

Teodora Peneva

Energy Poverty in Bulgaria: Dimensions and Factors



Prof. Marin Drinov Publishing House
of Bulgarian Academy of Sciences

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for his long-term support and guidance in
energy poverty research methods.*

*This monograph is the result of a research project
developed by the Economic Research Institute with
the Bulgarian Academy of Sciences on the topic
«Energy poverty in Bulgaria: dimensions and factors».*

ECONOMIC RESEARCH INSTITUTE
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**Prof. Marin Drinov Publishing House
of Bulgarian Academy of Sciences**

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ABBREVIATIONS

2M	Double Median of Energy Expenditure (2M)
2MS	Double Median Share of Energy Expenditure (2 Median Share)
ASA	Agency for Social Assistance [of Bulgaria]
BAS	Bulgarian Academy of Sciences
BGN	Bulgarian Lev [the official currency of Bulgaria]
BREDEM	The Building Research Establishment Domestic Energy Model
EWRC	Energy and Water Regulatory Commission [of Bulgaria]
SoLR	Supplier of last resort
DoG	A decree of the Government [of Bulgaria]
DSA	Directorate of Social Assistance [of Bulgaria]
EEA	Executive Environment Agency [of Bulgaria]
ERI	Economic Research Institute (at BAS) [in Bulgaria]
EU	European Union
FPM	Fine Particulate Matter
GDP	Gross Domestic Product
LIHC	Low Income – High Cost
LIHCS	Low Income – High Cost Share (Low Income – High Cost Share)
M/2	Half Median Energy Expenditure (M/2)
ME	Ministry of Energy [of Bulgaria]
MEW	Ministry of Environment and Water [of Bulgaria]
MLSP	Ministry of Labour and Social Policy
MRDB	Ministry of Regional Development [of Bulgaria]
MS/2	Half Median Share of Energy Expenditure (MS/2)
MLSP	Ministry of Labour and Social Policy [of Bulgaria]
NEC	National Electric Company [of Bulgaria]
NPP	Nuclear Power Plant
NSI	National Statistical Institute [of Bulgaria]
OECD	Organization for Economic Co-operation and Development
PHES	Pumped hydroelectric energy storage
PMF	Fine dust particles

RES	Renewable energy sources
RPL	Poverty after Energy Expenditure - Relative Poverty Line
RRP	Recovery and Resilience Plan
SEDA	Sustainable Energy Development Agency
SG	State Gazette [of Bulgaria; in Bulgarian: <i>Държавен вестник</i>]
SILC	Survey on income and living conditions
TPP	Thermoelectric power plant, thermal energy (in the figures)
TPR	Ten-Percent Rule
WHO	World Health Organization

INTRODUCTION

The Bulgarian version of this monograph was published in August 2022, but the research results thereof were first disseminated on several conferences organized by the Economic Research Institute (ERI) at BAS first, several NGOs and the trade unions in the months before its official publication, receiving vast acceptance among the national audience. The main conclusion of the research study was officially sent by ERI to the government at the end of July 2022, and served as a basis for the adoption of an official energy poverty definition in Bulgaria.

The research makes a theoretical and empirical analysis of 12 indicators for measuring energy poverty included in the recommendations of the EU and the Energy Poverty Observatory in Brussels, using data from the annual «Household budgets survey» of NSI for 2014-2019, as well as time series data for 15 years with macroeconomic indicators of household income and expenditure, GDP, inflation, employment, prices of energy resources, etc.

There are two main results of the research project, which are based on the understanding that before adopting a definition of energy poverty, the ‘most suitable’ one must be chosen for the specifics of the country.

First, among the analyzed 12 indicators for measuring energy poverty, a reasoned choice was made of the most adequate and suitable ones for Bulgaria, and in particular – the so-called ‘disposable income after typical energy consumption’. It counts as energy poor those individuals or households that fall below the official poverty line after deducting their energy costs.

Currently, according to the methodology for determining the poverty line in the country (adopted by Dog No. 241 of 24.09.2019, as amended SG

No. 68 of 17 August 2021), this line represents 60% of the median total net income per equivalent unit. This methodology has its imperfections but the chosen indicator for determining the energy poverty line is relatively neutral to them, as it makes use of the typical (not actual) energy expenditure to be deducted from the individuals' or households' income. For instance, the indicator should not consider the actually made energy cost (as reported by the NSI or billed to individuals) but typical energy expenditure, which should replace the energy audit, provided that very few buildings in Bulgaria have underwent audits at all.

The typical energy consumption should ensure adequate thermal comfort in winter at 21°C in the heating season, and be able to reflect individual differences in energy consumption caused by heat losses in the absence of insulation of walls and windows, high consumption due to the type of building (house/apartment), lower or higher outside temperature in different climatic areas, presence of a person with a specific 24-hour need for energy to achieve higher thermal comfort, as well as regional differences in energy prices.

The selected indicator for determining energy poverty measurement:

- 1) estimates about 34.5% of the population as being energy-poor throughout the scrutinized period 2014-2019.
- 2) shows a high concentration of the energy-poor in the lowest income decile groups;
- 3) shows zero (or near-to-zero) energy poverty in the middle and high income decile groups;
- 4) combines a relative and an absolute approach, allowing timely and adequate reflection on energy-price changes for household consumers;
- 5) provides an opportunity to monitor energy efficiency measures and replacement of heating systems on a national scale, including private investments, with only the addition of 4 questions in the NSI national research surveys. (At a later stage, a methodology was elaborated by SEDA and NSI, which utilizes available data in an aggregated manner without need of changing or adding anything.)

Second, on the above basis, the proposal for an official definition of energy poverty of the ERI at the BAS consists of the following:

An energy-poor is a consumer (person or family) who, at the current prices of energy services (electricity, heating, gas), due to their income, age, employment, family and/or health condition, falls below the official poverty line after deducting their expenses related to reasonable consumption at home of energy services necessary for the effectuation of various non-commercial household activities, in order to ensure decent heating standards in the heated compartment of the dwelling, as well as lighting, use of various appliances for cooking, lighting, cooling, hot water boiling, running devices for entertainment, information exchange, etc., which are necessary to satisfy the basic needs.

With little correction this definition will be proposed to the parliament for voting in the newly-elected XLIX National Assembly of Bulgaria to start in the second half of April 2023. So far, there is a large consensus on it. Yet, there is no consensus on its applications. As the above definition covers over 2 million people, and the country's social support system is of limited capacity, it will be used only for programmes and schemes for energy-efficiency measures. Direct financing will continue to use the existent heating allowance mechanism, that covers just 300 thousand people, until the country finds other funding sources other than the national budget.

Objective and tasks of the book

This monograph is focused on the dimensions, factors and mechanisms to reduce the energy poverty in Bulgaria, each discussed in a separate chapter. The results are oriented not only to the academic community, experts or government institutions, but also to the society as a whole.

The relationship between energy poverty and its determinants is examined on the basis of anonymized data for the last 5 years from the Households' budget survey conducted by NSI. This allows to assess the stability of the methodology for measuring energy poverty, to objective-

ly assess changes in the groups at risk covered by it, to measure the elasticity of energy costs from the income of specific types of households, changes in the consumption of different energy carriers, as well as the impact of individual demographic and economic factors on the level of energy poverty. In this sense, the project offers a wide range of assessments and analyzes the state and development of individual factors over a sufficiently long period, which allows establishing their influence on the level of poverty.

So far the European Union lacks a common definition of energy poverty and a uniform methodology for its measurement. It is believed that the basic energy needs of households are too different, not only in individual climate regions, but also in individual countries, due to the different building stock and heating systems, individual dwellings, and this makes it impossible to assess the level of poverty, determine the groups at risk, and therefore the development of policy instruments to deal with the problem. The database necessary for a comprehensive and adequate analysis of energy poverty has not yet been developed. The influence of the main socio-demographic factors that give rise to it, the elasticity of household energy consumption costs, etc., has not been studied. Yet, this monograph shows that there are methods that allow for objective quantitative measurement of energy consumption of households without resort to energy audits, and relying on available statistical indicators. This is particularly important for Central and Eastern European countries, where few energy audits have been conducted and where the social system is unable to cover the large numbers of energy-poor households.

The monograph offers solutions to a number of open methodological issues related to the measurement of energy poverty and contributes to establishing its scope in the country based on various indicators. Assessing the factors of energy poverty is of particular importance for the correct understanding and development of adequate policies in the field.

The aim of the present work is to measure the scope of energy poverty in Bulgaria, to assess the influence of the primary factors on the dynamics of this poverty and to propose solutions related to policies in this area. For this purpose, the following tasks have been completed:

- Systemizing main indicators for energy poverty; clarification of key methodological issues for its quantification based on data from the NSI's Survey on the Household budgets in Bulgaria;
- Measuring the scope and trends in the development of energy poverty by use of various indicators;
- Determining the main socio-demographic and economic factors of energy poverty in Bulgaria; studying the relationship between the selected factors and energy poverty;
- Assessing the impact of selected factors on energy poverty such as energy expenditure, type of heating, household income level and age of household members;
- Developing specific solutions related to the introduction of an official energy-poverty line and a mechanism for energy-poverty reduction.

The main research hypotheses are the following:

- Energy poverty is formed under the influence of many factors, but the dominant ones are socio-demographic and economic;
- The subjective measures of energy poverty are not suitable for the situation in Bulgaria;
- The influence of the dominant factors can be adequately reflected only using the expenditure approach and indicators containing income and energy costs of households, allowing a quantitative assessment of needs through indicators of building envelope, windows insulation, heating type, etc.

Research Methodology

To prove the formulated hypotheses, a wide scientific toolkit was used, including research of literary sources; theoretical and empirical analysis; processing and analysis of anonymized statistical data from the Surveys of household budgets after 2014 and statistical analysis. An analysis of the factors for the last 10 years (2011-2020) was carried out using anonymized data from the NSI Survey on the Household budgets in Bulgaria for the period 2014-2019.

The statistical analysis is based both on all secondary data related to income, energy prices and consumption, and on data from energy-poverty indicators constructed according to different measurement methods, using household energy income and expenditure. For each of the methods and each of the costs, an energy-poverty indicator was created, which marked with '1' (one) the energy-poor households and with '0' (zero) the energy non-poor households.

The trends in the development of energy poverty were investigated by way of three approaches: objective, subjective and expenditure-oriented ones. The results of eight measurement methods were analyzed within the expenditure approach.

Each result was analyzed in terms of: 1) household coverage, coverage efficiency at the lowest deciles; 2) direction and intensity of dependence on household income and energy costs, type of heating, number of children and adults in the household, as well as other macroeconomic indicators such as GDP, energy prices, amount of goods purchased by households, etc; 3) functional capabilities – for annual monitoring, through the inclusion into research, for supplementing energy-efficiency indicators, for reflecting development and effect of upcoming programmes.

After conducting a detailed comparative analysis, as well as an analysis of the factors, an option for an official energy-poverty line has been proposed, as well as a mechanism for reducing energy poverty in Bulgaria. A number of methodological issues related to the study of energy poverty have been resolved. The Appendix proposes three different methodologies for determining typical energy consumption of households, the last one being officially adopted by the government to be submitted to the parliament in 2023.

With the adoption of the Green Deal by the European Union in December 2019, huge financial resources are expected to be directed towards a green economy, but it is questionable if some of them will be allocated to reduce energy poverty, which is one of the main factors of air pollution in winter in populated areas. Although several European policies aim to reduce energy poverty in the European Union, and despite the prioritization of the issue in recent years, all real actions exhibit an overt underestimate of the problem and direct finances rather to service sectors

such as training companies, information programmes, audit projects, and at best – to solar panels and energy-efficiency schemes in an extremely limited scope for all citizens, usually reaching just those that can invest first, before applying for the scheme.

This book offers a solid ground for the first step – defining energy-poor households. Very important next steps would be the energy-poverty mapping, synchronizing of these maps with the renovation plans; heating-replacement plans should be devised by the municipalities; and last but not least: the social climate plans. Securing enough financial instruments and budget to gradually remove energy poverty, replacing fossil-fuel heating systems and installing renewable equipment will be the next step along with guaranteeing enough funds for the most vulnerable and energy-poor households.

CHAPTER ONE

DIMENSIONS

For nearly ten years until 2021, the term 'energy poverty' has been used in Bulgaria with different content, especially after the protests against high energy bills in January 2013. In society and even among government experts, there are several intertwined concepts in use: 1) 'vulnerable customers'¹, for which there is an official definition in the Energy Law §1, item 66 (Ministry of Energy, 2016); 2) 'energy-poor'; and 3) 'socially weak'. Each of these concepts is different, but at the end of 2022, there is still no official definition in Bulgaria what energy-poor should mean.

This first chapter provides an overview of the theoretical research, EU-regulatory requirements for measuring energy poverty, the grounds for developing an official definition of energy-poor households in Bulgaria, and the methods of measuring energy poverty. The main methodological problems are analyzed, such as the choice of an equivalent scale, peculiarities in the analysis with current energy costs and typical energy costs. The positives and negatives of each choice are highlighted. Energy poverty in Bulgaria was measured quantitatively with each method, and the results of the different quantitative dimensions have been analyzed. A proposal has been made for an official energy-poverty line in Bulgaria.

¹ Households, that take part in the market, placed in an unequal position from the point of view of purchasing a product. It is an artificially created category aimed at singling out a group of consumers who represent an explicit societal 'minority' to be granted minimal free access to energy resources for a limited period of time in order to reduce the number of interruptions in energy supply.

1.1. Theoretical and regulatory framework of energy poverty

A theoretical framework of energy poverty

With the rise in fuel prices worldwide in the late 1970s energy poverty as a concept began to expand its definition from being a term, primarily related to the accessibility of the energy network to the population, towards the affordability of energy as a product in terms of purchasing power of the population. The socialist countries were temporarily protected from the phenomenon of energy poverty with the serious support by the state and the cross-subsidization of prices (Buzar, 2007), and that is why first scientific studies and examination of energy poverty, understood as insufficient provision of adequate comfort at home, started precisely in Western Europe.

Theoretical studies of energy poverty commenced in the 1990s with claims for necessity of research and systematic policy by researchers such as Broadman (Broadman, 1991) and Dyer (Dyer, 2000). The multidisciplinary nature of the problem and the need for joint work of engineers and economists in formulating policies in the field of energy were recognized. From the very beginning, the aim to conduct a systematic analysis was pursued, and not an energy model to be used in order to support state policies and company strategies at the same time. That period was characterized by a small number of researchers involved and a focus on conceptual analyzes and recognition of the problem at the political level. Following the publication of an official definition of energy poverty in Great Britain in 2001, a new wave of research began, also based on annual surveys and physical measurements of home temperatures and building characteristics. The main problems reflected by the scientific publications of this period were the lack of clear targeting in the current definition (Ten-Percent Rule), and the correspondingly low effectiveness of policies (Sefton, Chesshire, 2005). The results of the first studies and analyses on energy poverty in countries such as France, Ireland and Great Britain also came to the fore, and the purposeful development of social schemes to support the energy-poor population began.

Initially, the estimate of the number of energy-poor people in Britain was based on the average percentage of energy expenditure of the

income of the poorest 30% of households, which was 10% in 1988 (Palmer et al., 2005). When the ten-percent-rule of energy expenditure made from the net income was introduced as the energy-poverty threshold, this was twice the median share of energy expenditure from the income of all households. In the Fuel-Poverty Strategy of Great Britain approved in November 2001 (DECC, 2001) a household is considered energy-poor if it has to spend at least 10% of its income to heat its home to acceptable levels (those recommended by the World Health Organization, such as 21°C for the main living area of the home and 18°C for the other rooms).

In the mid-2000s, more and more articles began to appear about the need to develop modern energy services in developing countries (Sagar, 2005), (Saghir, 2005). These articles, in addition to analyzing the lack of physical accessibility of energy services and the consequences thereof, also commented on the financial inaccessibility of the services. It measured different types of energy resources consumed by households as per decile groups in order to highlight differences according to income. The World Bank raised at the international level the problem of financial inaccessibility to energy, and the negative effects on people's health, children's education, women's quality of life and the environment. Energy affordability was dealt with in the framework of tools to address the problems of poverty, especially in segregated groups, rural areas, etc.² This problem has been also found in Bulgaria. According to a report by the Commission for Social Protection in Bulgaria from 2009 „*the main problem (and not only in Bulgaria) concerns the effectiveness of anti-poverty policies and measures. Even during the most prosperous years of economic activity, no significant reduction in poverty and social exclusion occurred*” (ESC, 2009).

The consequences of energy poverty continue to be a constant part of research, with the Marmot Review Team providing significant results on the impact of energy poverty and cold homes on the health status of people in the UK (Marmot Review Team, 2011). The consequences of

² Ibidem.

poor building quality and inadequate heat in homes continued to be commented on in articles in later years (Tod et al., 2016).

Gradually, there is an interest in studying the phenomenon outside the national framework of a country. Healy raised the problem of energy poverty at a pan-European level in 2004 (Healy, 2004), and Buzarowski explored the situation in the Eastern European bloc (Buzar, 2007), where similar trends and problems were observed, arising from the change of the communist regime and the reorientation of the energy sectors in the conditions of a market economy, and analyzed by other researchers at the time (Kovacevic, 2004).

Research on the effectiveness of different measurement methods and of different programmes, policies and instruments started in the 2010s (Moore, 2009; Hills, 2011; Thomson, Snell, 2013; Petrova et al., 2013), and moved into a new stage of development with the recognition of the problem at the pan-European level, with an increase in funding for various programmes and measures and following the establishment of the Energy Poverty Observatory in 2018. A key contribution to this direction is the Hills report of 2011, disproving the effectiveness of the current definition in the UK and introducing a new one in its final report (Hills, 2011). Commissioned by the government, Hills analyzed the various indicators of energy poverty and recommended that the 'Ten-Percent Rule' should not apply in the UK, as it also covers many high-income households. As a result of the 2013 report, a new indicator called «Low income - high cost» is being introduced in England. With this indicator, a poverty threshold after energy expenditure is also introduced, as a basic concept recommended for use in measuring energy poverty.

In summary, after 2010, the following several indicators and methods for determining energy poverty are actively researched and analyzed:

- 1) 'Ten Percent Rule' for households with energy expenditure exceeding 10% of their net total income.

- 2) 'Poverty after energy expenditure' for households with net total income after (reduced by) energy expenditure below the official poverty line. This indicator mixes an absolute approach with a relative one. The absolute approach includes the individual size of the household's energy expenditure, and the relative approach refers the remaining part of the

household's income after this expenditure to the threshold of the official poverty line. The official poverty line is set at 60 % of the equivalent net total income of all households in the country. This tool was proposed by Hills in 2011 to isolate cases of high-income households with high energy consumption falling into the energy-poor group due to their high cost-to-income ratio. By offering this method in practice, two types of energy poverty are already being discussed – before and after heating costs, in a strategy paper presented to the Parliament by the Secretary of State for Energy and Climate Change commissioned by the Queen in March 2015 (HM Government, 2015).

With the definition thus proposed, the poverty line at income after (reduced by) energy expenditure is shifted in a fairer way, encompassing more households with high energy expenditure but with slightly higher income than the threshold of the official line of poverty (presented in more detail in Chapter 1, item 2 Dimensions of energy poverty).

3) 'Low Income-High Cost' for households with net total income after energy expenditure below the poverty line and energy expenditure above the national median. For this indicator in Great Britain, an annual survey specifically on energy poverty in the country is used, from which data on household costs, building characteristics, heating systems, electrical appliances, consumption patterns and energy prices are taken, and an individual typical energy expenditure is developed – what is needed by the household in relation to the characteristics of the dwelling and its occupancy. On this basis, an equivalent cost scale was developed, similar to the modified OECD income scale, and this scale was applied to equalize household costs according to their demographic and energy consumption characteristics (Peneva, 2021).

4) 'Low income-high cost share' for households with a net total income below the poverty line and a share of energy expenditure above 10% of net total income. This indicator combines the 'Ten Percent Rule' and the official poverty line for the country (equivalent gross household net income below the poverty line, set at 60% of the median equivalent net gross income for the country).

5) '2M - Double Median' of the cost (the median multiplied by two) identifies households that have unusually high costs for energy services.

An advantage of this method is the elimination of the influence of extreme low and high costs in the sample. Another type of definition developed based on this method is the double median of the share of household income expenditure.

6) 'M/2 - Half the median' (the median divided by two) of the expenditure and of the share of energy expenditure in the income of all households in the sample.

Several basic understandings adopted by researchers can be summarized using disposable income after housing and energy expenditure as a fairer basis for assessing the income status of consumers. A parameter for measuring the depth of energy poverty is also set. Equalization of energy expenditure and different measures of household expenditure against median expenditure are applied – 2M (double median), M/2 (half median), M (median) or share of expenditure against median variants (M, 2M, M/2). In the next few years, in the scientific circles, the new Hills's indicator with different variations is massively studied, applied, and analysed (Lojandre, 2013; Schuessler, 2014; Miazga et al., 2016; Buzarovsky, Herrero, 2016).

Schuessler rejects the logic of all the indicators listed above. He believes that if the Ten-percent rule is even developed methodologically and meets norms of heat adequacy, then its purpose is to identify the problem in low-income households, and it does not necessarily coincide with the double median. He points out that neither the Ten-percent rule nor the Double-median Expenditure Share used by British researchers are suitable for determining energy poverty in Germany. The reason for this is the lack of data in Germany on a national scale, with which to determine a standard level of adequate consumption and actual consumption, above all for heating. He criticizes Hills's Low Income-High Spending indicator for its lack of logic for low-income households to spend a lot, much more than the national average. Schuessler sets the freedom to choose an arbitrary percentage of the share of energy expenditure, as long as it meets the criterion of adequacy. According to him, the choice of a threshold should be reasoned and proven, and not just apply some percentage. The questions «Why exactly 10%?», «Why exactly double the median of the expenditure?» or «Why exactly double the median of the expenditure

share?» must be answered. In any case, the choice of a given threshold must be justified and at least set adequate for energy services. Otherwise, both the median is a lot for a low-income household, and a 10% share is a lot. Introducing a constant to an otherwise unchanged distribution will certainly reduce the number of households. He himself is more inclined to choose the median, in the absence of justification, simply following the theory of justice. His criticism mainly refers to the lack of objectivity of any relative approach. Lowering the income criterion deliberately reduces the number of affected groups, while raising it artificially increases poverty.

This criticism of the relative approach in determining the poverty lines was also made by Bulgarian researchers during the last change in the methodology in 2019 in Bulgaria (Tsanov, 2020). Tsanov criticizes the removal of a component of an absolute approach (valuation of a living minimum of 2,700 kcal consumption for food products), as well as the artificial maintenance of a high level of poverty, when incomes increase in the country (an additional provision in the Methodology for determining the poverty line, not allowing it to be lower than the line in the previous year).

Here comes the application of the Minimum Income Standard (Bradshaw et al., 2008) to the needs of energy poverty, first introduced by Moore in 2009 (Moore, 2009) and then in more detail in 2012 (Moore, 2012).

When applying the 'Minimum Income Standard', energy poor households are those where the minimum equivalent living wage is greater than the residual equivalent income after equivalent energy expenditure. Or, to put it more simply, where the net residual income after energy expenditure is not enough to cover the minimum living expenses of the household. Schuessler also raises the issue of a minimum income standard in energy poverty as an objective method, but questions the content of the energy-specific standard.

With the advent of EU funding, the focus shifts to covering more countries in one study, where a new problem is brewing: lack of sufficient indicators in both local and European research, differences in databases and indicators, and a strong need from harmonization at the European level. Following the publication of the 2013 European Commission Opinion

on Energy Poverty (commented in part 1.2 on regulatory requirements), and requirements for follow-up action in Member States, scientific research is beginning a more focused quest for an effective definition of the problem with potential for application in more countries, and leaving the national context. By order of the European Parliament, the *Energy Poverty Handbook* was published in 2016 (Meszerics, 2016), which sets guidelines for defining the problem, after summarizing data for all EU countries.

In the same year, a publication made a comparative analysis of the indicators in the EU countries the definitions of vulnerability and of energy poverty in all countries, and noted their progress (Redmakers et al., 2016). The report also analyzes 178 indicators for assessing energy poverty, of which 42 were selected by the EU Building Fund Observatory, 12 by Eurostat and 7 by the Income and Living Conditions Survey. The rest of the indicators were collected from various European projects, statistics and literature at the local level in the respective countries. In the report these indicators are divided into six large groups: demographic, income/expenditure, energy demand, regulatory, physical infrastructure and results. Subsequently, these indicators were evaluated according to the effectiveness and the possibility of a systematic assessment of energy poverty in the contextual framework of the European Union. For this purpose, a matrix with several criteria was developed and the indicators were rated from 1 to 3, with 3 being the highest rating. The report also analyzes the strengths and weaknesses of each indicator. Here, it is recommended to use one indicator from the subjective approach (impossibility to keep the home adequately warm) and three indicators from the expenditure approach (low income - high cost, 2M and M/2), which are also used in the latest EU recommendations regarding energy poverty and energy efficiency.

2018 was also the year when the Energy-Poverty Observatory was established in Brussels, and a targetted development of criteria and indicators for measurement in the EU Member States began. The 2019 European Convention of Mayors for Climate and Energy highlighted the issue as part of opportunities to improve clean air. A handbook of useful resources was published that summarized hundreds of energy-poverty projects in four main areas: how to get more people involved in projects,

how to finance projects, what energy poverty policies are and what are the monitoring tools. The areas themselves show clearly that all the projects were focused on the practical and applied side of the problem, looking for tools, solutions to reduce both solid-fuel combustion and for investments in more energy-efficiency solutions.

In recent years, until 2021, several articles have been published containing proposals for composite indices of energy poverty – representing several indicators at the same time. These include the *European Domestic Energy Poverty Index (EDEPI)* – made up of the share of energy expenditure in all household expenditure, and three indicators from the subjective approach related to heating, utility bills, leaks and dampness at home. In other studies, such indices even include indicators of energy infrastructure affordability, clean energy, energy-sector governance, and then financial affordability (Qurat-ul-Ann, Mirza, 2021), when looking for a solution to the problem in developing countries. Double-median variation consumption was proposed in early 2022 by the European Parliament (Taylor, 2022) for the purposes of a dedicated new social climate fund, with the draft legislation saying that a definition was needed to «*define energy poverty as households in deciles with the lowest incomes whose energy costs exceed twice the average ratio of energy costs to disposable income after deducting housing costs*».

Despite all research and the huge resources at the European level, the scientific community fails to provide a solution to the following several problems:

- The Subjective Approach, the only one studied at the European level in all EU Member States, cannot be the basis of criteria for selecting households for financing;
- The Expenditure Approach contains a number of unresolved issues such as the use of actual or typical energy costs, energy cost thresholds, equalization of costs with a separate equivalent scale and a number of other methodological problems.

In the latest EU Recommendations on energy poverty and energy efficiency several sets of indicators are issued and each country is left to decide which to use.

Research experience in Bulgaria

On this basis, the development of an indicator for the identification and monitoring of energy-poor households in Bulgaria was made on the basis of already published opinions, reports and scientific works on the subject.

In 2013, Peneva for the first time commented on the high level of the share of energy expenditure from the respective income, and the lack of sufficient indicators for energy-poverty research in the country (Peneva, 2013). In 2014, Peneva highlighted the seriousness of the problem by binding the three main factors into one: high energy prices, low incomes and poor-quality building stock with low energy efficiency (Peneva, 2014). The seriousness of the problem was also reflected by Kisyov (Kisyov, 2014) the same year, with an analysis of macroindicators.

In 2015, the Economic and Social Council published an Opinion (ESC, 2015) on «Measures to Overcome Energy Poverty in Bulgaria». The opinion emphasizes the importance and urgent need to define policies for energy poverty. In the assessment of the energy poor, the Council refers to the subjective approach (also known as *consensus approach*) of the Income and Living Conditions Survey by the Eurostat, which takes into account the inability of households to keep their homes adequately warm, as well as to a study by the Bulgarian Institute of Philosophy and Sociology on indebtedness in Bulgaria, and Eurostat data on public-utility arrears. The high rate of poverty in Bulgaria, as well as the percentage of the population living in conditions of acute material deprivation, which occupies leading positions compared to the other EU-28 Member States, are also emphasized. The opinion focuses on the causes and consequences of energy poverty, and makes a comprehensive review of political measures specifically for energy poverty in other countries, and in the sphere of social assistance, housing programmes, and energy system in Bulgaria. It does not propose a definition or method of measuring energy poverty, but expresses the position that there should be a definition, that it can use the indicators from the subjective approach with data from Eurostat, and that when developing a definition in Bulgaria, it should to take long-term social determinants of poverty such as «chronic illness,

disability, retirement and long-term unemployment, as well as number of household members». It is recommended to use good practices from EU countries and adapt them for national specifics.

In 2016, Shopov analyzed energy poverty through the prism of current targetted social assistance and the shortcomings of the system for covering the specifics of energy-related poverty (Shopov, 2016). The individual indicators for measuring energy poverty according to the expenditure approach are analyzed, and it is concluded that there is no, and is not being sought for, a unified definition in practice in the EU countries.

In the same year, Slavkova analyzed the energy-poverty policies in Bulgaria (Slavkova, 2016), making an overview of the measurement indicators, and emphasized the main problem: the inaccessibility of energy, the mass use of solid-fuel stoves by households, the discrepancy between the required amount of energy and the actual amount used. She concluded that all metrics used in Western European countries would be appropriate if they account for the financial unaffordability of energy, inefficient housing and low incomes.

In 2017, Shopov presented a comparative assessment of energy poverty in the country compared to the EU-27 average (Tsanov, Shopov et al., 2018), based on a composite indicator proposed by Healy (Healy, 2004), including three indicators from the objective approach of Eurostat research on income and living conditions: share of the population living in a home with a leaky roof; damp walls; foundations; broken or rotten windows, doors, floors; share of the population with arrears on household bills; a population with great financial difficulties in maintaining the home; and share of the population that cannot heat their home normally. The comparative assessment showed that, despite Bulgaria's stable trend towards improving indicators, the distance compared to the average European level is more than two times. A lag in policies to combat energy poverty, a lack of their clear and comprehensive identification, were noted, and with regard to the measurement indicators, it was concluded that the expenditure approach is more suitable for Bulgarian practice, but requires clarification of methodological issues such as scope of expenses, scope of income, type of expenses, etc.

In 2017, Peneva measured energy poverty according to the expenditure approach with actual cost, and developed typical and modelled energy cost with four types of indicators: *10% rule*, *Low income/High cost*, *After-energy-costs Poverty*, and *Minimum income standard* (Peneva, 2021). Advantages and disadvantages for each indicator were emphasized, and a factor analysis with binary logistic regression was made, establishing the relationship of energy poverty with the type of heating and the number of persons in the household, and the incomes being able to lead out of poverty at that time, only if they were several hundreds of leva. On this basis, four definitions were proposed in the conclusions, and the main characteristics of each of them were summarized. This analysis was based on data from 2014 and used net cash income as the income indicator. The monograph concludes that the indicator of «*After-energy-costs Poverty*» best reflects the situation in Bulgaria, while the problem of the type of expenditure remains unresolved, despite the proposed several options and the analysis of the advantages and disadvantages of each of them. This monograph makes for the first time a proposal about fixing what typical spending is, by summarizing practice and patterns in Britain, Australia and the USA, and exploring the possibility of simplified application with data available from the NSI's Annual Household Budget Survey.

In 2017, Kulinska analyzed the available definitions of energy poverty in Bulgarian and European legislation (Kulinska, 2017), criticizing the lack of clarity regarding the terms used and the need for a clear definition. The analysis uses data on primary and final energy intensity of GDP, harmful emissions into the atmosphere, electricity consumption per person, electricity imports and exports, and reaches the conclusion that when developing energy-poverty policies for energy-efficiency purposes, there is need for studies on household energy-consumption behaviour to be included.

A 2018 article by Shopov and Peneva provides a detailed analysis of targetted heating subsidies as part of measures to reduce energy poverty, and summarizes possibilities of developing policies in this direction (Shopov, Peneva, 2018).

The Centre for Energy Efficiency Eneffect published an analytical rationale in 2019 (EnEffect, 2019), reviewing the definitions of energy poverty in other countries, and recommending the use of a combination of direct measurement indicators, namely the *expenditure approach* (with three main components to measure energy poverty: low household income, high energy prices and poor energy performance of buildings and heating systems) and the *subjective approach*. In the expenditure approach, the Eneffect Centre proposed the inclusion of absolute and relative measures, not specifying the absolute measures, but as for the relative measures – they listed *10%-indicators, Low income/High cost, Median/Average of costs*. In conclusion, they proposed the definition of poverty after typical energy expenditure, supported by the Centre for the Study of Democracy, which has also published a number of opinions and positions on the subject.

In subsequent analyses of energy poverty by Kisyov (Kisyov, 2020; Kisyov, 2021), and Ilieva (Ilieva, 2021), the main emphasis was put on the requirement to comply with the EU recommendations regarding the definition and monitoring of energy poverty and energy efficiency, with compliance with the proposed measurement indicators, but the analysis was more focused on developing a holistic mechanism of policies to reduce energy poverty. In this direction, a paper by Lazarova (Lazarova, 2020) analyzed the overall policy of civil energy cooperatives with a focus on energy poverty, and measured the effect of their introduction at the national level on energy poverty according to the expenditure approach. An analysis by Jeliaskova (Jeliaskova et al., 2021) on the vertical and horizontal consistency of energy poverty policies in Bulgaria showed a moderate consistency in vertical tracking of the quality of the provided targetted aid for heating, and a lack of horizontal consistency and even policy blocking in the field of environmental protection and energy due to unresolved problems of energy poverty.

In response to the theoretical presentation, it can be summarized that the researchers in Bulgaria share the general opinion that the expenditure approach is the most adequate for the needs of the country, and some of them propose a composite index for monitoring. There is a

consensus that it is important to analyze the methodological problems in measuring energy poverty, by developing an adequate methodology for a norm/standard of energy consumption, and to set upper income limits.

The problem of unresolved methodological issues was raised by Jeliaskova (Jeliaskova, 2020; Jeliaskova et al., 2021), concluding that the absence of a definition in the EU leads to even contradictory results in the Member States, and a lack of adequate support and sufficient solutions to the problem. The report recommends that measurement should not be limited to energy-saving indicators, but must develop individual practices, and must be adopted a holistic approach that includes the causes of energy poverty, with a specific set of indicators. Very important advice in the report is the recognition of energy as a human right.

In this sense, the present study goes deeply into the essence of thresholds and costs, and resolves a large part of the methodological issues that have remained unexplained so far by the scientific circles in the EU and Bulgaria, and provides a proposal with concrete indicators for a measurement that can give the most suitable assessment of the energy status of Bulgarian citizens.

EU regulatory requirements on energy poverty

Since the early 2000s, the European Union has set requirements to protect vulnerable energy consumers with directives establishing transparency and fair competition in the electricity and natural-gas markets, establishing minimum energy-efficiency requirements for buildings, and requiring energy-class labels on electrical appliances. Directive 2003/54/EC³ of the European Parliament and of the Council of 26 June 2003 on general rules for the internal electricity market requires guaranteed pro-

³ <https://eur-lex.europa.eu/legal-content/BG/TXT/PDF/?uri=CELEX:32003L0054&from=en>

tection of the rights of small and vulnerable customers. The requirement to protect vulnerable consumers in the conditions of the internal electricity market is introduced. An explicit requirement for the protection of vulnerable consumers is also introduced in Directive 2003/55/EC for the gas market.

Moving out of the framework of «energy vulnerability» and into the broader context of «energy poverty» and subsequent policies only began after 2010, and specific measures were required after 2015. The term ‘energy poverty’ gained formal recognition in the **Third Energy package of the European Commission (EC)** in the year 2009. The directives 2009/72/EC (EC 2009a) and 2009/73/EC (EC 2009b) on the internal markets in electricity and gas recognize energy poverty as a growing problem in Member States and invite affected countries to develop national action plans. The directives require Member States to create a concept for vulnerable groups that are affected by energy poverty and to prohibit the exclusion of such customers at critical times.

In 2010, despite previous requests from the European Parliament to the European Commission for a definition of ‘energy poverty’ from 2008 and 2009, the Commission came out with an official opinion that at this stage it did not consider it appropriate to propose a European definition of energy poverty or of vulnerable consumers, due to the different situations of consumers.

In 2012, Directive 2012/27/EU on energy efficiency was published which recognized the importance of removing financial constraints for vulnerable consumers and targetted funding of energy-efficient programmes for the prevention of energy poverty.

In 2013, the European Economic and Social Committee published an Opinion (EESC, 2013) **«For coordinated European measures to prevent and combat energy poverty»** developed on its own initiative, and aimed at protecting citizens from energy poverty, taking actions to reduce structural factors leading to vulnerability, and encouraging everyone to assume their responsibilities regarding the use of energy resources from renewable and sustainable sources. The opinion is a key moment in the development of EU policy on energy poverty, as it calls for estab-

lishing a European Energy Poverty Observatory, the harmonization of statistics to better identify the problem and the definition of European energy poverty indicators. The Opinion recommends the creation of a European Energy Solidarity Fund. By the beginning of 2022, all this has already become a fact.

Energy poverty monitoring was mentioned for the first time in 2015 in a Resolution of the European Parliament on the achievement of the European Energy Union. The Commission calls on Member States to submit an annual report on the implementation of the Energy Union, including detailed information on the implementation of energy legislation, progress made towards the 2020 and 2030 targets, and to develop and update a set of key indicators to be included in the report and to allow an assessment of progress towards the Energy Union.

«These indicators could include, but are not limited to, interconnection capacity, market integration, reduction of energy imports, degrees of diversification, energy prices and costs, development of community and citizen-owned energy production, levels of energy poverty and vulnerability», noted the conclusions of the Energy Council of 26 November 2015.

Meanwhile, energy poverty, in the sense of affordable energy for all, is set as goal No. 7 in the 17 goals for sustainable growth⁴ of the European Union with dimensions up to 2030, as proposed by the United Nations.

In 2016, the European Commission introduced the **«Clean Energy for All» package**, in order to ensure the necessary legal framework for the implementation of the objectives of the Paris Agreement. In December 2018, four of the package's eight dossiers were formally adopted and political agreement was reached on the remaining four. Of these packages, energy poverty requirements are directly related to building energy-efficiency requirements and the new energy market rules oblige the Member States to measure and monitor energy poverty and report to the Commission every two years.

⁴ Goal 7 for sustainable growth: ensure access to affordable, reliable, sustainable and modern energy for all.

Such measurement and monitoring requires common indicators and research so that there is comparability across EU Member States. A challenge for this is the differences in the conducted national surveys of household budgets, with different indicators, as well as the insufficient number of indicators in the Eurostat survey on living conditions and incomes of the population (SILC – Survey on Income and Living Conditions), which has been conducted since 2004 in Bulgaria too.

Therefore, in 2018, the Observatory of Energy Poverty was established in Brussels, which specifically deals with the task of harmonizing the indicators for monitoring energy poverty. In the same year, Regulation (EU) 2018/1999 of the European Parliament and of the Council and the recast Electricity Directive by the Commission required Member States to provide indicative guidance on appropriate indicators for measuring energy poverty (Article 3(3) (d)). This requirement is strengthened with the inclusion of Art. 29 in Directive (EU) 2019/944 with the requirement to also provide indicators regarding the definition of «significant number of households in a situation of energy poverty».

In 2020 the Energy Poverty Observatory developed and published **Commission Recommendation (EU) 2020/1563 of 14 October 2020 on energy poverty** (EU, 2020). It highlights the need to define and tackle the problem in order to implement the measures in the Green Deal to renovate private and public buildings to meet the requirements of the Third Energy Package «Clean Energy for All» and to include assessment in national energy and climate plans. Of particular note is the definition of energy-poor households in national long-term remediation strategies.

In this regard, the Recommendation directs to a selection of four applied groups of indicators, and requires the development of measures and the implementation of social policies and an increase in energy efficiency. The need to allocate public financing, especially free of charge, to direct the funds to low-income households with limited own resources and access to commercial loans is emphasized. The table below presents the four groups of energy-poverty assessment indicators.

Table 1.1: Indicators for the assessment of energy poverty
in the EU Recommendation

Group	Specifics	Dimensions
<i>Indicators comparing energy cost</i>	Quantification of energy poverty	Percentage or number of households that spend more than a certain share of their disposable income on domestic energy services
<i>Indicators based on self-assessment</i>	Subjective assessment of the extent to which households feel they are able to afford energy	Ability to keep their home sufficiently warm in winter and sufficiently cooled in summer
<i>Indicators based on direct measurement</i>	Physical variables for determining the adequacy of energy services	Room temperature
<i>Indirect Indicators</i>	Related Factors	Overdue utility bills Number of interruptions

Source: Commission Recommendation (EU) 2020/1563 of 14 October 2020 on energy poverty

Requirements of the European Green Deal on energy poverty

With the adoption of the European Green Deal, radical changes in energy poverty policies are set in motion, requiring Member States to make a number of legislative and administrative changes to fulfil the goals of the pact. The goals are secured also with appropriate funding. The European Commission envisages that 458 million euros from the European budget will be set aside for Bulgaria between 2021 and 2027 to help it make the transition to a cleaner economy.

With the adoption of the Green Deal, EU Member States are committed to developing long-term strategies and roadmaps to renew the housing stock and make energy savings in every sector, including buildings. One of the leading programmes of the Green Deal is precisely «Renovation of buildings», with the goal of doubling or tripling the rate of renovation of buildings, which at the time of the adoption of the document was about 1% (for all buildings) (European Commission, 2019).

For the development of the strategy, there is a specific document – **Recommendation (EU) 2019/786 of the Commission on building renovation** (EU 2019), and in the part «Review of policies to increase the efficiency of the building stock», monitoring is required in several aspects, such as the indicators for energy poverty are:

- 1) percentage of people affected by energy poverty;
- 2) share of household disposable income spent on energy;
- 3) arrears on utility bills;
- 4) population living in inappropriate housing conditions (e.g. leaky roof) or insufficient heating and cooling.

Requirements of the European Union regarding the liberalization of the household segment of the electricity market

The pressure from the European Union for full liberalization of the energy market, and specifically in the direction of the household segment, is decreasing after the publication of the European Economic and Social Committee's Opinion on «Energy Poverty in the Conditions of Liberalization and Economic Crisis» (EESC, 2010), in which it emphasizes the need for a common definition of energy poverty at the level of the European Union, and harmonization of statistical data in the EU Member States in order to have a more accurate assessment of the situation.

The liberalization of the household segment of the electricity market has been long delayed precisely because of the large number of vulnerable and energy-poor consumers in Bulgaria. The sharp rise in electricity prices on the free market at the end of 2021 has also caused serious concerns for the businesses, industry, and last but not least, the ability of hospitals, dispensaries, clinics, social homes and schools to pay the sharp rise in prices. Various schemes were developed and implemented to compensate the affected organizations and institutions in the conditions of global energy crisis. Temporarily protected, residential customers (households), however, have no guarantee that the terms for liberalization of the electricity market will always be postponed.

At the moment, it is expected that by the end of 2025, all electricity consumers will switch to the free market. The phase-out of the hybrid

model will be implemented with quotas. This is an extremely delicate process that must also be accompanied by clarity about the depth of energy poverty and the vulnerability of consumers to rising prices.

It remains questionable to what extent the 2016 «Mechanism for the Protection of Vulnerable Consumers» developed by the Bulgaria's Ministry of Energy will be fit for the situation today, with rising prices of energy resources and a growing number of vulnerable consumers. Currently, the Mechanism offers a social tariff for electricity in the amount of 100 or 150 KWh of energy per month for nearly 500 thousand individuals and families. However, whether this amount of support and coverage of consumers is adequate, is difficult to assess without a mechanism for assessing the extent and depth of energy poverty.

1.2. Arguments for measuring energy poverty in Bulgaria

Apart from the above-mentioned EU requirements for introducing official energy-poverty indicators, binding the financial instruments for building renovation and energy efficiency with a definition of energy poverty, and monitoring with a report every two years on the state of energy poverty, Bulgaria also has her own prerequisites of a political, economic and social nature, in favour of introducing an official definition.

Politically, Bulgaria has committed to protect vulnerable consumers during the liberalization of the electricity market for household customers and to bind the energy efficiency measures to the Recovery and Sustainability Plan, and the Green Deal.

In the «Integrated plan in the field of energy and climate of the Republic of Bulgaria 2021-2030» published by the Ministry of Energy at the end of 2020, prepared by Bulgaria in accordance with the requirements of Article 20, paragraph 3 of Regulation 2019/943 of 5th June 2019 on the Internal Electricity Market, in Section III 'Retail market', item 4. is noted that:

„The process of full liberalization of the electricity market for household customers is linked to the introduction of a mechanism to protect vulnerable electricity customers in accordance with Direc-

tive 2009/72, revised by Directive 2019/944 on the Internal Electricity Market.”

According to the Opinion of the Institute for Energy Management, for the transposition of Directive 2019/944 at the national level, a commitment has been made with a deadline of 31st December 2021 to define criteria for identifying households in a position of energy poverty given the criteria of the directive such as low income, high energy costs and low energy efficiency. According to the Institute, this will allow an assessment of the number of energy poor according to Article 3, paragraph 3 et seq. of EU Regulation 2018/1999 and to determine possible measures to reduce them.

In 2021 the Government of Bulgaria bound its commitments to act on the issue with the Recovery and Resilience Plan. In part 2B ‘Green Bulgaria’, reform no. 2 aims at *«developing a definition of ‘energy poverty’ for households in the Energy-Efficiency Law for the purposes of financing energy-efficiency projects»*.

Economically the main prerequisites are the constant rise in the prices of energy resources, as well as the upcoming liberalization of the retail electricity market, additional growth being expected even compared to the price increases of 2021 (see Fig. 1.1)

In Bulgaria, there are a high percentage of households heated with electricity, nearly two-thirds, with about 60% of the total energy expenditure spent on electricity, according to an analysis of NSI’s data (see Fig. 1.2). **The rising energy-price trends of recent years show a faster rate than the rate of growth of household incomes of the low and middle decile groups, which inevitably leads to increasing energy poverty.**

In the long term, there are no indications of a reversal of trends. Both nuclear and coal-fired generation capacity is due to be phased out due to the Green Deal commitments. All this will impose additional costs on the state and society for investments in new capacities, which will again be paid for through energy prices. An additional factor for the increase in prices is the carbon tax on the households (in the building and transport sector with the introduction of ETS2), which is about to be introduced.

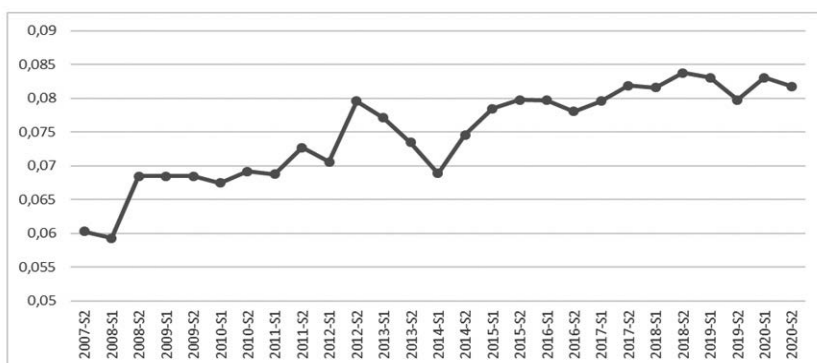


Figure 1.1: Household electricity prices with taxes included, 2007-2020

Source: Eurostat

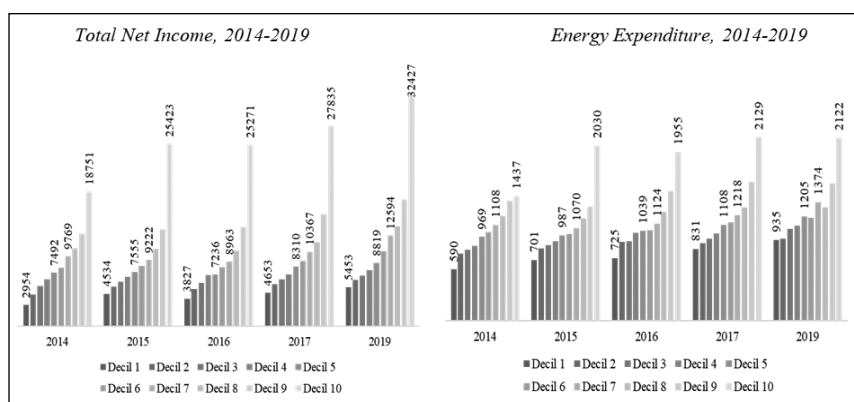


Figure 1.2: Net total household income and energy expenditure by decile groups, BGN/year

Source: NSI, ERI-BAS

Last but not least, the economic crisis related to the coronavirus pandemic, which led to the emergence of new groups of unemployed, as well as additional costs that households had to undertake for medication and health care, and the state expenses to support the unemployed people and the affected sectors.

Socially it is the long-term state of poverty of Bulgarian society, with nearly 22% of the population living at risk from poverty for years. There is a direct relationship between general poverty and energy poverty, and it is important to reflect on how large this relationship is, in which groups it is stronger and in which weaker, and how this relationship changes according to different definitions.

In Great Britain, as a result of an analysis of the relationship between energy poverty and low incomes (Palmer et al., 2008), a concentration of the problem in rural areas was found, and subsequently the policies for energy poverty, energy efficiency and reducing carbon emissions in households are aimed at rural areas, allocating about 30% from the budget of the relevant policy instruments for these purposes (Peneva, 2016).

An important factor for poverty in Bulgaria is the increasing indebtedness of households through taking loans from financial institutions or from relatives and friends. In 2009, BAS conducted a survey, the results of which showed that «87% of the requested loans were taken to satisfy basic needs, while 67% of the withdrawn loans were related to costs intended to maintain the housing infrastructure and satisfy basic needs (Jeliakova, 2009). A large part of the loans were taken out by households with low incomes, up to BGN 600 per month, which represent 46.3% of households at the time of the survey conducted by BAS.

Low incomes and high indebtedness determine the financial constraints of households when implementing the wave of renovation of private buildings from the Green Deal, and thus impose a targetted and differentiated distribution of grant funds.

At the same time, the official poverty line is a possible tool to use for the purposes of the Recovery and Resilience Plan and the Green Deal, but insufficient, for the following reasons:

- 1) High percentage of inequalities in Bulgaria, where a relative method of determining the poverty line does not reflect the depth of the problem.
- 2) A continuous and significant increase in the gap between median and mean household income in the years up to 2019 (Tsanov, 2020).

- 3) Systematic lag of income growth compared to the growth of energy costs in recent years.
- 4) A high percentage of energy expenditure in the net total income of households, which – with an increase in energy prices – leaves households unable to pay for other basic necessities.
- 5) Impossibility of reflecting the growing energy needs of the population at rising prices, due to the lack of a special component for energy costs when determining disposable income, calculated with a quantitative component valued with energy prices on an annual basis.
- 6) The need to rehabilitate 40% of the building stock, with an estimated free financial resource of less than 8%, which necessarily requires a planned adequate distribution of finances. Otherwise, high levels of indebtedness of the population and low incomes can delay, complicate and completely prevent the implementation of climate commitments.

In summary, apart from the long-term underestimated social and economic reasons, which require targetted work with energy-poor households, there are also urgent regulatory reasons for introducing an energy-poverty line in Bulgaria. These are Article 3 of Regulation (EU) 2018/1999 of the European Parliament and of the Council and Article 29 of Directive (EU) 2019/944. Pursuant to Article 3, paragraph 3, letter D of the Regulation, EU Member States are obliged to assess the number of households in a situation of energy poverty, by choosing appropriate indicators for measuring energy poverty and to define the definition of «significant number of households in a state of energy poverty».

When developing a definition, it is important to reflect the following EU requirements:

- Energy-poverty monitoring, with indicators specified in the Recommendation of the European Commission (EU) 2020/1563 of 14th October 2020 on energy poverty;
- Member States report every two years on progress, according to Regulation (EU) 2018/1999;

- Directing the financing of energy-efficiency measures, especially the free ones, to energy-poor households, according to the Recommendation (EU) of the Commission on the renovation of buildings, in the part «Review of policies to increase the efficiency of the building stock».

Thereby, it can be inferred that the assessment of energy poverty should be made on the basis of the indicators recommended by the EU, to be carried out through annual surveys conducted by the National Statistical Institute, and to serve as an assessment of consumers who are entitled to finance under implementation of measures to rehabilitate buildings and increase energy efficiency.

1.3. Dimensions of energy poverty in Bulgaria

There are three main approaches to measuring energy poverty: **1) an objective approach** (based on the consequences of energy poverty: morbidity and mortality); **2) a subjective approach** (also called ‘conceptual’ or ‘consensual’ (Thompson, Snell, 2013; Rademaker et al., 2016), based on respondents’ subjective perception of energy poverty) and **3) expenditure approach** (based on energy costs, household income, and in countries with available data, on their housing characteristics). Within the expenditure approach, multiple indicators are observed to measure energy poverty. **The main indicators used in Great Britain and some countries of the European Union are:**

1) Ten-Percent Rule (TPR) (Boardman, 1991): the share of energy expenditure from the household’s net total income is over 10%;

2) Poverty-after-Energy Expenditure – Relative Poverty Line (RPL) (Hills, 2011): the net total income after energy expenditure of the household is below the poverty threshold;

3) Low Income – High Cost (LIHC)⁵: the net total income after energy expenditure of the household is below the poverty threshold and at the same time their energy expenditure is above the median for the country;

⁵ Ibidem.

4) *Low Income – High Cost Share* (LIHCS) (Pye, Dobbins, 2015): the net total income after energy expenditure of the household is below the poverty line and at the same time the share of energy expenditure in the net total income is over 10%;

5) *Double Median Energy Expenditure* (2M) (Moore, 2012): Household energy expenditure exceeds twice the national median;

6) *Half Median Energy Expenditure* (M/2) (Heindl, 2013): household energy expenditure is below half of the national median;

7) *Double median share of energy expenditure* (2 Median Share – 2MS): the share of energy expenditure from the household's net total income is over twice the median share;

8) *Half of the Median Share of Energy Expenditure* (MS/2): The share of energy expenditure in net total household income is above half of the median share.

The sources of each indicator and analysis of advantages and disadvantages are presented at the beginning of this chapter, on page 22-24 in the theoretical framework of the topic.

All eight indicators are analyzed for the purposes of the study in order to specify their characteristics applied to anonymized data from Bulgarian households.

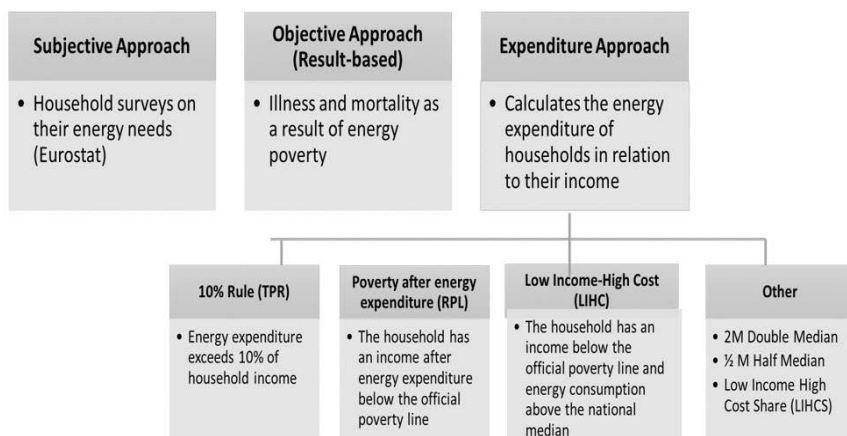


Figure 1.3: Approaches and indicators for measuring energy poverty

The three approaches and several methods of measuring energy poverty are presented in the figure below.

When two or more of the above approaches are applied, the term ‘**combined approach**’ is used⁶.

In order to make a proposal for an official energy-poverty line in Bulgaria, it is necessary to track which of these approaches and indicators have available indicators in the currently existing annual surveys conducted by NSI or other agencies/institutions, and to what extent these indicators can respond to EU requirements for energy-poverty monitoring.

1.3.1. Energy poverty according to the objective approach

The objective approach monitors indicators such as mortality and morbidity due to energy poverty. This approach focuses on the outcome rather than the causes of energy poverty and has little application as a policy tool. This approach has been used mainly in Great Britain, where the above-normal winter mortality rate is investigated. Recently, similar indicators have also been used at the European-Union level, such as pollution/mortality from fine particulate matter (FPM), frequency of respiratory diseases in winter, etc. In Bulgaria, there is limited research, and only variants of indicators such as pollution caused by fine particulate matter and mortality due to respiratory diseases. There is no research involving a direct relationship of these indicators with energy poverty.

In Bulgaria, an increase in emissions of FPM_{2.5} was observed in the period from 1990 to 2019 from 23 kt to 30 kt, which, according to the Bulgarian Ministry of Environment and Water, is mainly due to the increase in emissions from the burning of fuels in the household sector (EEA, 2019). Household heating accounted for 54% of emissions of the total amount of FPM₁₀ and 77% of FPM_{2.5} released into the atmosphere in 2019.

⁶ Ibidem.

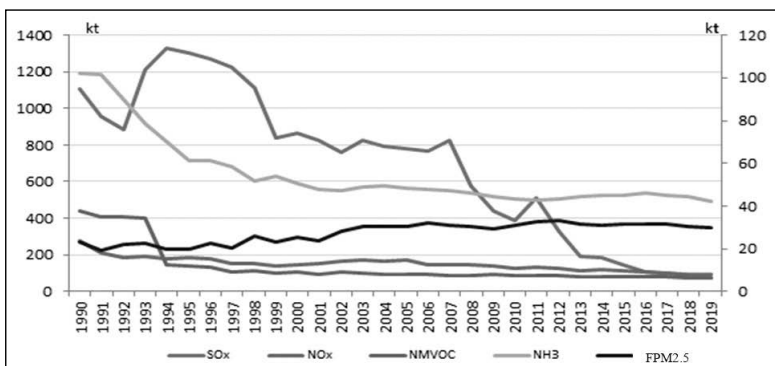


Figure 1.4: Emissions of major pollutants

Source: NSI and EEA, Ministry of Water and Environment of Bulgaria

The link between this indicator and energy poverty was confirmed by data monitoring the budget of households, which showed that in the period 2014-2019, the relative share of household expenditure on solid fuel had been increased, especially among low-income households. This factor is discussed in detail in Chapter 2. The impact of particulate matter on human health is described by the Environment Executive Agency (EEA). Below figure 1.5 includes data on deaths caused by respiratory diseases, which also increased in the observation period of 2014-2019.

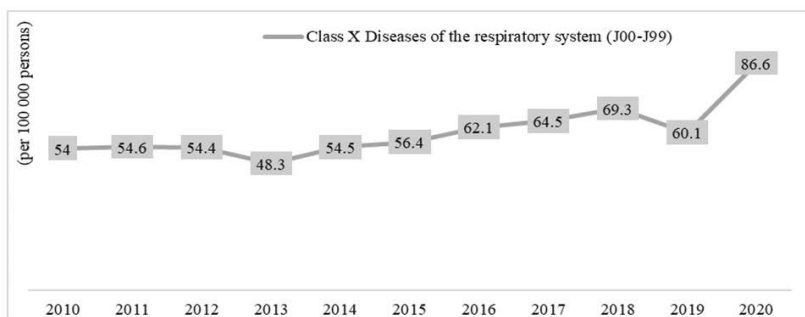


Figure 1.5: Mortality caused by diseases of the respiratory system

Source: NSI

The application of this approach is limited because there is a lack of scientific and empirical basis to establish the causal relationship of energy poverty with the relevant diseases. It can be seen that in 2020, as a result of the coronavirus pandemic, the death rate from diseases of the respiratory system increased sharply, therefore this indicator is also difficult to be perceived as a consequence of energy poverty only, without taking into account the other factors that have an impact on it. In order to make them suitable for energy-poverty purposes, morbidity and mortality indicators should be introduced into a single database with indicators of energy expenditure, household income and energy efficiency of buildings.

Therefore, there are mainly two approaches – the expenditure one (related to energy costs) and the subjective one (termed also consensual or conceptual) (Rademaekers et al., 2016).

1.3.2. Energy poverty according to the subjective approach

The subjective (conceptual, consensual) approach provides information on current energy needs, subjectively determined by the households themselves through surveys. It includes indicators of the number or percentage of households that succeed or fail to keep their home adequately warm, have difficulty paying their energy bills on time, and have severe difficulties with their utility bills. These indicators are included in the *Survey on household incomes and living conditions* in the Eurostat survey (SILC) as part of the indicators of material deprivation. They were officially approved and added to the set of social inclusion indicators at the EU level only after 2009.

According to the subjective approach, which is most often cited in EU political documents, energy poverty in Bulgaria has decreased in the last few years after 2011. The Eurostat statistics report a sharp drop in the range of the population unable to keep the home adequately warm (Figure 1.6) – from 67% in 2010 to 46% in 2011 and a smooth decline in the remaining few years to 27.5% in 2020 without any significant changes in the survey methodology. At the same time, the percentage of households in homes with leaks, damp and rotting has fallen sharply from levels of nearly 30% by 2008 to 23.9% in 2009, 15.4% in 2010, and a smooth de-

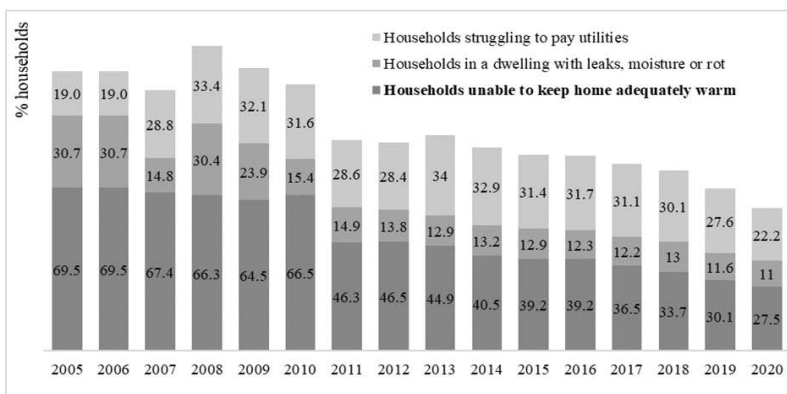


Figure 1.6: Energy-poverty indicators from a SILC study on Bulgaria

Source: Eurostat

cline to 11% in 2020 .A total energy poverty index composed of the three indicators in Figure 9 shows a decline from 119.2% in 2005 to 61.7% in 2020, or nearly twice. **The objectivity and reliability of these statistics remains questionable, given the ineffective reflection of changes in income, and the lack of implemented policies with the potential to double the condition of Bulgarian citizens over the past 15 years.**

At the same time, energy poverty in Luxembourg and some other EU countries, which recorded the lowest levels in 2010, more than doubled by 2019. With the change in statistics of the survey of income and living conditions, the differences in energy-poverty levels between EU countries are decreasing. Despite Eurostat's trends for convergence with regard to the above indicators, Bulgaria remains again with the highest level of energy poverty in the EU according to the subjective measurement approach.

1.3.3. Energy poverty according to the expenditure approach

Trends in the development of energy poverty, calculated by using the expenditure approach for the last six years to 2019 show **a relative stability of the share of energy poor in the observation period, a slight increase in energy poverty in 2016 and a decline in 2017. For the**

whole period, there was a minimal increase in the percentage of energy poor at the end of 2019 compared to the baseline in 2014, despite the different changes over the years reflected by the different indicators. A more stable level is observed over the five years of observation for indicators that include only energy expenditure (2M, M/2 and LIHC may also be included due to income restrictions), a decline according to indicators applying the official poverty line after expenditure on energy (2 and 4 in Figure 1.7) and a slight increase according to the *Ten-Percent*

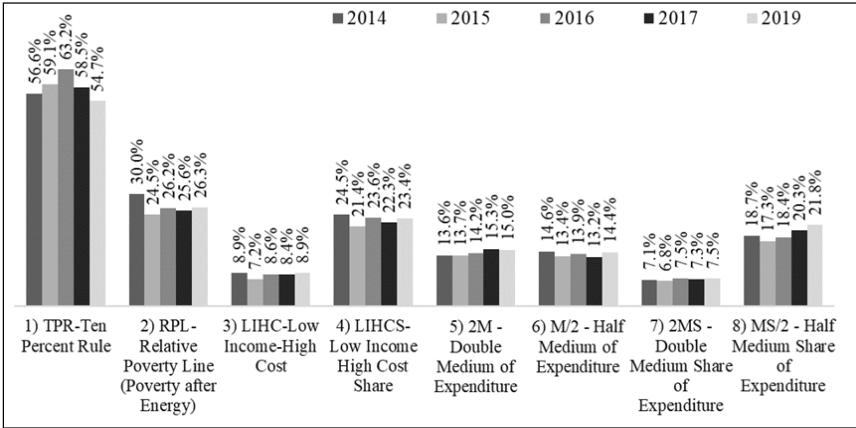


Figure 1.7: Energy poverty at a poverty line of 60% of the median equivalent net total income of the sample (Survey of Household Budgets)⁷

Source: Own calculations in compliance with NSI data

⁷ Households are energy-poor if: **1)** The share of their energy expenditure from net total income is over 10%; **2)** Net total income after energy expenditure is below the poverty line; **3)** Net total income after energy expenditure is below the poverty line and at the same time their energy expenditure is above the median for the country; **4)** Net total income after energy expenditure is below the poverty line and at the same time the share of their energy expenditure in net total income is over 10%; **5)** Their energy consumption exceeds twice the median for the country; **6)** Their energy consumption is less than half of the national median. **7)** The share of their energy expenditure from net total income is more than twice the median share; **8)** The share of their energy expenditure in net total income is above half the median share.

Rule' in the first three years until 2016, including a decrease in the last two years until 2019.

The trends of decline or increase in energy poverty with this approach cannot be interpreted unambiguously without clarifying important methodological issues, such as the used poverty threshold in one and the other figure, such as changes in expenditure and income, etc. If the official poverty line of the Eurostat's SILC survey is applied to the Household Survey sample, the results of the indicators using a poverty line change (indicators for *Poverty after energy expenditure*, *Low income - high cost* and *Low income - high cost share*, seeing an expansion of the energy poor due to the higher threshold and a minimal increase in energy poverty over the period in four of the eight indicators. The influence of different methodological aspects is analyzed after the statistics in Figure 1.8.

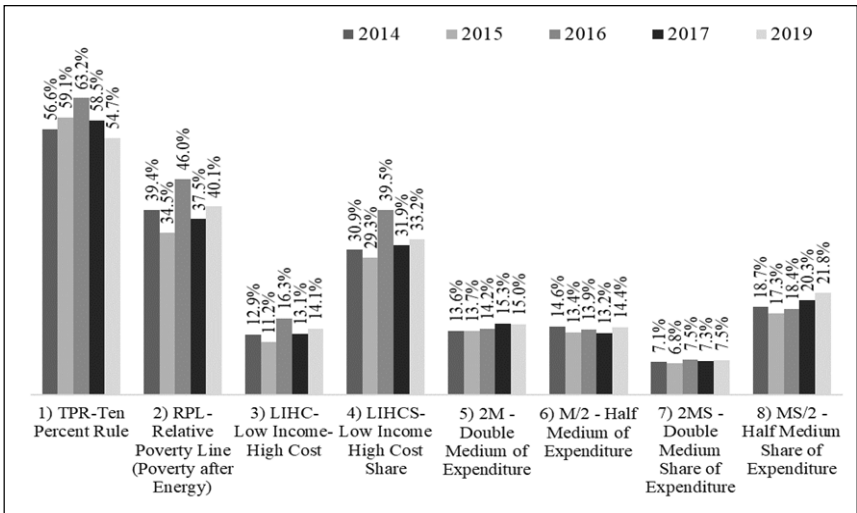


Figure 1.8: Energy poverty at the official SILC poverty line⁸

Source: Own calculations in compliance with NSI data

⁸ The official poverty line for the country from the Eurostat's SILC survey and from a sample of the *Household Budget Survey*.

All indicators show an increase in energy poverty in 2016, and then a slight decline according to the indicators containing the income component, while for the indicators where the energy expenditure component is leading (2M and M/2) or the expenditure is below the median for the country, minimal growth was observed in 2017 and 2019 as well.

- According to the *Ten-Percent Rule*, energy poverty in Bulgaria fluctuated at around 58% in the period 2014-2019, with an increase of up to 2% per year until 2016, and then a decline of over 4% in 2017 and another nearly 4% in 2019 compared to 2017. Calculations with this indicator show the highest volatility of the range of the energy-poor with changes in income.
- According to *Poverty-after-Energy Expenditure*, the range of energy-poor fell from 30% in 2014 to 23.4% in 2019, being slightly higher in 2016 than in 2015, due to the higher poverty threshold.
- According to *Low Income – High Cost*, the range of the energy-poor did not change significantly during the observed period, falling by nearly 1.7% in 2015 compared to 2014, and then varying around 8.6% of all. This indicator concerns only households with very high energy consumption above the median and below the poverty line. This type of behaviour is not typical of Bulgarian households, which usually take different kinds of measures in order to be able to afford other necessities other than energy.
- According to *Low Income – High Cost Share* the trends are very similar to those of the *Poverty-after-Energy Expenditure* indicator, with the overall decrease in energy poverty from 2014 to 2019 being much less, and is less related to the income.
- According to *Double Median Energy Expenditure*, the percentage of households in energy poverty rose slightly from 13.6% in 2014 to 15.0% in 2019 with smooth but steady growth, which signifies that more households can afford higher energy expenditure.
- According to *Half Median Energy Expenditure*, a stable range of 14.4% of households with energy expenditure below the national median is observed. In 2015 and 2017, there was a slight decline to 13.4% and 13.2%, respectively, but then it rose again.

- According to *Double Median Expenditure Share of Income*, energy poverty rose slightly from 7.1% in 2014 to 7.5% in 2019, reflecting annual changes in other indicators as well, with slightly higher growth in energy poverty in 2016

The comparison of the range of energy poverty according to the different indicators shows the highest range of this poverty calculated according to the *Ten-percent rule* and a similar range (11% - 16%) according to the indicators *Low income - high cost*, *Double median expenditure* and *Half the median cost*. From the viewpoint of defining energy poverty and the policies to limit it, this circumstance is of essential importance, since the choice of the indicator depends on what will be the officially accepted definition of energy poverty, the scope of the policies, including the burden on public finances related to policies' implementation (Shopov, 2016).

The analysis of the scope of energy poverty by decile groups with a focus on the first three decile groups in Table 1.2 allows the following conclusions to be drawn:

- Zero (or close to zero) energy poverty in deciles with high incomes for indicators using a poverty threshold: *Poverty-after-energy Expenditure*, *Low Income – High Cost*, *Low Income – High Cost Share*.
- High concentration of the energy-poor in the lowest deciles of the definition *Poverty- after-Energy Expenditure* and of *Low Income – High Cost Share* (first four deciles).
- Indicators with double medians, either of expenditure or share of expenditure, report a rise in coverage with income, following an inversely proportional trend in poverty.
- Increasing inequalities. The percentage of energy poor households in the top three deciles increased from 2014 to 2019, regardless of whether the overall percentage decreased or increased (except for the *Poverty-after-Energy Expenditure* indicator, where there was a 1% decrease in energy poor households from the top three decile groups at the end of the period).

Table 1.2: Energy poverty by decile groups according to the expenditure approach

	1) TPR	2) RPL	3) LIHC	4) LIHCS	5) 2M	6) M/2	7) 2MS	8) MS/2
2014								
Decile 1	4.2%	5.0%	0.7%	4.2%	0.2%	2.3%	1.0%	0.2%
Decile 2	4.9%	6.1%	1.7%	4.9%	0.3%	1.8%	0.9%	0.3%
Decile 3	5.4%	7.1%	2.2%	5.3%	0.4%	1.6%	0.6%	0.7%
Decile 4	5.7%	5.3%	1.8%	4.2%	0.5%	1.5%	0.7%	1.0%
Decile 5	5.9%	3.1%	1.2%	2.8%	0.8%	1.7%	0.8%	1.4%
Decile 6	6.9%	2.2%	0.7%	2.0%	1.2%	1.5%	0.9%	1.6%
Decile 7	6.1%	0.8%	0.4%	0.8%	1.4%	1.0%	0.5%	1.9%
Decile 8	6.0%	0.3%	0.2%	0.3%	1.8%	1.4%	0.7%	2.2%
Decile 9	6.3%	0.0%	0.0%	0.0%	2.6%	0.9%	0.5%	3.4%
Decile 10	5.3%	0.0%	0.0%	0.0%	4.2%	0.9%	0.3%	6.0%
All Households (%)	56.6%	30.0%	8.9%	24.5%	13.6%	14.6%	7.1%	18.7%
Decile 1-3 (%)	14.5%	18.2%	4.6%	14.4%	1.0%	5.7%	2.5%	1.3%

2019								
	1) TPR	2) RPL	3) LIHC	4) LIHCS	5) 2M	6) M/2	7) 2MS	8) MS/2
<i>Decile 1</i>	5.1%	6.0%	1.7%	4.9%	0.4%	2.0%	1.1%	0.6%
<i>Decile 2</i>	6.5%	6.1%	1.6%	5.1%	0.5%	2.6%	1.1%	0.9%
<i>Decile 3</i>	7.3%	5.2%	1.6%	4.7%	0.8%	2.0%	1.2%	0.9%
<i>Decile 4</i>	7.4%	4.3%	1.4%	3.9%	1.0%	2.2%	1.3%	1.5%
<i>Decile 5</i>	7.0%	2.9%	1.1%	2.8%	1.3%	1.9%	0.9%	1.3%
<i>Decile 6</i>	5.7%	1.2%	0.9%	1.2%	0.7%	1.0%	0.8%	1.8%
<i>Decile 7</i>	4.7%	0.5%	0.4%	0.5%	1.5%	1.0%	0.5%	2.0%
<i>Decile 8</i>	4.2%	0.1%	0.1%	0.1%	1.3%	0.7%	0.3%	3.2%
<i>Decile 9</i>	4.3%	0.0%	0.0%	0.0%	2.7%	0.6%	0.2%	3.7%
<i>Decile 10</i>	2.6%	0.0%	0.0%	0.0%	4.8%	0.3%	0.0%	5.9%
All Households (%)	54.7%	26.3%	8.9%	23.4%	15.0%	14.4%	7.5%	21.8%
Decile 1-3 (%)	18.8%	17.2%	4.9%	14.8%	1.7%	6.6%	3.4%	2.4%

Source: Own calculations in compliance with NSI data

- The percentage of households using more than 10% increases with income under the *Ten-Percent Rule* in 2014, which can be interpreted as increasing the opportunity to spend more on energy as income increases. This hypothesis is confirmed for *Double Median Energy Expenditure (2M)*, which clearly shows the increase in the percentage of households spending more than twice the median energy expenditure as income increases.

To track how each indicator reflects the lowest income decile groups, their share of all households and their share of energy poor households are plotted in figure 1.9.

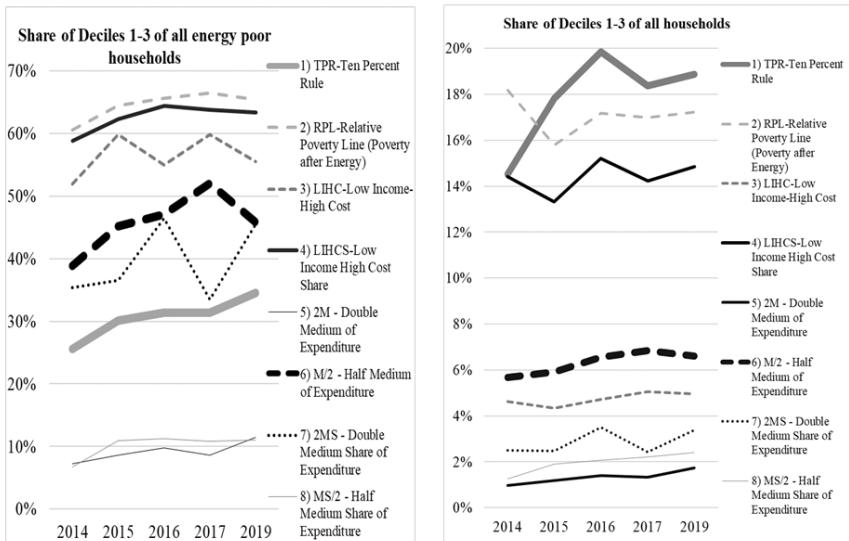


Figure 1.9: Share of energy-poor households in the first three decile groups relative to the rest and relative to all households

Source: Own calculations in compliance with NSI data

The '*Poverty-After-Energy Expenditure*' indicator covers the largest percentage of the lowest income households, as well as '*Low income – high cost share*'.

Indicators with median values 2M, M/2, MS/2 register very low percentages of low-income households, and do not particularly clearly report the growth in energy poverty in 2016, with an increase in consumption for the entire sample by 5% and a decrease in income by 1.5%. The only exception is the 2MS indicator - double median of the share of energy expenditure, which registers the largest deviations on an annual basis together with the *Ten-Procent Rule*. The *'Low Income – High Cost'* indicator shows the opposite trend of the others: a decrease in the percentage range of the energy-poor from the low decile groups in 2016.

Methodological features of the expenditure approach

With variable sample size each year, as well as the median income reported by the NSI, the median annual energy expenditure of the sample of households is shown in Table 1.3:

Table 1.3: Sample parameters of Household Budget Monitoring

	2014	2015	2016	2017	2019
Number of households	2956	2957	2946	2958	2951
Number of people in households	7193	7056	6939	6936	6446
60% of the median income /in BGN/, according to NSI	3225	3162	3113	3506	3962
Official poverty line, /in BGN/, according to SILC	3910	3698	4213	4213	4956
Median energy consumption /in BGN/	885	922	972	990	1065

Source: NSI, own calculations

In order to correctly interpret the energy-poverty indicators, it is necessary to clarify and refine methodological issues that lead to different results. They can be summarized in the following few aspects:

- 1) Components of energy-poverty indicators;
- 2) Choice of poverty line (from the survey of household budgets of NSI or of SILC-Eurostat/NSI) and energy-expenditure threshold;
- 3) Equalizing income and energy costs per person/household with equivalent scales;
- 4) Determining the typical energy consumption of households;
- 5) Other issues: extreme values, negative income and costs, zero-energy values, statistical data weights, reporting period.

1) Components of energy-poverty indicators

Using each definition, an energy-poverty indicator is created, where the energy-poor are denoted by one (1) and the others by zero (0). The following formulae are applied to assess whether a household is energy-poor:

- EP=1, if $EE/NOD > 10\%$ (Ten-percent rule)
- EP=1, if $NOD - EE < OPL$ (Poverty-after-energy expenditure)
- EP=1, if $NOD < OPL$ и $EE > \text{median } ER$ (Low income – High cost)
- EP=1, if $NOD < OPL$ и $EE/NOD > 10\%$ (Low income – High energy cost share)
- EP=1, if $EE > 2 * \text{median } EE$ (Double Medium of Expenditure)
- EP=1, if $EE > \text{median } EE/2$ (Half Medium of Expenditure)
- EP=1, if $EE > 2 * \text{median } EE/NOD$ (Double Medium of the Share of Expenditure)
- EP=1, if $EE > \text{median } EE/NOD/2$ (Half Medium of the Share of Expenditure)

Where:

EP – household energy poverty

EE – energy consumption of the household

NOD – net total household income

OPL – official poverty line/poverty threshold for the relevant year.

Table 1.4: Components of energy-poverty indicators

	Net Total Income	Poverty Line	Energy Expenditure	Expenditure Share
1) Ten-percent rule	√			√
2) Poverty-after-energy expenditure	√	√	√	
3) Low Income – High Cost	√	√	√	
4) Low Income – High Cost Share	√	√		√
5) Double Median Cost			√	
6) Half Median Energy Expenditure			√	
7) Double Median Share of Energy Expenditure	√			√
8) Half the Median Share of Energy Expenditure	√			√

Table 1.4 can be used to explain the presence or absence of dynamics in the level of energy poverty compared to the previous one (annual growth/decrease). It can be concluded that **indicators where energy expenditure is below the median (#3 Low income – high cost and #6 Half Median Energy Expenditure) are least affected by changes in income**. These are the households with so-called ‘hidden poverty’, which do not consume enough of their energy to be able to pay their bills. However, this does not apply if the income component is included, significant deviations are observed for indicator #8 Half the Median Share of Energy Expenditure. The dynamics in energy poverty of these indicators is indicated by a dotted line in figure 1.10.

Changing the poverty line from the sample to the SILC survey, which is higher, automatically increases energy-poverty levels as more people fall below the poverty line. Despite the greater growth in the share of energy-poor households in 2016 and the larger drop in 2017, the indicators without the income component remain the most stable – 2M and M/2.

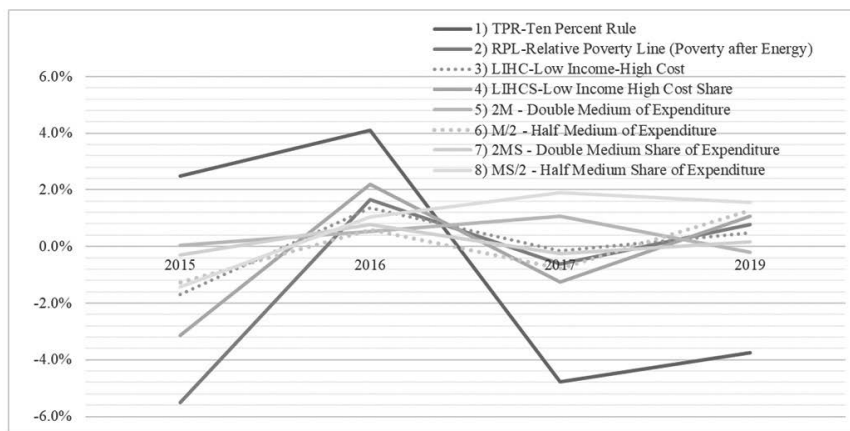


Figure 1.10: Growth/decrease in energy poverty compared to the previous year, in %, at poverty line calculated from the sample

Source: Own calculations in compliance with NSI data

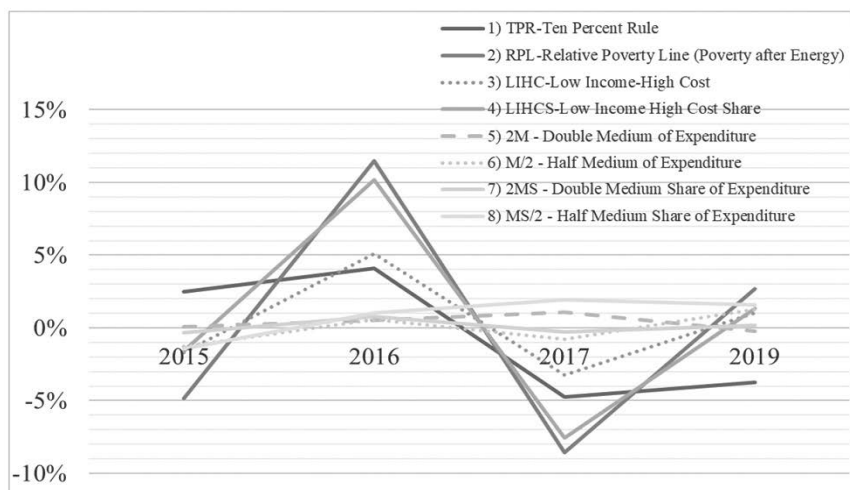


Figure 1.11: Growth/decrease in energy poverty compared to previous year, in %, at the official SILC poverty line

Source: Own calculations with NSI data

2) Choice of poverty line and energy-expenditure threshold

Choice of poverty line and study of the energy-poverty monitoring

In principle, the poverty line should not be a matter of choice. In Bulgaria, the official poverty line is based on data from the Eurostat's survey of incomes and living conditions –SILC. Despite the number of advantages of this study, the main problem is the lack of energy costs, both in total and by type of energy carrier, which makes it impossible to apply the expenditure approach. In this case, for the purposes of the study, it is considered most logical to use the poverty line from the study sample itself, since the costs are taken in proportion to the income status of the sample. However, when introducing an official energy-poverty line, the threshold should be applied as an income criterion, and its choice may also depend on other factors.

Table 1.5 below presents a comparative analysis of the possibilities and limitations of the two studies for the purposes of official measurement and monitoring of energy poverty.

Table 1.5: Comparative analysis of studies for the purposes of an official energy-poverty line in Bulgaria

SILC (Eurostat)	Household budget survey (NSI)
✓ The total sample size for 2020 is 9,052 households; ✓ It is used in determining the official poverty line in the country; ✓ Contains elements of the subjective (consensus) approach;	✓ As of 2010, the sample size is 3,060 households ✓ Contains annual energy consumption; ✓ Contains energy costs by type of heating; ✓ Contains a number of other expenses (for food, water, medication, etc.) with the possibility to upgrade the poverty analyses;
✗ Does not contain annual energy consumption; ✗ Does not contain energy costs by type of heating; ✗ Does not contain a question about the main type of heating; ✗ Does not contain questions about the energy performance of the home.	✗ Does not contain elements of the subjective (consensus) approach; ✗ Does not contain a question about the main type of heating; ✗ Does not contain questions about the energy performance of the home.

The other special features of the two studies must also be taken into account, such as:

- Ability to track energy efficiency measures with a direct impact on energy costs, respectively – for the presence of cost indicators;
- Possibility of upgrading with indicators for heating and energy characteristics of the buildings: assessment by NSI is required for the administration and costs for each study;
- Ability to combine the subjective approach with the expenditure approach;
- Extent of energy poverty: it is unclear whether there would be differences across studies;
- Research reliability/quality.

Choice of poverty line according to components

Another important element in the choice of definition is the choice of a poverty line composed of income alone and a poverty line composed of income after deducting energy costs. Below are the threshold formulas:

- ❖ Poverty line = 60% of the median equivalent net total income;
- ❖ Energy poverty line = 60% of the median equivalent disposable net total income after energy expenditure.

There are substantial arguments in favour of choosing a threshold definition of the second kind. This threshold was proposed by Hills (Hills, 2011) in a strategy paper presented to the British Parliament by the Secretary of State for Energy and Climate Change commissioned by the Queen in March 2015 (HM Government, 2015). According to Hills, **the poverty line after energy income shifts in a fair way**, by including more households with high energy costs but with an income slightly above the official poverty-line threshold (point A in figure 1.12) and at the same time excluding households with a lower equivalent income but and with much less energy consumption (point B in the figure).

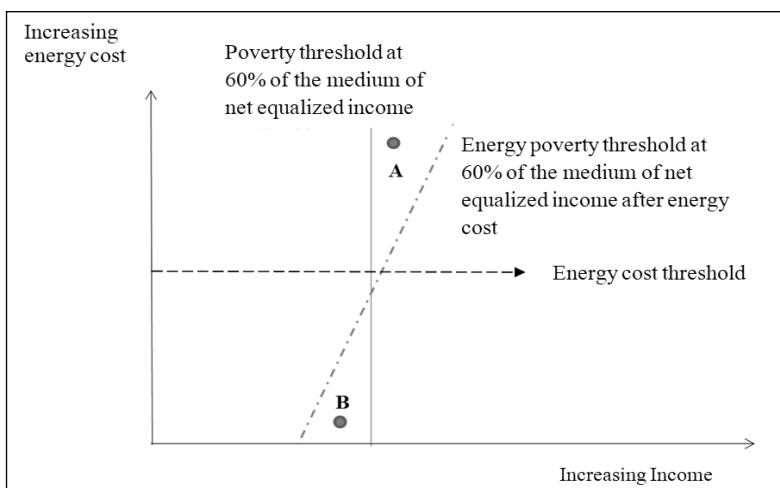


Figure 1.12: Poverty threshold and energy poverty threshold, energy expenditure threshold

Source: Hills, our revision

Choice of energy-expenditure threshold

The dynamics in the median values show a stronger volatility of the share of the expenditure in the net total income, which is clearly visible in 2016, when the sample with households recorded a decrease of 1.5% in the net total income on average compared to 2015. At the same time there is a 5% increase in energy consumption compared to 2015, or 5.4% for the median. In this case, the median value grows by 11.5% compared to the previous year, regardless of whether it is measured by M, 2M or M/2. The three-time cost share indicators are declining, while energy spending is rising, and it is a matter of growth, not direction, as energy prices are not expected to fall or energy efficiency to rise significantly.

A histogram of the distribution of households by energy expenditure and by share of energy expenditure shows on fig. 1.14 that there are far fewer households between M/2 and M and after 2M, if the share rather than the energy expenditure is measured, which is very talkative of inequalities in society.

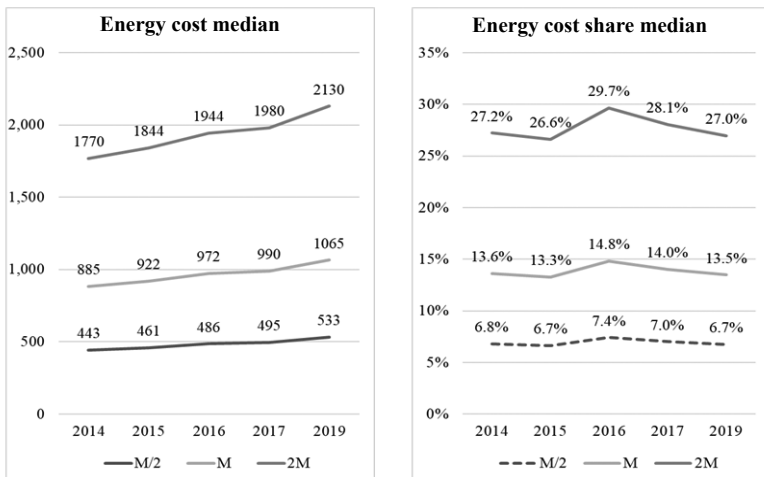


Figure 1.13: Median values of expenditure and share of expenditure

Source: Own calculations with anonymized data

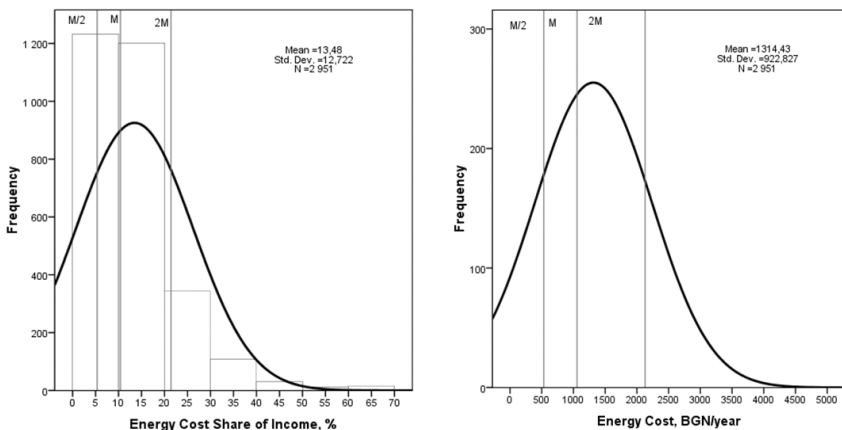


Figure 1.14: Distribution by expenditure and median thresholds M, 2M and M/2, 2019

Source: Own calculations with anonymized data

3) Equalizing income and energy costs per person/household with equivalent scales

Household size equalization is done using the official poverty-line methodology and the modified OECD equivalent scale, whereby the first adult aged 14 and over is given a weight of 1, the second adult aged 14 and over is given a weight of 0.5 and each child under 14 receives a weight of 0.3. Weights are assigned to each household member and added up together to obtain an equivalent household size.

- The total net income for each household is divided by its equivalent size and a net total income per equivalent unit is formed.
- Total net income after energy expenditure for each household is calculated in the same way by firstly subtracting energy expenditure from the total income and then multiplying by the weight of the household formed by each member to obtain net total income after energy consumption per equivalent unit.

In Bulgaria, there is no developed equivalent scale of energy consumption, and such a scale should exist, as there is a real possibility to do it according to the methodology applied in the third chapter of this research, using data from the national census of 2021. This is the practice in Great Britain, for example, where the scale, based on national surveys, is:

- 0.82 for a single-person household
- 1.00 for a two-member household (basic index)
- 1.07 for a the tree-member household
- 1.21 for a four-member household
- 1.33 for a five-member and multi-member households

This scale has its own characteristics, as it was formed thanks to long-term research on energy poverty, in which the so-called ‘modelled’ energy consumption, which represents the «necessary amount of energy to achieve adequate heat» for the particular household. The model used

to calculate household energy costs in Great Britain is called BREDEM⁹. It is questionable to what extent this scale applied in Bulgaria can reflect the peculiarities of households such as demographic characteristics, consumption modes, building characteristics. Therefore, it is considered that such a scale should be available after researching these characteristics in our country, as a second step after determining a typical energy consumption setting standards for individual consumption.

4) Determining typical energy consumption

Determining standard amounts of energy for certain needs under certain conditions is a mandatory practice in Great Britain, USA, and Australia. Such standards are also laid down in the drawing up of an energy-poverty line in Great Britain, for which actual expenditure is not used, but a typical one, i.e. that expenditure which is necessary for the given household to reach a thermal comfort of 21°C for a certain space, at the specific type of building envelope and heating used in the given region. For the relevant characteristics, the average supply prices of the type of energy used for the season are set. This standard depends on the mode of occupancy of the dwelling and is different according to the number and type of household members. This expenditure is then used in relation to household income to give an estimate of whether that household is energy poor or not.

This is one of the most common problems in discussions on the topic of energy poverty in Bulgaria, namely how exactly to determine the amount of energy for a norm, since this is an element with individual specifics. Among the conflicting points of the discussions is the definition of the amount of expenditure for people living alone in large apartments or multi-member households in low-quality housing, overconsumption of energy for heating a room at over 25°C or underconsumption of energy. The determination of this quantity must follow specific standards both for the individual characteristics of consumption and the type of heating and building characteristics of the dwelling.

⁹ The Building Research Establishment Domestic Energy Model.

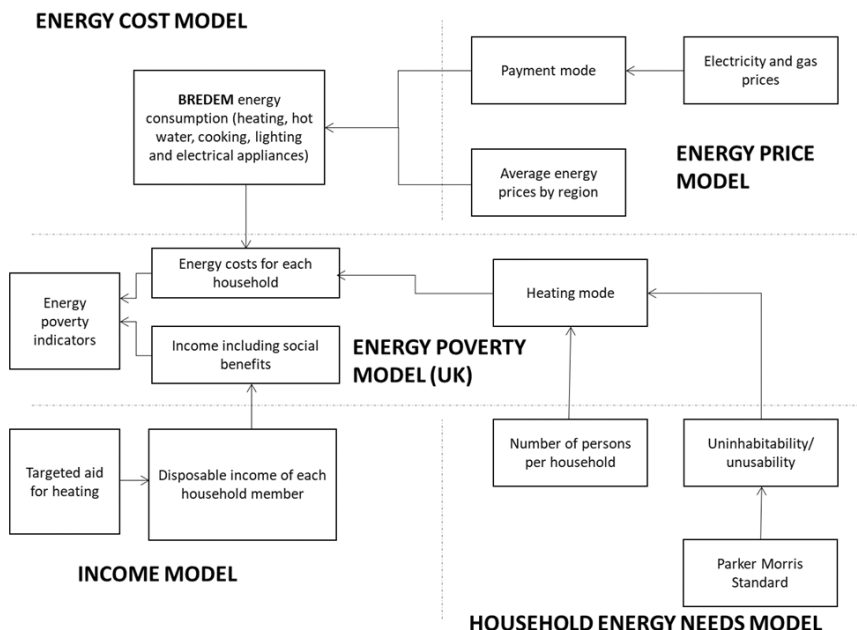


Figure 1.15: A model of energy poverty in the UK

Source: Henderson J., Hart J. 2012, Peneva T. 2021.

Energy-expenditure model (basic amount)

An analogue of the BREDEM model in Bulgaria is Ordinance No. 7 (MRDB, 2014) from the year 2004 on energy efficiency of buildings, which is used as a basis for energy survey of buildings. However, this model needs to be applicable to an annual survey of a nationally representative sample of between 3,000 and 10,000 households, depending on the choice of survey, which is practically impossible. It is therefore important to simplify it as much as possible to serve the purposes of energy-poverty monitoring.

First of all, the basic amount of energy needed by a household should be calculated according to the number of its members, the age and char-

acteristics of the members and of housing and heating, and then the price of energy carriers by location for the given period should be applied. It is also possible to apply a calculation of the differences in the baseline amount of energy according to the climate area.

The key elements for determining the amount of baseline energy needed by households should include separate components for the purposes of different policies to increase energy efficiency (Ren et al, 2013):

- Heating
- Cooling
- Lighting
- Hot-water heating
- Building envelope
- Electric appliances.

In this way, the development of policies and tools will best meet the needs of users. When carrying out a large-scale investment in the renovation of buildings and different types of energy efficiency measures, it is important to have a mechanism that reflects the individuality of needs and monitors their gradual satisfaction, that is, to establish a sustainable reduction in the ‘energy-cost’ component in the definition of energy poverty, as a result of investments made and measures implemented. The individuality of the needs should determine the individual nature of the political instruments as well. That is, a baseline amount of energy should be able to serve the following purposes:

- Development of policies according to energy needs (heating, cooling, hot-water heating, building envelope, electrical appliances);
- Development of policies according to consumer characteristics (mode of consumption and increased needs in newborns, adults);
- Development of policies according to criteria with a significant impact on household expenditure/income;
- Individual/differentiated support approach with the possibility of covering a wider range of users, and activating more investors in energy-efficiency measures.

Bulgaria has got experience in determining a **basic amount of energy to cover heating needs**. Since the creation of the scheme in 1995¹⁰, specific norms for minimum monthly energy needs have been laid down in the targeted subsidies for heating. Unfortunately, over the years, the heating aid remained only for one-room dwellings, the differentiation according to the size of the dwelling was removed and the aid for other energy needs and for the non-heating season, the amount of the norm was reduced, the differentiated payment of aid up to the amount of the income criterion was removed. (Shopov, Peneva, 2018). As of 2022, the aid includes 500 kWh for a one-room dwelling for the winter season.

Table 1.6: Norms for minimum monthly energy needs for heating by seasons and size of the dwelling

Season	Energy needs	Dwelling size	Standards for minimum monthly energy needs as of 1995	Standards for minimum monthly energy needs as of 1996
Heating season: from 1 st November till 30 th April	For heating , regardless of the fuel type used	One-room dwelling	560 kWh, incl. 280 kWh day tariff 280 kWh night tariff	560 kWh, incl. 390 kWh day tariff 170 kWh night tariff
		Two-room dwelling	840 kWh, incl. 420 kWh day tariff 420 kWh night tariff	840 kWh, incl. 590 kWh day tariff 250 kWh night tariff
	Other energy needs	One-room dwelling	100 kWh, incl. 50 kWh day tariff 50 kWh night tariff	100 kWh, incl. 70 kWh day tariff 30 kWh night tariff
		Two-room dwelling	170 kWh, incl. 90 kWh day tariff 80 kWh night tariff	170 kWh, incl. 120 kWh day tariff 50 kWh night tariff

¹⁰ Regulations for social assistance. Adopted by DoG No. 398 of 27.10.1997 promulgated in SG No. 100 of 31.10.1997, effective from 1.11.1997. [in Bulgarian]

Season	Energy needs	Dwelling size	Standards for minimum monthly energy needs as of 1995	Standards for minimum monthly energy needs as of 1996
Non-heating season: from 1 st May till 31 st October	Other energy needs	One-room dwelling	100 kWh, incl. 50 kWh day tariff 50 kWh night tariff	
		Two-room dwelling	170 kWh, incl. 90 kWh day tariff 80 kWh night tariff	

Source: DoG No. 43 of 1995; DoG No. 205 of 1996, Shopov, 2018

With the amount of aid thus determined, even in the most complete version since 1995, there is no possibility to reflect individual differences in energy consumption caused by:

1. Heat losses in the absence of insulation of the walls and windows;
2. High cost due to the type of building (house/apartment);
3. Lower or higher outside temperature in different climate areas;
4. Presence of a person with a 24/7 need for energy to achieve higher thermal comfort;
5. Difference in energy prices by locality, respectively, different degree of coverage of the needs of the same amount of aid.

However, this amount could serve as a basis for drawing up a standard for the purposes related to the EU's regulatory requirements on the definition of energy poverty and the implementation of the measures included in the Green Deal.

Bulgaria has experience in determining a baseline amount of energy to cover the needs for electrical appliances and water heating. In May 2016, the Ministry of Energy announced a mechanism for the protection of vulnerable energy consumers, with additional assistance for the most vulnerable 17+3 new groups of consumers, in the form of 100/150 KWh of electricity at preferential prices. This aid is provided in the form of a social electricity tariff to cover 70% of the energy component in the price of electricity, or on average about 33% of the final price of electricity. The following costs are included in 100kWh:

Table 1.7: Norms for minimum monthly energy needs for electrical appliances and hot-water heating

	No Boiler		With Boiler	
	kWh/ year	kWh/ month	kWh/ year	kWh/ month
Boiler			648	54
Refrigerator	200	17	200	17
Lighting	72	6	72	6
Oven	712	59	712	59
TV-set	22	2	22	2
Washing machine	99	8	98.8	8
Steam iron and other electrical appliances	15	1	15	1
Additionally	36	3	36	3
Total	1200	100	1800	150

Source: Ministry of Energy

These costs do not include heating and they represent an existential minimum of electricity for household needs other than heating.

Another important condition is to ensure the possibility to update this typical expenditure annually with national surveys. Therefore, it should be based on a base quantity methodology, and indicators to be included in the questionnaires of one of the two possible annual surveys, to build a basis for the missing three models in the general model of energy poverty – a model of household needs and energy expenditure model. This requires to simplify the model of energy needs. An example of such indicators is:

Model of household needs	Model of energy expenditure
✓ Number of household members ✓ Children up to 3 years old ✓ Adults over 65 years old ✓ People with disabilities	✓ Main type of heating ✓ Type of dwelling (house, apartment, etc) ✓ Type of energy efficiency measures: window-frame, insulation

5) Other issues (extreme values, negative income and expenses, zero-energy values, weights of the statistical data, reporting period)

When developing a methodology for an official energy-poverty line, consideration should also be given to allowing negative or zero values of energy or income that are currently acceptable, as well as extreme values exceeding the limits of reasonableness. Such problems would be solved, if a methodology was introduced for a typical amount of energy, which is additionally calculated on the basis of indicators from the study, and valued according to the location of the household. For the purposes of this study, these values have been trimmed, reducing the sample by an average of 2 to 6 households per year.

In conclusion, it is considered that for the purposes of measuring and monitoring energy poverty in Bulgaria, a survey is needed that allows:

- Assessment of individual energy needs according to the type of building, heating, settlement;
- Assessment of individual energy needs according to the type of household/user;
- Assessment of the differences in needs caused by differences in the prices of energy carriers by region;
- Assessment of the differences in needs caused by the different outdoor temperature in the nine climatic regions of the country.

And accordingly, the survey must include the following indicators:

- Household incomes;
- Number of persons per household;
- Age of the dwellers;
- Number of persons with disabilities;
- Energy characteristics of the home (windows, insulation);
- Main type of heating.

Therefore, the main steps for developing an energy-poverty model for the purposes of measuring, monitoring and subsequently financing energy-efficiency measures are as follows:

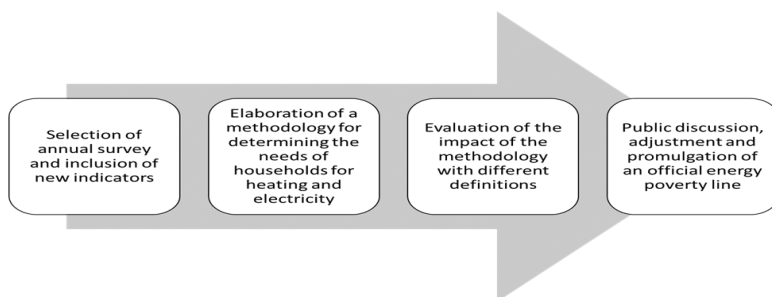


Figure 1.16: Steps for developing an official energy-poverty line

1.3.4. Energy poverty according to a combined approach

The combination of both approaches – the expenditure one and the subjective one – was put into practice in the Belgian Energy-Poverty Barometer as early as 2015. This was an initiative of the «Platform to fight energy poverty» managed by the King Baudouin Foundation (Rademaekers et al., 2016). The barometer was first published in 2015, following a survey conducted by the University of Antwerp and the Free University of Brussels. The barometer combines three types of poverty:

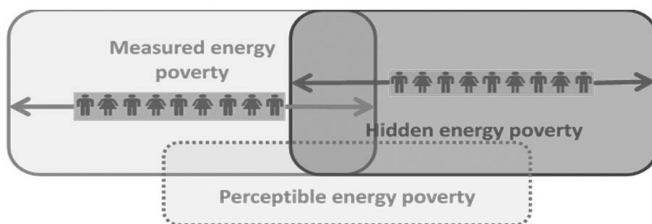


Figure 1.17: Combined approach of the Belgian energy poverty barometer (Rademaekers et al., 2016)

- 1) Measured energy poverty: the percentage of households spending a large share of their expenditure on energy;
- 2) Hidden energy poverty: the percentage of households that have low energy consumption due to deprivation and insufficient satisfaction of their energy needs; and

- 3) Perceived energy poverty: the households that report to have difficulty in paying their energy bills.

Sometimes households spend too high a percentage of their income on energy, and yet do not meet their energy needs – this is the part of the graph above where measured and hidden energy poverty overlap.

The combined approach is increasingly used in energy-poverty research, often developing a ‘**multidimensional energy-poverty index**’ combining the expenditure approach and the consensus approach.

Researchers refer to a combined approach, explaining that energy poverty is a complex problem (ComAct, 2021), and policy interventions of different natures influence each other. Therefore, it is important to be able to separate the effect of different policies by simultaneously monitoring several indicators.

At the macrolevel, it is possible to track all the presented indicators in total up to the moment, for the period 2014-2019, in which the development can also be observed in the expenditure approach.

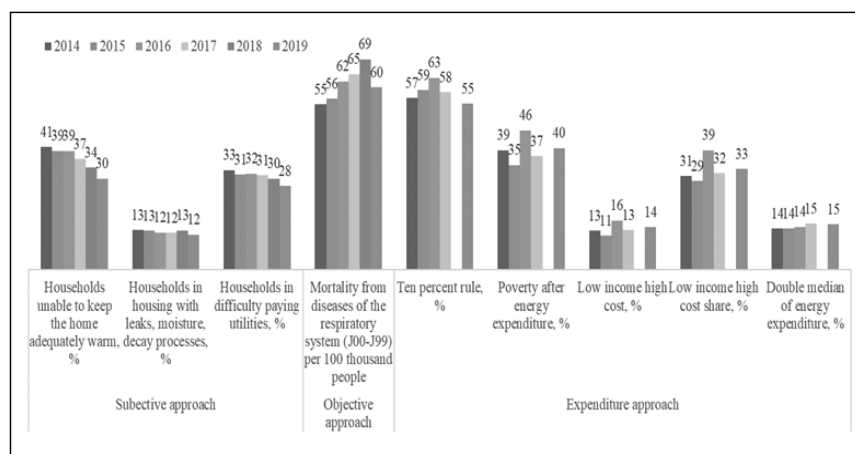


Figure 1.18: Summarized data from the three approaches to measuring energy poverty

Source: NSI, Ministry of Environment and Water, Eurostat, own calculations with NSI data

The data show differences in the trends of the three approaches – a significant increase in the objective, a decrease in the subjective and relative stability in the expenditure approach. A relationship, albeit weak, can be found rather between the objective and expenditure approaches.

At the level of decile groups, in this research it is possible to track how many types of energy poverty are registered in individual decile groups, each definition being marked with 1 (unit), and the index is composed of a total of 6 indicators, and can be a number of 0 to 6. The following dimensions are combined:

- 1) Measured energy poverty: «Ten-Percent Rule», «Poverty-After-Energy Expenditure», «Low Income – High Cost Share».
- 2) Hidden energy poverty: «M/2 Half Median Expenditure» and «Low Income – High Cost », «Low income – high cost share».

Given the conclusions drawn from the analysis by decile groups, namely with the indicator «Double Median Share of Energy Expenditure» energy poverty increases with income, an index of only 5 indicators is compiled, which excludes it.

The table below presents the results with two indices – with 6 indicators, and with 5 indicators – without 2M. The trends of a significant decrease in the index among the high decile groups in the 5-indicator energy-poverty index is prominent. The composite indices are the sum of the units of the individual dichotomous indicators, where 0 is lack of energy poverty, 1 is energy poverty. The composite index of 6 indicators takes values from 0 to 6, with 0 reflecting the absence of energy poverty and 6 reflecting the presence of energy poverty across all 6 indicators. The composite index of 5 indicators takes values from 0 to 5.

The table shows that in the bottom three decile groups, on average, households are measured as energy-poor by three of the possible five or six indicators. In middle-income decile groups 4 and 5, households are usually energy-poor by one or two indicators at most, while from the 7th decile group upwards, two out of three households fall into the energy-poor groups, usually by the ‘Ten-Percent Rule’ indicator or the ‘Double Median Expenditure’. When removing the ‘Double Median Expenditure’ indicator, the percentage of energy-poor in the upper decile groups drops sharply.

Table 1.8: Composite indices of energy poverty

Index composed of 6 indicators, at levels from 0 to 6					
	2014	2015	2016	2017	2019
<i>Decile 1</i>	3.35	2.99	3.22	3.08	3.21
<i>Decile 2</i>	3.24	2.59	2.82	2.64	2.55
<i>Decile 3</i>	2.98	1.98	2.11	2.20	2.20
<i>Decile 4</i>	2.21	1.63	1.65	1.65	1.90
<i>Decile 5</i>	1.62	1.51	1.67	1.48	1.56
<i>Decile 6</i>	1.32	1.19	1.18	1.14	1.04
<i>Decile 7</i>	0.98	0.94	1.05	0.96	0.87
<i>Decile 8</i>	0.82	0.80	0.92	0.79	0.61
<i>Decile 9</i>	0.75	0.69	0.79	0.75	0.69
<i>Decile 10</i>	0.63	0.78	0.77	0.79	0.68
Average	1.48	1.39	1.50	1.43	1.43
Index composed of 5 indicators, without 2M, at levels from 0 to 5					
	2014	2015	2016	2017	2019
<i>Decile 1</i>	3.31	2.96	3.17	3.05	3.14
<i>Decile 2</i>	3.18	2.54	2.75	2.59	2.50
<i>Decile 3</i>	2.92	1.92	2.05	2.12	2.12
<i>Decile 4</i>	2.15	1.55	1.57	1.56	1.81
<i>Decile 5</i>	1.53	1.40	1.58	1.38	1.45
<i>Decile 6</i>	1.21	1.11	1.09	1.04	0.97
<i>Decile 7</i>	0.85	0.84	0.95	0.83	0.72
<i>Decile 8</i>	0.67	0.66	0.76	0.64	0.48
<i>Decile 9</i>	0.55	0.51	0.58	0.51	0.44
<i>Decile 10</i>	0.38	0.36	0.35	0.35	0.26
Average	1.35	1.25	1.36	1.28	1.28

Source: Own calculations with anonymized data

Key challenges at developing a definition

The use of different indicators to identify energy poverty varies from country to country and covers different target groups. The fight against energy poverty has a strong local, but above all, political character. In an article from 2010, Brenda Boardman wrote that “who is energy-poor depends on the definition”; but “the definition depends on who you want to focus on, and that’s a matter of political judgment” (Boardman et al., 2010). Similar is the view of Shopov, developed and enriched in (Shopov, 2016), according to whom, before choosing a definition of energy poverty, various meters/indicators should be calculated and on this basis the scope of energy poverty should be considered, so that an informed choice to be made, when developing and adopting a national definition of this poverty. The comprehensive study of Peneva relies on the aforementioned basis supported by data from 2014 (Peneva, 2021). She laid therein the basis for measurements by means of an expenditure approach.

The main challenges for choosing and determining a definition of energy poverty specifically for the situation in Bulgaria, are mostly lack of political will, but also lack of information and uncertainty about the possibilities of such a definition to reflect:

1) Differences in current energy expenditure reflected in statistical surveys caused by different strategies of households to deal with energy poverty – control of consumption by maintaining low temperatures at home, changing the type of heating in order to reduce heating bills, ambiguity regarding differences between habitable and heated areas, etc.

2) The difficulties in defining ‘adequate needs’ or the so-called ‘typical energy consumption’, required for a household to reach adequate levels of thermal comfort in winter, defined by the World Health Organization for 21°C, and sufficient cooling in summer. To define such an expense, a political will is needed from an institution – let be SEDA (Sustainable Energy Development Agency), ME or MLSP to set a standard that shall be suggested for public discussion, and then reflect important stances ex-

pressed by all interested parties, which shall be publicly accepted, to form the basis of an official definition.

3) The complexity of the causes of energy poverty: low incomes, indebtedness, old and poor-quality building stock, impossibility of investment in efficient electrical appliances and heating systems, difficult organization of the residents of condominiums in panel buildings to apply for programmes, etc.

4) A high percentage of home ownership in Bulgaria, over 95%, and the impossibility of the most affected groups, mainly the elderly or socially weak, for any kind of replacement of the home with another one with a smaller heated volume or with better building characteristics and correspondingly less heat loss.

5) Differences in the type of buildings, climate and availability of various energy resources in different localities; discrepancies in energy prices.

6) Ability of definitions to reflect individuality of needs, energy-efficiency measures, concentration of poverty in lower decile groups, and resilience at changes in income.

To be adequate, the definition of energy poverty must:

- 1) effectively reflect each of the main causal factors for its manifestation, namely:
 - Low income;
 - High energy prices;
 - Low energy efficiency of the home;
- 2) deliver an adequate standard of energy consumption;
- 3) provide opportunity for annual update;
- 4) provide an opportunity to reflect the progress of energy-efficiency programmes.

A brief summary of the statistics makes it possible to synthesize the strengths and weaknesses of the different approaches to measuring energy poverty (see table 1.9 below).

Table 1.9: Comparative analysis of measurement approaches

	Strengths	Weaknesses
<i>Objective approach</i>	- Objectivity of the consequences of energy poverty	- Impossibility to identify the connection with energy poverty - Interference of external factors on the result - Limited number of measurement indicators - Inability to upgrade research with additional indicators (income, housing, medication costs, energy)
<i>Subjective approach</i>	- Possibility to combine results with income	- Unreliability of statistics - Lack of cost indicators - Lack of housing indicators
<i>Expenditure approach</i>	- A variety of definitions - Ability to focus on a specific group - Accounts for changes in energy costs - Possibility of monitoring the effect of renovation/efficiency measures	- Different trends in the different definitions - Difficulty in choosing the most effective and adequate definition - Lack of housing indicators

For each approach, it is necessary to include additional indicators to adequately reflect the problem. A comparative analysis of the indicators of the expenditure approach is also needed (Table 1.10).

Table 1.10: Comparative analysis of indicators in the expenditure approach

	Strengths	Weaknesses
<i>Ten-Percent Rule</i>	- Good base for other indicators - Easy measurement by anyone - Best covers the over 65 age group. - Reflects the differences by type of housing the best possible	- Covers high income decile - Very high coverage nearly 2/3 of the population - Volatility at the smallest changes in income and expenses - weak positive relationship with energy expenditure¹¹
<i>Poverty after-Energy-Expenditure</i>	- Combines relative and absolute approach - Almost zero range in the highest 4 deciles - Covers also the middle deciles but to a lesser extent - Stability with changes in income and expenses - Reflects the differences by type of housing the best possible	Ø
<i>Low Income – High Cost Share</i>	- Focusses on the lowest decile - Stability with changes in income and expenses	- A range close to the official poverty line

¹¹ This means that energy poverty increases with higher energy expenditure typical of higher decile groups. This implies only one thing: that energy poverty also exists in the higher groups in Bulgaria, because with every increase in income, households from the higher deciles increase their energy costs. In this case, however, the reflection of this trend is negative when choosing criteria/indicators for energy poverty.

<i>Low Income – High Cost</i>	- Stability with changes in income and expenses	- Lowest population coverage, with 2MS - Three times below the poverty line close to the current guaranteed minimum income - weak positive relationship with energy expenditure
<i>2M</i>	- Strong correlation with income	- The scope grows with income - Covers the highest decile and - Low coverage of the population living below the poverty line
<i>M/2</i>	- Covers the lowest decile and - Discovers hidden energy poverty	- Low coverage of the population living below the poverty line
<i>2MS</i>	Ø	- The lowest range of the population, with ‘Low Income –High Cost’, three times below the poverty line – close to the current guaranteed minimum income Strong volatility
<i>MS/2</i>	- Strong correlation with income	- Range grows with income Covers the highest Decile and Low coverage of the population, below the poverty line

Any indicator that is close to or less in scope than the official poverty line calls into question the need to use it for any purpose other than meeting EU requirements for an explicit definition of poverty. The introduction of a definition of energy poverty is also due to its connection with financing for the implementation of the goals in the ‘Long-term national strategy for the renovation of the housing stock until 2050’¹².

¹² <https://www.me.government.bg/themes/dalgosrochna-strategiya-zabnovyavane-na-nacionalniya-sgraden-fond-ot-jilishtni-i-nejilishtni-sgradi-do-2050-g-2271-1545.html>

Thus, it can be concluded that only the indicator ‘Poverty after-energy-expenditure’ meets all the criteria for a definition suitable for Bulgaria’s conditions. It can also be summarized that **for energy consumption it is necessary to use a developed norm** that allows adequacy of energy services to meet heating and other needs, reflects changes in the prices of energy resources, reflects the type of housing and the energy efficiency measures that have been taken, the type of the main heating system and, last but not least, the type of household and the mode of use of the dwelling.

Therefore, in the next chapter, four factors determining energy poverty will be examined in more detail: income, energy costs (prices and quantity), type of heating and type of household.

CHAPTER TWO

FACTORS

Energy poverty is based on three pillars – low income, high energy prices and low energy efficiency of the dwelling (Thomson, 2013). Each one of the termed ‘pillars of energy poverty’ is formed by a number of other factors. Energy prices are directly related to the produced energy mix and consumption structure at the macrolevel, and to the type of energy used in the respective household at the microlevel. The energy efficiency of the buildings, the electrical appliances used in the household and the mode of consumption determine the amount of energy spent to satisfy a certain type of needs. The energy efficiency of buildings is itself predetermined by a number of socio-political and economic factors, such as age of buildings (years of construction), type of buildings and construction materials, energy-efficiency measures taken, etc. Household incomes are flexible and depend mainly on the employment and economic activity of the persons in the households themselves, and the economic situation of the country. During the period from 2014 to 2019 electricity prices followed a stable upward trend in Bulgaria. The growth of incomes during this period did not reach the growth of energy prices.

This chapter analyzes separately four main factors thought to influence energy poverty: income, expenditure, type of heating and type of household. For each factor, macrolevel trends and the relationship with energy poverty are analyzed.

2.1. Income and Energy Poverty

Low incomes are a major pillar of energy poverty. When the household has a low income, even with a low consumption of energy, both in quantity and price, it remains unaffordable. Bulgarian electricity prices

are among the lowest in Europe, and nonetheless the percentage of poor households, according to the official definitions of poverty and measurement methods of Eurostat, is among the highest in the European Union. This is a prerequisite for the existence of energy poverty, and one of the factors by which energy poverty in Bulgaria differs fundamentally from that in the developed countries of Western and Northern Europe, where the main reason is the poor quality of housing. The higher weight of this causal factor in the formation of energy poverty is important when choosing a method of measuring it. If a definition and method of measuring energy poverty have been adopted in the UK, which tend towards households with low energy efficiency of their homes, and to some extent ignore energy-efficient low-income households, in our country such a definition may be inappropriate or not applicable at all, if such households do not exist, or represent too small or too large portion of the population.

Poor households in Bulgaria have been slightly below or above 22% of the population for more than two decades. The absolute number of poor people in Bulgaria has fluctuated over the past few years around this number, rising in 2008 and 2011, then falling in 2012 and 2013, and then again showing annual growth. The effect of anti-poverty policies has been weak. As long as there is no general change in these policies and the amounts of social transfers, the number of poor Bulgarians will be maintained at this level of 1.6 million people on average, and this factor for forming energy poverty will continue to be relevant.

The long-term state of the population's income is a primary factor before the temporary changes of the macroeconomic cycle, when the economy enters an upswing or downswing. The income status of the population determines the relative size of inhabited dwellings, the ownership of the dwelling and, accordingly, the use of a given type of social support from the state. It also predetermines the amount of energy consumed from the point of view of the households' ability to invest in the home and increase its energy efficiency. The causes of permanent poverty are also included here: permanent disability, long-term unemployment, lack of education and qualification, etc.

The ups and downs in the economy, in turn, decrease or increase the income of the population and have a direct impact on the level of energy

poverty. Energy poverty can significantly decrease in periods when the economy is growing, and accordingly increases in periods of crisis (Bouzarovski et al., 2015). This is also confirmed by data of the present study. The years reflecting a decrease in energy poverty according to the expenditure approach are precisely those with growth in economic indicators: 2017 and 2019. The increase in energy poverty in 2016 is related to the decrease in the total expenditure of households and the employment of economically active individuals aged 20-64 (Figure 2.1).

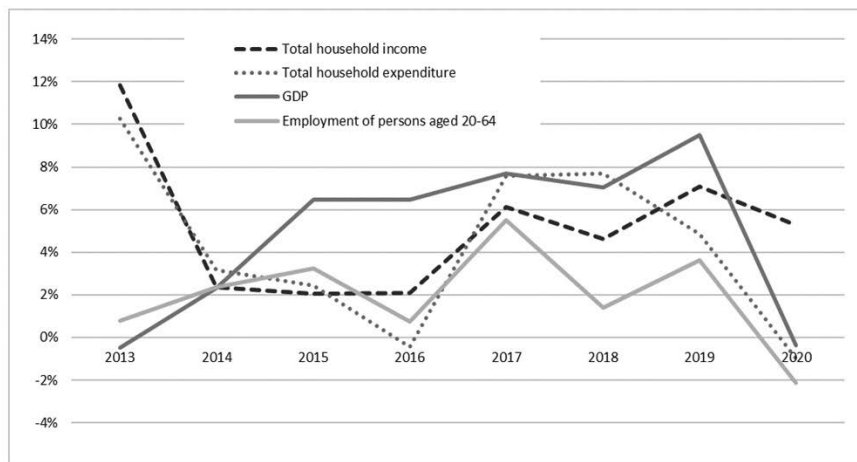


Figure 2.1: Dynamics in GDP, employment and income in Bulgaria, annual growth in %

Source: NSI

The relationship between the total household income and the energy-poverty indicators set by the expenditure approach with data from the Household Budget Monitoring is shown in the figure 2.2 below.

The data on Fig. 2.4 show that the negative relationship between income and energy poverty according to the objective and subjective approach is not as well pronounced as in the expenditure approach.

Correlation analysis of energy poverty indicators shows a negative moderate relationship of net total income with energy poverty. Among

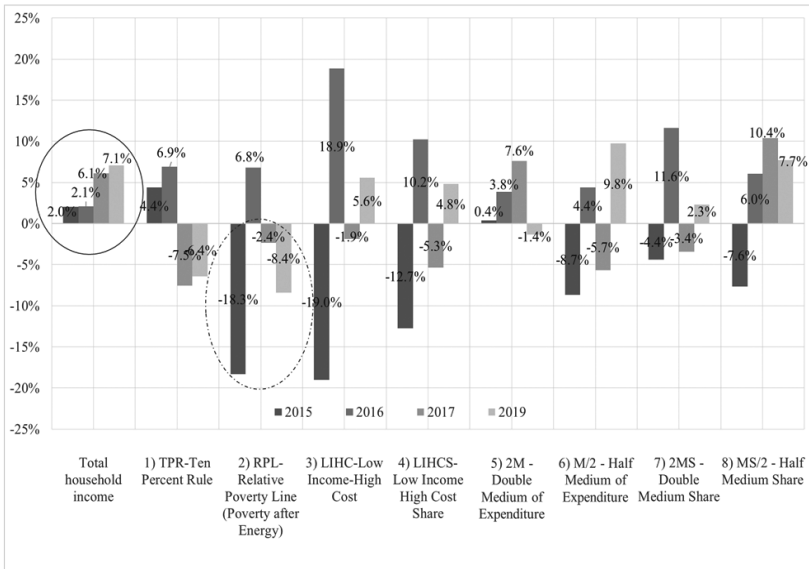


Figure 2.2: Annual growth of total household income and energy poverty according to the expenditure approach

Source: Own calculations with anonymized data

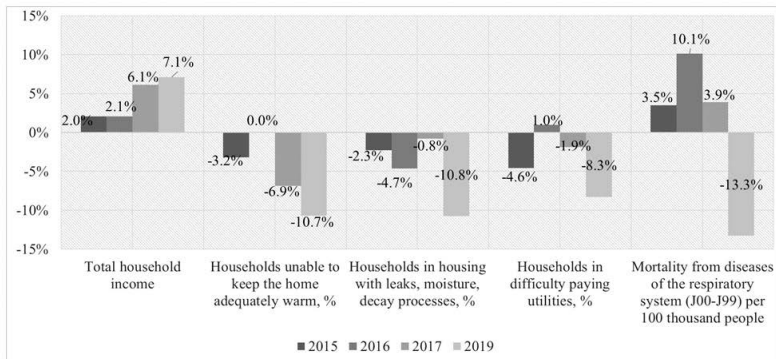


Figure 2.3: Annual growth of total household income and energy poverty according to the objective and the subjective approach

Source: NSI, Eurostat

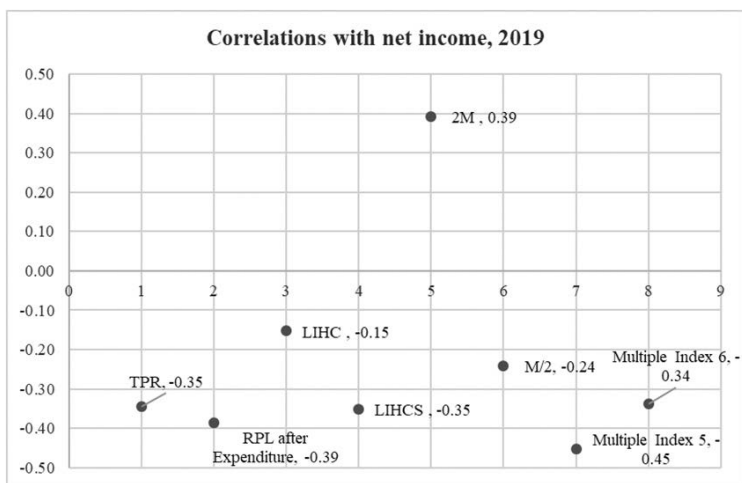


Figure 2.4: Correlation of energy poverty indicators with net total income in the sample

Source: Own calculations with anonymized data

the indicators confirming this direction are the Ten-Percent Rule, Low Income – High Cost Share, Poverty After-Energy-Expenditure; Half of the Median of the Energy Share has a positive moderate relationship, and for the rest of the indicators the relationship is weak.

In conclusion, given the importance of income in reducing energy poverty, in order to adequately reflect the problem, it is necessary to use a cost-based approach to analysis, monitoring and policies. The application of an objective approach will not adequately reflect changes in income, regardless of whether they are caused by the economic situation in the country or by a certain type of policy.

From the point of view of the expenditure approach, the indicators of ‘Poverty After-Energy-Expenditure» and ‘Low Income – High Cost Share’ are most directly related to income. The composite energy poverty index representing the sum of the five indicators has a more pronounced moderate relationship with net total income, but its application to policies and assessment of energy poor households would be complex. It is presented here for illustration only.

2.2. Energy Expenditure and Energy Poverty

Energy costs are related to two factors of energy poverty: high energy prices and low energy efficiency of housing. The structure of energy production and consumption in our country is extremely important for the formation of energy carrier prices. As such, it represents a factor in the formation of energy poverty in Bulgaria. This part examines the various factors influencing the price of energy and the energy efficiency of housing in Bulgaria, and respectively the possibilities for policies to reduce energy poverty by influencing these two groups of factors.

Factors influencing the price of energy in our country

In our country, the structure of energy production is characterized by a large percentage of use of coal to produce primary energy (40% of total production), 36.8% production from nuclear energy, and 21.8% from renewable sources and biofuels, according to data from the Ministry of Energy for 2019 (ME, 2020). This structure is determined by the natural resources of our country, but also by political decisions – regarding the construction of production facilities – taken during the years of the Communist rule (1944-1989) and the subsequent post-communist period till today.

The electricity market in Bulgaria consists of two segments: a regulated and a free one. High prices on the regulated market depend on the production mix in the country and the energy balance. Annual electricity production for the past ten years till 2020 has fluctuated around 40 terawatt-hours (TWh), with annual consumption fluctuations of less than 10% from the previous year. Fluctuations for the import and export of electrical energy are significantly greater (Nedev, 2015). In principle, a large part of the electricity produced by coal is used in the regulated market, which determines the higher prices in this segment, while the cheaper nuclear power is used in the free market or for export.

The Energy and Water Regulatory Commission (EWRC) also reports a deficit of energy that can be traded at market prices, also due to the ‘expensive energy’ produced in our country, which is subject to man-

datory purchase under various forms of long-term contracts. On the one hand, these are the long-term contracts with the American thermoelectric power plants '*3C Maritsa Iztok 1*' and '*Kontur Globul Maritsa Iztok 3*', which have not yet been terminated at the beginning of 2022, and on the other hand, these are the long-term contracts with producers of 'green energy', i.e. energy from renewable sources. This energy is also bought under long-term contracts at higher than market prices, the named 'preferential prices'. In addition to current costs, these producers also form an expense for unpurchased availability, as regards the energy that was not produced, because there was no consumption in the country, and the price is significantly higher than the market price, and it cannot be exported to the neighbouring countries.

Liberalization in Bulgaria began on 18th 09.2004 with the registration of the first electricity supply schedule from '*Kozloduy NPP EAD*' to a privileged client connected to high voltage. The free market initially covered only traders and consumers connected to high voltage, then gradually consumers from medium voltage as well. Since the amendments to the Energy Act of 2014, all high and medium voltage consumers have went out on the free market, and the Energy and Water Regulatory Commission has not set regulated prices for them. The energy on the regulated market has been provided by the '*National Electric Company (NEC) EAD*' in its capacity as a public supplier also by means of purchase from the quota power plants under Art. 93A of the Energy Act and Long-Term Contracts.

The free electricity market has been developing extremely dynamically in recent years in Bulgaria. During the price period from 1st 07.2014 to 30th 06.2015, a rapid and dynamic transfer of medium-voltage customers from regulated to freely negotiated prices is underway in our country, and the process of transfer of low-voltage business customers to free prices.

From April 2016, the liberalization of the low-voltage consumers' market was expected to begin, but only small commercial consumers actually entered the free market at the end of 2020. The liberalization of the household segment remained only on paper, hindered by the crises and the need to secure lower prices coming from a regulated market for residential customers. By the end of 2020 a large number of low-voltage

business users were paying a higher price for electricity than residential users, thus resulting in ‘cross-subsidization’ of the segments. This subsidy has now fallen away, leaving solely to the state the cost burden for keeping prices low for the regulated market.

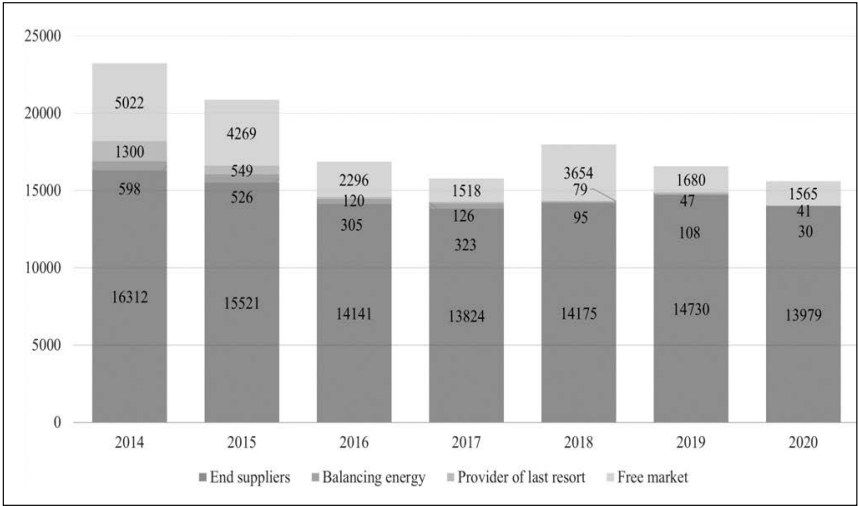


Figure 2.5: Electricity sales of NEK EAD in GWh (NEC, 2015)

By 2025, household consumers will have to shoulder the burden of high energy prices caused by the country’s production mix.

With the full liberalization of the market, the keeping of household prices at a low level due to energy poverty in order to stabilize the social environment, creates a number of negative consequences. The main ones are low investment in the grid due to low liquidity; low level of open-market trading; the issue of financing energy companies; indebtedness to energy suppliers due to higher purchase price and lower selling price; and last but not least, external sanctions on the ‘*Bulgarian Energy Holding*’, due to the delay in the liberalization process.

For this reason, the quotas for providing consumption on a regulated market are decreasing year after year (see «end suppliers» in the figure above), as well as a result of a general decline in energy consump-

tion in industry and households. In 2015, sales done by NEC EAD to the customers of a supplier of last resort (SoLR) decreased by 58% in 2015 compared to 2014 due to the exit of many business customers to the free market, where electricity prices are significantly lower. The exit of small commercial low-voltage users in 2020 is also reflected in a similar decline from 108 GWh in 2019 to 41 GWh in 2020. This reduces the source of subsidy for residential customers in the regulated segment, as already mentioned, and creates indebtedness of NEC to energy suppliers from thermal power plants with long-term contracts.

In 2020, the prices of these power plants also grew up due to an increase in the prices of carbon emissions on international stock exchanges, purchased for produced electricity. Although the higher prices reflect on the activity of the SES Fund (Electrical energy-system security fund), EWRC assesses the price of purchased electricity from the thermal power plants in the price decisions for the next period. **The prices of carbon emissions will continue to rise**, and thus will be an important factor in accelerating the transition to alternative sources, and inevitably increasing the share of energy from RES.

The energy from different types of RES creates an annual expenditure of over BGN 1.1 billion in 2015. This energy also cannot be sold on the neighbouring regional markets, as it has a high purchase price. The price of energy from RES is nearly 10 times higher than the price from 'Kozloduy NPP'. In addition, green energy is characterized by difficult controllability and predictability, and generates additional costs for the system through the use of pumped-storage hydroelectricity. They are included in the hours of low energy consumption, playing the role of a large consumer and thus using the superfluous energy produced.

In addition to production costs, the final price for energy consumers on a regulated market includes a number of transmission fees, a green energy supplement, a fee for non-reimbursable investment costs, a 'Society fee', etc. The main large consumers of electricity are the electricity distribution companies – ČEZ, EVN and Energo-Pro, which buy the electricity at fixed prices, guaranteeing a profit of 8%, according to the regulations of EWRC and the privatization contracts. This fee is included in the structure of the energy components as a 'margin'.

The structure of energy consumption is an important factor in the formation of energy poverty and is conditioned by the structure of production. The gross domestic electricity consumption in 2015 was 38.6 TWh, which is an increase of 1.8% compared to 2014. The production of electricity from renewable energy sources covered 20.8% of the gross domestic electricity consumption in the country in 2015. The final electric energy consumption in the country in 2015 amounted to 29.6 TWh (2.3% more compared to 2014), including non-residential customers (19.0 TWh) and residential customers (10.6 TWh). The commercial export of electrical energy in 2015 was 10.6 TWh, which is 11.2% more compared to 2014 and represents 21.5% of gross production (ME, 2015b).

In Bulgaria, households are heated mainly with electricity and solid fuel, according to two different sources – a report by *Sofena* (Georgiev, Taneva, 2012) and a report by the World Bank (WB, 2016), both reports with data from 2012. Data from the ‘Household Budgets Survey’ also show energy consumption from electricity with a share of 58% of the total weighted consumption, solid fuel with a share of 29% and thermal energy with a share of 11% in 2019.

Energy prices are an important factor - part of the three «pillars» of energy poverty. Household electricity prices in Bulgaria are the lowest in the EU, as well as among the countries of Central and Eastern Europe. Unfortunately, prices fail to reflect the differences between the price level and real household incomes in these countries (Bouzarovski, Herrero, 2016).

In the ‘*Handbook of Energy Poverty*’ of 2016, Buzarowski and Herrero analyze household electricity prices measured through purchasing parity in Eurostat’s Purchasing Power Standard (PPS). It is an artificially created currency that eliminates price-income differences by adjusting prices denominated in local currencies through Purchasing Power Parity (PPP), calculated on the basis of the prices of a hypothetical basket of products and services (EC, 2019). The data is presented in figure 2.6. below.

The vertical shows household electricity prices in kWh measured in purchasing power parity, starting at 0.10 parity units in countries such as Finland and France (in the lower right quadrant) per kWh and

rising to 0.24 parity units per kWh. Along the horizontal line are the countries with an increasing percentage of the population at risk of poverty, with the countries with the lowest percentage on the left and the countries with the highest percentage of the population at risk of poverty on the right.

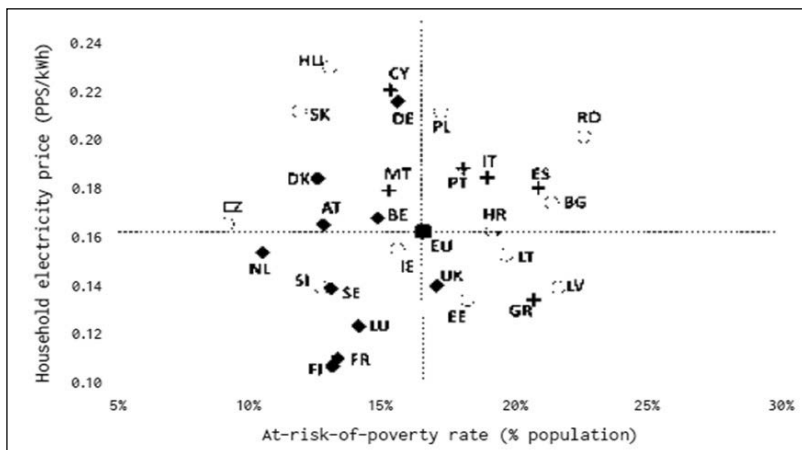


Figure 2.6: Relationship between electricity prices and the proportion of the population at risk of poverty (Bouzarovski, Herrero, 2016)

The results show a more realistic picture of the price level and its relationship with the percentage of the population at risk of poverty. In this case, Bulgaria is located in the upper right quadrant of the graph, and is characterized by a high percentage of the population at risk of poverty, with a high price of electricity as measured by Eurostat's purchasing parity. In this quadrant are also most of the countries of the former socialist block, such as Hungary, Poland, Romania, and also the countries with relatively high energy prices, such as Italy, Spain and Portugal. The reality that these countries are more affected by energy poverty is directly related to energy prices. Italy, for example, is characterized by a relatively isolated electricity system and a high dependence on energy imports, which predetermines the high price of electricity. Although the factors for the formation of high electricity prices are different, the result is similar,

namely, a high percentage of people at risk of poverty, and premises for high energy poverty.

In summary, the following several factors with a direct impact on the price of energy for households can be stated:

- A large share of coal in the energy mix, causing a high price of energy from the concluded long-term contracts at preferential prices and price for availability;
- Rising electricity prices from coal-fired power plants due to a rise in the price of carbon emissions;
- Interruption of cross-subsidization on the regulated market by part of the small business users who entered the free market at the end of 2020;
- High growth in gas prices worldwide, also causing future price growth in the market of electricity and thermal energy;
- Increase in the share of RES and the requirements for energy consumption from RES in households.

Therefore, when developing a mechanism to reduce energy poverty, it is important to include programmes aimed at lowering the price and the energy consumption of households, through the supply of energy from alternative sources: solar collectors, solar panels, pellet fuels. Only in this way all the above-mentioned factors and long-term trends of energy price growth caused by the structure of production and the peculiarities of the energy system can be avoided.

Factors of underconsumption of energy

From the point of view of consumption habits, households in Bulgaria are distinguished by extreme frugality, deprivation of comfort and judicious energy consumption. Typical is the deprivation that is clearly visible, when comparing energy consumption in the private households per square meter and per person. The following graph shows the final energy consumption per person in Bulgaria compared to the EU countries, lagging nearly 2 times behind the EU average levels, and ranking among the countries with the warmest climate in the continent.

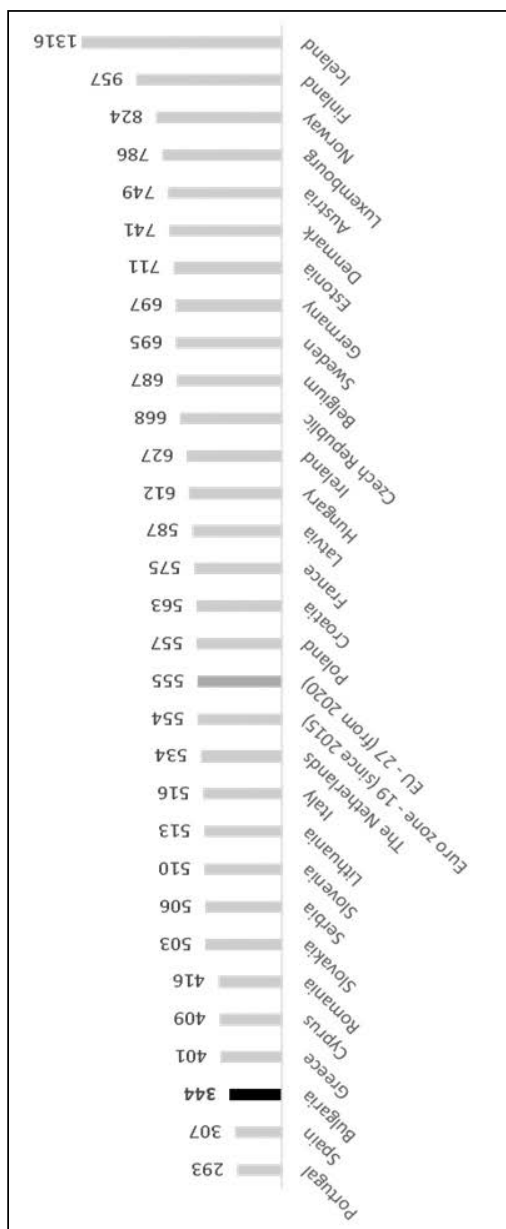


Figure 2.7: Final energy consumption per capita in the EU households, kg.o.e. 2020

Source: Eurostat

Figure 2.7 shows the final energy consumption per person in households in the EU Member States, ordered by value, with Bulgaria in the third place from left to right. As can be seen, the value of this indicator is the lowest in Bulgaria compared to the rest of the EU countries, with only Portugal and Spain having lower values than her, in the EU.

These data speak of the so-called hidden energy poverty. Indicators that measure energy poverty equally or similarly with countries that consume more energy per person (figure 2.7) should therefore be rejected (Bouzarovski et al., 2020).

In this sense, **2M (2MS) and M/2 (MS/2) from the expenditure approach are not suitable for Bulgaria's conditions.** They are considered indicators that reflect hidden poverty, but apparently 2M and MS/2 show a range that increases with income; it turns out that the high deciles also have hidden energy poverty, and even if M/2 and 2MS are concentrated in the low deciles, measure relative to a common entity that has the lowest consumption in the EU.

Factors influencing the energy efficiency of housing in Bulgaria

The building stock in Bulgaria is often commented on as 'outdated' and 'energy-inefficient'. Unfortunately, the data on it in our country is limited. The TABULA project is co-financed by the European Commission with the aim of building an «Approach of typologies for energy assessment of the building stock in Bulgaria». The project was carried out in the period from 2009 to 2012. The coordinators of the project were the German Institute for Housing Construction and the Environment, and a national expert group on the creation of a national typology led by the Sofia Energy Agency (SOFENA). As part of the project, a report is published that provides the data from in-depth studies and analyses of the main types of housing construction, building installations and energy-efficiency measures for building elements and systems in the period 2009-2012.

The SOFENA report (Georgiev, Taneva, 2012) summarizes the process of typology of the housing stock in Bulgaria, with data processing starting in 2001 with the census of the population, housing stock and

agricultural holdings. Then the first data on the country's housing stock were published, with classifications by building systems, storeys, year of construction, settlements, and type of heating and energy source.

After 2001, an interdepartmental working group was created to collect and collate additional information on the building stock, and as a result, in 2004, the National Housing Strategy of the Republic of Bulgaria was developed and published, adopted by Decision No. 395 of 14th May 2004. On the basis of the strategy, a National Programme was developed, which typologizes residential buildings by structural systems and types of building materials, by number of storeys, by building systems and year of construction.

Subsequently, in 2011, the next census of the population and the housing stock was carried out and for the first time information was collected about the presence of solar panels, and for the individual dwellings information was also collected about the energy-saving measures carried out: replacement of windows and laying of external insulation. These data were also used in the development of the Long-term National Strategy for the renovation of the housing stock until 2050.

According to the latest data from this census, 2,060,745 residential buildings were counted in 2011, of which 37% were in cities and the rest in villages. 83.7% of residential buildings in cities and 66.7% of residential buildings in villages are occupied, according to the SOFENA report.

Table 2.1: Building fund of the Republic of Bulgaria

Year of construction	Houses, 1 000 units	Multifamily buildings, 1000 units	Total heated area of the buildings, 1 000m²
<i>Until 1949</i>	433 859	4 194	3 209,74
<i>1950-1959</i>	347 473	4 679	2 065,49
<i>1960-1969</i>	381 145	12 234	3 424,37
<i>1970-1979</i>	240 816	14 162	2 219,59
<i>1980-1989</i>	198 857	13 125	1 845,31
<i>1990-1999</i>	96 922	7 913	912,591
<i>2000-2001</i>	74 144	13 023	758,791
Total	1 773 216	69 397	15 435,886

Source: Sofena 2012 (Georgiev, Taneva, 2012)

The available data on the housing stock in our country is very limited. There is no annual monitoring of individual parameters and characteristics of housing construction. The process of renovation and taking energy-saving measures is also not monitored, which is an obstacle to monitoring a phenomenon such as energy poverty. The targets set in the long-term housing strategy until 2050 can currently only be tracked through population censuses every 10 years.

In order to offer an opportunity to include indicators for household housing in national surveys, an analysis of the indicators according to the type of household housing contained in «Household budgets survey» is made. The analysis shows a significant difference in energy-poverty levels by housing type, with **energy poverty in detached houses predominating**, reaching the highest levels by all definitions, and 26% higher than in apartments under the ‘Ten-Percent Rule’, by 25% according to ‘Poverty After-Energy-Expenditure’ and by more than 20% according to ‘Low Income – High Cost Share». These indicators would be most suitable for an official energy-poverty line when choosing criteria for funding energy efficiency programmes, as they would reflect the most effectively implemented measures.

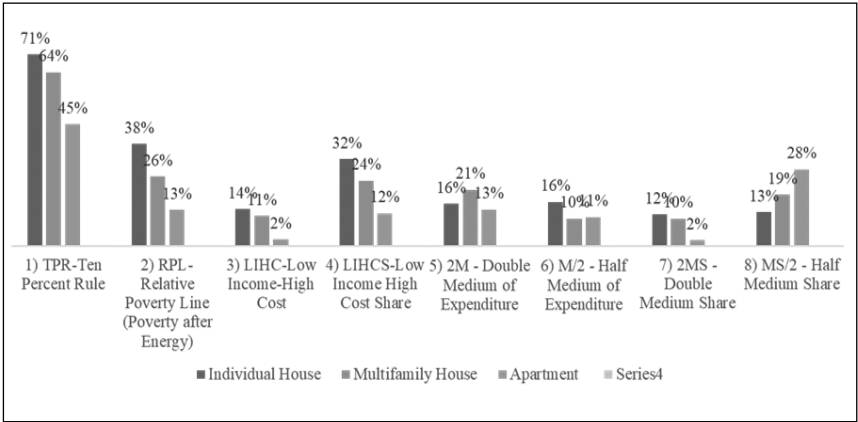


Figure 2.8: Energy-poor households by building type, 2017

Source: Own calculations with anonymized data from NSI

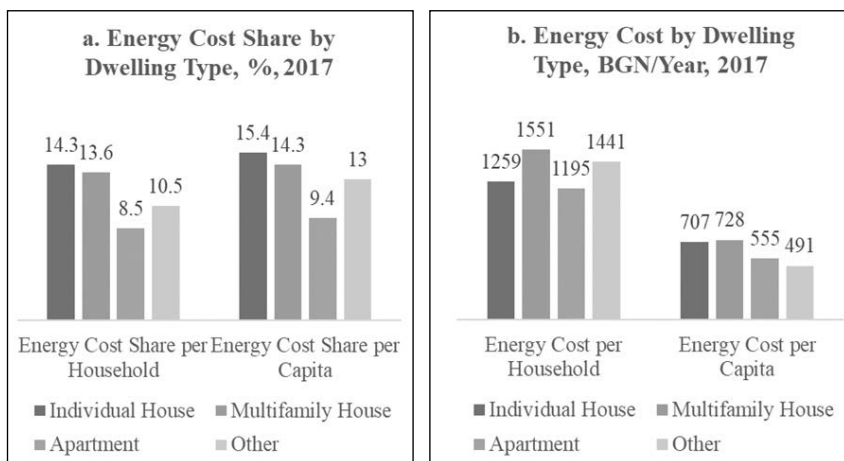


Figure 2.9: Energy cost and cost share by building type, 2017

Source: Own calculations with anonymized data from NSI

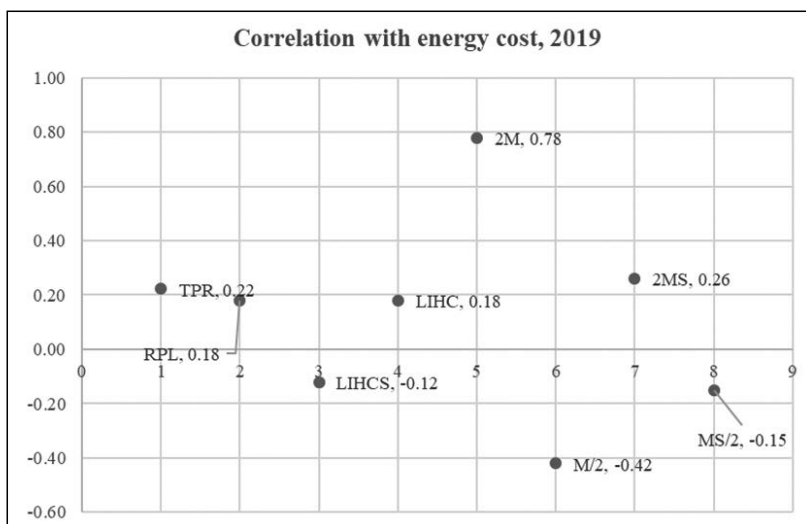


Figure 2.10: Correlation of energy poverty indicators with energy expenditure in the sample

Source: Own calculations with anonymized data

A correlation analysis of energy expenditure shows an ambiguous and varying strength of correlation with expenditure indicators of energy poverty. This means that the choice of indicator is essential for the adequate reflection of the problem, and at the same time that the measures aimed at reducing the expenditure will have a weaker effect than the measures to increase the income.

As a factor, changes in energy consumption affect energy poverty indicators as follows:

- Strong positive correlation with the 2M indicator, weak positive correlation with the TPR, LIHC indicators and the composite index of 6 indicators.

• Negative weak correlation with RPL and LIHCS and moderate with M/2 – which should for this reason be prioritized at choosing a definition, in the absence of arguments to the contrary.

Another factor must be taken into account: the problem of availability of capitals. Energy poverty is not only the inability and difficulty to meet current energy needs and obligations. It is also a problem of capitals available (Scott et al., 2008). Households do not have the capital to invest in energy efficiency. This hampers the implementation of national housing renewal programmes. An organization for renovating blocks with co-financing by the owners is practically inapplicable, if even two or three households cannot afford such an investment. Therefore, applying a differentiated financing approach will be an important part of the energy-poverty reduction policy.

2.3. Heating Type and Energy Poverty

The structure of energy consumption in households by type of energy carrier is determined by many factors depending on the political and economic system: the physical infrastructure, which includes heating infrastructure (energy-consumption structure), the type of buildings and housing ownership, and the structure of energy production. Bulgaria is cited by Buzarovski as the most classic example of a strong influence of the socio-political system on the current state of the building stock in the country, as a consequence of the communist regime and the massive

construction of panel housing. In this aspect, the physical infrastructure in Bulgaria is characterized by a relatively outdated building stock, an undeveloped domestic gas supply network, and a district heating network in 17 cities of the country with declining consumption. These are the long-term factors influencing the type of heating and the type of consumption according to the energy carrier in households.

In Bulgaria, households are heated mainly with electricity and solid fuel, according to two different sources: a report by Sofena (Georgiev, Taneva, 2012) and a report by the World Bank (WB, 2016), both reports with data from 2012 (Figure 2.11).

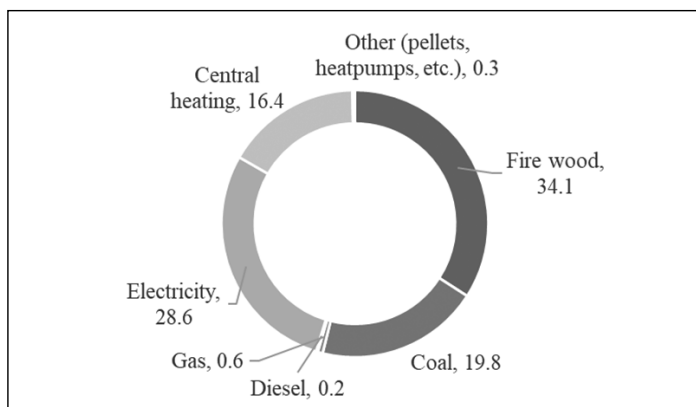


Figure 2.11: Main source of heating in households in Bulgaria (% of inhabited dwellings), in 2011 (Georgiev, Taneva, 2012)

According to data from the Bulgarian Natural Gas Association, only 1.5% of Bulgarian households in 20 cities in the country use gas as of December 2013 (MRDPW, 2015). According to the National plan for Accelerated Gasification in Bulgaria, gasification of 30% of the Bulgarian population is foreseen by 2020, and it is expected that at this level, the annual gas consumption in the country will increase to 750m³ per capita, and will approach the EU average. As of 2020, no more than 3% of these goals have been achieved. High gas prices internationally in late 2021

and early 2022 put under scrutiny how reliable are the expectations for developing a household gas network.

Central heating is available in 12 cities in Bulgaria, and the total percentage of citizens using this service is below 15%. The percentage is too small, but the most important thing is that instead of being the cheapest heating, providing the highest level of comfort in Bulgaria, central heating often becomes one of the causes for energy poverty, because the bills are uncontrollable.

In second place as a factor is the behaviour of the consumers, which in the last few decades has been characterized by the following clear trends:

- 1) Choice of heating allowing control over consumption (mass non-consumption and withdrawal of central heating supply);
- 2) Choice of heating at a lower price (solid fuel);
- 3) Choice of heating to increase energy efficiency (RES systems) and cost saving.

The first two trends are caused by insufficient incomes, while the third trend is related to the availability of incomes allowing investments in efficient and renewable energy systems.

When analyzing energy consumption by decile groups with data from the «Household Budgets Survey», the following trends are outlined:

- In the case of low-income households, the consumption of energy from solid fuel increases, the consumption of heat energy and, to a lesser extent, electricity decreases.
- In high-income households, the consumption of heating energy and gas increases, and that of solid fuel decreases.
- The choice of heating, as well as the amount of energy used, is directly related to income.

Correlation analysis on Figure 2.13 shows that gas and oil are not related to energy poverty, with zero-dependence coefficients, due to low household consumption. Solid-fuel consumption has a weak positive dependence; electricity consumption has a positive negative dependence.

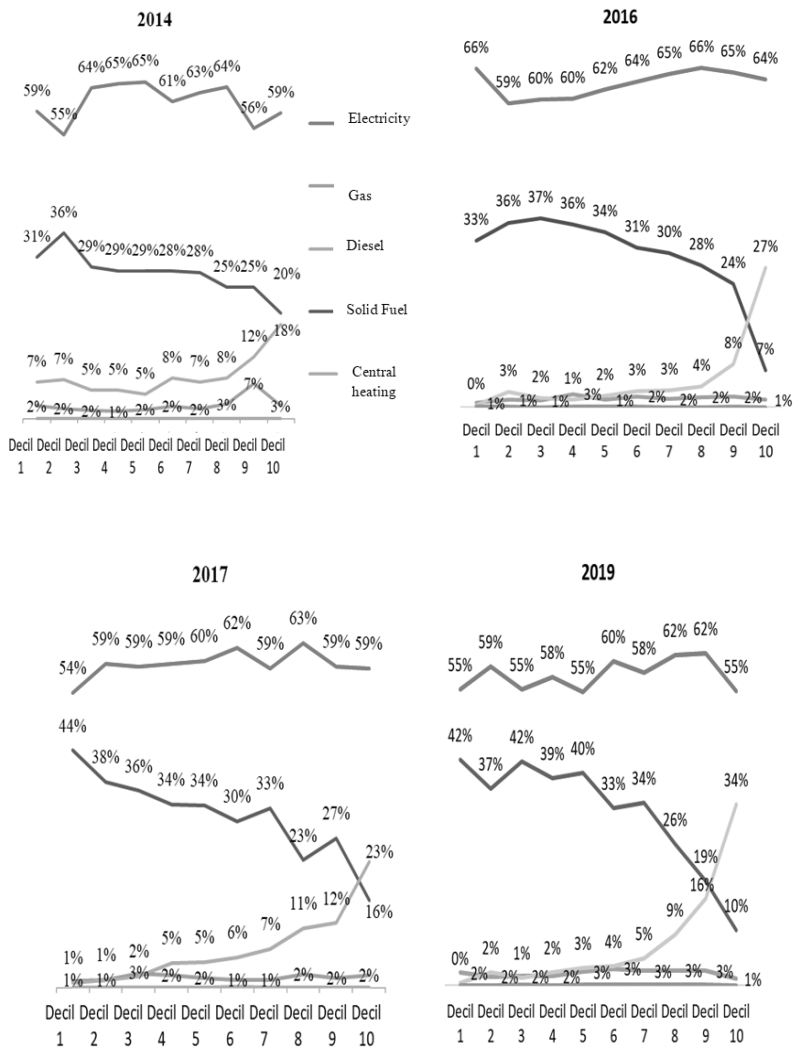


Figure 2.12: Energy consumption by type and decile groups, weighted amount, in %

Source: Own calculations with anonymized data from NSI

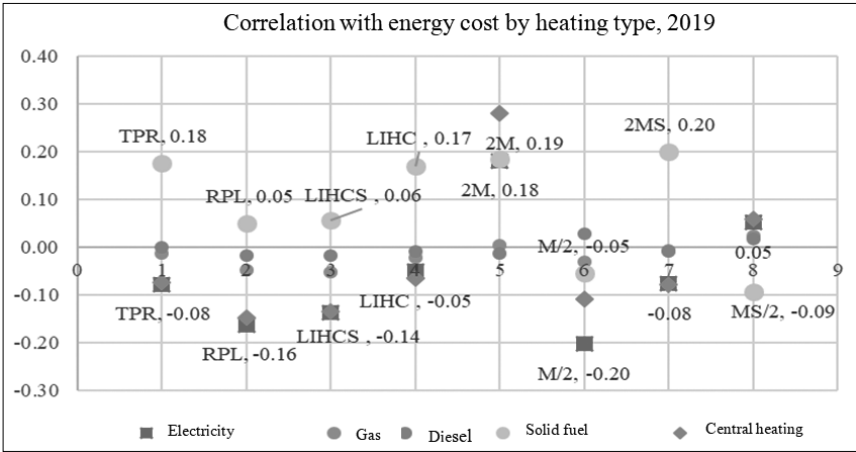


Figure 2.13: Correlation of consumption by type of heating with energy-poverty indicators

Source: Own calculations with anonymized data from NSI

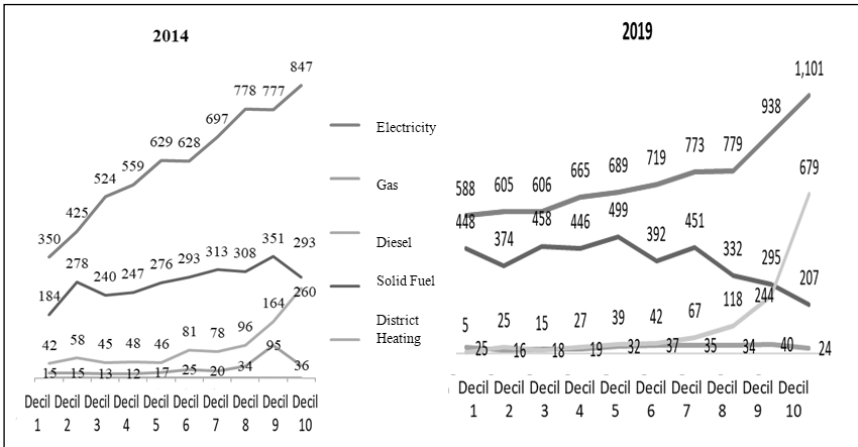


Figure 2.14: Average energy expenditure by type of heating and decile groups, BGN/year

Source: Own calculations with anonymized data from NSI

Factor analysis with data from 2014 (Peneva, 2021) shows that for the indicators ‘Low Income – High Cost’ and ‘Ten-Percent-Rule’, the type of heating is the most important in the first place, and the number of persons living in a household, followed by the type of dwelling.

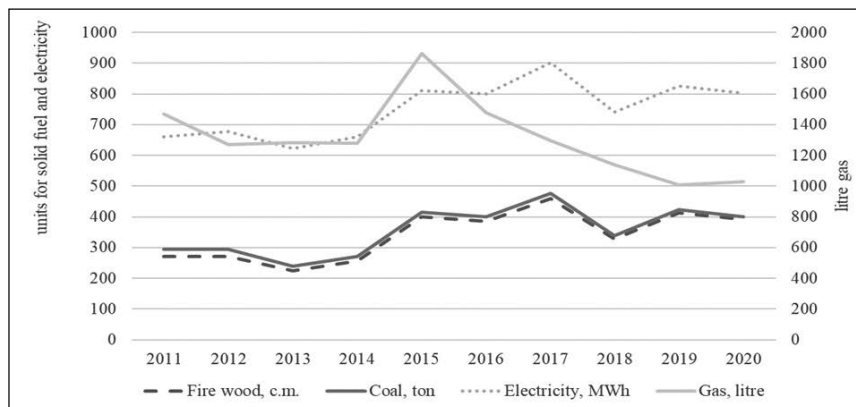


Figure 2.15: Amounts of basic goods purchased by households

Source: NSI

Data from NSI on purchased amounts of basic goods (Figure 2.15) shows an increase in the amount of solid fuel in the period 2014-2017, which is also evidenced by the data of the expenditure approach for increasing energy poverty, with a subsequent decline in 2018, when the amount of energy resources sought by the households also declined. This is another signal how important is the climate factor in the calculation of energy poverty, since in 2018 the amount of all energy resources fell.

Calculations on elasticity as regards prices and quantities per household conducted by NSI in table 2.2 showed strong modifications in both direction and intensity, which also speaks to the weight of factors other than the prices of the resources.

From the statistics above, it can be concluded that energy poverty in Bulgaria is increasing, and as a result, an increasing share of the population switches to heating with solid fuel. The increase in energy poverty has led to a smaller gap in electricity and solid fuel use, with solid fuel

displacing electricity even in the lower decile groups, as resource prices rise faster than income growth.

Table 2.2: Elasticity of demand for energy resources for households

	Fire wood	Coal	Liquid fuel	Electricity	Gas
	m ³	kg	litre	KWh	litre
2012	0.0	0.6	1.7	0.7	-2.4
2013	4.1	4.0	3.7		-0.4
2014	-8.4	3.8	-0.8	-0.3	0.2
2015	17.2	-2.7	1.7	0.1	-3.8
2016	-0.5		-1.7		1.6
2017	3.9	2.9	9.4		-1.2
2018	-4.0	-3.1		-0.9	-2.1
2019	4.5	-0.3	3.3		4.3
2020	-3.4	-2.8	-5.8	0.0	-0.5

Source: Calculations with NSI data

Switching the type of heating is used as the only effective way to reduce poverty, control costs, and limit energy injustice. The choice of heating, as well as the amount of energy used, are directly related to income.

2.4. Household Type and Energy Poverty

The structural factors among the sociological factors also include all demographic factors, such as household size. In Bulgaria, households are relatively small, with an average of 2,3 people per household. This implies smaller needs for heating, and also explains the fact that in the country, on average, one room is heated, and the others do not reach the level set by the World Health Organization of 18°C. An analysis of energy poverty among the working poor (Peneva, 2015) shows that nearly 60% of them spend less than 10% of their income on energy, and that the

actual thermal comfort they provide falls short of WHO standards for nearly half of them. Only 7% of households in the 2015-sample achieved adequate comfort with spending up to 10% of their income.

Demographic factors also include the characteristics of groups that may be at risk of energy poverty: the elderly, people with disabilities, people in small localities, single parents, and families with many children without a fixed income who rely on social assistance and other sources of support. In Bulgaria, since 1995, special criteria have been developed for grouping and defining vulnerable consumers in the country, included in a mechanism for social assistance, the so-called ‘targeted aid for heating’. This mechanism is relatively well developed and working, including 20 types of vulnerable groups, but due to a low income criterion, the scope of these groups is small, up to 7% of the population (MLSP, 2021). The binding of the Guaranteed Minimum Income, which does not reflect the rise in the cost of living, predetermines a shrinking range, lagging behind in incomes.

An energy-poverty line should be able to adequately reflect the greater need of vulnerable groups for energy due to their permanent residence in housing. An appeal for the inclusion of vulnerable groups in the development of policies to reduce energy poverty was made (Jeliazkova, 2020; Kisiov, 2020; Shopov, 2016; Peneva, 2021) as well as was formulated in opinions of the Economic and Social Council of the Republic of Bulgaria (ESC, 2009) and the Ombudsman.

Data from 2019 for households per number of children under 18 shows a positive trend in energy expenditure with number of children, but a negative trend when looking at expenditure per person, possibly from the cap on income per person, also decreasing with the number of children.

A table of data from 2014 to 2019 shows that energy costs increase with the first and then further with the second child (excluding 2014), with an average difference of 22% for the first child and 30% for the second. This is an average coefficient based on the sum of the average energy costs of the respective group of households in a five-year time period.

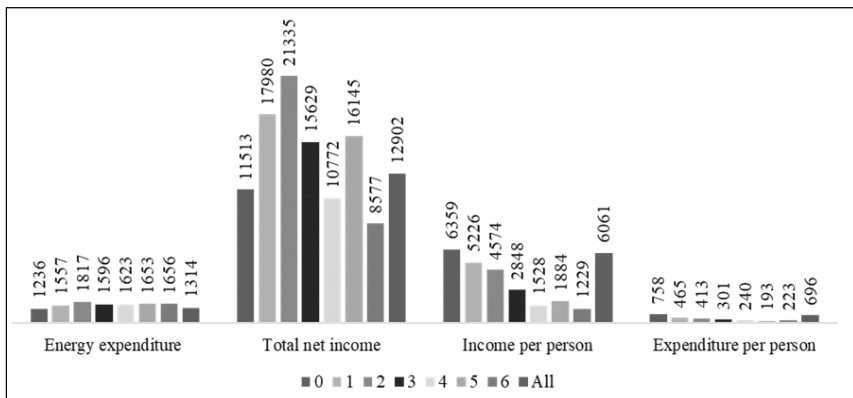


Figure 2.16: Household expenditure and income by number of children under 18, BGN/year, 2019

Source: Own calculations with anonymized data

Table 2.3: Household expenses by number of children up to 18, BGN/year

Num-ber of children below 18	Water cost 2019	Average energy cost						Coeff-icient for energy 2014-2019	Coeff-icient for water 2019
		2014	2015	2016	2017	2019	2014-2019		
0	167	1094	1055	1135	1214	1248	5746	1.00	1.00
1	234	1156	1430	1433	1478	1502	6999	1.22	1.40
2	262	1027	1445	1543	1521	1936	7473	1.30	1.57
3	303	1363	1085	1147	1612	1773	6980	1.21	1.81
4	224	987	1212	1019	1386	2405	7009	1.22	1.34
5		1639	1075	383	430	/	3526	0.61	0.00
Total	179	1101	1132	1189	1262	1314	5998	1.04	1.07

Source: Own calculations with anonymized data

The coefficients obtained when indexing household consumption per child show an increasing trend.

After the second child, there is a drop in average household consumption, which may be due to the lower average income of households with 3 or more children, and a corresponding restriction in energy consumption, the smaller sample of the respective group of households with especially 4 and more children, and also limited space for heating regardless of the increase in the number of children.

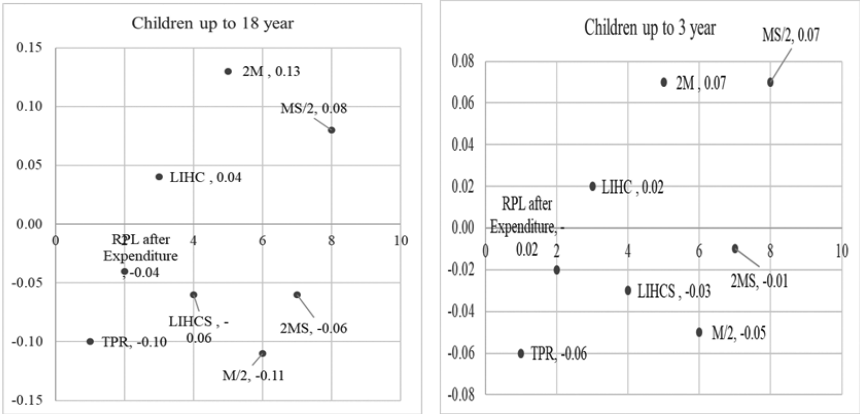


Figure 2.17: Correlation of energy poverty indicators with the presence of children in households, 2019

Source: Own calculations with anonymized data

Correlation analysis on Figure 2.17 shows zero dependence of energy-poverty indicators for children up to 3 years of age and weak dependence with children up to 18 years of age only for some of the indicators related to expenses, with two of the indicators showing growth with increasing incomes 2M and TPR, while M/2 reflects poverty and specifically child energy poverty in a weak relationship with energy expenditure. The relationship between the presence of children and income is also visible at figure 2.18, as there is a positive correlation with these indicators, where an increase in the range with an increase in income is noted. However, due to the higher energy expenditure, apparently families with children under 18 are more vulnerable than others without children.

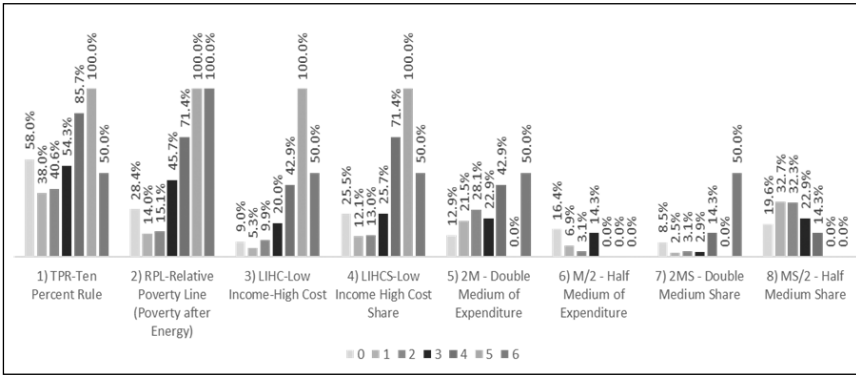


Figure 2.18: Energy-poor households by number of children under 18

Source: Own calculations with anonymized data

The analysis of households by the number of elderly persons over 65 (Figure 2.19) shows similar trends, and here the characteristics of energy poverty are even clearer. As the number of adults increases, income per person per household falls, while expenditure per person is higher than in households without adults (Figure 2.19).

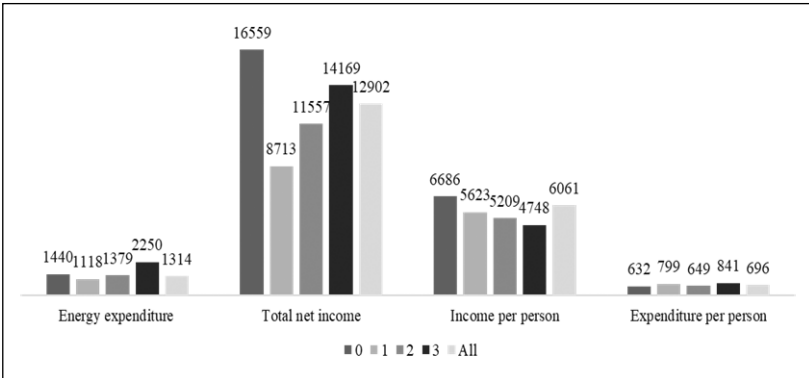


Figure 2.19: Household expenses and income by number of adults over 65, BGN/year, 2019

Source: Own calculations with anonymized data

The correlations of energy-poverty indicators with the number of adults are positive (Figure 2.20), albeit weak, or zero, with only 2M and M/2 having a negative dependence. Here, even LIHC shows a positive relationship with the number of adults in the family. There are 4 indicators with weak dependence, of which ‘Ten-Percent Rule» has a coefficient of 0.16, and ‘Poverty after-Energy-Expenditure’ and ‘Low Income – High Cost Share’ has a coefficient of 0.10.

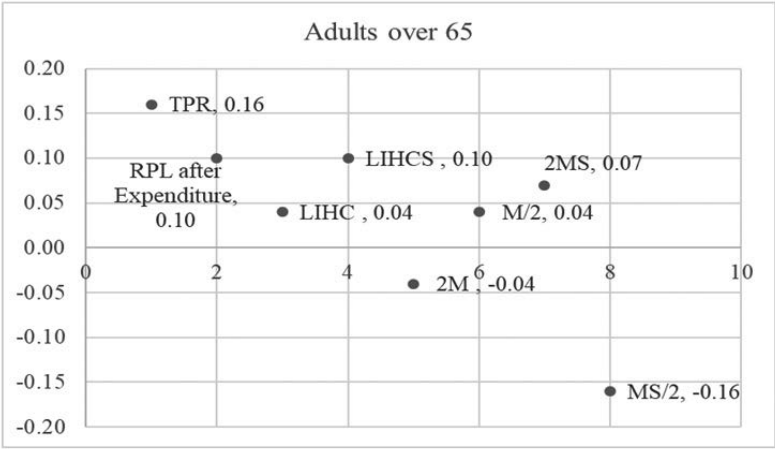


Figure 2.20: Correlation of energy-poverty indicators with the presence of elderly people in the household, 2019

Source: Own calculations with anonymized data

The vulnerability of single elderly is strongest, according to calculations with indicators #1, 2, 4, 6, 7 (Figure 2.21), which show an average of 50% to about twice the percentage of vulnerability when there is an elderly person in the household, regardless of the number of its members.

From the statistical analysis above, **it can be concluded that households with children and the elderly have higher energy needs**, and when they cannot afford them, they register higher levels of energy poverty. Therefore, they are clearly vulnerable groups where targeted efforts

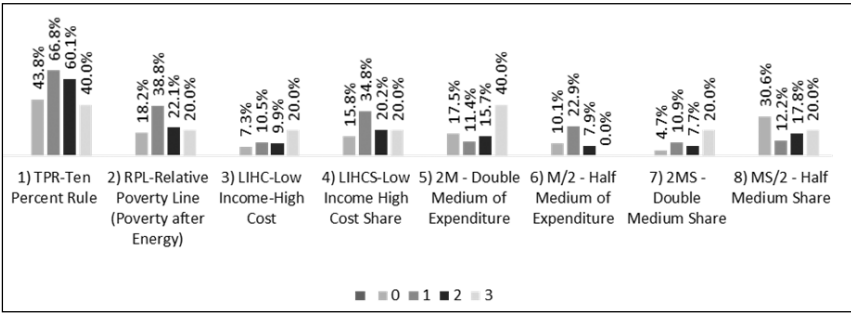


Figure 2.21: Energy-poor households by number of adults over 65

Source: Own calculations with anonymized data

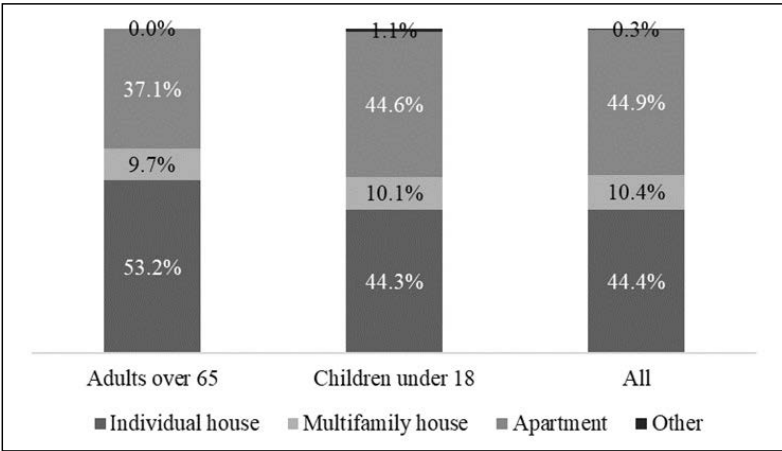


Figure 2.22: Distribution of living adults and children by type of buildings, %, 2017

Source: Own calculations with anonymized data

are needed. Families with children, especially up to two children, have higher incomes than those without children, and this allows for more energy consumption, but for the elderly, unfortunately, this is not the case. Single elderly and large families – with many children and extremely low incomes – remain the most vulnerable.

It is necessary to pay special attention to persons with disabilities who do not use social services and are all day in a home environment. They are not covered by research at the moment, falling under the general category of «disabled due to illness», which needs to be specified. For this reason, no analysis was done in order not to distort the results due to the wide scope of this concept at the moment, including children under 18. Persons with disabilities are covered in the 20 groups of vulnerable consumers, in the table for differentiated income criterion for admission to targeted aid for heating. Persons with disabilities should be in the range of vulnerability to energy poverty, not only because of higher energy needs, but also because of low incomes of the families in which they live.

For this purpose, when developing an official poverty line and defining criteria for vulnerable groups, persons with disabilities without the possibility of placement in the labour market and without the possibility of using social or educational services should be equally included, on an same basis with children and the elderly.

CHAPTER THREE

POLICIES

This chapter aims to provide a proposal for a formal definition of energy poverty, and for a clear energy-poverty reduction mechanism to work on the basis of the definition. First, a general overview of the policies is made, without entering into a detailed analysis, given the objective of the task – how to identify and support energy-poor households, according to what criteria and indicators. Analyses of the policies in this area have so far been made very in-depth by researchers such as Shopov, Tsanov, Kisev, Slavkova, Ilieva, described in the theoretical part of Chapter 1. Here the aim is to set the framework of the mechanism and its mode of action, with the aim rehabilitation policies as per the housing stock to be practically implemented, to increase energy efficiency, and therefore to ease the burden of households on energy bills.

3.1. Proposal for an Official Energy-Poverty Definition

Arguments for introducing an energy-poverty line in Bulgaria

The national goal of an official energy-poverty line should be in the role of a main tool for measuring, monitoring and reducing energy poverty, as part of a comprehensive mechanism for reducing energy poverty in the country in three main aspects:

- Meeting basic heating needs
- Meeting basic electricity needs
- Improving the energy efficiency of the building stock by fulfilling the goals set in the «Long-term national strategy to support the renovation of the national building stock of residential and non-residential buildings until 2050» in two main directions:

- Renewal of buildings (high-cost measures)
- Replacement of heating systems and electrical appliances (low-cost measures)

On this basis, as well as on the basis of the recommended indicators for measuring energy poverty in the EU Recommendations, the present concept applies the first group of indicators for determining the energy-poverty line, namely ***indicators comparing energy costs with income***. Indicators that “*quantify energy poverty by comparing the amounts that households spend on energy with a measure of income (e.g. percentage or number of households that spend more than a certain share of their disposable income on domestic energy services)*”.

Indicators for measuring energy poverty

The following **four groups of indicators** are used to determine the energy poverty line:

1) **Net total income of a household**, below 60% of the median net equivalent income declared annually according to the official methodology of Eurostat, based on the «Survey of household income and living conditions». For this purpose, the necessary indicators here are:

- Number of household members;
- Number of household members under the age of 14;
- Total net total income of all household members from all sources of income, including social benefits.

2) **Amount of energy per household for heating**, legally determined according to a special methodology for determining the needs of households for heating and electricity, with the following indicators:

- a. **Basic amount of energy** according to the type of household for three standards of heated area: 40m², 65m² and 80m², with a basic heated standard of 500kWh/month for 40m², of which 300kWh daytime and 200kWh night tariff (A standard applied in Ordinance No. RD-07-5 of 16th May 2008 on the terms and conditions for granting targeted aid for heating, issued by the Ministry of Labour and Social Policy).

b. Coefficient for heating mode according to the presence of children and people with greater heating needs as follows:

- Pregnant women after the 6th month;
- Children up to 18 years of age;
- Persons over 65 years of age;
- Certified persons with disabilities, who do not use educational and social services, and unemployed or with employment for less than 6 months for the previous year.

If there is at least one member of the above-mentioned groups, a full 24-hour heating regime is applied. If no member of these groups is there, the baseline amount of energy remains.

c. Coefficient for climate zone, in compliance with the average annual number of heating degrees for the respective climate zone based on the average temperature value of the nine climate zones in Bulgaria, as indicated on the map and in the tables of Annex No. 1 in Ordinance No. RD-16-1058 of 10th December 2009 on energy-consumption indicators and energy characteristics of buildings, issued by the Ministry of Economy, Energy and Tourism and the Ministry of Regional Development and Public Works.

Table 3.1. Average temperatures in winter by climate zone

	Zone name	Average temperature for November – April
Climatic zone 1	Northern Black Sea coast and the adjacent regions	5.5 °C
Climatic zone 2	Dobrudja	3.7 °C
Climatic zone 3	Northern Bulgaria - the Danube river	4.3 °C
Climatic zone 4	Northern Bulgaria - central part	4.4 °C
Climatic zone 5	Southern Black Sea Coast and the adjacent regions	6.0 °C
Climatic zone 6	Southern Bulgaria - central part	5.1 °C
Climatic zone 7	Sofia and the Sub-Balkan valleys	3.4 °C

Climatic zone 8	Southern Bulgaria	5.5 °C
Climatic zone 9	Southwest Bulgaria	6.7 °C
Country Average		5.0 °C

Source: Ordinance No. RD-16-1058¹³

The nine climatic regions are presented on the following map, pursuant to Ordinance No. RD-16-1058:

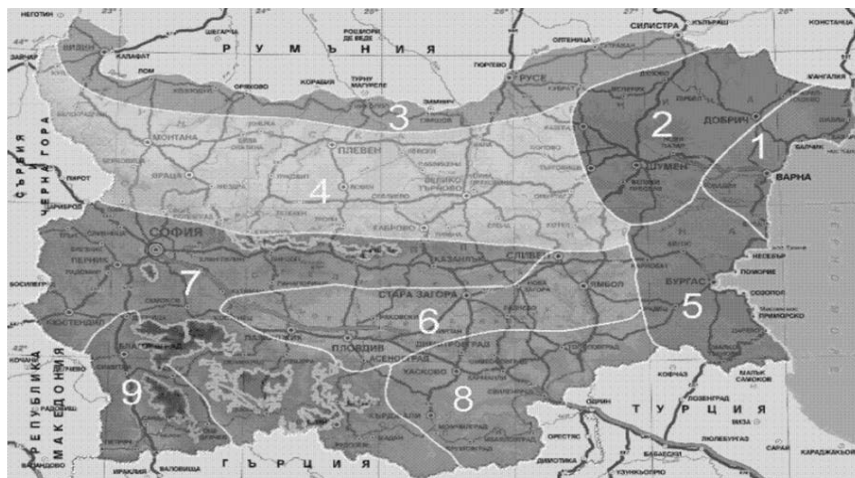


Figure 3.1. Map of climate zones

Source: Ordinance No. RD-16-1058

d. Coefficient for building type (according to the classification of the research used - in the Households' budget survey of NSI) for three types of buildings:

- Detached house
- Apartments
- Multi-family house

¹³ Ordinance No. RD-16-1058 of 10th December 2009 on energy-consumption indicators and energy performance of buildings.

e. Coefficient for main heating system type

- electricity
- thermal energy
- natural gas
- Solid fuel

f. Coefficient for the type of energy-efficient measures taken

- External insulation (full, partial, without)
- Internal insulation (full, partial, without)
- Joinery (full, partial, without)

The amount of energy for heating a household, as determined by the regulatory framework, is to reach 21°C thermal comfort for the specified surface at an average outdoor temperature for a season of 5°C (the average for the country, according to average values of all 9 climatic areas as stipulated by Ordinance No. RD-16-1058)

Table 3.2.: Criteria for determining a regulatory standard
of energy consumption

Household Type	Basic amount* KWh per season	Full heating mode KWh per season	Climate zone index	Building type index	Heating system type index	Energy-efficiency measures index
Single person (40m ²)	1430	3215	For 9 zones	For 3 types of buildings	For 4 types + renewable energy	For external insulation, internal and joinery
Two persons (40m ²)	1430	3215				
Three persons (65m ²)	2320	5220				
Four and more persons (80m ²)	2860	6430				Full / partial / none

* Methodology for determining the base amount of energy – *see in the Appendix*

3) Amount of energy per household for electrical appliances and hot-water heating

According to the methodology used by the Ministry of Energy, announced on 16th May 2016 in a presentation of the Mechanism on the protection of vulnerable energy-users, the amount for electrical appliances and water is defined as 150 KWh per month for heating with a boiler and 100 KWh for heating with thermal energy. This development was made with the aim to implement a social tariff for electricity; consumers of heat energy being excluded from it.

The quantity of energy needs during the non-heating season was developed by MLSP in 1995 in the initial form of a targeted-aid-for-heating, which also included energy for other purposes during the non-heating season. As stated by the measure, a one-room apartment needs 100 KWh, and a two-room apartment needs 170 KWh (see 1.3 Dimensions of energy poverty in Bulgaria).

For the purposes of devising an energy-poverty mechanism, 150 KWh is used for all households, which can be increased to 200 or 250 according to the number of members in the household.

4) Energy price per household for the relevant type of energy and energy source (heat energy, electricity, solid fuel, gas) and for the respective zone:

- a. For heating (for the respective city when using heat energy, for the respective zone of electricity-supply companies when using electricity, for the corresponding gas supplier in the city, and in line with the average statistical value for the country for solid fuel);
- b. For electrical appliances and for heating hot water.

5) Energy class of a building (applicable only to long-term high-cost measures, to prioritize energy-poor households in G and F energy-class buildings).

Definition of energy poverty

Currently, there are various definitions proposed by Bulgarian researchers:

- **Shopov** (Tsanov et al., 2018): *“Energy-poor are consumers who, at the current prices of energy services (electricity, heating, gas), due to their income, age, work, family and/or health status, cannot cover their expenses related to reasonable consumption of energy services in their home, necessary for carrying out various non-commercial, indoor activities, such as heating, lighting, use of various household and other appliances for cooking, lighting, cooling, hot water, entertainment, exchange of information, etc., which are necessary for the satisfaction of the respective basic needs.”*

This wording uses more general concepts and factors of energy poverty. With a view to its practical use for the purposes of social support (if it will be decided to practically deal with energy poverty, which is logical and necessary), the institutions should further specify and quantify in the regulatory framework the parameters of costs for ‘reasonable consumption of energy services at home’, necessary to meet the corresponding basic needs of heating, cooling and lighting of residential premises, hot water, and other non-commercial indoor activities, as well as the characteristics of the ‘status’ of the poor people.

- **Centre for energy efficiency EnEffect** (EnEffect, 2019) offers several definitions, which are closer to the analysis in our work: 1) *“Energy-poor are those households whose disposable income, after ensuring the temperatures, as determined by the regulatory framework, in the heated part of their homes, falls below the official poverty line”*; 2) *“Energy-poor are those households that spend more than 10% of their income on energy.”*

Given the recommendation to use the indicator for ‘Poverty after-Energy-Consumption’ as the most adequate and effective one for the situation in Bulgaria, a combination of the above proposals can be made to explicitly include a norm for needs other than heating, as follows:

“Energy-poor is a consumer (person or family) who, at the current prices of energy services (electricity, heating, gas), due to their income, age, work, family and/or health status, falls below the official poverty line after deduction of their expenses related to reasonable consumption of energy services in their home, necessary for the performance of various non-commercial, indoor activities, to ensure

legally established standards for heating in the heated part of the dwellings, lighting, use of various household and other appliances for cooking, lighting, cooling, hot water, entertainment, exchange of information, etc., which are necessary for the satisfaction of the corresponding basic needs.”

The established standards in the regulatory framework for energy by type of activity are regulated in the **Ordinance for determining the needs of households for heating and electricity**.

On this basis, another definition can be developed, after holding working groups and public discussions.

In order to apply an energy-poverty line for energy-efficiency policies and replacement of heating systems, it is necessary to publish the coefficients of the individual indicators as regards calculating the amount of household energy for heating in a special **Ordinance for determining the needs of households for heating and electricity**.

It is important to use the data from the national census from the year 2021 whenever possible to develop the coefficients, and also to assess the impact of a criterion before its official introduction.

To monitor energy poverty, it is necessary to add the following questions from the National Census to the annual «Household Budgets Survey»:

- In the dwelling section, questions 14, 15 and 16 for type of external and internal insulation, as well as for windows;
- Question 20 for the main type of energy source for heating.

For monitoring, analysis and policy recommendations to reduce energy poverty, it is also necessary to create an 1-person unit to coordinate all agencies and with the above developed coefficients and on the basis of census data to make an initial assessment of the proposed definitions, on the basis of which to choose which of them to add to the Energy Law¹⁴.

¹⁴ Although the RRP envisages the inclusion of a definition of energy poverty in the Energy Efficiency Law, the author believes that first of all the definition should be promulgated in the Energy Law, as a paragraph after the definition of vulnerable consumers.

Applying either definition, a **Methodology for Determining an Official Energy-Poverty Line** is to be developed that describes how to select the median energy-expenditure equivalent scale for energy expenditure and select research for annual analysis, how and how often to publish the official line.

(1) The energy-poverty line for the country is determined based on the data from the survey «Household Budgets Survey», annually conducted by the National Statistical Institute (NSI) with an income threshold determined by the official poverty line for the country by the Ministry of Labour and Social Policy.

(2) The energy-poverty line for the country is calculated according to the formula for each household:

$$EPL_t = 1 \text{ if } NOD_{t-1} - EE_{t-1} < OPL_t$$

and

$$EPL_t = EPL(HBS)_{t-1} * (PISB_{t-1}/100),$$

where:

- t = the current calendar year;
- t-1 = previous calendar year;
- EPL = energy poverty line for the country;
- OPL = official poverty line for the country from the SILC survey;
- NOD = net total household income
- EE = energy consumption, determined by law
- PL = poverty line per equivalent unit according to data from the Survey of Household Budgets;
- PISB = price index of the small basket, as announced by NSI, and valid for December of the year t-1 compared to December of the previous calendar year.

(3) The size of the energy-poverty line under paragraph 2 for the next calendar year is determined by 31st August of the current calendar year and may be less than the amount determined for the previous calendar year.

Impact assessment of an official energy poverty line

The assessment is made on the basis of data from 2019 in two main directions – when energy prices change and when the amount of typical energy changes. The data show that changes in energy prices lead to changes in the reach of the energy-poor by nearly 1.5 to 2 times greater than changes in energy quantity. This means that the measures in the direction of reducing the amount of energy such as insulation, joinery, etc. would give a weaker effect on the coverage of the energy-poor, which is related to the great depth of poverty, the suppression of consumption, and also the disadvantage of this estimate at the moment without applied coefficients, and the possibility of measuring with a database due to the lack of applied indicators, and conducted research with them.

Indicators using a share of energy expenditure (Rule of 10% and 15%) reflect in the largest range the changes in prices and quantity; they generally exhibit the greatest volatility of incomes as well. With the smallest changes in the economic cycle, and with crises, inflation, etc. these indicators will be exposed to more drastic changes. The most stable indicators with typical expenditure are ‘Low Income – High Cost Share’ and ‘Poverty after-Energy-Expenditure’. These are also the conclusions of Chapter 1 *Dimensions of energy poverty*, which says that regardless of what standard is applied for an official measure of adequate energy services, these indicators will react in a similar way. That is, they show stability in their specifics, with changes in their individual components.

Table 3.3: Extent of the energy-poor at increases in price, %

Indicator	0%	+10%	+20%	+30%	+40%	+50%
	Scope, share of population, %					
<i>Poverty after energy expenditure</i>	48,1	48,9	49,4	49,8	50,6	51,4
<i>Low Income – High Cost Share</i>	37,9	41,0	43,2	45,0	47,0	48,8
<i>10% Rule</i>	42,8	47,7	52,4	56,8	60,0	63,1

<i>15% Rule</i>	22,1	27,1	30,6	34,9	38,7	42,8
	Scope, number of people ¹⁵ , in thousands					
<i>Poverty after energy expenditure</i>	2,426	2,466	2,491	2,512	2,552	2,592
<i>Low Income – High Cost Share</i>	1,911	2,068	2,179	2,269	2,370	2,461
<i>10% Rule</i>	2,158	2,406	2,643	2,865	3,026	3,182
<i>15% Rule</i>	1,115	1,367	1,543	1,760	1,952	2,158

Source: Own calculations with NSI data

Table 3.4: Extent of the energy poor when changing the amount of energy, %

Indicator	+10%	+20%	+30%	+40%	+50%
	Scope, share of population, %				
<i>Poverty after energy expenditure</i>	48,5	48,9	49,3	49,5	49,9
<i>Low Income – High Cost Share</i>	39,7	41,3	42,5	43,5	44,9
<i>10% Rule</i>	45,7	49,0	51,6	54,3	56,7
<i>15% Rule</i>	24,8	27,9	29,9	32,7	34,7
	Scope, number of people, in thousands				
<i>Poverty after energy expenditure</i>	2,446	2,466	2,486	2,496	2,517
<i>Low Income – High Cost Share</i>	2,002	2,083	2,143	2,194	2,264
<i>10% Rule</i>	2,305	2,471	2,602	2,738	2,859
<i>15% Rule</i>	1,251	1,407	1,508	1,649	1,750

Source: Own calculations with NSI data

¹⁵ According to NSI data as of 31.12.2020, a total of 5,043,186 people.

Table 3.5: Ranges of change in the extent of the energy-poor with changes in energy prices and quantity for every 10%

	Energy-price change	Energy-quantity change
<i>Poverty after energy expenditure</i>	0,40% - 0,80%	0,20%-0,40%
<i>Low Income – High Cost Share</i>	1.80% - 3.10%	1,00%-1,80%
<i>10% Rule</i>	3.10% - 4.70%	2,40%-3,30%
<i>15% Rule</i>	3.50% - 5.00%	2,00%-3,10%
<i>Poverty after energy expenditure</i>	20 – 40 thou persons	10 – 20 thou persons
<i>Low Income – High Cost Share</i>	91 – 156 thou persons	50 – 81 thou persons
<i>10% Rule</i>	156 – 247 thou persons	121 – 161 thou persons
<i>15% Rule</i>	177 – 252 thou persons	101 – 156 thou persons

Source: Own calculations with NSI data

3.2. Mechanism for energy-poverty reduction

Current Policies Review

The Energy-Poverty Reduction Mechanism is a tool to identify households most in need of government support to address energy poverty caused by the three main factors – low income, high energy prices, and low energy efficiency of buildings. Along the lines of the three factors, the mechanism should contain clear principles and criteria for admitting households to partial or complete free financing from the state in three main situations:

- Vulnerability of energy consumers caused by low incomes;
- Liberalization of the electricity market or in case of high growth of electricity prices, previously defined as critical with a risk of a rare rise in energy poverty (20%);

- Implementation of energy-efficiency measures from the Recovery and Resilience Plan and the objectives of the Long-term National Strategy to support the renovation of the national stock of residential and non-residential buildings in Bulgaria until 2050.

Each of the three situations covers a range of users of different sizes and needs. For each situation, separate measures and support mechanisms have already been developed, which work independently (in the first situation) or have not yet been implemented.

The first situation of consumer vulnerability caused by low income is a social problem and directly affects the sphere of social protection through targeted social assistance. The measures were developed by the Ministry of Labour and Social Policy. **Ordinance No. 5 on targeted heating allowances** has been in force since 1995, the only social protection instrument reflecting changes in electricity prices annually, covering 252,615 individuals and families in the 2019/2020 season (about 3.6% of the population). Until 2007, the aid was determined on the basis of a monthly norm of 450 kWh of electricity for heating one room, which was reduced to 385 kWh in 2008 and increased to 500 kWh per month in 2019. For the 2019/2020 season this amount, at the respective prices, equals BGN 93.18 per month, or BGN 465.90 per heating season (November-March), or BGN 495.8 for the 2020/2021 heating season¹⁶. The criterion for determining the eligible range of users of targeted assistance for heating is the differentiated minimum income for heating, developed on the basis of basic income for heating and coefficients for 20 groups of vulnerable persons.

The second situation is a problem for the energy system and affects a wider range of consumers, defined by the Ministry of Energy as nearly 500,000 individuals and families, or 1 million people (14% of the popula-

¹⁶ For more details see Shopov G., Peneva T. (2018).

tion). The instruments intended for this group, described in the Mechanism for the Protection of Vulnerable Consumers¹⁷ by the Ministry of Energy in May 2016 (ME, 2016a), are of three types: financial (social electricity tariff), non-financial (vulnerable customer register, information campaigns, suppliers' code of ethics) and long-term measures (to increase energy efficiency). The criterion for determining the permissible circle of users of the tools has not been defined, the mechanism itself is not spelled out in a law or a regulation. A possible eligibility criterion could again be the differentiated minimum income scheme with coefficients for 20 groups of vulnerable consumers, with an increased income criterion to allow twice as many individuals and families. The duty to execute the measures rely on the electricity suppliers, which means the need for synchronous work of the electricity-distribution companies with the

¹⁷ The definition of the term 'vulnerable users' is presented in Tsanov V., G. Shopov, I. Beleva, Y. Hristoskov, 2018. *The labour market and social protection on horizon 2020*, pp. 235-237 [in Bulgarian]: "Vulnerable are household customers whose premises are inhabited by persons who, due to their relatively less favourable income, health, work, family and/or age status and quality of the inhabited dwellings, are unequally positioned and cannot provide in their homes the consumption of energy services sufficient in volume, necessary to satisfy their basic physical, spiritual or social needs, therefore they need specific social protection, including targeted social assistance, as well as measures for continuous supply of energy services and energy efficiency."

In addition to this definition, a rewording is also possible, according to which "Household customers are vulnerable, in whose premises live persons who are energy-poor, therefore they need specific protection through the social and energy policy, including measures for targeted social assistance, as well as affordable prices and continuous supply of energy services necessary to meet their basic physical, spiritual or social needs.", which would be socially accepted, explicitly emphasizing, however, that vulnerability requires specific protection from society, understood as a combination of measures in the field of social assistance, but also those regarding the guaranteed/continuous supply of affordable services. The other possible measures related – let's say – to the energy-efficiency of buildings, the optimization of indoor energy consumption, etc., (should) be directed against energy poverty.

Social Assistance Agency, which will approve individuals and families for admission to the financial instruments.

The third situation concerns energy-efficiency programmes that are long-term but targeted at the whole population and do not have an income criterion applied, since the buildings are usually occupied by families with different types of income. A total of nearly 150,000 homes, or nearly 360,000 people, received funding under the **«Support for Energy-Efficiency in Multi-Family Residential Buildings» Programme** (ME, 2016) of the Operational Programme «Regional Development» (2007-2013) with a total budget of BGN 500 million, with renovated 155 buildings with 2,184 dwellings for the period 2007-2013, and under the **National Programme for Energy-Efficiency of Multi-family Residential Buildings (2015-2020)** (MRDPW, 2015) with a total budget of BGN 1 billion with renovated 2,022 buildings with 147,761 dwellings with a total area of 11,525,389 m². In the event that a differentiated income-based financing approach was applied to the financing of these buildings, the number of renovated dwellings could have been at least doubled. Apart from them, in Bulgaria there is experience with a programme aimed at people living in areas with severe air pollution. The **Programme «Improving the quality of the air»** (MEW, 2018) of Operational programme «Environment» 2014-2020, including replacement of old solid-fuel stoves (15,000 in Sofia for BGN 44.5 million (Spasov, 2020), the **Life+** programme, addressing the replacement of 5,000 stoves in Sofia, in Vidin (1,600 families at BGN 3,000 each (24chasa), and in several other cities such as Montana, Dimitrovgrad, Burgas and Blagoevgrad – only part of the 26 municipalities identified with a requirement to replace solid-fuel stoves by 2021 in order to reduce pollution with fine-dust particles as required by the World Bank (Nikolov, 2018). Unfortunately, the development of this programme has not been without problems, and some media have commented on receiving only 1.55% of the funds intended to combat fine-dust particles in 2019 (Gocheva, 2019).

The goals set in the Long-Term National Strategy to Support the Renovation of the Building Stock of Residential and Non-Residential Buildings in Bulgaria by 2050 (ME, 2020), require nearly 60% of all residential buildings to be renovated by 2050 and nearly 17% of non-residen-

tial buildings. The area of renovated buildings from the entire building stock will be over 45%. The valued measures amount to nearly BGN 23 billion for residential buildings alone, according to the strategy, of which BGN 4 billion will be gratuitous finance. This means that only one sixth of the finances will be provided by the EU, while the remaining 5/6 must be financed by private individuals. This important feature means finances for only 17% of the population, with a requirement to renew 60% of the housing stock. Measurements of energy poverty show that not a small part of the middle decile groups are also affected by the problem, and when there is a drop in income or a rise in electricity prices at the national level, they fall into the group of vulnerable. The depth of poverty and the risk of falling into poverty and energy poverty are two new concepts to be included in the mechanism. At the same time, not all households from the low decile groups fall into the dimensions of energy poverty. Therefore, the financial measures here should affect a wider circle, admissibly above the official poverty line, with applied differentiated support according to income, to be able to include more participants in the process of renovation of buildings, and not to hinder the implementation of measures that deal with saving of energy.

At the moment, quite a few analyses and reports have been developed with proposals for measures and policies to reduce energy poverty, described in the theoretical part, and presented in a little more detail below. Until now, unfortunately, work is being done «piecemeal», various projects financed by European programmes and funds are being tried, and there is no unified coordination, analysis, monitoring and possibility to implement the effective measures at the national level. Therefore, below, first, an overview of the measures is given, and then the processes and the way of working of a comprehensive mechanism for synchronized and coordinated management of the various measures in the country are commented.

The proposals for measures in this part further develop and enrich already published ideas and views on a comprehensive mechanism (Shopov, Peneva, 2018). An updated summary of the mechanisms according to recent publications by experts and researchers in the field is presented synthesized below.

Measures for energy poverty reduction

The policy to limit energy-poverty in Bulgaria should include three main groups: **financial, non-financial and long-term** (ME, 2016a). In 2019, the Institute for Economic Research of the BAS developed a «National Energy Strategy (with a focus on electricity)». In «Activity VII - Social dimensions of the development of the electricity-industry and the liberalization of the electricity market». These measures are presented and analyzed in detail, therefore only a brief summary is made here.

Financial measures include targeted heating aid, a social tariff for electricity and credit lines, and grant funding for investments in long-term measures to increase energy efficiency. In the case of financial measures, the most important is to answer the questions: how to identify the users of these measures, according to what criteria and indicators.

Along with the financial measures, it is important to include those of an organizational nature. Flexible payment methods were also proposed by the Economic and Social Council of the Republic of Bulgaria in 2015 in an opinion (ESC, 2015) on the subject and by the Ombudsman of the Republic of Bulgaria Maya Manolova in June 2016 in her statement (Manolova, 2016) to the media. In addition, the ombudsman also proposed the following non-financial measures:

- National scheme to support the replacement of electrical appliances with higher energy-efficiency and free replacement of measuring devices;
- Structuring a fund to support the energy-poor, in which funds will be collected from both the state and the free market traders and the electricity producers to support vulnerable groups;
- A voucher system to be used both to pay electricity bills of the socially disadvantaged and to replace low-efficiency heating appliances with more efficient ones.

Non-financial measures ensure the protection of consumers by improving their awareness and the awareness of the government and, respectively, the energy companies of the target groups, and ensuring the protection of their rights to continuity and accessibility of services.

- *Information campaigns* should be provided for rights of accessibility and continuity of services, for energy saving, for programs and projects. The campaigns aim to enrich households' knowledge about energy consumption and the way they use appliances in the home, provide information about the equipment in the home, about the types of electrical appliances, insulation and the way of heating in the home. Information campaigns by energy suppliers, in the form of information brochures, radio-television campaigns, press articles, and also projects with a certain number of households included.

- *Register of vulnerable customers* for whom the electricity suppliers have a prohibition to suspend the electricity supply during the winter period. This measure aims to protect the most vulnerable groups of users during periods when heating is extremely important for the health and normal functioning of the human body. The measure is also regulated by directives 2009/72/EU; and 2009/73/EU, and in Bulgaria it was proposed for implementation by the Ministry of Energy in May 2016, with the ban being for a period of 30 days after the specified final date for payment for persons with over 90 percent reduced working capacity, with a certain external aid. In most countries of the European Union, there are regulated warnings before disconnection, with a certain minimum period and number of warnings, but only in some countries this measure has been introduced with an announced period of prohibition, both for electricity supply and for gas supply. In France, such a measure was introduced in April 2013, and in Poland this measure is general, affecting all households, not only vulnerable ones.

- *Code of ethics for energy suppliers*. This measure was proposed by the Ministry of Energy in Bulgaria in May 2016, and aims to establish rules for good behaviour of electricity suppliers. Similar codes exist in countries where the energy market is at a more advanced stage of liberalisation, and the number of energy suppliers is large, with many small suppliers. The creation of codes increases the transparency of electricity supply rules and helps energy consumers.

Long-term measures, in turn, refer to the renovation of residential homes in order to increase energy efficiency in the home, the replacement of electrical appliances with energy-efficient ones, and all other

products, services and mechanisms related to the implementation and financing of measures for the long-term reduction of energy consumption. These measures have been developed in 11 packages specifically for residential buildings in the Long-Term National Strategy to Support the Renewal of the Building Fund for Residential and Non-Residential Buildings in Bulgaria by 2050, and have been evaluated. They are divided into three groups by type of housing, for single-family houses, multi-family houses, multi-family buildings, but can be summarized in the following several areas:

- Installation of solar collectors in single-family and multi-family houses in the presence of pitched roofs and the technical possibility of deploying solar collectors/elements with the required orientation;
- Replacement of the fuel base of the individual dwellings/residential buildings using a biomass boiler, heat exchange unit, etc. This includes the improvement of the energy performance of the heating/cooling and domestic water heat systems (incl. replacement of the fuel base);
- Insulation of walls, windows, ceiling, floor, pipes, replacement of radiators, boilers;
- Energy-efficient appliances (lighting, electrical appliances, small energy-saving appliances, water-saving appliances, small measurement tools);
- Smart meters and billing.

Among the long-term measures, we also included the following organizational measures:

- Introduction of a system for measuring and monitoring the energy-poor in the country, and subsequently national targets for reducing energy-poor households included in an updated poverty reduction strategy;
- The creation of an independent unit for tracking and monitoring energy poverty as an important prerequisite for setting and implementing goals in the field, and coordinating programmes and instruments with all affected institutions;

- Minimum requirements for energy efficiency of buildings and passports (certificates) for energy class of buildings;
- Establishment of civic energy cooperatives with the aim of equalizing the rights of vulnerable consumers and the possibility of state support for households unable to invest on their own.

Measures to reduce energy poverty are summarized in the table below:

Table 3.6: Areas for policy intervention to limit energy poverty in Bulgaria

Group	Type of Measures	Target Group	Opportunities for optimization
<i>Financial</i>	Targeted heating allowance	500 thousand people 7% lowest income 20 vulnerable groups defined with a differentiated minimum income	Broadening the scope of users by linking to an official poverty line; Payment in kind for better differentiated support for reaching a norm of adequate services; Possibility of substitution with income replacement measures such as installation of solar collectors
	Social tariff for electricity	1 million people, 14%	Introduction from 2022 Specifying the amount and the criteria and method of access, reporting, payment
	Credit lines and grants under energy efficiency programmes	From 1 million to 2 or 3 million, expected 35% – 45%	Introduction from 2022; Specifying the amount and the criteria and method of access, reporting, payment; Differentiated support up to the energy poverty line according to income status.

<i>Non-financial</i>	Information campaigns for rights of accessibility and continuity of services, for saving energy, for programmes and projects	All	Media campaigns, in ASA, in schools, public places, energy consultants
	Register of vulnerable clients, Household database	All, vulnerable customers	introduction
	Prohibition to suspend electricity supply during the winter period	Vulnerable customers	introduction
	Automatic system for signalling, when electricity prices rise in the free market	All, vulnerable customers	
	Code of ethics for energy suppliers	All	introduction
	Possibility of debt restructuring	Vulnerable customers	introduction
	Consultations and tips for saving energy at home	Vulnerable customers, energy poor	introduction

<i>Long-term</i>	Increasing the energy efficiency of residential buildings and heating systems: 1) Installation of solar collectors in single-family and multi-family houses; 2) Replacement of the fuel base of individual homes/ residential buildings using a biomass boiler, heat pump unit, etc.; 3) Insulation of walls, windows, ceiling, floor, pipes, replacement of radiators, boilers) 4) Energy-efficient appliances (lighting, electrical appliances, small energy-saving appliances, water-saving appliances, small measurement tools); 5) Smart meters and billing; 6) Building civic energy cooperatives for facilitated investment	Energy poor households	Development of a methodology for assessing the needs of households for energy for heating and other needs, for financing needs, and participation in low-cost measures Identification of target groups according to the criteria in the Energy Needs Ordinance Development of a process for reviewing and approving income and expenses of applicants Sharing data with energy providers at the request of consumers.
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	Minimum requirements for energy efficiency and building passports	All	
	National targets for combating energy poverty	Energy poor households	
	Unit for tracking and monitoring the phenomenon; mechanisms for systematic monitoring of the implementation of the set goals.	Energy poor households	

Source: own development based on a mechanism proposed by the Ministry of Energy and on analyses of European directives (EP, 2012) (Milieu, Ricardo, 2016)

Synchronization of measures in a clear process

Bringing these measures into a comprehensive mechanism for reducing energy poverty means synchronizing the measures in the implementation process from approval of candidates for programmes, through implementation of the measures, to reporting, monitoring and development of subsequent programmes and measures, taking into account problems and features signalled by execution time. This means the development of a mechanism for establishing (ascertaining) and upgrading the energy status of each household, and an individual plan for getting out of energy vulnerability. Here the emphasis is not only on what the measures should be, as every single document so far has offered a good summary, but in what order and how these measures should be arranged, provided, upgraded, at the national level and at the individual level. Therefore, it is important to follow a few steps:

- 1) Stage 1: Determination of energy needs. Therefore, a legally prescribed **Ordinance for assessing the needs of households for heating and electricity** is needed, to which there are attached survey cards and an accessible calculator for self-assessment of needs. The assessment will be carried out by the households themselves if they have the opportunity, employees of energy service providers, and social workers, but validation of data such as the presence of insulation should be done by social workers.
- 2) Stage 2: Determination of the income status according to income criteria (after expert working groups and public discussion) in three (minimum) aspects: for heating, for electricity, for investments in energy efficiency¹⁸.
- 3) Stage 3: Automated system for calculating the difference to the income criterion and differentiated grouping of households in order to determine energy support rights.
- 4) Stage 4: Determination of energy support rights. Differentiated grouping of households according to the depth of energy poverty. Providing the option of swapping entitlements – redirecting funding from targeted heating allowances to investment in installing solar collectors, for example, or other long-term measures. Stimulation of long-term investments through preferential schemes.
- 5) Stage 5: Inclusion in programmes and projects with a certain individual percentage of self-financing, percentage of access to free/credited financing.
- 6) Stage 6: Evaluation of the effect of the implemented policies and update of the status of households after using tools.

¹⁸ With three possible options: income criteria for heating (30% of the official poverty line under a differentiated approach), for electricity (60% of the official poverty line under a differentiated approach), for investments in energy efficiency (energy poverty line in different percentage ratio according to the type of measures – larger for low-cost measures and smaller for high-cost measures).

Outside of this vertical process, which seemingly affects the structures of the Agency for Social Assistance as the main entity that is entitled to execute the functions of validating income and expenses and approving rights, it is possible to develop a horizontal process of interaction with other interested parties and participants to support the implementation and the process of the stages of ascertainment of costs, determination of rights and implementation of measures.

- Involvement of licensed energy suppliers, auditors and consultants in validation of energy-cost assessment (Stage 1);
- Development and implementation of software for the automated determination of entitlements to energy support based on an issued «service note» for income from the Agency for Social Assistance, for use by the stakeholders in the above point (Stage 3 and Stage 4).

In this sense, for a better functioning of the system, it is necessary to implement software both for the automatic calculation of rights under set parameters, and for proposals for measures in ongoing programmes, projects or support tools. It is also important to have a system for preliminary assessment of the risk of a sharp rise in energy poverty when macro-indicators are set every month, quarter or other shorter or longer periods, such as GDP, household income and expenses, electricity prices, etc., – to be implemented in an automatic simulation of poverty levels, and to provide automatic measures for proposals for measures at the national level.

It is important to follow the basic principles of operation of such a mechanism, such as:

- Adequacy of energy services. Ensuring a minimum norm of energy consumption;
- Versatility of support. Providing a minimum of support for each household eligible according to the criteria, from awareness of the condition and programmes, to reducing heat losses and, accordingly, energy consumption and eventually bringing to zero consumption;

- User independence. Getting out of the state of vulnerability and poverty. Empowering vulnerable consumers through inclusion in energy cooperatives;
- Freedom to choose support at a certain amount and value according to the vulnerability of the applicants;
- Support upgrade. Start by establishing the energy needs of each household;
- Effectiveness and economy of the measures. Measures on income and energy prices, such as the installation of solar collectors and replacement of heating systems, have a stronger effect;
- Tracking and monitoring the state of energy poverty at the individual and national level. Possibility of periodic evaluation and comparative analysis of the programmes according to indicators such as coverage of the energy-poor, coverage of vulnerable groups, investments, saved energy, reduced emissions, renewed heating systems, renewed electrical appliances, etc.

CONCLUSION

The present study provides a detailed overview of the regulatory requirements and rationale for the introduction of an official energy-poverty line, a review of theoretical research and scientific debate on primarily methodological issues of a different nature, and conducts a statistical analysis of all available data to answer the unresolved methodological issues. Questions concerning the choice of an official energy-poverty line. At the end of the work, a proposal is given for an official energy-poverty line and for a mechanism to reduce energy poverty in Bulgaria.

The theoretical analysis of scientific research and the regulatory framework in the first chapter confirms the need to introduce an official energy-poverty line, which will adequately reflect changes in the energy status of households after energy-efficiency measures have been taken, and to monitor their development annually. The analysis shows the scientific arguments for and against the use of indicators from the three approaches to measuring energy poverty – the objective approach, the subjective approach and the expenditure approach. It is summarized that a consensus is formed among Bulgarian researchers regarding the use of an expenditure approach as the most adequate one, and regarding the possibilities of including subjective indicators.

The statistical analysis of data from the three approaches goes deep into the methodological questions raised in the scientific circles, presenting how the different components of the measures change specifically for the situation in Bulgaria, and gives an answer about the choice of poverty line for the income threshold, the choice of research, the selection of median cost values as a cost threshold, etc. It measures energy poverty by eight main indicators of the expenditure approach with up-to-date data for

five years from 2014 to 2019, and draws conclusions about the dynamics, characteristics and shortcomings of the various measures.

The second chapter presents the main trends in terms of factors such as the long-term state of incomes in the population, causes of permanent poverty, structural factors determining permanent and potential growth in electricity prices at the macro-level on the one hand. On the other hand, at the micro-level, the specifics in the consumption of Bulgarian households are presented, such as under-consumption due to low incomes, control of expenditure by changing the type of heating, greater energy needs of vulnerable groups, and strong trends of increasing poverty parameters among low decile groups, households with children under 19 and adults over 65, and with persons with disabilities.

The statistical analysis clearly shows the direction and intensity of the relationship of individual factors with measures from the subjective and expenditure approach. At the macro-level, indicators such as total household income, total expenditure, GDP, employment of persons aged 20-64, purchased quantities and prices of basic goods by households were studied. The data show that the negative relationship between income and energy poverty according to the objective and subjective approach is not as well pronounced as in the expenditure approach. At the micro-level, the correlations of individual indicators from the expenditure approach have been examined to determine which best reflect the trends from the macro-analysis.

After summarizing the theoretical analysis and the results of the statistical analysis, it can be concluded that the hypotheses presented in the introductory part of the present work are confirmed, namely:

- 1) Energy poverty is formed under the influence of many factors, but socio-demographic and economic factors are dominant.
- 2) The subjective measures of energy poverty are not suitable for the situation in Bulgaria.
- 3) The influence of the dominant factors can be adequately reflected only through indicators containing household energy income and expenditure and supporting a quantitative assessment of needs.

The theoretical analysis of the factors proved the first hypothesis with the review of the economic, systemic and demographic factors affecting the state of energy poverty of households in Bulgaria, and then with a statistical analysis of the relationships with different energy-poverty indicators. The second and third hypotheses were also confirmed, concluding that in order to adequately reflect the problem of income, energy costs, and the type of heating and household, it is necessary to use an expenditure approach for analysis, monitoring and policies to reduce energy poverty. The application of an objective approach will not adequately reflect changes in income, regardless of whether they are caused by the economic situation in the country or by a certain type of policy.

The research drew the following conclusions:

- 1) There are serious, long-term underestimated social and economic grounds, requiring targeted work with energy-poor households, as well as urgent regulatory requirements from the EU to introduce an energy poverty line in Bulgaria.
- 2) Indicators comparing energy costs through a quantitative assessment of energy poverty are most suitable for Bulgaria's conditions. This thesis is also supported by other researchers in the country, and is based on an empirically proven relationship between energy-poverty indicators and macro-indicators of income and prices of energy resources in the country. There is a lack of objectivity in indicators based on households' self-assessment of the extent to which they feel they can afford energy, due to the ineffective reflection of changes in macro-indicators of income and energy costs. Indicators based on direct measurement or indirect indicators are limited in our country, and there is a lack of scientific and empirical basis to establish the causal relationship of energy poverty.
- 3) 'Poverty after-energy-expenditure' is the most suitable indicator for measuring energy poverty in Bulgaria, after a comparative analysis of eight indicators from the expenditure approach. The following conclusions from the analysis are supported:

- Highest coverage of nearly 54% for the ‘Ten-Percent-Rule’, coverage of around 33-40% for ‘Poverty After-Energy-Expenditure’ and ‘Low Income – High Cost Share’, and around 11-17% for ‘Low Income – High Cost’, ‘Double Median Expenditure’, ‘Half Median Expenditure’ and ‘Half Median Share of Energy Expenditure’, i.e. the proposed indicator has an average «sensitivity» in relation to the range and a balanced heuristic ability;
- Strongest volatility of energy poor coverage as income changes under ‘Ten-Percent-Rule’;
- Zero (or close to zero) energy poverty in deciles with high incomes for indicators using a poverty threshold – ‘Poverty after-energy-expenditure’, ‘Low Income – High Cost’, ‘Low Income – High Share of Energy Expenditure’;
- High concentration of the energy-poor in the lowest deciles of the definition ‘Poverty after-energy-expenditure’ and of ‘Low Income – High Cost Share’ (first four deciles);
- Indicators with double medians, either of expenditure or of the share of expenditure, take into account an increase in the range with income and are not a suitable choice for a measure of energy poverty in Bulgaria;
- Indicators where energy expenditure is below the median (‘Low Income – High Cost’ and ‘Half Median Expenditure’) are least affected by, but do not reflect, changes in income and have the smallest range (7- 9%), which calls into question their usefulness;
- In this context, 2M and M/2 from the expenditure approach are not suitable for Bulgaria’s conditions. They are considered indicators that reflect hidden energy poverty, but obviously 2M grows with income, and M/2, although concentrated in the low deciles, is measured relative to a total that has the lowest consumption in the EU (final energy consumption per person at half the 2020 EU average).

- 4) It is necessary to determine a typical cost of energy, which can be included in an annual study of NSI, with the following parameters clarified in the analysis of methodological issues:
- The application of the official poverty line as an income criterion for monitoring purposes must be based on data from an annual survey by the National Institute of Statistics, which includes all indicators necessary for the assessment.
 - Neither of the two annual surveys of NSI and Eurostat contains all the necessary measurement indicators, and there is a need to supplement 4 to 5 questions on heating system, energy-efficiency measures and energy consumption.
 - A fairer energy-poverty line refers to 60% of the median equivalent disposable net total income after energy expenditure.
 - The dynamics of the median values of energy expenditure and the share of energy expenditure show a stronger volatility of the share of expenditure than net total income. Doubling the median or halving it does not make sense for the situation in our country, other than an artificial reduction of the range. In this sense, the introduction of an energy-poverty line based on these indicators makes no sense.
 - The development of typical energy expenditure is an urgent measure in order to be able to determine basic amounts of energy required for heating and other needs. The statutory amounts for minimum monthly energy needs for heating by season and size of dwelling from the Social Assistance Regulations of 1997 can be a good basis.
 - Typical energy consumption should be able to reflect individual differences in energy consumption caused by heat losses in the absence of wall and window insulation, high consumption due to the type of building (house/apartment), lower or higher external temperature in the different climatic areas, presence of a person with a 24/7 need for energy to achieve higher thermal comfort, difference in energy prices by settlement.

- Typical energy consumption should be simplified so that it can be updated annually with national surveys. It should include indicators for type of building, type of heating, settlement, type of household. On the basis of the settlement, prices of energy carriers are applied separately for the respective place.
 - Regulatory spending should include issues of consumer vulnerability – children up to 18 years old, disabled people not using social services, adults over 65 years old.
- 5) When developing a mechanism to reduce energy poverty, it is important to include programmes aimed at lowering the price and, as a result, the energy consumption of households by supplying energy from alternative sources: solar collectors, solar panels, heating systems using pellets. This is due to the following trends and facts identified in an analysis of the main factors related to energy poverty:
 - Growing risk of rising prices of energy resources, upcoming market liberalization, rising prices of carbon emissions, interruption of cross-subsidization from small business users from 2020, etc.;
 - Prevailing energy poverty in detached houses, reaching the highest levels by all definitions;
 - Suppressed energy consumption, changing the type of heating and using solid fuel for consumption control and lower cost;
 - High percentage of solid fuel users in low-income groups;
 - Clear trends of high spending and lower income among vulnerable groups.
 - 6) The official energy-poverty line should have the role of the main tool for measuring, monitoring and reducing energy poverty in three aspects - meeting basic needs for heating, meeting basic needs for electricity, and improving the energy efficiency of the building stock through fulfilment of the country's commitments.
 - 7) When measuring energy poverty for the needs of an official energy poverty line, it is necessary to include indicators such as

net total household income, amount of energy per household for heating, amount of energy per household for electrical appliances and hot-water heating, price of energy per household. Energy class of a building can be included when prioritizing applicants in a given programme or project.

- 8) The quantities of energy per household must be established in a special *Ordinance for determining the needs of households for heating and electricity*. It is possible that it includes a basic amount of heating energy according to the type of household in three basic standards of heated area 40m², 65m² and 80m², with a basic heated standard of 500kWh/month for 40m², of which 300kWh day and 200kWh night tariff. To this base quantity, a coefficient for heating mode, a coefficient for climate zone, a coefficient for type of building, a coefficient for type of heating system, and a coefficient for energy-efficient measures (external, internal insulation, windows) can be applied.
- 9) A possible definition of energy poverty could be: “Energy-poor is a consumer (person or family) who, at the current prices of energy services (electricity, heating, gas) due to their income, age, work, family and/or health status falls below the official poverty line after expenses related to reasonable consumption of energy services at home, necessary for the performance of various non-commercial, household activities, to ensure typically established standards for heating in the heated part of the dwelling, lighting, use of various household and other appliances for cooking, lighting, refrigeration, hot water, entertainment, information exchange, etc., which are necessary for the satisfaction of the relevant basic needs.”
- 10) The energy -poverty reduction mechanism should contain clear principles and criteria for admitting households to partial or complete free financing from the state in three main situations:
a) vulnerability of energy consumers caused by low incomes; b) liberalization of the electricity market or in case of high growth of electricity prices, previously determined as critical with a risk

of a rare rise in energy poverty (20%); c) implementation of energy-efficiency measures from the Recovery and Resilience Plan and the objectives of the Long-term National Strategy to support the renovation of the national stock of residential and non-residential buildings in Bulgaria until 2050.

- 11) The introduction of a comprehensive mechanism to reduce energy poverty means synchronizing the measures in the implementation process, from the approval of candidates for programmes, through the implementation of the measures, to reporting, monitoring and development of subsequent programmes and measures, taking into account problems and peculiarities signalled during of the performance. This means the development of a mechanism for establishing (ascertaining) and upgrading the energy status of each household, and an individual plan for getting out of energy vulnerability.
- 12) It is necessary to establish a clear process of implementation of the measures, synchronized among all institutions as follows: 1) Determination of energy needs; 2) Assessment of income status against income criteria (after expert working groups and public discussion) in three (minimum) aspects: for heating (30% of the official poverty line under a differentiated approach), for electricity (60% of the official poverty line with a differentiated approach), for investments in energy efficiency (energy-poverty line in different percentages according to the type of measures – larger for low-cost measures and smaller for high-cost measures); 3) Automated calculation of the difference to the income criterion and differentiated grouping of households in order to determine rights to energy support; 4) Determining rights for energy support with differentiated grouping of households according to the depth of energy poverty and the possibility of replacing rights; 5) Inclusion in programmes and projects with a certain individual percentage of self-financing, percentage of access to free/credited financing; 6) Evaluation of the effect of the applied policies and update of the status of households after using tools.

- 13) Basic principles of a comprehensive mechanism for reducing energy poverty in Bulgaria should be adequacy of energy services, universality of support, independence of users, freedom of choice of support, upgrading of support, efficiency and economy of measures, tracking and monitoring of the measures.

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APPENDIX

Methodology for determining the base amount of energy for heating households

In this proposal, three methodologies are presented for determining the basic amount of energy needs of households. The last two methodologies were developed after the publication of the Bulgarian version of the present monograph, for the purposes of operationalization and practical application. The official methodology proposed by the executive power for voting in the parliament is the third methodology of the Ministry of Energy and the Sustainable Energy Development Agency (SEDA).

1) Methodology 1. Determination of the basic amount of energy for heating with priority consideration of the type of household¹⁹

The methodology for determining the base amount of energy for heating households is developed in two steps:

- Determining the amount of energy needed to heat a 65 m² apartment for one season at nearly 5000 KWh., in the absence of windows;
- Determining the parameters that set the amount of energy needed for heating according to the type of household (number of members and mode of use).

¹⁹ Developed by Dipl. Eng. Emanuil Zabov, assistant professor at Sofia Technical University.

Step 1: The basic amount of energy for heating an apartment of 65 m² is calculated on the basis of Fourier's Law, defining the linear relationship between the power of heat losses and the temperature difference, the gradient of the heat exchange process between the heated volume and the environment:

Example:

The heating degrees at an average temperature in the heated rooms $\Theta_i=19^\circ\text{C}$ and a limit temperature $\Theta_{\text{HG}}=12^\circ\text{C}$ equal $\text{DD}_{19,12}=2900$, d K.

The deviation of the average temperature in the building is $\Delta\Theta_i=+1$ K

Task: Determine the percentage increase in the heating degree days (HDD). The duration of the heating season is $t_{12}=190$ days

Answer:

According to (9.6.3) it is determined that:

$$\text{HDD}_{20,12} = \text{HDD}_{19,12} + t_{12} * (\Theta_i - 19)$$

$$\text{HDD}_{20,12} = 2900 + 190 * (20 - 19) = 3090 \text{ dK}$$

An increase in the heating degree days (marked as DD below):

$$\frac{\text{DD}_{20,12} - \text{DD}_{19,12}}{\text{DD}_{19,12}} \cdot 100 = \frac{3090 - 2900}{2900} \cdot 100 = 6.55\%$$

Comment: The temperature change in the heated buildings with $\Delta\Theta_i=1$ K causes a change in heating degrees by $\pm 6 \dots 7$ %.

The duration of the heating season (t_y) provides information on the number of days in the year during which heating is required, or these are the days during which the outside temperature has a value lower than that of the limit. If heat gains from solar radiation and internal building heat sources are neglected, the value of the boundary temperature Θ_{HG} below which heating is required is determined by the equation:

$$\Theta_{\text{HG}} = \Theta_i$$

where Θ_i is the desired value of the average temperature in the building and Θ_{HG} is the limit value of the outside temperature below which the heating is switched on. The index «y» refers to the selected value of Θ_{HG} (for example at 12°C), and the duration of the heating season (in days) is denoted by t_{12} .

The heating degree days are defined as the sum of the temperature differences between the average temperature in the building Θ_i and the average day-night outdoor temperature throughout the heating season Θ_d at the boundary outdoor temperature Θ_{HG} . The selection of the luminal temperature for each building must be in accordance with its specific features (HG):

- accumulation capacity of the enclosing elements;
- condition and quality of thermal insulation;
- share of useful heat inflows compared to heat losses («gains/losses» ratio).

The following parameters are used:

- Heating cut outside air temperature: 11.5°C
- Design outside air temperature: 15.0°C
- Average indoors temperature: 19.0°C
- Living area (floor) 65 m²
- Height of the compartments 2.70m
- Form factor 0,85 (0-1)
 - a. 8.74m
 - b. 7.43m
- Perimeter 14,92
- Walls 40.27 m²
- Percentage of boundary with outside air 50.00 %
- Wrapping 20.14 m²

On this basis, it is calculated that the specific need for heating in Bulgaria at an average outdoor temperature of 5°C is 5,000 KWh per season for 65m², or **1.95KWh/ heating degree day/65m²**

This is a reference consumption for an average dwelling without window frames and insulation, which is subsequently standardized according to its area, the required comfort (temperature of the interior rooms) and the mode of use. Another way to express this consumption is 75 kWh/m²/year.

Step 2: Determining the parameters for energy needed for heating according to the type of household.

The model contains the following components:

- Total number of degree days for the heating season: 2500 on average. Here you can set degree days for a specific locality, according to the nine climate zones pursuant to Ordinance No. RD-16-1058 of 10th December 2009 on energy- consumption indicators and energy characteristics of buildings.
- Required temperature in the heated rooms (with variations from 20°C to 23°C according to the vulnerability of the residents)
- Number of hours of occupancy of the room at day tariff (DT) and night tariff (NT), at 6 hours for night tariff, 18 hours for day tariff at full occupancy mode (by adults, families with children and families with persons with disabilities), and 4 hours daily tariff for all other families.
- Apartment area with three choices: 40m² for one person, 65m² for two or three people, and 80m² for four or more people
- Thus, in this order, are calculated:
- Number of degree days per household = $(T_{\text{indoors}} - T_{\text{outdoors}})$ degree days for season / $(T_{\text{indoors}} - T_{\text{outdoors}})$
 $\text{*SUM (number of hours DT + number of hours NT) / 24}$
- Amount of energy per habitable area = number of degree days per household

* 1.95KWh/degree day *area factor where

- Apartment of 65 m is indexed by 1
- Apartment of 40 m² is equal to 40/65=0.615
- Apartment of 80 m² is equal to 80/65=1.231

Table 1: Base amount of energy for heating per season by mode of use (kWh)

Household type	Heating mode specifics				Amount of energy per living area		
	T needed indoors	Degree days	Day tariff	Night tariff	40	65	80
	C	day.K	hours	hours	m ²	m ²	m ²
<i>1 person at home all day</i>	20	2,678	18	6	3,214	5,222	6,427
<i>2 persons at home all day</i>	20	2,678	18	6	3,214	5,222	6,427
<i>2 working persons</i>	21	1,190	4	6	1,428	2,320	2,856
<i>1 working persons</i>	21	1,190	4	6	1,428	2,320	2,856
<i>2 people with a child</i>	23	3,212	18	6	3,854	6,263	7,708
<i>2 persons with two children</i>	22	3,034	18	6	3,641	5,916	7,281
<i>5 persons</i>	20	2,678	18	6	3,214	5,222	6,427
<i>More than 5 persons</i>	20	2,678	18	6	3,214	5,222	6,427

Table 2: Amounts of energy by type of household, area and tariffs

	Amount of energy per living area and tariff					
	40 m ²		65 m ²		80 m ²	
	Day tariff	Night tariff	Day tariff	Night tariff	Day tariff	Night tariff
	kWh	kWh	kWh	kWh	kWh	kWh
<i>1 person at home all day</i>	2,410	803	3,916	1,305	4,820	1,607
<i>2 persons at home all day</i>	2,410	803	3,916	1,305	4,820	1,607
<i>2 working persons</i>	238	357	387	580	476	714
<i>1 working person</i>	238	357	387	580	476	714
<i>2 persons with a child</i>	2,891	964	4,697	1,566	5,781	1,927
<i>2 persons with two children</i>	2,730	910	4,437	1,479	5,461	1,820
<i>5 persons</i>	2,410	803	3,916	1,305	4,820	1,607
<i>More than 5 persons</i>	2,410	803	3,916	1,305	4,820	1,607

Methodology 2: Determining the base amount of energy for heating with priority consideration of the area of the dwelling²⁰

According to this method, the basic heating is calculated for the real area of the dwelling up to a maximum of 120 m² of built-up area, at 45 kWh, required for heating per square meter for a year (heated season of 5 months) for a dwelling in the city of Sofia without windows and insulation. The formula for calculating the base amount of energy for heating follows those presented in fig. 2 steps.

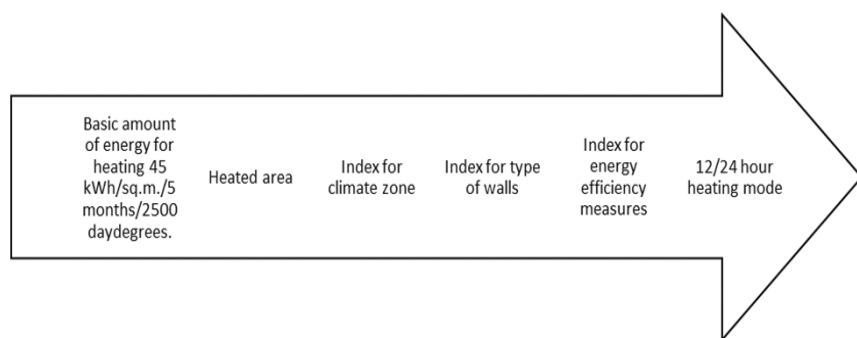


Figure 1. Steps for calculating the amount of heating for households with different indices

The climate zone index is equal to the degrees Celsius for the settlement, divided into 2900 degrees Celsius for Sofia or by region from Ordinance No. RD-16-1058 (see Table 3).

²⁰ A proposal by Eng. D. Dzhilov, made for the purposes of developing the Methodology for determining energy-poor households in Bulgaria under a project under the “Horizon 2020” programme (see Methodology for determining energy-poor households in Bulgaria).

Table 3: Index for climate zone

Region	degree days	Index	Basic energy, KWh/year/m²
<i>1. Northern Black Sea</i>	2400	0,83	37,4
<i>2. Dobrudja</i>	2800	0,97	43,7
<i>3. Along the Danube River</i>	2600	0,90	40,5
<i>4. Northern Bulgaria - Central</i>	2700	0,93	41,9
<i>5. Southern Black Sea Coast</i>	2300	0,79	35,6
<i>6. Southern Bulgaria – Central</i>	2400	0,83	37,4
<i>7. Sofia and Sub-Balkan valleys</i>	2900	1,00	45,0
<i>8. Southern Bulgaria</i>	2300	0,79	35,6
<i>9. Southwest Bulgaria</i>	2100	0,72	32,4

The wall type index is 1.00 for brick walls and 1.15 for panel constructions. In this way, a house in the city of Sofia in a panel block will need 51.75 kWh/m² for the heating season. The index for energy efficiency measures corresponds to a numerical value from 0 to 6 according to the insulation measures taken and the type of windows (see table 4).

Table 4: Indexing of the availability of energy efficiency measures (EEM)

	EEM windiw	EEMoutside walls	EEM inside walls
<i>No</i>	0	0	0
<i>Partly</i>	1	1	1
<i>Completely</i>	2	2	2

When summing up the answers, a number from 0 to 6 is obtained, in which an index is applied (Table 5).

Table 5: Index for energy efficiency measures

Sum of EEM	Basic energy, kWh/year/m ²	Index
6	20.0	0.44
5	22.5	0.50
4	25.0	0.56
3	30.0	0.67
2	35.0	0.78
1	40.0	0.89
0	45.0	1.00

According to the average statistical values from the energy surveys of the «Bulgarian-Austrian Consulting Company» (BACC) conducted so far, the heated area index is 0.90 of the deployed area. The index for heating mode is 2, in the presence of vulnerable energy consumers. The basic amount of energy is doubled if there is an elderly person over 65, a child under 18 or a disabled person living in the household. In this way, the representation in the table is obtained. 6 norm for the base amount of energy for heating a family with vulnerable consumers in a dwelling with a built-up area of 70 m² in the city of Sofia and the city of Plovdiv in kWh/ heated season.

Table 6: Examples of basic energy for heating of a two-member household living in an apartment with a built-up area of 70 m² in a multi-family building

Built-up area=70 m ²	Sofia	Plovdiv
Brick walls, kWh/season		
No EEM	5670	4706
Window EEM	4410	3660
All EEM	2520	4706
Panel building, kWh/season		
No EEM	6521	5412
Window EEM	5072	4209
All EEM	2898	2405

In summary, the following several indices are applied to the base quantity, leading to its reduction, in case the given type of measures is applied:

- index for the reduction of the base amount of energy for heating when energy-efficient measures are taken: (a) 15% with complete internal insulation and 7.5% with partial insulation; (b) 20% for fully laid external insulation and 10% for partially laid; (c) 10% for completely replaced windows and 5% for partially replaced. If the relevant measures are implemented, a smaller amount of heating energy is needed, which can drop in option 2 of the base heating amount from 45 kWh/m²/year to 20 kWh;
- an index for an increase in the base amount of heating of 30% on average for a building installation in households with working substations of District Central Heating Stations, regardless of whether they are active or abandoned users.

An index for the type of building is applied to the methodology in its form, if it is necessary to calculate the energy needs of households living in an individual house. Data from BACC's energy surveys show that with a large percentage of external walls and heat losses from the roof and floor require a doubling of the base amount of energy from 45 to 90 kWh/m²/year. Here again, a consumption threshold should be applied - for an area of up to 120 m², in order not to allow speculation with the square footage of the houses.

Methodology 3: Determining the basic amount of energy for all needs with priority consideration of the type of building²¹:

This approach is proposed in the texts of the Ordinance on the determination of the criteria, order and conditions for determining energy-poor

²¹ A building-based approach is a proposal of the Ministry of Energy and SEDA during discussions in the Commission for Energy Efficiency and Energy Poverty, included in the official proposal for the Ordinance on the conditions, criteria and procedure for determining households in a state of energy poverty, released for public discussion in the end of 2022.

households in Bulgaria, and is a development of the Ministry of Energy together with SEDA. In this approach, the monthly energy expenditure of a household is determined by multiplying the annual energy expenditure of the occupied building type by the typical area for the household according to the number of persons, the household vulnerability factor and the price of electricity, and thus dividing the resulting annual expenditure value by 12.

For this purpose, buildings are divided into five types:

1 Residential buildings built before 2010 that have not been completely renovated – specific annual consumption of primary non-renewable energy 400 kWh/m².

Class E (39%), F (34%), G (18%):

2. Residential buildings built after 2010 – specific annual consumption of primary non-renewable energy **180 kWh/m²**

Class D

3. Residential buildings built before 2010, with applied energy-saving measures to reach the minimum required class C – specific annual consumption of primary non-renewable energy of **216 kWh/m²**

Class C

4. Multi-family residential buildings, regardless of the year of construction, which have been updated in accordance with Ordinance No. RD-02-20-3 of 9th November 2022 on the technical requirements for the energy performance of buildings up to Class B

Class B **135 kWh/m²**

5. Single-family residential buildings, regardless of the year of construction, which have been renewed in accordance with Ordinance No. RD-02-20-3 of 9th November 2022 on the technical requirements for the energy performance of buildings up to class B with an average value for primary non-renewable energy of **125 kWh/m²** – Class B

A vulnerability factor of 1.3 applies for households with:

- ✓ elderly people over 65;
- ✓ disabled people with a type and degree of disability over 50%;
- ✓ children under 18.

For other cases, a coefficient of 1.0 is applied.

Typical energy consumption refers to the primary consumption multiplied by a generalized factor accounting for mining/production and transmission losses of 1,81.

A household electricity price of 70% day rate and 30% night rate is applied, and a vulnerability factor is applied. A typical household area is also applied, not real, as in the above two approaches, but according to the number of persons in the household, of 40 m² for one person, up to 90 m for 6 persons.

Teodora Peneva

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