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Motives for the Use of Photovoltaic Installations in Poland against the Background of the Share of Solar Energy in the Structure of Energy Resources in the Developing Economies of Central and Eastern Europe

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Abstract: Increasing the use of renewable energy sources (RES) is one of the greatest challenges faced by modern emerging and developing economies. Its effective implementation largely depends on the acceptance and involvement of consumers in the process of sustainable energy transformation. Bearing in mind the above premises, the purpose of this article is to identify the motives for the use of photovoltaic installations in Poland against the background of the share of solar energy in the structure of energy consumption in the developing economies of Central and Eastern Europe. In order to achieve this goal, the scope of the use of renewable energy sources in 11 countries of the analyzed region was determined in the course of the research; then, on the basis of the results of the survey, the motives for using solar energy by 754 Polish prosumers were identified (a statistically representative sample). The results indicate a low and relatively slow-growing use and a very different structure of RES in the surveyed economies. From the pro-consumer perspective, the decision to use solar energy is primarily influenced by economic motives, including, above all, the possibility of reducing costs and using energy also for heating. Independence factors related to the possibility of at least partial independence from energy suppliers and diversification of energy sources are also important. Ecological motivation and promotion of RES, including government incentives, are definitely less important.

Keywords: renewable energy sources; solar energy; energy resources; prosumer motives; social aspects of sustainable energy transformation

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1. Introduction

The use of renewable energy sources (RES) is a key element of the sustainable development of modern economies [1,2] and is a direct panacea for reducing greenhouse gas emissions and meeting the climate challenges of the 21st century [3,4]. In addition, as many studies and analyses show, the production of energy from RES is conducive to economic and civilization development [5–10]. It can also strengthen the innovativeness of the economy and stimulate the development and implementation of new technologies [11–19].

However, increasing the use of RES in the economy does not depend only on the will and capabilities of state or regional authorities and the adopted energy policy. It is determined by many complex factors, including climate, financial [20–22], and technological [23] factors. A significant role in decisions on the use of renewable energy is also played by its final users, who have to accept the changes and costs of the energy transition [24–26]. They also need to be aware of climate risks and have knowledge about the benefits of using renewable energy sources [27–29].

The use of renewable energy sources is complicated in emerging and developing economies, mainly due to a lack of access to capital [30–34] and modern technologies. Another problem is the low level of environmental awareness and acceptance of the need

for a sustainable energy transition [35,36]. Difficulties with the use of RES also result from organizational barriers, including poor support from government institutions and inconsistencies in the implementation of energy policy [37,38].

Considering the above circumstances, the main purpose of this article is to identify the motives for the use of photovoltaic installations in Poland against the background of the share of solar energy in the structure of energy consumption in the developing economies of Central and Eastern Europe.

To achieve this goal, the article uses the results of a survey conducted on a representative sample of 754 solar energy prosumers in Poland. The research was carried out in 2023. In the course of the analysis of their results, the tools of descriptive statistics were used. A multivariate ANNOVA was also used to determine the relationship between the motivation of prosumers and their environmental awareness.

The analyses indicated above were preceded by a study of the scope of using renewable energy sources in 11 countries of Central and Eastern Europe. These studies provide a background for considerations on the scale and scope of solar energy use in emerging and developing economies, and their results also allow us to look at the problems of sustainable energy transformation from a broader, quantitative perspective. In the course of this research thread, analysis of the structure and dynamics of phenomena and cluster analysis were used to group the countries in terms of strategies for the use of renewable energy sources.

The research results described in the article fill the research gap regarding the behavioral aspects of the use of solar energy in emerging economies. Analyses in this area are necessary to conduct an effective and sustainable energy policy and to adapt less developed countries to the environmental requirements of the European Union. An additional advantage of the research is the profiling of solar energy consumers in Poland. The research results also include the identification of existing emergent habits and attitudes of prosumers. Considerations in this regard have not been carried out so far.

The layout of the article is subordinated to the implementation of the research objectives described above. It begins with literature studies covering two key directions of consideration. The first concerns the use of renewable energy sources in emerging economies. The other relates to the motives for using photovoltaics by prosumers. The research methodology is presented in the further part of the study. Then, the results of the research are described, taking into account the use of RES in the economies of Central and Eastern Europe and the motives for the use of solar energy by Polish prosumers. The entire discussion concludes with references to previous research and recommendations for the benefit of resource policies, along with a summary including conclusions, research limitations, and directions for further research.

2. Literature Studies

As indicated in the introduction, the considerations and research in this article were conducted in relation to the use of photovoltaics in households. This issue can be considered both in general terms concerning the entire economy and energy policy, as well as in individual terms focusing on prosumers. For these reasons, the literature review is divided into two subsections, referring to the issues of using photovoltaics in emerging and developing economies and individual motives for using photovoltaics in households.

2.1. The Use of Solar Energy in Emerging and Developing Economies

The development of renewable energy sources in emerging and developing economies is much slower than in developed economies with a high level of national income and broad access to the latest technologies [39]. Nevertheless, without including these economies in the process of sustainable energy transformation, there can be no question of sustainable and effective actions to protect the environment and climate, and to improve the quality of life of present and future generations [40,41].

Economic and financial conditions are considered the key factors determining the development of renewable energy, including photovoltaics [42]. They can be considered from a macro-, meso-, and microeconomic point of view. On a macroscale, they relate primarily to economic growth and government support for RES [43,44]. At the mesoscale, these conditions apply to regional and local renewable energy development programs [45]. The microscale is of interest to prosumers and covers the issues of investment outlays, payback period, and economic efficiency of investing in a photovoltaic system. Below are the results of research on these determinants relating to developing and emerging economies, which are the subject of considerations in this article.

Thus, Alsagr (2023) [46] compared the impact of financial efficiency on the development of renewable energy sources in developing and developed economies. The conclusions he obtained showed that the increase in financial efficiency is conducive to the development of investments in RES infrastructure; however, the scope of the impact of this parameter on the development of this infrastructure in both types of economies varies. In connection with the above, the author recommended financing investments in solar energy sources using public–private partnership, which will increase the scope of projects in the area of sustainable energy transformation. In this context, it is worth adding that green bonds are also among the effective methods of financing renewable energy sources. Nevertheless, according to research by de Deus et al., (2022) [47], in emerging and developing economies, these are still poorly used and constitute a negligible part of the long-term debt securities market.

Research by Anam et al., (2022) [48] conducted in Bangladesh showed that the development of the use of solar energy is primarily influenced by the favorable geographical location that allows its use. The government's policy on sustainable, renewable energy and the need to reduce greenhouse gas emissions are also important.

Deka et al., (2023) [49], in the course of research on seven developing economies, focused on the financial barriers to the development of solar energy, aptly noting that the lack of access to capital is connected to the lack of access to modern technologies necessary for the use of photovoltaics. In less industrialized regions, these technologies are usually imported from abroad, which is associated with a high acquisition cost and significant exposure to exchange rate risk. Therefore, financial determinants should be considered the most important in the development of solar energy in the analyzed economic context.

Nevertheless, as Qi and Li (2017) [50] showed when analyzing the economies of the European Union, subsidizing renewable energy sources is not the only effective way to increase their share in energy mixes. Their research showed that there is no significant relationship between the level of subsidizing the use of RES and their share in energy production. Hence, there are other ways to encourage a sustainable energy transition.

ElSayed et al., (2023) [51] also drew attention to solar energy storage systems and power-to-X technologies that enable smooth and tailored transformation of energy from one form to another. This allows significantly improving the degree of use of photovoltaics in countries located in sunny areas, such as Egypt studied by the authors.

Liang et al., (2022) [52], in turn, examined the barriers that hinder the use of solar energy in developing economies. Their research showed that the most important of them is the lack of access to modern technologies. It can be equalized by limiting corruption and taking actions in R&D. The authors also raised the issue of the development of human resources and infrastructure related to photovoltaics. They also highlighted the role of educational activities in the use of solar energy, including information on the economic and ecological benefits of renewable energy sources. The importance of this factor in the acceptance of RES use costs was also described by Yu et al., (2022) [53] on the example of the Vietnamese economy and Fang et al., (2022) [54] on the example of Brazil, India, China, and South Africa.

Referring to the technological focus, Mahbub et al., (2022) [55] stated that foreign direct investment related to renewable energy in developing economies requires a structured and friendly institutional environment. Their research also showed that the development of

solar energy sources is positively influenced by the level of economic growth, access to local sources of financing RES, and the availability of land for investments.

It is also worth adding that, in the process of using solar energy, a holistic approach to various aspects is important, including the life cycle of photovoltaic installations [56] (Gressler et al., 2022). Such an approach was also analyzed by Milousi and Souliotis (2023) [57], who included photovoltaics in the assumptions of the circular economy. The comprehensive program for the development of this renewable energy source proposed by them takes into account the energy saving potential, the environmental impact, the expected service life, and the possibility of reuse and recycling. Researchers are, therefore, combining technical, economic, and environmental aspects in the long term.

Similar views were also presented by Van Opstal and Smeets (2023) [58], emphasizing in their research a long-term approach to the use of photovoltaic panels, including their disposal. The authors emphasized that, currently, in the course of intensive promotion of RES, the attention of all institutional and individual decision makers is focused on short-term benefits related to solar energy, which include primarily lower energy costs, energy independence, and security of supply. Issues related to the management of photovoltaic installations after their use are still omitted, which results from the lack of development of the waste management market and the lack of legal solutions in this area. Nevertheless, without filling these significant technological and organizational gaps and including photovoltaic installations in the circular economy, it will be difficult to consider solar energy as a fully sustainable source in the future, as also proposed by Zhao et al., (2022) [59] on the example of developed economies and Kinally et al., (2022) [60] on the example of African economies.

As part of the criticism of the use of solar energy, there are also threads regarding its domination of energy mixes in countries with favorable climatic conditions. According to Brunent et al., (2022) [61], basing energy production mainly on solar sources may lead to (1) the emergence of conflict situations, (2) fragile local development, (3) latent financial risk, and (4) limited economic development leverage. Therefore, the energy policy should assume the diversification of energy sources to reduce the economic risk.

The next section of the article presents the results of research relating to the Polish economy. It is, therefore, worth referring to the key factors determining the development of photovoltaics in this region. It should be emphasized that the intensive development of this RES has been going on in Poland for about 5 years. The main determinants of this process include the relatively low cost of installing solar panels, the government subsidy system for this investment [62], and, until recently, the possibility of recovering surplus energy transferred to the national grid. In turn, the barriers to the implementation of photovoltaics include climatic conditions and the current elimination of the possibility of recovering energy transferred to the grid, which previously significantly reduced the final cost of its acquisition.

Research to date also shows that decisions on the use of photovoltaics are made mainly on the basis of attitudes to solar energy, and the factors promoting this RES are of much less importance [63]. In addition, government programs subsidizing the use of solar energy are very well received by enthusiasts of such a solution, despite the fact that they see the high costs of such an investment and the lack of energy storage systems. Skeptics, in turn, emphasize the unpreparedness of the Polish power grid for the sudden increase in prosumers, which may make it difficult for the development of photovoltaics in Poland in the future [64].

2.2. Review of the Motives and Intentions of Using Photovoltaics

In the literature on the use of photovoltaics, there are several technological topics [65], which are focused on issues related to energy transmission and storage [66,67] and optimizing its use [68–70]. Much space is also devoted to modern energy trading systems [71,72], including those that use artificial intelligence. The described considerations are most often in the form of analyses conducted on a macroscale, relating to the entire sector.

The micro perspective—concerning individual prosumers—receives much less attention, although there is no shortage of considerations in this area about technological facilities offered to households. One of them is the Internet of things widely described as a tool to optimize the use of solar energy [73]. Smart homes are also popular [74].

Focusing on technical aspects ignores the fact that the energy system has a technical and social character [75]; without developing effective relations between the technical infrastructure and the community of energy consumers, it will not be possible to effectively optimize its operation. This issue was raised in considerations by, among others, Galvin (2020) [76], emphasizing that the optimal use of photovoltaics is only guaranteed by the simultaneous adjustment of the needs of prosumers, the requirements of the technical system, solar cycles, and legal and organizational regulations. Miller and Senadeera (2017) [77] also pointed out the lack of prosumer research and information about their needs and expectations. The authors believed that eco-feedback would certainly contribute to greater interest in RES and focus attention on those investing in solar systems. For these reasons, in this article, the issue of the use of photovoltaics is analyzed from an individual socioeconomic perspective.

In the current research on economic motivation, attention should be paid to publications on the costs of obtaining energy, including the problem of subsidizing photovoltaics [78]. In this context, Fikru and Canfield (2021) [79] emphasized the need to individualize energy rates and the level of solar energy subsidies. According to the authors, this is an effective way to increase the scope of use of this renewable energy source and also allows optimizing the cost of operating the electricity network. A differentiated system of tariffs in the use of solar energy was also proposed by Ferrara et al., (2021) [80]. It is designed to increase the responsiveness of prosumers and provide them with greater flexibility and comfort in using RES. Similar conclusions were also drawn by Saumweber et al., (2021) [81], Hendam et al., (2021) [82], and Gautier et al., (2021) [83].

The importance of costs in the process of using solar energy was also emphasized by Hanhel et al., (2021) [84] in the course of research on peer-to-peer (P2P) systems. According to the results obtained by them, the largest group of consumers of solar energy constitutes households primarily interested in reducing energy consumption costs. In turn, Nadolny et al., (2022) [85] stated that people with higher incomes are more likely to decide to be prosumers.

Notably, the study by Child et al., (2020) [86] conducted in Finland showed that the use of renewable energy sources, including photovoltaics, can effectively and, in the long term, reduce the cost of energy in households.

The importance of economic issues in the process of using solar energy is growing in emerging and developing economies due to the financial and technological problems mentioned at the outset that are ubiquitous in such regions. This was also pointed out by Osorio-Aravena et al., (2021) [87] in research conducted in Chile. The authors concluded that the biggest problem in the implementation of photovoltaics is the high cost of investment and the low level of household income. These barriers can be eliminated by appropriate legal regulations and financial support for investments in renewable energy sources.

Sotnyk et al., (2023) [88], examining the possibilities of photovoltaic development in Ukraine, also noted the significant role of economic factors in motivating potential prosumers to install solar systems. The authors emphasized that, without investment incentives and financing of energy storage, it will not be possible to increase the share of solar energy in the Ukrainian energy mix.

Moreover, the study by Liu et al., (2023) [89] conducted in China showed that additional income from the sale of surplus energy to the grid is an important determinant of the decision to use photovoltaics in households, especially in highly industrialized and urbanized regions, where prosumers are also more aware of the benefits of photovoltaics. On the other hand, in agricultural, economically less developed regions, behavioral factors—such as opinions and habits—are significantly gaining in importance.

In sociopsychological considerations on the use of photovoltaics, there are threads about the behavior and attitudes of prosumers. Thus, Oberst et al., (2019) [90] showed that prosumer households consume less energy than non-prosumer households, which is most likely due to their greater environmental awareness reflected in the purchase of less energy-intensive household appliances. The authors, however, did not notice significant differences in behaviors and habits regarding the use of energy between the analyzed groups.

On the other hand, Hansem et al., (2021) [91], based on photovoltaic research in Denmark, created a typical figure of a Danish prosumer. He is a man with a higher technical education who sees independence, as well as economic and ecological benefits, resulting from the use of solar energy. Furthermore, photovoltaics in Denmark are more likely to be adapted by older people who live in new houses and use heat pumps to heat them. The authors' research also showed that, in the process of promoting photovoltaics in the initial phase of its implementation, press materials and professional articles were of great importance, while, in the later stages, potential prosumers were more effectively influenced by information obtained from friends and the related imitation effect.

The results of a study conducted in the Netherlands by Georgarakis et al., (2021) [92] showed that the decisions of Dutch prosumers to use solar energy are most strongly influenced by ecological motivation, while economic factors are less important. This confirms earlier observations from the Danish economy. Moreover, the majority of prosumers stated that they were able to provide the surplus of generated energy to energy-poor households, which proves the very high ecological and social awareness of the Dutch respondents. This approach is conducive to a sustainable and fair energy transition.

In the literature on the subject—in the environmental trend—the relationship between the use of solar energy and pro-ecological attitudes of prosumers was also studied. It follows from research by Stikvoort et al., (2022) [93] conducted in Sweden on groups of prosumers and non-prosumers that both consumers and prosumers engage in pro-environmental behavior for the same reason. It is the conviction that pro-environmental behavior contributes to climate protection and improvement of the quality of life. In addition, the authors stated that the pro-environmental decisions taken by both groups do not have to be accompanied by economic benefits, because they are motivated by moral responsibility and a sense of agency, including the impact on sustainable consumption and energy saving.

Despite such optimistic conclusions, Paul et al., (2018) [94] noted that Swedish solar energy prosumers may experience an increase in energy consumption due to a reduction in overall energy costs. Therefore, the use of RES does not cause a permanent change in energy behavior and may also contribute to an increase in consumption if cost reduction is too attractive.

The above literature review provides knowledge about the possible motives for the use of photovoltaics. These motives can be assigned to four groups: economic, independent, ecological, and marketing (promotional). Their impact on the decisions of potential prosumers is diverse in geographical, social, and economic terms. In addition, their hierarchy may change over time. Therefore, monitoring and comparative analysis of the motives for the use of photovoltaic installations are important for creating effective strategies for the use of renewable energy sources.

3. Materials and Methods

In the course of research on prosumer motivation in developing economies, a two-stage approach was used. In the first stage of the research, the scope and structure of RES use in 11 economies of Central and Eastern Europe were characterized. Considerations in this trend are the background and reference point for the results of the survey on the motives for installing photovoltaic panels presented in the second research stage. In this way, research methods were triangulated allowing for a broader context of observations and deepening of analytical conclusions.

Analytical tools used in each of the stages, together with the purpose of their use, are presented in Table 1.

Table 1. Research tools used at individual stages.

Stage	Results Analysis Tools	Purpose of Using Selected Analytical Tools
Analysis of the results of surveys on prosumer motivation	Cronbach's alpha test	Assessment of the reliability of the survey questionnaire.
	Descriptive statistics: measures of central tendency (mean, mode, median)	Identification of the hierarchy of prosumer motives.
	Descriptive statistics: measures of variation (standard deviation, variation coefficient)	Assessment of the diversity of prosumer motivation.
	Descriptive statistics: skewness and kurtosis	Evaluation of the possibility of using ANNOVA—the condition of normal distribution.
	Levene's test for homogeneity of variances	Evaluation of the possibility of using ANNOVA—the condition of homogeneity of variance.
	Multifactorial ANNOVA	Assessment of links between prosumer motives and pro-ecological attitudes of prosumers (heat source/environmental awareness).
Analysis of statistical data on the use of RES	Share of RES in energy production	RES use range assessment.
	RES structure (energy: solar, wind, other)	Identification of RES development strategy.
	Average annual rate of change	Assessment of the pace of RES development.
	Cluster analysis	Segregation of countries taking into account the adopted strategy of RES used.

Source: own work.

The source of research for macroeconomic analysis was the BP Statistical Review of World Energy 2022 (71st edition) [95]. In turn, the microeconomic analysis, conducted from the perspective of a prosumer, used the results of proprietary surveys conducted on a quantitatively representative sample of 754 prosumers in Poland in 2023. The following assumptions were made in the sample size calculation process:

- Sample size: 700,000 prosumers;
- Fraction size: 0.5;
- A 4% maximum error defining the scale of the difference between the results obtained in the sample and the population;
- A 97% confidence percentage determining the certainty of the results obtained.

The metric questions were adapted to the characteristics indicated in the literature as the distinguishing features of prosumers. They included the following:

- Age of the property where PV is used;
- Type of heat source;
- Scale of taking into account energy consumption in the process of purchasing electrical equipment, determining the level of environmental awareness of the respondents.

The above approach made it possible to identify the relationships between individual motivators and the characteristics of prosumers.

The motivators themselves were included in four groups referring directly to those described in the previous literature review. These groups included the following factors:

- Economic—related to the possibility of reducing energy costs in the household and the payback period of the photovoltaic investment;
- Independent—related to the possibility of diversifying energy sources and dispersion of individual energy risk;
- Environmental—referring to the need for pro-ecological changes contributing to climate protection and in line with the policy of the European Union;
- Marketing—determining the impact of promotion, imitation effect, and snobbery on decisions on the use of photovoltaics.

4. Results

The research results are presented in the order corresponding to the research stages set out in the previous section, which allowed dividing this section into four subsections. The first of them concerns the use of solar energy in the developing economies of Central and Eastern Europe. It constitutes the statistical background for further considerations. The next three subsections cover the results of surveys and relate directly to the main research topic. These subsections describe in turn the assessment of the reliability of the survey questionnaire along with the characteristics of the research sample, the results of the assessment of the motives for choosing a photovoltaic installation, and the conditions characteristic of individual motivational factors.

4.1. Analysis of the Use of Solar Energy in the Developing Economies of Central and Eastern Europe

The research began with an analysis of the scope of solar energy use in developing economies in Central and Eastern Europe. They constitute the context of the survey, the results of which are presented later in the article.

Thus, Table 2 contains data on the consumption of renewable energy sources in the analyzed region in 2011–2021, along with their share in total energy production in 2021. The table shows that, in all 11 countries, the production of energy from RES steadily increased over time. Most of it was produced in Poland, Romania, and the Czech Republic, while the least was produced in Slovenia and Latvia. The value of energy generated from RES grew the fastest in Croatia, Latvia, and Romania. Nevertheless, the share of RES in energy production only in Poland exceeded 0.8%. In other countries of Central and Eastern Europe, its value in 2021 ranged from 0.05% to 0.2%. Despite the observed increase, this share is still small compared to the European leaders, which include Germany—5.9%, UK—3.2%, Spain—2.6%, and Italy—2.0%.

Table 2. Generation of energy from renewable sources in the countries of Central and Eastern Europe in 2011–2021 [in TWh].

Country	Years											Share in 2021	Change 2021/2011
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021		
Bulgaria	1.0	2.1	2.8	2.8	3.1	3.2	3.3	4.2	4.6	4.7	4.6	0.10%	370.00%
Croatia	0.3	0.4	0.7	0.9	1.1	1.5	1.8	2.1	2.5	2.9	3.3	0.10%	866.67%
Czech Republic	5.2	6.0	6.5	7.3	7.6	7.4	7.7	7.8	8.0	8.0	8.0	0.20%	53.85%
Estonia	1.2	1.4	1.2	1.3	1.5	1.5	1.8	1.9	2.1	2.7	3.1	0.10%	125.00%
Hungary	2.5	2.4	2.6	2.8	3.0	3.0	3.3	3.5	4.5	5.3	6.7	0.20%	112.00%
Latvia	0.2	0.4	0.6	0.8	0.9	1.0	1.1	1.1	1.1	1.0	1.0	0.05%	400.00%
Lithuania	0.6	0.8	0.1	1.1	1.3	1.6	1.9	1.8	2.1	2.3	2.0	0.10%	283.33%
Poland	10.8	14.8	14.6	17.7	20.7	20.7	21.6	19.6	23.5	25.3	27.8	0.80%	134.26%
Romania	1.6	2.9	5.2	6.5	9.6	8.9	9.8	8.5	9.1	9.2	9.0	0.20%	475.00%
Slovakia	1.2	1.4	1.5	2.0	2.2	2.3	2.2	2.2	2.3	2.3	2.7	0.10%	91.67%
Slovenia	0.3	0.3	0.5	0.6	0.5	0.6	0.6	0.5	0.6	0.7	0.6	0.05%	133.33%

Source: own work.

According to the data in Table 3, the largest share of solar energy—which is the subject of the research—was recorded in 2021 in Hungary, Slovenia, and Bulgaria, allowing us to conclude that solar energy is more popular in the southern part of the analyzed region, which also results from more favorable climatic and geographical conditions. In the structure of the use of renewable energy sources in Romania, Lithuania, Croatia, and Poland, wind energy dominates, which is not used at all in Slovakia and Slovenia. Slovakia, Latvia, Estonia, and the Czech Republic make significant use of other renewable energy sources, which include primarily biomass and/or geothermal energy.

Table 3. Share and average annual rate of change and structure of renewable energy sources in Central and Eastern Europe in 2021.

Country	Content	Pace of change	Structure		
			Wind	Solar	Other
Bulgaria	0.10%	16.49%	30.43%	32.61%	36.96%
Croatia	0.10%	27.10%	63.64%	3.03%	33.33%
Czech Republic	0.20%	4.40%	7.50%	27.50%	65.00%
Estonia	0.10%	9.96%	22.58%	9.68%	67.74%
Hungary	0.20%	10.36%	10.45%	56.72%	32.84%
Latvia	0.05%	17.46%	10.00%	10.00%	80.00%
Lithuania	0.10%	12.79%	65.00%	5.00%	30.00%
Poland	0.80%	9.92%	58.63%	14.03%	27.34%
Romania	0.20%	18.85%	74.44%	18.89%	6.67%
Slovakia	0.10%	8.45%	0.00%	25.93%	74.07%
Slovenia	0.05%	7.18%	0.00%	50.00%	50.00%

Source: own work.

The above analysis shows that the RES energy mixes in the countries of Central and Eastern Europe are quite diverse, and their composition does not always result directly from climatic conditions. Therefore, they are a derivative of individual, national energy strategies that are also dependent on political and social determinants.

Bearing in mind the above observation, in the further part of the article, an attempt is made to group the surveyed countries due to the characteristics of the RES used in them. For this purpose, a cluster analysis based on the parameters listed in Table 3 was used, including the share of RES in energy generation, the average annual rate of change in energy production from RES, and the structure of RES broken down into solar energy, wind energy, and other RES sources. Clustering was performed in Statistica. The entered data were the key determinants of the strategy for the use of renewable energy resources. They illustrated the extent of RES use, the progress in increasing the use of RES, and the proportions between RES in the energy balance. Thus, they could represent the basis for identifying similarities of the studied economies. The results of the analysis are shown in Figure 1.

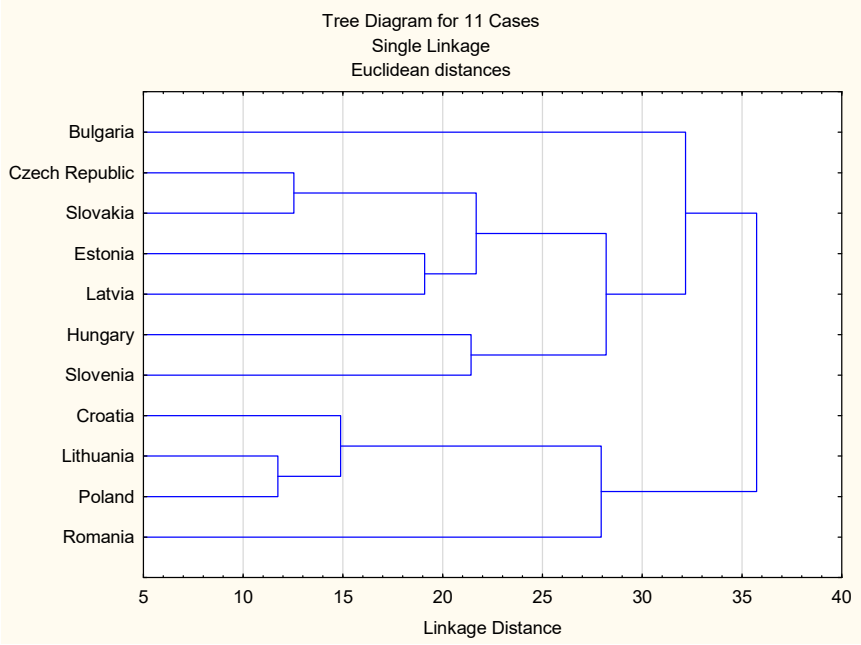

Figure 1. Cluster analysis for the examined countries of Central and Eastern Europe based on the parameters presented in Table 1.

Similar characteristics of the examined parameters characterized clusters formed as follows:

- Czech Republic and Slovakia: low/medium RES change rate, high share of solar energy, and dominant share of other RES;
- Estonia and Latvia: low/medium RES change rate, high share of wind energy, and dominant share of other RES;
- Hungary and Slovenia: average RES change rate, dominant share of solar energy, and significant share of other RES;
- Croatia, Lithuania, and Poland: medium/high RES change rate, dominant share of wind energy, and significant share of other RES.

Romania and Bulgaria are outliers that are difficult to assign to the groups described above. Romania is characterized by a rapid pace of changes in the volume of energy production from RES, with the dominant share of wind energy and the lowest share of other RES in the group. Bulgaria, on the other hand, is distinguished by a rapid pace of change in the use of RES and a very balanced use of wind, solar, and other renewable energy.

In the context of the conducted analysis, it can also be noted that, within individual clusters, there are countries that are geographically and historically and politically close. Currently, it manifests itself in similar strategies for the use of renewable energy sources. Nevertheless, it is difficult to reduce the entire region to a common location or climatic denominator within the scope studied in the article.

4.2. Evaluation of the Reliability of the Questionnaire and Characteristics of the Study Sample

The analysis of the survey results began with the assessment of the reliability of the survey questionnaire, for which the Cronbach's alpha test was used. The value of the Cronbach's alpha coefficient for the study in question was 0.8828, which allows us to conclude that the reliability of the developed research tool is good, close to perfect, and enables the continuation of the planned analyses. Detailed results of the Cronbach's alpha test for individual survey questions forming the research construct are presented in Appendix A.

Then, the research sample was characterized. A total of 754 respondents took part in the study, which, as indicated in Section 3, is a quantitatively representative research sample for the population of prosumers operating in Poland in 2023. When calculating the sample size, a fraction size of 0.5, 4% maximum error, and a 97% confidence level were assumed. Thus, the obtained results may differ by $\pm$4% from the results characteristic for all prosumers in Poland, and the certainty of the obtained answers is estimated at 97%.

The characteristics of the sample calculated in this way, taking into account the following parameters, are presented below:

- Types of heat sources used by the surveyed prosumers;
- Age of the property where photovoltaics are used;
- Period of using photovoltaics as an energy source;
- Environmental awareness expressed through the scope of taking energy consumption into account when purchasing electrical equipment.

Accordingly, more than half of the surveyed prosumers use conventional energy fuels to produce heat: coal (hard or lignite) and natural gas (Figure 2). This reflects to some extent the structure of the Polish energy balance, dominated by coal supplemented by natural gas and crude oil. The majority of them use heat pumps. Half as many households use biofuel and just over 3% are powered by system heat (which results from the fact that prosumers are mainly residents of single-family houses, and system heat in Poland is supplied mainly to multiapartment buildings). Therefore, it can be concluded that the respondents use mainly high-emission energy sources to obtain heat, which is the main problem of the Polish energy sector.

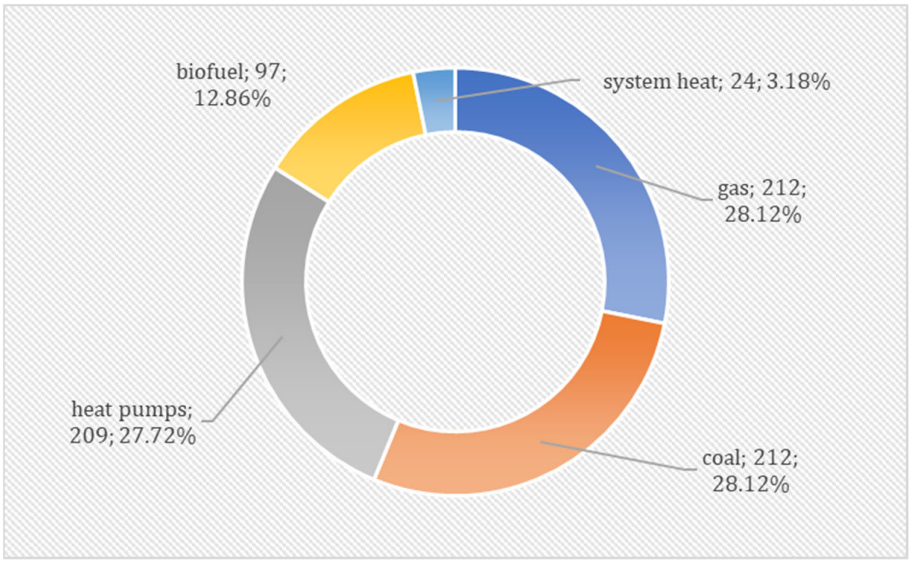

Figure 2. Types of heat sources used by the surveyed households.

Nevertheless, they are in the group of households making efforts for greener energy production because they have decided to install photovoltaic panels. The age of the properties where the installations in question are used is shown in Figure 3. Almost 40% of the properties used by the respondents are over 20 years old, and about 30% are between 10 and 20 years old. About 30% of respondents use photovoltaics in relatively new homes, which are less than 10 years old. The structure described above shows that photovoltaic panels are installed mainly in the old housing stock corresponding to the age structure of single-family houses in Poland. Notably, the owners of these properties see the need to modernize their energy systems and decide to diversify their energy sources with the use of photovoltaics.

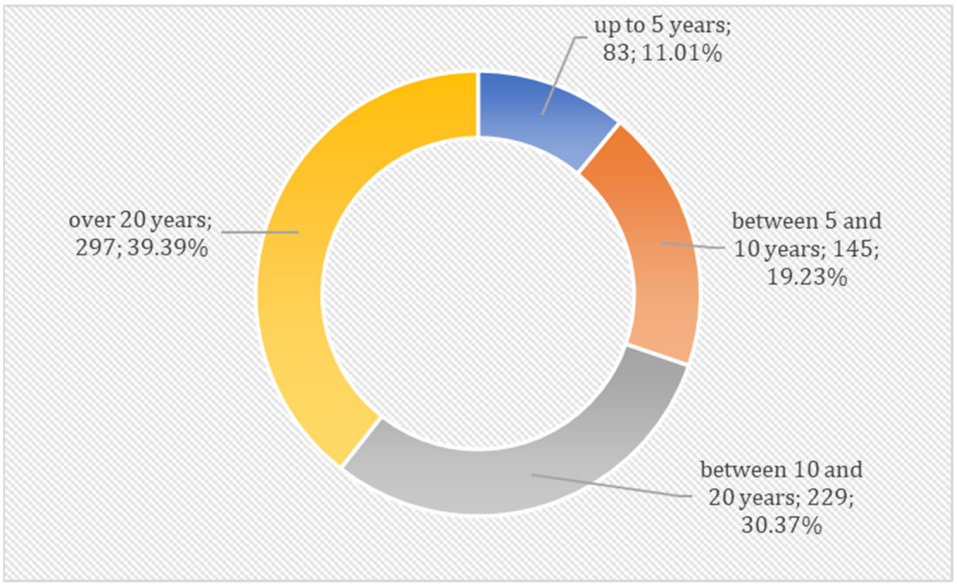

Figure 3. The age of the property where PV is used.

However, it should be noted that, according to the structure reflecting the life of photovoltaics, presented in Figure 4, the majority of respondents (over 97%) have been using photovoltaic installations for only 3 years. Less than 3% have been using this source of energy in the period of 4–5 years. None of the respondents have been using photo-

voltaic panels for more than 5 years. This means that the decision to install photovoltaic installations was made relatively recently and may have been triggered by the progressing energy crisis and/or accompanying economic government incentives (e.g., subsidizing the installation of a photovoltaic installation, the possibility of settling surpluses of energy produced over time, and favorable terms of crediting photovoltaic installations) to change energy systems to renewable and more ecological ones.

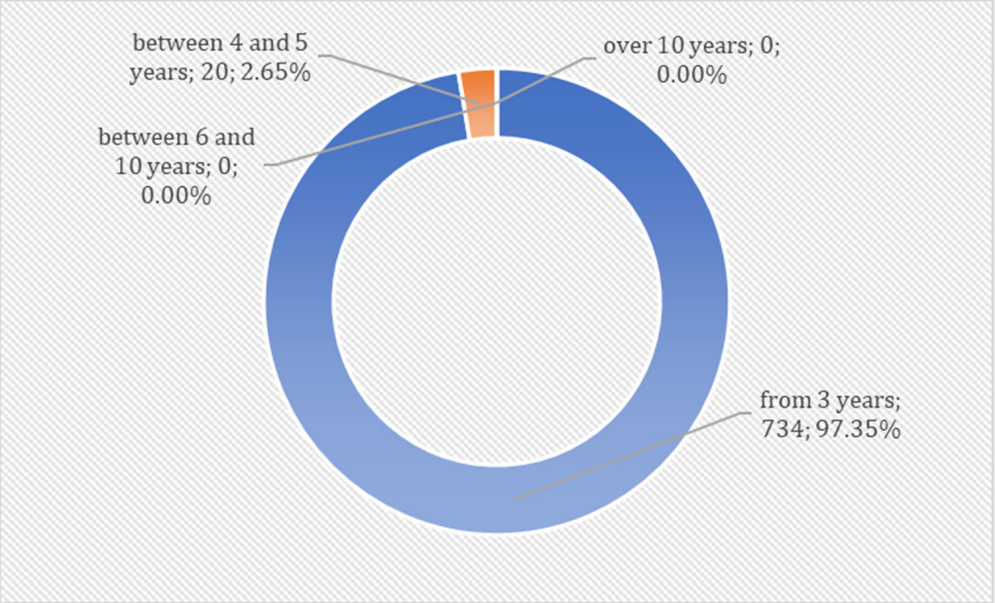

Figure 4. Period of using PV.

The last of the metric questions took into account the ecological awareness of the respondents, expressed in the scope of the impact of the energy intensity of electrical devices on the respondents' purchasing decisions. The distribution of answers to this question is shown in Figure 5.

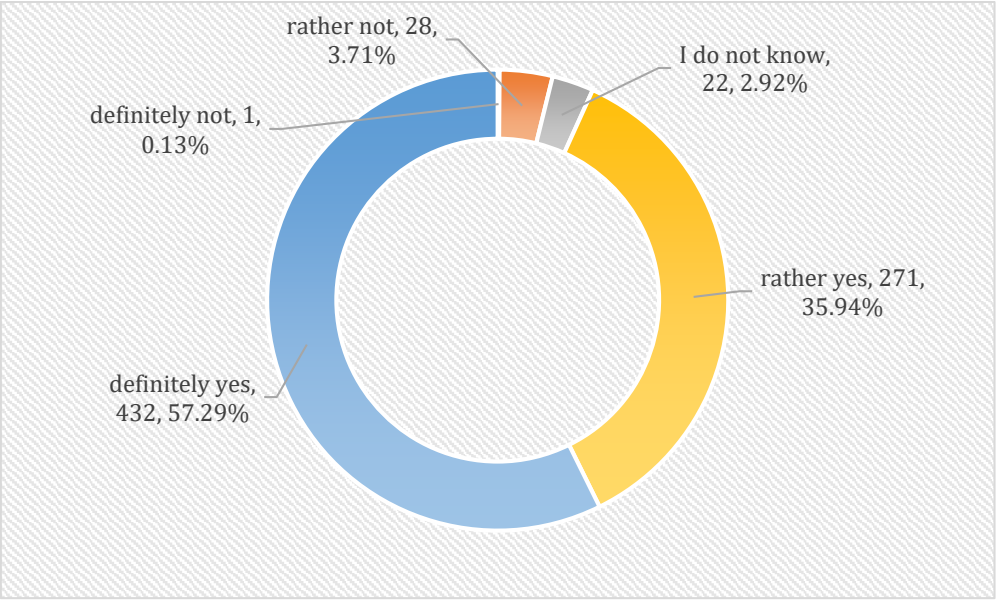

Figure 5. Environmental awareness (distribution of answers to the question: When choosing appliances that use electricity (washing machine, fridge, etc.), do you take into account their energy consumption expressed in energy class?).

The data presented reveal that the respondents show high ecological awareness, because over 93% of them, when choosing electrical devices, are guided by their energy consumption. Although it should be added that, in Polish socioeconomic conditions, considering the average level of disposable income (compared to the EU), such motivation certainly also has an economic source in the form of reducing the costs of consumed energy.

The analysis of the structure of the surveyed sample shows that the typical (most common) user of photovoltaics in Poland is the owner of a property older than 10 years, heated with coal or gas, interested in reducing costs and greening the energy sources used, and using photovoltaic panels for less than 5 years.

4.3. Motives for the Use of Photovoltaic Installations in Households in Poland

In the next stage of the survey, the answers to individual questions regarding the motives and conditions for the use of photovoltaics in households in Poland were analyzed. Table 4 provides descriptive statistics related to the motives. Moreover, Figure 6 shows the distribution of the studied conditions.

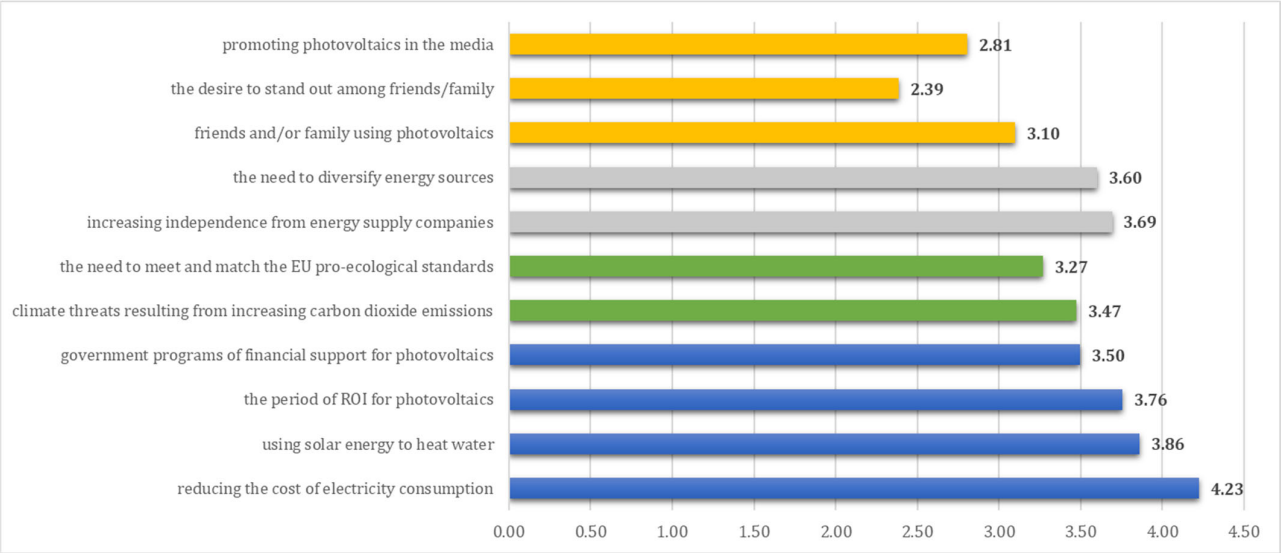

Figure 6. Arithmetic mean for statements regarding the motives for using photovoltaics. Source: own study based on the results of questionnaire surveys.

Thus, the data contained in Table 1 show that, in the process of choosing photovoltaics as an energy source, economic motives are the most important, particularly the possibility of reducing costs and using energy as a heat source. The average rating of these motives is the highest, and the dominant answer suggests that they influenced the decisions of the respondents "to a very large extent". In the case of costs, respondents' points are very unambiguous due to the lowest value of the standard deviation and the coefficient of variation. In addition, the negative skewness value and the high value of the upper quartile for this theme testify to the concentration of responses in the maximum values of the Likert scale.

Interestingly, among the economic motives, government support programs for photovoltaics are the least important, which suggests that these are not attractive to the respondents, or that they do not trust government institutions and prefer to rely on their own choices stimulated only by economic rationality. In addition to reducing the cost of electricity consumption—as part of economic motivation—the respondents are mainly guided by the possibility of using photovoltaic energy to heat water and the ROI period in this renewable energy source. Therefore, what counts for them are the benefits that can be converted into real financial effects in the form of reducing the costs of electricity and heat consumption.

Table 4. Descriptive statistics for individual motives for using photovoltaics.

Variable	Average	Median	Mode	Minimum	Maximum	Lower Quartile	Upper Quartile	Standard Deviation	Coefficient of Variation	Skewness	Kurtosis
					Motives						
Reducing the cost of electricity consumption	4.23	4.00	5.00	1.00	5.00	4.00	5.00	0.98	23.17	−1.39	1.60
Using solar energy to heat water	3.86	4.00	5.00	1.00	5.00	3.00	5.00	1.20	31.08	−0.95	0.03
the period of ROI for photovoltaics	3.76	4.00	4.00	1.00	5.00	3.00	5.00	1.03	27.55	−0.58	−0.13
Government programs of financial support for photovoltaics	3.50	4.00	4.00	1.00	5.00	3.00	4.00	1.22	34.75	−0.51	−0.64
Climate threats resulting from increasing carbon dioxide emissions	3.47	4.00	4.00	1.00	5.00	3.00	4.00	1.20	34.63	−0.48	−0.62
The need to meet and match the EU pro-ecological standards	3.27	3.00	3.00	1.00	5.00	2.00	4.00	1.24	37.94	−0.27	−0.84
Increasing independence from energy supply companies	3.69	4.00	4.00	1.00	5.00	3.00	4.00	1.07	28.95	−0.64	−0.09
The need to diversify energy sources	3.60	4.00	4.00	1.00	5.00	3.00	4.00	1.12	31.00	−0.55	−0.32
Friends and/or family using photovoltaics	3.10	3.00	3.00	1.00	5.00	2.00	4.00	1.23	39.80	−0.09	−0.88
The desire to stand out among friends/family	2.39	2.00	1.00	1.00	5.00	1.00	3.00	1.29	53.88	0.53	−0.85
Promoting photovoltaics in the media	2.81	3.00	3.00	1.00	5.00	2.00	4.00	1.25	44.61	0.08	−0.93

Source: own study based on the results of questionnaire surveys and Statistica.

The second group of motives that most strongly influence prosumers' decisions to choose photovoltaics is related to the need to become independent from energy suppliers and the resulting desire to diversify energy sources (reduction in supply risk). Such indications again emphasize the individualized approach of the respondents to the decision to choose photovoltaics and the primacy of "hard" (tangible) benefits associated with its use. It is also worth noting that the very need to become independent is more important than the way to satisfy it in the form of diversification of energy sources. At the same time, the level of diversity of answers to independent questions is moderate, and the values of skewness and kurtosis indicate that their distribution is close to normal, which indicates a small difference of opinion in the surveyed group of respondents.

Only in third place in the hierarchy of motives are environmental reasons, which include climate threats resulting from the growing carbon dioxide emissions and the need to meet and match the EU pro-ecological standards. Against this background, the individualized approaches of respondents for whom exposure to environmental risks related to carbon dioxide emissions are more important than EU institutional standards can be observed. However, it should be added that, in the case of environmental questions, the agreement of the respondents is slightly lower than in the case of the two previous groups, which is evidenced by slightly higher values of the standard deviation and the coefficient of variation. Thus, respondents present a more diverse approach to issues related to environmental and climate protection than to economic and independence issues.

In the process of deciding on the choice of photovoltaics, marketing motives are the least important, including the effect of imitation, the effect of snobbery, and the promotion of photovoltaics in the media. Of the above, the most important is the use of photovoltaics by friends/family. The dissemination of this renewable energy source through mass media is also of some importance. The least important is the desire to stand out among friends/family. It should be noted, however, that the marketing motivation is characterized by the greatest diversity, which proves the extremes of the respondents' opinions.

4.4. Analysis of the Reasons behind the Decision to Use Photovoltaics

The use of ANNOVA as a research method requires the assumptions of normality of data distribution and homogeneity of variances to be met.

Taking into account skewness and kurtosis (Table 1) calculated for individual responses (values exceeded the absolute value of 1 only in one case), it can be assumed that the assumption of normal distribution was met.

Levene's test for homogeneity of variances was used to assess the second condition listed above. The results of this test are included in Appendix B. They allowed the use of ANNOVA in the case of 4 survey questions that met the assumption of homogeneity of variance (Table 5).

Table 5. Results of the test for homogeneity of variance.

Motive	SS	Degrees of Freedom	MS	F	*p*
The need to meet and match the EU pro-ecological standards					
Heat source	19.2231	4	4.8058	3.2639	0.0115 *
Environmental awareness	39.6940	4	9.9235	6.7397	0.0000 *
Friends and/or family using photovoltaics					
Heat source	27.4415	4	6.8604	4.6047	0.0011 *
Environmental awareness	4.9286	4	1.2321	0.8270	0.5081
The desire to stand out among friends/family					
Heat source	31.8254	4	7.9563	4.9198	0.0006 *
Environmental awareness	8.9219	4	2.2305	1.3792	0.2394
Promoting photovoltaics in the media					
Heat source	34.2152	4	8.5538	5.6754	0.0001 *
Environmental awareness	22.0564	4	5.5140	3.6586	0.0058

* $p < 0.05$. Source: own study based on the results of questionnaire surveys and Statistica.

The ANNOVA results in Table 5 indicate four statistically significant relationships between the motives for choosing photovoltaics and the heat source used in the surveyed households, as well as one statistically significant relationship between the motives for choosing photovoltaics and the level of environmental awareness of the respondents. The decisions of the respondents, therefore, can be assumed to be more strongly dependent on their energy situation than on the need to green energy consumption. Therefore, the type of heat source used significantly differentiates the respondents in terms of the following:

- The need to meet and match the EU pro-ecological standards;
- Being guided by the opinions of friends and/or family when choosing photovoltaics;
- The desire to stand out among friends/family due to the use of photovoltaics;
- Reaction to the promotion of photovoltaics in the media.

Furthermore, the need to meet and match the EU pro-ecological standards is also affected by the level of environmental awareness.

Tukey's post hoc test of multiple comparisons (HSD) was used for data meeting the condition of homogeneity of variance. The obtained results are presented in Table 6.

Table 6. Tukey's post hoc test of multiple comparisons (HSD).

The need to meet and match the EU pro-ecological standards (Approximate probabilities for post hoc test error: between MS = 1.4724, df = 745.00)					
Basic heat sources:	1	2	3	4	5
Coal	-	0.5488	0.9981	0.0038 *	0.995
Natural gas	0.5488	-	0.8967	0.2582	0.8949
Solid biofuel	0.9981	0.8967	-	0.0910	0.9959
Heat pump	0.0038 *	0.2582	0.0910	-	0.3638
System heat	0.9994	0.8949	0.9959	0.3638	-
The need to meet and match the EU pro-ecological standards (Approximate probabilities for post hoc test error: between MS = 1.4724, df = 745.00)					
Environmental awareness:	1	2	3	4	5
Definitely not	-	0.9996	0.9990	0.9999	0.9956
Rather not	0.9996	-	0.9997	0.6827	0.0224 *
I do not know	0.9990	0.9997	-	0.6083	0.0275 *
Probably yes	0.9999	0.6827	0.6084	-	0.0003 *
Definitely not	0.9956	0.0225 *	0.02746 *	0.0003 *	-
Friends and/or family using photovoltaics (Approximate probabilities for post hoc test error: between MS = 1.4899, df = 745.00)					
Basic heat sources:	1	2	3	4	5
Coal	-	0.9999	0.9935	0.0032 *	0.9922
Natural gas	0.9999	-	0.9914	0.0037 *	0.9909
Solid biofuel	0.9935	0.9914	-	0.0099 *	0.9997
Heat pump	0.0032 *	0.0037 *	0.0099 *	-	0.2388
System heat	0.9922	0.9910	0.9997	0.2388	-
The desire to stand out among friends/family (Approximate probabilities for post hoc test error: between MS = 1.6172, df = 745.00)					
Basic heat sources:	1	2	3	4	5
Coal	-	0.0380 *	0.4543	0.6237	0.9851
Natural gas	0.0380 *	-	0.9792	0.0002 *	0.9440
Solid biofuel	0.4543	0.9791	-	0.0434 *	0.9945
Heat pump	0.6237	0.0002 *	0.0433 *	-	0.7753
System heat	0.9851	0.9440	0.9945	0.7753	-
Promoting photovoltaics in the media (Approximate probabilities for post hoc test error: between MS = 1.5072, df = 745.00)					
Basic heat sources:	1	2	3	4	5
Coal	-	0.9698	0.9982	0.0005 *	0.7403
Natural gas	0.9698	-	0.9996	0.0052 *	0.5595
Solid biofuel	0.9982	0.9996	-	0.0267 *	0.6827
Heat pump	0.0005 *	0.0052 *	0.0277 *	-	0.0187 *
System heat	0.7403	0.5595	0.6827	0.01870 *	-

* $p < 0.05$—mean values differ significantly for individual answers. Source: own study based on the results of questionnaire surveys and Statistica.

Hence, in the question about the need to meet and match the EU pro-ecological standards, the averages differ significantly in the case of households using coal as the primary source of heat and in the case of people with less radical declarations on environmental awareness (answers: 2—not really, 3—I do not know, 4—rather yes). It can, therefore, be concluded that the described respondents are more oriented toward the implementation of environmental goals, and their decisions on the choice of photovoltaics are more strongly determined by the motives related to the need to green energy sources.

In questions relating to marketing motives (the effect of imitation, snobbery, and promotion), the heat source used differentiates the groups of respondents to a large extent. People susceptible to suggestions from friends and/or family use coal, natural gas, and solid biofuel to produce heat. People who want to stand out among their friends are users of natural gas and solid biofuel. The heat source also significantly differentiates the sensitivity to the promotion of photovoltaics. It most strongly concerns people declaring a high level of interest in promoting renewable energy sources.

5. Discussion

5.1. Reference to Previous Research Results

The obtained results confirm previous observations about the low use of renewable energy sources in emerging and developing economies [39–41]. In Central and Eastern Europe, there are countries where fossil fuels, particularly hard coal, have been the main source of energy for decades. In addition, the economic system of these countries is still in the process of transformation, and the level of economic prosperity is far from developed economies [31–34,49]. According to previous research, the problem in these economies is also the lack of modern technologies [52], including those related to energy storage [51,64]. These circumstances are key barriers to a sustainable energy transition. They concern both the systemic/institutional level [37,38] and the social level, which causes difficulties in understanding and implementing pro-environmental changes in the directions of energy development.

The structure of RES used in the examined countries of Central and Eastern Europe is very diverse, which proves that the choice of energy sources is quite individual, not necessarily related to climatic conditions. The grouping carried out indicates rather geographical and historical–political proximity as variables determining the similarity of energy strategies for RES, which should be considered a new cognitive conclusion.

Survey results indicate that economic motivation dominates the decision-making process on the use of solar energy, which clearly shows the direction of government and regional incentives. This confirms the findings of Child et al., (2020) [86] and Osorio-Aravena et al., (2021) [87] on the effectiveness of subsidizing photovoltaics in the process of its development. A financial instrument supporting the use of photovoltaics can also be the settlement of energy surpluses by prosumers, as indicated, among others, by Liu et al., (2023) [89], as well as investing in energy storage, as described by Sotnyk et al., (2023) [88]. The possibility of collecting surplus prosumer energy from the power grid has already been used in Poland, contributing to the increase in the popularity of photovoltaics. Unfortunately, this form of economic support for RES has recently been abandoned, which may weaken the interest in installing photovoltaic panels.

When choosing solar energy in Poland, the possibility of becoming independent from network energy suppliers and diversifying energy sources is also of great importance, which indicates a high rank of priorities related to energy security. In the previous research on prosumer motivation, this topic does not appear too often, which may mean that it is characteristic in national or regional terms. The great importance of energy security for prosumers is most likely due to the growing sense of threat related to the war in Ukraine, unstable energy policy, and fears of disruptions in energy supplies. Recognizing the importance of the independence motive can be a valuable clue in the process of planning and organizing information campaigns for the development of photovoltaics.

In the context of the findings, it should also be stated that the profile of the Polish prosumer differs from Western European attitudes. Solar panels are most often installed in older houses, which until now have been heated with traditional energy fuels (mainly coal). Very often, these fuels are also a source of heat, unlike the solutions adopted in prosumer farms in the Netherlands, where heat pumps are mainly used for heating together with photovoltaics [91]. In addition, ecological motives are not a priority for Polish prosumers, which also clearly distinguishes them from the Dutch [92], Swedes [93], and Danes [91], whose income level is higher and is usually accompanied by higher environmental awareness.

The formulated observations allow concluding that the hierarchy of prosumers' motivation clearly differs between developed and developing economies. However, in the situation of not fully satisfied needs and material aspirations—characteristic of less developed regions—it is difficult to focus on the implementation of higher-order expectations, which include the greening of life, including the use of more expensive, renewable energy sources. In addition, the high level of needs in terms of independence from centralized energy supplies exposes the sense of insecurity among prosumers and lack of trust in institutional energy production and distribution.

5.2. Recommendations and Practical Implications

Taking into account the results obtained and previous observations on the use of RES in emerging and developing economies, recommendations for the energy policy of these regions can be divided into the following groups: economic, technological, and social. Detailed practical implications for the abovementioned areas are listed below.

Economic-related recommendations include the following:

- Continuation of subsidizing investments in photovoltaics due to the high rank of economic factors in the process of making decisions on the use of RES;
- The use of flexible rates in the settlement of energy produced and consumed by prosumers, which increases the flexibility of the energy system and encourages the use of photovoltaics [81,82];
- The use of green bonds and public–private partnerships in the process of supporting the development of solar energy [46,47], which would increase the range of photovoltaic installations used;
- Creating the possibility of settling surpluses of energy produced within the existing energy system or as part of launching the P2P market, which would allow maximizing individual benefits related to photovoltaics;
- Adapting the forms of promoting photovoltaics to diverse groups of recipients (e.g., residents of urban and rural areas) and the phase of photovoltaic development.

On the other hand, technology-related recommendation can be presented as follows:

- Attempting to systematically solve the problem of solar energy storage and/or optimize its consumption at the system level [64,70,71], which would allow developing the potential of Polish photovoltaics;
- Development of research on power-to-X technologies [51], which would make it possible to overcome the technological distance to developed economies in the use of RES;
- Increasing the safety of installed photovoltaic installations (fire hazards and technical failures) and/or proposing insurance solutions to protect prosumers against undesirable random events.

Lastly, the education-related guidelines are as follows:

- Informing and teaching about the benefits of solar energy from the youngest generation [53,54];
- Incorporating the assumptions for the development of solar energy into the circular economy [56,57], including planning issues related to the disposal of photovoltaic

cells [58–60] to maximize the environmental benefits of RES and protect the quality of life of future generations;
- Promoting the idea of smart homes that use modern technologies to protect the environment, including the use of clean energy [73,74].

6. Conclusions

Conclusions resulting from the considerations and research carried out in the article are presented in the next two subsections. The first of them includes key research observations relating to the scope and structure of the use of renewable energy sources in Central and Eastern Europe. The second one refers to research limitations and directions of further research in this field.

6.1. Recommendations and Practical Implications

The conclusions resulting from the analysis of the use of renewable energy sources in Central and Eastern Europe are as follows:

- All surveyed countries are characterized by a low share of RES use compared to EU leaders in this field (Germany, Great Britain, Spain, and Italy);
- The share of RES in energy generation is the highest in Poland (0.80% in 2021) and is growing the fastest in Croatia (pace of change 27.10%), Romania (pace of change 18.85%), and Latvia (pace of change 17.46%);
- The structure of RES use in the analyzed region is very different (dominant wind energy: Croatia (63.64% share in RES), Romania (74.44% share in RES), Lithuania (65.00% share in RES), and Poland (58.63% share in RES); dominant solar energy: Hungary (56.72% share in RES) and Slovenia (50.00% share in RES); dominant other RES (biomass, geothermal energy): Latvia (80% share in RES), Estonia (64.74% share in RES), Czech Republic (65.00% share in RES), and Slovakia (74.07% share in RES); a balanced mix of the above sources: Bulgaria);
- RES utilization structures are found in countries that are geographically, politically, and historically close.

In turn, the results of the survey conducted allow the following conclusions to be drawn:

- Decisions on the choice of photovoltaics are primarily determined by economic motives, including, above all, the desire to reduce the cost of electricity consumption (average score on a five-point Likert scale = 4.23);
- The other factors influencing decisions on the use of photovoltaics are independence premises related to the need to become independent from energy suppliers (average score on a five-point Likert scale = 3.69) and diversification of risk related to supplies (diversity of energy sources) (average score on a five-point Likert scale = 3.60);
- Ecological motivation is only in third place, which indicates a clear primacy of individual and financial determinants of the use of photovoltaics in Poland (average score on a five-point Likert scale = 3.27–3.47);
- Marketing motives are of the least importance when choosing photovoltaics, which include the effect of imitation (average score on a five-point Likert scale = 3.10), the effect of snobbery (average score on a five-point Likert scale = 2.39), and the promotion of photovoltaics in the media (average score on a five-point Likert scale = 2.81).

It is also worth noting that a typical user of solar installations in Poland lives in a property that is more than 10 years old, uses coal or natural gas (conventional energy sources) for heating, and has used photovoltaic panels for no more than 5 years.

In the course of the research, it was also found that there is a greater need to meet and match the EU pro-ecological standards and greater susceptibility to marketing motives among people using coal to heat their homes, which bodes well for potential and desired changes in the energy systems of Polish households and is an incentive to further promote renewable energy sources.

The originality of the results obtained and the contribution to the development of resource policies result from the following:

- Conducting an analysis of the effects of activities of Central and Eastern European countries for renewable energy sources, including solar energy;
- Identifying the motives for the use of photovoltaic installations by prosumers in Poland—one of the emerging economies of the analyzed region;
- Examining the relationship between pro-ecological attitudes and decisions on choosing photovoltaics as a source of energy in households.

It is also worth emphasizing that the research was conducted on a representative statistical sample, which allows generalizing the conclusions to the entire population of Polish prosumers. Therefore, the results of the analyses can provide an objective and valuable basis for shaping the policy of using renewable energy sources in emerging and developing economies.

6.2. Research Limitations and Directions for Further Research

The analyses of using RES in the economies of Central and Eastern Europe presented in the article are of a general nature and do not take into account the quality and scope of energy strategies of individual countries. They also do not refer to the conditions shaping energy and resource policies in this region. The above circumstances constitute a research limitation for the formulated conclusions.

In turn, the results of the survey described in the article refer to prosumers using solar energy in Poland, which geographically narrowed the area of conducted analyses and was the main research limitation. Nevertheless, some of the proposals may also apply to other emerging and developing economies that want to increase the use of RES.

In addition, the opinions of the respondents—despite the representativeness of the sample—may be characterized by a certain subjectivity, which may distort the final conclusions. It is worth noting, however, that the use of solar energy in households depends on the decisions of potential prosumers, which, despite the subjectivity of individual assessments or views, ultimately translate into the scope of RES use in the economy. Therefore, these opinions have a real dimension and impact energy policy.

Bearing in mind the research limitations indicated above and the conclusions obtained, further research should be continued in the following forms:

- Analyzing economic, social, and political conditions for the use of RES in Central and Eastern Europe;
- Identifying the causes and effects of choosing a specific RES use policy in the geographical clusters defined in the article;
- Conducting similar studies in other emerging and developing economies for comparison purposes;
- Linking the motives for the use of RES with the assessment of economic viability;
- Determining the possibility of using the attitudes of prosumers to increase energy efficiency on an economic scale;
- Exploring the possibility of engaging prosumers as active participants in the electricity trading market.

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Data Availability Statement: Data are available on request from the author via email (izabela.jonek-kowalska@polsl.pl).

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Cronbach's alpha test results for survey questions.

Variable	Summary for scale: Mean = 37.6724 SD = 8.73424 Valid N: 754 Cronbach's Alpha: 0.8828 Standardized Alpha: 0.8826 Average Inter-Item Corr.: 0.4150				
	Mean if Deleted	**Var. if Deleted**	**SD if Deleted**	**Itm-Totl Correl.**	**Alpha if Deleted**
Reducing the cost of electricity consumption	33.4470	69.4886	8.3360	0.3519	0.8858
Using solar energy to heat water	33.8130	64.5075	8.0317	0.5320	0.8767
The period of ROI for photovoltaics	33.9151	65.1387	8.0709	0.5976	0.8727
Government programs of financial support for photovoltaics	34.1750	63.4680	7.9667	0.5809	0.8735
Climate threats resulting from increasing carbon dioxide emissions	34.1976	61.5618	7.8461	0.6985	0.8656
The need to meet and match the EU pro-ecological standards	34.4032	61.0497	7.8134	0.7022	0.8652
Increasing independence from energy supply companies	33.9801	63.6190	7.9762	0.67039	0.8683
The need to diversify energy sources	34.0703	62.8558	7.9282	0.68310	0.8672
Friends and/or family using photovoltaics	34.5743	62.4991	7.9056	0.6246	0.8706
The desire to stand out among friends/family	35.2838	64.1767	8.0110	0.5025	0.8793
Promoting photovoltaics in the media	34.8647	62.3531	7.8964	0.6206	0.8709

Own elaboration: Statistica calculations.

Appendix B

Table A2. Results of Levene's test for homogeneity of variances for individual motives for the use of photovoltaics and two conditions (source of heat and energy consumption when purchasing electrical devices).

Motive	MS Effect	MS Error	F	*p*
Reducing the cost of electricity consumption	2.4323	0.3431	7.0900	0.0000
Using solar energy to heat water	3.7321	0.4769	7.8249	0.0000
The period of ROI for photovoltaics	2.2168	0.3252	6.816	0.0000
Government programs of financial support for photovoltaics	2.0620	0.4518	4.5638	0.0012
Climate threats resulting from increasing carbon dioxide emissions	2.4479	0.4590	5.3320	0.0003
The need to meet and match the EU pro-ecological standards	0.4518	0.4923	0.9177	0.4530 *
Increasing independence from energy supply companies	3.2375	0.3955	8.1855	0.0000
The need to diversify energy sources	1.4597	0.4114	3.5478	0.0070
Friends and/or family using photovoltaics	0.7641	0.5243	1.4572	0.2135 *
The desire to stand out among friends/family	0.5196	0.4256	1.2208	0.3005 *
Promoting photovoltaics in the media	0.0443	0.4660	0.0952	0.9840 *

Own elaboration: Statistica calculations. * The assumption of homogeneity of variances was met.

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