

SEPTEMBER 2023

REPORT

ENERGY POVERTY AND UNFIT HOUSING IN POLAND

An investment strategy to renovate the worst-performing segment of the housing stock.

Jakub Sokolowski



FEANTSA

European Federation of National Organisations Working with the Homeless

This report is published thanks
to the support of the European
Climate Foundation

About the author:

Jakub Sokołowski is an economist
and a researcher at the Institute
for Structural Research and the
University of Warsaw.

EDITOR:

Anna Bajomi, Energy Poverty Officer, FEANTSA

PHOTOGRAPHY:

Cover: ©Marina Khromova, Getty Images

DESIGN:

Bryony Martin, Communications, FEANTSA

For more information contact;

Anna.Bajomi@FEANTSA.org

Contents

	Executive Summary	4
1	Introduction	6
2	The housing stock in Poland	8
3	The energy efficiency of the housing stock in Poland	11
4	Energy poverty in Poland	15
5	Financial situation of households	22
6	Funding investment in healthy housing	24
7	Addressing energy poverty, unfit housing, and enhancing energy efficiency in Poland	32
8	Conclusions	35
	References	37

Executive Summary

Poland has access to substantial financial resources for addressing energy poverty and inadequate housing conditions, amounting to 65 billion EUR. However, the core challenge lies in allocating and efficiently utilising these funds to reach and uplift the most vulnerable households. Therefore, this report is a call to action for meticulous planning, transparent decision-making, and strategic execution to ensure that these funds contribute meaningfully to the well-being and improved living conditions of those who need it most.

The housing landscape in Poland is marked by nearly 15 million housing units, with approximately 40% being single-family homes. Over 80% of the Polish population resides in owner-occupied dwellings, highlighting individual homeowners' pivotal role in decisions related to energy consumption and efficiency improvements. Encouraging sustainable practices among homeowners, such as investing in renewable energy sources and enhancing insulation, is crucial for advancing the decarbonisation process in the country.

The energy efficiency of the housing stock in Poland is closely tied to the age of the buildings, with nearly 40% constructed before 1970. These older buildings often lack insulation, utilise outdated heating systems, and have inefficient windows, resulting in significant energy losses. It also contributes to energy poverty, where vulnerable households struggle to afford adequate heating and cooling. Approximately 11% of the population, equivalent to 1.5 million households, is affected by energy poverty. The causes of energy poverty in Poland are primarily attributed to low income, high energy costs, and the poor technical condition of buildings.

Poland has access to substantial EU funding programs that support energy efficiency improvements in buildings and the country allocates them to programmes like the 'Thermo-modernisation and Renovation Fund' and the 'Clean Air Programme.' The 'Clean Air Programme,' initiated in 2018, commands a substantial budget and focuses on

improving residential buildings' air quality and energy efficiency. Recent refinements have made it more accessible to low-income households as it is the only support scheme in Poland offering pre-financing to low-income people. The accessibility of other programmes to low-income households raises concerns about equitable distribution and efficient resource allocation.

Poland's Long-Term Renovation Strategy outlines ambitious goals for improving energy efficiency, with significant investment required by 2050. A key challenge lies in efficiently allocating funds and involving private capital to achieve these goals, especially in targeting the worst-performing building stock inhabited by those in energy poverty. The allocation of the substantial 65 billion EUR should primarily focus on constructing new, energy-efficient social housing and renovating existing housing stock. Particular emphasis should be placed on addressing the most poorly performing buildings and targeting low-income and energy-poor households. Establishing a transparent system for allocating funds, considering both social and environmental benefits, is essential for effective decision-making.

The initial phase of the renovation efforts should prioritise approximately 900,000 of the worst-performing housing units, offering grants that do not require repayment to these households. While grants should be the primary financial assistance, some low-interest loans could complement the funding. Setting annual renovation goals, such as renovating 150,000 dwellings per year, should be a practical yet challenging target, focusing on the poorest-performing buildings and the involvement of low-income households.

To comprehensively tackle energy poverty and housing inadequacies in Poland, several measures can be taken:

Poland has access to substantial financial resources for addressing energy poverty and inadequate housing conditions, amounting to 65 billion EUR. However, the core challenge lies in allocating and efficiently utilising these funds to reach and uplift the most vulnerable households. Therefore, this report is a call to action for meticulous planning, transparent decision-making, and strategic execution to ensure that these funds contribute meaningfully to the well-being and improved living conditions of those who need it most.

The housing landscape in Poland is marked by nearly 15 million housing units, with approximately 40% being single-family homes. Over 80% of the Polish population resides in owner-occupied dwellings, highlighting individual homeowners' pivotal role in decisions related to energy consumption and efficiency improvements. Encouraging sustainable practices among homeowners, such as investing in renewable energy sources and enhancing insulation, is crucial for advancing the decarbonisation process in the country.

The energy efficiency of the housing stock in Poland is closely tied to the age of the buildings, with nearly 40% constructed before 1970. These older buildings often lack insulation, utilise outdated heating systems, and have inefficient windows, resulting in significant energy losses. It also contributes to energy poverty, where vulnerable households struggle to afford adequate heating and cooling. Approximately 11% of the population, equivalent to 1.5 million households, is affected by energy poverty. The causes of energy poverty in Poland are primarily attributed to low income, high energy costs, and the poor technical condition of buildings.

Poland has access to substantial EU funding programs that support energy efficiency improvements in buildings and the country allocates them to programmes like the 'Thermo-modernisation and Renovation Fund' and the 'Clean Air Programme.' The 'Clean Air

Programme,' initiated in 2018, commands a substantial budget and focuses on improving residential buildings' air quality and energy efficiency. Recent refinements have made it more accessible to low-income households as it is the only support scheme in Poland offering pre-financing to low-income people. The accessibility of other programmes to low-income households raises concerns about equitable distribution and efficient resource allocation.

Poland's Long-Term Renovation Strategy outlines ambitious goals for improving energy efficiency, with significant investment required by 2050. A key challenge lies in efficiently allocating funds and involving private capital to achieve these goals, especially in targeting the worst-performing building stock inhabited by those in energy poverty. The allocation of the substantial 65 billion EUR should primarily focus on constructing new, energy-efficient social housing and renovating existing housing stock. Particular emphasis should be placed on addressing the most poorly performing buildings and targeting low-income and energy-poor households. Establishing a transparent system for allocating funds, considering both social and environmental benefits, is essential for effective decision-making.

The initial phase of the renovation efforts should prioritise approximately 900,000 of the worst-performing housing units, offering grants that do not require repayment to these households. While grants should be the primary financial assistance, some low-interest loans could complement the funding. Setting annual renovation goals, such as renovating 150,000 dwellings per year, should be a practical yet challenging target, focusing on the poorest-performing buildings and the involvement of low-income households.

1. Introduction

The European Union faces a significant challenge, as around **75% of its buildings are energy-inefficient** (Li et al., 2019). The renovation rate in the Member States varies between 0.5% and 1.0% per year (Sandberg et al., 2016). Recognising the urgent need for improvement, the European Commission has highlighted increasing the renovation rate as a top priority. **An estimated average renovation rate of 3% is necessary to achieve the Union's energy efficiency targets until 2050** (European Parliament, 2018). In line with this objective, the 'Renovation Wave' strategy, adopted in 2020, aims to double the average annual rate of energy renovation by 2030 and to promote comprehensive thermal renovation (European Commission, 2020).

In alignment with the goals of the European Green Deal, which envisions a contemporary, resource-efficient, competitive, and decarbonised economy, the role of the building sector is pivotal. Given the substantial greenhouse gas emissions attributed to buildings, the European Union is actively introducing progressive mandates for buildings and their energy sources. Concurrently, it encourages member states to enact energy-saving measures, forming a comprehensive strategy to mitigate environmental impact and propel sustainable development. Of particular significance are two legislative frameworks: the **Energy Performance of Buildings Directive (EPBD)** and the **Energy Efficiency Directive (EED)**. The EPBD assumes a crucial role in establishing minimum energy performance standards for buildings that will be introduced in Poland in 2024. This directive outlines the requisite energy efficiency benchmarks for both new and existing buildings and promotes the deployment of renewable energy sources and advanced building technologies. It considerably reduces buildings' carbon footprint but requires substantial effort to protect vulnerable households from price increases and gentrification. The EED is equally instrumental as it constitutes a framework designed to enhance energy efficiency across various sectors, emphasising buildings. Through the EED, member states are directed to implement ambitious measures to promote energy savings, reduce energy consump-

tion, and ameliorate energy poverty.

In the context of building energy efficiency and energy poverty, the EPBD and the EED emerge as the most relevant legislative instruments. Their combined influence empowers the European Union and its member states to orchestrate a multi-dimensional response to the critical challenges posed by inadequate building energy efficiency and the adverse consequences of energy poverty. The Russian invasion of Ukraine in 2022 has exacerbated and introduced new energy challenges. **Energy security and independence have emerged as critical priorities for each Member State.** It is clear that diversifying energy sources, using local resources and moving away from fossil fuels are essential steps to ensure a resilient and sustainable energy future and reduce the energy need. Since February 2022, the availability of energy resources has reaffirmed the direction of the European Union, as set out in the 'European Green Deal' strategy (European Commission, 2022). Reflecting this urgency, the European Commission has launched the REPowerEU plan to accelerate the development of renewable energy sources and implement key measures.

“In 2022, approximately 5% of the Polish population lived in cold homes”

Furthermore, the envisaged extension of the Emission Trading System (ETS) to residential buildings in Poland is poised to encounter substantial challenges due to the prevalent reliance on coal within this sector. This extension signifies higher energy and heating prices unless ambitious renovations that will encompass worst-performing buildings

inhabited by low-income households are in place. Poland is at significantly risk of higher energy prices because the country faces pressing challenges regarding energy poverty and inadequate housing. With almost 15 million housing units nationwide, improving energy efficiency and housing quality is paramount. In 2022, **approximately 5% of the Polish population lived in cold homes, while 35% lived in overcrowded apartments**, indicating that a significant proportion are affected by unfit housing (Eurostat, 2023). An estimated housing deficit of around two million housing units underlines the urgent need for adequate and energy-efficient housing (Nowak, 2021). Compounding these challenges is the pressing issue of energy poverty, which disproportionately impacts a substantial population segment. **Approximately 11% of the population, corresponding to 1.5 million households, are in energy poverty** (Sokołowski et al., 2020), and the buildings inhabited by them most likely fall below a minimum energy performance threshold or lack proper insulation, necessitating urgent renovation until 2030. This statistic underscores the scale of the renovation challenge, indicating the magnitude of efforts required to enhance energy efficiency and alleviate energy poverty within the Polish building sector.

While a significant proportion of the building stock demands urgent renovation to meet modern energy efficiency standards, the funding to complete this challenge should be available through European Union support. With an estimated 150,000 buildings annually in need of support in renovations until 2030, the main challenge lies in reaching the people in the energy poverty crisis, despite limited funding availability. Specifically, households residing in the worst-performing building stock face persistent challenges in accessing the necessary financial support for comprehensive renovations. This disparity between available funding and its allocation underscores factors impeding equitable resource distribution.

This report explores the causes and consequences of energy poverty and inadequate housing in Poland. It examines the impact on individuals, communities, and the broader energy landscape. The report also examines potential solutions and initiatives to improve energy efficiency, promote sustainable heating sources and mitigate energy poverty challenges. Finally, it evaluates the investment needs and funding available for the renova-

tion of the Polish residential stock and explores how the funds need to be designed to reach and enable the energy-poor households to renovate their low-performing homes.

2. The housing stock in Poland

There are almost 15 million housing units in Poland. Approximately 40% are single-family homes. More than 80% of the Polish population lived in owner-occupied dwellings (Figure 1), a figure significantly higher than in Western European countries. This suggests that individual homeowners, regardless of their financial capabilities, play a key role in decisions about energy consumption and efficiency improvements. Encouraging and supporting homeowners to adopt sustainable practices, such as investing in renewable energy sources, improving insulation, and using energy-efficient appliances, will be critical to driving the decarbonisation process forward. Implementing effective decarbonisation measures in these buildings will be critical to achieving national sustainability goals (Hurnik et al., 2018).

The social sector, which includes municipal resources and social housing associations (TBS), plays a relatively minor role in the total number of dwellings in Poland, accounting for about 6% in

2020 (Muczyński, 2020). Role of homeownership increases while the municipal sector is shrinking over time (from 8 to 5% in 2013-2020). Municipal dwellings comprise most of this category, with about 800,000 units in 2020.

As of 31 December 2021, 129,000 households were waiting for social rental housing, particularly in urban areas, highlighting the urgent challenge facing state and local government institutions responsible for social housing policy. Tackling this problem will require long-term cooperation between different segments of the public authorities, transcending political disputes and ideological conflicts. Over nearly two decades, Poland has witnessed a significant surge in vacant municipal dwellings, with numbers soaring from 20,000 in 2003 to 60,000 by 2020 (Figure 1).¹ This three-fold increase in vacant properties underscores a growing challenge for local authorities and communities. The rising number of unoccupied municipal dwellings raises concerns about housing accessi-

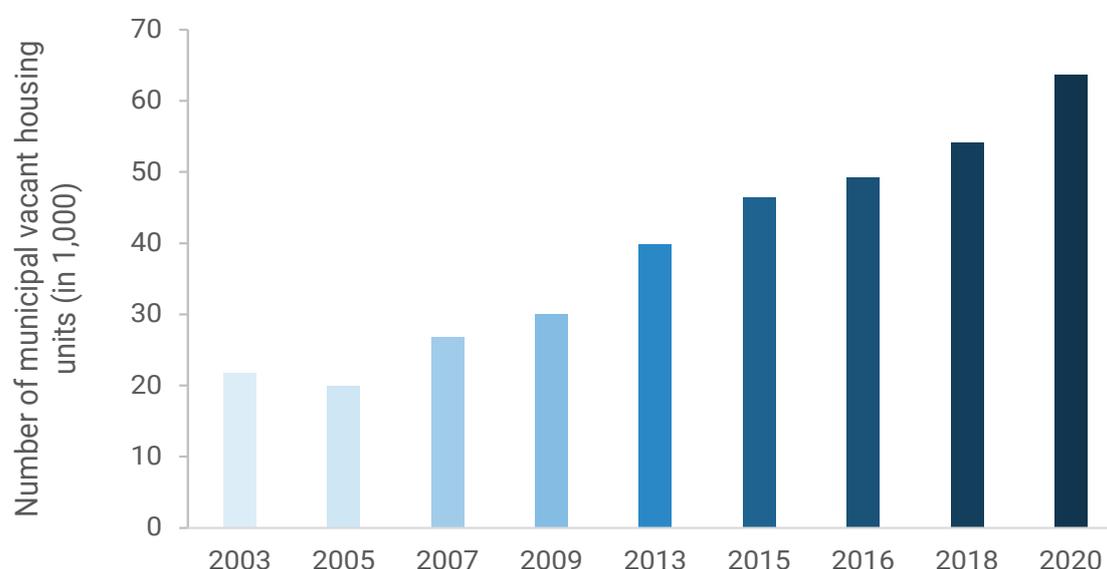


FIGURE 1. The number of municipal vacant housing units (in 1,000)

Source: own elaboration based on Statistics Poland (2022)

¹ The cost of renovating one municipal building in Poland was about 15,000 to 20,000 EUR (source: <https://samorzad.pap.pl/kategoria/bgk-dla-samorzadow/remonty-pustostanow-szansa-na-zwiekszenie-liczby-mieszkan-komunalnych>)

bility, urban development, and resource allocation.

Quantitative changes in the housing market, such as an increase in the number of available dwellings, occurred between 2010 and 2015. However, these statistics do not capture the complex housing situation experienced by different age, social, and occupational groups. Two universal factors influencing the case are the dominance of the free market in access to housing and Poland's declining population. To address these challenges, governments must effectively coordinate policy instruments to mitigate their adverse effects within the medium- and long-term housing policy.

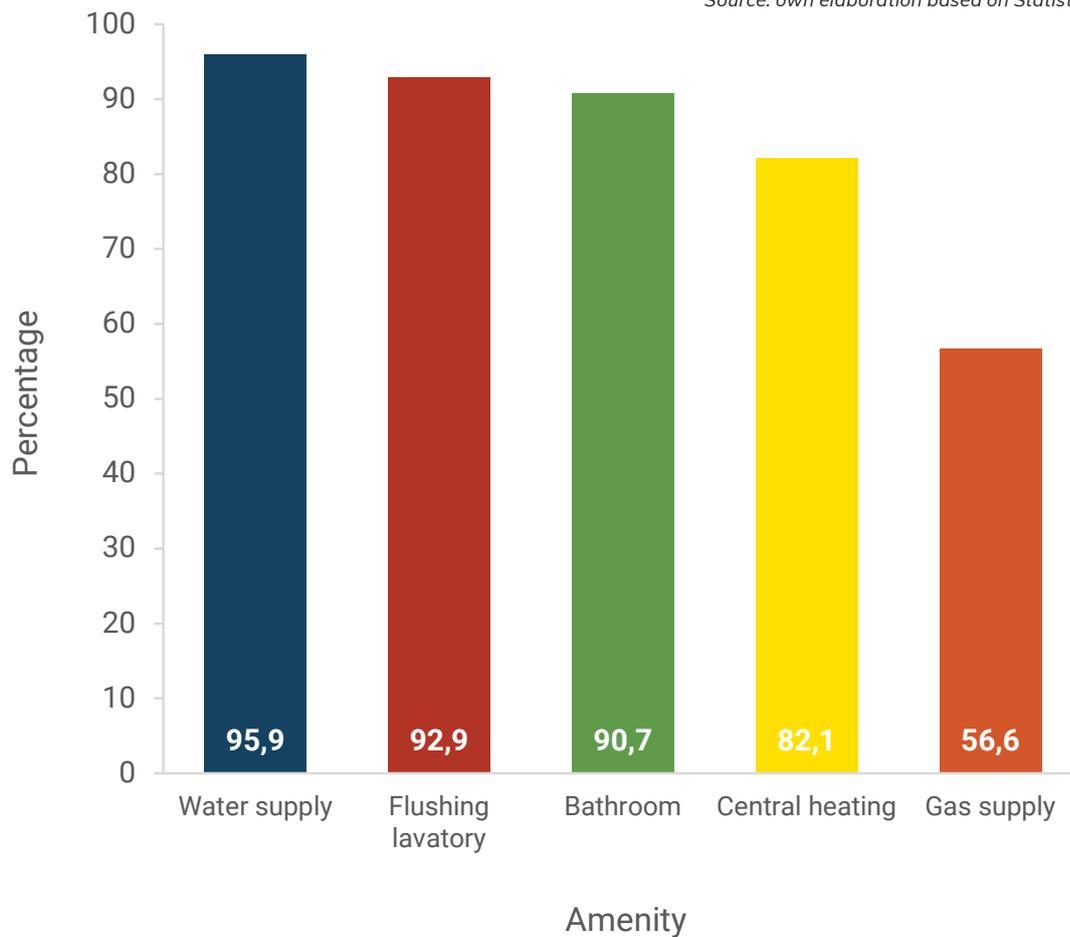
In addition, there are deficiencies in basic technical and sanitary facilities of Polish homes, with some dwellings lacking access to a water supply,

toilets, or central heating (Figure 2). According to the Ministry of Investment and Development, the statistical housing deficit in 2019 was approximately 650,000 housing units. The percentage of people living in substandard conditions in 2019 was about 8%.² These two statistics combined give a housing deficit of about 1.7 million housing units. (Nowak, 2021).

Regarding heating sources in Polish housing, around 40% of dwellings are connected to district heating systems (Figure 3). A further 13% rely on local heating networks, i.e., heating systems that supply energy to one or more dwelling units locally. In addition, around 30% of housing units in Poland use individual central heating systems,³ which are heating systems that serve a single house or apartment. The high share of local and individual

FIGURE 2. Housing stock and access to amenities (% , 2022)

Source: own elaboration based on Statistics Poland (2023)



² Buildings lacking access to running water or toilet or with a leaking roof.

³ Individual central heating is a system that heats one housing unit. Local central heating is a system that heats number of housing units locally, without a connection to the district heating network. No central heating means the house is heated by a stove.

heating sources highlights the challenge of energy poverty and inadequate housing in Poland, with 20% of dwellings relying on coal, an unsustainable fossil fuel harming the environment and exposing the inhabitants to increasing prices.

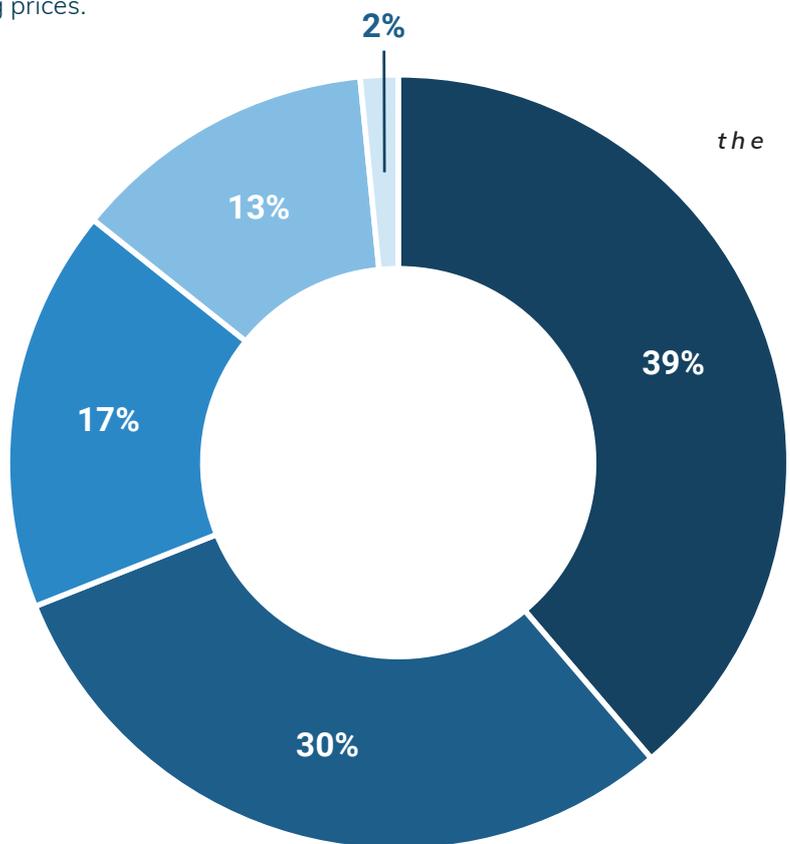
Insufficient amenities, outdated heating systems, and other inadequacies characterise housing conditions in Poland, posing significant challenges. In 2021, about 10% of the Polish population lived without access to basic amenities like a flushing toilet or lavatory. Living in such unfit housing conditions can lead to various problems, including discomfort and health risks. Additionally, 30-40% of households rely on individual heating, often using unsustainable fossil fuels like coal. This prevalence of individual heating sources underscores the crucial relationship between unfit housing and energy efficiency. are heating systems that serve a single house or apartment. The high share of local and individual heating sources highlights the challenge of energy poverty and inadequate housing in Poland, with 20% of dwellings relying on coal, an unsustainable fossil fuel harming the environment and exposing the inhabitants to increasing prices.

Insufficient amenities, outdated heating systems, and other inadequacies characterise housing conditions in Poland, posing significant challenges. In 2021, about 10% of the Polish population lived without access to basic amenities like a flushing toilet or lavatory. Living in such unfit housing conditions can lead to various problems, including discomfort and health risks. Additionally, 30-40% of households rely on individual heating, often using unsustainable fossil fuels like coal. This prevalence of individual heating sources underscores the crucial relationship between unfit housing and energy efficiency.

FIGURE 3. Types of heating systems in Polish housing stock (2022)

Source: own elaboration based on Statistics Poland (2023)

- District heating
- Central heating of the building
- Local space heating
- Central heating of the dwellings
- N/A



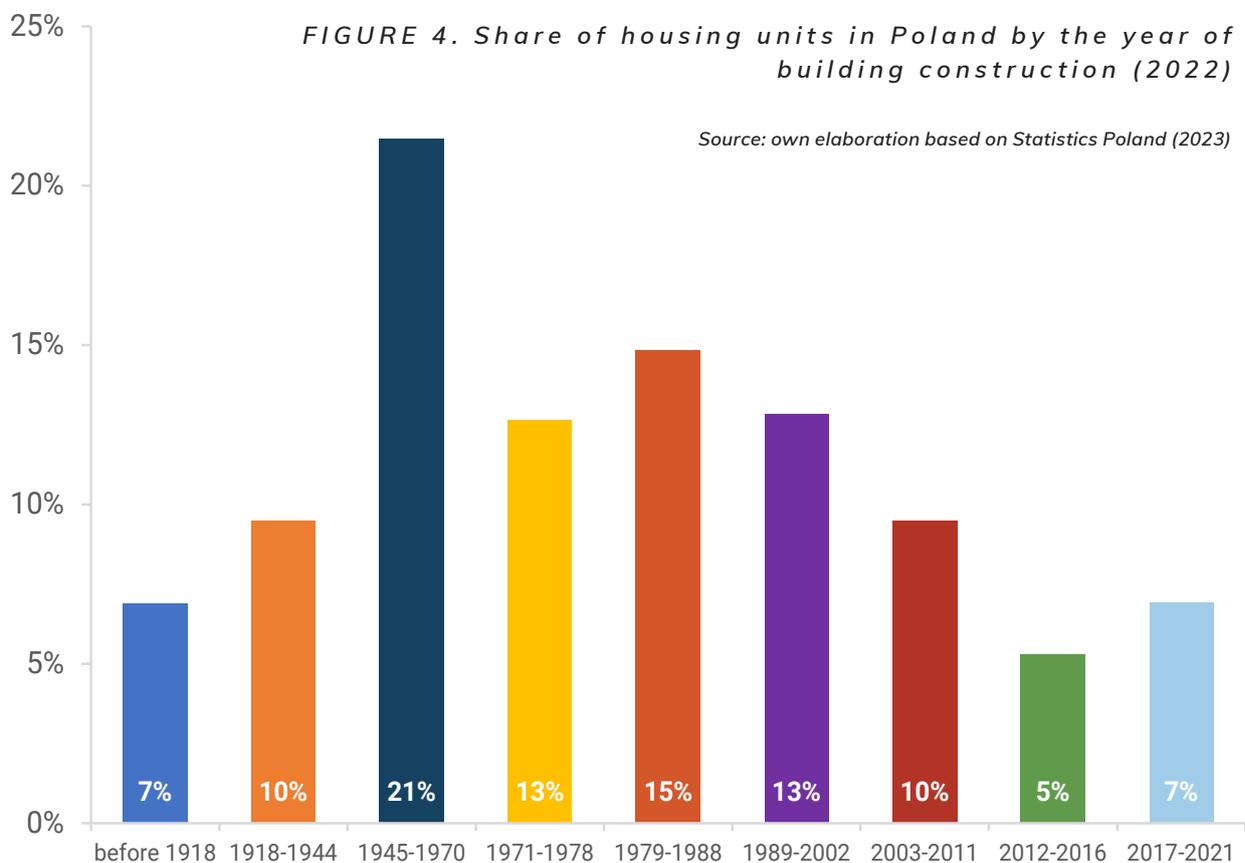
3. The energy efficiency of the housing stock in Poland

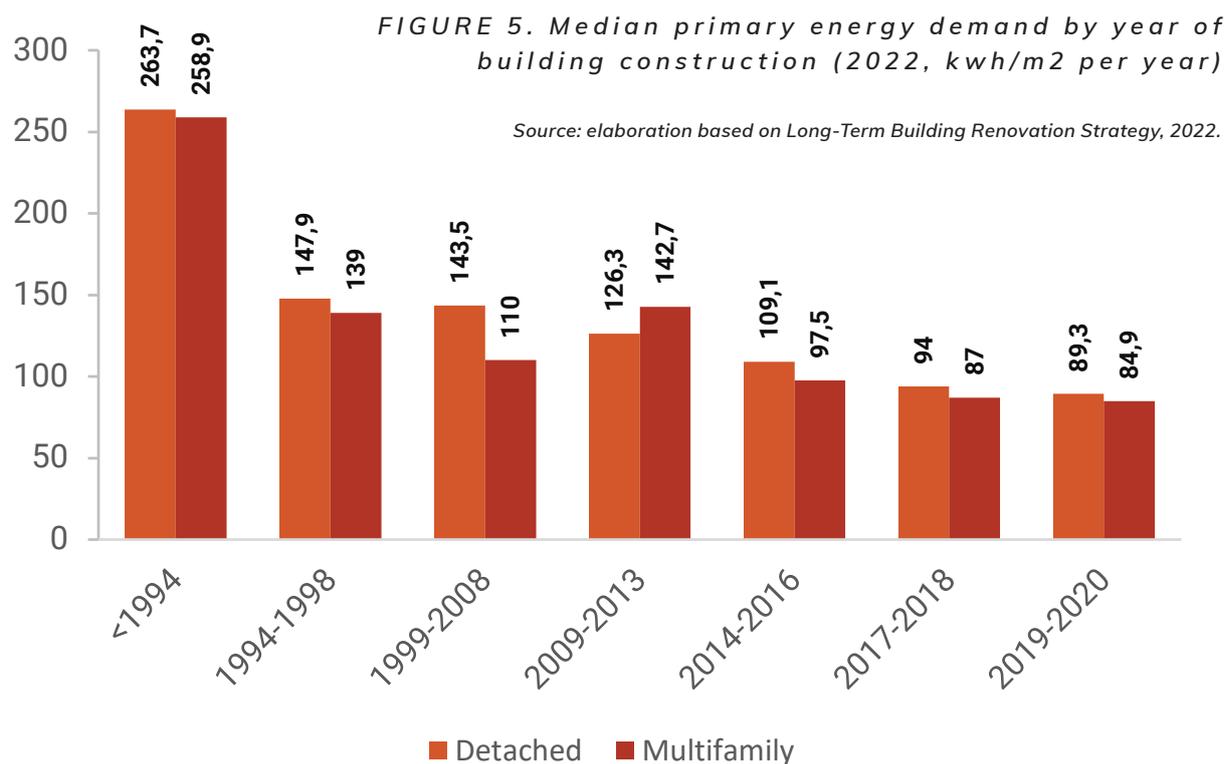
The age of the housing stock in Poland significantly impacts its energy efficiency (Figure 4). Almost 40% of the housing stock was built before 1970, with 30% constructed in the 1970s and 1980s, highlighting that many buildings are relatively old and may lack modern energy-efficient features. Buildings constructed before the 1970s often lack insulation, use outdated heating systems, and have inefficient windows, contributing to significant energy losses.

Similarly, housing stock built between the 1970s and 1980s may face similar energy efficiency challenges. While some improvements may have been made compared to older buildings, they may still need to meet current energy efficiency standards (Csoknyai et al., 2016). This energy inefficiency

has several implications for the overall energy efficiency of the housing stock in Poland. First, it leads to significant energy waste and increased carbon emissions, contributing to environmental degradation and climate change. Second, it increases residents' energy costs, particularly heating and cooling. This can be particularly burdensome for vulnerable groups and households experiencing energy poverty.

As thermal performance requirements for buildings have evolved, it is evident that older housing stock often lacks adequate insulation, contributing to energy inefficiency and increased energy demand (Figure 5). This is particularly concerning in energy poverty, where vulnerable households struggle to afford adequate heating and face higher energy





bills as they usually occupy older buildings in Poland (Sokołowski et al., 2020). In Poland, many buildings, especially multi-family ones, were constructed several decades ago when energy prices were low and did not reflect their economic value due to a centrally planned economy. Consequently, the technical solutions used then did not prioritise thermal insulation as much as today, relying on energy-intensive heating systems instead. These older buildings generally have higher energy demands compared to modern constructions. The energy standard of a building depends on various factors, including its age, usage, renovations, technologies used, and the requirements during its construction.

Construction technologies in Poland vary greatly. Pre-war urban housing primarily consists of brick-and-mortar apartment houses, often requiring extensive renovation, accounting for their historical value and consultation with monument conservators. Heating and hot water preparation methods vary, with coal boilers being the primary heat source, while some buildings use electric instantaneous water heaters or central heating systems with gas or solid fuel boilers. From 1946 to 1990, building construction significantly increased, especially with the rapid development of large panel technologies in the mid-1960s (Table 1). Both detached houses and large panel buildings in Poland face significant

Year of building construction	Number of buildings	Unitary demand for non-renewable primary energy kwh/m ² per year	Unitary demand for final energy
Before 1918	405,000	>350	>300
1918-1944	804,000	300-350	260-300
1945-1970	1,364,000	250-300	220-260
1971-1978	660,000	210-250	190-220
1979-1988	754,000	160-210	140-190
1989-2002	671,000	140-180	125-160

TABLE 1. Demand for energy of buildings constructed before 2002 by year of building construction (kwh m² per year)

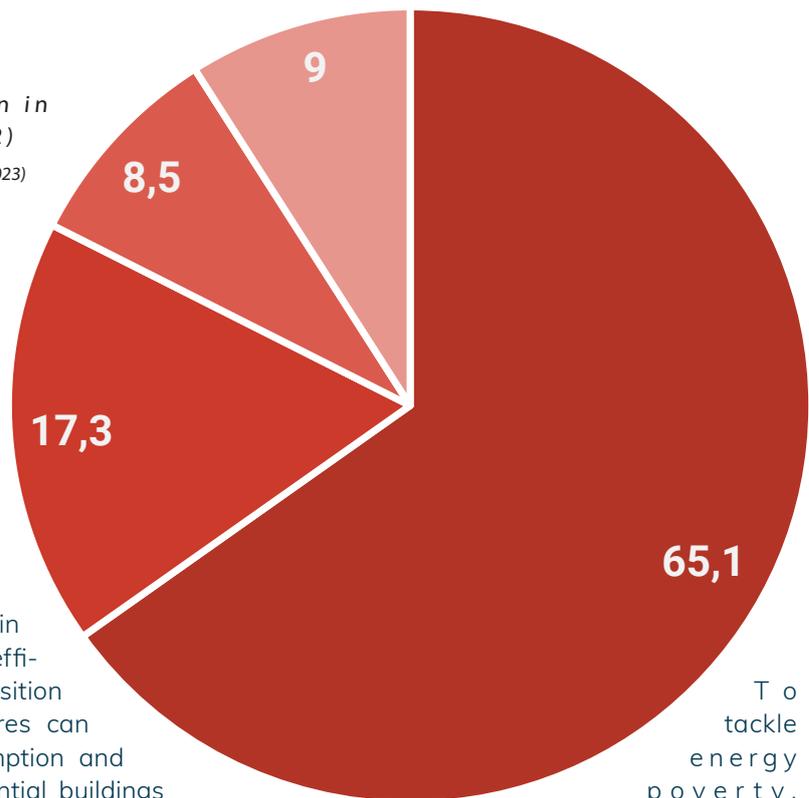
challenges, necessitating refurbishment to enhance thermal insulation and replace outdated central heating systems. Approximately 30% of multi-family buildings and 40% of detached houses lack proper insulation. However, a positive aspect is that most multi-family buildings are connected to district heating networks, highlighting the potential for more efficient heating solutions (Statistics Poland, 2020).

vulnerable groups to afford adequate heating and maintain comfortable living conditions. In Poland, the heating sources used in residential buildings pose challenges related to energy poverty and unacceptable housing conditions. A significant proportion of households, over 30%, rely on coal or wood for heating, which can contribute to indoor air pollution and health risks (Sokołowski et al., 2023). In addition, around 15% of households use gas as a heating source.

FIGURE 6. Energy consumption in residential buildings (% , 2022)

Source: own elaboration based on Statistics Poland (2023)

- Space heating
- Water heating
- Cooking
- Lighting and electrical appliances use



The composition of energy use in buildings determines their energy efficiency. By understanding the composition of energy use, appropriate measures can be taken to reduce energy consumption and address these challenges. In residential buildings in Poland, heating and ventilation significantly contribute to energy use, accounting for a substantial 70% (Figure 6). This statistic underscores the pressing need for improvement in the energy performance of buildings, revealing substantial heat losses through their envelope and low efficiency in energy conversion and use. It is important to note that while heating constitutes a significant portion of energy use across the EU, this alone does not necessarily indicate poor energy performance. However, through insulation and other measures, it is feasible to reduce the energy demand of households significantly.

Inefficient heating systems and inadequate insulation contribute to increased energy demand and higher household energy costs. This situation exacerbates energy poverty, making it difficult for

To tackle energy poverty, improve housing conditions and increase energy efficiency, it is crucial to prioritise the decarbonisation of buildings (Ürge-Vorsatz & Herrero, 2012). This involves replacing traditional heating sources with more sustainable alternatives. One practical approach is to switch to district heating systems, known for their energy efficiency and reduced environmental impact. District heating networks can provide affordable and reliable heating to multiple buildings, ensuring better heat distribution and comfort.

The change observed between 2018 and 2022 in the respective heating sources in Poland indicates a notable shift in energy consumption patterns and their impact on the energy efficiency of the housing stock (Figure 7). During this period, using individual

heating sources based on coal decreased by 16 percentage points (pp). Reducing the use of coal for heating is a positive development in reducing greenhouse gas emissions and improving energy efficiency. Similarly, the use of wood as a respective heating source decreased by 8 pp. Although wood is a renewable energy source, its use for heating can contribute to air pollution and indoor air quality problems if not properly managed. The decline in the use of wood as a heating source suggests a move towards cleaner and more efficient alternatives.

Oppositely, the share of district heating increased by 12 pp.⁴ The shift towards district heating suggests a more centralised and potentially more

efficient heating infrastructure, resulting in overall energy savings and reduced environmental impact. This change is likely driven by the discontinuation of using individual coal heating in the oldest houses. Additionally, the trend of urbanisation, with more people living in multi-family buildings heated by district systems, contributes to this shift (Kontokosta & Jain 2015).

With a significant proportion of buildings predating 1970, many structures lack modern energy-efficient features, leading to substantial energy losses. Buildings constructed between the 1970s and 1980s also contend with energy efficiency challenges, warranting continued attention. The thermal performance inadequacies of older buildings, particularly in the context of energy poverty, exacerbate discomfort and financial constraints for residents.

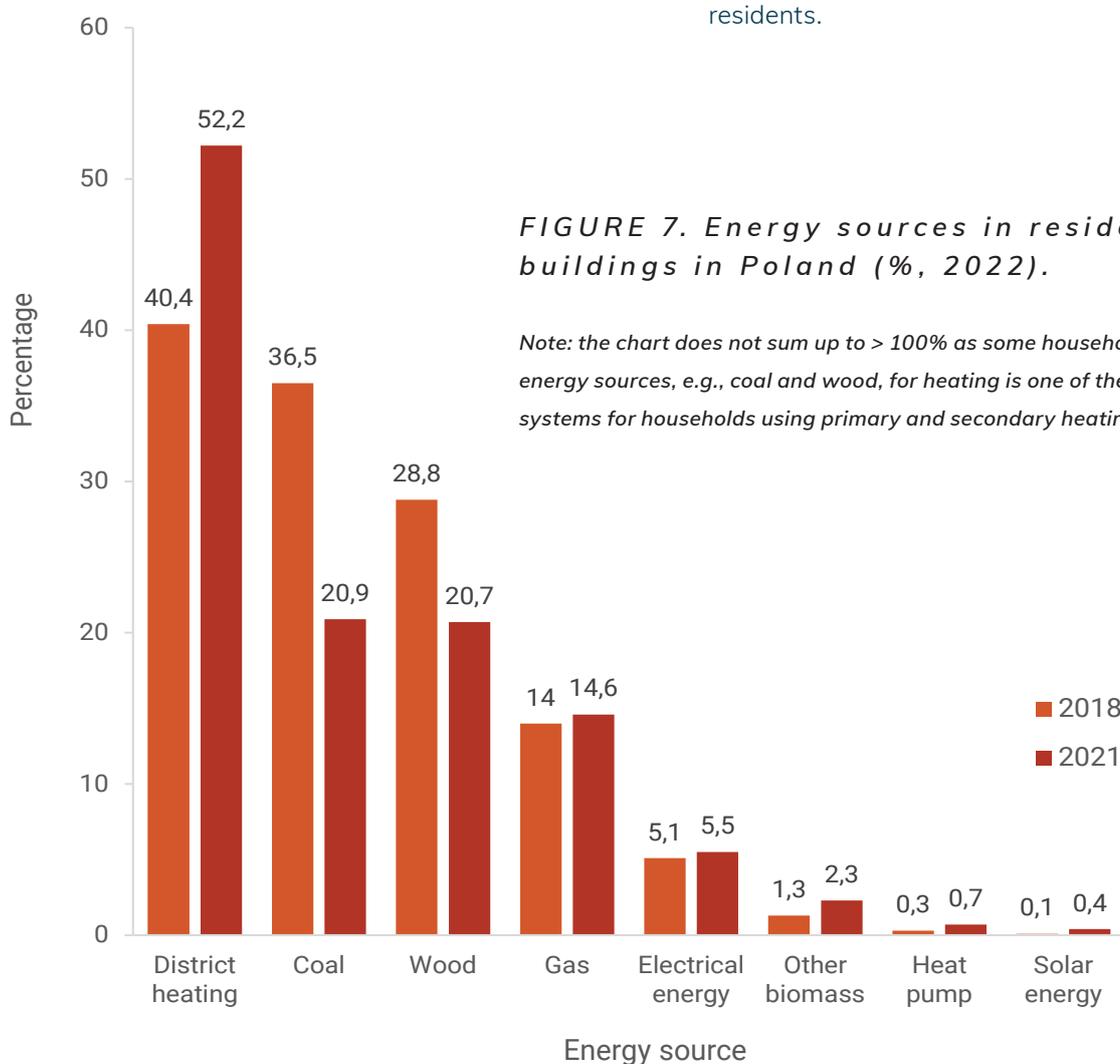


FIGURE 7. Energy sources in residential buildings in Poland (% , 2022).

Note: the chart does not sum up to > 100% as some households use two energy sources, e.g., coal and wood, for heating is one of the most common systems for households using primary and secondary heating sources.

⁴ In 2018, the energy mix in Polish district heating systems was the following: 72.5% coal / 8.6% gas / 4.8% oil / 8.1% biomass and renewable / other 6% (Forum Energii, 2019)

4. Energy Poverty in Poland

Energy poverty occurs when low-income households (in the lower deciles of the income distribution) struggle to afford necessary energy expenditures. This includes the need to spend a significant portion of their income on energy due to inadequate energy services, poor housing quality, financial difficulties, or limited access to essential and affordable energy services. Such services include adequate heating, cooling, lighting, and electricity to power appliances, all essential for maintaining a decent standard of living and good health. Difficulties securing energy services in the home can lead to arrears and bills, or reduced comfort due to the need to limit energy use below the appropriate levels.

The European Union has recognised the importance of tackling energy poverty by implementing the definition of energy poverty in the EED in 2023. Regarding country-specific definitions, only about a third of Member States, including Poland, have introduced national definitions of energy poverty. The absence of uniform acknowledgement

and delineation of energy poverty in the legislative frameworks of Member States contributes to a discrepancy in formulating effective mechanisms to address energy poverty directly. While energy poverty-related measures have been incorporated into relevant files, these measures typically lack binding force, except the new EED. This situation further underscores the challenges in achieving consistent and impactful interventions to alleviate energy poverty across the EU.

In Polish legislation, energy poverty is defined in the Energy Law. According to this definition, energy poverty is “a situation in which a household (...) cannot afford sufficient heat, cooling and electricity to power appliances and lighting and meets the following conditions: 1) has a low income; 2) has high energy costs; 3) lives in a building with low energy efficiency” (Energy Law, 2022). Thus, the Polish legislation considers the criterion of affordable access to essential energy services, the economic situation of households (including income and energy expenditure), and the conditions of the dwelling where they live.

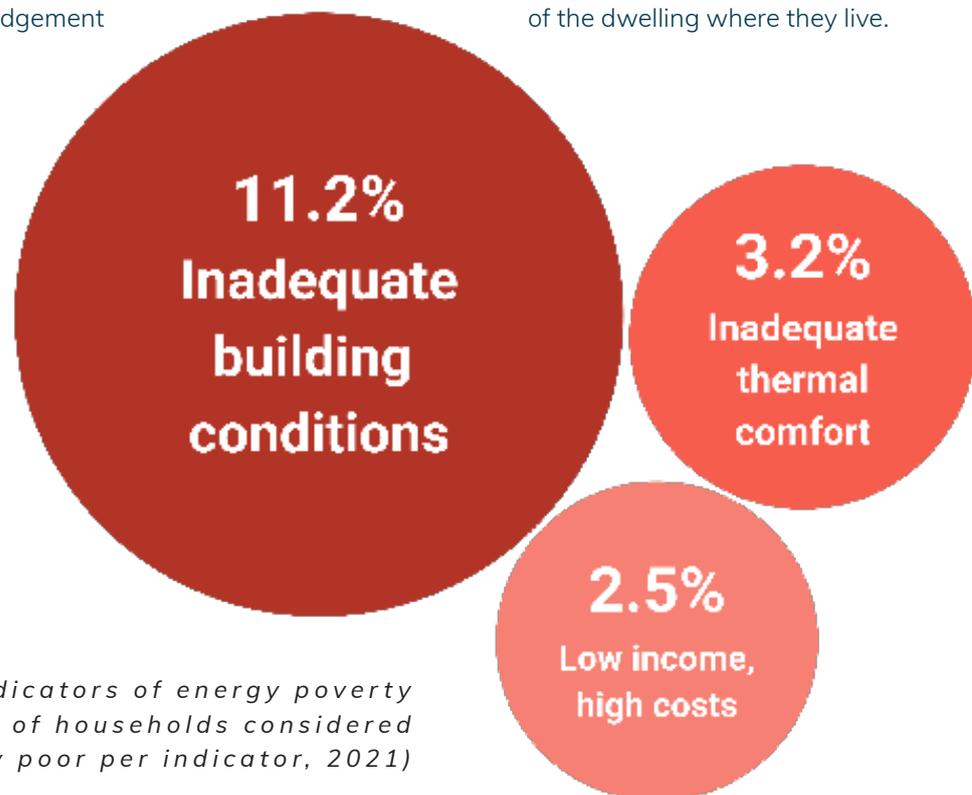


FIGURE 8. Indicators of energy poverty in Poland (% of households considered energy poor per indicator, 2021)

Source: own elaboration based on Statistics Poland (2022)

Indicator	Definition
Low Income, High Cost	A household is considered energy poor if it meets two criteria simultaneously: high hypothetical energy expenditure and low income.
Inadequate building conditions	The indicator is created directly from the following question in the survey: "In your opinion, does the dwelling in use: have a leaking roof, damp walls, floors, foundations, rotting windows or floors?". Households for which the answer to the above question is "Yes" are classified as energy poor.
Inadequate thermal comfort	The indicator is created directly from the following question in the survey: "In your opinion, is the dwelling in use: Is it warm enough in winter (technically efficient heating or sufficient insulation of the building)?". Households for which the answer to the above question is "No" are classified as energy poor.

TABLE 2. Energy poverty dimensions related to housing, Source: own elaboration.

Around 11% of the Polish population (equivalent to 1.5 million households) is affected by energy poverty, as measured by the Low Income, High Cost indicator (Figure 8). This indicator aligns with the definition of energy poverty in Polish law and the target for reducing energy poverty set out in the Polish Energy Policy until 2040. It identifies energy-poor households based on low income and high necessary energy expenditure. This definition is also used for this report. To comprehensively measure the dimensions of housing-related energy poverty, energy poverty indicators are calculated along three dimensions, as shown in Table 2.

Energy poverty in Poland has three leading causes, namely:

- 1. Low income:** Low income is a significant contributor to energy poverty. This is defined by an income threshold equal to or below that of 30% of the lowest-income households in Poland. Insufficient income limits the ability of families to afford essential energy services.
- 2. High cost of electricity and heating:** Electricity and heating costs contribute significantly to energy poverty. These costs include expenses related to lighting, space and water heating and the use of other electrical appliances. Rising energy prices can strain already financially vulnerable households. Finally, using outdated, individual heating sources (especially coal) can increase the heating cost.

3. Poor technical condition of the building: The technical state of a building plays a crucial role in its energy efficiency, as a leaky roof, dampness, mould, or inadequate insulation all harm energy performance and affect the comfort and well-being of inhabitants. Buildings that lack proper insulation and maintenance are more prone to energy loss, resulting in higher energy consumption and costs.

The high energy costs associated with energy poverty are evident in average monthly energy expenditure relative to income. In nominal terms, the spending on energy is almost the same between average families and those in energy poverty. In 2021, Poland's average monthly energy expenditure was 86 EUR. The corresponding figures for households experiencing energy poverty were 85 EUR. The disparities in energy expenditure become apparent when looking at the share of energy costs in household income. On average, energy costs account for 13% of household income in Poland (similar to the average in the EU; Menyhért2022). However, households experiencing energy poverty spend around 35% of their income on heating and lighting their homes (Figure 9).

Energy poverty in Poland is strongly related to low income. Households in energy poverty have an average income⁵ of 307 EUR, significantly lower than the average household income in Poland in 2021, 700 EUR. The limited income of these households means they need help to adequately meet

⁵ Monthly, equivalised, disposable income.

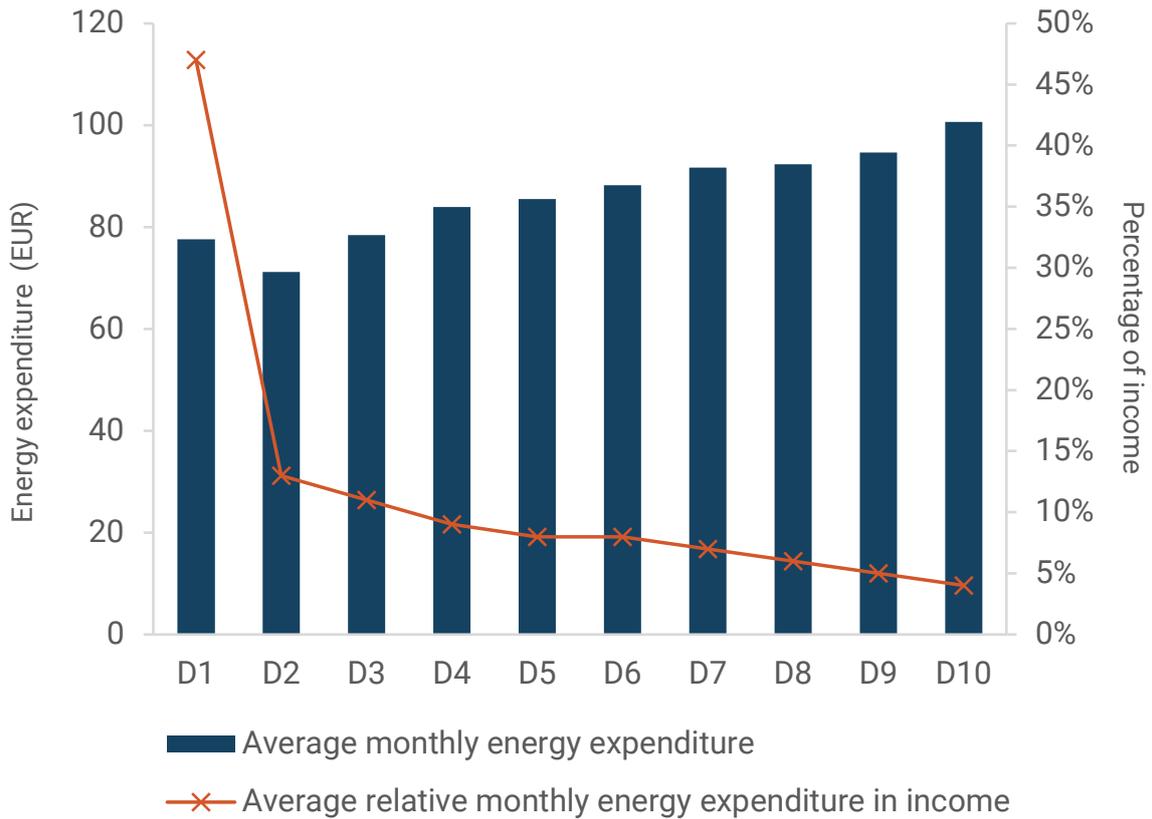


FIGURE 9. Nominal (left axis) and relative monthly energy expenditures by equivalised income in Poland (EUR and %, 2021)

Source: own elaboration based on Statistics Poland (2021)

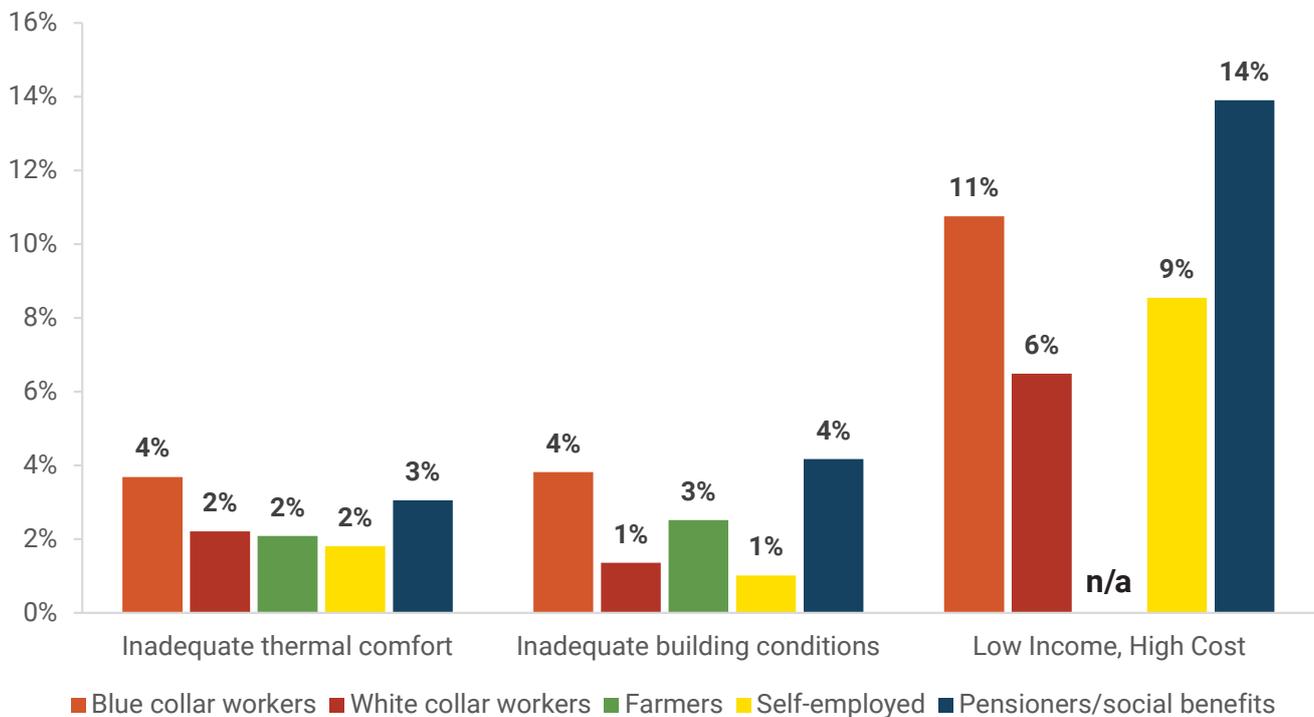


FIGURE 10. Risk of energy poverty by the main source of income (%)

Source: own elaboration based on Statistics Poland (2022)

their energy needs, especially when it comes to heating their homes to a comfortable temperature. Families facing financial difficulties often prioritise paying energy bills at the expense of other essential goods and services. As a result, they may resort to using low-quality fuels and outdated heating systems and stoves, exacerbating energy inefficiency and discomfort.

The financial situation of households is influenced by various factors, including the number of working individuals, their occupations, workplace conditions, and earnings, as well as other considerations such as age, education, work experience, and residential location (Figure 10). Low-income levels in Poland particularly affect retirees, pensioners, and those reliant on social benefits. This group often includes families with members who have disabilities, require special care, and have limited employment opportunities. This complex interplay of factors contributes to the financial landscape of households.

Residents of rural areas and small towns with fewer than 20,000 inhabitants are particularly vulnerable to energy poverty in Poland. This is mainly due to the prevalence of single-family homes in these

areas and lower incomes compared to bigger cities. Many of these homes are old, large, and have higher heating costs. As a result, there is an increased risk of inadequate heating and thermal discomfort for residents. Similar factors contribute to a high share of energy poverty in rural areas. In large cities with populations of over 500,000, approximately 10% of the population faces energy poverty. Energy poverty is often experienced by residents of old tenements and municipal buildings not connected to district heating networks. In such cases, a widespread but costly solution is to rely on electric cookers for heating, resulting in significantly higher heating costs (Figure 11).

The cost of maintaining residential buildings is significantly influenced by factors such as the size of the dwelling and the technical condition of the occupied building. Among these factors, the efficiency of the heating system and the type of fuel used play a crucial role. A higher energy efficiency rating for a building and efficient heating installations can significantly reduce maintenance costs. Improved energy efficiency leads to reduced energy consumption and therefore reduced costs. It is vital to prioritise energy efficiency measures to reduce

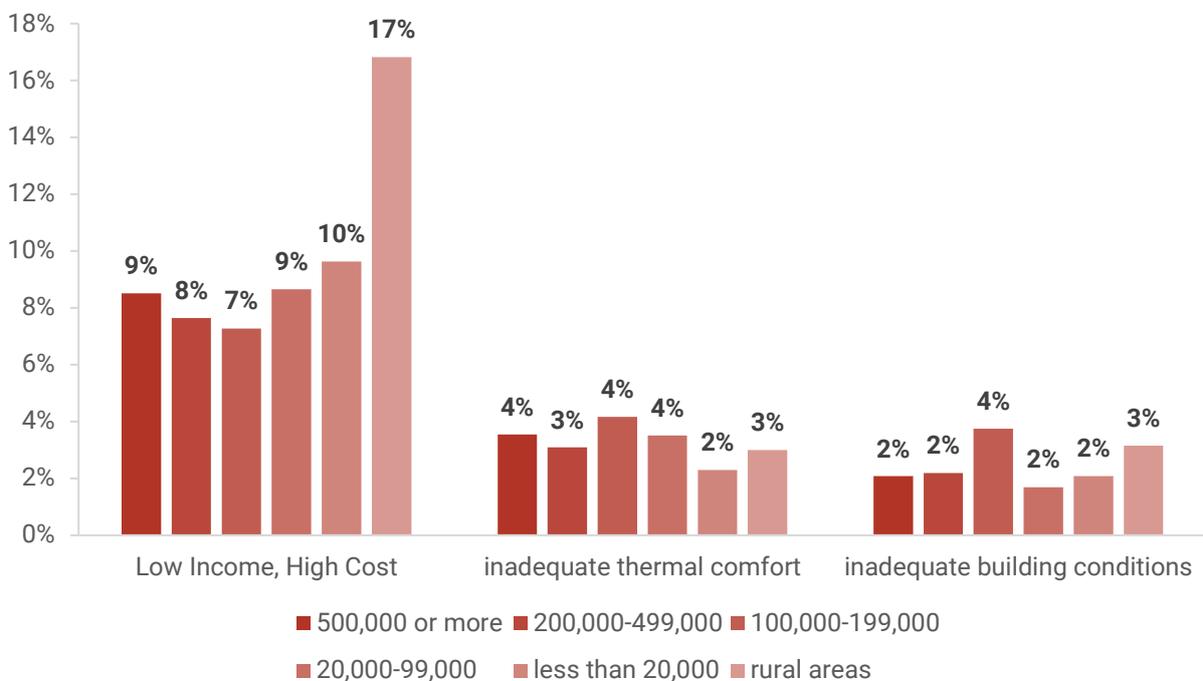
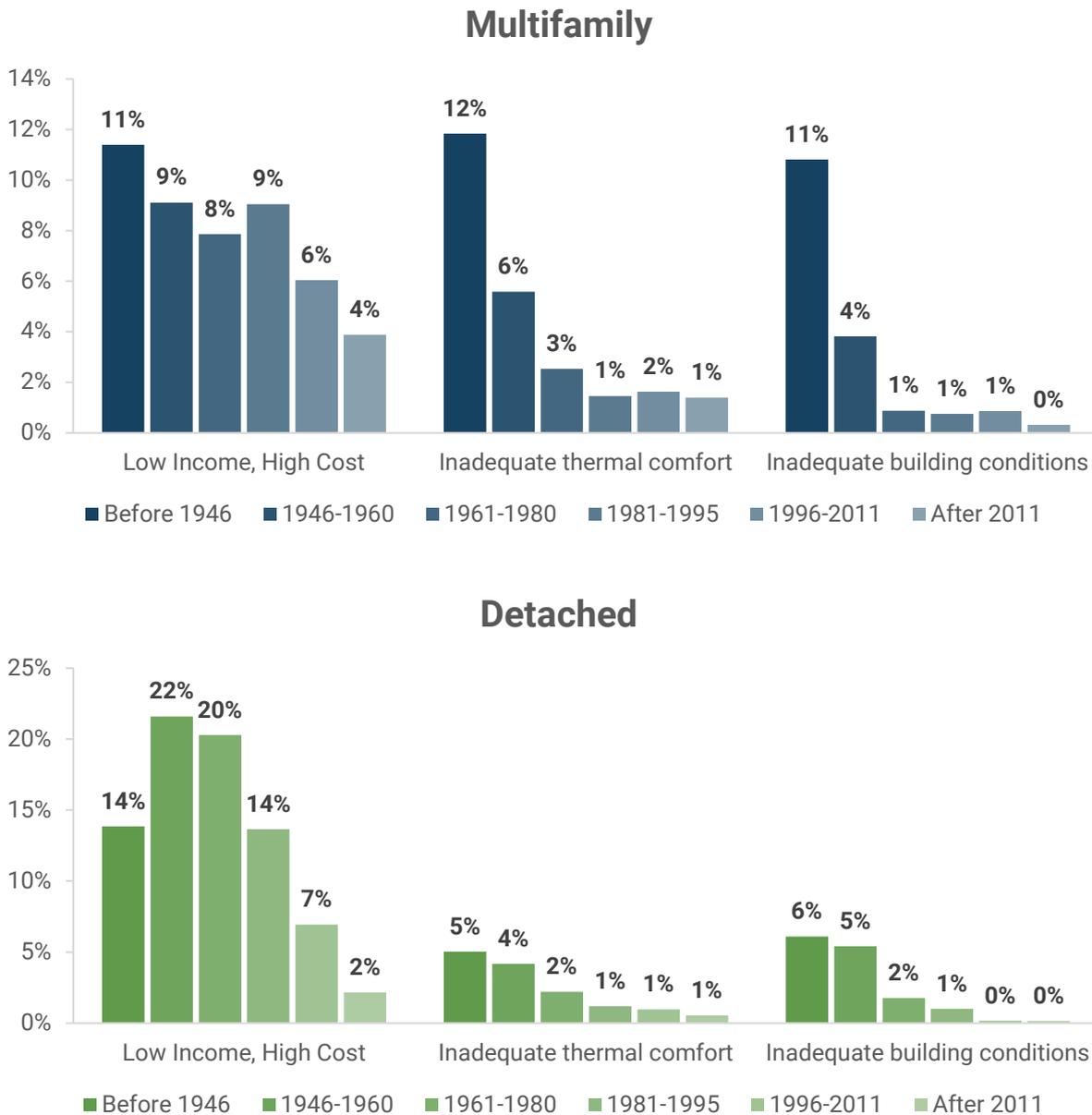


FIGURE 11. Risk of energy poverty by class of residence (% of energy-poor households)

Source: own elaboration based on Statistics Poland (2022)

FIGURE 12. Risk of fuel poverty by type and year of construction of the building (% of energy-poor households)



Source: own elaboration based on Statistics Poland (2022)

the risk of energy poverty (Bouzarovski et al., 2012).

When looking at the age of the building, it becomes clear that older buildings have a higher risk of energy poverty (as shown in Figure 12). Single-family dwellings built between 1946 and 1980 stand out, with an energy poverty risk of around 20%. Older buildings are more likely to be in poor technical condition, resulting in poor thermal comfort for occupants, especially during winter.

Renovating multi-family and detached homes

poses distinct challenges due to their varying characteristics and ownership structures. Detached homes often have higher energy poverty rates as they tend to be larger and require more heating and cooling, resulting in increased energy consumption and higher costs for homeowners. Renovating detached homes also entails individual investment, which can be a significant financial burden for many homeowners. Affording upfront costs for energy-efficient upgrades can be a considerable challenge, impeding progress in enhancing energy efficiency in these properties (Davies & Osmani, 2011).

Multi-family buildings present other obstacles. Decision-making in such buildings can be complex and time-consuming, as renovation decisions necessitate the agreement of multiple co-owners. This can lead to delays or blockages in the renovation process due to conflicting interests and differing priorities among co-owners. Moreover, insufficient financial products tailored to multi-family building renovations further complicate matters. Traditional loans and incentives may not effectively address the collective financing needs of multiple co-owners, making it difficult to secure funding for energy efficiency projects (Lujanen, 2010).

Another significant issue in multi-family buildings is the inability of energy-poor co-owners to invest in energy-efficient upgrades. Some co-owners may already be experiencing energy poverty, making it financially unfeasible for them to contribute to renovation costs. This financial constraint creates additional barriers to implementing much-needed energy efficiency improvements in multi-family

buildings.

In Poland, many households rely on individual and local heat sources rather than being connected to district heating networks supplied by centralised thermal power plants. This situation affects energy poverty, unacceptable housing conditions and energy efficiency. Using coal as an individual heating source exposes households to high energy price fluctuations, making it difficult for low-income families to cope with escalating energy costs during price spikes. This situation exacerbates energy poverty, as vulnerable households struggle to afford adequate heating, reducing the quality of life and increasing health risks associated with living in cold and poorly heated environments.

Moreover, the efficiency of heating equipment in many households is compromised, further contributing to unacceptable housing conditions. Older heating systems and poorly insulated buildings fail to provide sufficient warmth, leading to discomfort

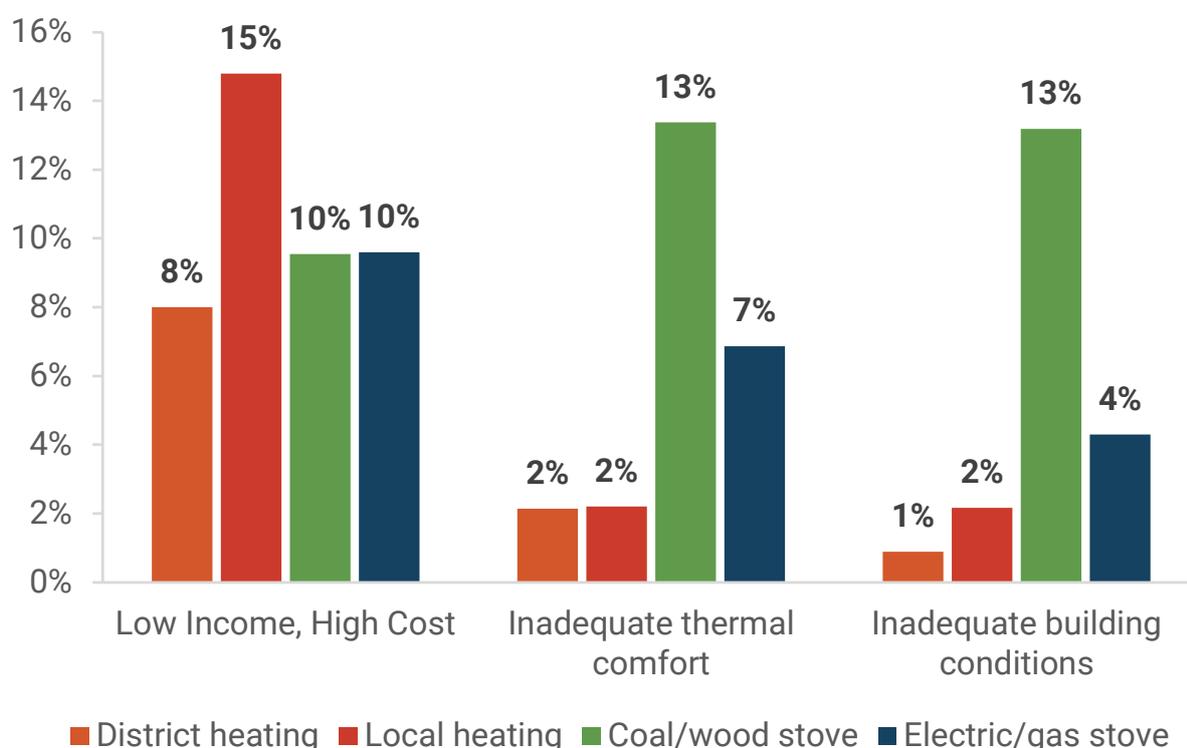


FIGURE 13. Risk of energy poverty by primary heating source (% of energy-poor households)

Source: own elaboration based on Statistics Poland (2022)

and health issues, particularly for vulnerable groups such as children and those with chronic illnesses. Rural areas are significantly affected, where the energy efficiency of the housing stock remains a pressing concern.

The reliance on coal as a heating source also challenges climate efforts. Coal is a carbon-intensive fuel, leading to higher carbon emissions and a more significant environmental impact. Using less energy-efficient heating technologies hampers efforts to reduce overall energy consumption and achieve national energy efficiency targets.

“Of the approximately six million households using individual or local heating sources, one million are considered energy-poor”

Type of heating also largely influences energy poverty. Of the approximately six million households using individual or local heating sources, one million are considered energy-poor (Figure 13). The risk of energy poverty, as measured by indicators based on energy expenditure, is exceptionally high for households not connected to district heating networks. Furthermore, among households that rely on fuel stoves for heating, 13% report living in homes that are too cold, indicating inadequate thermal comfort (compared to the 3% average in Poland). In addition, the same proportion of households in this category considers their dwellings to be in a poor state of repair. This points to the problem of unfit housing, where energy inefficiency and poor building conditions contribute to discomfort, higher energy consumption and increased vulnerability to energy poverty.

In summary, energy poverty, a critical concern for low-income households, arises from their inability to access essential energy services due to financial constraints and substandard housing conditions. Within Poland, approximately 11% of the population grapples with this challenge, allocating a substantial portion of their income to meet energy-related costs. Moreover, the disparities observed between urban and rural areas emphasise the multifaceted nature of the issue. Many Polish households rely on individual and local heat sources, such as coal, which exposes them to volatile energy prices and compromises the efficiency of heating equipment, leading to unacceptable living conditions. These challenges hinder progress towards energy efficiency goals and exacerbate health risks, particularly for vulnerable groups. The reliance on carbon-intensive fuels further amplifies environmental concerns. The undeniable link between energy poverty and low income underscores the pressing need for tailored interventions.

5. Financial situation of households

Understanding the financial situation of households is crucial for planning renovations and devising viable financing approaches. Examining households' financial capabilities becomes essential in the context of the varied financial disparities observed in Poland. This understanding forms the foundation for developing renovation funding strategies that cater to the specific economic conditions of these households.

Various inequalities characterised the financial situation of households in Poland in 2016 (National

Bank of Poland, 2018).⁶ The median net wealth of a household was 56,000 EUR. Financial assets were relatively small, with a median value of 3,200 EUR and debt levels at 2,100 EUR. The distribution of wealth varied across households. The majority of households owned their primary residence (79%) and vehicles (66%), while fewer households declared valuables (29%), other real estate (24%), or private business assets (20%) as components of their wealth. Financial assets were held by 91% of households, and deposits were the most common form of savings, although the average amount accumulated was relatively small (2,500 EUR).

In terms of debt, 40% of households declared

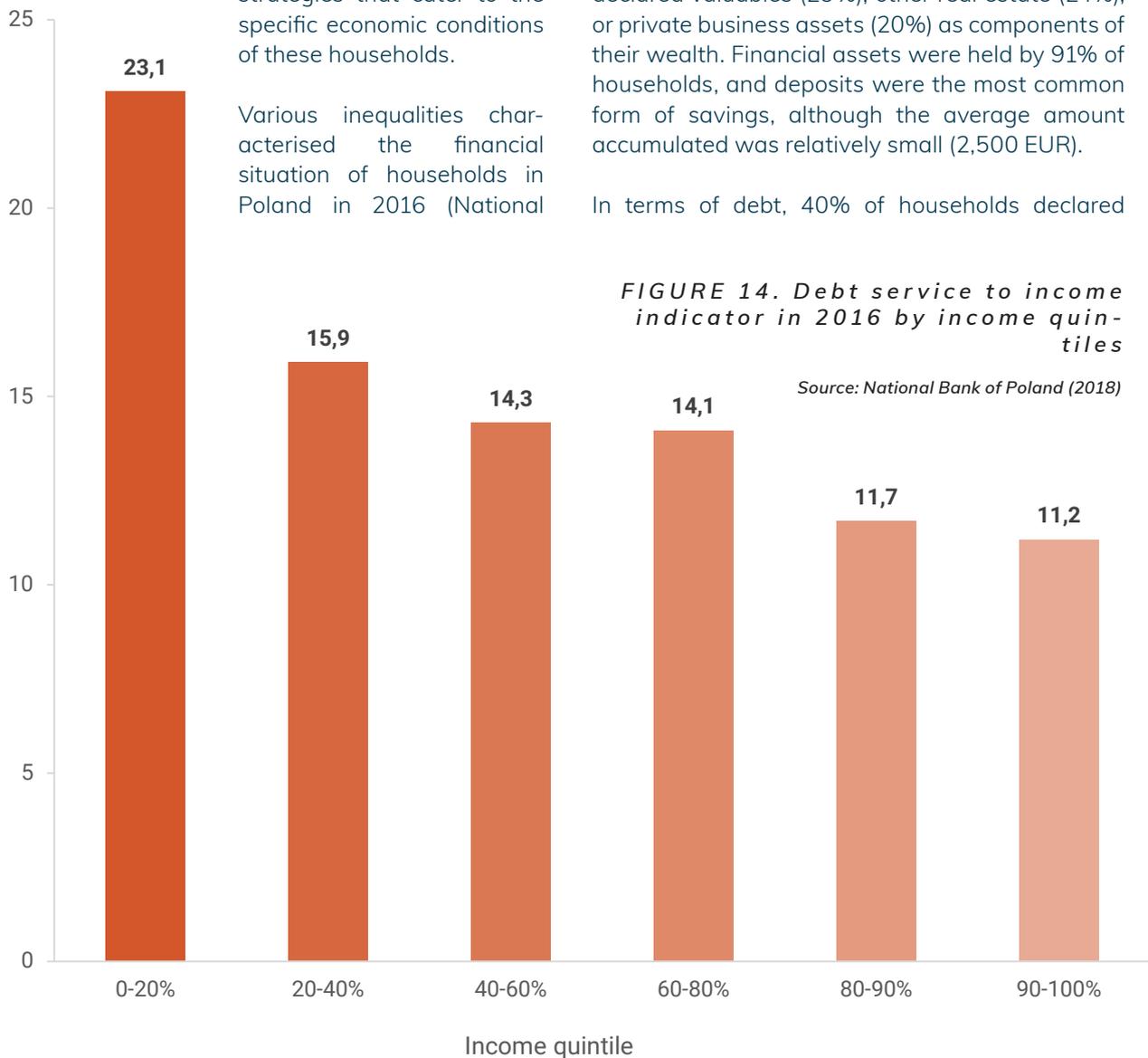


FIGURE 14. Debt service to income indicator in 2016 by income quintiles

Source: National Bank of Poland (2018)

⁶ The final year when the data was available.

liabilities. Mortgage loans secured on real property were the main component of household debt, declared by 14% of households. These mortgages, especially for low-income households, represented a relatively high burden, with an average value of 24,400 EUR. Oppositely, other loans, primarily consumer loans, were more common (33% of households), but their average value was much smaller, approximately 640 EUR.

The financial situation of households varied significantly based on several key characteristics. Net wealth increased significantly with higher household income, reaching its peak among the highest income group. Net wealth distribution was uneven, with the greatest concentration among the most affluent households. The top 10% of households held around 41% of the total net wealth, while the bottom 20% accounted for only 1% of all household wealth. The wealth inequality in Poland, measured by the Gini coefficient, amounted to 0.57. Tangible assets were less concentrated (Gini – 0.57) than financial assets (Gini – 0.72). In comparison, income inequality, measured by the Gini coefficient for net income, was lower at 0.32.

The depiction of the disparity in households' financial circumstances reveals implications for the feasibility of home renovations. **The concentration of net wealth predominantly among affluent households underscores a challenge for those in the lower deciles. The bottom 20% of households collectively hold a mere 1% of total household wealth, indicating a significant segment of the population that may lack the necessary financial means to pursue home renovations independently. This poses a potential barrier for these households to secure loans or allocate savings for much-needed home improvements.** Consequently, addressing this disparity becomes pivotal to ensure that financially vulnerable households have the opportunity to enhance their living conditions through adequate funding.

6. Funding investment in healthy housing

Poland's historical housing policy has often favoured middle and affluent households, leaving limited support for low-income families facing housing challenges (Lux & Sunega, 2014). Despite existing policy tools like owner-occupier and rental assistance and renovation initiatives, these measures have fallen short of effectively alleviating the housing hardships, resulting in persisting substandard living conditions and energy affordability issues. Renovating underperforming housing stock can potentially lift households out of energy poverty. However, it is essential to recognise how can these vital renovations be financially sustained given the limited economic capacity of these households and the challenge of directing resources towards those who need them the most. The issue is compounded by Poland's significant challenge of dealing with a large share of low-performing dwellings consuming excessive energy (Camarasa et al., 2021), which poses an undeniable environmental and economic burden. In light of these compelling concerns and the previously outlined highly inefficient housing stock, this section examines funding mechanisms for energy-efficient renovations, their implications, and their alignment with the needs of the most vulnerable households. Renovation instruments are explored later, allowing for a comprehensive assessment of their potential impact on addressing energy poverty and enhancing housing conditions.

EU policy requirements underscore the significance of energy efficiency and decarbonisation in the housing sector. The EU's dedication to energy efficiency, energy autonomy, and the Renovation Wave initiative adds substantial pressure on member states to elevate their buildings' energy performance. Accomplishing these ambitious targets and adhering to EU regulations necessitates implementing comprehensive energy-efficient renovation measures. Notably, the forthcoming extension of the EU Emissions Trading System (ETS) demands households' preparedness for potential shifts in energy costs. By embracing energy-efficient renovations, carbon emissions

from buildings can be curtailed, rendering them more resilient to future fluctuations in carbon pricing.

Furthermore, the ongoing developments in EU policies, such as the EPBD and the EED, play a pivotal role in shaping the trajectory of energy-efficient renovations. The EPBD, upon acceptance, is poised to establish minimum energy performance standards that compel the enhancement of the least efficient building stock. Simultaneously, the EED mandates yearly energy-saving targets (23% increase in energy efficiency in Poland until 2030) while specifically addressing energy poverty and its impact on vulnerable households (the goal for energy poverty reduction is to reach 6% until 2030 and is set in Polish Energy Policy). Additionally, Member States must strategise renovating their poorest-performing buildings as outlined in their Long-Term Renovation Strategies (LTRS). Unfortunately, Poland is missing a clear definition of the worst performing buildings in the strategy; therefore, detailed targets and measures are also absent in the document.

Through the EU Cohesion Policy, Poland has access to EU funding programmes for improving energy efficiency in buildings and housing conditions, such as the European Regional Development Fund (ERDF) and the European Social Fund (ESF). The Polish government have also allocated funds from the Emission Trading System through the National Fund for Environmental Protection and Water Management programmes to support thermal refurbishment. This fund is crucial in providing financial resources to refurbish thermal infrastructure throughout the country. Despite these positive efforts, it is essential to recognise that Poland has faced challenges in fully committing to climate action. Not all the money from the ETS is spent on the energy transition process, as Poland is the Member State with the most revenue not spent on climate action (over €6.5 billion), and the country has been criticised for not allocating its financial resources adequately to combat climate change.

Following the directives set forth by the EED, Poland has embarked on a series of strategic initiatives to enhance energy efficiency within its borders. The National Energy and Climate Action Plan for Poland, from 2021 to 2030, stands as a roadmap delineating a multifaceted approach to bolstering energy efficiency across various sectors. A cornerstone of this endeavour is implementing an energy-saving obligation scheme, predominantly executed through the issuance of white certificates. This scheme imposes a mandate only upon energy providers, compelling them to achieve end-use energy savings. Moreover, Poland has deployed various alternative measures to amplify its energy efficiency efforts. Notably, large enterprises are required to undergo mandatory energy audits. Tax relief incentives have been orchestrated to facilitate thermo-modernisation within single-family residential buildings.

There are two primary components of the Polish energy efficiency strategies, financed by the ETS revenues in place: the 'Thermo-modernisation and Renovation Fund' provides financial support for investors implementing thermo-modernisation and renovation activities, encouraging replacing old and inefficient heat sources with modern ones. The 'Clean Air Programme' aims to improve air quality and reduce greenhouse gas emissions by supporting projects that replace old and inefficient heat sources with modern, low-emission alternatives. The 'Stop Smog' component focuses on replacing high-emission heat sources and implementing thermo-modernization in energy-poor households. Other initiatives include support for photovoltaics in the 'My Electricity' programme and 'My Heat' - subsidies for investment in heat pumps.

Established in November 2008 under the auspices of Bank Gospodarstwa Krajowego (BGK), the 'Thermo-modernisation and Renovation Fund' stands as a pivotal financial instrument, with a projected budget of approximately EUR 0.5 billion has been earmarked for this endeavour within the ten years from 2020 to 2029. This fund is crucial in facilitating projects centred around thermo-modernisation and renovation efforts. Its beneficiary spectrum encompasses housing cooperatives, local governance bodies, social housing initiatives, businesses, and individual homeowners, extending its support to single-family house proprietors. The fund presents an array of bonus categories—from thermal-retrofit to renovation and compensation bonuses—that

alleviate a portion of the loans secured for energy efficiency enhancements. The financial sustenance of this fund emanates from the state budget allocation and dividends accrued from investments. As part of the Fund, the 'Thermal-modernisation allowance' allows eligible taxpayers who own or co-own single-family homes to deduct the expenses associated with thermal modernisation projects from their income tax base. This measure serves as an encouragement for homeowners to undertake energy efficiency improvements. The allowance offers financial relief of up to 11,200 EUR for single individuals, providing an additional incentive for property owners to engage in sustainable property upgrades.

The 'Clean Air Programme,' launched in September 2018 under the National Fund for Environmental Protection and Water Management, commands an extensive 22 billion EUR budget designated for deployment across the ten-year span from 2018 to 2027. The program's scope targets property owners or co-owners of single-family residential buildings—the program's mission centres around phasing out old heat sources and augmenting energy efficiency within single-family dwellings. The program aspires to facilitate thermal modernisation interventions spanning approximately three million buildings. Notably, 2021 witnessed refinements that aimed to enhance the program's accessibility and efficacy, emphasising its support for low-income households. This evolution came as an income threshold purposefully structured to enable full financing for investments in clean heating and thermal retrofits. The 'Clean Air Programme' is the sole scheme designed to cater to and be accessible to the most economically vulnerable households offering them pre-financing of their investments (Matczak et al., 2023). The 'Stop Smog' component, initiated in 2018, with a budget exceeding 0.2 billion EUR, offers up to 70% co-financing for investments in municipalities, aiding in replacing outdated heating installations, insulation enhancement, and the transition to eco-friendly heat sources. The eligibility requires residing in areas with anti-smog regulations and a 30% municipality contribution. The program's uptake is minor (about 2% of municipalities in Poland). In 2022, the Clean Air program further broadened its purview by introducing the 'Warm Home' fund—an extension designed with the distinct purpose of catering to the requisites of residents in multi-family dwellings. Because the initial uptake of the 'Warm Home' component was

offered to selected pilot dwellings, it is impossible to assess its efficiency at this stage.

The 'Priority programme My Electricity' was launched in August 2019 by the National Fund for Environmental Protection and Water Management. With a budget of 113 million EUR spanning 2021-2023, this initiative is dedicated to fostering the growth of prosumer energy. It extends investment support to individuals who generate their electricity through photovoltaic micro-installations. To optimise self-consumption, participants must incorporate additional components, including energy storage and management systems. The programme facilitates the seamless integration of micro-generated electricity into the grid and contributes to advancing sustainable energy practices. However, the accessibility of this program to low-income households is a challenge (Sokołowski, 2023). Specifically, the program does not entail pre-financing or immediate reimbursement of investments. Instead, it operates on a payback structure, whereby approximately 15-30% of the initial investment is returned once the photovoltaic panels have been successfully installed and are actively generating electricity.

Unveiled in 2022, the 'My Heat programme' emerges as a catalyst for installing heat pumps within new single-family homes with a budget of 127 million EUR. The program's reliance on financial subsidies

echoes the concerns raised by the 'My Electricity' initiative. The 'My Heat' programme hinges on a post-installation reimbursement approach and is available only in newly built homes, inadvertently introducing barriers for households with financial constraints. This approach presumes an initial capability for investment, sidelining low-income families who lack the immediate capital to engage with the program.

These various programs and initiatives have been established in Poland with the overarching goal of enhancing energy efficiency, combating energy poverty, and addressing the issue of inadequate housing conditions. By focusing on the thermo-modernisation of buildings, these efforts aim to foster sustainable practices, alleviate energy poverty, and rectify housing inadequacies. However, the ambitious pursuit of these objectives requires additional private financial resources. Since only the 'Clean Air Programme' is pre-financed, the funding schemes available potentially create a divide in accessibility. The 'Clean Air Programme' emerges as the most substantial initiative. However, effectively reaching lower-income households reliant on coal-based heating remains an issue, although substantial improvements have been introduced in the programme. Since January 2022 and the introduction of complete investment financing for low-income households, the share of vulnerable

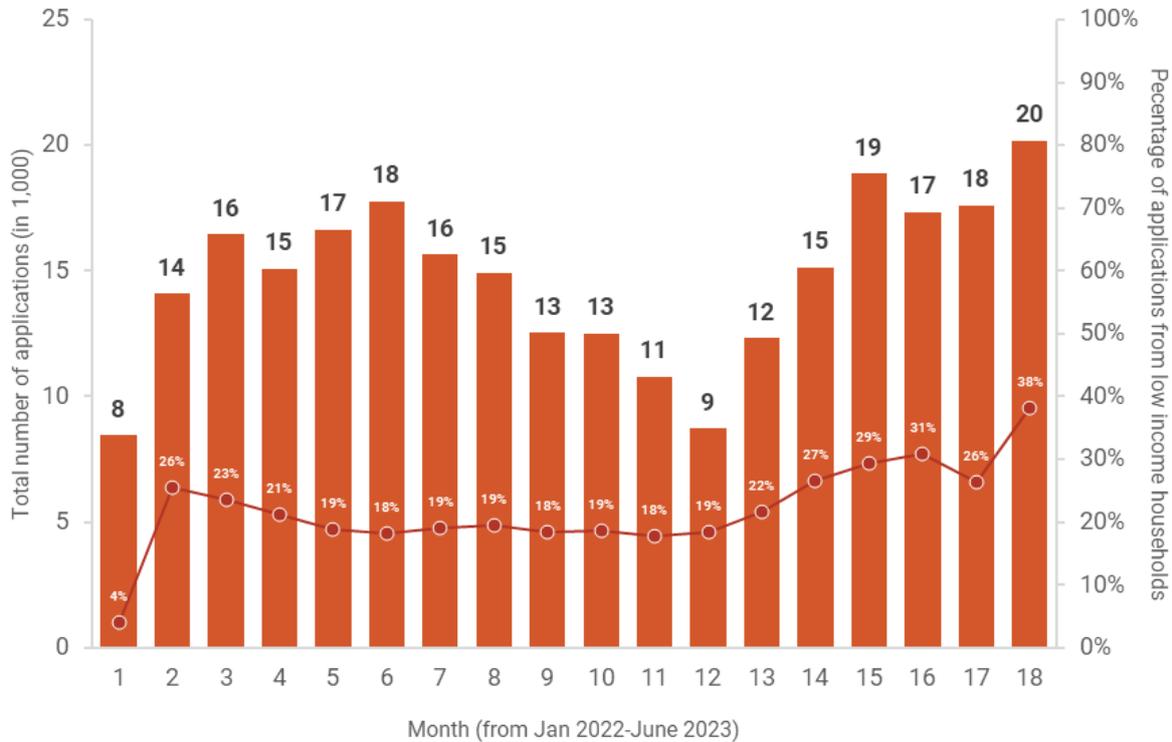
Name	Beneficiaries	Budget	Pre-financing
Clean Air Programme	Owners or co-owners of single-family residential buildings, or separate residential units within single-family buildings with a separate land and mortgage register.	21.9 billion EUR for 2018-2027	Yes
Thermo-modernisation and Renovation Fund	Housing cooperatives Local governments Social housing initiatives Companies Natural persons (including owners of single-family houses)	estimated budget for 2023 of 95 million EUR	No
Priority programme "My Electricity"	Individuals producing electricity for their own use, who have a comprehensive agreement governing the issues related to the introduction of electricity generated in a micro-installation into the grid.	113 million EUR in 2021-2023	No
My Heat programme	The beneficiary is an individual who is the owner or co-owner of a new single-family residential building.	127 million EUR	No

TABLE 3. Summary of financial programmes in Poland

Source: own elaboration

FIGURE 15. The number of applications for funding in the ‘Clean Air Programme’ since January 2022 (left axis 1,000) and the share of low-income households applications (right axis, %)

Source: National Fund for Environmental Protection and Water Management (2023)



beneficiaries has risen to 20%.

Apart from the ‘Clean Air Programme,’ many initiatives appear inaccessible to low-income households. This poses a question about aligning these endeavours to reduce energy poverty. The state allocates significant financial resources to energy efficiency, which reflects a strong commitment to energy efficiency on the surface. However, due to the lack of pre-financing in many programs, the impact is potentially skewed towards wealthier families, inadvertently sidelining low-income households. The accessibility of these programs to low-income households merits examination, raising concerns about whether the intended beneficiaries are genuinely benefitting. While pre-financed and with a significant budget, the ‘Clean Air Programme’ warrants further investigation into the mechanisms of efficiently targeting low-income households.

Additionally, the question arises whether allocating non-repayable funds, albeit through post-financing, to those who could potentially secure loans for renovations constitutes an optimal use of public

funding. This facet raises concerns about efficient resource allocation and equitable distribution. There is a need for a comprehensive review of these programs’ outcomes, accessibility, and impact on energy poverty. The effectiveness of these initiatives in benefitting low-income households calls for a discerning analysis that goes beyond budgetary figures.

Exploring the initiatives and their potential impact on energy poverty and household welfare requires a comprehensive assessment of their funding sources. The accessibility and effectiveness of these programs are not solely determined by their objectives and design, but also by the financial mechanisms that support their implementation. Several European funding mechanisms play a crucial role in advancing residential energy efficiency in Poland, each with its scope and size of financial allocation:

1. European Funds 2021-2027, boasting a budget for Poland of approximately 76 billion EUR, encompass a broad spectrum of initiatives, including innovation, entrepreneurship, digitalisation, infra-

structure, environmental protection, energy, education, and social affairs. Within this framework, the European Fund for Infrastructure, Climate, and Environment (FEnKS) is crucial, dedicated to enhancing energy efficiency and curbing greenhouse gas emissions. With a substantial budget of 25 billion EUR, FEnKS focuses on energy transformation. This initiative entails supporting the energy and environment sectors through the Cohesion Fund. Similarly, these sectors will be financed by the European Regional Development Fund (ERDF) to bolster energy efficiency initiatives further.

Addressing the energy sector, 6.08 billion EUR is dedicated to energy efficiency initiatives within diverse building types. This funding surge aligns with the challenges faced by the energy sector, influenced by dynamic economic and political landscapes, including external factors like the conflict in Ukraine. In the case of building renovations, this framework is vital in advancing the 'Clean Air' priority program.

2. Reconstruction and Resilience Fund: Allocated with over 58 billion EUR, this fund offers significant support for various measures, including energy efficiency and promoting renewable energy sources. The National Resilience Plan (NRP) underscores the prioritisation of reducing energy intensity and expanding green energy utilisation.

Under Poland's NRP, significant investments and reforms have been outlined across various sectors, including the energy industry and building renovations.

Green Energy and Reducing Energy Intensity Budget: 25.5 billion EUR (grant) + 36.7 billion EUR (loan)

- Clean Air Program Enhancement (three billion EUR).
- Energy Modernization of Educational Buildings (0.3 billion EUR): Funding will support adopting modern installation solutions for educational institutions, enhancing energy efficiency and sustainability.
- Energy Upgrades for Libraries and Community Centres (60 million EUR): Comprehensive energy upgrades for public facilities will reduce energy consumption and improve environmental performance.

mance.

3. Territorial Just Transition Plans (TJTJs) under the Just Transition Fund (JTF) provide over 3.85 billion EUR to support the transition to a greener economy in coal regions such as Silesia, Małopolska, Wielkopolska, Lower Silesia, and Łódzkie. These plans aim to address the challenges posed by shifting away from coal extraction and combustion while promoting sustainable growth and job creation. Each TJTJ has its allocation mechanism based on the list of projects submitted in the plan (e.g., installation of photovoltaic panels on public buildings in a particular municipality in a given coal region). The key highlighted issues related to building renovations in each region (with a total budget allocated to that region) are:

- Silesia and Western Małopolska (2.4 billion EUR) - Funding to support the transition from coal extraction and combustion, investments in energy efficiency improvements for public buildings and housing, including home insulation, rooftop solar installations, and heat pumps.
- Wielkopolska (415 million EUR) - Support for increasing energy efficiency through building insulation.
- Lower Silesia (581.5 million EUR) - Investments in renewable energies, including solar energy and building upgrades.
- Łódzkie (369.5 million EUR) - renovations are not explicitly mentioned among the most critical issues in the region.

4. Modernisation Fund (With a budget of approximately 4.3 billion EUR) is a strategic enabler of renewable energy production, energy efficiency enhancement across diverse sectors, energy storage implementation, and the modernisation of energy networks. Revenue generation stems from auctioning emission allowances within the EU Emissions Trading Scheme, ensuring a sustainable funding source for energy-related initiatives and directing it to the 10 lowest income members of the EU. The Modernisation Fund encompasses a range of support schemes designed to drive energy efficiency, curb greenhouse gas emissions, and bolster the utilisation of renewable energy sources across diverse sectors in Poland with an approximately 0.5 billion EUR allocation.

- ‘Renovation with a Guarantee of Savings’ program. With a budget of 25 million EUR, this scheme is set to operate between 2021 and 2026. The primary goal is to enhance air quality and decrease greenhouse gas emissions by optimising energy efficiency in multi-family residential and public buildings. This will be achieved through comprehensive upgrades, including thermal modernisation, ventilation system enhancements, renewable energy source integration, and other improvements. Beneficiaries include housing cooperatives, communities, local government units, and certain commercial entities.
- ‘My Heating’ program, with a budget of 133.3 million EUR, operates from 2021 to 2026 and centres on single-family housing.

Having explored the dynamics of the energy efficiency programs and their reliance on European Union funds, it is essential to put them in the context of Polish administration strategies. Poland’s Long-Term Renovation Strategy (Table 5) highlights the significant investment needed between 2021 and 2050 to improve the energy efficiency of the building stock. The total expenditure required for deep thermo-modernisation and transition of the residential and public buildings to zero-emission heat sources is around 0.32 trillion EUR. This substantial amount will require the involvement of private capital and the financial sector in addition to public funds, including those from the European Union.

By 2030, it is estimated that the thermal refurbishment of residential and public buildings will require an investment of 85 billion EUR. Of this amount, approximately 13 billion EUR (15%) would be needed to renovate the worst-performing building stock inhabited mostly by people in energy poverty.⁸ According to the Long Term Renovation Strategy, approximately 65 billion EUR will be secured by EU funds, including the Modernisation Fund, the Reconstruction and Resilience Facility, the European Regional Development Fund, the Cohesion Fund and the Just Transition Fund. The remaining

20 billion EUR should come from investors, the state budget, and the banking sector.

Significantly, a substantial portion of households, estimated at least 10% (representing the share of energy-poor households in Poland), necessitate non-repayable grants to initiate essential renovations. Furthermore, extending this assistance to up to 30% of individuals with the lowest incomes, roughly translating to 1.5 to 4.5 million households, becomes crucial. By offering financial support, these mechanisms effectively address low-income households’ financial constraints, enabling their engagement in energy-efficient renovations without added financial strain. As the availability of funds is evident, the key lies in effectively prioritising how the funds are spent. With a funding pool of 65 billion EUR for renovations, allocating 15% of this amount to address the worst-performing buildings is foreseeable. The 10% of households experiencing energy poverty within this allocation should be accommodated.

Contextualising these projections within the Long-Term Renovation Strategy’s goals offers insights into the scope of the task. The challenge and opportunity become apparent with the target of renovating 7.5 million buildings until 2050. To benefit between 1.5 to 4.5 million low-income and energy-poor households through these renovations and assume the implementation of a minimum energy performance standard as most likely to be prescribed by the EPBD, the government should commit to an absolute threshold of vulnerable households benefiting from the renovations. An example of a viable goal is at least 150,000 buildings inhabited by energy-poor or low-income households being renovated yearly since 2024. It would mean that at least 900,000 of the 2.4 million (37%) planned renovations until 2030 would target vulnerable households.

This idea brings up some complex issues, especially regarding how the administration will spend the available funds and how it will encourage investors to secure additional funding. To make a difference in fighting energy poverty through these renovations,

$$^8 \text{ Total Cost} = \sum_{i=1}^n (\text{Average Cost}_i \times \text{Building condition}_i \times \text{Energy poverty risk}_i)$$

Where:

- n is the number of different years of building construction considered.
- Average Cost_i is the average cost of modernization per square meter for buildings constructed in year i .
- $\text{Building condition}_i$ is the factor representing the building condition for buildings constructed in year i .

$\text{Energy poverty risk}_i$ is the factor representing the share of energy poverty risk for buildings constructed in year i .

Target year	Buildings renovated	Average renovation rate	Share of thermally insulated residential buildings in the total housing stock	Coal phaseout
2030	2.4 million	3.6%	70%	In cities
2040	5.2 million	4.1%	n/a	All residential buildings
2050	7.5 million	3.7%	65% of buildings with an EP<50 kWh/m ² /y, and 22% between 50 and 90 kWh/m ² /y	n/a

TABLE 4. Polish Long-Term Renovation Strategy targets

Source: Polish Long-Term Modernisation Strategy (Ministry of Development and Technology, 2022)

the Polish government needs to rethink how they finance these projects. The success of the Long-Term Strategy depends on a combination of policy changes: commitment to direct income transfers, pre-financing of investments, and substantial state contributions to bolster investment in social housing.

Creating financing mechanisms and attractive banking products will be a significant challenge. Banks must offer long payback periods and competitive interest rates to make thermo-modernisation investments financially viable. Direct financial support, such as grants and subsidies, is crucial in enabling thermo-modernisation investments, especially for households facing financial difficulties. The focus should be on non-repayable grants, aiming to cover the upfront expenses for households that may not have access to bank loans or struggle with repayment due to low income, limited consumption, or poverty. These grants serve as vital incentives, ensuring that thermo-modernisation projects are carried out effectively and inclusively. The reliance on transfers will gradually decrease, maintaining them at a level enough to encourage low-income household involvement in the subsidy programmes. Simultaneously, the role of loans should increase, adapting to the changing financial circumstances of households.

Managing the large inflow of EU funds for economic reconstruction and energy transition is a challenge for the entities responsible for its distribution, such as the National Fund for Environmental Protection and Water Management (NFOŚiGW), the Provincial Funds for Environmental Protection and Water Management (WFOŚiGW), local government administrations, and banks that start to establish themselves as stakeholders of the energy transition process.

To stimulate renovations, the Polish Long-Term

Building Renovation Strategy (Ministry of Development and Technology, 2022) outlines measures, including legislative measures (mainly EPBD-related), financial incentives such as grant schemes funded by the State budget and EU structural funds, and planning and organisational tools like National Energy advisers, Central Register of Building Emissions, and cooperation with Covenant of Mayors. The strategy emphasises the development of smart technologies and well-connected buildings and communities with energy-efficient construction. However, despite these advancements, a notable issue emerges in the strategy's approach to addressing the worst-performing building stock. While the 'Stop Smog' program targets energy-poor individuals residing in single-family homes and presents promising solutions, it does not effectively grapple with the challenge of renovating the most deficient building stock. This is a focal point for future refinement, especially considering the strategy does not establish explicit energy poverty reduction goals. This discrepancy highlights the need for a comprehensive strategy that integrates efforts like the 'Stop Smog' initiative and the broader Polish energy policy to effectively combat energy poverty and enhance the renovation of the most vulnerable buildings.

Finally, the document lays down the skill and educational needs in the construction sector, with planned training actions to meet the increasing demand for energy renovation specialised workers. The strategy estimates that energy renovation could create an additional 100,000 jobs in Poland. The injection of substantial funds into the economy for building renovation poses a challenge in matching the supply of building materials, construction teams and skilled human capital with the needs and pace of thermo-modernisation projects. The lack of preparedness of production companies and construction service providers and the shortage of

energy auditors and consultants may lead to inflationary pressures due to the high supply of capital, with a particular impact on the thermo-modernisation market segment. The new funding perspective for energy efficiency measures offers job creation and business development opportunities but also poses organisational challenges that require Polish companies and educational centres to be ready to train new staff.

In conclusion, the persistence of housing hardships in Poland highlights existing challenges despite the presence of policy tools and renovation initiatives. Questions arise concerning the accessibility of support schemes for low-income households and the efficient allocation of resources. Among the relevant support programs in Poland, the 'Thermo-modernisation and Renovation Fund' and the 'Clean Air Programme' stand out. While aiming to improve energy efficiency and combat energy poverty, these initiatives face difficulties in effectively reaching low-income households. Finally, it is worth noting that the Polish Long-Term Building Renovation Strategy reveals shortcomings, particularly in addressing the least-performing building stock and achieving energy poverty reduction goals.

7. Addressing Energy Poverty, Unfit Housing, and Enhancing Energy Efficiency in Poland

To address the challenges of energy poverty and unfit housing, it is essential to retrofit older buildings to improve their energy efficiency. Implementing measures such as improving insulation, upgrading heating systems and promoting renewable energy sources can significantly reduce the risk of energy poverty and improve the technical condition of buildings. Efforts should also be made to provide financial support, incentives, and educational programmes to help homeowners and occupants improve their buildings' energy performance. The best approach to utilising the 65 billion EUR should prioritise modernising and constructing new, energy-efficient social housing. The focus should be addressing the worst-performing building stock and targeting low-income and energy-poor households. A transparent system should be established to achieve this, considering social and environmental benefits in the decision-making process.

The funds should be allocated as full financing paid upfront, supported by municipalities and social workers who can identify the most vulnerable households needing renovation. By providing full financing, the authorities ensure the renovation process is swift and efficient without placing additional financial burdens on low-income families.

The administration should prioritise around 900,000 worst-performing units in the initial phase to start renovating the worst-performing stock. These units represent the buildings that require immediate attention due to their poor energy performance and living conditions. The funding should be directed towards providing grants that do not require repayment to these households. In addition to grants, some low-interest loans could also be considered to supplement the funding. However, most funds should be allocated as grants to ensure minimal burden on low-income households.

To reach the renovation targets effectively, setting yearly goals is essential. Considering the issue's scale, aiming to renovate 150,000 dwellings annually would be a practical yet challenging target. Focusing on the worst-performing stock and involving low-income households can make a meaningful difference in these buildings' living standards and energy efficiency. The upfront financing in the 'Clean Air Programme' could be extended to other support schemes as well, and with the support of municipalities and social workers, it would ensure the progress of the renovations and the realisation of the renovation targets.

Several measures can be taken to tackle energy poverty and improve housing conditions in Poland:

1. Extend the pre-financing support for low-income households to improve the energy efficiency of their homes offered in the 'Clean Air Programme' to other support schemes. This should include subsidies or low-interest loans for energy-saving improvements such as solar panels, heat pumps and energy efficiency improvements in multi-family buildings inhabited by low-income households.

2. Prioritise the swift implementation of an energy-saving obligation scheme. This initiative would be pivotal in enhancing energy efficiency across various sectors while addressing energy poverty concerns. To maximise the impact of the energy-saving obligation scheme, Poland must approach its planning with a clear focus on effective energy poverty alleviation. This entails careful consideration of how the scheme's investments can be aligned with other ongoing or planned initiatives to improve housing conditions and reduce energy poverty, e.g., allocating a portion of the investments foreseen within the energy saving obligation scheme to facilitate the renovation of the

worst-performing housing units.

3. Introduce regulations requiring developers to allocate a proportion of housing units for social purposes. In addition, developers should be responsible for providing social infrastructure. These obligations can be implemented at the local government level or through legislation. By increasing the availability of affordable housing and ensuring decent living conditions, these measures create inclusive communities, reduce housing inequality, and foster a sense of belonging. Such government support and sustainability can lead to long-term solutions, enabling households to move from unfit housing to safe and decent homes.

4. Facilitate access to housing for low-income earners by establishing a national rental housing programme with long-term financing through mechanisms such as housing bonds from Bank Gospodarstwa Krajowego. Local authorities can act as implementers of the programme.

5. Encourage the further development of social building societies (TBS) by incentivising local governments to transfer land to TBS. Increase funding for TBSs, including subsidies for the renovation of historic buildings. Adjust the income criteria for TBS eligibility, considering the relatively high wages and cost of living in large cities.

6. Initiate a discussion on regulations to control and limit short-term rentals. Establish guidelines that prevent the city's social fabric degradation. Create a government programme to meet the housing needs of students and learners, such as expanding university accommodation and school dormitories.

7. Increase the availability of social housing that meets energy efficiency standards. Provide funding for the construction or renovation of social housing, focusing on energy-saving features and sustainable building practices. Work with housing associations and NGOs to expand social housing options for vulnerable groups.

8. Involve social services that provide personalised support during the application process for energy assistance programs and offer technical guidance when needed. While public awareness campaigns remain important for promoting energy conservation and efficient practices, social services-based one-stop shops can play a significant role in offering

educational services. These shops can provide resources, information on energy conservation, and cost-effective energy solutions. However, to ensure accessibility and effectiveness for vulnerable communities, collaborating with social services will empower and accompany households throughout the renovation process, ensuring they can benefit from available assistance and technical support.

9. Promote and fund research initiatives to measure, monitor, and identify vulnerable households through administrative data. Policymakers can gain valuable insights into vulnerable households' specific characteristics and needs by leveraging administrative data sources, such as social welfare programs and housing registries. This data-driven approach will facilitate the development of targeted interventions and policies to effectively address energy poverty and housing challenges.

10. Enhance transparency and monitoring of energy poverty alleviation measures to ensure efficiency. It is crucial to ensure that the energy poverty alleviation measures are effectively planned and delivered to low-income households. Enhancing transparency and monitoring mechanisms becomes critical as the Energy Efficiency Directive (EED) constitutes the primary binding framework for EU-level energy poverty alleviation efforts. Therefore, robust monitoring and reporting mechanisms should accompany the energy-saving obligation schemes. These mechanisms should focus on tracking the reach and impact of energy savings measures on households, particularly those in vulnerable and energy poverty-affected categories. The monitoring can be achieved through access to data for independent researchers or in-house analysis developed by ministries and institutions responsible for implementing particular schemes. Ex-ante and ex-post evaluations will ensure the schemes' success in improving households' situation.

11. Developing robust energy efficiency financing programs in close collaboration with financial institutions is imperative. These programs should be meticulously tailored to extend accessible and affordable loan options that align with the unique needs of low-income families. Financial institutions can effectively empower these households to make energy-efficient renovations and adopt advanced technologies by offering loans characterised by low-interest rates and flexible terms. This, in turn, will substantially reduce their energy

consumption and associated utility costs. To ensure the efficacy of these programs, a comprehensive strategy encompassing education and training for bank personnel is essential. By providing thorough knowledge about the advantages of energy efficiency and a deep understanding of the distinctive circumstances of low-income households, bank staff can guide these families through the application process. This training should be equally extended to managers of multi-apartment buildings, equipping them with the expertise to lead energy-efficient renovation projects within their properties. A well-structured training curriculum should span topics ranging from energy audits and sustainable construction practices to available funding avenues and proficient project management techniques. Collaborative efforts with banks and public financial institutions to determine optimal levels of public incentives and loans can drive renovation uptake across varying income brackets.

poverty alleviation measures within the energy saving obligation scheme. By strengthening monitoring mechanisms and conducting research on the scheme's impact, policymakers can ensure that the objectives of Article 8 of the EED are met, leading to more effective and targeted energy poverty alleviation efforts.

12. Prioritise skill development and education within the construction sector. Investing in targeted training actions to meet the growing demand for specialised workers in energy renovation will play a pivotal role in achieving this goal. To start, it is essential to conduct a comprehensive assessment of the construction industry's current skill and education needs, specifically focusing on energy-efficient building practices. Identifying the specific skill gaps and knowledge deficiencies will enable the development of tailored training programs that address these areas effectively. The training initiatives should be designed to equip workers with the latest knowledge and best practices in energy-efficient construction techniques, renewable energy integration, and sustainable building materials. Continuous monitoring and evaluation of the training programs' effectiveness will help refine the curriculum and adapt to changing industry needs. Regular feedback from industry experts and participants will ensure the training initiatives remain relevant and impactful.

13. Learn from successful policy implementation in other countries and engage in public consultation, including forming citizens' panels. Issues for discussion could include the taxation of empty properties and measures to discourage the treatment of housing as a pure capital investment.

14. In conclusion, transparency and monitoring are key to the successful implementation of energy

8. Conclusion

The European Union faces a significant challenge as its building stock is highly inefficient. The renovation rate across the Member States varies, but it is evident that an increase in renovation efforts is urgently needed. Recognising this, the European Commission has prioritised the 'Wave of Renovation' strategy to promote comprehensive thermal renovation. Aligned with the European Green Deal's vision of a modern, resource-efficient, competitive, and decarbonised economy, the buildings sector is pivotal, intersecting environmental imperatives and economic ambitions. This urgency was outlined in the Energy Efficiency Directive and the Energy Performance of Buildings Directive. The resource constraints triggered by geopolitical events reinforce the salience of these directives, necessitating accelerated and coordinated efforts in their implementation.

In Poland, addressing energy poverty and inadequate housing presents significant challenges. Prioritising improvements in energy efficiency and housing quality is crucial. A key factor influencing energy consumption in Polish dwellings is the prevalent use of coal as the primary heating source, posing environmental concerns. To mitigate these challenges, a recommendation would be to encourage a gradual transition from coal-based heating systems to more sustainable and cleaner alternatives. Supporting incentives and initiatives that promote the adoption of renewable energy sources, such as solar, geothermal, or sustainable and clean biomass, can effectively reduce coal usage and contribute to a greener and more sustainable energy landscape in the country.

The report has shed a light on the persistent housing challenges in Poland, revealing poor housing conditions and energy poverty issues. The inadequate access to amenities and outdated heating systems underscores the urgent need for comprehensive solutions. The ageing building stock further exacerbates energy losses, particularly in structures predating the 1980s. Energy inefficiency remains a concern even for these buildings, reinforcing the need for ongoing renovation. These inefficiencies disproportionately impact vulnerable households, compounding their financial and living

“Supporting incentives and initiatives that promote the adoption of renewable energy sources...can effectively reduce coal usage and contribute to a greener and more sustainable energy landscape in the country.”

challenges. Approximately 11% of the population in Poland grapples with energy poverty, allocating a significant portion of their income to energy-related expenses. The disparities between urban and rural areas emphasise the complexity of the issue and the urgency for targeted interventions.

Furthermore, the report highlights the financial constraints low-income households face, hindering their ability to pursue home renovations independently. The concentration of wealth among affluent households leaves a substantial segment of the population without the means to improve their living conditions. This wealth disparity underscores the necessity of inclusive funding mechanisms to ensure that financially vulnerable households can access necessary resources for home improvements.

The examined policies and renovation initiatives, including the Thermo-modernisation and Renovation Fund and the Clean Air Programme, are crucial in addressing energy poverty and housing challenges. However, questions remain about the accessibility of these programs for low-income households and the optimisation of resource allocation. The Polish Long-Term Building Renovation Strategy also warrants further development to effectively address the energy performance of the building stock and achieve meaningful energy poverty reduction.

In order to renovate the high number of dwellings and achieve meaningful progress in improving energy efficiency and housing quality, Poland must prioritise adequate and socially targeted funding. Securing sufficient financial resources specifically earmarked for energy renovations and housing upgrades is essential to address the challenge's scale effectively. Poland should scrutinise the current distribution channels to determine whether they effectively reach low-income households in their current configuration. As this report reveals gaps and inefficiencies in the distribution of funds, appropriate adjustments and refinements must be promptly implemented. A further evaluation by public administration that has access to detailed data on the support beneficiaries should illustrate opportunities for enhancing the accessibility and reach of funding, thereby reinforcing its intended impact.

References

- Bouzarovski, S., Petrova, S., & Sarlamanov, R. (2012).** Energy poverty policies in the EU: A critical perspective. *Energy policy*, 49, 76-82.
- Camarasa, C., Kalahasthi, L. K., & Rosado, L. (2021).** Drivers and barriers to energy-efficient technologies (EETs) in EU residential buildings. *Energy and Built Environment*, 2(3), 290-301.
- Csoknyai, T., Hrabovszky-Horváth, S., Georgiev, Z., Jovanovic-Popovic, M., Stankovic, B., Villatoro, O., & Szendrő, G. (2016).** Building stock characteristics and energy performance of residential buildings in Eastern-European countries. *Energy and Buildings*, 132, 39-52.
- Davies, P., & Osmani, M. (2011).** Low carbon housing refurbishment challenges and incentives: Architects' perspectives. *Building and environment*, 46(8), 1691-1698.
- European Commission, (2022).** https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131
- European Commission, (2022).** https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
- European Commission, (2020).** A Renovation Wave for Europe—Greening our buildings, creating jobs, improving lives.
- Forum Energii (2019).** Ciepłownictwo w Polsce - edycja 2018. <https://www.forum-energii.eu/pl/analizy/cieplownictwo-2019>
- Hurnik, M., Specjal, A., Popiolek, Z., & Kierat, W. (2018).** Assessment of single-family house thermal renovation based on comprehensive on-site diagnostics. *Energy and Buildings*, 158, 162-171.)
- Kontokosta, C. E., & Jain, R. K. (2015).** Modeling the determinants of large-scale building water use: Implications for data-driven urban sustainability policy. *Sustainable Cities and Society*, 18, 44-55.
- Li, Y., Kubicki, S., Guerriero, A., & Rezgui, Y. (2019).** Review of building energy performance certification schemes towards future improvement. *Renewable and Sustainable Energy Reviews*, 113, 109244. <https://doi.org/10.1016/j.rser.2019.109244>
- Lujanen, M. (2010).** Legal challenges in ensuring regular maintenance and repairs of owner-occupied apartment blocks. *International Journal of Law in the Built Environment*, 2(2), 178-197.
- Lux, M., & Sunega, P. (2014).** Public housing in the post-socialist states of Central and Eastern Europe: Decline and an open future. *Housing Studies*, 29(4), 501-519.
- Matczak P., Frankowski J., Putkowska-Smoter R., Wróblewski M., Łoś I. (2023).** Tackling (Not Only) Air Pollution: Cross-sectional Tensions behind State-led Energy Retrofit Program in Poland, *Society & Natural Resources*, 36:9, 1140-1161, DOI: 10.1080/08941920.2023.2212286
- Menyhért, B. (2022).** The effect of rising energy and consumer prices on household finances, poverty and social exclusion in the EU, Publications Office of the European Union, Luxembourg, 2022, doi:10.2760/418422, JRC130650.
- Ministry of Development and Technology (2022) .** Polish Long-Term Building Renovation Strategy
- Muczyński, A. (2020).** Financial flow models in municipal housing stock management in Poland. *Land Use Policy*, 91, 104429.
- National Bank of Poland (2017).** Zasobność gospodarstw domowych w Polsce Raport z badania 2016 r. https://nbp.pl/wp-content/uploads/2022/09/Raport_BZGD_2016.pdf
- Nowak, K. (2021).** Krajowy i lokalny wymiar polityki mieszkaniowej.
- Papantonis, D., Tzani, D., Burbidge, M., Stavrakas, V., Bouzarovski, S., & Flamos, A. (2022).** How to improve energy efficiency policies to address energy poverty? Literature and stakeholder insights for private rented housing in Europe. *Energy Research & Social Science*, 93, 102832.
- Park, J. J. (2012).** Fostering community energy and

equal opportunities between communities. *Local Environment*, 17(4), 387-408

Sandberg, N. H., Sartori, I., Heidrich, O., Dawson, R., Dascalaki, E., Dimitriou, S., Vimm-r, T., Filipidou, F., Stegnar, G., Šijanec Zavrl, M., & Brat-tebø, H. (2016). Dynamic building stock modelling: Application to 11 European countries to support the energy efficiency and retrofit ambitions of the EU. *Energy and Buildings*, 132, 26–38. <https://doi.org/10.1016/j.enbuild.2016.05.100>

Sokołowski J. (2023). Peer effects on photovoltaics (PV) adoption and air quality spillovers in Poland, *Energy Economics*, Volume 125, 106808, ISSN 0140-9883, <https://doi.org/10.1016/j.eneco.2023.106808>.

Sokołowski, J., & Bouzarovski, S. (2022). Decarbonisation of the Polish residential sector between the 1990s and 2021: A case study of policy failures. *Energy Policy*, 163, 112848.

Sokołowski, J., Frankowski, J., & Lewandowski, P. (2023). Energy poverty, housing conditions, and self-assessed health: Evidence from Poland. *Housing Studies*. <https://www.tandfonline.com/doi/abs/10.1080/02673037.2023.2176831>

Sokołowski, J., Lewandowski, P., Kiełczewska, A., & Bouzarovski, S. (2020). A multi-dimensional index to measure energy poverty: The Polish case. *Energy Sources, Part B: Economics, Planning, and Policy*, 15(2), 92–112. <https://doi.org/10.1080/15567249.2020.1742817>

Statistics Poland (2020). Energy consumption in households in 2018 <https://stat.gov.pl/en/topics/environment-energy/energy/energy-consumption-in-households-in-2018,2,5.html>

Ürge-Vorsatz, D., & Herrero, S. T. (2012). Building synergies between climate change mitigation and energy poverty alleviation. *Energy policy*, 49, 83-90.



European Federation of National Organisations
Working with the Homeless
194 Chaussée de Louvain, 1210 Brussels, Belgium
T +32 (0)2 538 66 69 • information@feantsa.org

www.feantsa.org

Like us



Follow us



Connect with us

