









“Government support for addressing energy poverty in the context of low-carbon transition”

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GOVERNMENT SUPPORT FOR ADDRESSING ENERGY POVERTY IN THE CONTEXT OF LOW-CARBON TRANSITION

Abstract

The development and implementation of state policy to overcome energy poverty has become particularly important in Ukraine and requires adequate methods and tools to support consumers in transitioning to a low-carbon economy. The study aims to conduct a comparative analysis of energy poverty in the EU and Ukraine, evaluate the cost of government support for vulnerable households through subsidy mechanisms, and improve the methodology for calculating heating subsidies in Ukraine under low-carbon transition conditions. Based on statistical data, the study reveals the intensifying negative impact of the 2021–2022 energy crisis on households in both the European Union and Ukraine. The results of evaluating the cost and structure of energy subsidy portfolios indicate that most governments worldwide are shifting toward economic decarbonization and phasing out coal consumption subsidies in response to stricter climate obligations. The findings reveal that while energy subsidies in Ukraine are socially oriented, they place a significant burden on the state budget and fail to address the root causes of energy poverty. The paper explores the mechanism of fuel subsidies and argues that the implementation of energy efficiency measures must accompany the gradual elimination of such support. It also presents a calculation of heating subsidies based on the energy efficiency class of residential buildings, consistent with the goal of introducing NZEB standards. The formulated proposals seek to strengthen support for energy-vulnerable households and enhance monitoring activities to obtain more comprehensive and objective data on the extent of energy poverty in Ukraine.

Keywords

public finance, state budget, energy poverty, sustainable development, energy subsidies, fossil fuel subsidies, energy transition

JEL Classification

D62, I38, Q41, Q48

INTRODUCTION

The need to meet the EU's Paris Agreement commitments to reduce greenhouse gas emissions is strengthening the demand for greening national budgets. The Glasgow Climate Pact, adopted at COP26 in 2021, called for the phase-out of inefficient fossil fuel subsidies, which was later displayed in COP27 and COP28 documents. According to the European Commission, achieving current climate and energy targets by 2030 will require additional annual investments of 260 billion EUR. Therefore, greater use of green budgeting instruments will help redirect public investment toward environmental priorities by eliminating environmentally harmful subsidies.

In transitioning to a low-carbon economy, the question arises about the advisability of using energy and fossil fuel subsidies. At the same time, ensuring access to sustainable energy for the general population is of particular importance for Ukraine and requires strengthening public policies aimed at ending the spread of energy poverty. In this

regard, the feasibility of supporting energy-vulnerable households through energy subsidy instruments requires more detailed consideration.

The assessment of fossil fuel consumption subsidies in net fuel-exporting and net fuel-importing countries reveals differences that should be considered when calculating the budget burden. When conducting a comparative analysis of the cost and structure of the energy subsidy portfolio in different countries around the world, the question arises of choosing indicators that more accurately display the effectiveness of such subsidies as a tool for combating energy poverty.

In the context of the growing number of energy-vulnerable households in Ukraine, the mechanism of state subsidies must be improved, taking into account the efficiency of energy resource use, which entails revising the current methodology for calculating the cost of subsidies for heating housing.

The lack of formalized energy poverty criteria hinders government support measures for energy-vulnerable households in Ukraine at both the state and local levels. In this regard, there is a need to improve the regulatory framework to strengthen the focus of monitoring activities and obtain more complete and objective information on households' energy vulnerability.

1. LITERATURE REVIEW

The concept of energy poverty is believed to have been first introduced by Isherwood and Hancock (1979) during a significant growth in the number of households affected by energy crises following the oil shock in the early 1970s. One of the first scholars to focus on the need for broad population access to energy services was Brenda Boardman, who introduced the term “affordable warmth” and defined fuel poverty in the UK (Boardman, 1991). This theme has been further developed in the context of quantitative assessment of fuel poverty, namely that fuel poverty occurs when a household has to spend more than 10% of its income on fuel to maintain adequate indoor temperatures (Boardman, 1991; Foster et al., 2000).

Energy poverty is explored using the expenditure and consensus approaches. The expenditure approach links household energy poverty to low incomes and high energy prices (Hills, 2012; Rodriguez-Alvarez et al., 2021). The consensus approach defines energy poverty as the inability to meet the basic necessities of life that the broader community considers essential (Novak, 2020). The consensus approach is based on the hierarchy of needs theory (Maslow, 1943).

Implementing the concept of sustainable development for countries with a high level of debt burden in the context of geopolitical and climate threats

gives rise to new challenges and contradictions (Naumenkova et al., 2023; Yehorova et al., 2024). Moreover, energy deprivation is classified as one of the most significant problems of sustainable development (Han & Wei, 2021; Ulucak et al., 2021). It should be noted that there is no conceptual alignment and connection between concepts such as poverty, fuel, and energy (Primc et al., 2021). If the poverty of the population is assessed based on income or expenditure indicators, there is a need to use special indicators for end-to-end monitoring of energy poverty (Pachauri et al., 2004; Naumenkova et al., 2022). To achieve and shape decarbonization targets, the UK has introduced the Low Income Low Energy Efficiency (LILEE) measure, which adds energy efficiency to fuel poverty assessment (Andreoni, 2024).

Energy poverty is related to the availability of a minimum set of energy services, including lighting, cooking, heating, and cooling needs etc. (Legislation European Union, 2020; European Commission, 2024). The question arises of defining criteria for creating this minimum set for different countries. Novak (2020) examines energy poverty based on deprivation characteristics. Drescher and Janzen (2021) study the sustainability and dynamic properties of energy poverty.

Unevenly distributed energy consumption is viewed as a barrier to achieving sustainable development goals. Income differences have a direct

impact on increasing the carbon load. Thus, in 2019, the bottom 50% of the population accounted for only 12% of greenhouse gas emissions, while the richest 10% accounted for 48% (Chancel, 2022). According to Oswald et al. (2020), the richest 10% of the world's population accounts for 39% of the final energy footprint, while the poorest 10% are responsible for only 2%.

Different approaches are used to construct indicators and models for measuring energy poverty. Using multivariate analysis, Bardazzi et al. (2021) found that income inequality was significantly correlated with energy poverty indicators. Kashour and Jaber (2024) showed the results of an energy poverty study based on a composite index. Pachauri et al. (2004) propose a two-dimensional measure of energy poverty and energy distribution. Faiella and Lavecchia (2021) proposed an energy poverty assessment calculation in Italy based on the heating costs required to achieve a minimum comfort level. Croon et al. (2023) deepened the practical aspects of using Foster-Greer-Thorbecke indices in energy poverty.

The issue of affordable energy is fundamental in the context of an economy's digital development, as the availability of sustainable, affordable energy sources is essential for equal access to the Internet and digital financial services for the general population (Mishchenko et al., 2025).

The issue of developing policies to overcome energy poverty deserves special attention. Castaño-Rosa et al. (2019) examined initiatives and assessments of energy poverty in EU countries, noting the lack of a clear program to combat energy poverty in the European Union. Since the start of the global energy crisis, governments have spent approximately 900 billion USD on short-term measures to reduce consumer prices, in addition to existing support and subsidy programs; however, only a quarter of this amount has been spent on supporting low-income households and the hardest-hit industries (Monschauer & Bizeul, 2023). Makridou et al. (2024) used fixed-effect regression models to identify factors affecting energy poverty in European countries and discovered that renewable energy does not contribute to overcoming energy poverty in Europe.

Pysar et al. (2018) modeled a fuel poverty index for Ukraine's regions. Akizu-Gardoki et al. (2024) analyzed differences in direct and indirect energy consumption of the Spanish population.

Financial assistance measures for vulnerable population groups, reduction of energy prices, and improvement of energy efficiency of buildings are widely used in European countries to combat energy poverty (Rodriguez-Alvarez et al., 2021). Clements et al. (2013) and Kojima and Koplow (2015) revealed the specifics of estimating the fiscal cost of expenses based on energy subsidy provision. The increase in support adds to the financial pressure on both governments and utilities, which may raise rates to offset rising costs during an energy crisis.

The aim of this paper is to conduct a comparative analysis of energy poverty in the EU countries and Ukraine, to assess the cost of government support for energy-vulnerable households through energy subsidies, and to propose an improved methodology for calculating heating subsidies for the Ukrainian population within the framework of the low-carbon transition.

2. METHODS

The study's methodological basis is the recommendations of the UN, OECD, IMF, European Commission, and International Energy Agency on implementing just energy transition principles. The content of the energy poverty, energy subsidies, and fossil fuel subsidies concepts is disclosed, and a comparative analysis of energy poverty in EU countries is carried out, taking into account the requirements of the legislative framework of EU countries. The value and structure of the energy subsidy portfolio in the EU countries were analyzed based on data from Eurostat and the State Statistics Service of Ukraine.

The International Energy Agency (IEA) approaches were used to assess the cost and structure of subsidies for fossil fuels consumed directly by end consumers or used as raw materials for electricity generation. This ensures the correctness of comparative data analysis from different countries, depending on their role in the energy market as exporters or importers.

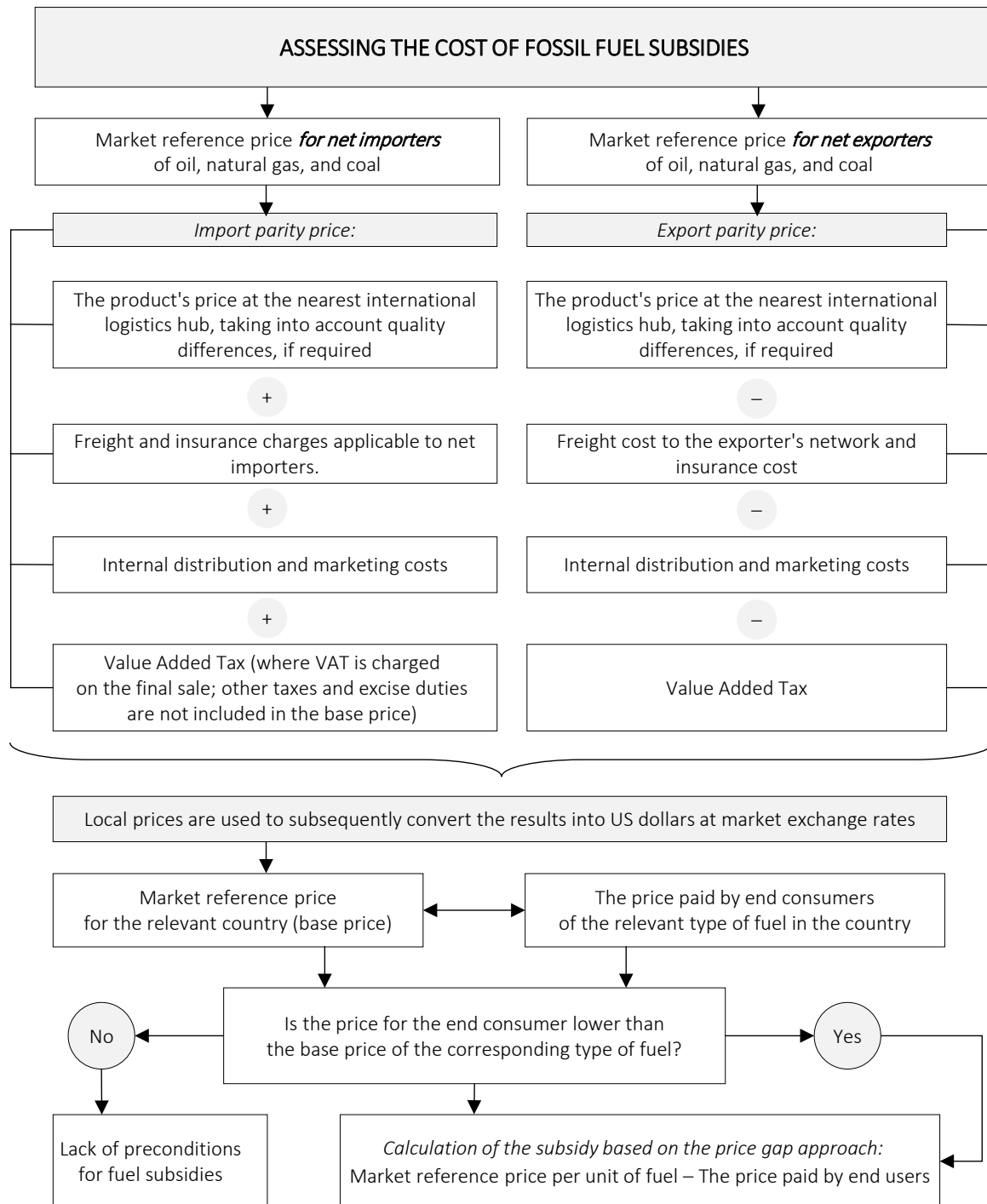


Figure 1. Sequence of estimating the cost of fossil fuel consumption for energy-exporting and energy-importing countries

The decision on whether to subsidize fossil fuels for end consumers is made based on the price-gap approach. According to international practice, subsidization occurs when a price gap exists between the basic reference price and the end-use price. Figure 1 presents a sequence of estimates of the cost of fossil fuel consumption subsidies for

energy-exporting and energy-importing countries based on this method.

The analysis of the cost of energy subsidies applies the 'inventory approach' used by the OECD to identify and value measures to support the production and consumption of fossil fuels in OECD

countries and selected partner countries (OECD, 2015, 2023). Based on this approach, the cost of government subsidies covers all direct budget transfers, tax expenditures, and incentives that provide any form of benefit or advantage to the production or consumption of fossil fuels compared to alternative energy sources.

3. RESULTS AND DISCUSSION

Due to the deteriorating energy market situation, addressing energy poverty will be a major priority in the foreseeable future (EU, 2023). A significant increase in prices for the main types of fuel resources in 2022–2023 necessitates increased attention from governments in most countries to supporting energy-vulnerable households.

According to the European Commission, rising energy prices in recent years (Figure 2) and the cost-of-living crisis have led to the number of people in energy poverty rising to 40 million in 2022 (EU, 2023).

Energy poverty is defined as “the lack of access by a household to basic energy services for a decent standard of living and health, including adequate heating, hot water, cooling, lighting and energy to power appliances, in the relevant national context, existing social policies and other relevant policies, caused by a combination of factors including, but

not limited to, lack of affordability, inadequate income, high energy costs and low energy efficiency of homes” (Council of the European Union, 2023).

The European Commission provides recommendations for assessing energy poverty based on the use of a system of metrics that can be divided into four groups:

- income-based energy poverty metrics: compare the amount households spend on energy with their income;
- self-assessment metrics: based on the answers that households provide to the questions asked (e.g., the ability to keep the home sufficiently warm in winter and sufficiently cool in summer);
- direct measurement-based metrics: measure physical variables to determine the adequacy of energy services (e.g., room temperature);
- indirect metrics: measure energy poverty through related factors such as a number of power outages, utility debt, and housing quality (Legislation European Union, 2020).

Energy poverty is a central concept in the “Clean Energy for All Europeans” legislative package, which seeks to promote a just and inclusive energy transition. The European Pillar of Social

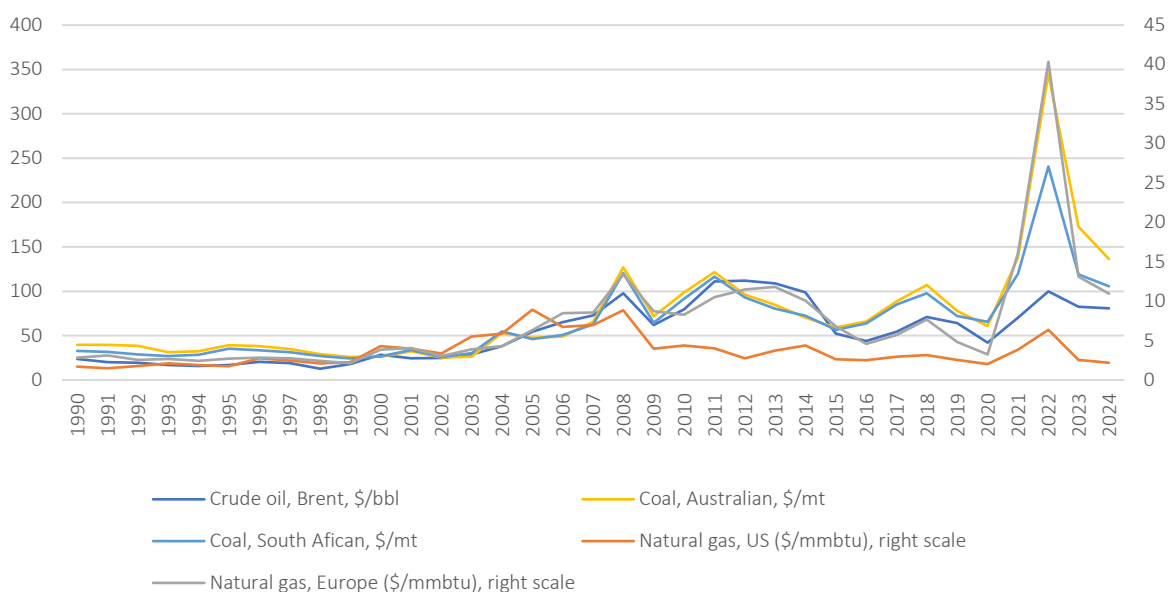


Figure 2. Fossil fuel annual prices in 1990–2024

Rights recognizes access to energy as a fundamental right that must be guaranteed for all individuals, regardless of income or social status (Legislation European Union, 2017; European Commission, 2019).

The concept of energy poverty is closely linked to broader issues such as general poverty, vulnerable households, and energy security. As a result, various indicators are used to analyze and monitor the phenomenon, depending on the scale and context of assessment. According to the Legislation European Union (2020), key indicators for measuring energy poverty include:

- the poverty rate (defined as the share of the population at risk of poverty, i.e., living on less than 60% of the national average);
- inability to maintain adequate indoor heating levels;
- arrears in the payment of utility bills;
- household expenditure on electricity, gas, and other fuels.

Primary information for monitoring energy poverty is obtained based on sociological surveys, in particular, on the results of household budget surveys (HBS) – national surveys conducted by EU member states and coordinated by Eurostat. Generally, the survey is conducted every four years. Consequently, the dynamics of household expenditure on electricity, gas, and other fuels in an unstable situation on energy markets have high volatility, which makes it difficult to obtain objective information in terms of medium-term dynamics.

In 2023, according to the Classification of Individual Consumption According to Purpose (COICOP), approximately 94.6 million people, or 21.4% of the total population, in EU countries were at risk of poverty or social exclusion (Table 1).

The highest rates were recorded in Romania (32%), Bulgaria (30%), Spain (26.5%), and Greece (26.1%). People at risk of poverty are at significantly higher risk of not being able to adequately heat their homes. The number of EU citizens un-

able to maintain sufficient heat at home was 7.5% in 2020 and 10.6% in 2023. The number of people unable to maintain a proper temperature in their homes remained high in Eastern, Central, and Southern European countries, and in Bulgaria, Greece, Spain, Lithuania, and Portugal, the values of these indicators in 2023 were the highest among EU countries. The situation worsened in France, Italy, Czechia, the Netherlands, Ireland, and other European countries.

More than 30 million Europeans (6.9% of the EU population) were in arrears with their utility bills in 2023. Expenditures on electricity, gas, and other fuels in the structure of household expenditure reached 9–10% in Bulgaria, Czechia, Poland, and Slovakia. In 2023, the proportion of the population in the Eurozone countries living in premises with dampness, leaks, and rot increased to 18%.

National legislation has no definition of energy poverty with clear formalized criteria. However, implementing the EU's Third Energy Package in Ukraine has led to the term 'vulnerable consumers' in Ukrainian legislation on natural gas and electricity markets.

Access to energy services for the Ukrainian population has deteriorated significantly in the context of prolonged military actions, extensive damage to energy infrastructure, declining incomes, and economic uncertainty. Thus, the number of Ukrainians living in poverty is approximately 29% of the population. According to a World Bank sample survey conducted in June 2023, approximately a quarter of Ukraine's population lacked sufficient funds to purchase food, and about a fifth of households were unable to pay for utilities (World Bank, 2024). The proportion of the Ukrainian population unable to provide adequate heating for their homes increased from 9.2 to 17.2% between 2010 and 2021. The situation is particularly threatening for the rural population, 26.4% of whom could not maintain adequate heating at home.

The spread of energy poverty has forced governments in many countries to pay more attention to protecting energy-vulnerable households. At the same time, in the context of constant attention to the implementation of climate commitments, calls are increasingly being made to abandon en-

Table 1. Values of the key energy poverty indicators in the EU countries and Ukraine*

Source: EU (n.d.) and data of the State Statistics Service of Ukraine.

Country	Persons at risk of poverty or social exclusion, %		Inability to keep home adequately warm, %		Arrears on utility bills, %		Total population living in a dwelling with a leaking roof, damp walls, floors, or foundation, or rot in window frames or floor, %		Electricity, gas, and other fuels in the structure of consumption expenditure by COICOP consumption purpose, % ¹
	2020	2023	2020	2023	2020	2023	2020	2023	2020
EU – 27 countries (since 2020)	21.5	21.3	7.5	10.6	6.5	6.9	14.8	15.5	n/a
Eurozone countries – 20 countries (since 2023)	21.5	21.6	7.8	11.3	6.1*	6.9	16.7*	18.0	n/a
Austria	16.7	17.7	1.5	3.9		5.5	9.1	10.5	4.1
Belgium	20.3	18.6	4.1	6.0	3.8	3.7	15.7	14.5	4.5
Bulgaria	33.5	30.0	27.5	20.7	22.2	17.8	11.0	8.4	9.2
Croatia	20.5	20.7	5.7	6.2	13.6	11.6	9.4	5.6	7.4
Cyprus	17.6	16.7	20.9	16.9	9.2	9.0	39.1	31.6	3.7
Czechia	11.5	12.0	2.2	6.1	1.9	1.9	6.8	8.5	10.3
Denmark	16.8	17.9	3.0	6.9	4.2	4.7	16.8	15.0	6.3
Estonia	22.8	24.2	2.7	4.1	3.3	4.6	10.2	10.5	5.6
Finland	14.9	15.8	1.8	2.6	7.1	7.4	4.5	5.3	3.8
France	19.0	20.4	6.7	12.1	5.5	7.5	18.0	21.1	4.3
Germany	20.4	21.3	7.0	8.2	3.3	5.4	12.0	16.0	5.2
Greece	27.4	26.1	17.1	19.2	28.2	32.9	12.5	13.5	6.4
Hungary	19.4	19.7	4.2	7.2	10.4	7.3	20.4	12.6	6.5
Ireland	19.1	19.2	3.6	7.2	8.2	7.6	16.3	n/a	n/a
Italy	24.9	22.8	8.3	9.5	6.0	4.1	19.6	17.1	4.8
Latvia	25.1	25.6	6.0	6.6	8.3	7.0	17.5	18.8	7.1
Lithuania	24.5	24.3	23.0	20.0	6.3	6.5	10.9	8.6	8.0
Luxembourg	19.9	21.4	3.6	2.1	2.9	4.8	15.4	18.0	2.6
Malta	19.9	19.8	7.2	6.8	6.3	4.9	6.1	7.2	2.8
The Netherlands	16.0	15.8	2.4	6.9	1.5	1.2	14.8	15.4	4.0
Poland	17.0	16.3	3.2	4.7	4.7	4.0	6.0	5.7	9.1
Portugal	20.0	20.1	17.5	20.8	3.5	3.8	25.2	29.0	n/a
Romania	35.6	32.0	10.0	12.5	13.9	13.6	10.0	7.5	n/a
Slovakia	13.8	17.6	5.7	8.1	5.2	7.2	4.9	5.8	10.5
Slovenia	14.3	13.7	2.8	3.6	9.4	6.6	20.8	18.5	6.6
Spain	27.0	26.5	10.9	20.8	9.6	9.6	19.7	23.0	4.3
Sweden	17.7	18.4	2.7	5.9	2.4	3.3	7.1	4.8	n/a
Ukraine, in general*	n/a	n/a	n/a	17.2	n/a	15.4	n/a	8.2	16.6
Rural population	–	–	–	26.4	–	18.3	n/a	11.5	15.5
Urban population	–	–	–	12.6	–	13.9	n/a	6.5	16.9

Note: ¹ Calculated based on the results of a household survey every 4 years. * For Ukraine, data from the latest survey results for 2021 are provided.

ergy subsidies, which remain an important instrument of state support for the population. Energy subsidies are “government measures that affect the prices or costs of energy. They vary greatly in size and type across fuel industries, end-use sectors, and countries” (Morgan, 2007).

According to the WTO, a subsidy is “a financial contribution by a government or an agent of a

government that provides a benefit to the recipients” (Kojima & Koplow, 2015). According to the IMF, energy subsidies are categorized into two types: consumer subsidies and producer subsidies. Consumer subsidies are introduced when prices at final consumption for households are lower than the cost of supply, including transport costs. Producer subsidies are applied when prices exceed this level (Clements et al., 2013).

Table 2. Types of energy subsidies

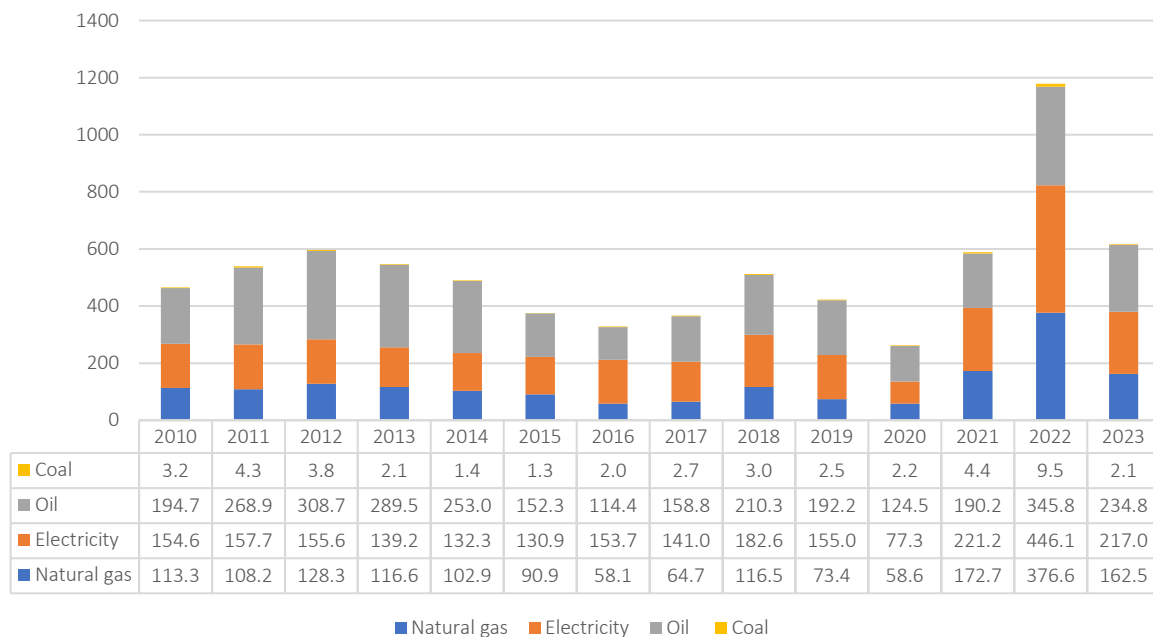
Type of subsidies	Characteristics and direction of use
Direct transfers of funds	<ul style="list-style-type: none"> • Direct payments, budgetary and extra-budgetary transfers • State purchase of shares in energy sector enterprises
Indirect transfers and price support	<ul style="list-style-type: none"> • State setting lower prices for energy resources • Regulation of prices for energy sector services and state-owned energy infrastructure facilities
Tax expenses	<ul style="list-style-type: none"> • Tax incentives • Government spending on capital injections at below-market rates • Below-market lending to energy-related businesses, including loans to energy exporters, as well as debt restructuring and cancellation
Risk transfer	<ul style="list-style-type: none"> • Credit guarantees • Restructuring and debt relief • Insurance and compensation for damages • Acceptance of risks related to occupational health and safety and accidents • Taking responsibility for eliminating damage to the environment

World Bank documents use the term ‘fossil fuel subsidies’ to describe deliberate government policy actions aimed at reducing the cost of purchased energy, reducing the costs of producing or delivering fuel, electricity, or heat, and increasing the revenues of resource owners or suppliers of fuel, electricity, or heat.

Energy subsidies differ in the form of provision, types, and nature of impact (Table 2).

Direct payments and budget transfers to consumers and producers are simple and transparent forms of support, but they require significant ac-

counting and transaction costs and place a significant burden on the state budget. Direct budget transfers are sometimes used as a price control instrument, resulting in lower full-cost prices, particularly when the energy company is state-owned or there are requirements for energy buyers to obtain a minimum quantity from a specific, usually local, source of supply. Thus, energy subsidies are not only an instrument of state support for households, social protection, or prevention of environmental pollution or global warming. Various countries also actively use them to strengthen their positions in international trade and provide competitive advantages to individual producers.



Note: The data provided cover the value of the fossil fuel subsidy used by end consumers or as inputs to electricity generation for 82 countries worldwide.

Figure 3. Cost of fossil fuel subsidies 2010–2023, billion USD (in real prices)

Assessing the budgetary burden of fuel subsidies deserves special attention. According to OECD methodological approaches, in 2022, the cost of state support for fossil fuels reached the highest level of 1,483.3 billion USD. In the 2022 expenditure structure, 81% was allocated to support consumers (both households and companies), 16% to support producers, and 3% to support general services (OECD, 2023).

In contrast to the OECD approach, the IEA defines energy subsidies as fossil fuel subsidies associated with any government action that affects the energy sector and results in lower costs of energy production, higher prices received by energy producers, or lower prices paid by energy consumers. Thus, the scope of this approach is narrower compared to the methodology applied by the OECD.

An analysis of fossil-fuel subsidy dynamics indicates a rapid increase in their value in 2022 – to 1,126 billion USD, equal to 1.1% of global GDP (Figure 3). The data presented following the IEA methodology are based on local prices with subsequent conversion of the results into US dollars at market exchange rates.

In 2023, fossil fuel subsidies fell sharply to 616.4 billion USD or nearly 0.6% of global GDP. The bulk of energy subsidies are in non-OECD countries, where they are used primarily to support end consumers through price reductions. In OECD countries, the focus of subsidies is somewhat different: the majority of subsidies are allocated to the production side, primarily through direct transfers to producers or funding for research and development activities.

An analysis of the structure of fossil fuel subsidies suggests that governments in most countries are moving toward supporting policies to decarbon-

ize the economy. Thus, the share of subsidies for coal consumption decreased in 2023 to a record low of 2.5% (Table 3).

Reducing the cost of subsidizing coal reduces its price for end consumers and stimulates the consumption of this type of fuel. This, in turn, leads to increased carbon dioxide emissions and other greenhouse gases.

The share of oil subsidies in the global fossil fuel subsidy portfolio peaked between 2012 and 2014, fluctuating between 53% and 55%. However, in 2022–2023, the share of this type of subsidy decreased by about 36–39%. As noted above, in conditions of high price volatility in the energy market, many countries actively use oil subsidies to ensure competitive advantages in international trade.

The share of electricity subsidies accounted for one-third of the global portfolio of fossil fuel subsidies, calculated based on data from 82 countries. This type of subsidy is important in supporting energy-poor households' access to a stable electricity supply. The value of electricity subsidies was the highest in 2022 at 422.7 billion USD, or 31.4% of total subsidies (Table 3). It should be noted that the share of households in the final electricity consumption structure in EU countries is gradually growing, increasing from 27.2 to 28.7% over 2015–2023 (Appendix A).

Given the fiscal burden, the impact of subsidies differs between energy-importing and energy-exporting countries. In energy-importing countries, fuel subsidies aimed at lowering end-user prices in the domestic market often result in a substantial increase in public expenditure. In contrast, for energy-exporting countries, subsidies may not impose a direct budgetary cost but instead represent

Table 3. Structure of fossil fuel consumption subsidies in 2010–2023, %

Source: Compiled based on OECD (2024) data.

Products	Structure of fossil fuel consumption subsidies, %													
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Natural gas	23.1	19.8	21.2	20.7	19.9	22.1	17.6	17.4	21.0	16.6	20.0	26.9	30.4	31.2
Electricity	27.1	24.9	22.5	20.9	21.7	26.2	34.1	28.8	25.3	26.7	20.6	29.0	31.4	27.7
Oil	44.8	51.4	52.9	55.0	54.5	46.4	42.8	47.8	48.8	51.4	52.5	39.9	35.5	38.6
Coal	5.0	3.9	3.4	3.4	3.9	5.3	5.5	6.1	5.0	5.3	6.8	4.3	2.7	2.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

a form of the lost rent from selling energy resources on the external market at higher prices.

In 2023, the largest amounts of fossil fuel subsidies were spent by the Russian Federation (126.3 billion USD) and Iran (81.2 billion USD). In Iran, Venezuela, Uzbekistan, and Algeria, fossil fuel subsidies reached 22-36% of GDP in 2022–2023.

The cost of subsidies per capita is a more accurate indicator for determining the social focus of subsidies. The highest values of this indicator were observed in fossil fuel-importing countries (Bahrain, Kuwait, Qatar, Saudi Arabia, the UAE, and Turkmenistan), where the cost of subsidies per capita in 2022–2023 ranged from 2,000 to 5,000 USD (Table 4).

In Ukraine, in 2022, the total amount of fossil fuel subsidies was 19.61 billion USD, almost 13% of GDP. Compared to 2021, this amount has almost doubled, from 9.66 to 19.61 billion USD. However, in 2023, due to military actions and the deterioration of public finances, subsidies decreased significantly to 5.24 billion USD, which amounted to about 3% of GDP (Table 4). In 2022, the cost of fossil fuel subsidies per capita in Ukraine was 7.5 times higher than the established general current subsistence minimum.

When analyzing the situation in Ukraine, it is important to note that electricity subsidies have dominated the overall subsidy structure, with their share rising from 41.36% in 2010 to 71.86% in 2023 (Table 5).

Table 4. Fossil fuel consumption subsidies in 2022–2023

Source: Compiled based on IEA data (n.d.).

Country	Subsidies per capita, USD		Total amount of subsidies provided*			
			USD billion		relative to a country's GDP, %	
	2023	2022	2023	2022	2023	2022
Fossil fuel-exporting countries						
Kuwait	2077.16	4939.37	8.95	21.08	5.53	11.42
Qatar	1895.21	3762.49	5.15	10.14	2.20	4.50
Bahrain	1894.85	2797.00	2.81	4.11	6.30	9.28
Saudi Arabia	1604.61	2113.36	59.29	76.94	5.55	6.94
The UAE	1477.48	3922.60	14.06	37.03	2.79	7.30
Libya	1168.62	1784.14	8.05	12.15	17.88	27.58
Turkmenistan	955.39	2385.49	6.23	15.34	8.07	19.67
Iran	917.50	1433.77	81.82	126.96	20.28	36.05
RF	881.50	1124.37	126.31	160.86	6.32	7.26
Kazakhstan	768.24	1794.37	15.24	34.45	5.85	15.26
Algeria	583.16	1109.99	26.595	56.935	10.87	25.51
Azerbaijan	496.04	1103.90	5.07	11.24	6.62	16.08
Venezuela	468.03	453.10	13.50	12.82	24.13	21.61
Uzbekistan	307.01	640.38	11.11	22.72	2.96	28.25
Egypt	257.07	596.56	28.98	66.21	7.36	13.93
Argentina	195.00	438.95	9.07	20.21	1.38	3.20
Fossil fuel-importing countries						
Austria	n/a	232.18	n/a	1.17	n/a	0.44
Great Britain	n/a	217.77	n/a	5.98	n/a	0.48
India	33.15	19.78	47.36	55.62	1.33	0.83
China	34.73	73.32	49.03	103.55	0.28	0.57
Poland	n/a	468.93	n/a	2.97	n/a	2.71
The Slovak Republic	n/a	278.37	n/a	1.06	n/a	1.38
France	n/a	173.52	n/a	6.57	n/a	0.42
Croatia	n/a	418.43	n/a	0.66	n/a	2.28
Ukraine	149.05	490.85	5.24	19.61	2.96	12.94

Note: * in real terms, taking into account the base prices of the corresponding year according to the IEA methodology.

Table 5. Fossil fuel subsidies in Ukraine in 2010–2023*

Source: Compiled based on IEA (n.d.) data.

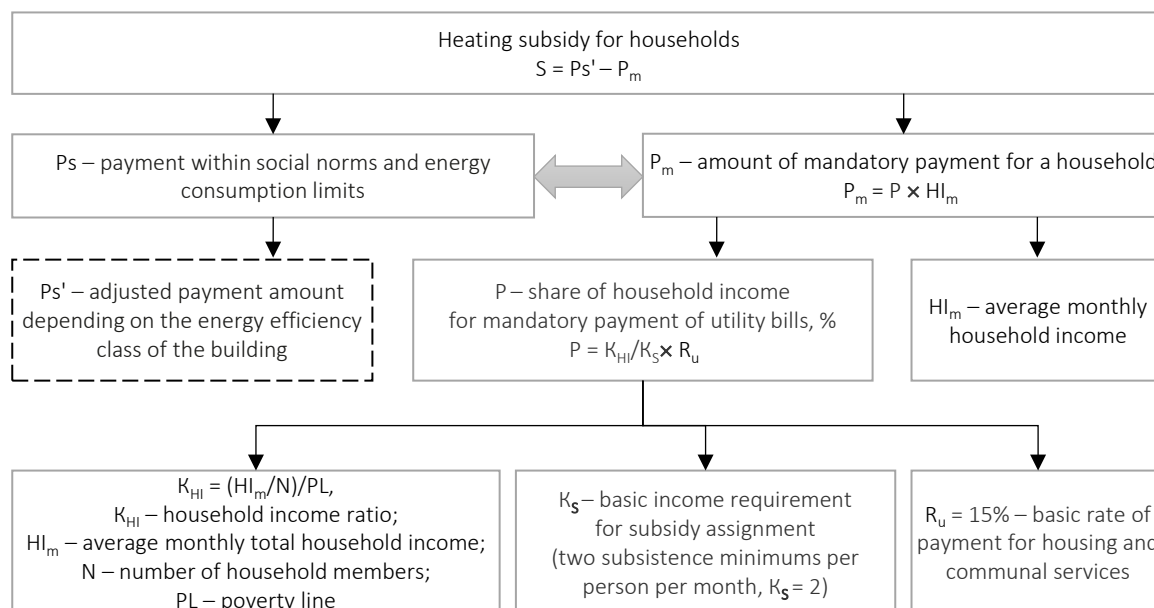
Year	Total, USD billion	Electricity		Natural gas	
		USD billion	% of total subsidies	USD billion	% of total subsidies
2023	5.242	3.767	71.86	1.475	28.14
2022	18.290	10.840	59.27	7.450	40.73
2021	11.322	8.302	73.33	3.020	26.67
2020	2.897	2.897	–	n/a	–
2019	3.318	3.318	–	n/a	–
2018	7.152	5.556	77.69	1.596	22.31
2017	4.868	4.868	100.00	n/a	–
2016	6.172	6.172	100.00	n/a	–
2015	12.361	7.620	61.64	4.741	38.36
2014	15.042	6.565	43.64	8.477	56.36
2013	14.688	5.174	35.22	9.514	64.78
2012	17.351	5.115	29.48	12.236	70.52
2011	20.162	6.816	33.81	13.345	66.19
2010	18.040	7.462	41.36	10.578	58.64

Note: * – The data provided include the cost of gas subsidies for end-use and subsidies for fuel used as a resource for electricity generation.

The growing number of energy-vulnerable households in Ukraine requires the development of a national concept for overcoming energy poverty with the corresponding consolidation of basic provisions harmonized with EU standards in the legislative framework. Given the difficult situation during the 2024–2025 heating season, the Ukrainian government continued providing subsidies to households. Thus, in recent years, about a third of Ukrainian households have received subsidies, leading to the need to improve the mecha-

nism for providing subsidies as a tool for combating energy poverty. A situation in which spending on energy efficiency programs accounts for only 1/20 of the subsidy funding volume is clearly doomed to perpetuate itself (DiXi Group, 2019).

In this regard, it is advisable to examine the methodology for calculating subsidies for heating housing, which is an important tool for protecting the population in the context of increasing energy poverty in Ukraine (Figure 4).

**Figure 4.** Calculation of the cost of heating subsidies for households

A household receives subsidies when the cost of heating the home, calculated using social housing standards and maximum energy consumption indicators, exceeds the cost of the mandatory payment for the household based on its average monthly income (Figure 4).

Determining the share of income (R_u) that a household can use to pay for utilities (in this case, for heating) is difficult due to numerous coefficients. In Ukraine, the value of this indicator is 15%.

The use of social norms and maximum standards when calculating the amount of payment for utilities is an important factor in strengthening the social protection of the population and protecting it from the spread of energy poverty. The social housing norm is 21 m² of heated area per person and an additional 10.5 m² per family. The monthly energy consumption standards for heating housing are set per 1 m² of heated area in the amount of:

- electricity: 30 kWh/1 m²;
- thermal energy for centralized or autonomous heating: 0.0383 Gcal/1 m²;
- natural gas for individual heating: 4 m³/1 m².

The existing subsidy methodology aims to support low-income populations and directly depends on the average monthly total household income, as well as the subsistence minimum.

Energy poverty is a consequence not only of the low incomes of the population but also of irrational use of energy, which depends on the energy efficiency of buildings, a significant part of which was seriously damaged during the military actions in Ukraine.

Table 6. Value of the coefficients for adjusting the heating fee depending on the building's energy efficiency class

Energy efficiency class of the building	Value, ΔE , %	Heating fee adjustment coefficient, C_e
A	$\Delta E < -50$	0.90
B	$-50 \leq \Delta E < -20$	0.95
C	$-20 \leq \Delta E \leq 0$	1
D	$0 < \Delta E \leq 20$	1.05
E	$20 < \Delta E \leq 35$	1.05
F	$35 < \Delta E \leq 50$	1.1
G	$50 < \Delta E$	1.1

In this regard, this study proposes to apply heating fee adjustment factors depending on the energy efficiency class of the building (Table 6).

In Ukraine, seven energy efficiency classes of buildings have been established – from A to G (MinRegion, 2018). The energy efficiency class of buildings depends on the value of ΔE – the percentage difference between the total (E_{use}) and the limit (E_{lim}) values of specific energy consumption (for heating and cooling), kWh/m².

The formula for calculating ΔE :

$$\Delta E = \left[\frac{(E_{use} - E_{lim})}{E_{lim}} \right] \cdot 100, \quad (1)$$

where E_{use} is the overall indicator of specific energy consumption for heating and cooling the building, kWh/m², and E_{lim} is the limit value of specific energy consumption for heating and cooling residential and public buildings, kWh/m².

Table 7 presents the calculation of the heating subsidy for two-person families. As the calculation results show, with an increase in the poverty line (PL), the value of subsidies will increase, which inevitably leads to an increase in the burden on the budget (Table 7). Adjusting payments based on the energy efficiency of buildings is a more appropriate approach and aligns with the transition toward implementing NZEB (Nearly Zero-Energy Buildings) standards (Legislation European Union, 2018).

At the same time, the implementation of measures to improve the energy efficiency of buildings based on the created Energy Efficiency Fund indicates the insufficiency of accumulated funds. With this

Table 7. Example of calculating heating subsidies for households

Indicator	Subsidy amount according to current social norms		Subsidy amount by options				
	Household 1	Household 2	Increase in the subsistence minimum	Adjustment of heating charges depending on the building's energy efficiency			
HI_1	60,000	46,800	46,800	46,800	46,800	46,800	46,800
HI_2	48,000	33,500	33,500	33,500	33,500	33,500	33,500
Average monthly income per family member: $(\sum HI_n)/12$	4,500.00	3,345.83	3,345.83	3,345.83	3345.83	3345.83	3,345.83
The poverty line (PL)*	2,920	2,920	4,100	2,920	2,920	2,920	2,920
Mandatory payment amount (P_m)	12,482.88	6,900.78	6,900.78	6,900.78	6,900.78	6,900.78	6,900.78
Amount of payment according to current social norms (P_s)	9,100	9,100	9,100	9,100	9,100	9,100	9,100
Coefficient corresponding to the energy efficiency class of the building (C_e)	1.0	1.0	Not applicable	0.95	1.05	1.1	1.15
Payment amount depending on the energy efficiency class of the building (P_s')	–	–	–	8,645	9,555	10,010	10,465
Heating subsidy amount ($P_s' - P_m$)	0.0	2,199.22	4,298.84	1,744.22	2,654.22	3,109.22	3,564.22

Note: * The poverty line in Ukraine in 2025 (about 70 USD).

in mind, it is desirable to accelerate the development of local energy plans at the community level, which should be consistent with the National Action Plan for Energy Efficiency. However, as of April 2024, only a few communities out of 1,439 existing ones had developed and approved local energy plans, which is explained by the difficult internal situation in Ukraine under martial law.

An important avenue for overcoming energy poverty is ensuring population access to sustainable energy and introducing modern European practices in stimulating green energy production

(Verkhovna Rada of Ukraine, 2015). However, in the context of continued military actions in Ukraine, access to alternative energy sources for energy-poor households is becoming more difficult, thus also affecting the increase in energy poverty. This is primarily due to the significant destruction of energy infrastructure. Thus, at the beginning of 2024, the capacity of Ukrainian wind generation reached 1,900.8 MW; however, wind power plants operated at only 30.7% of their capacity. In addition, problems with settlements with operators under the 'green tariff' have worsened (Figure 5). This led to the creation of a

**Figure 5.** Level of settlements with electricity producers under the green tariff in 2021–2024, %

working group on debt repayment in the electricity market in January 2024.

The establishment of an energy poverty monitoring system warrants special attention in the context of energy subsidies and support for households. Thus, it is advisable to apply clearer criteria and approaches to the formation of target groups of the population in the process of energy monitoring. Before the war in Ukraine, the State Statistics Service conducted household income surveys and assessments of material deprivation every two years. Given the situation in Ukraine, it would be appropriate to improve the organization of surveys based on three target groups of respondents:

- adult population – individuals who have an adequate income level but do not have stable access to energy sources and cannot satisfy their need for energy services;
- adult population – individuals who have stable access to energy services but cannot receive them for various reasons, including low income;
- adult population – individuals who do not have stable access to energy sources and lack the financial means to satisfy their need for energy supply services.

The population in these three groups can be classified as energy poor, and those in the last group can be classified as energy vulnerable. The feasibility of this approach will enable a more accurate formulation of a list of government support measures to address energy poverty for various population groups. In addition, implementing this approach will allow for the separation of measures to combat energy poverty from the system of state support for low-income households.

Thus, to overcome energy poverty in Ukraine, additional measures are needed at the state and regional levels aimed at increasing the energy efficiency of buildings, as well as identifying additional sources of funding for energy renovation programs for buildings.

The issues of determining the volumes of energy needs and their threshold values for assessing the level of energy poverty in Ukraine are debatable.

What is the structure of needs a person should satisfy based on access to stable energy sources? It is worth noting that social energy consumption standards should be based on household needs and considered when determining the threshold level of energy poverty. Ensuring access to energy should be seen in the context of digital development and the recognition of digital rights as a fundamental right for every person.

Due to the intensification of internal and external migration processes under martial law, it is impossible to organize monitoring of energy poverty in Ukraine using EU statistical indicators (EU, n.d.). Energy poverty of the population can be identified using indirect indicators – signs of deprivation. The frequency of surveys for various groups of respondents in Ukraine also affects the receipt of objective information, given the unstable situation in the energy markets.

When considering how to overcome energy and fuel poverty, more holistic approaches are needed to take into account technological and engineering factors (Abbasi et al., 2022; Naumenkova et al., 2024). Calculation of subsidies for households depending on the energy efficiency class of housing is possible by conducting an energy audit of buildings and obtaining the corresponding certificates, which requires additional funds, specialists, and motivation on the part of households. Although NZEB levels for new builds are around 30% higher, renewable energy use in low energy-efficient homes varies significantly, ranging from 9% to 55% (Maduta et al., 2025), which can also complicate the calculation of subsidy costs.

Incentivizing energy efficiency through long-term structural subsidies (for housing renovation) has advantages over ad hoc cash transfer policies, which can lead to a more diversified stakeholder landscape at the local level (Zabel & Hendlin, 2025).

The implementation of energy-efficient building renovation projects to overcome energy poverty in Ukraine requires effective interaction with banking institutions to obtain the information necessary for credit risk assessment (NBU, 2024). The demand for loans is driven by the fact that building construction and reconstruction, according to

NZEB standards, leads to a 30% increase in construction estimates (Lytvyn, 2024).

Government initiatives to overcome energy poverty in Ukraine should not be slowed down by the

lack of effective control over the targeted spending of funds when organizing, monitoring, and implementing energy efficiency projects, which must be consistent with strategic documents for the recovery of the Ukrainian economy.

CONCLUSION

This study aims to carry out a comparative analysis of energy poverty in the EU countries and Ukraine, assess the cost of state support for households based on energy subsidies, and clarify the calculation of heating subsidies in Ukraine in the context of the transition to a low-carbon economy.

In the context of significant growth in fuel prices, rising cost of living, and worsening geopolitical situation, energy poverty risks are increasing. This complicates a fair energy transition based on guaranteed access to energy for every person. An analysis of energy poverty indicators in EU countries in 2020 and 2023 shows a worsening situation not only in Eastern, Central, and Southern Europe but also in the Eurozone. In Ukraine, energy poverty is exacerbated by the war and destruction of energy capacity, high energy costs, low population incomes, and low energy efficiency of housing.

Energy subsidies, as evidenced by global experience, have a certain social focus and have become widespread in various countries. The social effectiveness of subsidies as an instrument of state support for the population is characterized by the per capita cost of subsidies, the highest values of which were observed in fossil fuel-importing countries. Unlike fuel-exporting countries, the use of energy subsidies to support energy-vulnerable households in net fuel-importing countries, including Ukraine, significantly increases the burden on the state budget.

The analysis of the structure of the global energy subsidy portfolio shows that governments in most countries are abandoning coal subsidies in the context of economy decarbonization. In the energy subsidy portfolio, the share of electricity subsidies is growing, reaching 72% in 2023 in Ukraine.

The implementation of energy poverty alleviation policies based on subsidies does not address the root causes of energy poverty. It would be appropriate to raise the issue of developing a national concept for addressing energy poverty in Ukraine, including organizing, monitoring, developing, and approving national energy poverty indicators, in line with the strategic directions for energy sector development. A promising direction for overcoming energy poverty is strengthening energy efficiency measures based on the energy modernization of buildings. It is proposed to adjust the approaches to calculating heating subsidy costs, taking into account the energy efficiency class of buildings.

The expansion of energy modernization programs for housing stock in Ukraine is slowing down due to significant public finance deterioration and economic and political instability. So, the refusal to use energy subsidies for households as a mechanism for overcoming energy poverty in Ukraine should occur gradually and be consistent with economic and energy policy directions, and state support for the population based on subsidies and investment measures to improve energy efficiency should not oppose but rather complement each other in the context of post-war recovery.

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APPENDIX A

Table A1. Household electricity consumption as part of electricity available for final consumption, %

Source: Calculated based on EU (n.d.).

Country	2015	2017	2019	2021	2023
European Union – 27 countries (from 2020)	27.27	27.31	27.43	28.73	28.68
Euro area – 20 countries (from 2023)	27.23	27.29	27.50	28.87	28.96
Albania	53.05	47.82	47.78	49.84	47.96
Austria	27.09	27.45	27.95	31.88	34.26
Belgium	21.87	21.05	20.68	20.95	20.66
Bosnia and Herzegovina	39.63	40.36	41.82	44.07	47.13
Bulgaria	35.91	35.42	34.87	37.71	39.53
Croatia	39.42	38.15	37.45	39.13	38.58
Cyprus	36.96	36.58	37.46	39.03	34.39
Czechia	24.52	24.96	24.93	27.77	26.95
Denmark	32.03	30.49	31.79	32.54	30.67
Estonia	23.23	25.08	25.07	27.52	30.92
Finland	26.26	27.36	27.28	29.12	29.25
France	35.11	35.65	35.93	38.35	36.77
Germany	24.36	24.64	24.93	25.78	27.34
Greece	33.44	35.29	33.59	34.71	31.53
Hungary	28.42	28.02	28.06	28.46	29.62
Ireland	30.69	29.63	28.78	29.48	25.82
Italy	22.27	21.69	21.73	22.31	22.07
Latvia	27.22	25.54	24.85	25.92	25.15
Lithuania	26.17	25.90	25.53	28.53	28.45
Montenegro	44.25	43.27	42.11	44.88	53.86
The Netherlands	20.31	19.55	19.00	19.82	19.98
North Macedonia	46.51	49.90	47.87	49.77	52.78
Norway	32.34	32.40	31.97	31.76	30.78
Poland	20.36	19.93	19.34	19.45	19.52
Portugal	25.56	26.42	27.09	29.63	29.03
Romania	25.79	25.71	26.16	28.37	29.82
Serbia	49.41	47.02	45.67	45.39	n/a
Slovakia	19.85	18.20	20.96	22.56	26.42
Slovenia	24.85	24.42	24.82	28.06	32.75
Spain	29.37	28.94	30.05	31.11	31.74
Sweden	33.64	34.59	34.37	35.26	32.08
The United Kingdom	34.08	34.34	34.30	n/a	n/a
Ukraine	28.41	28.87	29.31	n/a	n/a
Moldova	44.81	43.70	43.29	43.67	41.89

Share of final electricity consumption by sector:

- 0%–30%
- 30%–40%
- 40%–50%
- > 50%

