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RESEARCH ARTICLES

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CURRENT CHALLENGES IN ENERGY SECURITY IN TERMS OF HEAT POVERTY IN POLAND[1]

A b s t r a c t

The aim of the article is to present the current challenges related to energy security in terms of heat poverty, based on an analysis of the current situation of households in the town of Biała Rawska, Poland. The main factors that inspired the author to address this issue encompass the increasing importance of energy, including heat, in the quality of the life; the rising prices of energy; the existing correlation between energy security and environmental security, as well as the policy to improve the energy and climate efficiency of Poland by 2030 and its implementation by 2050, which will also become a tool to complement the policy and strategy of the European Union. The research topic focuses on four issues: the state of energy security in terms of heat poverty; the indicators that determine the level of energy security regarding heat poverty; the factors that determine the lack of energy security regarding heat poverty and the challenges in shaping energy security by eliminating heat poverty, based on the example of the analysed town. The research topic discussed in the article is of an empirical nature. To provide a more in-depth analysis of the problem, theoretical, qualitative, and quantitative methods were used along with a diagnostic survey (an in-depth interview with use of the PAPI (Paper and Pencil Interview)) conducted among 1200 respondents (households) in the town of Biała Rawska. Furthermore, analytical/synthetic methods were used and conclusions drawn. The applied research questionnaire contained 33 questions, including seven

[1] The article was prepared as part of the 6th International Scientific Conference 'Dilemmas of Modern Defense and Security' organized by the Institute of Security and Defense of the Faculty of Security, Logistics and Management of the Jarosław Dąbrowski Military University of Technology on 10–11 December 2024.

metric questions: gender, education, professional status, number and age of household members, income and place of residence. The basic 26 questions concerned various aspects of household life important in the context of the problem of thermal energy poverty. Therefore, questions were asked about the location, characteristics and technical condition of the inhabited property (questions 1 to 8), thermal comfort (questions 9 to 11), use of social assistance (question 12), heating costs (questions 13 to 16), saving (questions 17 to 19), quality of life, including air quality (questions 20 to 24) and willingness to use renewable energy sources (questions 25 and 26). The survey questionnaire used various types of questions: closed, semi-open and open, single and multiple choice.

This analysis of energy security may be applied not only for learning purposes, but it may also enable the assessment and determination of the scale and scope of the analysed phenomenon in the context of the urgent challenge faced by individuals (households), communities, nations, and states.

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K e y w o r d s: energy security, thermal energy poverty (heat poverty), heat poverty indicators, heat poverty measures, conditions for heat poverty, energy security challenges.

INTRODUCTION

According to the research conducted by the Polish Institute of Economics, the share of households affected by energy poverty, including heat poverty, in Poland increased to 21.4 percent in 2020 – i.e., by 14 percent in comparison to the year 2019. The main reason for such growth is the recent global COVID-19 pandemic, whose consequences have appeared in various aspects of human lives, not only those related to health, but also in economic, financial, and professional areas—for example, redundancies and lower wages, especially for individuals at the lower end of the pay scale. The requirement to introduce certain hygiene restrictions and the related necessity to perform work online that affected not only employees, but also thousands of children and young people who attend schools, resulted in millions of Europeans being forced to stay at their homes for longer and use heating devices more frequently, in particular during the winter season. These devices are used to satisfy the everyday existential needs of households, such as heating the home, heating water, or preparing meals. The use of outdated, inefficient heat transmission devices, low quality sources of heat and buildings

(apartments) of low energy efficiency has led to a significant increase in heating bills, which, in turn, resulted in growing fuel poverty in households. Such a situation has been noted not only in Poland, but also in other European countries. Even before the COVID-19 pandemic, at least 50 million Europeans—i.e., 25 percent, (1 in 4) households—were affected by energy poverty. The highest percentage of residents who claimed that they could not afford to heat their homes was noted in Bulgaria—34 percent, followed by Lithuania——28 percent, Greece—23 percent, Cyprus—22 percent, Portugal——19 percent, Italy—14 percent, and Romania—ten percent. On the other hand, lower, one-digit figures were noted among the inhabitants of Spain—nine percent, Croatia—eight percent, Malta—eight percent, Latvia—seven percent, Hungary—six percent, Belgium—five percent, Poland—five percent, Slovakia—five percent, Ireland—four percent, Denmark—three percent, Czech Republic—three percent, and Germany—three percent.[2]

Research has shown that the scale of fuel poverty that is being experienced now may continue to increase. The reasons for this are not only adverse circumstances, including erosion of financial security, recession, reduced wages, loss of employment, low quality and energy efficiency of heat sources, and low energy efficiency of buildings, but also the expected further increase in heat prices, which is caused by numerous political and economic factors, as well as military factors. As far as Poland is concerned, the main group of factors includes the rights to CO^2 emissions that account for 59 percent of energy prices, manufacturing costs—25 percent, costs of renewable energy sources (RES)—eight percent, costs of retailers——six percent, excise tax—one percent, and the profit margin of energy retailers—one percent.

Another important factor that influences the growth in heating prices is the energy policy of Russia regarding gas supplies to European countries, including Poland. The fact that Gazprom does not reserve flow capacity for gas transit through the Jamal–Europe gas supply line across Poland causes anxiety in European countries

[2] M.D. Alba-Rodriguez, C. Rubio-Bellido, M. Tristancho-Carvajal, R. Castano-Rosa, and M. Marrero, 'Present and Future Energy Poverty, a Holistic Approach. A Case Study in Seville', *Sustainability* 13: 14, 2021, art. 7866, https://doi.org./10.3390/su13147866; L. Rodrigues, M. Gillott, J. Waldron, L. Cameron, R. Tubelo, R. Shipman, N. Ebbs, and Ch. Bradshaw-Smith, 'User Engagement in Community Energy Schemes: A Case Study at the Trent Basin in Nottingham, UK', *Sustainable Cities and Society* 61, 2020, art. 102187, https://doi.org/10.1016/j.scs.2020.102187.

and strong market reactions. This, in turn, results in increasing prices of this raw material and a smaller stock of gas reserves. Another, extremely important factor that contributes to the growing prices of power-generating resources is the military aspect that is manifested in the current geopolitical situation in Eastern Europe, connected to the Russian military invasion on Ukraine. For example, natural gas prices, which—before Russia's aggression against Ukraine——oscillated around 80 euros/MWH, are now around 116 euros/MWH. This situation will change with the military circumstances and the potential sanctions imposed on Russia, which will likely result in unpredictable market behaviour.

Considering the above, the author of this article attempts to present the current challenges related to energy security in terms of heat poverty, based on an analysis of the current situation in households in the town of Biała Rawska, Poland. The research topic presented here focuses on this question: What are the main challenges for energy security in the effective and efficient elimination of heat poverty locally, based on the example of the town Biała Rawska? The hypothesis set in this article is as follows: The level of heat poverty of households reflects the status and quality of energy security locally and may be referred to as a measure of such security. The research problem discussed in the article is of an empirical nature. To provide a more in-depth analysis of the problem, theoretical, qualitative, and quantitative methods were used, along with a diagnostic survey (in--depth interview with use of the PAPI—Paper and Pencil Interview) conducted among 1200 respondents (households) in the town of Biała Rawska. Furthermore, analytical/synthetic methods were used and conclusions drawn.

The choice of the city of Biała Rawska was not accidental. Its selection was determined by three criteria: the type of heat source used by the household (i.e. conventional heat source); the geographical location of the city (i.e. an area with the potential to use geothermal energy as an alternative source to combat heat poverty) and three types of indicators: technical, social and economic. The technical indicator was information on heating companies operating in the studied city and the method of producing heat (what energy sources they use). The social indicator was information on the structure of district heating recipients in the studied city. The economic indicator was the prices of district heating in the studied city.

THE ENERGY SECURITY OF HOUSEHOLDS: A REVIEW OF INTERNATIONAL RESEARCH

An analysis of international research shows that there have been no systemic and uniform attempts to define energy security. Both in the theoretical and practical approach, this term is understood in a comprehensive (multi-faceted) and polysemical way. The conceptualisation of this notion has been evolving continuously. This has been significantly influenced by various global, international, national, and even local factors, which include political, economic, environmental, or awareness-related aspects. These factors influence the level of this security to a various extent, as well as the values and the related good (common good), which should be protected by such security.[3] Hence, the essence of energy security and its interpretation are highly dependent on the context of the energy landscape of the given state, including the accessibility of energy, power sovereignty and independence, the level of economic development, the progress of power generation technologies, energy efficiency, energy prices, diversification of energy sources, the level and extent of perceiving threats, dominant geopolitical issues, social consequences, and, finally, the growing awareness of climate changes and sustainable growth.[4]

The correct understanding of energy security of households, i.e., on the level of the local community, requires a more in-depth, comprehensive approach, as all these aspects overlap and are interrelated. This is clearly shown in the Government Document 'Energy Policy of Poland until 2030', which defines energy security as:

> ensuring stable supplies of fuels and power on a level that guarantees that national needs are satisfies, at prices that are acceptable for the economy and the community, assuming the optimum usage of national energy resources

[3] P. Gasser , J. Suter, M. Cinelli, M. Spada, P. Burgherr, S. Hirschberg, M. Kadziński, and B. Stojadinović, 'Comprehensive Resilience Assessment of Electricity Supply Security for 140 Countries', *Ecological Indicators* 110, 2020, art. 105731, https://doi.org/10.1016/j.ecolind.2019.105731; L. Chester, 'Conceptualising Energy Security and Making Explicit Its Polysemic Nature, *Energy Policy* 38, 2010, https://doi.org/10.1016/j.enpol.2009.10.039; L. Xue, H. Li, W. Shen, X. Zhao, Z. Liu, Z. Zheng, J. Hu, and S. Meng, 'Applying GeoDetector to Disentangle the Contributions of the 4-As Evaluation Indicators to the Spatial Differentiation of Coal Resource Security', *Energy Policy* 173, 2023, art. 113418, https://doi.org/10.1016/j.enpol.2023.113418.

[4] B.W. Ang, T.S. Choong, and T.S. Ng, 'Energy Security: Definitions, Dimensions and Indexes', *Renewable and Sustainable Energy Reviews* 42, 2015, https://doi.org/10.1016/j.rser.2014.10.064; J. Rosenow, S. Thomas, D. Gibb, R. Baetens, A. De Brouwer, and J. Kornilliego, 'Clean Heating: Reforming Taxes and Levies on Heating Fuels in Europe', *Energy Policy* 173, 2023, art. 113367, https://doi.org/10.1016/j.enpol.2022.113367.

and by diversifying the sources and directions of supply of petrol, liquid, and gaseous fuels.[5]

The above definition outlines five main preferences, such as the availability of energy, security of energy supplies, reduction of energy prices, which are determined based on justified costs and accepted by the recipients, the use of own energy sources, and, finally, diversification of sources of energy supply.[6] This definition of energy security is complemented by the definition provided by the International Energy Agency (IEA), which, in the document entitled *Energy Security. Reliable, Affordable Access to All Fuels and Energy Sources* defines the essence of energy security as the: 'uninterrupted availability of a sufficient amount of energy at an affordable price, as part of sustainable economic growth, with use of environmentally friendly measures'.[7]

A particularly important aspect of this definition, that stresses the timeliness of investment in energy supplies, is the emphasis on the need to implement sustainable development that will take into account the current environmental challenges and the needs of economic growth.[8] On the other hand, according to this definition, the essence of energy security focuses on the ability of the power supply system to respond quickly to sudden changes in the balance of supply and demand. A similar definition of energy security can

[5] 'Energy Policy of Poland until 2030', p. 8; M. Kaźmierczak, 'Poprawa poziomu bezpieczeństwa energetycznego państwa wynikająca z nowej koncepcji gospodarowania ropą naftową w Polsce', *Zeszyty Naukowe AON* 2: 91, 2013.

[6] L. Martišauskas, J. Augutis, R. Krikštolaitis, R. Urbonas, L. Šarūnienė, and V. Kopustinskas, 'A Framework to Assess the Resilience of Energy Systems Based on Quantitative Indicators', *Energies* 15: 11, 2022, art. 4040, https://doi.org/10.3390/en15114040; M. Tvaronavičiene, *Innovation in Energy Security and Long-Term Energy Efficiency. Energies* (2020).

[7] *Energy Security. Reliable, Affordable Access to All Fuels and Energy Sources*, International Energy Agency, 2022, https://www.iea.org/topics/energy-security (access: 12 March 2024); W.L. Filho, A.L. Balogun, D. Surroop, A. Lange Salvia, K. Narula, C. Li, J.D. Hunt, A. Gatto, A. Sharifi, H. Feng, S. Tsani, and H. Azadi, 'Realising the Potential of Renewable Energy as a Tool for Energy Security in Small Island Developing States', *Sustainability* 14: 9, 2022, art. 4965, https://doi.org/10.3390/su14094965; P. Raghoo, D. Surroop, F. Wolf, W. Leal Filho, P. Jeetah, and B. Delakowitz, 'Dimensions of Energy Security in Small Island Developing States', *Utilities Policy* 53, 2018, https://doi.org/10.1016/j.jup.2018.06.007.

[8] Y.A. Krupnov, V.G. Krasilnikova, V. Kiselev, and A.V. Yashchenko, 'The Contribution of Sustainable and Clean Energy to the Strengthening of Energy Security, *Frontiers in Environmental Science* 10, 2022, art. 1090110, https://doi.org/10.3389/fenvs.2022.1090110; W. Jia, X. Jia, L. Wu, T. Yang, E. Wang, and P. Xiao, 'Research on Regional Differences of the Impact of Clean Energy Development on Carbon Dioxide Emission and Economic Growth', *Humanities and Social Sciences Communications* 9: 1, 2022, p. 25, https:doi.org/10.1057/s41599-021-01030-2.

be found in the report of the World Energy Council (WEC) entitled issues *Monitor 2020: Decoding New Signals of Change* of 2020. As far as energy security is concerned, this document points to one very important aspect, which is environmental protection and the related need to apply new, innovative measures (technologies) both in power generation and transmission. These measures should be fully energy efficient, capable of reducing emission and thus mitigate climate change.[9] This aspect of energy security was also noted by the European Commission, which, in the 'New Green Deal' of 2019 defined the notion of energy security by focusing it clearly on climate neutrality and emphasising such measures as: energy efficiency, the greening of the energy system, clean energy or bioenergy sustainability.[10] The continuation of this approach to defining energy security may be found in the publication by A. Azzuni and C. Breyer, who also emphasised the need to implement the sustainable policy of the given state at the same time, to foster building its security on these values.[11]

Another definition of energy security that is worth noting was provided in the Act of 10 April 1997, on Energy Law. The Act defines the term as:

> such a state of the national economy that is able to cover both the current and prospective demand of the recipients for fuels and energy in a manner that is technically and economically justified while maintaining the requirements of environmental protection.[12]

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[9] World Energy Issues *Monitor 2020, Decoding New Signals of Change*, 2020, World Energy Council, London, https://www.worldenergy.org/assets/downloads (access: 12 March 2025).

[10] Announcement of the Commission, 2019, pp. 6–8; European Green Deal, 2021, pp. 16–17; V. You, and M. Makinaka, 'Modern and Traditional Renewable Energy Sources and CO2 Emissions in Emerging Countries', *Environmental Science and Pollution Research* 29: 12, 2022, https://doi.org/10.1007/s11356-021-16669-2; B. Igliński, M.B. Pietrzak, U. Kiełkowska, M. Skrzatek, A. Gajdos, A. Zyadin, and K. Natarajan, 'How to Meet the Green Deal Objectives—Is It Possible to Obtain 100% RES at the Regional Level in the EU', *Energies* 15: 6, 2022, art. 2296, https://doi.org/10.3390/en15062296; S. Caravella, V. Costantini, and F. Crespi, 'Mission-Oriented Policies and Technological Sovereignty: The Case of Climate Mitigation Technologies', *Energies* 15: 6, 2021, art. 6854, https://doi.org/10.3390/en14206854.

[11] A. Azzuni, and C. Breyer, 'Definitions and Dimensions of Energy Security: A Literature Review', *WIREs Energy and Environment* 7: 1, 2018, p. e 268, https://doi.org/10.1002/wene.268; Y. Krozer, 'Valorisation of Energy Services: Essay on the Value Addition Due to Renewable Energy', *Energy, Sustainability and Society* 9: 9, 2019, https://doi.org/10.1186/s13705-019-0191-6.

[12] Energy Law, 1997, Art. 3 item 16; F. Wolf, D. Surroop, A. Singh, and W. Leal, 'Energy Access and Security Strategies in Small Island Developing States', *Energy Policy* 98, 2016, https://doi.org/10.1016/j.enpol.2016.04.020; M.M.V. Cantarero, 'Of Renewable Energy, Energy Democracy, and Sustainable Development: A Roadmap to Accelerate the Energy Transition in Developing Countries', *Energy Research & Social Science* 70, 2020, art. 101716, https://doi.org/10.1016/j.erss.2020.101716.

A similar definition of energy security can be found in the Government Document 'Energy Policy of Poland until 2025', where this notion is defined as:

> such a state of the national economy that is able to cover both the current and prospective demand of the recipients for fuels and energy in a manner that is technically and economically justified while minimising the negative impact of the energy sector on the environment and living conditions of the society.[13]

It is also worth mentioning the definition of energy security provided by the Polish Institute of International Affairs (PISM), which defined the term as the capacity of the state to ensure the continuity of energy supplies at optimum costs, while, at the same time, maintaining political independence and adhering to the principles of sustainable growth.[14] According to experts from the National Security Bureau, energy security defined in this way constitutes an indispensable part of national security, which includes actions that are related to satisfying the demand of the national economy for specific energy carriers.[15] It is worth noting that this definition points to a very important aspect of energy security, which is the energy independence and sovereignty understood as the ability to provide various sources of energy to satisfy the needs of the whole population and economy, regardless of the geopolitical situation, in particular import.[16] This approach to understanding energy security was continued by G. Bartodziej and M. Tomaszewski, who understand this notion as an absence of threat during interruptions in the supplies of energy (energy resources).[17] All the above definitions of the analysed term are supplemented by the definition provided by the American economic analyst D. Yergin. According to him, energy security means ensuring an appropriate and secure level of energy supply at reasonable prices, which does

[13] A.S. Blazev, *Energy Security for the 21st Century* (River Publishers: Aalborg, Denmark, 2021).

[14] A. Gradziuk, W. Lach, E. Posel-Częścik, and K. Sochacka, 'Co to jest bezpieczeństwo energetyczne państwa?', *Biuletyn PISM* 103, 2002.

[15] J. Kowalski, and J. Kozera, 'Mapa zagrożeń bezpieczeństwa energetycznego RP w sektorach ropy naftowej i gazu ziemnego', *Bezpieczeństwo Narodowe* I–II: 9–10, 2009.

[16] K. Świerszcz, and B. Ćwik, 'Subjectivity of Energy Security With Respect to Using Geothermal Resources in Selected Regions of Poland', *Przegląd Nauk o Obronności* 1–2, 2016, https://doi.org.10.5604/01.3001.0012.9704; C. Zou, S. Pan, and Q. Hao, 'On the Connotation, Challenge and Significance of China's "energy independence" strategy', *Petroleum Exploration and Development* 47: 2, 2020, https://doi.org/10.1016/S1876-3804(20)60062-3; Caravella, Costantini, and Crespi, 'Mission-Oriented Policies'.

[17] G. Bartodziej and M. Tomaszewski, *Polityka energetyczna i bezpieczeństwo energetyczne* (Racibórz and Warszawa, 2009).

not endanger the fundamental interests, values, and objectives of the state.[18] The final part of this definition, which emphasises the strategic aspect of energy security that is manifested in form of securing the national interest, the values and goals of the state, is particularly important. A similar definition of energy security was provided by P. Baxendell, who defined the essence of energy security as the availability of energy in appropriate amounts, at the appropriate time and place and at an appropriate place to guarantee economic development and to ensure the possibility to create energy reserves not only for the nearest future, but also for longer periods.[19] A review of various definitions of energy security should also include the definition of the Polish Industrial Lobby, according to which the term is understood as: 'the continuity and reliability of energy supplies to individual, municipal, and industrial recipients at the lowest competitive costs and prices while adhering to the environmental protection standards in energy production, transmission, and consumption'.[20]

In spite of the differences in wording, the referenced definitions of energy security are mutually complementary and create the integrity of the term, pointing to four fundamental aspects. The first is economic, which should be understood as ensuring that the prices of the supplied energy resources, chosen by means of a competitive selection of the economically reasonable energy source, will not create barriers for the economic development of the state, will not lead to energy poverty of the population or expose it to energy vulnerability. The economic aspect of energy security points to the need to create an appropriate framework for the functioning of the energy sector. This may be achieved by applying legal administrative measures of an economic nature. Another important issue is the ability to achieve the competitiveness of the national energy sector on the European or global market. Therefore, the economic aspect of energy security is one of the main dimensions in which the term is defined, as it has a significant, decisive influence on the possibility to pursue the national policy in multiple important aspects of life.

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[18] D. Yergin, 'Ensuring Energy Security', *Foreign Affairs* 85: 2, 2006.

[19] P. Baxendell, 'Oil Companies and the Changing Energy Market', in: D. Hawdon, ed., *The Energy Crisis Ten Years After* (London, 1984).

[20] P. Soroka, *Bezpieczeństwo energetyczne – między teorią a praktyką* (Warszawa: Elipsa, 2015).

The second aspect of energy security is its geostrategic aspect, which is defined as the security of supplies and ensuring the continuity (reliability) and quality of energy supply in the short- and long-term perspective, on a level that is determined by both social and economic needs and expectations. These activities are supported by several key factors that are measures of such security. One of them is the policy of diversification of energy supplies and a developed, diversified network of infrastructure that guarantees not only various methods of generating energy, but also an improved resistance of the system to failures or the exhaustion of one of the energy sources. Another important factor is the technical condition of the energy transmission, transport, and distribution systems. The continuous, reliable, and fault-free supply of energy through those systems to the recipients depends on the power of the energy-generating equipment, its technical condition and quality, the standard of distribution systems, and the level of their modernisation and the innovations applied.

The state of energy reserves in an amount that enables maintaining the continuity of energy supplies to recipients is another significant factor (measure). Considering the above, each state is obliged to establish reserves of energy resources that will ensure the continuity of energy supplies to the end users, in particular during natural disasters or in situations of threat or increased defence reediness of the state. These reserves are particularly important in the current, dynamic period, when they are treated as a guarantee and protection against threats (especially military ones) that might occur in the uncertain future. Another important factor (measure) is the degree of balancing the supply and demand for energy. The increasing demand for energy both in developed countries and developing ones results from the increasing needs of humans (of the populations, states) to improve the quality and standards of their existence. The problem of demand exceeding supply is exacerbated by the depletion of fossil fuel sources and by environmental requirements. Due to the latter, energy resources have been divided into environmentally friendly resources (natural gas, petrol, renewable energy sources) and those that contribute to environmental degradation (coal and lignite). This leads to the necessity to implement new technologies of energy generation and to increase technological diversification. Social education, raising awareness of the need to save energy and

natural resources and to use them efficiently, is also extremely important.[21]

The third dimension of energy security is the environmental aspect, which should be understood as the production of energy in a way that does not lead to excessive environmental pollution and irreversible changes in the environment. In this dimension of energy security, particular focus is placed on sustainable development and climate neutrality that require support and taking action related to energy efficiency, implementing low-emission and renewable heat sources and the connected reduction of greenhouse gas emissions, implementing smart power networks and systems and power storage facilities.

Finally, the fourth aspect of energy security is the social dimension, which should be understood as providing stable, continuous, and reliable energy supplies for local communities and households. From the point of view of energy users, who are guaranteed common access to its sources as well as higher quality of services, these areas are extremely important. They determine the quality and comfort of daily life, as well as the freedom. The need to constantly raise social awareness and to provide education on the topic of development are also important.[22]

Considering the list of definitions of energy security discussed above, in the general meaning and on the national level, considering all four aspects, one may attempt to refer the notion to a more local level, in the context of households. This definition will take into consideration the overall definition of energy security. In this approach, the energy security of households should be understood as a state in which the residents are provided with constant (uninterrupted) expected level of access (supply) to specific (diverse) forms and sources of energy that meet the relevant qualitative and quantitative parameters, including technological and environmental ones, that do not cause low emission (air pollution) and that may be purchased by users when necessary and in the required amount, at a price that is affordable (for users), and on a level that ensures the fulfilment of basic needs and social and existential values.

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[21] W.L. Filho, A.L. Balogun, D. Surroop, A. Lange Salvia, K. Narula, C. Li, J.D. Hunt, A. Gatto, A. Sharifi, H. Feng, S. Tsani, and H. Azadi, 'Realising the Potential of Renewable Energy'.

[22] Katarzyna Świerszcz, 'Air Pollution as an Indicator of Local Environmental Safety Based on the Town of Barlinek', *Polish Political Science Yearbook* 51, 2022, https://doi.org/10.15804/ppsy202231.

The above definition of local energy security proposed by the author clearly points to the need of an integral approach to the problem. The absence of even one of the components of energy security mentioned above will inevitably lead to the phenomenon of energetically vulnerable households and further to heat poverty. This is precisely why the phenomenon of heat poverty is a measure of the energy security level both on the national and local scale.

Additionally, the definition proposed by the author demonstrates that there is no single, universal definition of energy security, just as there is no universal definition of security *sensu largo.* Nevertheless, the above definitions of energy security, including the definition of the energy security of households in the local aspect proposed by the author, allow for the identification of its main elements (components) that constitute the necessary basis for further discussion and the resulting solutions, which should be as efficient and effective as possible.

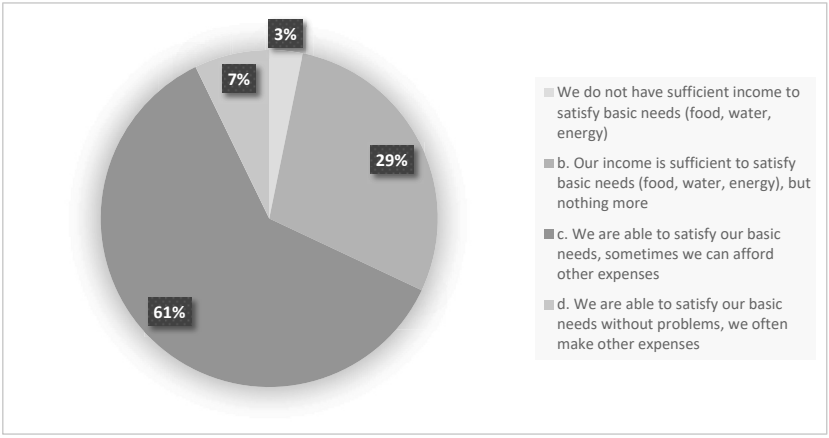
THE STATE OF ENERGY SECURITY IN TERMS OF HEAT POVERTY OF HOUSEHOLDS IN THE TOWN OF BIAŁA RAWSKA

Biała Rawska is a town situated in the Lodz Voivodeship, Rawa Poviat, with a population of 3,151 inhabitants.[23] In 2020, the poviat was characterised by lower wages, equal to 82.1 percent of the average remuneration in Poland—i.e., PLN 4,234. This was confirmed by research that revealed that 41 percent of households in the town of Biała Rawska had an income lower than PLN 4,000. 0.94 percent of them did not have sufficient income to be able to satisfy all their fundamental needs. Additionally, 27 percent of the households faced difficulties in satisfying more than their basic existential needs. This situation is presented in Figure 1.

Research also demonstrated that the households incurred very high heating costs: PLN 1,900 per month for heating their homes and approx. PLN 88 for heating water. This is shown in Table 1.

[23] *Biała Rawska w liczbach*, https://www.polskawliczbach.pl/Biala_Rawska (access: 9 April 2022).

FIGURE 1
The ability of households in Biała Rawska to satisfy existential needs



Source: own research.

TABLE 1
Heating costs of households in Biała Rawska

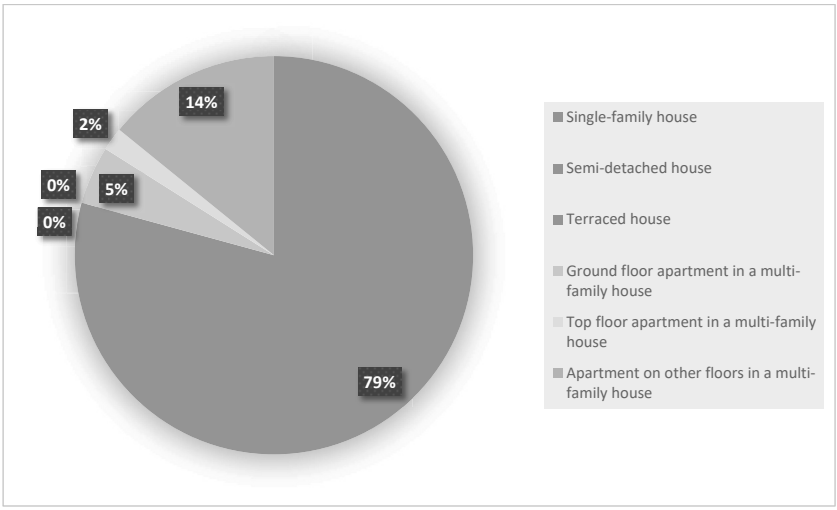
Heating costs	Statistics	Monthly costs (gross) of heating the home during the winter	Monthly cost (gross) of heating water during the winter
Biała Rawska	Average	556.50	88.70
	Median	500	100
	Minimum	90	0
	Maximum	1900	200

Source: own research.

Most of the households (79 percent) live in single-family houses, while 20.8 live in multi-family houses. This situation is illustrated in Figure 2.

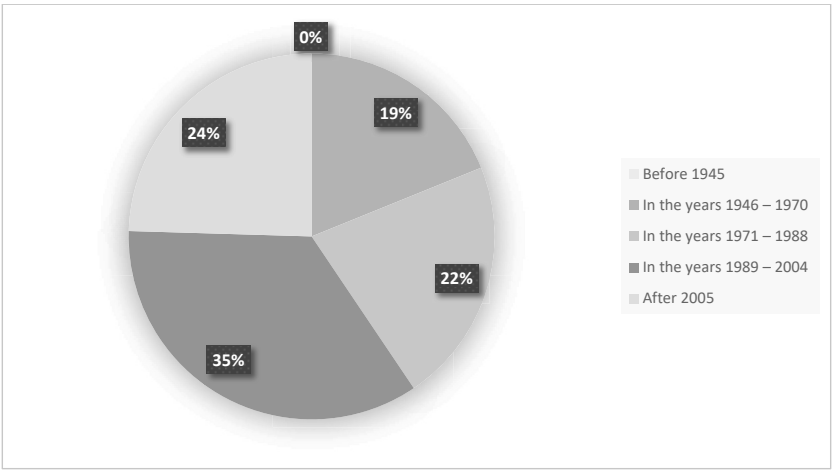
The average surface area of homes is approx. 122 sqm. The households own 94.3 percent of those apartments or houses, 4.6 percent are municipal housing, and 1.9 percent are social housing premises. It should be noted that 27.36 percent of the households mentioned a lack of thermal insulation, while 37.74 percent noted a lack of energy--efficient windows. According to research, 19 percent of the surveyed households inhabit buildings constructed before 1970, and 40 percent before 1989. This means that the buildings in Biała Rawska are quite new: as many as 35 percent of the buildings were erected in the years 1990–2004, and 60 percent after 1989. This is shown in Figure 3.

FIGURE 2
Structure of residential properties in Biała Rawska by type of building



Source: own research.

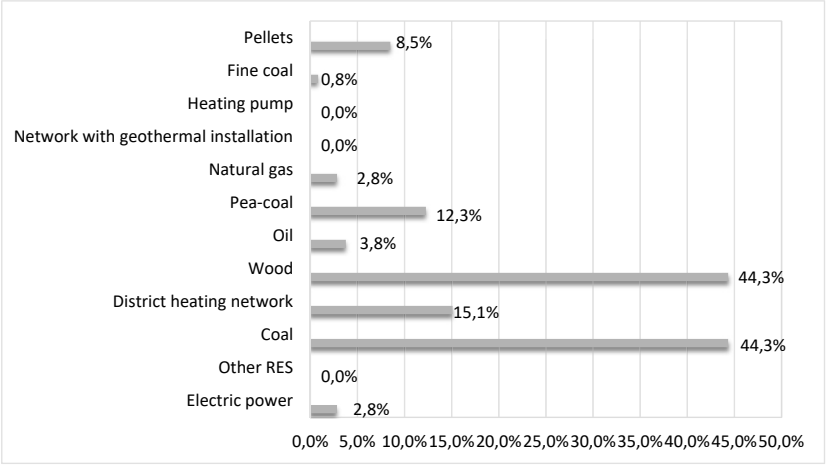
FIGURE 3
Structure of building age groups in Biała Rawska



Source: own research.

Considering heating sources, research has shown that only a small proportion (15 percent) of households use district heating from the network. Most households use coal—44 percent, pea coal——12.3 percent, and fine coal—0.8 percent, as well as wood——44 percent. This is presented in Figure 4.

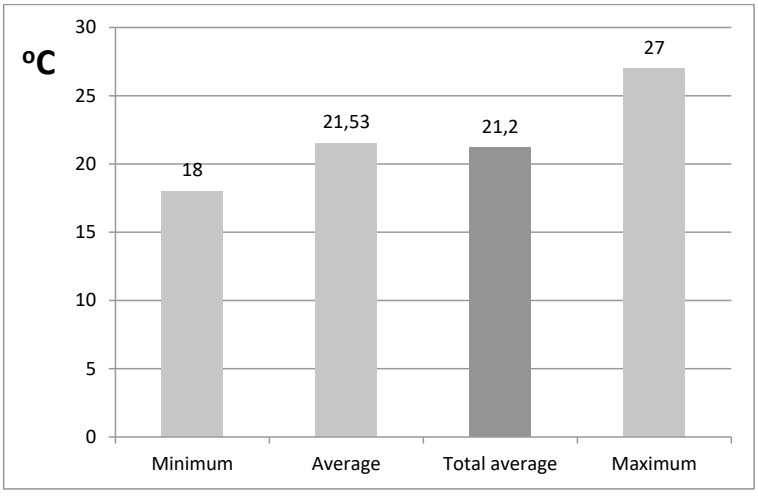
FIGURE 4
Share of specific types of fuel in heating residential homes in Biała Rawska
(The percentage values do not add up to one hundred percent as respondents could choose more than 1 answer.)



Source: own research.

The overall thermal comfort obtained from the above heating sources is slightly above the standard level and amounts to 21.53°C. However, the answers varied significantly and fell within the range from 18°C even up to 27°C, which is shown in Figure 5.

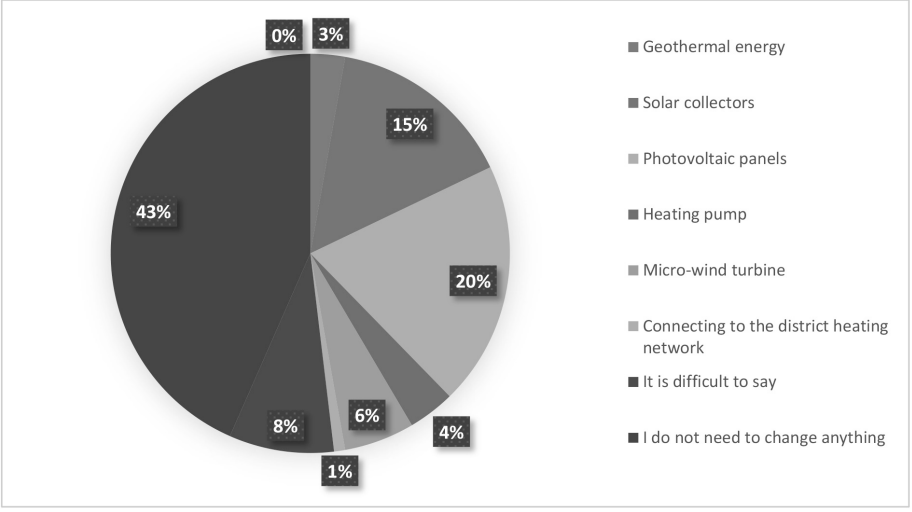
FIGURE 5
The temperature of thermal comfort provided by residents of Biała Rawska



Source: own research.

As far as heating installations are concerned, none of the respondents in the survey had taken subsidies to replace heating sources. Better results were noted for subsidies on the thermal insulation of buildings. This form of support was used by 6.6 percent of the respondents. 30.2 percent of the respondents stated that they were willing to install systems that use renewable energy sources (RES) to produce heat in their homes. On the other hand, as many as 34.9 percent respondents were against it, although only 11.3 percent of the respondents declared that they did not have suitable conditions to install such equipment. 54.1 percent of the respondents would like to replace the heating installations in their homes. They were most willing to change their heating systems to photovoltaic panels (19.8 percent) or solar collectors (15.1 percent). Very few respondents (0.9 percent) would like to connect to the district heating network. The distribution of answers is presented in Figure 6.

FIGURE 6
Distribution of respondents who expressed their interest in various forms of energy generation in Biała Rawska



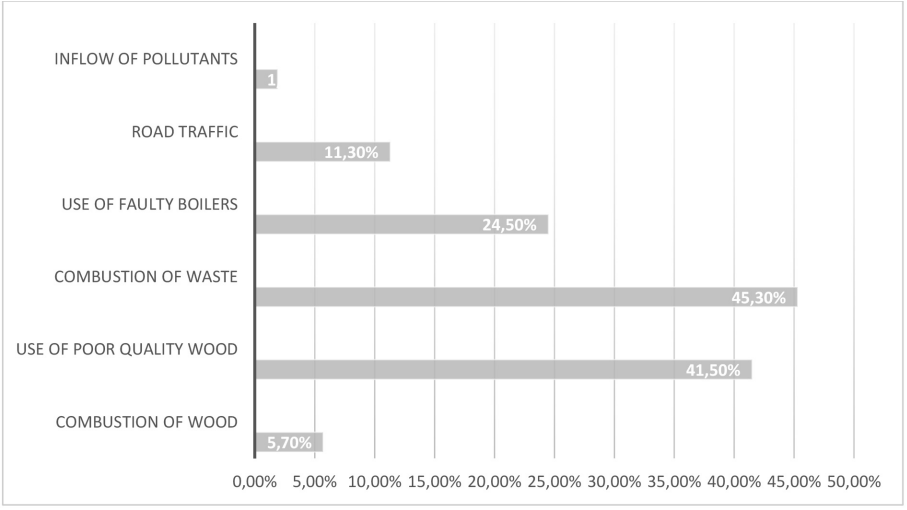
Source: own research.

In an attempt to determine the level of energy security in terms of heat poverty of households in Biała Rawska, the study took into account the social security benefits granted to the residents of the town. According to the data of the Central Statistical Office (GUS), 54 percent of the residents of municipal housing resources were in

arrears with payments of fees. The average outstanding payment per apartment was approximately 1,500 PLN. In 2020, the town authorities paid over 88,000 PLN in housing benefits to the residents. According to information provided by the Social Welfare Centre in Biała Rawska, in 2020 purpose-specific benefits totalling 28,950 PLN to cover the fees for heating fuel were granted to sixty households; housing allowances amounting to 88,531 PLN were granted to forty-three households, while four households were given an energy allowance of 704 PLN in total. In Biała Rawska, 6.6 percent of the respondents were on a form of social welfare, including 5.7 percent of the respondents who received housing allowance, and 0.9 percent took advantage of this to write off their debts.

For the question regarding a subjective assessment of quality of life, as many as 88 percent of the households gave positive answers concerning energy security, and 51.9 percent stated that they did not have problems with poor air quality, while 11.3 percent stated that it was a serious problem, and 17 percent that the problem was rather serious. Furthermore, for the question concerning the reasons for poor air quality, most of the respondents (45.5 percent) mentioned the combustion of waste and 41.5 percent the use of poor quality coal. The distribution of respondents, according to the listed reasons for poor air quality in Biała Rawska, is presented in Figure 7.

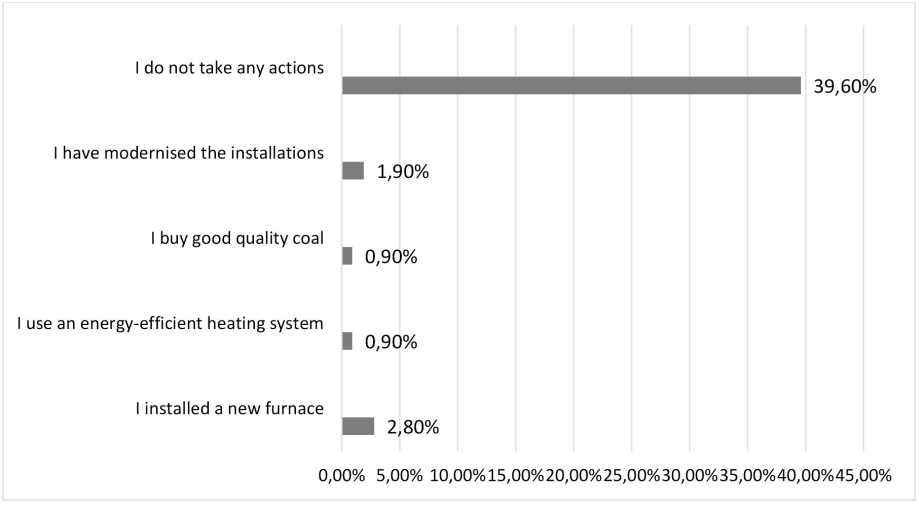
FIGURE 7
The distribution of residents of Biała Rawska who listed various reasons for air pollution



Source: own research.

It should be noted that such a high assessment of the experienced level of energy security in terms of heat poverty, while, at the same time, identifying the main sources of air pollution as burning waste and using poor quality coal, demonstrates the low level of awareness of energy security among the respondents. This is confirmed by further research results that reveal that as many as 39 percent of the respondents declared that they took no action to prevent air pollution. Those who did take such action most often mentioned replacing their furnace (2.8 percent) or modernising their heating system (0.9 percent). The relevant results are presented in Figure 8.

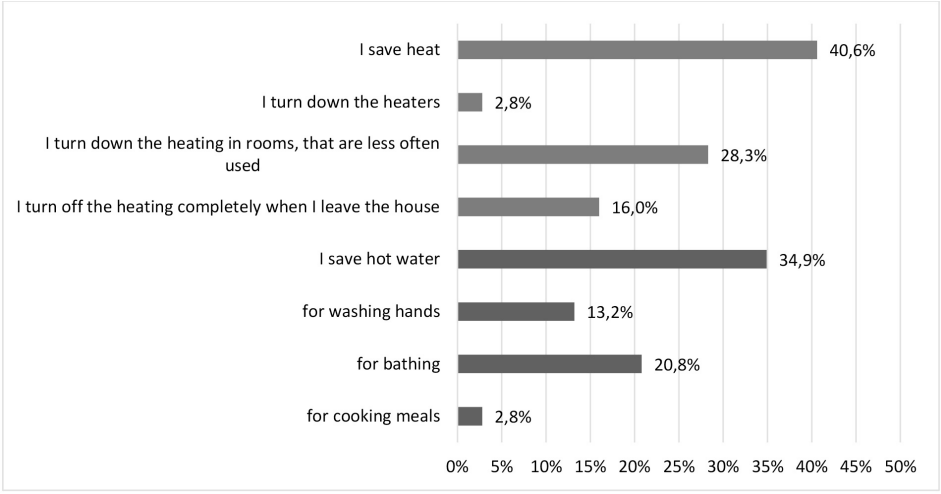
FIGURE 8
Actions taken in order to prevent air pollution in Biała Rawska



Source: own research.

The survey also brought interesting results concerning saving heat energy. As many as 40.6 percent of the respondents declared that they took some action in order to do so. Many respondents (28.3 percent) declared that they turned down the heating in rooms that are seldom used, while 16 percent turn off the heating when they leave their homes and 2.8 percent turn the heating down. A large number of respondents (34.9 percent) also declared that they saved energy used for heating water, while 13 percent saved water used for washing hands, 20.8 percent saved water used for bathing, and 2.8 percent saved the water used for cooking meals. This is shown in Figure 9.

FIGURE 9
Saving heat by residents of Biała Rawska



Source: own research.

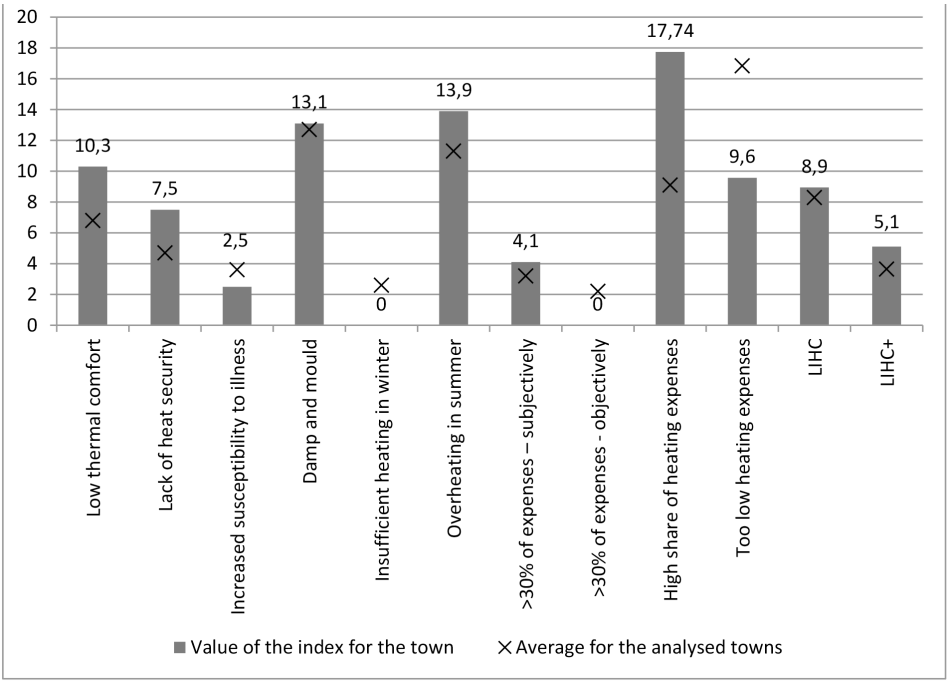
MEASURING ENERGY SECURITY IN TERMS OF HEAT POVERTY IN THE TOWN OF BIAŁA RAWSKA

All the factors calculated for households in Biała Rawska are presented in Figure 10. One may notice that the largest proportion of households which suffer from heat poverty is defined by indicators such as: a high share of heating expenses—17.74 percent, overheating their homes in summer—13.9 percent, and the presence of damp and mould in flats—13.1 percent. The most seldom indicated factors of heat poverty are: increased susceptibility to illness—2.5 percent, insufficient heating in winter—zero percent, and heating expenses—zero percent. In Biała Rawska, the index of low thermal comfort seems very poor compared to the other analysed towns (10.3 percent), as well as the high share of heating expenses—17.74 percent and lack of heat security—7.5 percent. On the other hand, indices such as greater than thirty percent heating expenses (subjective index)—4.1 percent; too low heating expenses— 9.6 percent, are lower than in other towns. As far as the new index—i.e., Low Income, High Costs + (LIHC+) is concerned, a high score was noted. This means that 5.1 percent of households suffer from inconveniences caused by low income, high heating costs, and their home being in a poor state of repair. The basis for calculating the index 'insufficient heating expenses' was

the one hundred and three respondents who gave correct answers concerning the costs of heating their flat and hot water. The basis for indices such as the LIHC and the objective index of greater than thirty percent heating expenses was the sixty-two respondents who gave correct answers to questions concerning their income and energy costs.

Therefore, in Biała Rawska, it is the subjective indices of heat poverty that point to the relatively large problem of heat poverty, although the objective measures show that the severity of this phenomenon is similar to the national average. This leads to the conclusion that the heat poverty experienced by residents of Biała Rawska to a greater extent results from the poor condition of housing resources than from the actual costs of heating energy and from the poor financial situation of the inhabitants. In practice, the new index shows that in Biała Rawska, the share of residents who are affected by heat poverty is rather low.

FIGURE 10
Indices of heat poverty calculated for Biała Rawska



Source: own research.

THE CONDITIONS FOR ENERGY SECURITY IN TERMS OF HEAT POVERTY IN THE TOWN OF BIAŁA RAWSKA

The research conducted on households that use traditional heating sources revealed the main circumstances that influence the level of energy security analysed in terms of fuel poverty. The first is the dependence on financial income among those households with a high percentage of expenditure on heating energy[24] and more difficulties in ensuring thermal comfort in the house or flat.[25] These households have low incomes, below 4,000 PLN and are above the threshold of ten percent of expenses on energy. The second condition is the type of premises, as it turns out that respondents from low-income households live in apartments in multi-family housing rather than in single-family houses. Although the number of respondents who live in single-family houses in the whole sample was higher than those who inhabit multi-family houses, the number of people who felt low thermal comfort in multi-family housing (forty-nine persons) was higher than those who felt such low thermal comfort in single--family houses (thirty-three persons). The third condition is the type of home ownership: the number of those who live in municipal or social housing is higher in the group of households with relatively low income. Approximately fifty percent of respondents who inhabit social housing mentioned a low level of thermal comfort. The number of people who mentioned low thermal comfort was also higher than average in the group of inhabitants of municipal housing: 19.5 percent. Only 5.6 percent of respondents who are owners of the inhabited properties experienced low thermal comfort, although the number of persons in this group was also the largest (sixty-two persons). Finally, the fourth condition is the employment situation: among households that have a high percentage of energy expenses——i.e., above thirty percent—as many as forty percent are retirees and

[24] K. Świerszcz, *Stan bezpieczeństwa energii cieplnej w Polsce na tle Europy* (Warsaw: WAT, 2021); V. Ballesteros-Arjona, L. Oliveras, J. Bolívar Muñoz, A. Olry de Labry Lima, J. Carrere, M. Martín Ruiz, A. Peralta, A. Cabrera León, I. Rodríguez, A. Daponte-Codina, and M. Marí-Dell'Olmo, 'What Are the Effects of Energy Poverty and Interventions to Ameliorate It on People's Health and Well-Being?: A Scoping Review with an Equity Lens', *Energy Research & Social Science* 87, 2022, https://doi.org/10.1016/j.erss.2021.102456.

[25] K. Świerszcz, 'Current Challenges in Sustainable Management of Local Energy Security in Reducing Heat Poverty: A Case Study of a Selected Region of Poland', in K.S. Soliman, ed., *Proceedings of the 37th International Business Information Management Association Conference (IBIMA), Innovation Management and information Technology impact on Global Economy in the Era of Pandemic* (Cordoba: IBIMA, 2021), pp. 192–202.

pensioners.[26] Another important factor is the age of the building: the older it is, the lower the perceived thermal comfort. Even 23.3 percent of respondents who live in houses constructed before 1945 declared a low or very low level of thermal comfort.[27] Only in the group of inhabitants of buildings erected after 1989 does the percentage of respondents who felt low thermal comfort fall below the average among the whole population. The state of repair of the building in terms of energy efficiency was also relevant. It turns out that people whose houses do not have even partial thermal insulation had more problems with maintaining thermal comfort at home. The number of respondents who mentioned low or very low thermal comfort was also higher than average in the group of persons who lived in homes without thermal wall or roof insulation or did not have energy efficient windows. For houses without thermal insulation, they accounted for 12.2 percent of the group (12 percent in partly insulated buildings), for homes without an insulated roof——10.6 percent of the group (and 14.6 percent for partly insulated roofs), and for houses without energy efficient windows, they accounted for 13.3 percent of the group. The seventh factor is the sources of fuel used by the household for heating the premises or heating water: as many as 10.6 percent of those who used coal for heating mentioned a lack of thermal comfort.[28] However, this group does not include respondents who use special types of coal—i.e., fine coal or pea-coal. Another condition for fuel poverty is the use of various forms of social security: the group of respondents who did not feel thermal comfort was significantly higher among those who use such forms of aid. In this group of respondents, three or four

[26] K. Świerszcz, *Heat Poverty as a Measure of Local Energy Security* (Warsaw: WAT, 2020); R. Bardazzi, L. Bortolotti, and M.G. Pazienza, 'To Eat and not to Heat? Energy Poverty and Income Inequality in Italian Regions', *Energy Research & Social Science* 73, 2021, art. 101946, https://doi.org./10.1016/j.erss.2021.101946.

[27] Świerszcz, 'Current Challenges in Sustainable Management of Local Energy Security'; H. Rau, P. Moran, R. Manton, and J. Goggins, 'Changing Energy Cultures? Household Energy Use before and after a Building Energy Efficiency Retrofit', *Sustainable Cities and Society* 54, 2020, art. 101983, https://doi.org/10.1016/j.scs.2019.101983.

[28] K. Świerszcz, 'Management of Local Heat Poverty in Households—on the Selected Example', *Journal of Eastern Europe Research in Business and Economics* 20–21, 2021, art. 922351, https://doi.org/10.5171/2021.922351; N. Creutzfeldt, C. Gill, R. McPherson, and M. Cornelis, 'The Social and Local Dimensions of Governance of Energy Poverty: Adaptive Responses to State Remoteness', *Journal of Consumer Policy* 43: 3, 2020, https:doi.org/10.1007/s10603-019-09442-z; I. Siksnelyte-Butkiene, D. Streimikiene, and T. Balezentis, 'Multi-criteria Analysis of Heating Sector Sustainability in Selected North European Countries', *Sustainable Cities and Society* 69, 2021, art. 102826, https://doi.org/10.1016 / j.scs.2021.102826.

times as many persons experienced low or very low thermal comfort (25.9 percent) than the average among all respondents (6.8 percent).[29]

THE CHALLENGES IN SHAPING ENERGY SECURITY BY ELIMINATING HEAT POVERTY IN THE TOWN OF BIAŁA RAWSKA—RESULTS AND DISCUSSION

The conducted analysis of the state of energy security in terms of heat poverty in the town of Biała Rawska clearly indicates several challenges that need to be addressed both on the level of Territorial Self-government Units and households.[30] On the level of TSUs, it is necessary to identify the scale of heat poverty; to define the areas that need improvement in terms of actions aimed at preventing the phenomenon on a local scale; develop a system and sources of support adequate to the needs of households affected by heat poverty that would be assisted (at least partly) by funds other than local government funding in the area; to propose more effective, comprehensive instruments that help counteract the phenomenon; to monitor heat poverty to offer more precise estimations in the subsequent years and thus an assessment of the effectiveness of the actions taken to prevent it; to conduct an informational and educational campaign in the media to educate residents about the ways to combat heat poverty in the area; and, finally, to invest in renewable energy sources as alternative heating sources.[31]

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[29] Świerszcz, 'Management of Local Heat Poverty in Households'; N. Creutzfeldt, C. Gill, R. McPherson, and M. Cornelis, 'The Social and Local Dimensions of Governance of Energy Poverty: Adaptive Responses to State Remoteness', *Journal of Consumer Policy* 43: 3, 2020, https://doi.org/10.1007/s10603-019-09442-z; A. Arsenopoulos, V. Marinakis, K. Koasidis, A. Stavrakaki, and J. Psarras, 'Assessing Resilience to Energy Poverty in Europe through a Multi-Criteria Analysis Framework', *Sustainability* 12: 12, 2020, art. 4899, https:doi.org/10.3390/su12124899.

[30] K. Świerszcz, T. Szczurek, S. Mitkow, J. Zalewski, and B. Ćwik, 'Knowledge of the Problem of Fuel Poverty Among Local Government Authorities—in the Aspect of Local Energy Security', *Journal of Eastern Europe Research in Business and Economics (JEERBE)*, 2019, art. 780276, https://doi.org/10.5171/2019.780276; Y.M. Xiao, H. Wu, G.H. Wang, and M. Mei, 'Mapping the Worldwide Trends on Energy Poverty Research: A Bibliometric Analysis (1999–2019)', *International Journal of Environmental Research and Public Health* 18: 4, 2021, art. 1764, https://doi.org/10.3390/ijerph18041764.

[31] K. Świerszcz, *Postrzeganie bezpieczeństwa energetycznego w kontekście przeciwdziałania ubóstwu energetycznemu społeczności lokalnej z wykorzystaniem zasobów geotermalnych na terenie Gminy Wiśniowa* (Warsaw: WAT, 2019); eadem and B. Grenda, 'Geothermal Energy as an Alternative Source and a Countermeasure Against Low Emission in the Ecological Security Strategy', in *Proceedings of the 2018 Joint International Conference on Energy, Ecology and Environment (ICEEE 2018) and International Conference on Electric and Intelligent Vehicles* (ICEIV, 2018), pp. 1–6; Bardazzi, Bortolotti, and Pazienza,

On the household level, it is necessary to improve the accessibility of energy services and supplies of high-quality heat for all households in the area; to improve the possibility to purchase energy sources, including heating energy, at prices that are reasonable, easily and clearly comparable, acceptable and non-discriminating, by all recipient households; to improve the energy efficiency (of buildings, heating supply networks, and heating sources) for all households; to improve the heating comfort of flats and houses and the well-being for all households; to ensure healthier living conditions for all household recipients; to stimulate the possibilities of structural renovation, modernisation and thermal modernisation of private buildings for all households; to improve the budgets of a large number of recipient households; to promote using renewable energy sources for heating in most households; and to raise the awareness of responsibility for energy security in the area.[32]

CONCLUSION

Energy security, in particular the heat security of households, is currently a great challenge both on the local and national level, due to the drastic increase in heating prices on the market. This is caused by the geopolitical situation: the Russian energy policy, the Russian military invasion of Ukraine, as well as the restrictive requirements of the European Union concerning the reduction of CO^2 emissions and increasing widely understood energy efficiency.[33] This is confirmed by the research conducted on a local scale among the households in the town of Biała Rawska. The fact that most of the respondents suffer, to some extent, from heat poverty, confirms the reasonability

'To Eat and not to Heat?'; T. Herudziński, *Sprawiedliwa transformacja Wielkopolski Wschodniej w oczach przedsiębiorców* (Warsaw: Polska Zielona Sieć, 2023), https://zielonasiec.pl/wp-content/uploads/2023/10/Raport-26-10.pdf (access: 12 March 2025).

[32] Świerszcz and Grenda, 'Geothermal Energy as an Alternative Source'; K. Świerszcz, B. Grenda, T. Szczurek, and B. Chen, 'The Importance of Geothermal Energy in Energy Security: Towards Counteracting Energy Poverty of Households', in K.S. Soliman, ed., *Proceedings of the 33th International Business Information Management Association (IBIMA)* (Granada: IBIMA, 2019), p. 771–81; P. Sadura, 'Edukacja w Zielonym Nowym Ładzie, w: D. Szwed, ed., *Zielony Nowy Ład w Polsce* (Green European Foundation, Luksemburg, bd.), https://pl.boell.org/sites/default/files/zielony_nowy_lad_w_polsce.pdf (access: 12 March 2025).

[33] K. Świerszcz, T. Szczurek, S. Mitkow, J. Zalewski, and B. Ćwik, 'Knowledge of the Problem of Fuel Poverty Among Local Government Authorities'; Y. Fan, and Ch. Fang, 'Insight into Carbon Emissions Related to Residential Consumption in Tibetan Plateau: Case Study of Qinghai', *Sustainable Cities and Society* 61, 2020, art. 102310, https://doi.org/10.1016/j.scs.2020.102310.

of conducting such research. It also confirms the need to develop and implement reliable action to address these challenges, both by Territorial Local-Government Units, and by town inhabitants.

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