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Residential Energy Efficiency and Energy Poverty in the EU: Building Conditions, Thermal Comfort, and Vulnerable Groups

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Executive Summary

Buildings' energy performance is among the main factors driving energy poverty in the European Union (EU). **Vulnerable households are disproportionately likely to live in dwellings with poor thermal insulation and inefficient or absent heating and cooling systems.** Low-energy performance results in either **abnormally high energy bills or self-restriction**, in which households reduce energy use below the level needed for comfort, health, and well-being. These dynamics are most acute among **low-income households, migrants, people with disabilities, and low-income tenants**, who are more likely to have limited options on the housing market, insufficient disposable income to invest in efficiency upgrades, and reduced capacity and rights to navigate renovation services and support schemes.

This report assesses the current state of energy efficiency (EE) in the EU's residential building stock in relation to the incidence of energy poverty (EP) across Member States. Drawing on EU-SILC and OECD Affordable Housing Database indicators, the report examines building characteristics, heating system ownership, thermal comfort, and energy performance certification data across Member States. It also analyses ongoing policy efforts and progress in improving energy performance levels, and examines the links between poor housing conditions, inefficiency, and potentially vulnerable population groups, including those related to poverty and social exclusion, age, migrant background, degree of disability, and level of urbanization.

The results highlight that **significant improvement of the housing stock is still needed across Member States**. For MS with open-access information, the available energy performance certificates show **a prevalence of lower-efficiency classes (C or below or D or below)**. Moreover, there remains **a predominance of inefficient building elements, such as single-glazed windows and room-based heating systems** (e.g., portable electric heaters and individual room stoves), particularly in Southern European countries such as Portugal, Spain, Malta, and Greece.

In 2023, **the population at risk of poverty and social exclusion reports a higher percentage of the population living in dwellings that are not comfortably warm during winter (31.3%) and a higher rate of households without a heating system (6.2%)**, reinforcing the relationship between low EE, low income, and higher energy poverty vulnerability. In urban areas, a higher percentage of the population reports experiencing thermal discomfort during winter (19.1%) and a lower percentage undertakes energy-efficiency improvements (22.9%) compared with rural or peri-urban areas. **Single-parent households report higher winter thermal discomfort (27.1%)** and implement fewer energy efficiency improvements (21.6%). **Population with some or severe disabilities (23.1%) and migrants (23.8%) report higher winter thermal discomfort.** Notably, no marked differences were found in the 65-and-over age group, a finding that may reflect the buffering effect of existing pension and social protection systems for this demographic.

The report also identifies **considerable data gaps that limit cross-country benchmarking**, notably, the lack of comparable, openly accessible energy performance certificates. Moreover, data collection through optional and ad hoc EU-SILC modules does not allow for consistent trend monitoring and policy impact assessments. **Addressing these gaps should be a priority to enable evidence-based energy poverty policy across the EU.**

The comparative evidence outlines a clear strategic implication for the EU and the Member States. In the context of the National Energy and Climate Plans for 2030, and the National Building Renovation Plans, **tackling energy poverty requires treating energy efficiency improvement in the housing sector not only as a climate and energy policy tool but also as a social policy instrument.** This requires **targeted support tailored to household vulnerabilities, tracked using robust, comparable data** to guide investment across diverse European contexts.

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List of Abbreviations

AROPE	At-risk of poverty or social exclusion
CEE	Central and Eastern Europe (Slovenia, Slovakia, Romania, Poland, Lithuania, Latvia, Hungary, Estonia, Czechia, Croatia, Bulgaria)
EE	Energy Efficiency
EP	Energy Poverty
EPC	Energy Performance Certificate
EU	European Union
EU-SILC	EU Statistics on Income and Living Conditions
OECD	Organisation for Economic Co-operation and Development
SE	Southern Europe (Spain, Portugal, Malta, Italy, Greece, Cyprus)
WNE	Western and Northen Europe (Sweden, Netherlands, Luxembourg, Ireland, Germany, France, Finland, Denmark, Belgium, Austria)

1. Introduction

Historically, low energy performance of buildings and lack of energy efficiency have been identified as one of the important drivers of energy poverty. Boardman (2010) described energy efficiency as a permanent, non-reversible component of reducing energy poverty, highlighting its improvement as a long-term solution to EP. Furthermore, Bouzarovski (2013) emphasized that energy consumption levels observed in energy-poor households are often linked to the low energy efficiency levels of their dwellings. More recently, Cornellis (2025) stated that vulnerable population groups are more likely to live in poor housing conditions, such as low-quality dwellings that overheat during summer, and to rely on low-EE mobile equipment for space cooling, resulting in higher energy costs.

Low-income households, older adults, single-parent households, people with disabilities and migrants have typically been identified as groups with higher vulnerability to energy poverty (Middlemiss, 2022; Komljenović, 2022; Goņčarovs & Kährik, 2025). This vulnerability can often be exacerbated by dwellings' lower energy efficiency levels and higher energy needs and compounded by lower uptake of energy efficiency measures and limited affordable options in the housing market (Jessel *et al*., 2019; Keene & Blankenship, 2023).

EP literature often describes the experience of energy-poor households in two forms. On the one hand, a dwelling's inadequate insulation and/or inefficient heating or cooling systems lead to higher energy bills, increasing energy poverty vulnerability. On the other hand, due to the dwelling's low energy efficiency and potentially unaffordable energy bills, energy-poor households may restrict their energy use by relying on coping mechanisms, struggling with thermal discomfort while maintaining abnormally low energy expenditure. These coping practices include restricting heating or cooling to a single room, wearing more clothes indoors, avoiding being at home and seeking public spaces, modifying daily routines to adapt to indoor discomfort, or relying on low-cost or free fuels such as wood or waste (Grossmann *et al.*, 2021; Stojilovska *et al*., 2021).

Additionally, lower energy efficiency generally results in greater heat transfer and higher energy requirements to maintain uniform temperatures. Non-uniform indoor climate conditions, such as varying temperatures, can also be a determinant of mould growth (Orlik-Kożdōń, 2024), indirectly linking low energy efficiency to the deterioration of building elements, the indoor environment, and occupants' health.

Since poor energy performance of the building is a main driver of energy poverty and related health problems for inhabitants, its improvement through energy efficiency renovation is a structural solution to tackle it sustainably and in the long-term. Still, significant barriers stand in the way of comprehensive energy efficiency improvement and building renovation, and these are often more acute for vulnerable groups (Sequeira *et al.*, 2024). These barriers are not only financial, but also social, regulatory, and technical. High upfront costs, limited information on the most suitable energy efficiency measures, split incentives between tenants and landlords[1], and uncertainty regarding renovation suppliers are among the documented barriers (Shnapp *et al.*, 2020; Bertoldi *et al.*, 2021; Pillai *et al.*, 2021). Middlemiss *et al.* (2023) found that vulnerable households often do not engage in energy efficiency improvements due to, for instance, a lack of understanding of the benefits of the measures, a fear of incurring debt or increased energy costs, a reluctance to lose control over their home, or even the stigma of asking for support.

Building type and location can also increase the complexity of renovation. Multi-apartment buildings often experience decision-making challenges due to a high number of decisionmakers, greater information and funding asymmetries, as well as heightened split-incentive challenges (Matschoss *et al.,* 2013; Palm & Reindl, 2016). Rural areas face greater vulnerability to energy poverty (Dokupilová *et al.*, 2024), often associated with difficulties in accessing renovation providers (MacDonald *et al.*, 2020). The private rental sector is frequently associated with low levels of renovation due to split incentives between tenants and landlords; a dynamic particularly acute for low-income households with few affordable alternatives in the housing market (Economidou, 2018; Croon *et al.*, 2024; Papantonis *et al.*, 2025).

EP strategies in the EU, therefore, typically include the renovation of the building stock as a core dimension for structurally improving energy efficiency, thereby reducing energy bills, improving thermal comfort, and enhancing indoor environment, health, and well-being. The scientific literature has demonstrated a direct link between energy poverty and poorer physical and mental health, including higher incidence and worsening of chronic conditions, higher mortality, increased use of health services, and greater exposure to health risks; impacts that fall disproportionately on vulnerable groups (Ballesteros-Arjona *et al.*, 2022).

Studies on the impact of energy efficiency improvements show that such measures stabilize indoor temperatures within comfort ranges, reduce humidity, and lower energy bills, with positive effects on physical and mental health (McAndrew *et al.*, 2021; Fisk *et al.*, 2020; Middlemiss *et al.*, 2023). Poortinga *et al.* (2019) found that energy efficiency improvements led to higher indoor temperatures, reduced energy bills, and improved social and economic conditions in low-income areas, successfully addressing energy poverty during winter in Wales. In a meta-analysis of 36 studies totalling 33,000 participants, Maidment *et al.* (2014) note that low-income households typically report greater health improvements following energy efficiency interventions. In an experimental field study in low-income areas of Wales, Grey *et al.* (2017) found increased thermal satisfaction, fewer reports of energy-use restrictions, and reduced economic strain and social isolation following energy efficiency improvements.

While energy poverty across Central and Eastern Europe (CEE), Southern Europe (SE), and Western and Northern Europe (WNE) is often driven by a common set of structural factors, these manifest

[1] The EED defined split incentives as «the lack of fair and reasonable distribution of financial obligations and rewards relating to energy efficiency investments among the actors concerned, for example the owners and tenants or the different owners of building units, or owners and tenants or different owners of multi-apartment or multi-purpose buildings.»

differently across regions. Geographic and climatic conditions, housing typologies, urban–rural patterns, and energy system characteristics shape how energy poverty is experienced, influencing whether households primarily struggle with heating, cooling, or both.

In SE, characterized by milder heating needs but greater cooling demands, countries combine a higher risk of poverty or social exclusion with widespread low-energy-performance buildings constructed before the introduction of thermal regulations (Kyprianou & Serghides, 2020; Palma *et al.*, 2024). The public and social housing stock is also more limited in these countries, representing, for instance, only 1.1% of total dwellings in Portugal and Spain (OECD, 2024).

In WNE, energy poverty tends to appear in specific vulnerable regions or communities and is typically addressed through broad but well-developed welfare mechanisms. In the Netherlands, for example, energy poverty is associated with tenure type, housing size, and population density (Mulder *et al.*, 2023; Gasparini *et al.*, 2025). Self-restriction, coping mechanisms, and hidden energy poverty have also been documented in studies from Austria and France, identifying minorities, pensioners, and people living in rural areas as the most affected groups (Stojilovska *et al.*, 2021; Eisfeld & Seebauer, 2022).

In CEE, the post-socialist transition brought declining incomes and rising utility prices (Bouzarovski & Tirado Herrero, 2017), while energy vulnerability has been further shaped by the legacy of an inefficient residential stock built during a period of subsidized energy prices and reliant on outdated energy supply systems (Tirado Herrero & Ürge-Vorsatz, 2012). An estimation based on 60% of the national median after-housing-costs disposable income estimates that 22.6% of households in CEE countries are energy-poor (Karpinska & Śmiech, 2023). Some vulnerability factors include age, tenure, housing size, and household type (Karpinska & Śmiech, 2023, 2025).

Notwithstanding these regional differences, the link between promoting energy efficiency and reducing energy poverty is clearly embedded in EU legislation. The Energy Efficiency Directive (Directive (EU) 2023/1791) provides the first definitions on energy poverty, split incentives, and other key concepts relevant to improving energy efficiency and addressing structural barriers in the energy market. The recast Energy Performance of Buildings Directive (Directive 2024/1275) requires Member States to prioritise vulnerable households and those experiencing energy poverty when designing financial incentive schemes. It calls for targeted financial and technical assistance and includes a requirement to tackle and report split incentives and safeguards to prevent rent increases and evictions following renovation works, without prejudice to their national economic and social policies and systems of property laws. Member States must also report on the measures focused on reducing the number of people affected by energy poverty in their National Building Renovation Plans.

These National Building Renovation Plans, which replace the former National Long-Term Renovation Strategies, must provide a comprehensive overview of the national building stock by building type, establish national targets for 2030, 2040, and 2050 with a view to achieving a zero-emission building stock by 2050, accompanied by measurable progress indicators, outline planned policy measures, and specify investment needs and financing sources for implementation.

The structural dimension of energy poverty is further emphasised in Commission Recommendation (EU) 2023/2407, which highlights energy efficiency improvements as a long-term solution that addresses the root causes of energy poverty and supports a just energy transition. More recently, the European Affordable Housing Plan has extended this integrated approach by promoting the expansion of social housing and strengthening the construction sector to accelerate energy-efficient building and renovation. In addition, the Citizens Energy Package targets energy efficiency as one of many ways to reduce energy consumption, thus energy bills, to shield households from energy prices fluctuations and alleviate energy poverty in the EU.

The relationship between housing, EE, and energy poverty has also been a critical dimension addressed by the European Commission Initiative's Energy Poverty Advisory Hub (EPAH). EPAH's handbooks reinforce the need to include energy efficiency indicators in energy poverty diagnosis and to plan and implement energy efficiency measures as part of multi-level energy poverty actions (EPAH, 2025). EPAH's country fiches also detail energy sources and uses in the residential sector, providing an overview of each country's context.

This report further expands EPAH's work by providing a comparative assessment of energy efficiency status across EU Member States. Drawing on indicators related to building characteristics, heating systems, implementation of energy efficiency measures, inability to keep homes adequately warm, and the share of persons living in dwellings not comfortably warm or cool, the analysis examines how structural housing conditions and socioeconomic vulnerability jointly shape energy poverty risk across the EU. Where available, indicators are disaggregated across key vulnerability dimensions, including poverty or social exclusion risk, tenure status, disability, migration background, and degree of urbanization. By distinguishing between affordability-related and building-related thermal discomfort, the report aims to clarify how different contexts might focus on different pathways to more effectively tackle EP. The report is structured into four chapters. The introduction reviews existing studies on energy poverty and energy efficiency. Chapter 2 outlines the materials and methods used in the analysis and examines key indicators related to energy poverty, energy efficiency, thermal comfort, and tenure. Chapter 3 presents recommendations and best practices to address energy poverty through energy efficiency, based on the results. The final chapter provides the conclusions, offering an overall synthesis of the report's findings.

2. Residential Building Stock, Thermal Comfort, and Energy Poverty Across the EU

2.1 Analytical approach

The following sections assess energy efficiency and energy poverty across EU Member States, cross-analysing energy efficiency and energy poverty indicators and examining specific vulnerability factors associated with increased energy poverty risk. The goal is to take stock of the current state of energy efficiency in the residential sector across vulnerable groups, assess its relationship to energy poverty vulnerability in each Member State, and evaluate progress achieved in recent years.

The indicators analysed in this report largely derive from the EU-SILC 2023 (Eurostat, 2025a), its Ad Hoc Energy Efficiency Module (EC, 2023; Eurostat, 2025) and the OECD Affordable Housing Database (OECD, 2024). Other sources, including scientific reports and national databases, are used for specific indicators, such as the JRC report on cooling and summer energy poverty (Koukoufikis *et al.*, 2026) and national energy performance certificate (EPC) databases (see Section 2.2). The EPC national databases were collected in collaboration with National EPAH Antennas. These databases were selected because they contained the most up-to-date information available at the time the report was prepared.

In the OECD Affordable Housing Database, data are available for 22 out of 27 Member States (Austria, Belgium, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, and Sweden), excluding the five Member States that are not part of the OECD. The indicator "Tenure structure of low-income households with difficulties to keep dwelling warm" was extracted from this source.

The EU-SILC energy efficiency module is an ad hoc module collected in response to policy needs rather than on an annual cycle, and several of its questions are optional and therefore not available to all Member States. It covers the building's year of construction, window type, heating system type, main energy sources, uptake of energy efficiency improvements, and summer and winter thermal comfort. Table 1 sets out the indicators available by country. Where available, disaggregation by vulnerable groups follows the categorizations identified in the literature review in Section 1, for example, at risk of poverty or social exclusion (AROPE), level of urbanization, age, household type, among others.

Table 1*: Indicators used from SILC-EU and their source, whether they are mandatory or optional, countries with information available, and disaggregation analysed in the report.*

Indicator	Source	Mandatory?	Countries with data available	Disaggregation analysed
Type of Windows	EU-SILC Energy Efficiency Ad hoc Module	No	BE, BG, CY, GR, HU, IT, MT, PT, RO, SI, SK. Only a share of the data is available.	None
Year of Construction	EU-SILC Energy Efficiency Ad hoc Module	No	AT, BG, CY, DK, GR, FI, HR, IT, LU, MT, PT, RO, SI, SK. Only a share of the data is available	None
Type of Heating System	EU-SILC Energy Efficiency Ad hoc Module	Yes	All	AROPE, Level of Urbanization, 65 and over, One adult with dependent children, level of disabilities
Main energy source used for heating	EU-SILC Energy Efficiency Ad hoc Module	Yes	All	AROPE, Level of Urbanization, 65 and over, One adult with dependent children.
Persons living in a dwelling not comfortably cool during summer	EU-SILC Energy Efficiency Ad hoc Module	No	AT, BE, BG, CY, GR, ES, FI, HU, IT, LU, MT, PL, PT, RO, SI, SK	AROPE
Persons living in a dwelling not comfortably warm during winter	EU-SILC Energy Efficiency Ad hoc Module	Yes	All. However, Eurostat does not present information for Denmark and Luxembourg in some of the disaggregation categories	AROPE, Level of Urbanization, 65 and over, One adult with dependent children, level of disabilities, country of birth.
Persons living in dwellings whose energy efficiency had been improved in the last 5 years	EU-SILC Energy Efficiency Ad hoc Module	Yes	All. However, Eurostat does not present information for Denmark and Luxembourg for some of the disaggregation categories. The question also included the number of measures implemented (one, two or three or more); however, this data is only available for a reduced number of countries	AROPE, Level of Urbanization, 65 and over, One adult with dependent children, level of disabilities, country of birth
Total population living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor	EU-SILC	Yes	All	At risk of poverty, 65 and over, One adult with dependent children.
Housing cost overburden rate by tenure status	EU-SILC	Yes	All	Tenure Status

For indicators with data available for most or all Member States, a group-level analysis was conducted. Countries were categorized into three regional clusters: Southern Europe, Western and Northern Europe, and Central and Eastern Europe. The reported values (presented on sections 2.2, 2.3 and 2.5) were aggregated using a population-weighted average, where each country's contribution was proportional to its population, as specified in Equation 1.

$$\bar{p} = \frac{\sum(p_i * Ni)}{\sum N_i}$$

Equation 1: Weighted average for the calculation of regional cluster values.

Where p_i corresponds to the percentage of the indicator under analysis for the country i , and N_i corresponds to the population size of the country i.

2.2 Buildings' Energy Performance and Heating Equipment

Energy Performance Certificate

One way to assess residential sector energy efficiency is by analysing available dwellings' energy performance certificates (EPCs). This rating tool is used across Member States and provides information on thermal insulation, heating, cooling, ventilation, renewable energy, and other relevant building characteristics, classifying buildings according to their energy performance.

However, the current (pre-2026) design of EPC systems across Member States does not allow for meaningful cross-country comparison, as significant differences in calculation methodologies persist. The EPC scale ranges from A+, A++, or A+++ (higher energy performance) to G, I, H, F, or D (lower energy performance), depending on the country. For example, Croatia uses a scale from A+ to G, Spain, Belgium, Denmark, France, Finland, Bulgaria, Czechia and Romania use a scale from A to G, Luxembourg uses a scale from A+ to I, Germany uses a scale from A+ to H, Estonia uses a scale from A to H, Ireland uses a scale from A1 to G, Austria uses a scale from A++ to G, Slovakia uses a scale from A to D and Portugal uses a scale from A+ to F. Even where the same scale is used, the thresholds between ratings differ, preventing rigorous comparison. Some countries apply different rating thresholds within their own territory: Belgium, for example, has three co-existing scales for the regions of Brussels, Wallonia, and Flanders, while Luxembourg uses different thresholds for apartments and detached houses (DataWarehouse, 2024). A further limitation is that several national EPC databases still cover only a limited share of the total housing stock (Volt *et al.*, 2020). Most Member States also lack open access to even basic aggregated EPC statistics. The revised Energy Performance of Buildings Directive (2024) addresses this fragmentation by mandating that, from May 2026, all EPCs use a harmonised A-to-G scale and be mandatory for selling or renting a dwelling (with the revised EPBD adding major renovations and the renewal of rental contracts as additional trigger points).

EPCs are a proxy for energy efficiency, reflecting the building fabric's thermal performance and the efficiency of dwelling systems. With energy efficiency as one of the structural drivers of energy poverty, EPC ratings are a valuable tool for estimating dwelling energy performance and integrating household vulnerability assessments at both the dwelling and territorial levels (*e.g.*, Camboni *et al*., 2021). At the household level, low EPC ratings (E, F, G) are associated with higher energy demand, which can lead to higher energy costs relative to income, poor indoor thermal conditions, and a heightened risk of energy poverty, particularly among low-income households. Regional EPC data can be used to map the distribution of inefficient housing stock across territories, identifying areas of structural vulnerability that correlate with, but do not fully determine, the prevalence of energy poverty (Frankowski *et al*., 2025). However, the relationship between EPC ratings and energy poverty is not straightforward: EPC scales measure performance under standardised conditions rather than actual consumption behaviour, meaning households may under-consume energy due to affordability constraints. Conversely, EPC ratings do not capture local energy prices, or household income, all of which are central to diagnosing energy poverty, making careful contextualisation essential when using EPCs for cross-country assessment.

Despite these limitations, EPC data from several Member States can be analysed[2].In Portugal, 72.8% of certified buildings (26% of the total) are rated C or below in 2025 (on a scale from A+ to F), and this indicator is part of the monitoring framework of the Portuguese Long-Term Energy Poverty Strategy 2023-2050 (ONPE, 2026). In Estonia, 12% of residential buildings have an E or below class in 2026 (on a scale from A to H) (E-ehitus, 2026). In Czechia, more than 50.5% of buildings are classified as C or below in 2023 (on a scale from A to G) (Ministry of Industry and Trade, 2024). In Denmark, 33.8% of semi-detached houses, 62.8% of apartments, and 67.1% of detached houses have a D or below rating (on a scale from A to G) (SparEnergi, n.d.). In Bulgaria, lower classes (E to F, on a scale from A to G) represented 29% of all the EPC (SEEA, 2026). In Romania, where EPC represent only 1.4% of residential buildings, in 2023 18.9% of the covered floor area of buildings are classified as E or below (scale from A+ to G) (MDLPA, 2025). In Greece, 80.3% of buildings are rated D or below in 2025 (on a scale from A+ to G) (Bpes, 2025). In France, 53% of residential buildings have a D or lower rating in 2026 (on a scale from A to G) (ADEME, 2026). In Italy, 84.6% of residential buildings are rated C or below in 2026 (on a scale from A4 to G) (SIAPE, 2026). In the Netherlands, G class residential buildings accounted for 2% of the dwellings with EPC in 2024 (Ministry of BZK/VRO, 2026). In Slovenia, the D class represents most of the residential buildings, with 35% of residential buildings having E or below EPC (class from A to G) (Republic of Slovenia, 2025) In Slovakia, the majority of buildings are classified as B (61%), with only 10.2% rated D or below on a scale from A to G) (InfoReg, 2026). In Spain, 85.1% of buildings were classified as E or below in 2023 (on a scale from A to G) (MIVAU, 2025). In Finland, considering only EPCs issued since 2018, 50% have a D or below in 2026 (on a scale from A to G) (Energiatodistusrekisteri, 2026). As noted, EPC only covers a share of dwellings in the country that already have an energy performance certificate, so these figures do not represent the country's entire building stock.

[2] The data reflects the total number of buildings with EPCs in each country, based on the information available at the time the references were extracted. More information is available in each dataset reference.

Year of construction

Examining the prevalence of specific construction elements in residential buildings provides further insight into their energy performance at the country level, and helps guide policy priorities by informing the development of targeted funding schemes for building renovation and energy efficiency improvement.

The year of construction is a relevant indicator when assessing the energy efficiency status of the building stock. Where buildings have not been renovated, older stock tends to have lower energy performance, often having been built before the introduction of national thermal regulations setting minimum energy performance requirements. Among the 14 Member States with available data, Belgium and Denmark recorded the highest shares of pre-1945 buildings, at 22.2% and 32.8% respectively (Eurostat, 2025b). In the 1961–1980 construction period, the highest shares were observed in Hungary (41.2%), Slovenia (37.6%), and Romania (37.3%). Buildings from 1981–2000 are most prevalent in Bulgaria (40.5%), Portugal (38.3%), and Cyprus (36.3%). For the 2001–2020 category, the highest shares were recorded in Slovakia (52.8%) and Cyprus (39.4%). For buildings constructed in 2021 or later, the highest percentages were observed in Slovakia (5.7%) and Luxembourg (5.4%).

Type of windows

Window type is another key characteristic of a building's energy efficiency. Single-glazed windows have a lower U-value[3], meaning greater heat loss and higher energy consumption, increasing households' vulnerability to EP. As noted in Section 2.1, this data was collected for 12 Member States only, as the relevant question was optional in the 2023 EU-SILC energy efficiency Module (Eurostat, 2025b). The data indicate the highest prevalence of double-glazed windows in Belgium (83.8% of households), Slovakia (76.0%), and Slovenia (74.1%). Single glazing (the least efficient option) was most prevalent in Malta (55.1%), Portugal (43.7%), and Cyprus (39.4%), and was rarely found in Belgium (3.8%) and Luxembourg (4.0%). Triple glazing, the most efficient option, was most prevalent in Luxembourg (20.0%) and Slovenia (17.4%) (Eurostat, 2025b). Some households also reported mixed glazing types: in Portugal and Greece, 7.6% and 7.2% of the population, respectively, reported a mixture of single- and double-glazed windows, while 3.2% and 2.7% in Hungary and Italy, respectively, reported a mixture of double and triple glazing (Eurostat, 2025b). The presence of mixed glazing may reflect a situation where households lack the financial capacity for full window renovation, in the absence of sufficient state subsidies — as was the case in Portugal and Greece, where recent funding schemes did not cover 100% of the cost of window replacement (Government of Greece, 2023; Fundo Ambiental, 2023).

Type of heating system

Ownership of heating systems is also relevant to both energy poverty and energy efficiency assessment (Figure 1) (Eurostat, 2026a, 2026b, 2026c). The absence of a heating system may reflect

[3] Thermal transmittance value, which represents how good the material is as an insulator. The lower the U-value, the better the material performance as an insulator.

income constraints that prevent its purchase, while inefficient heating systems are often associated with higher energy costs or self-restriction of energy use. The heating system categories used in the EU-SILC are: district heating or teleheating (thermal energy supplied to the dwelling via a heating network from a location outside the building); central heating (a common heating system for the whole housing unit, building, or co-property serving several dwellings); individual heating (stoves fuelled by wood or gas, fixed electric radiators, individual boilers, and similar room-level equipment); non-fixed heating (portable heaters such as electric radiators or fan heaters); and no heating system or unknown (Eurostat, 2025b).

In 2023, 3.1% of the EU population reported having no heating system. Half of the population owned individual heating equipment (52.8%), 27.1% had central heating systems, and 12.6% heated their dwellings using district heating or teleheating. The share without any heating system rises to 6.2% among the population at risk of poverty and social exclusion (AROPE). The situation varies considerably across Member States: in nine Member States, the entire population lives in a dwelling with a heating system, while the highest rates of no heating system are found in Southern Europe (9.6%). This group also has a higher prevalence of non-fixed heating (6.2%), highlighting a possible relationship between low heating equipment ownership, poor EE, and low income.

Across all regional groups, the largest share of the population relies on individual heating systems: 54.9% in Central and Eastern Europe (CEE), 44.8% in Western and Northern Europe (WNE), and 63.0% in Southern Europe (SE). WNE stands out for its comparatively high prevalence of central heating (38.8%), while it represented 19% in CEE and 15% in SE. District heating represented 25% in CEE, 13.6% in WNE, and 2% in SE. SE is the only regional group with a substantial share of non-fixed heating (11%). The use of individual, non-fixed heaters is often associated with more intermittent heating patterns and partial-space heating. While these differences partly reflect climatic variation, SE countries' milder climates reduce the need for comprehensive heating solutions; they may also signal heightened energy poverty vulnerability and hidden energy poverty situations.

Disaggregating by level of urbanization, district heating is heavily concentrated in cities (20.4%), dropping sharply in towns and suburbs (9.5%) and especially in rural areas (5.1%), reflecting its dependence on dense infrastructure (Eurostat, 2026b). Individual heating becomes progressively dominant outside urban centres, rising from 43.4% in cities to 54.0% in towns and suburbs and 65.3% in rural areas. The share of the urban population reporting no heating system (3.9%) is higher than in towns and suburbs (3.5%) and rural areas (1.5%).

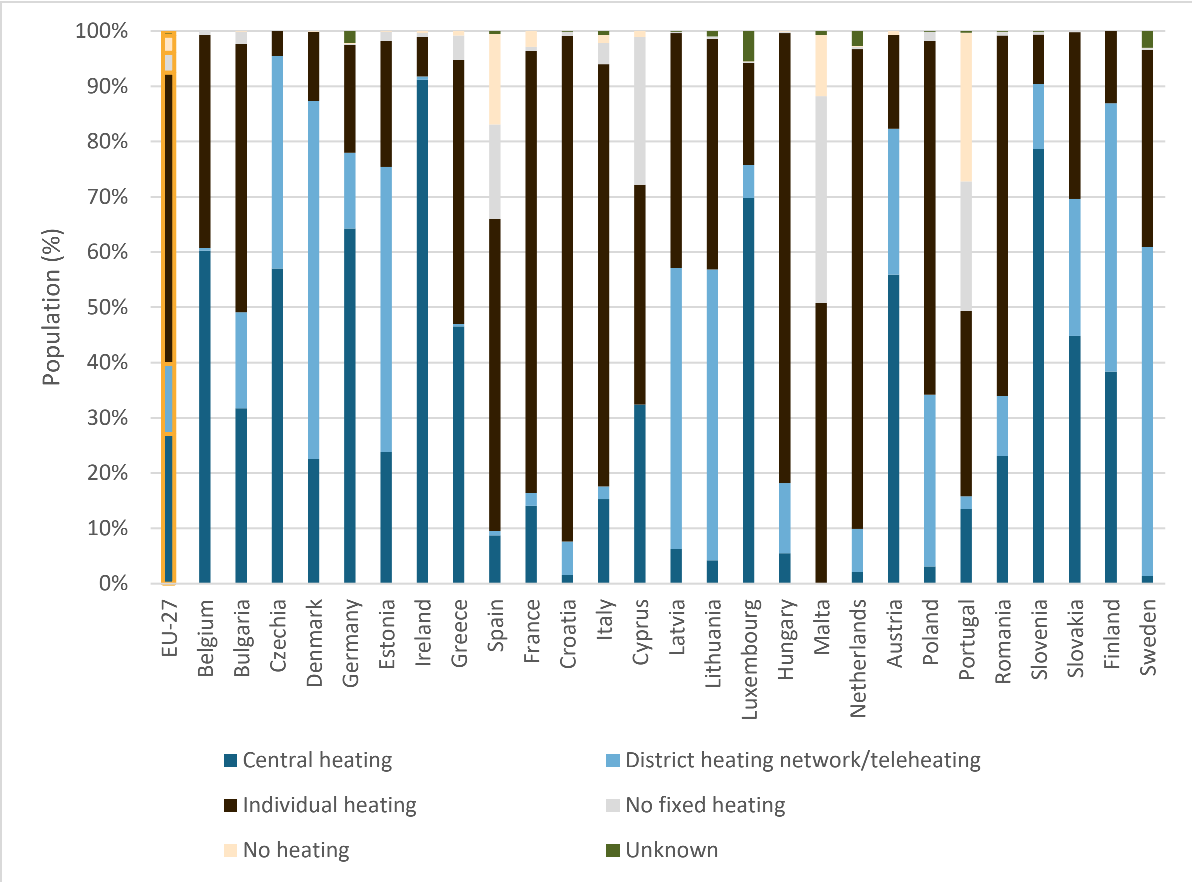

Figure 1: *Persons living in private households by type of heating system. Data from 2023. Extracted from Eurostat (2026a).*

Disaggregating by other vulnerability dimensions, no marked differences were found between the 65 and over age group and the general population (Eurostat, 2026a), a finding that may reflect the buffering effect of existing pension and social protection systems for this demographic. This group shows a high share using individual heating (53.6%), followed by central heating (26.9%), with 2.9% reporting no heating system. Single-parent households with dependent children follow a similar pattern: 48.7% use individual heating, 27.3% use central heating, and 4.2% report no heating system (Eurostat, 2026b). No marked differences were found between the population with some or severe disabilities and the population with no disability (Eurostat, 2026c).

Source of energy for heating

The type of energy source used for heating also provides important information on system efficiency and its potential link to EP. Across the EU, the energy mix for heating differs considerably among households using systems other than district heating (Figure 2). Gas (natural or propane) is the dominant source in the EU-27 (50.1%), followed by electricity (16.6%) and oil or coal (13.8%) (Eurostat, 2026d). While the highest share of gas use is found in SE (56%), country-level analysis reveals high shares of electricity use in Malta (72.8%), Portugal (48.4%), and Cyprus (46.5%); gas dominance in the Netherlands (86.1%), Italy (83.3%), and Hungary (65.4%); and high shares of wood logs in CEE (29%). This cross-country heterogeneity underscores the need for differentiated decarbonisation strategies for the heating sector, including demand reduction through deep building renovation, expanded district heating, and electrification. Electricity is currently used in both low-efficiency individual heaters and in heat pumps, which are generally considered the most efficient option for space heating and cooling (Rosenow & Hamels, 2023).

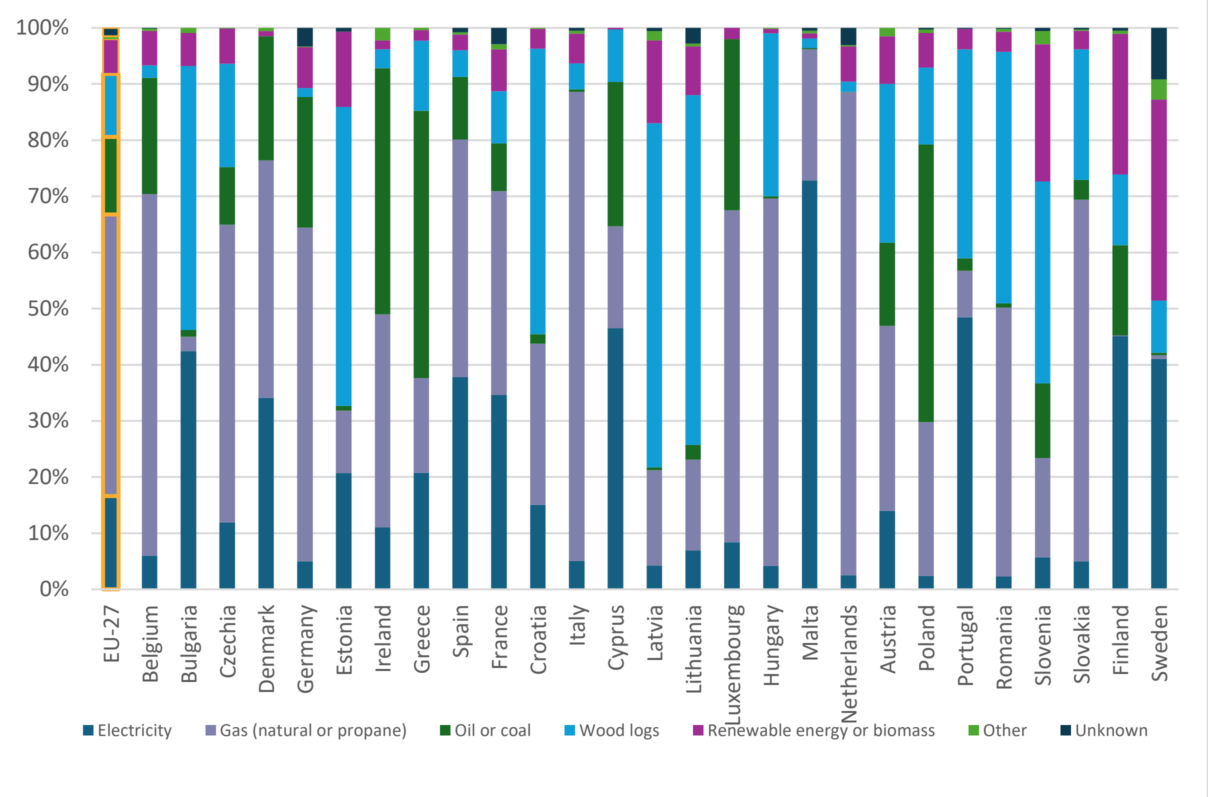

Figure 2: *Persons heating their dwelling with other than district heating by used energy source. Data from 2023. Extracted from Eurostat (2026d).*

The urban–rural divide also shapes the mix of energy sources. In cities, gas is the dominant fuel for heating (63.4%), with electricity as the main secondary source (19.9%) and very limited reliance on wood (Eurostat, 2026d). Natural gas networks are primarily found in urban centres and often do not extend to rural settlements, where residents rely on alternative sources. In towns and suburbs, gas remains the leading fuel (56.5%) but declines noticeably, while wood logs, biomass, and oil or coal increase, indicating a more diversified heating profile. The most pronounced shift occurs in rural areas, where gas drops sharply to 25.8%, and wood logs become the single largest source (26.1%), closely followed by oil or coal (23.2%), producing a markedly more carbon-intensive mix. The use of coal poses risks not only to energy poverty, given the lower efficiency of coal equipment compared to modern systems, but also to indoor and outdoor air quality and regional decarbonisation efforts. Biomass presents a more complex picture: as Stojilovska *et al.* (2023) note, while fireplaces can be less efficient than other solutions and negatively affect indoor air quality, a significant share of rural households may have access to free or low-cost firewood from their surroundings, enabling them to heat their homes at minimal cost and thereby reducing energy poverty vulnerability.

Disaggregating by vulnerability group, the AROPE population shows a lower share of gas use (45.3%) compared to the non-AROPE group (51.3%), and a higher share of wood logs (16.0% vs 10.0%). Single-parent households with dependent children show higher rates of electricity (20.6%) and gas use (55.0%) than the general population. No marked differences were found between the 65-and-over age group and the general population.

Population living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor

The presence of dampness and other poor physical conditions — such as a leaking roof, damp walls, floors, or foundations, or rot in window frames or floors — is also an indicator of low dwelling energy performance. In 2023, 15.6% of the EU-27 population reported living in such conditions, with higher rates in SE (20.0%), followed by WNE (16.0%) and CEE (7.8%) (Eurostat, 2026e) (Figure 3). The population at risk of poverty (23.6%) and single-parent households (22.6%) report higher rates. No marked differences were found between the 65-and-over age group and the general population.

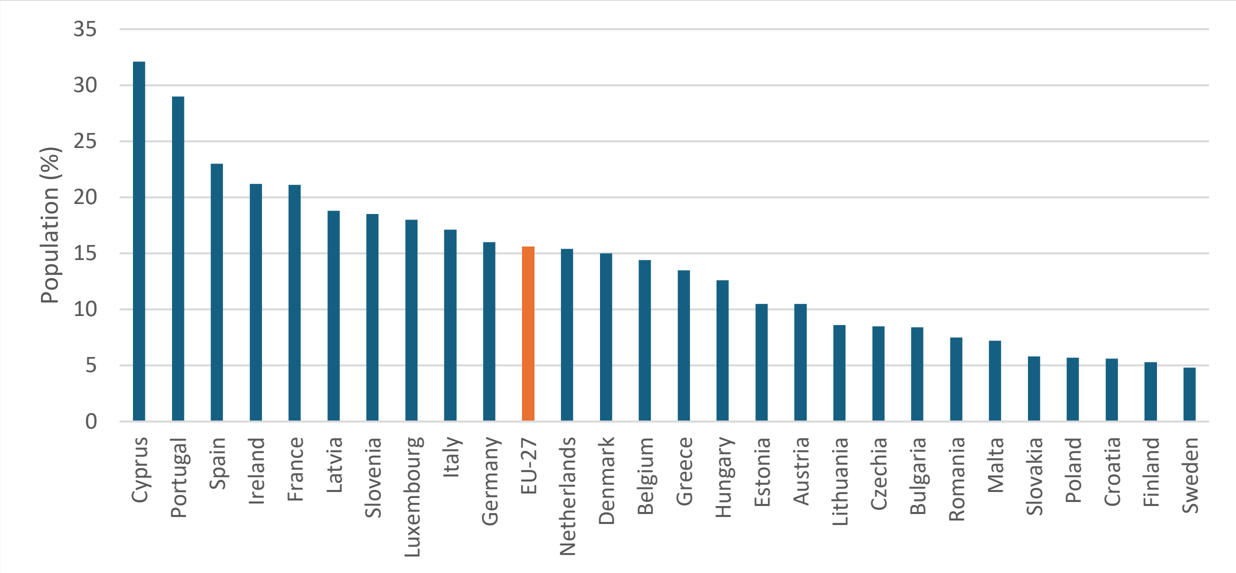

Figure 3*: Population living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor. Data from 2023. Extracted from Eurostat (2026e).*

2.3 Summer and Winter Thermal Comfort

Section 2.2 showed that poor energy performance and inefficient heating systems continue to characterise a significant share of the EU housing stock, with potential consequences for energy poverty (EP) vulnerability. Fully demonstrating the connection between energy efficiency (EE) and energy poverty across Member States remains challenging due to data and indicator gaps. Nevertheless, perceived thermal comfort indicators offer valuable insights into this relationship, including through available disaggregation by vulnerable population groups. This section analyses indicators of summer and winter thermal comfort, highlighting their relationship with energy poverty vulnerability.

Three indicators capture thermal comfort and correspond to two distinct dimensions. Two relate to households' self-reported thermal comfort based on the physical attributes of the dwelling and its heating or cooling equipment: "Persons living in a dwelling not comfortably warm during winter" (Eurostat, 2026f, 2026g, 2026h, 2026i, 2026j) and "Households living in a dwelling not comfortably cool during summer" (2023 data are not yet available on Eurostat; see Table 1 in Koukoufikis *et al.*, 2026 for an analysis based on EU-SILC microdata). These indicators capture energy poverty vulnerability through households' self-reported ability to maintain comfortable indoor temperatures, which relates directly to the dwelling's level of insulation and the efficiency of its heating and cooling systems. A third indicator, "Inability to keep home adequately warm" (Eurostat, 2026k), captures a different dimension, reflecting whether households can afford to heat their homes to an adequate level, regardless of whether they actually need to do so. No equivalent indicator exists for summer, representing a data gap for summer energy poverty vulnerability assessment.

Households living in dwellings not comfortably cool during summer

The indicator on households living in dwellings that are not comfortably cool during summer due to the building's thermal attributes [4]was collected in 16 Member States[5] (Figure 4). Data are available for three reference years (2007, 2012, and 2023). Among countries with 2023 data, the indicator increased compared to 2012 in Belgium, Spain, Luxembourg, Austria, Portugal, Slovakia, and Finland, while it decreased in the remaining countries. The rise in total heat stress and in the frequency and intensity of heatwaves is likely a contributing factor (Copernicus Climate Change Service, 2024), as found in the historical analysis of heat stress days indicators (EPAH, 2026). High vulnerability is also observed among low-income households: an analysis of EU-SILC microdata from 2023 found that in the lowest income quintile, 34.8% of households reported not living in a comfortably cool dwelling during summer (Koukoufikis *et al.*, 2026).

[4] Meaning, indicator who covers the question "Is your household able to keep the dwelling comfortably cool during summer, taking into account the insulation of the dwelling and the cooling system you have in place ? Please do not consider whether the household had financial resources to keep the dwelling comfortably cool during summer"

[5] Austria, Belgium, Bulgaria, Cyprus, Finland, Greece, Hungary, Italy, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, and Spain

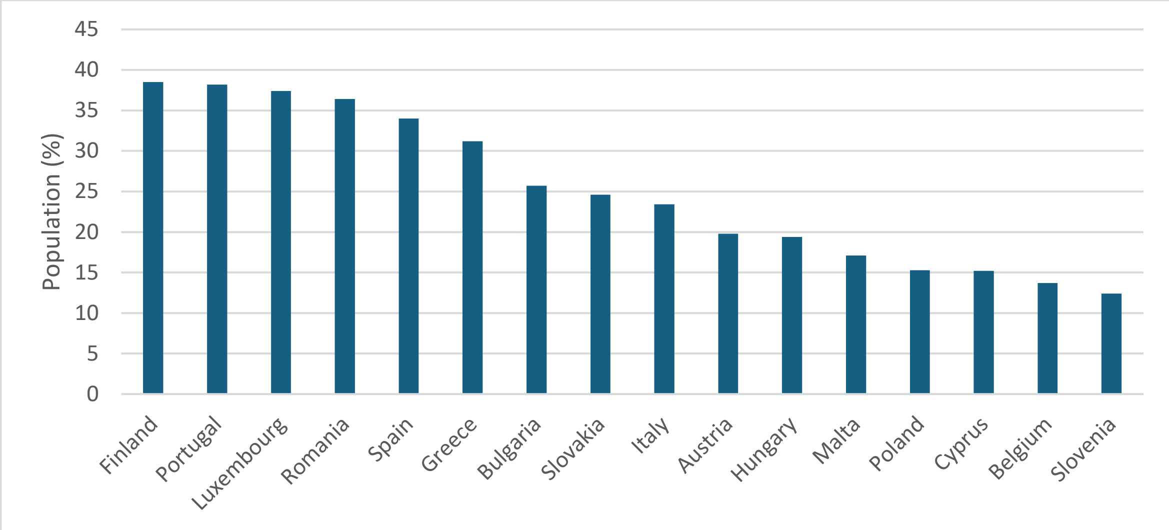

Figure 4*: Share of households living in a dwelling not comfortably cool during summer. Data from 2023. Extracted from Koukoufikis et al. (2026).*

Population living in dwellings not comfortably warm during winter

The indicator on persons living in dwellings not comfortably warm during winter, attributable to the building's physical characteristics and equipment, was collected for all Member States in 2007, 2012, and 2023. Disaggregation is available by risk of poverty or social exclusion, degree of urbanization, level of disability, age, household composition, and country of birth.

Across the EU[6], 17.9% of the population reported living in a dwelling that was not comfortably warm in winter due to dwelling conditions and heating system characteristics in 2023 (Eurostat, 2026f). This share rises markedly among the population at risk of poverty and social exclusion (AROPE): 31.3% of the AROPE population reported this, compared to 14.4% among those not at risk. This pattern was also observed in the heating system ownership analysis and reinforces the finding that the AROPE population is considerably more likely to live in a dwelling with low EE, poor insulation, and/or inefficient heating systems.

Regional patterns reveal substantial variation across Member States (Figure 5). CEE countries record relatively lower average winter thermal discomfort (10.5%), and WNE countries also perform comparatively well (16.4%), reflecting better building energy performance and the presence of efficient heating systems. In contrast, SE countries stand out as hotspots of energy poverty vulnerability, with nearly one quarter of the population (24.6%), and 40.3% of those AROPE, unable to keep their homes comfortably warm during winter. At the country level, Portugal records the highest prevalence, with 38% of the total population and over half of the AROPE population reporting winter thermal discomfort, followed by Ireland, Greece, France, and Spain. Austria, Estonia, Slovenia, the Netherlands, and Belgium rank at the lower end. The AROPE population's share of thermal discomfort reports is more than double that of the non-AROPE population in most countries, though the gap is

[6] Information is not available for Denmark on this indicator on Eurostat

particularly pronounced in Greece and Bulgaria, suggesting that income poverty strongly exacerbates difficulties in accessing quality housing and efficient heating.

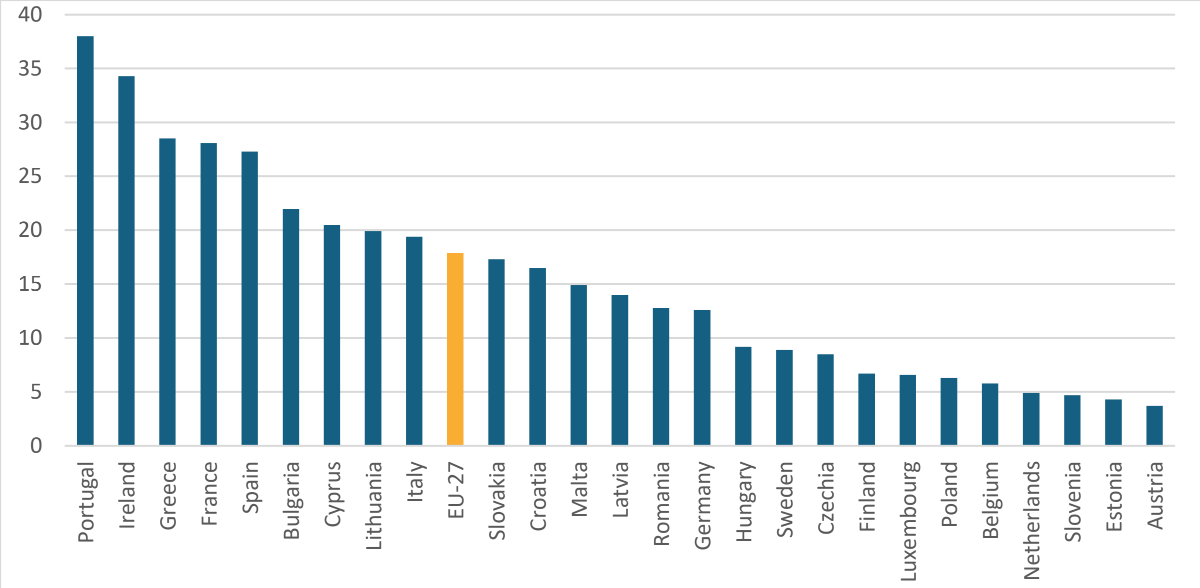

Figure 5*: Persons living in a dwelling not comfortably warm during winter. Data from 2023. Extracted from Eurostat (2026f)*

Differences in winter thermal discomfort also emerge along the urban–rural gradient, as highlighted in Figure 6. Across the EU, 19.1% of residents in cities report being unable to keep the dwelling comfortably warm in the winter, compared with 17.7% in towns and suburbs and 16.3% in rural areas, suggesting a modest but consistent urban disadvantage (Eurostat, 2026g). In several WNE countries (where the share of the population living in dwellings not comfortably warm is 18.4%, including Belgium, Germany, France, the Netherlands, Austria, the Nordic countries, and Portugal), cities register the highest shares. In contrast, several SE countries, notably Greece, Italy, and Cyprus, display higher prevalence in towns and suburbs. The percentage of the population reporting thermal discomfort in towns or suburbs in SE is 25.3%. Meanwhile, rural areas are most affected in parts of CEE, such as Bulgaria, Romania, and Poland. In CEE, the percentage of the population reporting this indicator is 11.8%.

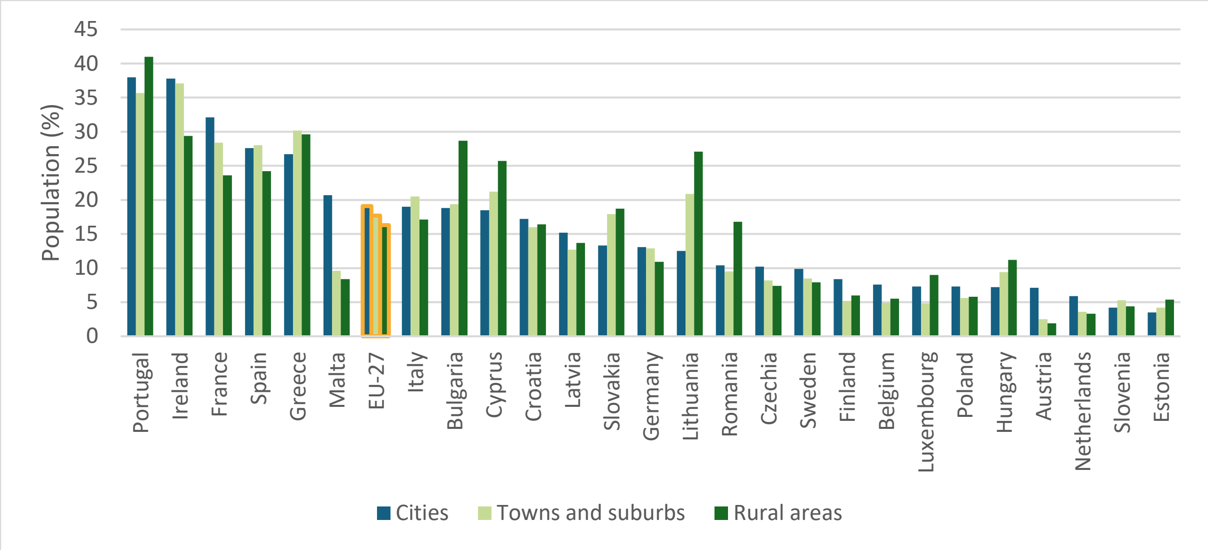

Figure 6*: Persons living in a dwelling not comfortably warm during winter by degree of urbanization. Data from 2023. Extracted from Eurostat (2026g).*

Disaggregating by level of disability, 25.0% of people with severe limitations and 22.4% of people with some level of disability reported winter thermal discomfort, compared to 16.9% of the population with no disability (Eurostat, 2026h). This gap may reflect the greater difficulty people with disabilities face in managing heating systems, or the likelihood that they live in dwellings with lower overall energy efficiency (Ivanova & Middlemiss, 2021). While this pattern is observed across all Member States, its magnitude varies: Lithuania, Portugal, and Spain show gaps of more than 10 percentage points between the population with and without disabilities, whereas Austria, the Netherlands, Estonia, Slovenia, Belgium, and Czechia show smaller differences.

Disaggregating by country of birth reveals persistent inequalities in winter thermal comfort. At the EU level, 17.0% of people born in the reporting country experience winter thermal discomfort, compared with 23.8% among those born abroad and 26.2% among those born outside the EU; a gap of nearly 10 percentage points between native and non-EU-born populations (Eurostat, 2026i). Consistent with findings in previous sections, no marked differences were found between the 65 and over age group and the total population (17.4%). Single-parent households with dependent children report higher thermal discomfort than the general population (23.7%) (Eurostat, 2026g).

Comparison between the two winter thermal comfort indicators

The availability of two complementary winter thermal comfort indicators: one capturing thermal discomfort attributable to the physical attributes of the dwelling and heating system[7], and another capturing affordability-related[8] inability to keep the home adequately warm, enables a comparative

[7] Meaning, the indicator who covers the question "Is your household able to keep the dwelling comfortably warm during winter, taking into account the insulation of the dwelling and the heating system you have in place ? Please do not consider whether the household had financial resources to keep the dwelling comfortably warm during winter"
[8] Meaning, the indicator who covers the question "Can your household afford to keep its home adequately warm?"

assessment of the relative contribution of structural and financial factors to thermal discomfort across Member States (Figure 7). Several distinct country groupings emerge.

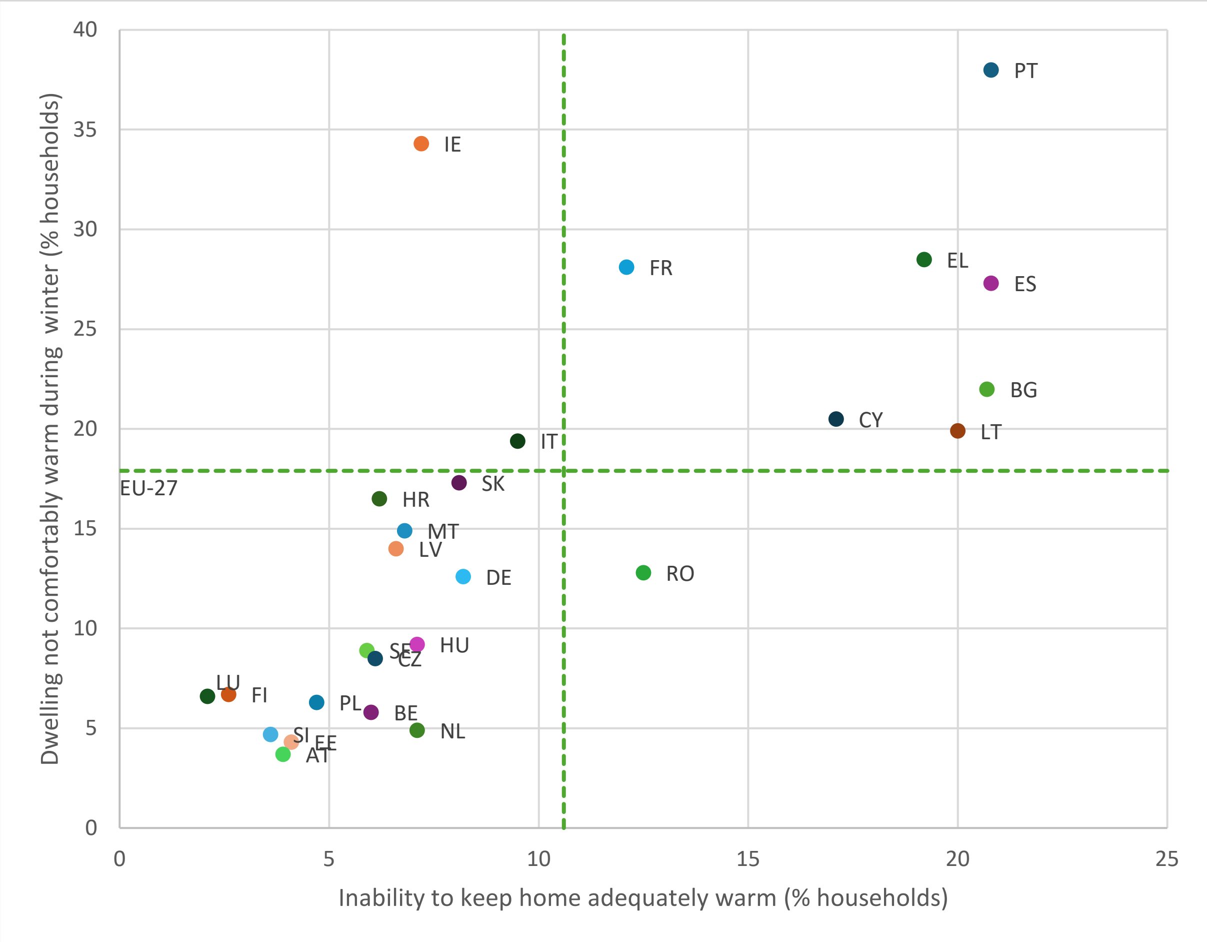

***Figure 7**: Comparison of the inability to keep the home adequately warm due to affordability and thermal attributes factors. The affordability factors indicator corresponds to the indicator «Population unable to keep home adequately warm » while the thermal attributes factors correspond to the « Dwelling not comfortably warm during winter ». Both data from 2023.*

In Belgium, Estonia, Luxembourg, Hungary, the Netherlands, Austria, Poland, Slovenia, Finland, and Sweden, both indicators remain low. Ireland, France, and Italy present a markedly higher share of population reporting thermal discomfort attributable to the physical characteristics of the dwelling than to affordability. Ireland is a particularly striking case: while only 7.2% of the population reported an affordability-related inability to keep the home adequately warm in 2023, 34.3% reported living in a dwelling that was not comfortably warm during winter due to building insulation or heating system type. A similar pattern is observed in France and Italy, where 12.1% and 9.5% of the population, respectively, reported affordability-related discomfort, while 28.1% and 19.4% reported building-related discomfort. In both countries, a high share of the population relies on individual heating systems (80% in France and 76.5% in Italy), which are generally less efficient.

A third grouping consists of countries with high vulnerability on both indicators, but with a larger gap in favour of the building-related dimension. Three SE countries fall into this category: the difference between building-related and affordability-related discomfort is 17.2 percentage points in Portugal, 9.3 in Greece, and 6.5 in Spain. Individual heating is also the predominant system type in all three countries.

It should be noted that both indicators are self-reported and perception-based, which means that social stigma or reporting norms may influence how households characterise the source of their discomfort, with some populations potentially more willing to attribute it to building attributes than to affordability. A further relevant observation is that only Portugal and Spain record a high share of population without a heating system, implying that in other countries with high reported thermal discomfort, the underlying cause is more likely to be inefficient heating systems or insufficient thermal insulation rather than the complete absence of heating.

2.4 Tenure Status and Energy Poverty Vulnerability

The literature identifies tenure status as an important factor shaping both energy efficiency and vulnerability to energy poverty. Tenants have been identified as a group particularly susceptible to energy poverty (Papantonis *et al.*, 2022), primarily because they have limited control over the energy performance or overall quality of their dwelling (Jessel *et al.*, 2019). A key structural barrier is the misalignment of interests between tenants and landlords, commonly referred to as the split-incentive problem, whereby neither party has a sufficient individual incentive to invest in energy performance improvements, ultimately leading to inaction (Weber & Wolff, 2018; Jessel *et al.*, 2019; Papantonis *et al.*, 2025). Even when energy efficiency improvements are implemented in rented properties, they may result in rent increases that disproportionately affect low-income tenants (Kholodilin *et al.*, 2017). A study in Germany found that energy efficiency retrofit led to a 70% reduction in energy consumption, but more than half of the affected households experienced rent increases following the works (Weber & Wolff, 2018). A related phenomenon is "renoviction", the eviction of tenants following renovation, which some authors have framed as a form of low-carbon gentrification (Bouzarovski *et al.*, 2018). These dynamics underline the importance of designing energy efficiency policies in the rental sector with explicit safeguards for vulnerable tenants. Article 17 of the EBPD recommends member states to introduce mechanisms that safeguard tenants by rents increases derivates from renovations, such as on-bill schemes, pay-as-you-save schemes or energy performance contracting.

Against this background, it is relevant to assess how EU member states compare on housing tenure. In 2024, the majority of the EU-27 population owns their home: 44.2% outright and 24.3% with an outstanding mortgage or loan. Between 2016 and 2024, homeownership rates remained largely stable, with a slight decline since 2020: from 70.1% to 68.4%. Among renters, 21.1% rent at market price and 10.5% at a reduced price[9].

[9] According to EU SILC methodological guidelines, rent at a reduced price include (a) renting social housing, (b) renting at a reduced rate from an employer and (c) those in accommodation where the actual rent is fixed by law.

Marked differences emerge across member states (Figure 8). Central and Eastern European countries have the highest homeownership rates (87.4%), followed by Southern Europe (74.3%) and Western and Northern Europe (57.2%). Countries such as Romania (94.3%), Slovakia (93.1%), Hungary (91.6%), and Croatia (91%) record the highest shares of owner-occupiers in the EU, mostly due to the post-socialist transition which led to privatization of dwellings, leading to a higher percentage of ownership. At the other end of the spectrum, France (38.8%), Denmark (39.1%), Austria (45.5%), and Germany (52.8%) have the largest shares of renters.

The composition of the rental sector also differs by region. While reduced-price rentals represent a significant share of the rental sector in several Central and Eastern European countries, this pattern is not uniform across the region. In countries such as Czechia, and to some extent Slovakia, private market rentals play a more prominent role. Homeownership is generally associated with higher income levels across the EU: 72% of homeowners are above 60% of median equivalised income, while 28% of tenants are above the 60% of median equivalised income and 49.6% of owners are below the 60% of median equivalised income and 50.4% of tenants are in this income range. However, this relationship varies substantially across countries. In several Central and Eastern European countries, ownership rates remain high across the income distribution, with a large share of low-income households also owning their homes, namely in Romania (93.5% of population below 60% of median equivalised income own their home), Slovakia (84.6%) or Croatia (86.4%), as a result of post-socialist housing privatisation observed in these countries.

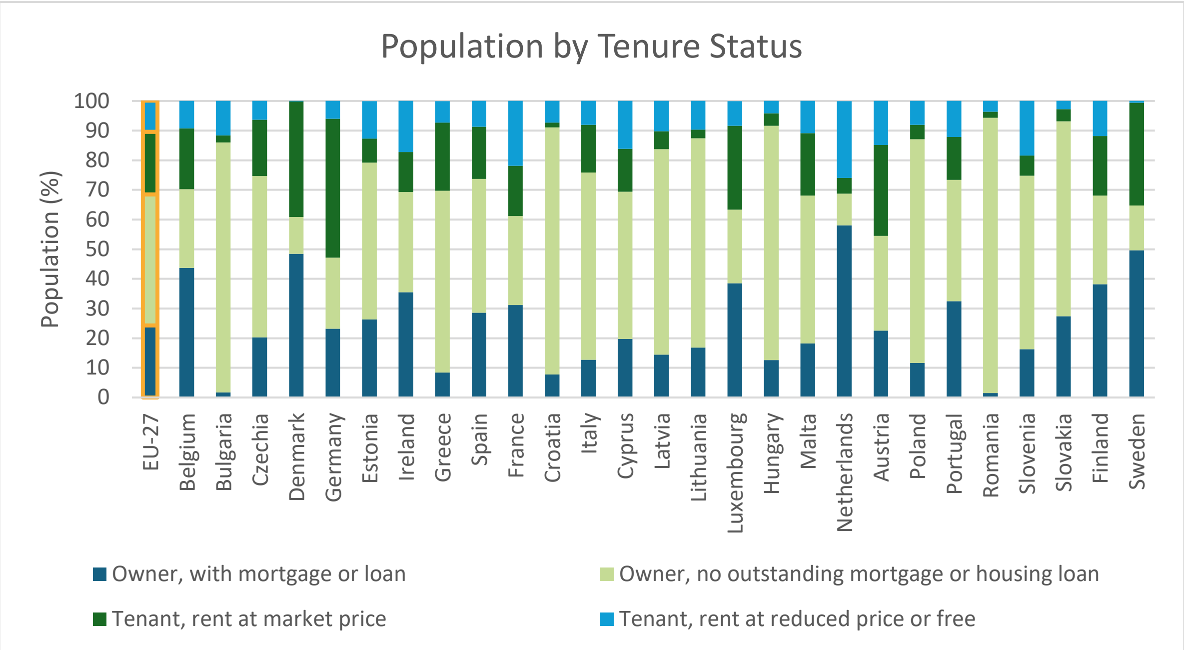

Figure 8*: Population by tenure status. Data from 2024. Extracted from Eurostat (2026).*

Figure 9 presents the housing cost overburden rate by tenure status across regional country groups. Housing cost overburden reflects the share of the population living in a household where total housing costs exceed 40% of disposable household income (EPAH, 2023). Housing cost overburden is heavily concentrated among market-price tenants, with rates four to five times higher than among homeowners across all regions. CEE countries record a slightly higher rate among market-price tenants (38.9%) than the other two regional groups, though the gap is modest.

For the 22 EU Member States that are also OECD members, tenure-disaggregated data are available on the indicator capturing the inability to keep the home adequately warm due to affordability factors (Figure 10). Among low-income households across 15 Member States with available data, higher rates of inability to keep the home adequately warm are observed among owner-occupiers without a mortgage. Countries with elevated rates among low-income tenants tend to be those in which the rental sector is larger, and market rents represent a substantial share of low-income households' outgoings, including the Netherlands, Austria, Denmark, Belgium, Malta, and Czechia.

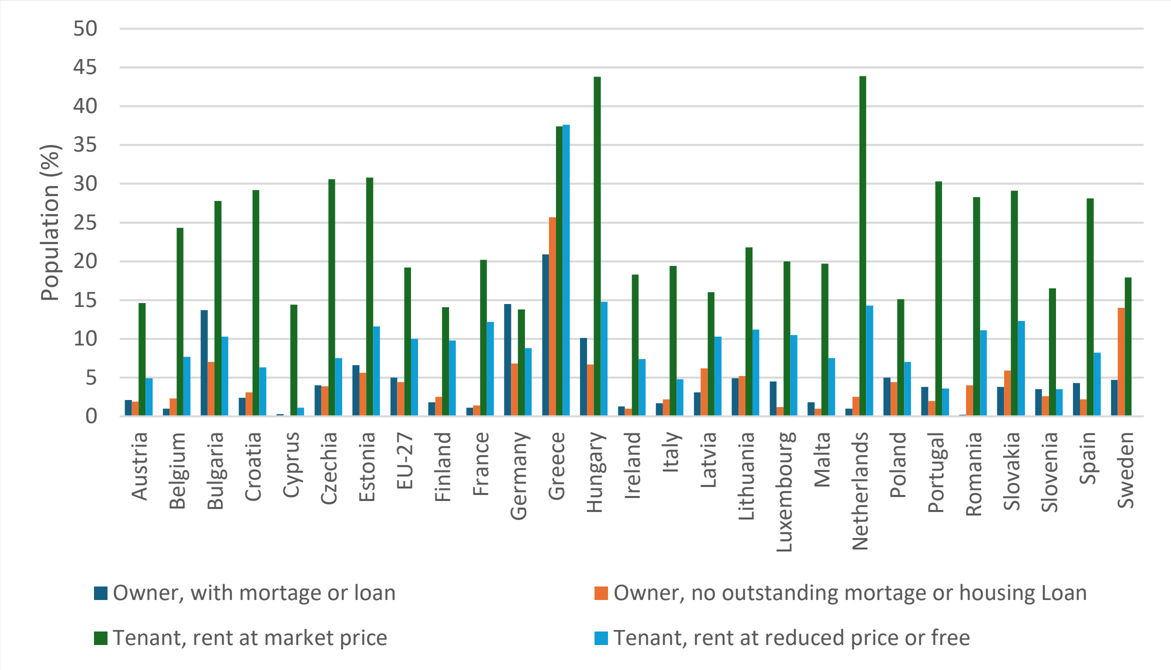

Figure 9: *Housing overburden cost by tenure status. Data from 2024. Extracted from Eurostat (2026l).*

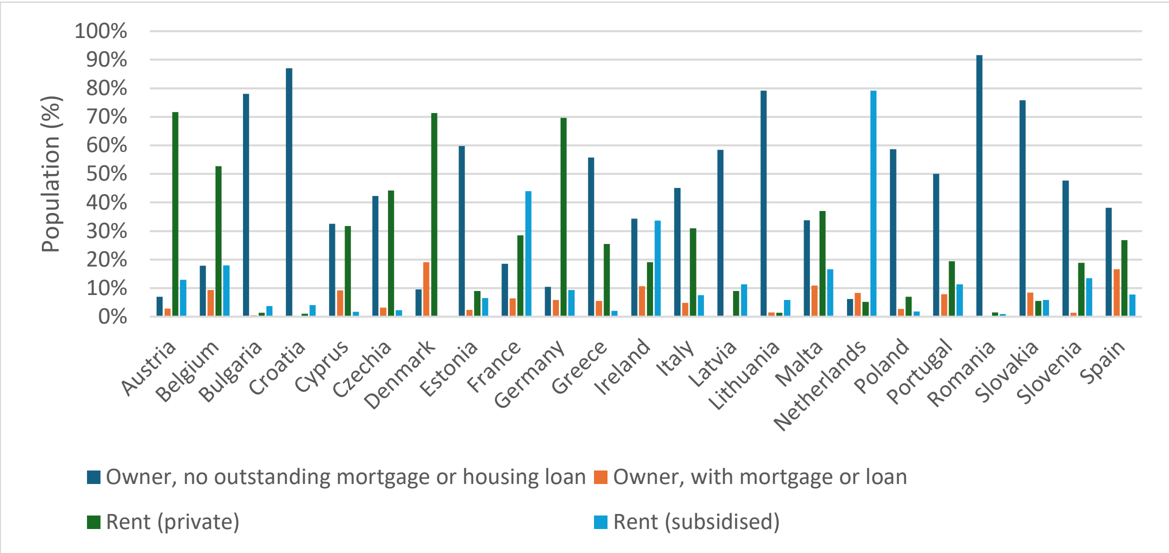

Figure 10: *Tenure structure of low-income households with difficulties to keep dwelling warm. Data from 2024. Extracted from OECD (2024).*

2.5 Energy Efficiency Improvements

The previous sections provided an overview of the current energy performance of the EU housing stock, focusing on building characteristics and heating systems. Section 2.3 then examined some of the consequences of poor energy performance, linking it to increased energy poverty vulnerability and thermal discomfort, with particular attention to vulnerable groups. Moving from problem diagnosis to progress assessment, this section explores how energy efficiency in the residential sector has evolved over the last five years across the EU, as a long-term strategy for energy poverty mitigation and for achieving broader energy and climate goals, including decarbonisation.

In 2023, 25.5% of the EU population[10] reported having improved the energy efficiency of their dwelling in the last five years. The highest rates were recorded in the Netherlands (58.5%), Estonia (46.7%), and Latvia (36.7%), while Greece (11.9%) and Malta (8.4%) registered the lowest (Eurostat, 2026m). At the regional level, CEE (29.6%) and WNE (29.4%) countries reported higher average shares of population reporting energy efficiency improvements than SE countries (Figure 11).

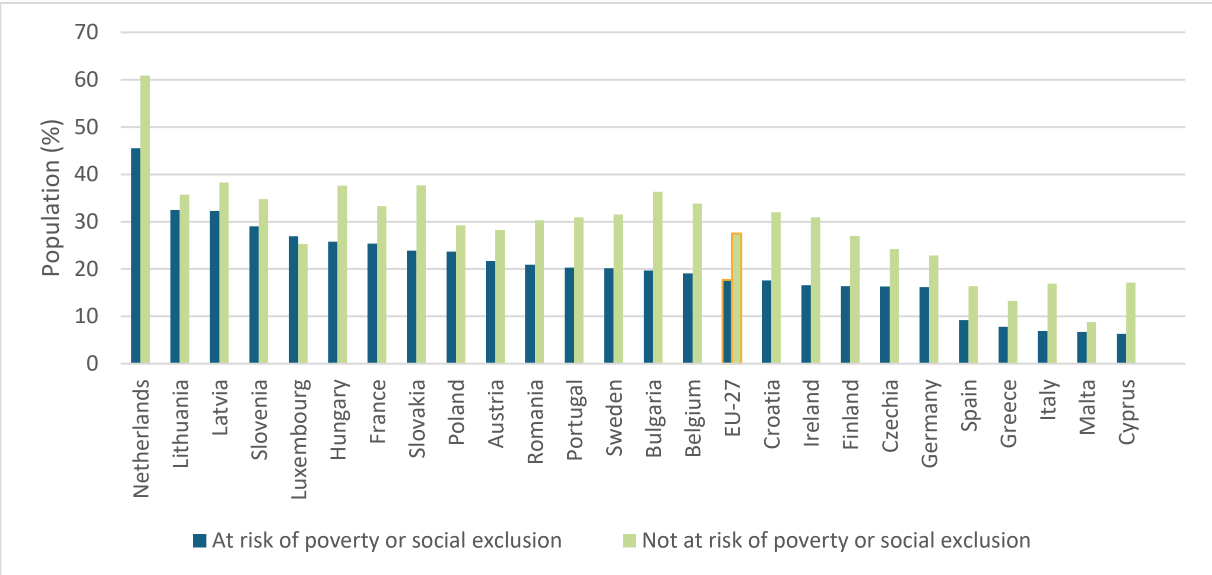

Figure 11*: Persons living in dwellings whose energy efficiency had been improved in the last 5 years, due to a risk of poverty or social exclusion situation. Data from 2023. Extracted from Eurostat (2026j).*

The population at risk of poverty and social exclusion reported a lower rate of energy efficiency improvements, reflecting the link between low income and limited capacity to invest in energy efficiency measures: 17.7% of the AROPE population reported improvements, compared to 27.5% of those not at risk. Looking at the urban–rural gradient, rural areas show the highest shares of energy efficiency improvements (29.4%), followed by towns and suburbs (25.4%) and cities (22.9%), suggesting that renovation activity is somewhat more concentrated outside dense urban centres (Eurostat, 2026n). This may reflect the greater feasibility of upgrading owner-occupied detached

[10] Information is not available for Denmark on this indicator on Eurostat

houses in rural and peri-urban settings, compared with multi-family or rental buildings in cities, where split incentives, horizontal ownership, and technical complexity often pose barriers to renovation (Shnapp *et al*., 2020; Bertoldi *et al*., 2021). Country patterns vary considerably: in Poland, Romania, Latvia, Hungary, and Austria, rural residents are clearly more likely to report improvements, while in Portugal, Bulgaria, and Slovakia, cities record equal or higher shares. Notably, the Netherlands and Estonia report high renovation rates across all settlement types, indicating broadly distributed retrofit activity rather than strong spatial divides.

Differences in energy efficiency improvement rates across vulnerability groups are relatively modest in some dimensions. The share reporting energy efficiency improvements is nearly identical among the population with no disability (24.6%) and those with some or severe disability (24.3%) (Eurostat, 2026o). Similarly, 24.6% of those aged 65 and over reported improvements in EE, in line with the general population (Eurostat, 2026m). Single-parent households with dependent children reported a slightly lower rate of energy efficiency improvements at 21.6% (Eurostat, 2026n).

The EU-SILC also captured the number of energy efficiency measures adopted: one, two, or three or more. The one-measure category was most prevalent in Estonia (24.9%), Switzerland (23.4%), and Slovenia (22.8%), and least prevalent in Malta (5.4%). The two-measures category was most common in the Netherlands (13.7%), Slovakia (12.1%), and Estonia (9.6%), with the lowest levels in Greece (1.3%) and Italy (1.8%). While data on three or more measures are available only for a limited number of countries (as noted in Table 1), the distribution across categories suggests meaningful cross-country variation in the depth of renovation activity, not only in its prevalence.

3. Energy Efficiency as a Response to Energy Poverty

The developed cross-analysed indicators on energy poverty and energy efficiency reveal considerable variation in residential building stock performance across Member States and identify several data gaps that constrain a more comprehensive analysis. **The evidence shows that poor building energy performance and inefficient heating systems affect winter thermal comfort beyond affordability-related factors alone, with more severe impacts on vulnerable groups and tenants.** While energy efficiency improvements are occurring across the EU, their breadth and pace vary considerably across Member States, underscoring the need for strengthened building renovation policies.

Where EPC evidence is available, it indicates substantial shares of the residential stock are classified in lower-efficiency bands, against a backdrop of an older building stock with considerable renovation needs. This is further reinforced by the prevalence of inefficient envelope elements, most notably single-glazed windows in Malta, Portugal, and Cyprus. The higher shares of mixed glazing types observed in some countries may indicate that existing funding schemes have not provided sufficient coverage to enable full window renovation. Future schemes should consider increasing the budget allocated to these interventions to support comprehensive envelope improvements.

Several data gaps were identified that limit comparative analysis. The first concerns EPC data: it is currently challenging to use EPCs as a cross-country benchmarking tool, due to differences in scales, thresholds, and calculation methodologies, compounded by limited national database coverage and restricted public access to aggregated statistics. The forthcoming harmonisation of EPC classes under the revised Energy Performance of Buildings Directive (a closed A–G scale from May 2026) addresses one barrier. In addition, Member States' implementation of the EPBD provisions (Article 22 of the EPBD Recast) on national and EU databases on the energy performance of buildings and on access to data will improve the availability of EPCs and facilitate cross-country comparability. A second gap concerns the temporal and geographic coverage of key indicators: many indicators in the 2023 EU-SILC energy efficiency Module are optional and available only in a subset of countries, and none are collected annually. **Indicators such as window type, heating system type, heating energy sources, number of energy efficiency measures implemented, and the share of the population living in thermally uncomfortable dwellings are essential for monitoring renovation progress and evaluating the impact of policies, plans, and funding instruments**. Their regular, mandatory collection across all Member States should be a priority. They should also be made available on an open-access centralized database. One example is with the indicator "Persons living in dwellings whose energy efficiency had been improved in the last 5 years", where both the percentage of population who implemented energy efficiency measures and the number of measures (one, two, or three or more) implemented were collected. However, only the first data is present on Eurostat, which prevents a comprehensive analysis of the level of renovation in each member state. A third gap is the absence of an indicator that captures summer thermal discomfort attributable to affordability factors, which is an important limitation for summer energy poverty assessment, particularly given increasing heat stress across Europe.

Regarding thermal comfort, **the share of the population reporting discomfort attributable to poor insulation or inefficient heating systems is generally higher than the share attributing it to affordability constraints.** This pattern is most pronounced in SE countries, such as Portugal, Greece, and Spain, where inefficient heating systems are widespread, and also in Ireland and France, where high reliance on individual heating systems appears to be a key factor. For summer cooling discomfort, Portugal, Spain, and Greece again rank highly, alongside Finland, Luxembourg, and Romania. In the SE countries, this may be linked to inefficient buildings, absent or inefficient cooling systems, and increasing heatwave frequency. In Romania, the frequency of heat waves has risen considerably over recent decades (Antonescu *et al.*, 2025). In Luxembourg and Finland, the higher values likely reflect buildings designed primarily for cold climates, with limited active cooling or mechanical ventilation; a dynamic also highlighted by Koukoufikis *et al*. (2026).

Across all Member States, a consistent finding is that a higher share of the population at risk of poverty and social exclusion (AROPE) reports thermal discomfort. **In some countries, the figures are particularly striking: in Portugal, more than half of the AROPE population reports winter thermal discomfort**. This reinforces the well-documented relationship between low income, residence in inefficient dwellings, and energy poverty vulnerability, and underscores the need for policies that address the specific barriers low-income households face in accessing home renovation support. People with disabilities, urban residents, and migrants also reported higher rates of living in dwellings not comfortably warm during winter.

Evidence on recent energy efficiency improvements points to uneven progress across Member States. Around 26% of the EU population reported home efficiency upgrades in the last five years, with the highest rates in the Netherlands, Estonia, and Latvia, and the lowest in Malta, Greece, and Spain**. energy efficiency uptake is lower among those at risk of poverty and among residents of urban areas.** Tenure status also shapes energy poverty vulnerability: the literature consistently finds that tenants are more likely to reside in inefficient dwellings that they cannot upgrade, primarily due to the split-incentive problem in the private rental sector. However, the absence of tenure-disaggregated data for energy poverty and thermal comfort indicators limits the depth of analysis possible for this group.

A number of existing policies and instruments already illustrate how energy-efficiency support can be designed with vulnerable consumers in mind. In Slovenia, the ZER programme, managed by the ECO Fund, provides incentives of up to €18,000 for insulating roofs and facades, installing energy-efficient windows, replacing old heating appliances with new biomass systems, and other energy-saving solutions, providing 100% subsidy for energy-poor households. In Austria, the Clean Heating for Everyone programme funds up to 100% of eligible costs for replacing fossil fuel heating systems for low-income households; the Verbund Stromhilfefonds, promoted by the social support organisation Caritas, provides energy efficiency audits and free replacement of broken household appliances, having supported 22,694 people across 8,669 households as of June 2025. In Bulgaria, a renovation funding scheme has been launched to support the renovation of multi-family apartments located in coal regions, with the first round having 329 proposals and over 117 contracts signed. A funding scheme for renovation in Czechia presents a light variant (NZÚ Light) targeted for vulnerable households, which includes simplified paperwork, upfront support and higher subsidy rates for seniors, low-income and other vulnerable groups.

Additionally, efforts should be made to promote energy efficiency in the rental sector and to provide support to overcome split incentives, by promoting energy efficiency but also protecting tenants from renovictions. Some practices are already observed in some countries. Examples of direct incentives, such as loans or grants, for energy renovations in the rental sector can be found in Austria, France, Germany, Greece, Italy, and Spain. In France, under the Climate and Resilience Law, dwellings below a minimum energy efficiency threshold cannot be rented out, and rents on already-rented low-efficiency dwellings cannot be increased. In Germany, the CO_2KostAufG law redistributed the carbon costs of heating between landlords and tenants, creating a financial incentive for landlords to renovate heating systems. The FOCUS association for sustainable development, EPAH's Slovenian Antenna, reviewed examples of best practices to tackle energy poverty in the rental sector, dividing them into legal, financial, and technical support and awareness raising.

Further examples of energy efficiency schemes targeting vulnerable households and promoting energy efficiency in the rental sector can be found in the online EPAH Atlas, EPAH country fiches, and databases such as Odyssee-Mure.

National building renovation plans and upcoming financing schemes, including those in the Social Climate Plans, can be further strengthened by pairing financial support with in-person assistance through initiatives such as one-stop shops and energy communities. These can help residents navigate the complexity of available funding schemes, overcome barriers to home renovation, and identify the energy efficiency measures most suited to their individual circumstances, particularly for those groups least able to engage with these processes independently.

4. Conclusions

This report from the European Commission's Initiative Energy Poverty Advisory Hub contributes to a deeper understanding of energy poverty through the lens of buildings energy efficiency. It aimed to provide a current diagnosis of energy-efficiency conditions across Member States, examine specific vulnerable groups and analyse building stock energy efficiency from a social vulnerability perspective. The analysis explored energy performance indicators, thermal comfort, vulnerability factors, tenure status, and Member States' progress in improving residential EE.

The results indicate that **Member States still have a long way to go in improving energy efficiency in the residential sector, with Southern European countries facing the most acute challenges.** In these countries, a large share of the population lives in dwellings with single-glazed windows, inefficient or absent heating systems, and reports winter thermal discomfort. For the smaller number of Member States with data on summer cooling discomfort, higher rates are also observed in SE countries, such as Portugal, Spain, and Greece, as well as in Finland and Luxembourg. Across Member States, **a consistently higher share of the population at risk of poverty and social exclusion (AROPE) reports living in dwellings not comfortably warm in winter, while the rate of energy efficiency improvements in this group is substantially lower.** People with disabilities and migrants also reported higher rates of winter thermal discomfort. Along the urban–rural gradient, **residents of cities report higher thermal discomfort and lower rates of energy efficiency improvements than those in towns, suburbs, or rural areas**, though with considerable variation across Member States. Tenants also show greater vulnerability, as reflected in markedly higher housing-cost overburden rates. The findings reinforce the importance of maintaining policies that place vulnerable consumers at the centre, as reflected in the recast Energy Efficiency Directive, Energy Performance of Buildings Directive, the European Affordable Housing Plan, and the Citizens Energy Package. **These measures should reduce upfront costs for vulnerable households, provide technical assistance and trusted intermediaries, such as one-stop shops, and ensure that interventions are sufficiently deep and target passive measures to deliver durable improvements in thermal comfort and energy bill reductions.** Member States should also strengthen regulatory and financial tools to overcome split incentives in the rental sector while protecting tenants from rent increases and renoviction, as reflected in Article 17 of EPBD.

Importantly, this analysis identifies practical constraints that currently limit the effectiveness of policy design and evaluation. EPCs are a proxy for energy efficiency, reflecting the building fabric's thermal performance and the efficiency of dwelling systems. As energy efficiency is one of the structural drivers of energy poverty, EPC ratings are a valid option to assess energy efficiency and integrate multidimensional energy poverty assessments, keeping in mind their identified limitations. Since they measure performance under standardised conditions rather than actual consumption behaviour, they do not fully capture affordability constraints or income. Furthermore, generalising EPC energy performance to the whole dwelling stock may overestimate average dwelling performance levels, since most EPCs are issued for new or renovated dwellings or dwellings for sale. **EPC data also**

remain insufficiently comparable and accessible across Member States, though this will be progressively addressed in the coming years. In the short term, the harmonisation of EPC classes under the revised EPBD (A–G scale, mandatory from May 2026) removes one key barrier. In the medium term, the implementation of Article 22 of the EPBD Recast, which mandates the establishment of national energy performance of buildings databases and the transfer of top-level aggregated information to the EU Building Stock Observatory, will substantially improve data availability and enable more meaningful cross-country comparisons. In the longer term, as national databases mature and coverage expands, EPCs have the potential to become a robust tool for monitoring buildings and related energy poverty vulnerability at both national and regional levels.

Beyond EPC data, several additional gaps constrain the depth of analysis currently possible. **There is still a lack of disaggregation of energy poverty-related indicators by tenure status,** which limits the diagnosis of vulnerability among tenants and owners. **Several energy-efficiency-related indicators are not collected annually or at the subnational level**, though some EU-SILC data already exist at the regional level and could be further exploited for subnational energy poverty assessment. In the short term, including selected indicators from the EU-SILC 2023 Energy Efficiency module in the set of variables collected annually and mandatorily would represent a significant step forward. In the medium term, making these indicators available at the regional level across all Member States would enable subnational monitoring of renovation progress and policy impact. Additionally, Eurostat microdata offer an important pathway for more granular analysis in the near term, allowing researchers to explore distributional dimensions and profiles of vulnerable groups that aggregate statistics cannot capture. Availability of representative microdata per NUT3 region would be an important step towards more granular assessments and bridging national and regional analyses. **Addressing these gaps in a structured and progressive manner would substantially strengthen evidence-based policymaking and enable a more robust assessment of policy impacts over time.**

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