A CRITICAL ANALYSIS OF SOME ENERGY POVERTY INDICATORS

Researcher 3rd Degree, PhD. Alina Georgeta AILINCĂ
"Victor Slavescu" Financial and Monetary Research Center, INCE, Romanian Academy
E-mail: alinageorgetaailinca@gmail.com

Abstract: *Current challenges, through wars and conflicts, at global and EU27 level, demonstrate that the energy issue can be used as a weapon against the population. Thus, energy plays a fundamental role in ensuring the well-being of households by affecting health, work, education and financial prosperity. In this context, energy poverty is described as a complex phenomenon, which affects all aspects of life and highlights the inability of the population to secure the necessary energy products and services, whether it is infrastructure or costs. Thus, the article aims to critically analyze a series of energy poverty indicators proposed by the Energy Poverty Advisory Hub (EPAH) at the European Union level and to highlight which could be considered the most valuable indicators to be taken into account in further analyses. The results highlight that the issue of energy poverty encompasses various aspects of life, extremely complex, each of the indicators bringing a new nuance, a new facet to the complete image of this concept.*

Keywords: *sustainability, energy poverty, housing conditions, inequity.*
JEL Classifications: *I14, I32, R2.*

1. Introduction

Although the topics of the day focus on regional security issues, resources, energy, trade wars, tariffs, taxes, etc., however, the issue of energy poverty, often not addressed publicly, should also be in the spotlight, being the consequence of uninspired decisions regarding the above, both in public and private policy. Energy poverty represents a complex form of poverty, generally describing the impossibility of households to ensure their basic needs by having the energy needed for cooking, lighting, heating or cooling. The complexity of this form of poverty comes from the countless causes, but also from the multitude of effects and consequences through which it manifests itself. Whether it is the inability to pay bills for the energy consumed, whether it is a self-imposed restriction in order not to end up with non-payment of bills (hidden energy poverty), whether the homes have low energy efficiency, whether there are no elements of local infrastructure that allow access to energy or the cost of this access is prohibitive, all of these represent forms of energy poverty that lead to the impact on the economic well-being of households.

If we refer to the effects, the effects of energy poverty can be multiple: from affecting physical, emotional and mental health, affecting the educational level, accentuating social disparities and inequalities, accentuating regional disparities, but also those between village and city, affecting access to work and a decent life, etc. In general, energy poverty comes to accentuate the financial and social troubles already existing in vulnerable households, worsening all forms of social disparities.

In this context, although it does not seem like a front-page topic, energy poverty is in reality a central element of the social well-being of households that should be approached more seriously within the framework of policies, an element that must be viewed and analyzed more and more thoroughly in its depth. Although energy poverty is treated mainly in the family, household context, nevertheless, special attention must also be paid to energy poverty at the institutional level, but also at the private, company level.

2. Problem description

In addition to economic and social factors, energy poverty mainly speaks about the condition of buildings, which were often built in other periods of time when energy vulnerability was not taken into account (e.g. the 1980s or even earlier, the 1960s). If in developed countries, the inhabitants of homes are often tenants and not their owners, in Central and Eastern Europe the situation is exactly the opposite. However, although owners, the majority of citizens in Central and Eastern Europe do not have the financial means, but also the trust in the authorities and the community to resort to the rehabilitation and renovation of their homes. In Central and Eastern Europe, for decades the focus has been on forced industrialization and urbanization, and the quality of people's lives and especially living and housing conditions has been passed over in silence. These shortcomings really showed their face when the market economy forced the gradual abandonment of forms of state energy subsidies (https://www.infoclima.ro/ and Sinea et al., 2021), and buildings became increasingly energy-dated, increasingly vulnerable to weather and the passage of time, increasingly energy-consuming.

Also, a relatively paradoxical situation is also occurring in the southern part of Europe, although with a generally warm climate, under the increasing impact of climate change, European Union (EU27) countries such as Spain, Portugal, Italy and Greece are increasingly facing energy poverty problems. The technical condition of old buildings, the superficial way of approaching the problem of heating or cooling the home, the dubious quality of new constructions that do not take into account the need to adjust to climate change, the lack of rehabilitation programs or insufficient rehabilitation of the building stock, insufficient public, private or mixed financing as well as subsidies or other state financial and fiscal instruments granted at an insufficient and/or inefficient level can lead to aggravation of the energy poverty problem.

3. Review of the specialized literature

Energy poverty has been a consistent focus of researchers for several decades. It either starts from tangible, clearly measurable elements, such as cost factors, estimating the phenomenon based on electricity bills adjusted with information on the energy efficiency of buildings and the socio-economic conditions of households (Boardman, 2009; Fiorio, and Florio, 2013; Li et al., 2014; Antepara et al., 2020) or from subjective aspects, perceptible at the individual level, such as indicators describing the comfort and adequacy of housing, the behaviour of occupants, or issues related to the improper functioning of insulation, cooling or heating systems (Calì et al., 2012; Bouzarovski, 2014; Bakaloglou and Charlier, 2021; Koukoufikis and Uihlein, 2022).

Studies at the global level seem to slightly stir the surface water of the problem (Chan and Delina, 2023; Castro-Cárdenas and Ibarra-Yunez, 2023; Filho et al., 2024), but at the European Union level there is a focus on regional disparities between the centre and the periphery, but also substantial inter-countries disparities in terms of energy poverty (Copus, 2001; Petrakos et al., 2011; Featherstone and Kazamias, 2014; Kerr et al., 2019; Heeman et al, 2022).

From the perspective of systematizing indicators, if some authors treat the issue of energy poverty individually (Rademaekers et al., 2016; Thomson et al., 2017; Castano-Rosa et al., 2020), others consider more appropriate a composite index (Gouveia et al., 2019; Palma et al., 2022). Without proposing to resolve the issue at this stage, the option in this study is to

analyze the EPAH indicators individually, in order to better discern their qualities. Of course, the area covered in this study is at the level of the European Union countries.

4. Methodology and data sources

The analysis is based on a comparative, critical study at the European Union level on the indicators proposed by the Energy Poverty Advisory Hub (EPAH) so that we can discern which may be the most relevant indicators for energy poverty. At the same time, based on the available EPAH data, several indicators considered more relevant are selected and analyzed (including at a graphical level). Table 1 describes the EPAH indicators.

Table 1. Description of variables, systematization and presentation of data sources

Topic	Subtopic	Indicator
Climate		Cooling degree days
		Heating degree days
Facilities / housing	Building Stock	Dwellings with energy label A
		Final consumption expenditure of households
		Population living dwelling with presence of leak dump and rot
		Population living dwelling equipped with heating facilities
		Population living dwelling equipped with air conditioning
		Population considering their dwelling as too dark
	Energy Consumption and Equipment	Final consumption expenditure of households
		Final energy consumption in households by energy use
		Final energy consumption in households by type of fuel
Mobility		Final consumption expenditure of households
		Population who cannot afford a regular use of public transport
Socio-economic aspects	Social Economic and Living Conditions	Arrears on utility bills
		At risk of poverty or social exclusion
		Disposable annual household income
		Final consumption expenditure of households
		Housing cost overburden rate
		Inability to keep home adequately warm
		Population living in dwellings comfortably cool in summer time
		Population living in dwellings comfortably cool in winter time
	Energy Expenditure and Energy Markets	Energy expenditure by income quintile
		Energy prices
		High share of energy expenditure in income (2M)
		Low absolute energy expenditure (M/2)
	Health	Causes of death
		Excess winter mortality/deaths
		Final consumption expenditure of households
		Population reporting a chronic disease

Source: European Commission, EPAH online course.

Based on the description of the variables, a series of factors for and against choosing some of them is highlighted, ultimately selecting only a few for graphical representation, which we can consider the most relevant.

5. Results

Thus, energy poverty is treated with particular care at the level of the European Union institutions, especially the European Commission, one of which is the Energy Poverty Advisory Hub (EPAH). In addition to courses, trainings, studies and practical guides to help local authorities and other bodies interested in managing the problem of energy poverty, EPAH also provides a series of indicators, but also valuable data for them to allow a good assessment of energy poverty at the level of EU countries.

Thus, in the table below, based on the EPAH systematization above, the 25 energy poverty indicators are presented (Final consumption expenditure of households, repeating five times in almost every subsection presented), whether it is climate, facilities/household aspects, mobility or socio-economic aspects, from the perspective of the pros and cons that could convince us to choose them. EPAH proposes its indicators based on data from the Survey on Income and Living Conditions (SILC) and the Household Budget Survey (HBS).

Tabel 2. Pros and cons of choosing to describe energy poverty

Indicator	Pros	Cons
Cooling degree days	-Provides insight into climate variables and the building's energy needs for cooling. -The indicator focuses on average temperatures. -With additional indicators (e.g. "Final Energy Consumption in Households" and "Inability to heat or cool") can help build a more comprehensive picture of energy poverty.	- It does not account for buildings' energy efficiency or affordability. - It does not capture short-timed temperature fluctuations (e.g. heat waves) which can considerably impact residential energy consumption and comfort
Heating degree days	-Provides insight into climate variables and the building's energy needs for heating. -The indicator focuses on average temperatures. -With additional indicators (e.g. "Final Energy Consumption in Households" and "Inability to heat or cool") can help build a more comprehensive picture of energy poverty.	- It does not for buildings' energy efficiency or affordability. - It does not capture short-timed temperature fluctuations (e.g. cold waves).
Dwellings with energy label A	- Describes the housing situation relatively well, providing a series of valuable information regarding energy poverty. -Its analysis is integral in efforts to understand and assess energy poverty. - It is of significant relevance for national assessments.	-It leaves behind information on the worst performing buildings. - It needs additional indicators on the economic and social dimensions for an adequate energy poverty diagnosis. - It cannot accurately say whether the building's occupants are in energy poverty or not, for example, energy consumption may not cover energy needs or comfort preferences.
Final consumption expenditure of households	- It can help to identify potential affordability problems, if it is compared to the household's income. - Indicator disaggregation may show consumption inelasticity, highlighting the types and levels of consumption considered essential for families. - In combination with thermal comfort or energy efficiency indicators may disclose trade-offs in consumption preference that leads to energy poverty.	-Low or high consumption expenditures do not necessarily point to energy poverty.
Population living dwelling with presence of leak dump and rot	- Indicator refers foremost to the consequences of poor construction practices of dwellings and humid indoor conditions. - It is a self-reported indicator, it is a consensual based indicator, it has a degree of subjectivity but it is a qualitative indicator.	- May not be directly connected to situations of energy poverty but can also be a consequence of an inability to keep the house adequately warm. -It describes energy efficiency rather than energy poverty. -It requires corroboration with other indicators for an adequate description of energy poverty.
Population living dwelling equipped with heating facilities	- It can be an important indicator in diagnosing energy poverty, but it does not speak about the comfort of the residents or energy consumption.	- The fact that a household owns equipment does not necessarily mean that they use it often or at all. - It need additional information such as space heating patterns, duration, schedule, and proportion of space heated, as well as the type of energy carrier, equipment age, and efficiency.
Population living dwelling equipped with air conditioning	-It can be an indicator, along with other indicators, to describe the capacity of households to cope with high or low temperatures without having access to electrical equipment intended for this purpose. - It is an informative indicator to assess energy poverty in summer based on access to air conditioners or other electrical equipment (simple fans are not taken into account).	- Owning an air conditioner does not necessarily mean that household use it and not necessarily mean that household is being in energy poverty. A household might live in a region with mild summers where natural ventilation is enough.
Population considering their dwelling as too dark	- Indicator depicts self-perception of indoor light conditions, which depends on personal preference and culture.	- It does not consider the underlying causes of the perceived lack of light, including building design, shading, and direction, which may not directly relate

		to energy poverty. - If connected to a lack of artificial light, it can be a symptom of an even deeper vulnerability.
Final energy consumption in households by energy use	-The indicator can be used to understand which type of energy use consumes more energy, helping to identify potential challenges in accessing specific energy services if compared to the national average or median consumption and in the light of income levels.	- The indicator can be in conjunction with others, such as self-reported thermal comfort indicators. Thus, low levels of energy services, especially space heating and cooling, may indicate a problem of energy poverty.
Final energy consumption in households by type of fuel	- The cost and efficiency of transformation vary according to the fuel type, impacting primary and final energy consumption per energy use.	-The dependency of households on expensive and inefficient fuels may create affordability and environmental problems, increasing vulnerability to energy poverty. -It need additional indicators such as regional-specific aspects in fuel access conditions and cultural fuel use.
Population who cannot afford a regular use of public transport	- This indicator addresses the financial barriers to accessing public transportation, a relevant determinant of transport energy poverty.	- It overlooks other transportation-related factors like service quality and availability. - It needs to be combine with indicators reflecting domestic hardship, inability to heat, analysing energy expenditure or housing costs.
Arrears on utility bills	-Is a simple yes/no-question to clear the meaning of this indicator. - The indicator takes into account the total number of households and the total income situation. -The indicator aims to record financial difficulties for which there are arrears.	- The indicator does not clarify the reason why invoices are not paid on time. - It does not cover situations where households need to borrow money to cover their bills on time or catch energy limiting behavior.
At risk of poverty or social exclusion	-The indicator may primarily capture poverty in general.	- It need additional information about the impact assessments of energy-related social policies.
Disposable annual household income	-The indicator is an effective tool for assessing the economic well-being of EU households and identifying locations at risk of energy poverty due to low disposable income levels.	- It cannot fully reflect the complexities of energy poverty and should be complemented with additional variables relating to energy use, efficiency, and specific energy-related expenses.
Housing cost overburden rate	-The indicator is valuable for measuring housing affordability. Increases in housing costs can affect access to energy services.	- It doesn't provide information about housing quality and energy efficiency. -Increases in housing costs can also result from household decisions without sacrificing other essential needs. -It should be supplemented with indicators related to energy consumption, affordability, or thermal comfort.
Inability to keep home adequately warm	-This indicator is subjective, qualitative and refers to an individual's perception of 'adequately', which may differ from one country to another or between age groups, etc.	-The indicator only refers to the warmth and does not cover summer energy poverty. -The indicator does not provide information on the causes for the inability. - It should be considered together with other indicators, such as energy expenditures, to identify potential causes.
Population living in dwellings comfortably cool in summer time	-Summer energy poverty is an increasing concern in the EU. It might be useful for a comprehensive understanding of summer energy poverty vulnerabilities.	- It needs information about the ownership of cooling systems and space cooling energy consumption patterns.
Population living in dwellings comfortably cool in winter time	- It is a subjective indicator, the winter energy poverty is an increasing concern in some EU countries, and it might be useful for a comprehensive understanding of winter energy poverty vulnerabilities.	-The self-reporting of thermal comfort is influenced by a series of factors for consensual-based indicators such as gender, age, socioeconomic situation, culture, and social practices, which justify various possible results both within one- and across countries.
Energy expenditure by income quintile	-Describes the economic dimension of energy poverty, more precisely the financial burden of energy services for households. -Income is important for energy consumption and takes into account the distribution of income across income quintiles.	- The indicator has arguable effectiveness because it does not provide information on the level of energy consumption that determines the expenses or the energy uses.
Energy prices	-It is a clear, quantitative indicator that links energy poverty to the cost of energy.	-The quality of the product and the share of freely or illegally sourced biomass products can significantly impact energy poverty levels, especially in rural regions, and therefore should be considered in diagnosis assessment. - It is important to have information about all types

		of prices (for gas, electricity, oil, biomass, etc.) and the technologies available at regional or local level.
High share of energy expenditure in income (2M)	- The indicator describes the percentage of people living in households whose share of expenditure on residential energy in the household's equivalised disposable income is more than two times higher than the national median share of residential energy in equivalised disposable income. -A indicator which identify the proportion of budget spent on the energy bills in a household.	-It is based on national income levels and it is hard to use as a standalone indicator for comparing energy poverty levels in different Member States. -It does not capture underconsumption cases so it can be more informative to read it together with the indicator "Low absolute energy expenditure (M/2).
Low absolute energy expenditure (M/2)	-It shows the percentage of persons living in households whose expenditure on residential energy is more than 2 times lower than the national median expenditure on residential energy. -The indicator measures energy expenditure, capturing the economic dimension in each Member State, specifically cases of underspending.	-It leaves out details such as energy efficiency, conditions of households, and climate variability. It can be useful to read it together with the indicator 'High share of energy expenditure in income (2M)' to also capture abnormally high energy expenditures.
Causes of death	-It can capture some effect of energy poverty. -Analyzed jointly with the "Population reporting chronic disease", the indicator can identify potential contributing factors and their relationship with energy poverty.	-But the cause of death can be determined by a diversity of factors. By identifying the main cause, this indicator does not reflect all the risk factors contributing to mortality. - Variations in medical diagnosis may result in unequal reporting across regions or countries.
Excess winter mortality/deaths	- It may reflect energy poverty if the indicator is analyzed together with others related to building energy efficiency, income levels, energy expenditure, population density, material deprivation, or access to medical services.	- It cannot be taken into account individually, as this could lead to misinterpretations.
Population reporting a chronic disease	-Chronic diseases can be either a symptom or a cause of energy poverty. - It needs a wider set of indicators and a robust analysis is needed to investigate this possibility.	- Due to their complexity and multicausality, it is challenging to draw a connection between their occurrence and energy poverty vulnerability. -Relying solely on self-reports may also not fully represent the prevalence of such illnesses within a population.

Source: European Commission (2022), EPAH site, author systematization.

In general, all subsections: Climate, Building stock, Energy consumption and equipment, Mobility, Social, economic and living conditions, Energy expenditure and energy markets, Health, have extremely valuable indicators that describe energy poverty relatively adequately, but choosing just one or a few can prove difficult. From the description above, although there is a recurring indicator (e.g. Final consumption expenditure of households), we can conclude that all the indicators analyzed cannot be viewed individually as the most representative to describe, by themselves, energy poverty. Thus, all EPAH indicators can only constitute an overall picture together. Taken individually, or without even the slightest form of grouping to complete them, the indicators cannot fully describe what energy poverty means.

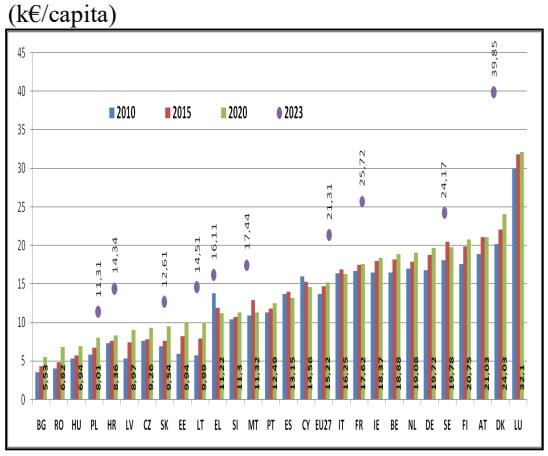
In addition, it must be said that they require permanent revisions and additional searches to find better, more synthetic ways of rendering energy poverty at the level of EU countries. Among the preferred indicators, some of them also found within the Eurostat indicators. For graphic rendering of energy poverty it has been chosen: Final consumption expenditure of households (Expenditure-based, quantitative indicator), Population living dwelling with presence of leak dump and rot (subjective, qualitative indicator), Arrears on utility bills (subjective, qualitative indicator), Income-based indicator inability to keep home warm (IKHW) (subjective, qualitative indicator), High share of income on energy expenditure (2M) (Expenditure-based, quantitative indicator), Low absolute energy expenditure (M/2) (Expenditure-based, hidden energy poverty, quantitative indicator).

If we look at some of the selected indicators, we observe some worrying trends in recent times. Thus, the final energy consumption of households increased substantially after 2020, with 2023 marking huge increases for some countries compared to 2020, the year of the outbreak of COVID-19. This may indicate in itself that 2020 was an exceptional year, with abnormal values, with probably self-imposed restrictions against the background of uncertainty about the future. At the same time, although we could consider it normal for the countries of the north-west of the continent to have increases in household spending against the background of a more severe climate compared to its south and east, nevertheless, the countries of the Eastern EU27 (e.g. Bulgaria, Romania, Hungary, Poland, Croatia) could still be marked by a restricted consumption possibly self-imposed and against the background of much lower wage and other earnings than the western countries. This indicator can also be corroborated with that of the population living in inappropriate conditions (mold, leaks, etc.).

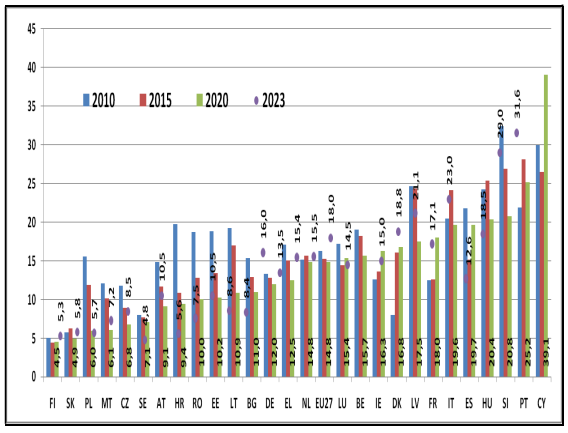
The indicator Population living in homes with dump, leaks and rot, indicating the southwest of the continent countries, such as Portugal, Cyprus, Slovenia, Hungary, Spain, Italy and France, as being in the top of countries with serious problems with this indicator. At the same time, taking into account the available data, if we analyze the indicator over time, if we compare the year 2020 with 2010 and the year 2023 with the year 2020, we observe a deterioration of the overall situation, the number of countries recording problems increasing to 14 in 2023 compared to 2020 from 5 countries (comparing the year 2020 with the year 2010).

Figure No. 1. Final consumption expenditure of households and Population living dwelling with presence of leak, dump and rot and in EU27 in 2010, 2015, 2020 and 2023

Final consumption expenditure of households (k€/capita)



Population living dwelling with presence of leak dump and rot



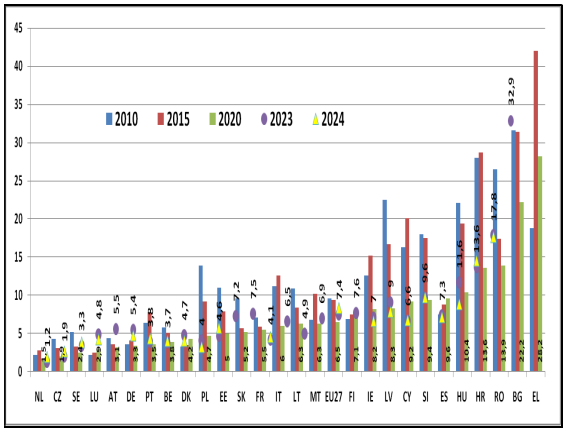
Source: EPAH indicators, author's processing and conception

If we analyze the indicator on arrears in payment of bills, we observe that Greece, Bulgaria, Romania, Croatia, Hungary, Spain and Slovenia have the most problems, and for the indicator there is also a deterioration in the values of the indicator over time, the number of countries with higher values of the indicator in 2023 compared to 2020 increasing to 11 compared to 5 (when we look at 2020 in report to 2010). Equally, regarding the indicator Inability to keep the home warm enough - Total (% of households) we observe that countries

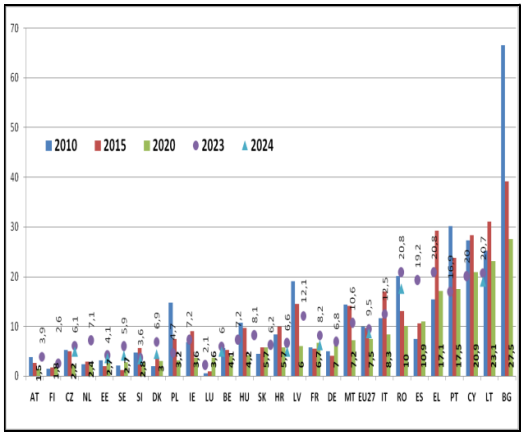
such as Bulgaria, Lithuania, Cyprus, Portugal, Greece, Spain and Romania also have very high values compared to the other EU27 states. At the same time, the indicator registered a dramatic increase in 2023 compared to 2020, with over 20 countries registering a dramatic deterioration of the indicator.

Figure No. 2. Arrears on utility bills (subjective, qualitative indicator) and Inability to keep home warm (IKHW) in EU27 in 2010, 2015, 2020, 2023 and 2024

Arrears on utility bills - No disaggregation (% of households)



Inability to keep home adequately warm - Total (% of households)

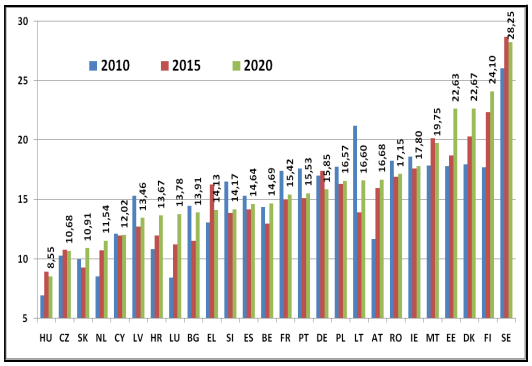


Source: EPAH indicators, author's processing and conception

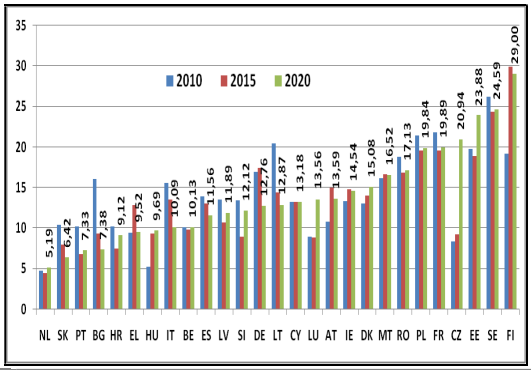
If we analyze the indicators High share of energy expenditure in income (2M)(% of households) and Low absolute energy expenditure M/2 (% of households), we notice that the top seven for the first indicator are: Sweden, Finland, Denmark, Estonia, Malta, Ireland and Romania, and for the second, the top seven are: Finland, Sweden, Estonia, Czech Republic, France, Poland and Romania.

Figure no. 3. High share of energy expenditure in income (2M) and Low absolute energy expenditure (M/2) in EU27 in 2010, 2015, 2020

High share of energy expenditure in income (2M)(% of households)



Low absolute energy expenditure M/2 (% of households)



Source: EPAH indicators, author's processing and conception

These two indicators suggest that not only some Nordic countries have problems with excessive energy costs, but also countries on the eastern and southern flank of the EU27, some of which are also confirmed among countries with extremely low energy expenditure, demonstrating energy self-restraint. Equally, both indicators demonstrate deterioration in energy poverty over time, with over half of the countries recording increases in 2020 compared to 2010.

6. Conclusions

Energy poverty is an issue that is increasingly being considered in academia, but also in the mainstream media. It draws attention to the living conditions and well-being of the population. Thus, the article critically analyzes the energy poverty indicators formulated by the Energy Poverty Advisory Hub (EPAH), noting that most of them cannot be viewed individually but analyzed within a larger group of indicators, so that they corroborate the information accordingly. If we refer to the data of these indicators, in recent years, in general, a deterioration of their situation has been recorded at the level of all Member States, with energy poverty increasing. At the same time, the countries in the East and South of the EU27 seem to be particularly marked by this phenomenon, requiring public, local and governmental authorities to pay special attention to counteracting the causes and finding the best long-term solutions.

References:

1. Antepara, I., Papada, L., Gouveia, J. P., Katsoulakos, N., & Kaliampakos, D., 2020. Improving Energy Poverty Measurement in Southern European Regions through Equivalization of Modeled Energy Costs. *Sustainability*, 12(14), 5721. https://doi.org/10.3390/su12145721 .
2. Bakaloglou, S. and Charlier, D., 2021. The role of individual preferences in explaining the energy performance gap. *Energy Economics*, 104/2021,105611.
3. Boardman, B., 2009. *Fixing Fuel Poverty: Challenges and Solutions*. London; Sterling, VA: Routledge.
4. Bouzarovski, S., 2014. Energy poverty in the European Union: landscapes of vulnerability. *Wiley Interdisciplinary Reviews: Energy and Environment,* 3(3), pp.276–289.
5. Calì, D., Osterhage, T., Streblow, R., Müller, D., 2016. Energy performance gap in refurbished German dwellings: Lesson learned from a field test. *Energy and Buildings*, 127/2016, pp.1146-1158.
6. Castro-Cárdenas, C. and Ibarra-Yunez, A., 2023. *Contaduría y Administración 68(2)/2023*, pp.175-198.
7. Castano-Rosa, R., Solís-Guzm´an, J., Marrero, M., 2020. Measuring Energy Poverty – A Review of Indicators, 10. *Revista H´abitat Sustentable*, pp. 8–21. https://doi.org/10.22320/07190700.2020.10.01.01.
8. Chan, C., Delina, L.L., 2023. Energy poverty and beyond: The state, contexts, and trajectories of energy poverty studies in Asia. *Energy Research & Social Science*, 102/2023, 103168.
9. Copus, A.K., 2001. From core-periphery to polycentric development: concepts of spatial and aspatial peripherality. *European Planning Studies,* 9(4), pp.539–552.

10. European Commission, 2022. *EPAH Energy Poverty National Indicators: Insights for a More Effective Measuring. Publication date 28 October 2022*.

11. Featherstone, K., Kazamias, G., 2014. *Europeanization and the Southern Periphery*. London: Routledge.

12. Filho, W.L., Gatto, A., Sharifi, A., Lange Salvia, A., Guevara, Z., Awoniyi, S., Mang-Benza, C., Nwedu, C. N., Surroop, D., Teddy, K. O., Muhammad, U., Nalule, V. R., da Silva, I., 2024. Energy poverty in African countries: An assessment of trends and policies. *Energy Research & Social Science*, 117/2024, 103664.

13. Fiorio, C.V., Florio, M., 2013. Electricity prices and public ownership: evidence from the EU15 over thirty years. *Energy Economics*, 39, pp.222–232.

14. Gouveia, J.P., Palma, P., Simoes, S.G., 2019. Energy poverty vulnerability index: a multidimensional tool to identify hotspots for local action. *Energy Reports*, 5, pp.187-201.

15. Heeman, J., Faassen, E., Rogulj, I., Pizzini, G., Anagnostopoulos, F., Oikonomou, V., Gallerand, A., Oprea, M., Bouzarovski, S., 2022. Status of energy poverty and policies to address it in CEE/SEE countries. European Energy and Climate Policy (IEECP). European Climate Foundation.

16. Kerr, N., Gillard, R., Middlemiss, L., 2019. Politics, problematisation, and policy: a comparative analysis of energy poverty in England, Ireland and France. *Energy and Buildings*, 194, pp.191–200.

17. Koukoufikis, G. and Uihlein, A., 2022. Energy poverty, transport poverty and living conditions – An analysis of EU data and socioeconomic indicators. *Publications Office of the European Union, European Commission, Joint Research Centre.*

18. Li, K., Lloyd, B., Liang, X.-J., Wei, Y.-M., 2014. Energy poor or fuel poor: what are the differences? *Energy Policy*, 68, pp.476–481.

19. Palma, P., Pedro Gouveia, J.P., Mahoney, K., Bessa, S., 2022. It starts at home: space heating and cooling efficiency for energy poverty and Carbon emissions reduction in Portugal. *People, Place and Policy Online*, 1–20. https://doi.org/10.3351/ppp.2022.5344968696 .

20. Petrakos, G., Kallioras, D., Anagnostou, A., 2011. Regional convergence and growth in Europe: understanding patterns and determinants. *European Urban and Regional Studies*, 18(4), pp.375–391.

21. Rademaekers, K., Yearwood, J., Ferreira, A., Pye, S., Hamilton, I., Agnolucci, P., Grover, D., Kar´asek, J., Anisimova, N., 2016. Selecting Indicators to Measure Energy Poverty. Under the Pilot Project 'Energy Poverty – Assessment of the Impact of the Crisis and Review of Existing and Possible New Measures in the Member States.

22. Sinea, A., Jiglău, G., Vornicu, A., 2021. Energy poverty in buildings in Romania. Centrul pentru Studiul Democratiei. Online at: https://democracycenter.ro/publicatii/energy-poverty-buildings-romania/

23. Thomson, H., Bouzarovski, S., Snell, C., 2017. Rethinking the measurement of energy poverty in Europe: a critical analysis of indicators and data. *Indoor and Built Environement,* 26(7), pp.879–901.