensitive renovation programs, targeted financial and advisory support
Uncontracted tenants	Informal rental arrangements, exclusion from subsidies and energy support schemes	Measures to formalize tenancy, equitable access to renovation support
Middle-income households	Fall into a ‘support gap’: earn too much for targeted assistance but lack disposable income for major renovations; limited trust in renovation markets; perceived inconvenience of renovation processes	Tailored support via OSS, staged renovation options, targeted credit products, awareness campaigns

Rural households	Large, inefficient homes with partial occupancy; limited access to renovation providers and advisory services; higher exposure to energy poverty; reluctance to disrupt daily routines	Rural-focused OSS, flexible renovation standards, tailored outreach, community-based renovation support
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Source(s): Authors' analysis based on multiple sources discussed in this chapter

5.3 Key policy approaches to ensuring a just transition in the context of energy renovations

At the EU level, a range of policies now embed justice objectives into building decarbonisation, including the revised Energy Performance of Buildings Directive (EPBD), the Energy Efficiency Directive (EED), the Renovation Wave, the Just Transition Fund (JTF), and the Social Climate Fund (SCF). As discussed in chapter 2.3, these instruments establish the framework within which Member States must act, requiring national energy and climate planning to ensure consistency with the JTF and SCF.

At the national level, effective policy design requires securing sufficient public funding and embedding safeguards to ensure that financial mechanisms, such as the SCF, reach vulnerable households and do not exacerbate inequalities. This means moving beyond loan-based models that undermine affordability, and ensuring that rent increases in social housing are offset by guaranteed energy savings. Member States must also design National Building Renovation Plans (NBRPs) that align technical efficiency with social objectives, such as those of the Affordable Housing Initiative (see chapter 2.3).

At the regional and local levels, authorities play a key role in operationalising just transition principles. They can provide financial support through loan procedures for vulnerable individuals, establish risk-reduction mechanisms like social guarantee funds, and foster public-private partnerships. Importantly, empowering energy communities and supporting individual prosumers can help households gain greater control over their energy supply and costs, while generating local benefits.

Finally, as highlighted in chapter 2, the wider socio-economic context, financial constraints, the energy crisis, social tensions, and the housing affordability crisis, creates a complex environment for implementing these policies. Overcoming barriers requires empowering households with clear information, technical support, and advisory tools (e.g. One-Stop Shops) to navigate renovations. By adopting a holistic, multi-level approach that integrates social welfare and inclusivity with climate goals, policymakers can ensure that the decarbonisation of Europe's building stock leads to a genuinely just and equitable transition.

5.3.1 Targeted financing mechanisms

Distributive fairness calls for a combination of targeted subsidies, low-interest financing and social tariffs to ensure that retrofits reduce, rather than exacerbate, energy poverty. For example, European guidelines stress that Member States should offer equal access to financing for energy efficiency investments including for the most vulnerable categories (EEA, 2024c). The Social Climate Fund provides an opportunity to directly support vulnerable households in accessing energy renovations.

Progressive financing schemes that link support levels to household income have demonstrated the greatest potential to ensure that renovation benefits reach all society categories while still implementing climate targets. Recent evidence suggests that including household energy bills and the carbon intensity of energy use in targeting criteria can improve effectiveness, ensuring support reaches households with the highest energy vulnerability. Streimikiene et al. (2021) include *'household's energy prices'* and *'GHG intensity of energy'* as key metrics to track economic and environmental dimensions of vulnerability. As pointed out by national interviewees a good social mix in social apartment buildings, which is generally good for social mobility etc, can make it more difficult to use the social climate fund in a targeted manner. Innovative financing mechanisms are essential to overcoming the increased upfront costs of energy renovations, especially for vulnerable categories.

5.3.2 Integrated planning and governance

Policies must prioritize positive social impacts and prevent negative ones. As highlighted in chapter 5.1.2 on procedural justice, governance that is transparent, participatory, and inclusive is central to delivering fair renovation outcomes. Integrated planning builds on these principles by embedding them in multi-level governance structures and national strategies.

Crucially, when defining national strategies, such as the Social Climate Plan, a participatory approach is essential and legally mandated. This ensures broad stakeholder engagement and reflects diverse societal needs. Similarly, building renovation targets should be set through multi-level negotiations (national, regional, city) so that local contexts and needs are reflected, rather than imposed by remote bureaucracy (EEA, 2024b).

This participatory approach is particularly critical for defining national-level Social Climate Plans, as mandated by relevant legislation, ensuring these plans truly address the specific challenges and opportunities faced by diverse communities. Furthermore, these targets and accompanying policy frameworks must not solely focus on reducing heating demand or energy efficiency during colder months. They must also comprehensively integrate climate change adaptation strategies, specifically considering local scenarios for increasing summer heat and other extreme weather events, to ensure that homes remain liveable and resilient year-round.

5.3.3 Human rights-based approach

As emphasized in chapter 5.1.3 on recognitional justice, acknowledging and respecting diverse needs and rights is essential to a just energy transition. FRA (2024b) states that a human rights-based approach to climate policy also requires strong focus on ensuring a just energy transition. This means safeguarding the rights and livelihoods of those at risk of being adversely affected by decarbonisation measures.

From a human rights standpoint, it is essential to balance the urgency of climate action with careful consideration of the potential harms it may cause, ensuring that no one is left behind. For a Member State, this concretely translates into actively identifying vulnerable populations, conducting thorough human rights impact assessments before implementing new climate policies, ensuring meaningful public participation in policy design, and establishing robust grievance and redress mechanisms for those potentially harmed. Integrating human rights into climate policies ensures that climate action is participatory, just, and equitable. Ignoring human rights risks exacerbating vulnerabilities and inequalities (IHRB, 2020).

5.3.4 Addressing the digital divide

As highlighted in chapter 5.1.2 on procedural justice, and closely linked to recognitional justice, the digital divide represents a major barrier to fair participation, as digitally excluded groups risk being left out of renovation policies and support schemes.

EAPN (2022) notes that insufficient social protection, inequalities and digital divide, create a myriad of obstacles to accessing essential renovation services. Policies must address these barriers to ensure equitable access. Further, Heidenreich et al. (2024) state that digital tools for renovation and energy management may exacerbate inequalities if not carefully designed, raising distributional, recognition, and procedural justice concerns.

Crucially, this means that support mechanisms like One-Stop Shops (OSS) must not only be designed to bridge the digital divide, ensuring accessibility for all citizens, including those less comfortable with digital tools, but also adopt proactive outreach strategies to reach individuals who may be unaware of their entitlements (Eurofound, 2025). While OSS can effectively leverage websites and internet tools for digitally-savvy homeowners, it is equally important to provide physical contact points and tailored assistance for older people or others who are not digitally native, thereby offering a choice of communication and service channels (EEA, 2022b). This multi-channel approach helps simplify owners' decision-making processes and provides comprehensive, end-to-end service, regardless of their digital proficiency.

5.3.5 The role of National Building Renovation Plans (NBRPs)

The NBRPs, introduced as a strategic planning tool under the 2024 recast Energy Performance of Buildings Directive (EPBD), are pivotal to advancing a socially fair energy transition in the built environment. As stated in chapter 2.3, National Building Renovation Plans (NBRPs) are the successor to the national long-term renovation strategies that EU Member States have been required to submit since 2014. Their purpose is to guide the transformation of the entire national building stock, residential and non-residential, public and private, into a highly energy-efficient and decarbonised stock by 2050, with the overarching goal of achieving zero-emission buildings (EC, 2024d). As public consultations unfold across Member States, the design and governance of these plans are increasingly embedding justice principles: distributional, procedural, and recognitional. This integration of justice is crucial, as NBRPs are designed to be consistent with Member States' Social Climate Plans (SCPs), ensuring a cohesive approach to cushioning vulnerable groups against the social impacts of the energy transition, particularly those arising from carbon pricing (ETS 2) on buildings and transport.

As EU Member States conduct open public consultations for their National Building Renovation Plans (NBRPs), the BUILD UP Board of Ambassadors¹⁸, a group of experts in renewable energy and energy efficiency in buildings who advise and disseminate the work of the European Commission's BUILD UP initiative, offers comprehensive country reports detailing each nation's consultation process, stakeholder engagement, and timelines for these vital strategies to decarbonize the built environment by 2050. These reports show that in countries such as Estonia and Lithuania explicitly prioritize energy poverty mitigation. Estonia's consultation also incorporates vulnerable households and energy poverty

¹⁸ <https://build-up.ec.europa.eu/es/about/board-of-ambassadors>

as core considerations and mandates social input, elevating justice alongside technical efficiency (BUILD UP, 2025).

Recognitional and procedural justice are visible in Finland's approach, which actively engages advocacy organisations representing vulnerable groups. The country's coordination between NBRP development and its Social Climate Plan further reinforces alignment between technical and social climate policies. Italy's consultations also highlight labour and social impact dimensions, engaging trade unions and civil sector actors.

Broad procedural justice is being implemented through open, inclusive public consultations. Czechia opens its process to all citizens via professional organisations and round tables. Estonia, Finland, and Lithuania ensure the involvement of housing associations, NGOs, tenant unions, and the academic sector. Spain structures its consultation with expert panels, including one focused exclusively on energy poverty, and coordinates across interministerial and regional authorities.

In terms of distributive justice by design, some Member States prioritize the poorest-performing building stock, which often houses vulnerable groups. For example, Estonia targets the worst-performing 43% of residential buildings, and Slovenia prioritizes buildings with poor seismic, fire safety, and energy efficiency ratings, features closely linked to energy deprivation and social vulnerability.

An assessment of the Long-Term Renovation Strategies (LTRS) previously submitted by Member States (Castellazzi et al., 2022) provides useful background for understanding how justice considerations have historically been integrated into national renovation planning. Countries adopted varied approaches: some offered direct financial and renovation support (e.g., subsidies, tax incentives, low-cost refurbishments in Spain, emergency funds in Belgium, eco-reduction schemes in Malta). Others relied on loan and credit facilities (e.g., interest-free loans in Brussels and Flanders, tax-credit transfer mechanisms in Italy, the Stop Smog programme in Poland). A third group emphasized information and advice services, such as free energy scans and targeted outreach in Austria, France, Germany, and Slovenia. Finally, many countries explicitly focused on social housing renovation, with Ireland, Italy, Spain, and several regions in Belgium prioritizing vulnerable tenants.

From a justice perspective, however, the assessment also highlighted gaps. Distributive justice was partly addressed through financial instruments, but procedural and recognitional justice remained weak: three Member States did not conduct any consultation, and four provided insufficient detail, revealing a widespread lack of transparency and inclusiveness. This experience underlines why the newer NBRPs must go further, embedding justice more systematically across all dimensions rather than relying on fragmented or technocratic measures.

These experiences from the LTRS provide valuable foundations for the NBRPs, underscoring the importance of systematically embedding distributive, procedural, and recognitional justice in future renovation strategies.

5.3.6 Challenges in policy design and implementation

Despite existing frameworks, EU Member States struggle to translate justice principles into effective building renovation strategies. As addressed in chapter 2.3 all EU countries have failed to hand in the National Social Climate Plans on time by end of June 2025. Jüngling et. al (2025) states that the biggest challenge lies in effective targeting. AK Europa (2025) states that the biggest challenges lie in limited administrative capacities at national level and in reaching vulnerable households while striking a

balance between simple measures that might lead to misallocation and targeted measures that require significant administrative effort. They furthermore point out that some lack sufficient financial and technical support for preparing implementation as well as lack of information on the possibilities and implications for households themselves.

One concrete measure of targeting effectiveness is the actual take-up rate among vulnerable groups. Even when funds exist, barriers such as complex eligibility rules or administrative gaps reduce participation. Proactive approaches, including personalized guidance to households, are crucial to prevent non-take-up of benefits and unintended exclusion. For example, many households are denied subsidies due to the absence of formal rental contracts, a widespread issue in Slovakia and Slovenia, which also affects access to tax benefits in Croatia (Eurofound, 2023). Low take-up in such cases demonstrates how design flaws can undermine otherwise well-funded programs. Furthermore, there is a persistent risk that deep renovations could displace low-income households.

Policymakers must acknowledge intersectionality, understanding that an individual's age, sexuality, gender, ethnicity, and socio-economic status influence their perception of and access to justice; without this, certain groups' needs may be neglected (EEA, 2024c). The Local Alliance has criticized the development of the National Social Climate Plans, noting that most countries have failed to comply with Articles 4 and 5 of the Social Climate Fund. These provisions require Member States to engage with local and regional governments in the process. The critique is based on a survey of cities and regions across 14 Member States, including Belgium, Finland, Germany, Greece, and Spain (Dubeta et al., 2024). Bankwatch also notes that the quality of stakeholder engagement varies significantly across countries, highlighting Romania as a positive example and Bulgaria as a negative one in terms of structured consultation processes and transparency (CEE Bankwatch Network and E3G, 2025).

Finally, policy responses remain fragmented in their scope and integration. Only a few countries, such as France and Spain, systematically collect data on populations affected by summer heat, and even fewer integrate socio-economic vulnerability into broader energy renovation and adaptation strategies (EC, 2025d). However, some cities are pioneering targeted measures; Paris's cooling network prioritizes low-income areas, and Athens' Green Corridor initiative combines urban greening and biodiversity with thermal resilience (EC, 2025d).

When comparing the approaches to existing frameworks and member state actions, several parallels and gaps emerge. Many of the proposed solutions, such as targeted financial mechanisms and the emphasis on integrated planning and governance, are already being integrated into EU policy instruments and the Renovation Wave at large, like the revised Energy Performance of Buildings Directive (EPBD), the Social Climate Plans, and, and more recently the affordable housing initiative, both of which now include explicit justice objectives. Furthermore, the call for a human rights-based approach is reinforced by the European Commission's *Council Recommendation on ensuring a fair transition towards climate neutrality*. (EC, 2022b)

In practice, however, assessments of policy effectiveness reveal serious gaps. Most national climate and energy plans (NECPs) have not taken a comprehensive, integrated approach to a just transition, failing to fully address EU requirements. An EC-wide assessment found that Member States provide only partial analyses of socio-economic impacts and rarely consider distributional effects on households (EC, 2023a). Key issues include incomplete socio-economic impact assessments, with only a third of plans properly evaluating new policies. Furthermore, less than half of the NECPs detail strategies to maximize social and environmental benefits or mitigate negative impacts, and many lack

coherence with Territorial Just Transition Plans. Additionally, only a third of plans thoroughly address reskilling needs.

Likewise, the Social Climate Fund, which is intended to cushion vulnerable energy users against ETS 2 costs, risks falling short unless explicitly stipulated for renovation assistance. EAPN and other civil society groups insist that the SCF should go beyond one-off vouchers and instead fund lasting programs (e.g., grants for insulation, lower-rate loans) that empower low-income households to become prosumers or participate in community energy schemes (EAPN, 2022). While the EC's intention is to support low-income households in transformative actions, national-level policy choices ultimately determine whether these objectives are delivered effectively, highlighting the need for clear guidance, monitoring, and alignment with local implementation frameworks. One-Stop-Shops (OSS) as a tool for a just transition in energy renovations. While the EC's intention is to support low-income households in transformative actions, national-level policy choices ultimately determine whether these objectives are delivered effectively, highlighting the need for clear guidance, monitoring, and alignment with local implementation frameworks.

5.3.7 One-Stop-Shops (OSS) as a tool for a just transition in energy renovations

One-Stop-Shops (OSS) are recognized as effective mechanisms to facilitate access to energy renovation services, particularly for vulnerable and hard-to-reach groups. One-stop shop is considered 'a virtual or physical place where stakeholders are supported in all questions as well as implementation stages of renovation project[s] related to energy efficiency, ranging from advice on the topic to all information and services they need to implement an ambitious global energy efficiency/renovation project' (EC, 2024d). By providing a single point of contact, OSS streamline complex procedures related to technical advice, financing, and administrative support, thereby reducing barriers for low-income households, renters, and elderly residents (BPIE, 2023).

In practice, OSS offer tailored services such as free or low-cost energy audits, personalized financial guidance, and assistance with navigating funding schemes, which help to address disparities in access to renovation opportunities, helping vulnerable households shielding from rent increases after the renovations (EC, 2020a). Furthermore, OSS may include language support and outreach programs aimed at ethnic minorities or socially isolated groups, ensuring inclusivity and reducing informational asymmetries. However, while OSS have shown promise in enhancing equity in renovation uptake, challenges remain in ensuring that they reach the most vulnerable populations effectively and sustainably (EEA, 2024c). Boza-Kiss et al. (2021) identified 63 One-Stop Shops (OSS) across 22 EU Member States, with 57 of them operational in 2020. Approximately two-thirds of EU Member States have at least one OSS in their renovation markets, collectively handling an estimated 100,000 projects annually. This volume accounts for roughly 4-5% of all renovation projects within the EU during that time.

While this represents a significant contribution, it also indicates a substantial untapped potential, suggesting that OSS could play a more pivotal role in Several EU-supported and city-led OSS initiatives demonstrate their capacity to provide technical, financial, and social support to vulnerable households. (Habitat for Humanity International, 2024b) covers several One-Stop-Shops across Europe, including the Oktave project in France, a mixed-economy company serving condominiums and single-family homes; Opengela in Spain, under the Basque Energy Agency, focusing on multi-family buildings; the De Energiecentrale in Ghent, operated by the municipality for individual flats, single-family homes, and condominiums; the Vilnius Renovation Agency, a public company managing condominium renewals; Hauskunft in Vienna, a public OSS providing comprehensive counselling for apartment owners and

tenants; and the Asenovgrad OSS in Bulgaria, operated by the local municipality to run national subsidy programs and engage homeowners.

In Ghent (Belgium), the OSS model De Energiecentrale, combats energy poverty through a multi-level strategy. They raise awareness of renovation projects among vulnerable, low-income residents and facilitate their participation. The OSS also promotes and supports basic energy efficiency renovations with customized guidance. It is a free one-stop-shop offering personalized advice and guidance to increase the energy efficiency of private homes, including single-family homes and condominiums. Its core mission is to alleviate concerns about energy renovation. To effectively alleviate energy poverty, De Energiecentrale collaborates closely with various social partners (Habitat for Humanity International, 2024b). Its success illustrates how OSS, when embedded in municipal governance and social services, can overcome access barriers and deliver tangible equity outcomes. The project's integrated renovation coaching model includes financial advice, contractor coordination, and application support resulting in over EUR 58 million invested (Thöne et al., 2023).

Similarly, in the Basque Country (Spain), the Opengela OSS in Bilbao and Eibar targets deprived urban districts. It combines technical and financial advisory services with social outreach. In Bilbao alone, the project generated 4.25 GWh/year of energy savings and EUR 15.2 million in investment, while creating several local jobs in OSS offices (OpenGela, 2022). These OSS operated as proximity-based neighbourhood offices, designed to improve trust and remove procedural barriers, especially for older adults and tenants in multi-family buildings.

The REVERTER project (Cattaneo et al., 2024), active in Portugal, Latvia, Bulgaria, and Greece, demonstrates how social outreach enhances OSS effectiveness. The project trained 75 building managers and social workers as renovation ambassadors, who conducted over 1,500 household visits to identify needs and provide renovation pathways to low-income residents (Habitat for Humanity International, 2024a). Its digital OSS prototypes were specifically designed to be inclusive and accessible for rural and low-income populations.

In addition, EC (2023d) 'Staff Working Document Accompanying the Recommendation on energy poverty' lists several one-stop shops across Europe illustrating how tailored support mechanisms can reduce structural inequalities:

- Austria's Burgenland OSS provides free, multilingual advice on renovation, insulation, heating, and photovoltaics, reaching rural and marginalized populations. Consultations occur in local offices, municipal centres, or even over the phone, offering cost-optimal renovation plans with records of advice.
- France's FAIRE network includes 450 contact points nationwide and collaborates with NGOs and public agencies to offer support to households in identifying renovation solutions and accessing funding.
- Denmark's BetterHome OSS simplifies the process for low- and middle-income homeowners by assigning one certified installer to guide the homeowner throughout the renovation. It includes a digital platform for transparency and follow-up, ensuring that support remains accessible across income levels.
- Spain's OSS ('ventanillas únicas') offer financial and technical advice and are complemented by public campaigns like *Ni un hogar sin energía* to increase awareness among vulnerable households.

Collectively, these case studies suggest that OSS can be effective vehicles for addressing distributive, procedural, and recognitional justice in energy renovations, when they are purposefully designed to reach marginalized groups and backed by public investment. However, they also underscore the need for robust oversight and quality standards to prevent cost inflation or unequal service provision.

In addition to formal OSS, non-governmental organizations such as the Red Cross play a complementary role in supporting vulnerable households during energy renovations. As documented in chapter 4.1 Syntheses of Key Barriers and Enablers, these organizations provide advisory and social support alongside emergency aid that extends beyond formal renovation programs. By assisting households facing complex social challenges and offering tailored guidance, NGOs help bridge gaps in access and ensure inclusive just transition outcomes. This collaborative ecosystem of local authorities, NGOs, and community groups is essential to effectively support vulnerable populations throughout the energy renovation process.

Based on these experiences and assessments, Member States should adopt four strategic recommendations to ensure a well-functioning and equitable OSS ecosystem for energy renovations:

- Firstly, prioritize targeted outreach and inclusive design for vulnerable groups, proactively identifying and engaging low-income households, renters, and socially isolated populations, and offering tailored services like language support and personalized guidance.
- Secondly, embed OSS within municipal governance and foster strong collaboration with social partners and NGOs, leveraging their local presence and expertise to build trust and provide comprehensive social and advisory support (see also REScoop, 2025).
- Thirdly, provide comprehensive, tailored, and integrated renovation coaching, streamlining complex technical, financial, and administrative procedures from a single point of contact, and crucially, incorporating safeguards against issues like renovictions.
- Finally, ensure robust public investment, oversight, and quality standards, to guarantee the long-term sustainability and effectiveness of OSS, preventing cost inflation or unequal service provision and ensuring funds lead to lasting benefits for vulnerable households.

5.4 Measuring just transition outcomes

Measuring just transition outcomes of climate and energy policies in buildings (distributive, procedural, recognitional and wellbeing) is crucial for accountability and transparency, building public trust while ensuring that policies address social equity and can be adjusted as needed.

Current evaluation frameworks for renovation programs increasingly focus on technical and economic outcomes, while undervaluing justice dimensions that are equally critical for the long-term success and social acceptance of policies.

Recognizing this gap, the EEA stresses the importance of continuously assessing progress and refining policies to deliver justice. This requires robust systems for monitoring, evaluating, and adjusting measures based on evolving societal needs, while also anticipating unintended consequences, such as green gentrification from urban greening initiatives. Building on this, the EEA emphasizes that although the EU has established initiatives like the Just Transition Mechanism and the Social Climate Fund to support vulnerable territories and populations, these efforts must be embedded in a broader, holistic policy framework. Such a framework should integrate green transition policies with employment,

training, and social policies, while coordinating objectives across key economic sectors to ensure that justice considerations are systematically mainstreamed.

In line with this, the EESC (2023) highlights that accelerating the deployment of renewable energy, particularly through better application of EU laws on public and stakeholder ownership and energy communities, represents one concrete pathway to align climate ambition with social fairness. Additionally, accelerating the renovation wave is crucial, with a specific focus on low-income households and tenants through methods like non-repayable grants and competitive interest rates, all while adequately addressing the risks of renovation and rising rents.

While all EU Member States acknowledge energy poverty in their renovation strategies, Chlechowicz (2021) reveals that most countries lack a clear definition of energy poverty and fail to outline specific targets, measures, or resources to combat it. The study concludes that as of 2020 only 9 out of 27 EU Member States had an official definition of energy poverty, according to the EPOV's assessment of the 2021- 2030 National Energy and Climate Plans (NECPs). More recent analyses, however, suggest gradual progress: based on the latest NECPs submitted in 2020 and 2023, 82% of Member States now include a definition of vulnerable consumers, and around 61% either define or are in the process of adopting a definition of energy poverty (Odyssee-MURE, 2024).

A clear and official definition is crucial for accurately identifying households affected by energy poverty and for developing effective policies to address it. National Building Renovation Plans must include clear targets and progress indicators to enable and ensure implementation of energy renovation policies are effective and these plans are required to be submitted by December 2025 (EC, 2024d). Lager et. al (2023) argue that across policy sectors in Europe, vulnerable groups are at a heightened risk of having less influence on decision-making processes regarding justice and equity concerns. While distributive and procedural indicators (e.g., stakeholder consultation) exist to some extent, their screening found that recognitional aspects of justice lack any direct indicators, highlighting a persistent gap in measuring how vulnerable groups are represented.

To measure the outcomes of a just energy renovation, several potential indicators can be structured around the three justice dimensions. Distributive justice can be tracked through metrics such as energy poverty rates, the share of income spent on energy, renovation uptake among low-income households. Procedural justice can be evaluated by assessing stakeholder diversity, the incorporation of public feedback into policy decisions, and the accessibility of information. Recognitional justice can be monitored via the degree of policy customization for specific household types, attention to cultural sensitivity, collection of disaggregated data, and residents' self-reported wellbeing and comfort post-renovation. Collectively, these indicators provide a holistic picture of whether energy renovation policies equitably reach and benefit vulnerable groups while avoiding unintended social consequences.

5.5 Conclusions for just transition considerations

Decarbonizing the EU's built environment is essential for climate action but must not compromise social equity. A just transition in energy renovations requires addressing how climate mitigation, climate adaptation, housing, and social vulnerabilities interact.

Despite robust EU frameworks such as the Renovation Wave, the revised EPBD, Social Climate Fund, and Just Transition Mechanism, social equity appears to remain often inadequately implemented at national and local levels. Vulnerable groups, including low-income tenants, precarious homeowners,

older adults, Roma communities, and people with disabilities, continue to face significant barriers to renovation benefits.

Without targeted action, these gaps risk worsening inequalities through renovictions, green gentrification, and rising energy bills for lower-income households. Applying social-justice principles to energy-renovation policy is essential to meet emissions-reduction and energy-efficiency objectives while addressing adaptation. Member States should embed these aims in their National Building Renovation Plans (NBRPs) and ensure coherence with Social Climate Plans (SCPs), using participatory processes at national, regional, and local levels. To ensure a comprehensive, year-round just transition, summer energy poverty (SEPOV), alongside winter energy poverty, should be treated as a core dimension of essential-services poverty and integrated into both mitigation (renovation) and adaptation strategies, including equitable access to passive and, where needed, active cooling; safeguards against green gentrification; and indicators and support schemes that reflect seasonal needs.

Effective implementation should prioritize accessible, targeted support informed by intersectional needs, safeguards against rent increases, adequate public funding and inclusive service delivery via proximity-based one-stop shops (OSS) that build trust. Progress should be tracked with disaggregated indicators (income, tenure, disability, age) covering distributive, procedural, and recognitional outcomes, underpinned by human-rights-based safeguards. Addressing structural barriers, such as the lessor–tenant split incentive and digital exclusion, is critical to prevent further marginalization.

The EU possesses the tools and frameworks needed for a just renovation transition. Achieving this will not only advance climate goals but also foster social justice and strengthen trust in the green transition.

6 Conclusion

Energy renovation of residential buildings, including fuel and heating system switches, is central to the EU's Green Deal and further reinforced by the Clean Industrial Deal and the EU Competitiveness Compass, which position the green transition as a catalyst for innovation, industrial resilience, and economic growth. By aligning decarbonisation with competitiveness and supporting vulnerable households through mechanisms like the Social Climate Fund and the Affordable Housing Initiative, the EU aims to ensure a just and inclusive energy transition that advances climate goals across all member states. These initiatives align with recently recast legislation (EPBD, EED, RED, ETS2) to ensure that the decarbonisation and climate adaptation of Europe's buildings also responds to the housing crisis. However, this set of EU legislation will deliver only if the implementation in the member states succeed in overcoming the inherent challenges.

Achieving climate neutrality by 2050 requires accelerating energy renovations, including both thermal renovation and the replacement of fossil fuels with renewables-based heating/ cooling systems-, while considering the impact of climate change, grounded in strong justice principles to avoid worsening socio-economic inequalities. The transformation of the buildings stock is a massive economic move involving the daily life of people. Therefore, costs, benefits and how they distribute in the societies need to be carefully considered.

This project was initiated to address the decarbonisation of existing residential buildings by exploring the often-overlooked socioeconomic dimensions of energy-efficient renovation efforts.

Building on a brief analysis of the policy and social context as well as the stakeholder landscape of energy renovation, this report explored the social, economic, and environmental impacts of energy renovation. The report furthermore analysed key barriers and enablers for decarbonisation of existing residential buildings, including equity-focused innovative financing as well as country case studies, and examines how a just transition can be achieved across diverse regional and socio-economic contexts.

The analysis was informed by targeted literature reviews and expert interviews, conducted through an iterative process with continuous exchange with relevant experts. Key steps included workshops to refine the scoping note and validate the report's conclusions, as well as written feedback on the draft report.

6.1 Financial and economic challenges, benefits and enablers

Energy renovations are held back by a complex web of stakeholders affected by socio-economic-financial, technical, legal and behavioural barriers that interact with and reinforce each other. The literature highlights high upfront costs, long payback periods, split incentives (e.g. lessors bear costs, tenants benefit from savings) and limited access to suitable financing as key financial obstacles, especially for low-income households. Country case studies further confirm that the main barriers include a lack of financial resources and savings, insufficient and poorly targeted funding schemes, and a general lack of effective incentives.

To achieve the goals foreseen in the EPBD for the building sector (both residential and non-residential buildings) the investment need amounts to EUR 200 billion yearly until 2030, creating a current

investment deficit of EUR 127 billion each year (I4CE, 2025). Others even find that EPBD measures require a total annual investment of EUR 297 billion in the same time frame leaving an annual investment gap of EUR 149 billion (Keliauskaite et al., 2025).

The economic cost-effectiveness of energy renovations can be enhanced by recognizing that comprehensive deep renovation approaches, addressing entire buildings in a coordinated manner, achieve higher energy performance at lower overall cost compared to step-by-step measures (ADEME et al., 2020; Maia et al., 2024; Observatoire BBC, 2021). Additional efficiency gains can be realized through economies of scale when renovations are implemented on a larger scale, such as at the neighbourhood level (dena, 2022; Michelsen et al., 2015). Other cost determinants include the relative price of gas and electricity, the future price development of heat pump installations as well as emerging technological and organisational innovations e.g. off-site modular construction.

Whereas deep renovations enable an overall cheaper reduction of a certain amount of primary energy use, individual cost for homeowners are a significant barrier considering that the per square meter cost of deep renovations exceed those of medium renovations (I4CE, 2025) as energy renovations of residential buildings are often self-financed by owners (Agir pour le climat, 2021). Step-by-step renovation strategies, while less cost-effective overall, can play an important role in overcoming barriers such as split incentives, particularly when combined with targeted financial incentives and cost-recovery mechanisms. A smart combination of financial incentives and support mechanisms, such as subsidies, grants, or low-interest loans, can significantly lower upfront costs and improve affordability, particularly for low-income households.

In the analysed country cases, specific funding structures are in place to support renovation efforts. Slovakia relies on the State Housing Development Fund for apartment renovations, with future access to EU instruments like the Social Climate Fund expected to support detached homes through loan schemes backed by state guarantees. Germany has developed a broad framework supporting both individual measures and comprehensive renovations, though experts note that socially differentiated elements could further increase uptake among lower-income groups. Spain combines national funding instruments such as the Energy Efficiency National Fund with targeted programs administered by IDAE. Finland goes further by embedding recognitional and procedural justice, actively involving advocacy groups representing low-income households, persons with disabilities, and older populations in the design of its renovation and energy poverty policies.

LTRS assessment shows that many Member States¹⁹ offer financial incentives, direct support, or renovation subsidies targeted at vulnerable or low-income households, often through dedicated programs, tax incentives, or emergency funds. Loan and credit schemes, such as interest-free loans or transferable tax credits (e.g. Poland's Stop Smog program, which provides subsidies and support specifically for low-income homeowners to improve energy performance), aim to reduce upfront barriers for disadvantaged groups. Complementary approaches, including free energy audits, coaching, and targeted data collection efforts (e.g. Slovenia's study of vulnerable household needs), reflect efforts to improve outreach and inclusion. However, a widespread lack of transparency and inclusiveness signals a critical gap in recognitional justice, as the failure to meaningfully consult stakeholders undermines both the democratic legitimacy and social responsiveness of renovation

¹⁹ including Austria, Croatia, Cyprus, Greece, Hungary, Ireland, Italy, Poland, Romania, Slovenia, Spain, and Wallonia

strategies. In many cases, consultations have been weakly implemented, with limited clarity on how feedback, especially from vulnerable groups, shapes the final plans. Addressing this gap is essential in both National Renovation Plans and National Social Climate Plans, as meaningful consultation strengthens recognitional and procedural justice, improves legitimacy, and ensures that policies are socially responsive.

Taken together, these cases show that while Member States increasingly acknowledge the need to integrate distributive, procedural, and recognitional justice into financing instruments, implementation often falls short. Direct subsidies and loan schemes help address distributive barriers, but without inclusive consultation and tailored design, as seen in Finland, financial mechanisms risk excluding precisely those groups most in need. Overall, Member States' financing mixes are strongest on *distributive* justice (grants/loans), weaker on *procedural* justice (co-design, transparent rules), and thinnest on *recognitional* justice (tenure, disability, digital exclusion). The Affordable Housing Initiative can learn from examples of good practice such as Estonia that targets worst 43% stock to prioritise vulnerable households (BUILD UP, 2025), Finland that engages advocacy groups for older adults, disabled, migrants (BUILD UP, 2025) and Spain that dedicated energy-poverty panel in consultation (BUILD UP, 2025).

Comprehensive recognitional approaches are demonstrated by programmes like Amelio Pro in Lille Metropole (France), which combines social work, engineering, and legal support to meet the specific needs of low-income households. Similarly, procedural justice is promoted in Croatia's Long-Term Renovation Strategy through an 'Open Partnership Dialogue', which engaged stakeholders from the local to national level, including civil society, academia, and the private sector, in shaping the governance framework for energy renovation, while Poland's Ministry of Climate established a multi-stakeholder working group to define energy poverty and collect best practices, ensuring cross-sectoral input and local relevance. Distributive justice is exemplified by France's MaPrimeRénov scheme, which targets income-based renovation grants with vulnerable households also receiving state-backed loans to cover residual costs.

While economic incentives for private households and other demand-side stakeholders are essential to drive energy renovations, a holistic assessment of economic costs and benefits must extend beyond the household level (household investments & financing, household operating costs, property value), to also include the firm level (business case for construction/ renovation companies, business case for fossil industries) and the macro-level (energy imports, investments in electric grid, GDP growth, jobs, public budget balance) (Copenhagen Economics, 2018; IEA, 2025b; RAND, 2022). A significant opportunity for a Just Transition in this context lies in the creation of new jobs, particularly by integrating individuals from vulnerable groups into the workforce (Copenhagen Economics, 2018). The Healthy Homes Barometer 2022 by RAND Europe estimates that improving poor indoor climates in residential and public buildings across Europe could generate over EUR 600 billion in economic benefits by 2050, mainly through productivity gains (RAND Europe, 2022).

Building on these established tools, innovative financing instruments are emerging as complementary solutions. Innovative financing instruments refer to mechanisms that are either in the pilot stage or under active consideration within EU Member States, though often already operational in other regions such as the United States. Innovative financing instruments like On Bill Schemes (OBS), energy efficient mortgages, Property Assessed Clean Energy (PACE) financing, incremental property tax and crowdfunding have a strong focus on energy efficiency and create a direct link to energy performance improvements. Thereby, respective instruments aim at addressing key barriers to energy renovations

such as high upfront cost (Barbosa & Almeida, 2025; Bertoldi et al., 2021; Brown et al., 2019; Mundaca & Kloke, 2018).

OBS address common barriers such as high upfront costs, owners' reluctance to take on additional personal debt and limited access to traditional financial products. They further tackle challenges resulting from the landlord-tenant-dilemma as OBS reduce the need for upfront cost and lessors can simply permit their tenants to enrol in the program. OBS offer a degree of novelty by integrating the repayment for energy renovation into the utility billing process. Respective schemes are already implemented in the US, yet only few European countries like the UK and the Netherlands have launched initiatives to foster the uptake of OBS (Bertoldi et al., 2021; Bianco & Sonvilla, 2021; Mundaca & Kloke, 2018). In order to realize the full potentiality of innovative financing instruments, regulators may adapt the existing framework, in which agents operate, including measures related to capital lending requirements, risk assessment approaches as well as the tightening of Minimum Energy Performance (MEPS) (BPIE, 2022).

Public funding schemes have to fulfil the crucial role of not only promoting the overall increase in renovation but to make sure that those most exposed to energy shocks and climate policy induced price rises yet unable to finance energy renovations under market conditions, are given the opportunity to decarbonize their houses (Schumacher et al., 2025). Fostering the coordination and combination of private financing instruments and public funding schemes, which are linked to direct energy efficiency improvements, e.g., by employing OSS remains imperative (Oeko-Institut e.V., 2023).

Although all countries acknowledge the need to improve the targeting of funding, in practice this often proves to be the greatest challenge, as was also evident in the context of developing the National Social Climate Plans (AK Europa, 2025; Jüngling et al., 2025). The reasons are amongst others the significant administrative effort needed for social targeting that meets limited administrative capacities, lack of sufficient financial and technical support for preparing implementation as well as lack of information on the possibilities and implications for households themselves.

In light of the diversity of individual circumstances, funding models should also be diversified. Some user segments may respond more positively to grants, while others may be more willing to engage with third-party financing, on-bill schemes, or community-level cooperatives. A systemic approach that incorporates these differentiated behavioural and economic responses is essential for effective, equitable policy.

6.2 Behavioural and social challenges, benefits and enablers

Energy renovation challenges mirror broader structural inequalities across Europe. Many face a dual burden of energy poverty and housing unaffordability, shaped by regional disparities, urban-rural divides, and rising costs for middle-income households. In 2024, 21.0% of the EU population remained at risk of poverty or social exclusion (Eurostat, 2024b). While all EU Member States acknowledge energy poverty in their renovation strategies, BPIE (2024a) notes that less than half have established clear targets for reducing it, and only 35% of long-term renovation strategies include proper financing provisions for vulnerable categories.

To accelerate renovation while ensuring fairness, policies must embed distributive (allocation of costs and benefits across society), procedural (equal access to and participation in decision-making), and recognitional justice (respect for, engagement with and fair consideration of diverse cultures and

perspectives), moving beyond technical fixes toward governance that tackles social and economic equity (EEA, 2024c).

Renovation policies must apply intersectional analysis and, at minimum, explicitly include the following vulnerabilities in eligibility, targeting and delivery design: low-income private tenants (incl. renovation risk); homeowners without mortgages with low assets; marginalized communities (e.g., Roma, informal settlements, homeless); older adults and persons with disabilities; women-headed households (single mothers); uncontracted tenants (tenants without formal rental/energy contracts); migrants and mobile citizens facing documentation or administrative barriers; digitally excluded households; residents of worst-performing buildings (incl. social housing) and overcrowded or poor-quality dwellings; rural households with high energy cost shares and limited infrastructure; and households exposed to summer energy poverty (urban heat islands, poorly insulated homes).

At the same time key socioeconomic obstacles for energy renovation lie in behavioural and social factors as many homeowners lack awareness, trust, and motivation, often favouring short-term affordability over long-term savings, even when support is available. Moreover, country case studies highlight the importance of consistent policy frameworks and institutional trust as critical enablers for successful renovation programs.

Confidence and trust can be strengthened through the provision of clear, tailored information and support from reliable sources. Trusted intermediaries such as local installers, non-profit organisations, and one-stop shops that offer comprehensive advice and coordination services are essential in reducing perceived risks and guiding homeowners through the renovation process.

Scaling One-Stop Shops (OSS) for a Just Transition works best when they are proximity-based and embedded in municipal social services²⁰. Three cases illustrate this: De Energiecentrale (Ghent) engages low-income households with free, tailored advice in partnership with local social services (Habitat for Humanity International, 2024b); Opengela (Basque Country, Spain) combines technical and financial guidance with neighbourhood offices in Bilbao/Eibar, simplifying procedures for older adults and tenants while generating local jobs and energy savings (OpenGela, 2022); and the REVERTER 'renovation ambassadors' (Portugal, Latvia, Bulgaria, Greece) conduct home visits to identify needs and guide low-income residents through the renovation pathway (Cattaneo et al., 2024). Across these examples, common design features, co-location with social services, home/outreach visits, multilingual support, and end-to-end case management, consistently raise participation among vulnerable groups.

The social benefits emerge mostly for the inhabitants, mainly in terms of better health, sustainable cities and communities and reduced inequality due to lowering of energy poverty, which underlines the potential of awareness and communication campaigns to boost motivation for the uptake of energy renovations.

Energy renovation generates immediate and long-term social benefits, particularly by structurally reducing energy bills, thereby alleviating energy poverty, and by improving health and well-being (Copenhagen Economics, 2018; Dervaux & Rochaix, 2022; European Foundation for the Improvement of Living and Working Conditions., 2020; Giraudet & Lucas Vivier, 2024; IEA, 2025a; RAND, 2022; Ruiz-Valero et al., 2025; Wang et al., 2022). These improvements also support economic productivity and

²⁰ In our expert engagement it was highlighted that a barrier in this context could be fear of stigmatization.

lower public spending on healthcare and social aid. Additionally, renovations strengthen climate resilience (Ramboll, 2022) and contribute to attractive cities with social responsibility (Copenhagen Economics, 2018). These social benefits of energy renovation reinforce the goals of the Competitiveness Compass by building societal resilience and supporting inclusive, sustainable growth. Vulnerable groups (like low-income households, the elderly, or people living in poor housing) are the main beneficiary from relief from high energy costs (EC, 2025c), health and well-being improvements from energy renovation (O'Connor et al., 2024; EEA, 2023), greater climate resilience (EEA, 2025).

Whereas climate resilience is an important social benefit of energy renovation the analysed country cases show that change adaptation is largely overlooked in renovation finance instruments, appearing only in Slovakia and not explicitly in Germany. While Spain includes adaptation in strategies, the building sector there still needs capacity building. This highlights a broader need across Member States to address not just climate change prevention but also its unavoidable impacts, like heat waves and storms, through building renovations.

While energy renovations offer significant benefits, they can also create risks such as displacement, unbearable rent increases, or green gentrification, particularly in market-driven schemes. Addressing these challenges requires a strong focus on securing enough public funding, social safeguards, and inclusive, targeted policy design. Equally important is strengthening the labour market and expanding workforce capacity, particularly to meet the growing demand for deep renovations. This calls for a broader transformation of the renovation sector, including developing new skills, effective cost management, and innovation across multiple areas.

A just energy renovation must address distributional, procedural, and recognitional justice, with particular attention to vulnerable groups facing high upfront costs and limited credit access. Country comparisons show that, despite diverse housing contexts, common barriers persist. These findings highlight the importance of a flexible EU framework that supports tailored national solutions while promoting a fair and inclusive energy transition.

6.3 Environmental benefits and holistic policy design

The environmental benefits of energy renovation typically extend to both individual residents and to society at large through reduced emissions, energy consumption and energy sources, improved resource and waste management, land use and ecosystem efficiency (Abbasi et al., 2023; Giddings et al., 2002). Effective renovation benefits climate adaptation strategies such as shading devices, natural ventilation, thermal mass utilization, and the integration of climate-responsive materials (Ramboll, 2022), as well as nature-based solutions. Moreover, the transition holds the potential to deliver targeted advantages to vulnerable groups, particularly if revenues are redistributed in a way that supports a just and equitable transformation (Budolfson et al., 2021). When guided by Just Transition principles, these benefits can also help reduce inequality by ensuring vulnerable communities gain equitable access to cleaner, more resilient living environments (Tapia et al., 2022).

Evidence shows, that if not implemented equitably, some environmental benefits of energy renovation risk deepening inequalities. Rocha et. al (2024) found that unprivileged groups (lower-income residents, tenants, immigrants, and unemployed individuals) are less served by green cooling services in major European urban areas. Environmental impacts need integrated planning. While emissions and energy savings are central, renovation can also introduce environmental trade-offs (e.g. biomass

pollution, land use). The Affordable Housing Initiative already reflects an awareness of multiple policy goals.

As analysed in chapter 3, energy renovations offer a wide range of social, economic, and environmental benefits that must be assessed holistically in the policy-making process. A holistic assessment of environmental, social (including health), and economic costs and benefits can shift the focus from mere short-term cost-effectiveness of energy renovation to broader long term social cost-effectiveness, while ensuring that public support is allocated efficiently. To effectively steer the distributive impacts of renovation, it is important that all relevant social, economic and environmental costs and benefits are systematically and mandatorily considered in policy design and implementation, while avoiding double counting and capturing reinforcing effects.

While economic benefits of energy renovation such as lower energy bills and job creation can appear in the short term, social benefits often take longer to materialize, and environmental gains may require an even longer timeframe. Transparent communication of the multiple long-term benefits, coupled with policies that ensure equitable access and support for all citizens, is key to building trust and achieving a just and inclusive transition.

The revised Energy Performance of Buildings Directive (EPBD) emphasizes the consideration of environmental and health externalities of energy use, as well as the extension of the emission trading system and carbon prices, for determining the cost-optimal level of energy performance over the estimated economic life cycle (Official Journal of the European Union, 2024).

The comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements has been recently revised by the Commission (European Union, 2025). While the Commission Delegated Regulation 2025 provides a well-designed methodology and improved the scope compared to 2010, it cannot be seen as a fully holistic assessment tool as it lacks consideration of wider societal benefits e.g. reducing energy poverty and behavioural aspects and considers social vulnerabilities only to very limited extent. Therefore, it should be applied as part of multi-criteria decision-making together with other types of Life Cycle Assessments (LCAs) for buildings, e.g. Social LCA.

Understanding both the barriers and enabling factors is essential to effectively design measures that overcome obstacles. Policy instruments that reduce uncertainty, by ensuring long-term policy stability at the national level, and enhance the relative competitiveness of energy-efficient renovation technologies can remove key barriers. A well-balanced mix of instruments is required. Importantly, all policy measures should take behavioural aspects into account to ensure successful implementation and adoption.

A coherent, inclusive, and context-sensitive approach is needed to advance effective and just energy renovations in Europe. Building trust, ensuring affordability, and clearly communicating benefits are key to gaining public support.

More integrated governance, linking tax ministries, regional governments, and local authorities, as well as energy building experts, economists, environmentalists, social policy specialists, and city planners, is essential to avoid fragmentation and deliver fair outcomes. Where data is already available, a stronger integration is needed, particularly through the digitalisation of archives. To relevantly target

the right households, data on income level, energy consumption, energy bill and CO₂ emissions need to be used as joined criteria for support eligibility.

A coherent, inclusive, and context-sensitive approach is needed to advance effective and just energy renovations in Europe. Building trust, ensuring affordability, and clearly communicating benefits are key to gaining public support.

Policy design should explicitly account for the heterogeneity among target users. Addressing Just Transition in renovation policies implies an intersectional approach and ensure that vulnerable groups are explicitly included in eligibility, targeting, and delivery design: Low-income tenants, homeowners without mortgages, marginalized communities, elderly & persons with disabilities, women-headed households, uncontracted tenants, middle-income households and rural households. Going beyond a just funding of energy renovations, energy renovation should be made an integral part of social protection benefits to increase societal resilience.

While affordability is the primary goal of the Affordable Housing initiative, co-benefits of energy renovation such as energy poverty reduction, decreased vulnerability, and reduced inequality have value in their own right, as they directly improve people's well-being, while also supporting uptake of renovation measures and enhancing societal resilience.

7 List of abbreviations

Abbreviation	Name	Reference
AHI	Affordable Housing Initiative	www.eionet.europa.eu/etcs/etc-st
AI	Artificial Intelligence	
BPIE	Buildings Performance Institute Europe	https://www.bpie.eu/
CLD	Causal loop diagram	
EAA	Environment Agency Austria	https://www.umweltbundesamt.at/en/
EAPN	European Anti-Poverty Network	https://www.eapn.eu/
EEA	European Environment Agency	https://www.eea.europa.eu/en
EED	Energy Efficiency Directive	https://eur-lex.europa.eu/eli/dir/2023/1791/oj/eng
EE-FITs	Energy Efficiency Feed-in-Tariffs	
EEOS	Energy Efficiency Obligation Schemes	
EPBD	Energy Performance of Buildings Directive	https://eur-lex.europa.eu/eli/dir/2024/1275/oj/eng
EPC	Energy Performance Certificate	
ESPR	Ecodesign for Sustainable Products Regulation	
ETC ST	European Topic Center on Sustainable Transition	https://www.eionet.europa.eu/etcs/etc-st
EU	European Union	https://european-union.europa.eu/index_en
EU-27	European Union (referring to the 27 Member States)	

FRA	European Union Agency for Fundamental Rights	https://fra.europa.eu/en
GHG	Greenhouse Gas	
GlobalABC	Global Alliance for Buildings and Construction	https://globalabc.org/
ICLEI	International Council for Local Environmental Initiatives	https://iclei.org/
IDAE	Diversification and Saving of Energy of Spain	https://www.idae.es/en/
IPCC	Intergovernmental Panel on Climate Change	https://www.ipcc.ch/
LCA	Life Cycle Assessment	
LCC	Life Cycle Costing	
LTRS	Long-Term Renovation Strategies	
MDV SR	Ministry of Transport and Construction of the Slovak Republic	https://www.mindop.sk/en
MEPS	Minimum Energy Performance Standards	
MH SR	Ministry of Economy of the Slovak Republic	https://www.economy.gov.sk/en/ministry
NBRP	National Building Renovation Plans	https://energy.ec.europa.eu/topics/energy-efficiency/energy-performance-buildings/national-building-renovation-plans_en
NECP	National Energy and Climate Plan	https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en
NO _x	Nitrogen Dioxide	

OBF	On-Bill Financing	
OBR	On-Bill Repayment	
OBS	On-Bill Schemes	
PV	Solar photovoltaic system	
R&D	Research and Development	
RES	Renewable Energy Sources	
RP	Renovation Passport	
SCF	Social Climate Fund	https://commission.europa.eu/strategy-and-policy/eu-budget/performance-and-reporting/programme-performance-statements/social-climate-fund_en
SDG	Sustainable Development Goals	https://sdgs.un.org/goals
SHAPE-EU	Sustainable Housing for All People in Europe	https://shape-affordablehousing.eu/
S-LCA	Social Life Cycle Assessment	
SMCDA	The Social Multi-Criteria Decision Analysis	

8 Glossary of definitions

Term	Definition
Building Envelope and Design	Includes architectural design, material choice, and insulation of walls, ceilings, roofs, and windows
Climate Adaptation and Nature-Based Solutions	Climate resilience measures, nature-based solutions, bio-architecture practices, and improvements to building surroundings
Deep Energy Renovation	Deep renovations are based on an integrated renovation concept, that in one or a few steps process realises the full potential of a building to reduce its energy demand resulting in zero or near-zero energy buildings (BPIE 2021, Ramboll 2022, EC 2024).
Energy Communities	Energy communities are citizen-led legal entities that enable local groups to collectively produce, consume, share, or sell renewable energy.
Energy Performance Certificate (EPC)	An energy performance certificate is an official document that indicates the energy efficiency of a building or building unit. The energy performance is calculated using the methodology set out in the EPBD.
Energy Renovation	Building Envelope and Design, Heating and Cooling Systems, Climate Adaptation and Nature-Based Solutions, Renewable Energy Integration, User Needs and Behaviour
Energy poverty	Energy poverty is defined as a household's lack of access to essential energy services, such as heating, hot water, cooling, lighting and energy to power appliances (EP, 2023). Persistent energy poverty refers to a situation where a household experiences energy poverty over a prolonged period, typically measured over several years. It indicates a chronic inability to meet basic energy needs rather than a temporary.
Essential services poverty	The concept of essential services poverty is defined as a household's inability to access or afford services like water, sanitation, energy, and transport (Petracco et al., 2024).
Heating and Cooling Systems	Energy-efficient heating systems, cooling systems, and shading strategies
Innovative financing instruments	Innovative financing instruments refer to mechanisms that are either in the pilot stage or under active consideration within EU Member States, though often already operational in other regions such as the United States. They have a strong focus on energy efficiency and often create a direct link to energy performance improvements (Barbosa & Almeida, 2025; Bertoldi et al., 2021; Brown et al., 2019; Mundaca & Kloke, 2018).
Just Transition	Although there is no single, universally agreed definition, the concept of just transition advanced by the International Labour Organization (ILO) is broadly understood as the process of greening the economy in a fair and

	inclusive way, creating opportunities while ensuring that no one is left behind. The European Environment Agency (EEA) adds that just transitions must deliberately address the interplay between environmental goals and social fairness, with attention not only to outcomes but also to the processes and pathways through which change occurs with a focus on the dimensions of distributional justice, procedural justice and recognitional justice (EEA, 2024c).
Landlord-tenant split incentive	The landlord-tenant split incentive describes the situation that lessors bear the investment costs of refurbishment, but tenants benefit from lower operating costs. This means that the financial benefit does not accrue to the party that made the investment (Ramboll, 2022).
On Bill Schemes	On Bill Schemes (OBS), which includes On-Bill Financing (OBF) and On-Bill Repayment (OBR), refers to innovative mechanisms for funding residential energy renovations by integrating repayment into the utility billing process.
One-Stop-Shops	OSS are centralised service platforms that provide integrated support for energy renovations.
Renovation Passport	A Renovation Passport is a document that provides a tailored, long-term, step-by-step roadmap for the deep renovation of a specific building to enhance its energy performance.
Renoviction	Refers to the process where certain retrofitting policies and programs, rather than improving living standards or increasing the availability of quality affordable housing, instead lead to the eviction of vulnerable households due to subsequent rent increases.
Renewable Energy Integration	Renewable energy sources (e.g., solar panels) into residential buildings to enhance sustainability
Summer energy poverty	Summer energy poverty is considered the inability to maintain comfortable indoor temperatures during summer (EC, 2025c).
User Needs and Behaviour	occupants' behaviours, preferences, and interaction with renovated systems for optimized energy use

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Annex 1. Interview guideline on country case studies

1. How is Country X implementing speeding up home energy renovations?
2. What challenges does Country X face in speeding energy renovation pertaining to:
 - a. Policies and building regulations?
 - b. People's attitudes and knowledge?
 - c. State of the building sector?
 - d. Environmental, geographical or other local context-related issues?
 - e. Economic situation?
 - f. Finance
5. What has worked in Country X regarding speeding up energy renovations?
6. What has not worked well or needs improvement in Country X to address renovation needs?
7. What overall future challenges do you see that Country X faces in energy renovations?
8. What is needed for scaling up solutions?
9. What private financial instruments/ public funding schemes for energy renovation exist in your country that you would consider innovative?
10. In the mitigation policies for energy renovation, do you also address synergies with adaptation (such as making people and buildings more resilient to climate changes impacts)?
11. Country specific questions for Country X based on their NECP.
12. Here is a preliminary list of key enablers and barriers for energy renovation found in our project. Please take a few moments to study it and reflect on this framework. Which ones do you see as critical going forward? Which ones are missing in your view?

technical	economic/financial	behavioural/social	legal/political
barriers			
Inadequate or complex technologies & processes (e.g. lack of reliable or high-performance technologies, need for long-term planning of step-by-step retrofits to avoid lock-in effects, complex installation, maintenance and production processes)	High investment costs & long payback periods (e.g. High upfront and investment costs, Perceived financial risk)	Lack of awareness, knowledge and trust (e.g. outcomes and benefits of energy renovation, environmental awareness)	Lack of regulatory clarity and enforcement (e.g. comprehensive legal frameworks, building standards and labels)
Lack of professional expertise & support (e.g. need for trained workers for advice, planning, design, construction, installation, maintenance)	Unclear financial benefits (e.g. financial benefits and expected energy savings are unclear to owners)	Perceived inconvenience and low motivation (e.g. inconvenience of construction works, other priorities)	Lack of ambitious and clear political environmental targets
	Insufficient financing options (e.g. limited financial support mechanisms like subsidies, tax incentives, grants, but also underutilised funding options and financing mechanisms)	Behavioural biases (e.g. preference for immediate over future benefits, rebound effect)	Lack of holistic policy frameworks (e.g. focus on economic and technical aspects, behavioural factors often neglected)
	Split incentives (e.g. lessors bear costs, tenants benefit from savings)	Coordination and decision-making challenges in multi-unit housing	Lack of legal harmonisation across EU (e.g. EU directives implemented differently across member states)
			Perceived administrative burden (e.g. new legal instruments seen as bureaucratic)
enablers/drivers			
Improved technological features and user experience (e.g. better reliability and design, easier installation)	Energy cost savings and low running costs through improved energy efficiency	Improved marketing and communication of technology	Promotion of energy-efficiency, low-carbon or sustainability labels for buildings
Improved environmental performance and increased use of renewable energy	Financial support mechanisms (e.g. investment subsidies and low-interest loans)	Access to trusted information sources, formats and recommendations (e.g. public information campaigns, personal	Enforcement of building codes or by other legal requirements

		recommendations, one-stop-shops)	
	Price decrease and shorter payback time due to technological and organisational innovations	User-centered renovation motivation (e.g. improved consideration of demands by tenants and building owners, highlighting comfort benefits)	
		Collaboration and Community Engagement (e.g. with local intermediaries for local solutions, better coordination in multi-apartment buildings)	
		Social and environmental awareness and attitudes of stakeholders	

Ramboll (2022), Behavioural Factors Influencing The Uptake Of Energy Efficiency In Residential Buildings - Final Report

Camarasa et al. (2021), Drivers and barriers to energy-efficient technologies (EETs) in EU residential buildings

Barbosa and Almeida (2025), Strategies for Implementing and Scaling Renovation Passports: A Systematic Review of EU Energy Renovation Policies

Giraudet and Lucas Vivier (2024): Socio-economic Analysis of Energy-Efficient Renovation of Housing, Centre International de Recherche sur l'Environnement et le Développement (CIRED)

13. Do you have any insights or access to studies that provide average cost estimates for energy renovations in your country - either overall or broken down by specific renovation measures?

Annex 2. Interview guideline on innovative financing instruments

1. General questions to both experts

- What innovative (private) financing instruments do you consider suitable to tackle barriers for energy renovation including high upfront costs and split incentives (e.g., Landlord-Tenant-Dilemma)?
- What are the limitations of private financing instruments in tackling barriers for energy renovation including high upfront costs and the Landlord Dilemma?
- Which stakeholders play a role in developing innovative financing instruments? Are new players entering the game?
- Are private financing instruments available that address just transition aspects of energy renovations?
- Where private financing instruments fail to address just transition aspects of energy renovations, how can public financing schemes step in?

2. BPIE specific questions

- How can private financing instruments like On-Bill-Schemes (OBS) address the Landlord-Tenant-Dilemma for energy renovations of residential buildings in Europe?
- What are the Just Transition Implications of OBS; what are the main barriers for the OBS implementation amongst low-income households?
- What can you tell us about the uptake of OBS in recent years in Europe?
- Have there been significant changes in both the regulatory framework for OBS as well as the uptake of OBS since the RenOnBill Project ended in 2022?

3. Oeko Institute specific questions

- How do you define the role of public funding schemes in addressing energy renovations?
- What key components do public funding instruments for energy renovation require in order to foster a socially just transition?
- How can socially just/socially differentiated funding schemes for energy renovation address the landlord-tenant-dilemma?
- In this context, can you name public financing schemes for energy renovations that you consider good practice?
- What novelties do you see in public financing schemes for energy renovation in recent years?

Annex 3. Interview guideline on just transition considerations

1. Current vulnerabilities in the EU

- From your perspective, what are the most pressing social vulnerabilities in the EU related to housing affordability and access to energy services, considering current EU policies and regional disparities?
- Within the EU, which groups (e.g., by income, region, urban - rural) do you see as most at risk of being left behind in the transition to a low-carbon, energy-efficient housing stock?

2. Justice dimensions in EU renovation strategies

- How do current EU and national renovation policies address distributive justice, the fair allocation of costs and benefits – across member states? What mechanisms have shown promise in reaching vulnerable communities?
- Can you provide examples where EU or national renovation programs have successfully integrated procedural justice? How have participatory processes been structured to include local communities and stakeholders?
- In the context of EU building renovation policies, how well is recognitional justice — respecting and addressing the diverse cultural and social needs of communities — incorporated into policy design and implementation?

3. Policy approaches and EU implementation challenges

- What are the main barriers, administrative, financial, or institutional, that EU member states face in integrating just transition principles into their building renovation strategies?
- Could you identify any EU or national policies/programs that have been particularly effective or ineffective in addressing social vulnerabilities during building renovations? What lessons can be drawn from these experiences?

4. Learning from EU practice

- Are you aware of any case studies, whether at the municipal, regional, or national level within the EU, that serve as strong examples of ensuring a just transition in building renovations for vulnerable populations?
- Based on these case studies, what are the key lessons we can learn to inform future EU policy development for building renovations?

5. Recommendations for EU policy

Finally, what would be your top three recommendations to enhance the integration of social equity and justice into future EU building renovation strategies?