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Impact of COVID-19 on the Level of Energy Poverty in Poland

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Abstract: The main objective of the paper is to determine the impact of the COVID-19 pandemic on the level of energy poverty in Poland. In order to achieve such a goal, the first part of the article presents the definition of energy poverty and the nature of its measures, as well as the determinants and policies of the state addressing the issue of energy poverty mitigation. In the second part of the paper, the results of research into the level of energy poverty are analyzed and the variables affecting energy poverty in Poland during the pandemic are determined. It was established on the basis of these results that the present pandemic contributed to the aggravation of financial difficulties in Polish households with regard to financing expenditure on energy carriers. It was found that COVID-19 had a negative impact on the average disposable income of Polish households, which, with the increase in prices and expenditure on energy carriers, led to an increase in the proportion of disposable income spent on energy carriers. The most affected have been the poorest households. Moreover, the long downward trend in the level of energy poverty in Poland has reversed. Thus, it has been proved that COVID-19 has contributed to the intensification of energy poverty in Poland. The theoretical and empirical considerations contained in this paper may be a valuable source of scientific data on the impact of the pandemic on household energy poverty, while public institutions may find them a source of useful information, helping to create effective instruments to mitigate energy poverty in the Polish economy.

Keywords: energy poverty; COVID-19; Poland

1. Introduction

Since March 2020, the main problem facing the global economy has been the COVID-19 pandemic, which has had a negative impact on the economies of most of the countries affected, on the health situation of patients as well as on the state of national health care systems. These problems affect to the greatest extent the advanced economies, namely the countries of the European Union and the United States. However, it should be remembered that despite the global pandemic, economies still need to develop, and the social, economic, and political challenges that have existed until now have not disappeared. In the European Union, one of the most important priorities is still energy and climate policy [1], which not only aims to protect the climate and re-evaluate the role of individual energy carriers in the countries' energy mix [2], but also significantly contributes to agricultural development [3] and social welfare. As the United Nations [4] points out, although COVID-19 has significantly hampered the development of renewable energy and a low-carbon economy, the strategies for green energy, climate action, and no poverty are still among the main sustainable development goals for the world. This should be done with expanding energy (mainly electricity) access to everyone. Thus, energy security, understood as a continuous and uninterrupted supply of energy at affordable

prices, while respecting environmental requirements, is still an objective for European and global institutions. The lack of such access to energy sources carries the risk of energy poverty.

As the literature points out, energy poverty, i.e., the difficulty in accessing energy due to a lack of physical access or economic difficulty in financing expenditure on energy carriers, is a global problem that even the economies of EU countries are constantly struggling with. The importance and need for research into this issue may be evidenced by the fact that, at present, indicators of energy poverty are widely used to measure the level of sustainable development [5]. Moreover, the issue of energy poverty is increasingly often discussed in the literature [6]. The need to study this problem also stems from the difficulty in measuring it [7] and the diversity of definitions [8–10]. Moreover, energy consumption in the EU, including Poland, is constantly growing [2], but the majority of countries fail to adequately address this phenomenon [11]. This makes it difficult to determine how government policies and/or the economic situation may affect the scale of this type of poverty. Furthermore, it is worth remembering that energy poverty has a negative impact on human health, social relations, and educational opportunities [12,13]. At the same time, its level is strongly determined by income, the socioeconomic situation of households, and energy costs [10,14].

The purpose of the paper is to assess whether and how COVID-19 has affected the level of energy poverty in Poland. It examines whether the economic effects, which have undoubtedly hit the Polish economy, have also aggravated the scale of energy poverty. Following Boardman [15], the paper assumes that energy poverty is a situation when expenditure on energy carriers accounts for more than 10% of income per person. Thus, the focus was on the economic aspect of the phenomenon, since, according to González-Eguino [9], in developed and highly developed economies, energy poverty is associated with insufficient financial means to purchase energy, in contrast to developing countries where it is related to the physical lack of access to energy. The literature reports that within the European Union, Poland is one of the countries where the scale of energy poverty has been high [14]. At the same time, it has been pointed out that the Polish authorities take far too inadequate measures to mitigate this problem [16]. This is done only indirectly by conducting social policy which does not include direct actions to counteract energy poverty. It should be remembered that Poland, like other EU countries, will have to make an effort to increase the share of renewable energy carriers in the energy-mix. This increases the likelihood of higher costs of energy carriers. Moreover, COVID-19 has had a negative impact on the socioeconomic situation by reduced employment and wages and thus, disposable income. The pandemic has resulted in a complete loss of income for some Polish citizens. It should be remembered that poverty mainly affects people with the lowest incomes [17]. In addition, many people worked from home at that time, which might suggest that their spending on energy carriers has increased. These arguments imply that the COVID-19 pandemic could have increased the scale of energy poverty in Poland. On the other hand, the pandemic stopped investments in renewable energy, which may mean that there should be no increase in spending on energy carriers and, consequently, no increase in energy poverty. All social programs in Poland, which were intensified in the second half of 2019, have been continued, which implies that the poorest parts of the society have not suffered from the economic lockdown. Therefore, it is not easy to determine whether the COVID-19 pandemic has had a positive or negative impact on the scale of energy poverty in Poland. It is also difficult to determine without proper research what is the impact of the COVID-19 pandemic on the level of energy poverty in Poland. As it has been mentioned above, this subject has not yet been thoroughly investigated in the literature, especially with regard to Poland. So far, the literature has focused mainly on the nature of this phenomenon [8,17], measurement methods [12,16], and on its diversity [18]. Of all the countries of the region, the studies were conducted only in the Czech Republic [19], Bulgaria [20], and several countries of Central and Eastern Europe [21], but that was a long time ago. In Poland, the scale of the problem was measured [16], but the study covered the period until 2018, i.e., before the pandemic occurred. Therefore, the authors of this paper decided to investigate the effects the current COVID-19 pandemic had on energy poverty.

The paper structure is as follows: it starts with a review of the literature on the nature and measurement methods of energy poverty and its impact factors. The next section describes the research methodology adopted by the authors. In the third section, the research results are outlined followed by the discussion and conclusions.

2. The Nature, Measures, and Determinants of Energy Poverty

The nature of the problem of energy poverty has been studied in scientific discourse for over 40 years. Although many scientists and practitioners are working on this issue, there is still no consensus for a common definition of energy poverty. In this respect, it should be noted that in 1979, for the first time, two economists, Isherwood and Hancock, attempted to diagnose households that had difficulty in paying their fuel and energy bills [22]. In the course of their study, they found that this difficulty occurred in households that spent more than 12% of their income on energy. At the same time, they conducted a study on the relationship between household incomes and specific housing costs. They showed that the most fluctuating costs that determined disposable incomes the most were those relating to energy purchase. Thus, they found that any increase in energy costs limited strongly the households' income, which in consequence, may determine the occurrence of energy poverty. The results of Isherwood and Hancock's research provided a basis for in-depth studies on energy poverty conducted by Bradshaw and Hutton. The researchers considered energy poverty to be a social phenomenon that was related to the shortage of financial resources suffered by an individual or a group of people to provide them with adequate heating and lighting for their homes [23]. What is important is that by the word 'adequate', Bradshaw and Hutton understood the level of energy to be socially acceptable, i.e., one that should be provided for all people so that they can meet their basic needs. The above considerations encouraged Boardman to start her research on energy poverty. The researcher created the first formal definition of energy poverty using objective measures that were based on an absolute approach. Boardman believed that energy poverty affected households that had to spend more than 10% of their income on providing a minimum level of energy supply [24]. By minimum energy level, she meant the amount of energy needed to ensure the temperature of 18 degrees Celsius in a bedroom and 20–21 degrees Celsius in other rooms [24–26], and the amount of energy required for cooking, lighting, and using household appliances. According to Boardman, an average household uses 55% of energy for heating, 30% for lighting and other electrical appliances, 10% for heating water, and 5% for cooking.

In further research and scientific work, it has been found that the level of 10% of income is not always an exactly reliable measure of energy poverty. As it has been observed, in individual communities, there are groups of people who, despite the widely adopted income threshold of 10%, still are at risk of energy poverty. These are e.g., households consisting of single parents, the elderly, or single person households. Moreover, it has been diagnosed that there are high-income households that have much greater needs to be satisfied, thus spending much more than 10% of their income on energy costs. Consequently, due to their very good financial standing, these households do not have to save on costs of heating or fuel-consuming household appliances. With this in mind, Hills has determined that a level of energy spending of 10% of income can be sensitive to changes in electricity charges and fluctuations in disposable income, which may lead to numerous errors in determining the extent of energy poverty in households [27]. Moreover, according to Hills, Boardman's definition addresses only prospective and not actual energy expenditure. Furthermore, Hills points out that the assumptions based on room temperature cannot be applied to all households either, as they are made up of people with different needs in terms of the temperature perceived. Therefore, Hills proposes an objective measure of energy poverty that is based on a relative approach. This approach incorporates the Low Income High Cost (LIHC) parameter to diagnose energy poverty and then, to select a group with the lowest level of this indicator in the population in total. According to Hills' concept, households with low income and high energy expenditure should be regarded as energy-poor. In this respect, low incomes are defined at 60% of the median disposable income per capita in households. By contrast,

high energy expenditure is defined as the sum of expenditure on the provision of basic energy needs (i.e., heating of living quarters, water heating, lighting) above the median expenditure for the entire population under survey.

In recent years, other definitions of energy poverty, based on the physical availability of energy services or on a hybrid of the availability of energy supply and problems with paying for it, can be found in the scientific discourse. Liddle and Moris argue that energy poverty means underheating of buildings, which results in residents' higher vulnerability to respiratory diseases or hormonal disorders. The authors define neither the degree of underheating nor the inability of households to pay their energy bills. They focus on associating energy poverty with human health [28]. Another approach is presented by Buzarovski, who claims that energy poverty affects households that do not have access to energy services provided by external entities [20,21]. It is worth adding that Buzarovski equates energy services with all types of energy supply, thanks to which households can satisfy their fundamental needs related to food, heating, and water as well as with the household members' existence in a given society. Another definition has been given by Moore, for whom energy poverty is equated with a situation when the household's expenses for energy are higher than the household's net income reduced by the cost of living [8]. A definition, similar to that by Moore, has been proposed by Starkova, who considers energy poverty to be a state where the average monthly household expenses for electricity, gas, and hot water represent a significant part of the average monthly income [29]. Another attempt to define poverty is proposed by Healy, who in the so-called consensus approach describes poverty through the prism of subjective and objective variables. Thus, energy poverty occurs when a household declares (subjective evaluation) that it finds it difficult to:

- Heat their home;
- Regularly pay energy bills;
- Buy heat generating appliances, such as water heaters, radiators, water tanks, or heat pumps, and when in the living quarters of the household, there is (objective assessment):
- Damp in walls and/or floors;
- Rotten window frames and gaskets, cracked putty;
- No central heating [30,31].

One more definition of energy poverty, which is quite commonly used in the scientific discourse, has been devised by Thomson, Snell, and Liddel. They consider energy poverty to be a state when households spend more than 50% of their income on expenses related to satisfying energy needs. At the same time, they equate poverty with the feeling of cold, lack of comfort when using living quarters, and quality reduction [32]. Thus, they in a way return to the definition of energy poverty as a financial difficulty in meeting these needs rather than their physical lack.

A different approach to energy poverty than the one presented so far has been adopted by the European Commission, which equates energy poverty with a household's inability to maintain heating at an appropriate level for an appropriate price [33,34]. It is worth noting that the EU definition sees the "inability to maintain heating at an appropriate level" from the angle of households finding it difficult to:

- Pay their energy bills;
- Maintain the right temperature at home to ensure comfort for residents (e.g., due to leaking roofs, damp walls, floors, or foundations);
- Upgrade the heating system in the household;
- Install new heating systems [35].

Despite the European Commission's definition, countries and their institutions still define energy poverty in different ways. Some countries approach the problem as the households' lack of access to gas, electricity, and fuel supplies. Others address poverty in terms of energy costs and disposable household income [32]. The Polish literature also presents several definitions of energy poverty. Shepherd and

Miazga, making reference to the European Commission's definition, define energy poverty using the criterion of difficulty in meeting energy needs in the place of residence at a reasonable price. At the same time, they specify that fundamental energy needs are related to maintaining adequate temperature in the family living quarters and to satisfying other biological needs of the household members [36]. It is worth mentioning at this point that Shepherd and Miazga, based on their research, assume that 21 °C is the room temperature that satisfies the basic needs of Polish households. Consequently, if there are difficulties in ensuring this temperature by the household and additionally, they find it difficult to meet their other energy needs, then one can say that they are affected by energy poverty. Another definition is presented by Lis, Miazga, Salach, Szpor, and Święcicka, who characterize poverty as a phenomenon consisting of the household's difficulties in meeting its basic needs related to providing energy for heating their dwelling, lighting, preparing meals, and using necessary household appliances [37]. Flint and Ogurek associate energy poverty with insufficient financial means to purchase energy in order to meet the vital household needs [38]. Kurowski, on the other hand, defines poverty as a state in which a household spends more than 10% of its income on energy purchase [39].

Despite the fact that there is a diversity of definitions concerning energy poverty and due to the fact that in EU countries, energy poverty results from insufficient financial resources rather than the scarcity of energy services or lack of access to energy supply, in the further part of the study, the authors of the publication adopted a definition consistent with Boardman's proposal. By the same token, they have assumed that energy poverty occurs in a household when expenditure on providing energy needs necessary for the functioning of the household exceeds more than 10% of disposable income per person. The choice of the above definition results mainly from the purpose of the study and the fact that it focuses on poorer people, as well as from the application of the above definition in a number of studies concerning the analyzed problem.

While analyzing the nature of energy poverty, it is also worthwhile to describe the basic ways of measuring it. There are three main concepts of how to measure energy poverty:

- Examining the level of energy services provided to the household by direct measurement and then by reference of the results obtained to specific parametric standards;
- Analyzing expenses on the purchase of energy for the household with reference to a set quota or percentage threshold being an indicator of energy poverty;
- Surveying households' satisfaction with external energy services or analyzing data on living conditions that may result in energy poverty [40].

The first approach is not used often in the studies of energy poverty. This is mainly due to technical reasons as well as difficulties in defining uniform standards for energy services for households in general. It particularly hinders the comparisons of countries as most of them, due to their geographical location and weather conditions, adopt different parametric standards for energy services [41]. Therefore, the last two approaches are the most common as they are based on household expenses rather than on costs of energy purchase, housing conditions, and subjective assessment of energy need satisfaction. With the above in mind, the Table 1 presents the most important measures of energy poverty.

Bearing in mind the above constructions of household energy poverty indicators, the obvious conclusion to be drawn is that most of them use two basic parameters, i.e., income and costs related to the purchase of energy. Thus, it can be said that energy poverty is strongly linked to, or even conditioned by, economic poverty understood as limited access or even deprivation of material goods and resources [45]. Furthermore, it should be noted that energy poverty is strongly influenced by the poor technical condition of housing stock, which makes maintaining an optimal standard of heating more expensive. What is more, the reason for poverty may also be the poor technical condition of heating systems or a badly designed heating system supplying heat to individual rooms [46]. In addition, energy-intensive household appliances may increase expenditure on energy purchase. The type of heating can also determine the risk of energy poverty. For example, energy poverty is much more frequent in households using tiled stoves or wood burners, and the least frequent in those

using central heating [47]. In addition, an important limitation which determines higher energy costs is also the increase in energy prices. For example, Bosch, Palència, Malmusi, Marí-Dell'Olmo, and Borrell believe that legal regulations related to consumer protection and market liberalization can contribute to energy poverty [48]. Another limitation may also be globalization and financial development, which increase the level of energy intensity [49], and thus, also expenditure on energy carriers.

Table 1. Energy poverty measures.

Measure	Calculation Formula	Advantages and Disadvantages
After-Fuel-Costs Poverty (AFCP)	(income − housing cost − domestic fuel cost) < 60% of all households' net income median (energy expenditure and housing deducted)	Advantage: Includes all housing expenses of the household. Disadvantage: The measure does not take into account the energy needs of households.
Ten-Percent Rule (TPR)	Fuel cost/net income before housing costs If the quotient is more than or equal to 10%, then the household is considered energy-poor	Advantage: Simple calculation and easy analysis. Disadvantage: Based on theoretical rather than actual energy costs; no reference to real household income; arbitrary threshold of 10%.
Low Income/High Cost (LIHC)	household energy expenditure > median of all households' energy expenditure, and net income − energy expenditure and housing < 60% of the median of all households' net income (energy expenditure and housing deducted)	Advantage: Two percentage thresholds to distinguish energy poverty from economic poverty. Disadvantage: The indicator does not take into account the constraints on the supply of energy needs which are not the effect of the financial situation but on the behavior and standards adopted by a given household.
Energy saving index	theoretical energy needs − actual energy consumption	Advantage: Possibility to analyze costs related to household's energy demand. Disadvantage: Theoretical costs and energy demand are difficult to estimate.
M and 2M	If the household's energy expenditure is greater than or equal to the median (M indicator) or twice the median (2M) of the total energy expenditure of all households, then this household should be considered energy-poor.	Advantage: The indicator takes into account the actual expenditure of households on energy purchase. Disadvantage: The ratio for richer households can be more than twice the median and this will not mean that these households are energy-poor. Furthermore, the indicator does not take into account the disposable income of households.
MIS (Minimum Income Standard)	A household is energy-poor if the net income, i.e., income reduced by energy cost and other costs of living, is less than the minimum income in given economy or less than the level of income set as indicating economic poverty in this economy	Advantage: The indicator takes into account the disposable income of households. Disadvantage: Costly and complex procedure for estimating the index.

Source: own study based on [15,27,42–44].

The above listed reasons for energy poverty can be largely mitigated by government policies and instruments. Based on the measures and determinants of energy poverty, it can be assumed that in order to counteract this phenomenon, state intervention is required in three key areas: household income levels, energy prices, and energy efficiency of buildings [50,51]. In Poland, these areas are covered by three public policies: a social policy, an energy policy, and a housing policy. As regards the social policy, the Act on social assistance regulates government aid for members of households who have difficulties in meeting their basic needs with their own resources [52]. In this respect, such needs include regulating energy charges. Thus, in order to be eligible for social welfare assistance, households must meet the income criterion as well as the criterion of social risks, i.e., a household member must be unemployed or seriously and chronically ill/disabled or incapable of running the household. On the

basis of these criteria, a special allowance is granted, such as housing allowance, energy allowance or energy cost rebate which should be used to secure the basic needs related to the energy bills [51].

The second state policy is a housing policy that aims, among other things, at improving the technical condition of buildings and maintaining technical standards. In this respect, the Polish government has been implementing, among others, the revitalization and thermal upgrading program under the Act on support for thermal upgrading and renovation [52] and the Revitalization Act [53]. The purpose of such programs is to increase the energy efficiency of buildings and to improve the security of energy supply and the energy use in households. Importantly, the key instruments of this policy include a thermal upgrade premium (subsidies for thermal upgrading for households), tax exemptions for renovating elevations, exterior insulation of the building or its thermal upgrading, or subsidies for loans for the construction or purchase of energy-efficient houses.

The third policy is the energy policy which, according to the Energy Law Act [54], creates conditions for sustainable development of the country and for the rational use of fuels and energy. However, apart from this general statement, the Act does not specify the definition of energy poverty. The Act amending the Energy Law and certain other acts [55] merely defined the term 'sensitive recipient' and established a system of their protection against disconnection from the grid and introduced the energy supplement for people receiving housing allowances. However, this was only an indirect reference to the problem of energy poverty [16]. Other energy policy acts relating to energy poverty are the Energy Efficiency Act [56] and the Act on energy labeling of energy-related products [57]. On the one hand, these laws encourage investments that are related to improving the accessibility and use of energy by households, while on the other hand, they regulate the costs of using appliances that affect the household's energy consumption. What has been important in this respect are the instruments for consultancy support for developers regarding energy efficiency and renewable energy sources (e.g., the Prosumer Program). However, these instruments are also not directly related to the issue of energy poverty.

Taking into account the above outlined diversity of definitions, measures, and determinants of energy poverty, it seems justified to provide further in the paper examples of energy poverty in the face of the economic and social crisis caused by the COVID-19 pandemic.

3. Methodology

The purpose of this paper is to assess whether and how COVID-19 has affected the level of energy poverty in Poland. The literature review indicated that there is no unanimity on the terminology of the energy poverty phenomenon and how to counteract it. Therefore, when trying to achieve this goal, it is necessary to initially define how this phenomenon is perceived by the authors. The analysis of the literature has shown that in developed economies such as Poland, energy poverty is related to its economic rather technical sphere, i.e., to the lack of sufficient financial means to satisfy energy needs. For this reason, in this paper, it is understood, following Boardman's definition [15], as a situation where expenditure on energy carriers amounts to more than 10% of income per person. However, when measuring energy poverty, in contrast, the methodology proposed by Nagaj [16] has been adopted and applied for households affected by energy poverty. Since energy needs are satisfied from the income that is already available for consumption, i.e., after paying taxes and receiving transfer payments, therefore, when estimating the scale of energy poverty in Poland, it has been assumed that the energy-poor are those households whose expenditure on energy carriers per person exceeds 10% of their disposable income. As it is well known, energy demand is rather inflexible, especially in the case of low-income households [58]. In addition, energy consumption per capita in Poland does not change significantly [2]. Moreover, energy is a staple commodity, which means that regardless of the level of income, the amount of energy consumed per capita over the years is relatively stable and is not subject to significant income-dependent volatility. Therefore, it is the price that is the basic factor influencing the absolute amount of expenditure on energy carriers in Polish households. The income, on the other hand, varies within society. Hence, when calculating the share of expenditure

on energy carriers in different income groups of households, the same level of average expenditure on energy carriers per person in different income groups of households was assumed and at the same time, disposable incomes of energy consumers in Poland were differentiated by quintile groups (for households). Consequently, the ratio of expenditure on energy carriers to disposable incomes per capita was calculated for different quintile groups. Those groups of households in which the values of that proportion were above 10% were considered to be energy-poor. On the other hand, when estimating the scale of energy poverty in Poland, the distribution of disposable income per capita in households by decile groups was taken into account (in order to determine the proportion of such households) and the groups which were considered to be energy-poor were summed up.

In this paper, the level of energy poverty will be calculated for the period 2006–2020, except that for the years 2006–2019, it is calculated on an annual basis, i.e., according to data as of the end of a given year, while for 2020, it will be determined as of May this year (for which data are available). The data regarding the period between 2005 and 2019 will show the energy poverty level in Poland before the COVID-19 pandemic, while the data from May 2020 will reveal the level of energy poverty during the pandemic. The comparison of data collected before and during the pandemic will help to answer the research question: Did COVID-19 affect the level of energy poverty in Poland and if so—how?

The source of data for the calculations is the Central Statistical Office in Poland (CSO), Eurostat, and Trading Economics. For the years 2005–2019, i.e., the period before the pandemic, all data necessary to estimate the level of energy poverty in Poland (amount of expenditure on energy carriers in households per person, level of disposable income for different income groups, and distribution of disposable income per capita in households by decile groups) are available in the above mentioned data sources. However, no such data are available for 2020, i.e., the period covering the effects of the pandemic in Poland. Therefore, the authors have to estimate them by themselves. The analysis of the literature has shown that the factors that may affect the scale of energy poverty include income and the socioeconomic situation of households as well as the prices of energy carriers. Therefore, the data necessary to determine the level of energy poverty in the period of the pandemic (dependent variables) were estimated using data on the social and economic situation in Poland in May 2020 (independent variables, for which data are available for the whole period under analysis and which may theoretically affect the disposable income of households and its diversification). The estimation of the value of these data for May 2020 was made as follows:

The value of expenditure on energy carriers was calculated by adjusting the value of expenditure on energy carriers in 2019 by the consumer price index for the product group 'Energy Carriers' in May 2020 (the value of the index in relation to the end of 2019).

The value of disposable income for different quintile groups and the distribution of disposable income per capita in households by decile groups were estimated using multiple regression analysis. Basing on the data from 2005 to 2019, relationships between dependent and independent variables were determined, and then, the dependent variables were predicted for the same period by means of the multiple regression equation and the actual values of the independent variables in May 2020.

When predicting the dependent variables for May 2020, a multiple regression equation was built

$$Y\_(1,2, \dots ,m) = a + b\_1 \cdot X\_1 + b\_2 \cdot X\_2 + \cdots + b\_n \cdot X\_n,$$

where:

Y1,2, . . . ,m—Dependent variables for which the following values are estimated for May 2020: disposable income per capita in households in each of the 5 quintile groups in Poland and the share of each of the 10 decile groups in the distribution of disposable income per capita in households;

a, b1, b2, . . . , bn—The regression function parameters;

X1, X2, . . . ,Xn—Data reflecting socioeconomic situation in Poland during the pandemic (May 2020) that are independent variables affecting the dependent variables subject to prediction.

The following independent variables were used in the analysis:

X1—Average paid employment in an enterprise sector (CSO data);

X2—Registered unemployed persons (CSO data);
X3—Average monthly real gross wages and salaries in the enterprise sector (CSO data);
X4—Gross domestic product annual growth rate (Trading Economics data);
X5—People at risk of poverty or social exclusion (Eurostat data);
X6—Current consumer confidence indicator (CSO data);
X7—General business climate indicator for manufacturing (CSO data);
X8—Leading consumer confidence indicator (CSO data).

Since the correlation analysis revealed that the last two independent variables did not show a statistically significant correlation with the level of disposable income (or were low), only six independent variables (X1, X2, X3, X4, X5, X6) were used in the regression analysis. In the case of disposable income distribution, however, there was no such situation. Therefore, all eight independent variables were used in the regression analysis to predict the disposable income distribution in May 2020. This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation as well as the experimental conclusions that can be drawn.

4. Results

First, to assess the impact of COVID-19 on the level of energy poverty in Poland, the necessary data for May 2020 were estimated. This concerned the amount of expenditure on energy carriers, the level of disposable income per capita in households in different quintile groups, and its distribution within the decile groups (shares of individual groups).

On the basis of the consumer price index for the commodity group 'Energy Carriers', which in May 2020 was at 1.047 as compared to December 2019, it was calculated that the average expenditure on energy carriers per person in Polish households in May 2020 was PLN 128.42.

In the next step, the level of disposable income was estimated. For that purpose, a regression analysis was used. Table 2 presents the results of the analysis (it shows only the results for those independent variables whose influence on the estimated dependent variables was statistically significant).

The results of the regression analysis showed that the following variables had a statistically significant impact on the level of disposable income per capita in Poland: X1 (average paid employment in an enterprise sector), X2 (registered unemployed persons), X3 (average monthly real gross wages and salaries in the enterprise sector), and X5 (people at risk of poverty or social exclusion). Of those, the employment level was of key importance in the majority of decile groups, followed by the unemployment rate and then, the salary level. With these results, regression functions were created and income levels were estimated for different income groups in Poland (see Table 3).

The prediction results showed that in May 2020, the disposable income in all income groups was lower than in 2019 and fell by 6.1–10.4%.

In order to be able to calculate the level of energy poverty in Poland during the pandemic, it was also necessary to estimate the distribution of income in Poland. According to the adopted methodology, a regression analysis was used for that purpose and on its basis, the data for May 2020 were predicted. Table 4 presents that distribution by decile groups and shows which dependent variables impacted that distribution.

The results of the distribution of disposable income in Poland (Table 4) indicated that the shares of the first and second income group (people with the lowest income) depended on the consumer confidence indicator and employment level. In the case of the so-called middle-income class, the salary level was an independent variable, while the highest income decile groups were determined by the employment level and unemployment rate. It was also found that the pandemic did not significantly change income distribution compared to 2019, i.e., the period just before the pandemic. There was only a slight increase in the third, fourth, and fifth decile groups.

On the basis of data on the level of expenditure on energy carriers and disposable income, it was calculated what proportion of the disposable income was represented by expenditure on energy in particular income groups (Table 5).

Table 2. Results of regression analysis for households' disposable income by quantile groups.

Specification	Coefficients	Standard Error	t-Statistic	*p* Value
Regression analysis for dependent variable Y_1—Disposable income per capita in households in the first quintile group				
$n = 14$	Regression statistics: R = 0.9858; R^2 = 0.9718; Adjusted R^2 = 0.9695; F(1,12) = 413.90; $p < 0.0000$; Standard error: 23.899			
Constant	−1436.4292	93.3623	−15.3855	0.0000
Variable X_1	0.3386	0.0166	20.3445	0.0000
Regression analysis for dependent variable Y_2—Disposable income per capita in households in the second quintile group				
$n = 14$	Regression statistics: R = 0.9971; R^2 = 0.9942; Adjusted R^2 = 0.9931; F(2,11) = 938.93; $p < 0.0000$; Standard error: 17.771			
Constant	−1141.3389	178.2880	−6.4017	0.0001
Variable X_3	0.1650	0.0270	6.1045	0.0001
Variable X_1	0.2277	0.0512	4.4481	0.0010
Regression analysis for dependent variable Y_3—Disposable income per capita in households in the third quintile group				
$n = 14$	Regression statistics: R = 0.9985; R^2 = 0.9969; Adjusted R^2 = 0.9964; F(2,11) = 1777.00; $p<0.0000$; Standard error: 15.810			
Constant	−190.5057	62.4736	−3.0494	0.0111
Variable X_2	−6.4313	2.3983	−2.6816	0.0213
Variable X_3	0.3257	0.0096	33.8442	0.0000
Regression analysis for dependent variable Y_4—Disposable income per capita in households in the fourth quintile group				
$n = 14$	Regression statistics: R = 0.9782; R^2 = 0.9568; Adjusted R^2 = 0.9490; F(2,11) = 121.83; $p < 0.0000$; Standard error: 71.563			
Constant	−4519.1721	762.6305	−5.9258	0.0001
Variable X_1	1.0064	0.1113	9.0461	0.0000
Variable X_2	34.9739	14.6409	2.3888	0.0359
Regression analysis for dependent variable Y_5—Disposable income per capita in households in the fifth quintile group				
$n = 14$	Regression statistics: R = 0.9965; R^2 = 0.9930; Adjusted R^2 = 0.9910; F(3,10) = 476.28; $p < 0.0000$; Standard error: 46.018			
Constant	−2220.4299	837.1228	−2.6525	0.0242
Variable X_1	0.9615	0.1159	8.2991	0.0000
Variable X_2	59.5221	9.7376	6.1126	0.0001
Variable X_5	−43.6569	5.4440	−8.0193	0.0000

The analysis of the ratio of expenditure on energy carriers to the households' disposable income indicated that three turning-point periods were observed in Poland over the time of study, i.e., 2006–May 2020. These are: 2009–2013, 2016, and April 2020. Since 2006, a decrease in the share of this spending has been seen in all income groups. A change in these trends took place between 2009 and 2013, when the ratio of expenditure on energy carriers to income increased, especially in the case of the lowest-income and middle-class families. That was a time of economic slow-down when the economic growth hit a low twice, first in 2009 and then in 2012–2013. From 2014 onwards, the downward trend in the ratio under review continued. In 2016, the ratio of expenditure on energy carriers to disposable income fell sharply in the first three income groups. This coincided with the introduction of government social welfare programs for families with children. That reduced proportion was seen primarily in households from the first and second decile group, i.e., in the poorest families. In the first decile group, the decrease in the ratio of expenditure on energy carriers to the households' disposable

income per capita was as low as 5.35 percentage points, while in the second decile group, it fell by 1.77 percentage points. In the following years, i.e., until 2019, there was a permanent, albeit slow, decline in the ratio of expenditure on energy carriers to disposable income in all the income groups. However, that decrease was stable enough to fall below 10% in the second income group, i.e., below the threshold marking energy poverty.

Table 3. Disposable income per capita in Polish households by quintile groups in 2006–2020.

Year	Quintile Group				
	First	Second	Third	Fourth	Fifth
2006	274.44	500.87	693.44	951.93	1756.82
2007	316.23	564.67	771.36	1041.98	1954.44
2008	352.48	646.03	878.53	1184.02	2170.62
2009	369.60	687.46	940.00	1270.04	2311.00
2010	409.69	728.78	994.29	1342.27	2495.24
2011	399.33	757.07	1031.65	1390.76	2560.29
2012	411.25	780.54	1075.27	1452.10	2679.19
2013	403.68	792.93	1098.25	1479.64	2727.66
2014	429.74	832.07	1149.28	1548.06	2748.25
2015	456.98	871.66	1193.56	1592.18	2824.20
2016	557.19	975.01	1286.70	1684.43	2878.81
2017	654.78	1072.76	1388.97	1795.34	3086.40
2018	673.01	1141.43	1478.95	1903.45	3277.02
2019	711.00	1237.00	1606.00	2060.00	3491.00
5.2020	654.09	1109.27	1438.47	1904.18	3278.45

Source: data own calculations based on [58–60].

Table 4. Predicted distribution of Polish households' disposable income by decile groups in May 2020 and its impact factors.

	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10
Independent variables	X8	X8	X6, X1	X1	X3, X5, X6, X7	X3	-	X2	X1, X2	X1
Distribution of income	2.6	4.9	6.5	7.4	8.6	9.3	10.0	12.0	14.7	24.0

Table 5. Proportion of expenditure on energy carriers in disposable income by quintile group.

Year	Quintile Group				
	First	Second	Third	Fourth	Fifth
2006	31.39%	17.20%	12.43%	9.05%	4.90%
2007	26.76%	14.98%	10.97%	8.12%	4.33%
2008	27.34%	14.92%	10.97%	8.14%	4.44%
2009	29.12%	15.66%	11.45%	8.48%	4.66%
2010	28.85%	16.22%	11.89%	8.80%	4.74%
2011	31.10%	16.41%	12.04%	8.93%	4.85%
2012	30.94%	16.30%	11.84%	8.76%	4.75%
2013	32.15%	16.37%	11.82%	8.77%	4.76%
2014	28.77%	14.86%	10.76%	7.99%	4.50%
2015	27.22%	14.27%	10.42%	7.81%	4.40%
2016	21.87%	12.50%	9.47%	7.23%	4.23%
2017	19.16%	11.70%	9.03%	6.99%	4.07%
2018	18.21%	10.74%	8.29%	6.44%	3.74%
2019	17.23%	9.91%	7.63%	5.95%	3.51%
5.2020	19.62%	11.57%	8.92%	6.74%	3.91%

The third turning point was May 2020, i.e., the time of the COVID-19 pandemic when the trend reversed abruptly, i.e., the ratio of expenditure on energy carriers to disposable income per capita soared. These increases have pushed Polish families back to the situation from 2017. Comparing the data from May 2020 to those from 2019, it can be clearly seen that the increase in the ratio of spending on energy carriers to disposable income happened in all the income groups, i.e., from 0.4 percentage points in the fifth decile group to 2.39 percentage points in the first decile group. The poorer the group of the population, the greater the increase in the ratio. Therefore, it can be concluded that the lower the household's income, the more severe the effects of the COVID-19 pandemic on financing expenditure on energy carriers.

Such trends in the ratio of expenditure on energy carriers to the households' disposable income per capita were reflected in the level of energy poverty in Poland over the time under study. Figure 1 shows the level of energy poverty in Poland from 2006 to 2020.

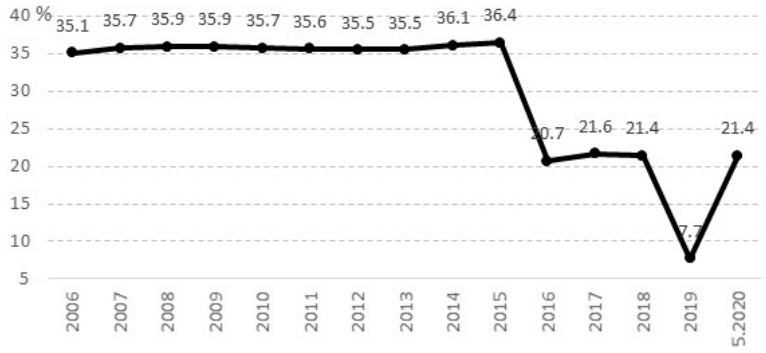

Figure 1. Level of energy poverty in Poland in 2006–May 2020. Source: own calculations based on [58–60].

The study results have shown that the level of energy poverty remained relatively stable by 2015 at around 36%. In 2016, there was a sharp drop in the level of energy poverty to about 21% to remain stable for the next 2 years and then, to fall further to 7.7% in 2019. This decrease is associated with a decline in the ratio of expenditure on energy carriers to the disposable income in the first three decile groups, which was a result of the government's social policy and social welfare programs aimed at families with children. First, in 2016, the 500+ program was introduced, consisting of the payment of a parental benefit for each second and subsequent child, regardless of the income earned by the family. In mid-2019, it was extended to cover all children up to the age of 18.

However, in 2020, i.e., the time of the COVID-19 pandemic, the level of energy poverty has fallen to the levels recorded in 2017–2018. That has happened despite the fact that there have been no changes in the social policy of the state and all the existing pro-family and welfare programs have been maintained. Thus, the changes in the level of energy poverty are clearly a result of the lockdown of the economy during the pandemic. It is also worth noting that during the pandemic, not only has the number of people who were energy-poor increased (Figure 1), but so has the ratio of their spending on energy carriers to their disposable income (Table 5).

In order to expand the scope of the conclusions from the study, the authors compared the ratio of expenditure on energy carriers to the average disposable income per capita in households, the dynamics year-over-year of expenditure on energy carriers, and of the average disposable income per capita in Poland during the time under study (Figure 2).

The results of the study revealed (Figure 2) that the decrease in the ratio of expenditure on energy carriers to the average disposable income per capita in Polish households took place when there was a positive difference in the dynamics of changes in disposable income and expenditure on energy carriers. The period of the COVID-19 pandemic, i.e., May 2020, is particularly distinct in the examined period as then, the difference was negative and amounted to as much as 14.5 basis points.

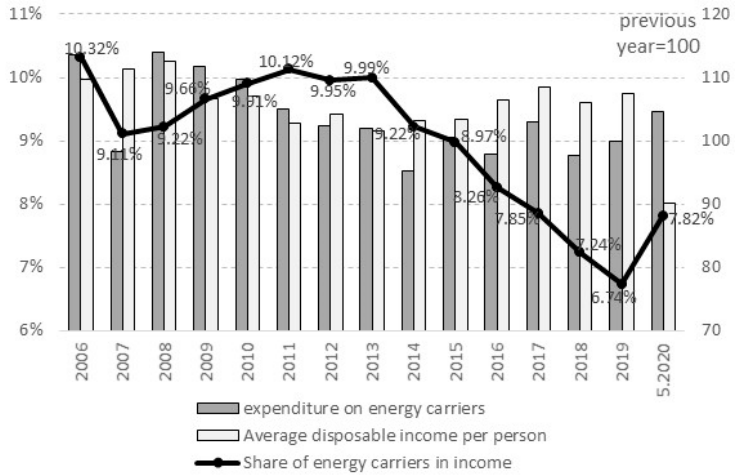

Figure 2. Ratio of expenditure on energy carriers to households' average disposable income per capita (in %), dynamics of expenditure on energy carriers, and average disposable income per capita in Poland (previous years = 100). Source: own calculations based on [58–60].

Then, what was the reason for that? The answer to this question is provided by a comparison of the development of the ratio of expenditure on energy carriers to income with the GDP annual growth rate and with the family benefits public spending (as % of GDP) over the period considered (Figure 3).

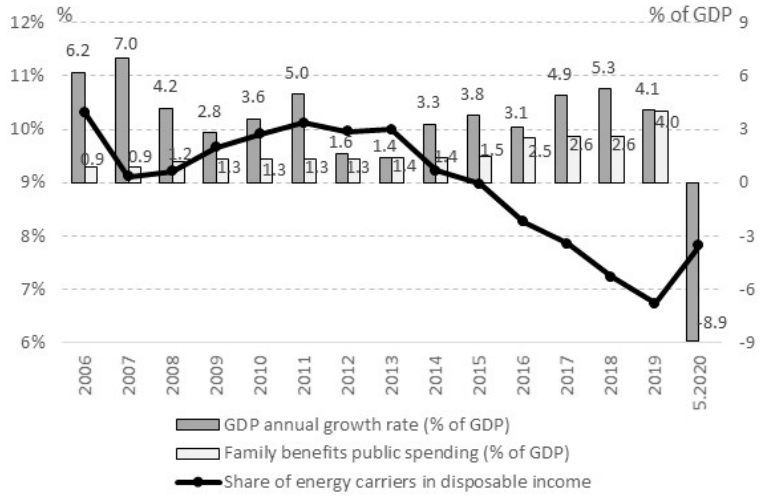

Figure 3. Factors influencing ratio of expenditure on energy carriers to average disposable income of Polish households per capita in the period 2006–May 2020 *. * projected economic growth in the second quarter 2020 (Year over Year). Source: own study based on [58–60].

The results of the research have shown that the disposable income growth per capita in Polish households was negative only in the time of the pandemic (it fell by 9.8%). What is more, it was not accompanied by a decrease in the public spending on family benefits in that period. Although there are no data for 2020, the social policy from previous years was continued. Therefore, it can be predicted that in 2020, the amount of these benefits will be at a similar level as in 2019. The results of the research also show that since 2016, the Polish government has been spending more and more money on pro-family programs which benefit primarily people with the lowest incomes. All the above means that the sharp increase in the ratio of expenditure on energy carriers in the average disposable income per capita in Polish households that occurred in May 2020 was a result of the COVID-19 pandemic and the consequent rapid economic downturn.

5. Conclusions and Discussion

When assessing the impact of COVID-19 on the level of energy poverty, it should be stressed that the authors of this paper have shown that the present pandemic has contributed to the aggravation of difficulties for Polish households in financing expenditure on energy carriers. This fact has had a direct impact on the increase in energy poverty in Poland. Moreover, it has been proved that COVID-19 has had a negative effect on the average disposable income of Polish households, which with the simultaneous increase in energy purchase costs has led to a higher ratio of expenditure on energy carriers to disposable income. The results obtained for Poland turn out to be similar to the data on the British economy for which calculations have been published by Aimee, Baker, Brierley, Butler, Marchand, and Sherriff [61]. In the time of COVID-19 in the United Kingdom, energy consumption in the whole national economy has fallen due to the lockdown and in an average British household, the monthly cost of energy has increased by GBP 16 [62]. The situation was similar in Italy, where energy consumption and prices decreased by about 30%, but these decreases were observed in the industrial sector and not among households [63]. The rise in energy expenditure among households has been mainly due to the fact that members of households are staying at home much longer than before the pandemic as a result of the lockdown and thus, use more appliances and energy carriers. Moreover, the British authors point out that a significant part of the increased households' spending on energy is the cost of heating. This is mainly due to the fact that warm homes enable human immune systems to fight viruses more effectively and that maintaining high room temperature contributes to a faster recovery process for those returning from hospital after virus treatment [64]. Although the Polish researchers have not looked yet at increased use of energy carriers, they have found that the reason for the increased spending on energy carriers is the rise in their prices. This corresponds to some extent to the results of Hussain et al. [49], which indicate that globalization increases energy intensity, which is consequently reflected in higher energy prices. Consequently, higher energy costs may determine the aggravated difficulty for households to pay their current bills. The research has indicated that at the time of COVID-19, the main factor determining the spread of energy poverty is a decrease in employment and an increase in unemployment, which is reflected in lower average income from paid work. Thus, the most considerable growth of the ratio of expenditure on energy carriers to disposable income in Poland during the pandemic has affected people with the lowest and average income. This conclusion is in line with the results of Karpinska and Śmiech [65], who, when analyzing the phenomenon of exposure to hidden energy poverty, indicated that it is mainly linked to income poverty.

Based on the work by Asner et al. [66], an assumption can be made that COVID-19 has not only contributed to the increase in energy poverty, but will also contribute to growing economic poverty in the future, thus aggravating energy poverty even more. This vicious circle may be caused by job losses and budgetary constraints that result from the household members' loss of unemployment, illness, or reduced earnings [67].

The reasons for growing energy poverty in Poland presented in the paper, as well as the conclusions drawn by foreign authors, indicate that this phenomenon will be gaining global importance. According to the presented research results, energy poverty in Poland should be treated as one of the dimensions of multifaceted poverty that may lead to social exclusion. In order to avoid the difficulties with paying for energy which arise as a result of COVID-19, at the time of the current economic crisis and in the future, the state should create a comprehensive policy for combating energy poverty. It should pursue a policy of both indirect and direct impact on this type of poverty. Therefore, the authors of this study propose that the government should implement a flexible policy concerning energy payments and debt relief for energy bills, while controlling electricity prices that are rising and are likely to rise in the years to come. Furthermore, it should also further develop the existing instruments, for instance, by simplifying procedures concerning thermal upgrading of residential buildings and the use of renewable energy sources by households, which should help reduce energy consumption. This is in line with the literature [49,65,68], which indicates that the implementation

of policies directly targeting energy poverty and measures to improve the socioeconomic status of households will alleviate energy poverty.

The above conclusions are to be considered as recommendations as the present study was burdened by certain limitations resulting from the fact that the energy poverty survey was carried out in the first months of the COVID-19 pandemic, when data on the national economy have not been available yet. Due to the above, presumably, as the COVID-19 crisis continues, the proportion of the energy purchase costs in households' budgets will grow sharply. Furthermore, as the results from Yumashev et al. [69] indicate, this may affect the level of prosperity and the level of sustainable development of the country. Moreover, the choice of several dimensions to assess complex theoretical constructs may also be a limitation here. There is, therefore, no doubt that these studies need to be continued. Nevertheless, despite this shortcoming, the paper successfully diagnoses the most important effects of the COVID-19 pandemic on the energy poverty of Polish households.

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