

ECONOMICS*Sociology*

Piwowar, A. (2025). Self-assessment of energy poverty determinants and effects in Farmer households: Findings from Poland. *Economics and Sociology*, 18(1), 11-26. doi:10.14254/2071-789X.2025/18-1/1

SELF-ASSESSMENT OF ENERGY POVERTY DETERMINANTS AND EFFECTS IN FARMER HOUSEHOLDS: FINDINGS FROM POLAND

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DOI: 10.14254/2071-789X.2025/18-1/1

ABSTRACT. Energy poverty is a significant problem for households in Poland today, especially given the sharp rises in energy prices. The multifaceted nature of issues related to energy poverty, both from the point of view of the causes and the effects, serves as a catalyst for research efforts aimed at analysing and assessing the phenomenon of energy poverty. This article presents the findings of a study on how farmer households self-assess their knowledge and attitudes toward energy poverty. The results were interpreted in the context of objective measurements of the level of energy poverty in Poland. The research sample comprised 480 farming households from Poland for the 1st research stage and 60 households for the 2nd stage. The study employed the diagnostic survey method with the use of a questionnaire. While the level of self-assessment among the studied households is relatively high, a certain dissonance is evident between the level of self-assessment and objective measurements. The research results can help inform social and economic policies, particularly in institutions focused on identifying and addressing energy poverty.

JEL Classification: Q12, Q49, D10**Keywords:** energy poverty, rural areas, Sustainable Development Goals (SDGs), Poland

Introduction

The Sustainable Development Goal 7 (SDG7) reflects the need to alleviate energy poverty (EP). As one of the 17 SDGs, energy poverty still plagues many regions worldwide (Alegre-Bravo *et al.*, 2025; Zou *et al.*, 2023). Energy poverty (EP) is a significant socioeconomic issue in many areas and countries, including Poland. It encompasses various social and health problems that arise when individuals, households and social groups cannot meet their energy needs (Adom *et al.*, 2021). This study examines energy poverty and considers aspects of energy justice (Bouzarovski & Simcock, 2017). The inspiration for this research stemmed from statistical studies covering several indicators of energy poverty in Poland, such as low income and high costs (LIHC), the double median energy expenditures (2M), the ability to pay bills on time (Bills), issues related to housing quality and thermal comfort (Thermal) and dwelling with leakage (Leaks) (Figure 1).

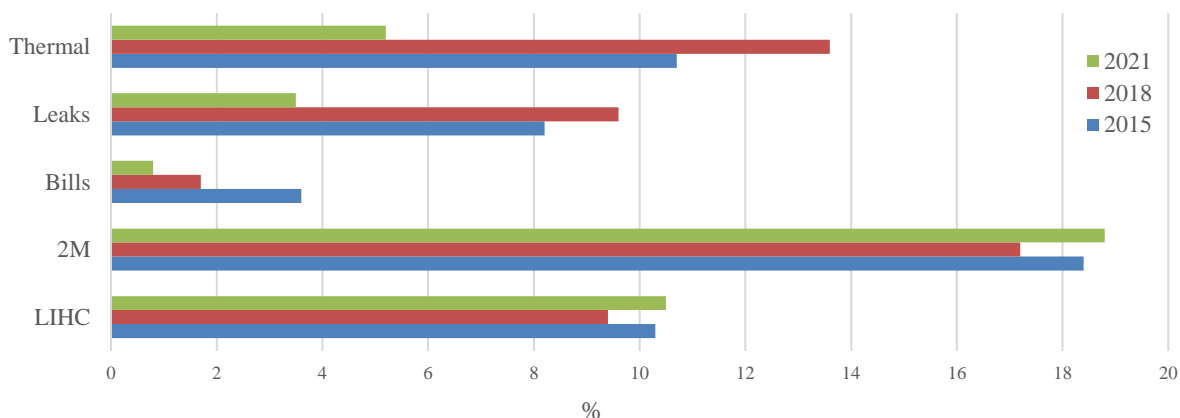


Figure 1. Measures of energy poverty in Poland

Source: own elaboration based on <https://stat.gov.pl/obszary-tematyczne/srodowisko-energia/energia/zuzycie-energii-w-gospodarstwach-domowych-w-2021-roku,12,2.html>

This phenomenon affects both urban and rural residents and is increasingly becoming a topic of public debate and academic study (Nasir *et al.*, 2022; Piwowar, 2022). Energy poverty refers to the difficulties some individuals and social groups face in meeting their basic energy needs (Panda and Pradhan, 2024; Pachauri *et al.*, 2024). These difficulties include not only physical access to electricity but also economic and environmental aspects. Analyses of this issue are increasingly concerned with digital exclusion, deficits in renewable energy sources and the ecological risks associated with energy production from non-renewable sources. Energy poverty is closely linked to material deprivation, as those affected often lack the means to improve their living conditions by investing in home improvements such as thermal insulation, window and door replacements, or instalment of modern, high-efficiency, low-carbon heating systems. Addressing energy poverty not only improves the living conditions of vulnerable or energy-poor individuals, it also has an ecological benefit as it reduces greenhouse gas emissions and improves energy efficiency.

It is worth noting that there is no consensus in the literature on fundamental issues such as the definition of energy poverty, methods and survey criteria (Nussbaumer *et al.*, 2012; Betto *et al.*, 2020; Wendt *et al.*, 2023). Similar to measuring other types of poverty, we can identify objective or quasi-objective methods and subjective methods based on respondents' opinions (Deniszczuk, 2000). This results in significant differences in determining the scale of energy poverty, developing methodological approaches and searching for new factors and variables relevant to this issue. Many scholarly articles review the analytical categories and methods used to study energy poverty (Pachauri and Spreng, 2011; González-Eguino, 2015; Lee and Yuan, 2024). In many countries, including those with relatively high socioeconomic development, this topic has gained importance due to the sharp rise in energy prices over the past 3–4 years (Mulder *et al.*, 2023). For this reason, there is growing research interest aimed at identifying the scale of energy poverty in Poland (Wendt *et al.*, 2023).

It is worth mentioning that in Poland, the first research on energy poverty emerged in 2012 (Miazga and Owczarek, 2015). Before that, the literature mainly focussed on reviewing the definition and basic conceptual scope (Figaszewska, 2009; Szamrej-Baran, 2010). Until 2013, energy poverty was not a popular topic of political discussion (Stępiak and Tomaszewska, 2016). The issue has always been relevant in rural areas. Still, studies have primarily relied on secondary data (mainly from the Central Statistical Office) or small,

purposely selected empirical research samples with limited spatial scope (e.g. specific voivodeships). This has created a research gap, especially concerning farmer households, which have unique characteristics since they combine livelihood and production functions with different sociodemographic traits than non-agricultural households. They also incur higher expenditures on electricity and heat, making them an interesting and underexplored subject.

This study aims to understand the self-assessment of energy poverty among farmer households, particularly those that are vulnerable to socioeconomic conditions. Although income in Polish agriculture has significantly increased since accession to the European Union, and substantial funds have been allocated for farm modernisation (including insulation and energy-efficient upgrades), agricultural income remains much lower than non-agricultural income. Polish agriculture shows great diversity in efficiency (Bereźnicka and Wicki, 2023). A key feature of farmer households is the strong link between consumption and production, as income primarily comes from farm use. Additionally, due to several income risk factors (e.g. weather conditions or risky farming decisions), these households have lower financial security than other socioeconomic groups (Kozera *et al.*, 2016). In Poland, high energy poverty risk among farmers is due to factors such as low income, high energy consumption, poor energy efficiency of rural buildings and demographic peculiarities.

The main objective of the study is to investigate how farmer households in Poland evaluate their own energy situation in the context of meeting their energy needs. This assessment goes beyond the subjective perspective, considering material and technical factors that broadly define energy poverty (including economic, social and technical elements and their qualitative aspects). Thus, this study contributes to the analysis of energy poverty by illustrating the severity of energy poverty experienced by farmer households. The research utilises survey methods and an analytical and synthetic approach to provide deeper insights. The methodology is detailed in a separate section of the paper.

The study is organised as follows. After the introduction, a review of previous research on the topic is presented. This is followed by a description of the research methodology. The next section reports statistical data on household energy consumption in Poland from 2018 to 2021 (the period of empirical analysis). The empirical outcomes and discussion follow. The paper concludes with a summary of findings, conclusions and suggestions for future research directions on the topic.

1. Background

Governments worldwide are struggling to mitigate EP. Household energy poverty is also a significant issue that impacts social inclusion across the European Union (EU). Southern and Eastern European countries generally report a higher incidence of energy poverty. Energy poverty is particularly pronounced in Central and Eastern Europe (CEE). These regions often face higher rates of energy poverty due to older housing stock, lower incomes, and less access to modern energy infrastructure (Bouzarovski and Tirado, 2017; Piwowar, 2024). Although this region has experienced significant change in the last thirty years, as the contributions show, it still faces considerable obstacles in modernizing its current housing stock and supplying its residents with inexpensive, clean energy (Jigla *et al.*, 2020). Wojewódzka-Wiewiórska *et al.* (2024) reveal that energy poverty is especially widespread in Bulgaria and Romania. The research confirms the clear geographical variation in energy poverty across Europe (EU27).

Energy poverty is a pressing and significant research topic in Poland. As it encompasses sociological, psychological and political aspects, it is a highly complex issue that spans multiple academic disciplines. Leading research centres in the social sciences, such as the Institute for Structural Research, the Institute for Eco-Development and the Institute for Rural and

INTERDISCIPLINARY APPROACH TO ECONOMICS AND SOCIOLOGY

Agricultural Development, are at the forefront of studying this issue. Additionally, researchers affiliated with many Polish universities contribute to this field. The media also frequently report on energy poverty in Poland, highlighting its unique characteristics, the social and health costs, and its connection to air pollution (Boguszewski and Herudziński, 2018).

Various studies have characterised energy-poor households in Poland, particularly focusing on single-family homes in terms of size, income sources, dwelling characteristics (such as area and age) and heating sources (Lewandowski *et al.*, 2018). Śmiech and Karpinska (2021a) assessed the persistence of energy poverty in Poland and identified two distinct profiles for it, one of which involves middle-aged, mostly inactive rural residents living in single-family households. In another paper, these authors proposed a method for assessing the hidden aspects of energy poverty in Poland (Karpinska and Śmiech, 2020).

In 2014, Węglarz, Kubalski and Owczarek (2014) identified three primary causes of energy poverty: technical issues, economic problems and individual attitudes. Reports and brochures detailing the scale of energy poverty in Poland are also available. One of the earliest studies, by Owczarek and Miazga (2015), describes the phenomenon in statistical terms. These reports are generally broad and depict the national and provincial situation based on standard measures, mainly income and costs. Studies from the Institute for Structural Research, such as "Energy Poverty in Poland: Diagnosis and Recommendations" (Lis *et al.*, 2016), provide insights into the scale of energy poverty from 2015 to 2016, identifying the social groups most affected based on statistical data.

Research is conducted at both macro and microeconomic levels. Economic factors such as income, costs and energy policy impacts are analysed at the macro level. Nagaj (2020) notes that energy and climate policies and the prices of energy carriers only marginally influence the degree of energy poverty; the main factor is changes in household disposable income in Poland. Microeconomic research is usually conducted at the local or regional level. For example, Wendt *et al.* (2023) analysed data from a single municipality, the Augustów district, while Kalinowski *et al.* (2022) studied the Mazovian voivodeship. In their 2024 study, Kalinowski *et al.* (2024) emphasise the influence of subjective perceptions of energy poverty. This study, based on a 2023 survey of 625 social assistance beneficiaries, reveals the importance of personal perceptions in understanding energy poverty.

The research papers also pinpoint technical aspects, particularly improvements in the energy efficiency of buildings. This is highly relevant to the topic, as enhancing energy efficiency can simultaneously alleviate income inequality and energy poverty (Dong *et al.*, 2022). Thermal insulation and energy-efficient upgrades generate economic and social benefits, making them a key factor in addressing energy poverty (Napiórkowska-Baryła, 2018). The link between energy poverty and inadequate energy infrastructure is also evident in neighbouring countries. Kirs and Volkova (2024) demonstrate a correlation between the lack of a district heating network and increased energy expenditures among lower-income households in Estonia.

Based on the available literature, it is possible to outline the emerging problem, identify vulnerable social groups and provide a detailed qualitative analysis, mainly on a local and regional basis (Świerszcz and Grenda, 2018). High rates of energy poverty are recorded especially among farmer households. The problem predominantly affects the poorest families, who often live in buildings with low energy standards (Szamrej-Baran, 2013). However, studies on household self-assessment of energy poverty are scarce, including those with objectively verified indicators based on public statistics. This gap is particularly notable for farmer households, which are the primary focus of this work. There is a distinct shortage of studies that focus on the subjective aspects of energy poverty. The lack of comprehensive studies on

household self-assessment of energy poverty, including those with verified indicators, makes it challenging to address this problem effectively (Lin et al., 2023).

2. Methodological approach

This paper utilises both secondary and primary sources. Secondary data come from public statistics, mainly from the Central Statistical Office, while primary sources include findings from an empirical survey conducted between October 2019 and March 2020 among 480 farmer households in Poland. This study is part of a project funded by the National Science Centre, conducted from 2019 to 2024. The surveys were carried out in collaboration with agricultural advisory centres under relevant contracts, ensuring all elements of personal data protection.

A two-stage survey was conducted. The first stage targeted households where one member is a farm user with a minimum of five hectares of agricultural land. The sample size was 480 households. The survey was administered in three randomly selected municipalities within six randomly chosen voivodeships (80 questionnaires from each voivodeship). The selection of the voivodeships was carried out using non-return random drawing within each macro-region in Poland. This method ensured that farms from across the country were included, with one voivodeship selected from each macro-region and specific municipalities drawn from within each selected voivodeship.

The second stage of the research involved an extended survey of 10 farmers in each voivodeship who had participated in the initial survey. Figure 2 shows the geographic scope of the empirical research, covering 18 municipalities across six voivodeships in Poland.



Figure 2. The spatial extent of field studies

Source: own elaboration

A diagnostic survey method was used, with separate questionnaires for the first and second stages of the survey. The questionnaires featured varied response scales, including the Likert scale. The first-stage surveys focused on fundamental, quantitative questions regarding energy expenditures and the relationship between the share of agricultural expenditures in the surveyed households and the physical and economic size of the farm, its location and the dominant mode of agricultural production (crop, livestock and mixed). The findings from this research form the basis for other scientific publications on the multidimensional patterns of energy poverty.

INTERDISCIPLINARY APPROACH TO ECONOMICS AND SOCIOLOGY

In contrast, the second-stage survey, designed for 60 farmers, was qualitative. This research sought answers to the following questions:

- Do the respondents believe energy poverty is a nationwide problem, specific to rural areas, or prevalent in farmers' households?
- Do the respondents think energy poverty is an issue in their municipality?
- Do the respondents feel that energy poverty in rural areas is adequately addressed in the media and public debates?
- What opportunities do the respondents see for saving energy and developing renewable energy sources in their households and agricultural operations?
- How do the respondents rate the thermal comfort of their households, and what are the potential health implications?
- What opportunities do the respondents see for improving energy efficiency in both the living and production areas of their farms?

In summary, the research aimed to gather both objective data and respondents' subjective assessments and opinions on energy poverty. This paper analyses selected results from these surveys.

3. Household energy consumption in Poland between 2018 and 2021

An essential background for the empirical analysis discussed in the following sections is the examination of statistical data from the same period as the empirical research. A key publication of official statistics, released every three years in Poland, provides the latest data available in May 2023, covering 2021. Energy consumption in the residential sector in Poland has shown steady growth over the past several decades. Electricity is widely used in households, mainly for lighting, cooking, powering household appliances, and consumer electronics. In recent years, households have experienced the highest growth rate in electricity consumption, accounting for 20.2% of annual electricity production in 2021. On average, domestic households consumed 24.6 GJ of energy per capita, placing Poland at the European average of 24.5 GJ per capita. Basic data on the consumption of energy carriers in households in Poland for 2018 and 2021 are listed in Table 1.

Table 1. Household energy consumption in Poland between 2018 and 2021

Energy commodities	Unit of measure of quantity	Average			
		quantity		value	
		in a unit of measure of quantity		in PLN	
		2018	2021	2018	2021
Electricity	kWh	2375	2523	1488	1749
District heat	GJ	31	35	1569	1824
Natural gas	kWh	5466	4854	1225	1339
LPG	kg	105	120	453	599
Heating oil	l	1565	1513	4596	4631
Hard coal	kg	3039	3068	2526	3034
Lignite	kg	3937	3506	1567	1352
Coke	kg	2570	3793	2242	4244
Fuel wood	m ³	8	10	770	1 128
Other types of biomass	m ³	11	13	1588	2732

Source: <https://stat.gov.pl/obszary-tematyczne/srodowisko-energia/energia/zuzycie-energii-w-gospodarstwach-domowych-w-2021-roku,12,2.html> and <https://stat.gov.pl/obszary-tematyczne/srodowisko-energia/energia/zuzycie-energii-w-gospodarstwach-domowych-w-2018-roku,12,1.html>

INTERDISCIPLINARY APPROACH TO ECONOMICS AND SOCIOLOGY

The analysis shows that the average annual expenditure on electricity in 2021 was PLN 1,749, an increase of 17.5% compared to 2018. This rise is attributed not only to increased electricity consumption but also to higher retail electricity prices for residential consumers. These data are closely related to the issue of energy poverty. Non-renewable energy sources are still widely used in Poland, particularly in rural areas, where coal and wood are commonly used for heating. As Karpińska and Śmiech (2021b) note, Poland's clean energy transition, which has recently replaced coal with natural gas in the household sector, has resulted in higher heating costs. This shift in energy sources has impacted the extent and depth of energy poverty in Poland. There is significant variation in household spending on electricity based on the degree of urbanisation (Fig. 3).

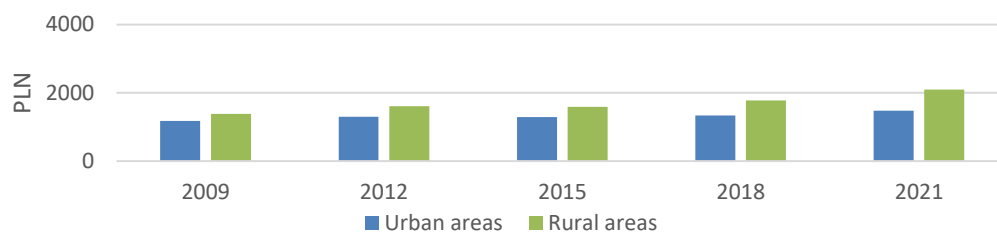


Figure 3. Average annual household spending on electricity in Poland: Urban vs rural areas
 Source: own elaboration based on <https://stat.gov.pl/obszary-tematyczne/srodowisko-energia/energia/zuzycie-energii-w-gospodarstwach-domowych-w-2021-roku,2,5.html>

As shown in Figure 3, the average energy expenditures of rural households are higher than those of urban households, and this gap is widening to the disadvantage of rural households. The high measures of energy poverty (Figure 1) are driven by the high costs associated with purchasing electricity and relatively low incomes.

4. Conducting research and results

4.1. Characteristics of the research sample

The surveyed farms (N=480) covered 16,907.95 hectares of agricultural land, averaging 35.22 hectares per farm. The 60 farms selected in the second stage of the survey had a combined area of 6,076.8 hectares, with an average farm size of 30.50 hectares. Considering the size of farms in Poland, the surveyed group had a larger average area, but the sampling methodology should be considered. Farms under five hectares were excluded due to their minimal commodity production. The characteristics of the surveyed farms, including basic features and land area, are shown in Table 2.

The average age of the respondents was 45 (N=480) and 42 years (N=60). The respondents had a relatively high level of education, with 21% (N=480) and 25% (N=60) holding a higher education degree. Additionally, 55% (N=480) and 48% (N=60) declared that their education was related to agriculture. Thus, similar characteristics were observed in the larger sample (N=480) and the smaller sample (N=60).

INTERDISCIPLINARY APPROACH TO ECONOMICS AND SOCIOLOGY

Table 2. General characteristics of the test sample (N=480 and N=60)

Description	Number of farms		The average age of the farm owner		The percentage of farmers with higher education [%]		The percentage of farmers with an agricultural education [%]		Agricultural land area [ha]		Agricultural land area per farm [ha]	
	N=480	N=60	N=480	N=60	N=480	N=60	N=480	N=60	N=480	N=60	N=480	N=60
	głogowski	25	3	46	37	20	0	36	0	911.21	28.60	36.45
górowski	30	4	41	35	27	75	57	50	828.51	106.9	27.62	26.73
legnicki	25	3	48	51	8	33	44	33	586.05	89.99	23.44	30.00
białogardzkii	26	3	48	46	8	0	42	100	2490.30	263.32	95.78	87.78
gryfiński	26	4	48	44	11	0	46	25	2687.83	187.00	103.38	46.75
koszaliński	28	3	47	49	21	0	46	0	1131.94	48.79	40.43	16.26
lubartowski	25	3	44	34	12	0	52	33	461.71	22.75	18.47	7.58
zamojski	28	4	48	53	14	50	21	25	492.96	90.00	17.61	22.5
bialski	27	3	43	32	33	33	66	100	730.55	117.67	27.06	39.23
giżycki	20	3	43	47	15	33	90	33	544.65	105.9	27.23	35.34
elcki	30	3	44	35	13	0	56	33	1198.84	140.1	39.96	46.76
olecki	30	4	37	42	36	33	87	100	1285.16	128.4	42.84	32.18
nowosądecki	27	4	45	46	4	0	44	100	219.30	25.45	8.12	6.36
tarnowski	27	4	46	37	11	0	67	100	420.75	91.04	15.58	22.76
krakowski	26	2	47	46	4	0	15	50	239.10	10.87	9.20	5.44
opoczyński	25	4	42	45	40	25	72	25	758.20	96.2	30.33	24.05
łęczycki	31	4	42	32	42	75	71	0	681.96	75.28	22.00	18.82
kutnowski	24	2	44	49	58	100	71	50	1238.93	201.32	51.62	100.6
Total	480	60	45	42	21	25	55	48	16907.95	6076.8	35.22	30.50

Source: own study based on questionnaire surveys (N=480, N=60)

Housing conditions, including building characteristics such as the age of the building and the area of the dwelling, are crucial factors in determining energy poverty. Table 3 summarises the specific characteristics of the housing stock in the survey samples.

Table 3. The main features of the residential properties studied

Specification	Number of responses		Percentage in the research sample [%]	
	N=480	N=60	N=480	N=60
Type of development				
free-standing	447	57	93.13	95.00
terrace house	8	1	1.67	1.67
semi-detached	9	0	1.88	0.00
apartment	16	2	3.33	3.33
Usable area (m ²)				
under 50	5	0	1.04	0.00
51- 99	85	2	17.71	3.33
100-149	161	23	33.54	38.33
150-200	101	19	21.04	31.67
over 200	128	16	26.67	26.67
Year of construction				
Earlier than the 1950s.	89	5	18.54	8.33
1950s.	24	1	5.00	1.67
1960s	47	7	9.79	11.67
1970s	71	13	14.79	21.67
1980s	98	13	20.42	21.67
1990s	59	11	12.29	18.33
2000-2009	45	3	9.38	5.00
After 2010	47	7	9.79	11.67
Total	480	60	100	100

Source: own study based on questionnaire surveys (N=480, N=60)

INTERDISCIPLINARY APPROACH TO ECONOMICS AND SOCIOLOGY

The vast majority of respondents live in single-family households with relatively large living areas. Notably, farmers' homes have more living space than the national average for all household types. Nearly half of the respondents in the first-round sample reported that their dwellings had a living area exceeding 150 m². This percentage was even higher in the second sample, with more than 58% reporting living areas larger than 150 m². The year of construction is also important, as it indirectly indicates the construction technology used at the time and the potential need for thermal modernisation. More than 60% of the buildings in the analysis were built before the end of the 1980s.

4.2. Relevance and incidence of energy poverty in rural areas in Poland according to respondents

One of the research questions in the questionnaire asked respondents for their opinions on the incidence of energy poverty. The respondents were provided with the following definition of energy poverty: 'Energy poverty is defined as the lack of funds to purchase the amount of energy necessary to meet the basic needs of a household to the extent necessary for its normal functioning (heating, lighting, cooking, use of household appliances, etc.).'

The respondents were then asked to consider the incidence of this issue in three spatial ranges:

- in Poland overall,
- in rural areas in Poland,
- in farmers' households in Poland.

The findings of this analysis are presented in Figure 4.

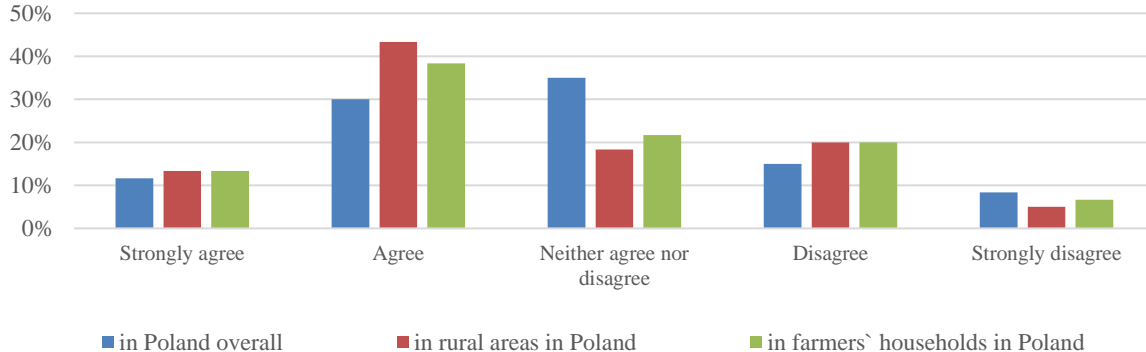


Figure 4. Respondents' opinions on the incidence of energy poverty in Poland
Source: own study based on questionnaire surveys (N=60)

The survey reveals that respondents viewed the situation in rural areas as worse than in Poland. Notably, a slight majority (56.67%) affirmed the presence of energy poverty in rural areas and farmers' households (51.67%). Many respondents were uncertain whether the issue affects the entire country, with 35% indicating 'difficult to say'.

Additionally, the respondents were asked if they believed energy poverty existed in their municipality. Twenty-one respondents (35% of the survey sample) answered yes, showing a high awareness level among farmers. Estimates suggest that one in five rural residents is affected by energy poverty, particularly those living in rural areas and small towns with populations of up to 29,000 (Lewandowski *et al.*, 2018; Piwowar, 2021).

The survey also sought opinions on how well energy poverty issues are highlighted in various forms of media. Respondents rated the emphasis on energy poverty in legislation,

INTERDISCIPLINARY APPROACH TO ECONOMICS AND SOCIOLOGY

scientific publications, popular science articles, training programmes for farmers and public debates using a Likert scale. The results of this analysis are shown in Figure 5.

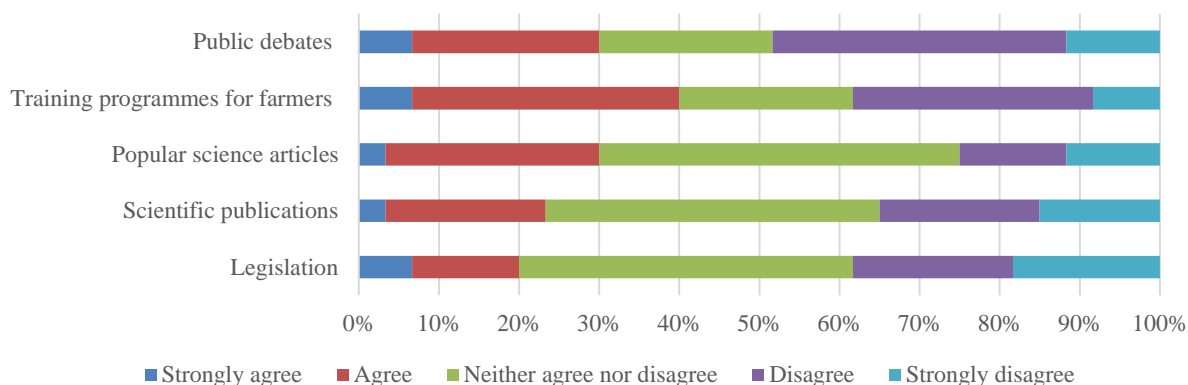


Figure 5. Respondents' declarations regarding the emphasis on energy poverty in rural areas in selected media outlets

Source: own study based on questionnaire surveys (N=60)

The respondents largely (over 40%) did not have an opinion on whether the topic of energy poverty in rural areas is sufficiently covered in popular science articles, legislation and scientific publications. They rated the coverage of the topic in training programmes for farmers relatively poorly. This is significant because successful energy poverty interventions rely heavily on user education (Middlemiss *et al.*, 2023). There are many opportunities for agricultural advisory institutions, both public and private, to provide training on saving energy, reducing energy bills, making rational purchases of electricity-powered equipment and changing inefficient habits related to electricity and heat usage. The literature highlights the need for training in these areas (Piwowar, 2021).

Survey data analysis suggested that respondents negatively viewed the emphasis on energy poverty in public discussions and debates. Almost half of the respondents (48.33%) stated that this subject is rather not or definitely not given enough recognition in public communications.

An important topic from the perspective of this study, which focuses on respondents' self-assessment, was how respondents managed their income in the context of energy spending in their households. The respondents could choose one of the following options:

1. We have enough money for everything and don't pay attention to expenses related to electricity and heat bills.
2. We have enough money for everything without any special sacrifices, but we live rationally regarding electricity and heat expenses.
3. We live frugally, including saving on electricity and heat expenses (lowering room temperature, saving on lighting, etc.).
4. We live modestly, with enough money for the cheapest food and clothing, and incur debt related to bills.

As the survey shows, the respondents most often chose option 2.

The survey revealed that 31 respondents have enough money for everything without sacrificing, but they live rationally regarding electricity and heat. A significant group of respondents (26) indicated that they live frugally, including saving on electricity and heat expenses. None of the respondents chose answer 4.

INTERDISCIPLINARY APPROACH TO ECONOMICS AND SOCIOLOGY

Energy poverty manifests in challenges both in maintaining adequate warmth during winter and ensuring adequate cooling in summer. Recent research underscores that energy poverty adversely affects public health, impacting both physical and mental well-being (Pan *et al.*, 2021; Churchill and Smyth, 2021; Zhang *et al.*, 2021; Katoch *et al.*, 2024). Saving on energy-related expenses therefore has potential health implications, as articulated in this study. Energy poverty diminishes quality of life and exposes household members to health risks due to living in cold, damp environments. It also correlates with deteriorating mental health. When asked if they worry about their health or that of their household members on account of insufficient satisfaction with basic energy needs (space heating, lighting, etc.), 14 respondents answered affirmatively. Additionally, when the respondents were asked if they experience adverse health effects related to housing conditions (underheating, dampness, etc.), 10 answered affirmatively, citing frequent colds, joint pain and similar issues.

Respondents also identified potential opportunities for energy savings through pro-environmental behaviours and attitudes (see Table 4).

Table 4. Opportunities identified by respondents for saving energy and developing renewable energy use in households and farms

Specification	Household		Farm (Premises and Equipment)	
	Yes	No	Yes	No
	[%]			
Installation of smart energy management systems (equipment control, consumption monitoring, etc.)	30.00	70.00	15.00	85.00
Home insulation and energy-efficient upgrades	43.33	56.67	26.67	73.33
Use of solar collectors	46.67	53.55	23.33	76.67
Use of photovoltaic panels	53.55	46.67	33.33	66.67
Use of wind energy (wind turbines)	13.33	86.67	10.00	90.00
Utilisation of heat pumps	15.00	85.00	5.00	95.00
Replacement of appliances with more energy-efficient models	80.00	20.00	58.33	41.67
Upgrading to energy-efficient lighting	56.67	43.33	45.00	55.00

Source: own study based on questionnaire surveys (N=60)

Respondents were more likely to mention environmentally friendly and cost-saving measures for their households than for their farms. The most frequently mentioned solution in both areas was replacing appliances with more energy-efficient ones (80% for households and 58.33% for farms). A considerable number of respondents also mentioned replacing lighting, using solar energy and upgrading insulation and energy efficiency. Notably, recent years have seen a substantial increase in investment in micro-photovoltaic installations in Poland, including in rural areas (Duda *et al.*, 2021; Dzikuć *et al.*, 2022; Igliński *et al.*, 2023). However, vulnerable households often face budget constraints that make it challenging to achieve full decarbonization of their energy demand (Romero *et al.*, 2025). Rural households often face unique challenges that make them more vulnerable to energy poverty. Factors such as lower incomes, older and less energy-efficient housing, and higher heating costs contribute to their vulnerability. This emphasizes the need for targeted financial support mechanisms during the energy transition (subsidies, grants, low-interest loans, social tariffs, etc.).

Conclusion

Energy poverty is a pressing social challenge in Poland, as it pointedly affects farmers' households. Given the current geopolitical situation and rising energy prices, the scale of energy poverty in Poland is expected to increase. Inadequate access to basic energy needs hampers

INTERDISCIPLINARY APPROACH TO ECONOMICS AND SOCIOLOGY

both social and economic development. For farmer households, it poses a barrier to adopting new technologies that drive economic progress, such as automation and robotisation. The findings of this study may inspire further research on household energy consumption and self-assessment of energy needs satisfaction in Poland.

The survey reveals that respondents are aware of the issue of energy poverty in rural areas of Poland, and they recognise that this topic is often overlooked in public discussions, debates and farmer training programmes. Additionally, respondents are mindful of their household energy expenses and make efforts to economise. They also understand the potential health consequences of energy poverty, such as illnesses and reduced immunity. However, they see opportunities to improve the situation, particularly in household management and, to a lesser extent, in enhancing energy efficiency in production.

The self-assessment methodology used in this survey offers a promising approach for further developing methods to assess the factors and extent of energy poverty. This includes considering various health impacts and the relationship between income and energy expenditure. This study aims to provide an empirical basis for future research on the causes and effects of energy poverty. This calls for better utilisation of social economics and expanded research based on behavioural economics. This could lead to a more comprehensive framework for identifying and measuring energy poverty, considering technical, demographic, social, economic and psychological factors.

Ultimately, this may help create more effective policies to support households facing the threat or reality of energy poverty. Targeted policy interventions focused on promoting thermal efficiency and providing support for low-income households are crucial. Implementing these measures can help alleviate energy poverty's socio-economic and health-related consequences. It is also worth paying attention to the best practices used in other regions (e.g. Germany, Denmark). The emphasis should be on localized solutions and renewable energy sources, such as mini-grids and household solar systems. Germany has implemented various programs to improve energy efficiency in buildings, such as the "*Energieeinsparungsgesetz*" (Energy Saving Ordinance). Some energy providers offer social tariffs or special rates for low-income households to help reduce their energy bills. The government promotes energy audits for households to identify potential savings and improve energy efficiency. Energy companies in Denmark are required to achieve energy savings for their customers, which includes providing free energy audits and implementing energy-saving measures. These best practices have proven effective in reducing energy poverty and can serve as valuable models for other countries looking to implement similar measures. In nature, the general findings, arguments, and policy implications may be applicable only to very similar contexts.

Acknowledgement

This study was conducted and financed in the framework of the research project "Socioeconomic, environmental and technical determinants of the energy poverty in rural areas in Poland", granted by the National Science Centre in Poland, program OPUS, grant No. 2018/31/B/HS4/00048.

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