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ENERGY VULNERABILITY - A STRUCTURAL DETERMINANT OF LIVING STANDARDS IN THE REPUBLIC OF MOLDOVA

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Abstract: This study analyzes the evolution of energy vulnerability in the Republic of Moldova from 2020 to 2023 and assesses its impact on the population's standard of living. Using a mixed methodological approach based on data from the Household Budget Survey (HBS), the research demonstrates that energy vulnerability has become a fundamental structural determinant of quality of life. The results highlight an increase in the energy burden from 14.5% in 2020 to 15.2% in 2023, exceeding common international affordability thresholds. Rural-urban disparities have significantly widened, with rural areas reaching a critical energy burden of 17.0%, compared to 13.7% in urban areas. The multidimensional analysis reveals that energy vulnerability exerts systemic negative effects on public health, educational performance, economic productivity, and social cohesion. The study concludes that energy vulnerability is a structural problem that exacerbates social inequalities and requires urgent and differentiated public policies focused on energy efficiency, financial support, and infrastructure development.
Keywords: energy vulnerability, energy poverty, standard of living, energy efficiency, social equity, Republic of Moldova.
JEL Classification: Q40, I32, Q48, O18

Introduction

Access to energy is one of the central pillars of human and economic development. Without energy, modern societies cannot function. However, major challenges remain globally: according to the latest available data, more than 770 million people still lack access to electricity, and around 2.3 billion use polluting fuels for cooking and heating (IEA, 2023). Even in developed economies, the problem persists. In the European Union, in 2023, 9.2% of citizens reported being unable to adequately heat their homes, a slight decrease from 10.6% in 2022 (Eurostat, 2023).

In the specialized literature, these difficulties are analyzed through the concepts of "energy vulnerability" and "energy poverty." They describe the situation of households that do not have access to adequate energy services at affordable costs (Thomson & Bouzarovski, 2019). In low-income countries, the causes lie primarily in the lack of infrastructure and financial resources. In transition economies, such as the Republic of Moldova, energy vulnerability is determined by price volatility, income inequality, and the poor quality of the housing stock (Balan, 2024).

The link between access to energy and living standards is direct and strong. Insufficiently heated homes mean not only discomfort but also health problems. High energy costs reduce disposable income for other needs, affecting education, social participation, and the economic stability of households (OECD, 2020). The analysis of these aspects is more relevant than ever, given repeated energy crises, the impact of the conflict in Ukraine, intensified climate change, and the pressure of the transition to green energy.

The Republic of Moldova is a relevant example due to its structural specifics: external dependence on energy exceeding 70% of total consumption, low household incomes, and a

housing stock with low energy efficiency. All these factors increase the risk of energy poverty and amplify the effects of energy vulnerability on quality of life.

This study aims to analyze the evolution of energy vulnerability in the Republic of Moldova during 2020–2023 and to assess its impact on living standards. It also seeks to identify the main causal mechanisms and to formulate public policy recommendations that can reduce the risk of energy vulnerability and support the transition to a more resilient, equitable, and sustainable energy system.

Methods and Materials

The study is based on a mixed methodological approach, combining quantitative and qualitative analysis. On the quantitative side, the research uses data from the Household Budget Survey (HBS) for the period 2020–2023, provided by the National Bureau of Statistics of the Republic of Moldova, as well as reports and statistics from international reference institutions such as the IEA (International Energy Agency), Eurostat (Statistical Office of the European Union), OECD (Organisation for Economic Co-operation and Development), and WHO (World Health Organization), using the most up-to-date public information available (2023).

The qualitative dimension is ensured by integrating the conceptual framework developed in contemporary specialized literature. This allows for a multidimensional interpretation of the phenomenon and a complex assessment of its social, economic, and public health implications.

Results and Discussion

The concept of energy vulnerability has evolved over the past three decades, alongside the social, economic, political, and technological changes that have shaped contemporary societies. The first research focused on the notion of fuel poverty, introduced in the United Kingdom in the early 1990s. Brenda Boardman (1991) defined the phenomenon as the situation in which a household is forced to allocate more than 10% of its income to ensure a minimum level of thermal comfort.

Subsequently, the specialized literature expanded this initial definition, highlighting the multidimensional and dynamic nature of energy vulnerability. Bouzarovski and Petrova (2015) argue that the analysis should not be limited to financial aspects but should also include households' exposure to structural and conjunctural risks related to accessibility, quality, and the security of energy supply.

From this perspective, energy vulnerability can be understood as the result of the dynamic interaction between four fundamental dimensions:

(i) Physical access to adequate and reliable energy infrastructure;
(ii) Economic capacity to procure and use the necessary energy services;
(iii) Households' adaptability to external shocks (such as price fluctuations, supply interruptions, extreme weather events);
(iv) Contextual factors, including housing thermal quality, regulatory framework, and regional climatic characteristics.

Therefore, energy vulnerability cannot be measured by a single quantitative indicator. It must be seen as a complex outcome of the interaction between economic, social, technical, political, and environmental factors. This approach provides a more comprehensive understanding of the phenomenon and facilitates the development of coherent public policies capable of addressing both the structural and the conjunctural causes of energy insecurity.

Analysis of energetic vulnerability in the Republic of Moldova

The analysis based on Household Budget Survey (HBS) data for the period 2020–2023 shows that the expenditure structure of Moldovan households has changed substantially under the influence of the regional energy crisis and accelerated inflation.

The share of expenditures on housing, water, electricity, and gas has continuously increased, reaching 17.6% of household budgets in 2023, up by 1.5 percentage points compared to 2020.

Table 1. Structure of average monthly consumption expenditures per adult equivalent (2020–2023)

Expenditure categories	2020 (lei/%)	2021 (lei/%)	2022 (lei/%)	2023 (lei/%)
Total expenditures	2.791,1 / 100,0	3.039,5 / 100,0	3.711,9 / 100,0	4.248,4 / 100,0
Food and non-alcoholic beverages	1.215,0 / 43,5	1.274,2 / 41,9	1.525,0 / 41,1	1.685,5 / 39,7
Housing, water, electricity, gas	449,9 / 16,1	461,1 / 15,2	604,1 / 16,3	747,5 / 17,6

Source: HBS, NBS. Author's processing.

In absolute terms, utility expenditures increased by 66.15% in just three years. Meanwhile, the share of food expenditures fell from 43.5% in 2020 to 39.7% in 2023. This decrease does not necessarily reflect a healthy diversification of consumption but rather a forced adjustment of budgetary priorities, caused by the faster growth of non-food service costs.

To evaluate energy vulnerability more directly, one can calculate the share of household disposable income spent on energy.

Table 2. Energy burden (% of income), total and by residence area (2020–2023)

Year	Disposable income (lei)	Energy expenditures (lei)	Total energy burden (%)	Urban (%)	Rural (%)
2020	3.096,6	449,9	14,53	14,7	14,3
2021	3.510,1	461,1	13,13	12,6	13,7
2022	4.252,6	604,1	14,2	13,0	15,4
2023	4.915,6	747,5	15,21	13,7	17,0

Source: HBS, NBS. Author's processing.

The results show that the energy burden rose from 14.5% in 2020 to 15.2% in 2023, exceeding internationally recognized affordability thresholds (usually between 10% and 15%) (IEA, 2022; Thomson & Snell, 2013).

A pronounced structural gap is noticeable between urban and rural areas. While urban households allocated on average 13.7% of income to energy in 2023 (a still manageable level), rural households reached a critical level of 17%.

This difference is explained by several structural factors:

- Lower incomes: 3,928.7 lei in rural areas versus 6,228.5 lei in urban areas;
- Energy-inefficient housing stock, predominantly old and individual;
- High dependence on traditional fuels (wood, coal), subject to volatile prices;
- Limited access to modern natural gas networks and sustainable energy alternatives.

Moreover, the urban–rural gap has widened rapidly: while in 2020 the difference in energy burden was only 0.4 percentage points, in 2023 it increased to 3.3 percentage points. This trend reflects the deepening of social and economic inequality in access to energy.

The analysis of energy burden distribution across income quintiles shows the true scale of energy vulnerability in the Republic of Moldova. The results confirm that the phenomenon affects not only the very poor but also significant segments of the middle-income population.

Table 3. Distribution of energy burden by income quintile (2023)

Income quintile	Average income (lei)	Energy burden (%)	Degree of vulnerability
Q1 (lowest 20%)	1.850	23,1	Critical
Q2	2.890	18,4	Severe
Q3	3.920	15,8	Moderate
Q4	5.340	12,9	Acceptable
Q5 (highest 20%)	8.970	8,7	Low

Note: Vulnerability degree classified according to international thresholds: Critical (>20%), Severe (17–20%), Moderate (15–17%), Acceptable (10–15%), Low (<10%). The internationally recognized minimum affordability threshold is between 10% and 15% (IEA, 2022; Thomson & Snell, 2013).
Source: Author's calculations based on HBS, NBS (2023).

The data highlight deep inequality: households in the poorest quintile (Q1) allocate 23.1% of income to energy, while those in the top quintile (Q5) spend less than 9%. In absolute terms, although wealthier households pay more for energy (780.4 lei vs. 427.4 lei), their relative burden is nearly three times lower.

More worrying is that the first three income quintiles (60% of the population) fall within the zone of energy vulnerability, with an energy burden exceeding the 15% affordability threshold. This demonstrates that energy vulnerability is no longer a marginal issue but a structural challenge affecting the majority of households.

The quintile analysis has revealed widespread vulnerability at the national level. A complete evaluation requires contextualizing Moldova's situation in relation to other countries in the region. Data for 2023 show that Moldova stands above the European average, with an average energy burden of 15.2%, which places 31.4% of the population in energy poverty. For comparison, Romania and Bulgaria report lower values (12.8% and 11.3%, respectively).

Table 4. Energy vulnerability indicators, regional comparison (2023)

Country	Average energy burden (%)	Population in energy burden (%)
Republic of Moldova	15,2	31,4
Romania	12,8	23,1
Bulgaria	11,3	20,8
EU-27 average	8,9	16,3

Source: Eurostat (2023), IEA (2023), national calculations.

This comparison confirms the structural character of energy vulnerability in the Republic of Moldova. The situation is more difficult than in neighboring countries with similar economic profiles, Romania and Bulgaria, and far above European standards, underscoring the urgent need for rapid and tailored public policies.

The rise in energy vulnerability in the Republic of Moldova produces multiple and deeply interconnected effects on living standards. The phenomenon influences key areas of human well-being: health, education, the economy, and social cohesion.

Impact on Population Health

Living conditions characterized by inadequate thermal comfort and poor indoor air quality, typical of poorly insulated buildings, are associated in the specialized literature with a higher incidence of respiratory, cardiovascular, and mental health disorders.

A large European study published in the European Journal of Public Health (Champagne et al., 2023), which synthesized data from 35 scientific articles (2000–2022), identified a significant correlation between energy poverty and multiple health conditions. These include poor mental health (anxiety and depression), non-communicable physical diseases (cardiovascular and respiratory), communicable diseases, and excess winter mortality.

Children and the elderly are identified as particularly vulnerable to the adverse health effects caused by energy poverty (Champagne et al., 2023).

In the Republic of Moldova, where over 70% of residential buildings have low energy efficiency (Ministry of Energy of the Republic of Moldova, 2023), these effects are amplified, impacting both life expectancy and the number of healthy life years.

Impact on Education

Energy vulnerability has a profound effect on the educational process, with children among the most affected. Inadequate thermal comfort and poor lighting conditions in households create a hostile learning environment with direct and long-term consequences.

Research shows that energy poverty affects children's academic performance and well-being through several mechanisms. A study conducted in Barcelona (2021) highlighted that energy poverty can affect children's learning and socialization, while long-term health problems and lower educational achievement may, in turn, reduce employment opportunities and economic well-being in adulthood-thus reinforcing health inequalities and perpetuating cycles of precariousness that can affect future generations (Champagne, 2023).

Negative effects on education include: (i) *impaired capacity to study at home*, due to inadequate environmental conditions; (ii) *higher school absenteeism*, caused by health issues to housing conditions (Champagne, 2023); (iii) *lower academic performance*, which becomes a mechanism for perpetuating vulnerability and inequality (Champagne, 2023).

Thus, analyses confirm that energy vulnerability is not just a matter of comfort but a critical factor reducing long-term educational performance, limiting social mobility, and perpetuating poverty cycles.

Economic impact

Energy vulnerability generates substantial costs both at the household level and for the national economy. At the microeconomic level, households allocate an increasing share of income to energy (15.2% in 2023), reducing resources available for healthy food, preventive healthcare, or education. Health problems linked to inadequate housing conditions also lead to reduced productivity and work absenteeism.

At the macroeconomic level, the healthcare system bears additional costs for treating preventable diseases associated with energy poverty, while the public budget faces increasing pressure from the expansion of social support programs designed to cover utility bills.

Impact on social cohesion

Energy vulnerability acts as a factor of social polarization, amplifying structural disparities between urban and rural areas as well as across income groups. These inequalities increase the risk of social exclusion and economic marginalization.

Inequitable access to energy is not only an economic issue but also one of *fairness and social justice.* Its effects are manifold: (i) fragmentation of communities and reduced social cohesion, (ii) perpetuation of inequalities and limited social mobility, (iii) erosion of public trust in institutions.

Thus, energy vulnerability must not be regarded merely as a consumption deficit. It represents a structural determinant of social stratification and quality of life, with profound and lasting implications for sustainable human development.

Conclusions

The empirical analysis confirms that energy vulnerability is a key determinant of living standards in the Republic of Moldova, with systemic and long-term effects on population well-being. The increase in energy burden by more than 40% between 2020 and 2023 and the widening of rural–urban disparities (from 0.4 to 3.3 percentage points) reveal a deep structural problem that goes beyond explanations based solely on conjunctural shocks.

Energy vulnerability is no longer limited to poor households but also affects significant segments of the middle class. The expansion of the phenomenon is driven by structural

macroeconomic factors, including the effects of the conflict in Ukraine on regional energy markets. These realities require differentiated public policies that take into account vulnerable social groups.

The rural environment faces a severe energy crisis (17.0% burden compared to 13.7% in urban areas), driven by inadequate infrastructure, dependence on traditional fuels with volatile prices, and lower incomes. This situation calls for urgent, targeted, and territorially differentiated interventions.

The upward trend in energy vulnerability shows that the phenomenon is structural, not conjunctural. It must be understood as a fundamental determinant of social stratification and limited economic mobility, and not treated as a temporary adjustment issue.

Combating energy vulnerability must become a major national priority. It is not merely a technical matter of energy access but a question of social equity, national cohesion, and human security.

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