Moldova's energy crises and the impact of the Energy Vulnerability Reduction Fund in alleviating poverty during the winter of 2022–2023

SEPTEMBER 2023

Acronyms and Abbreviations

EVFR: Energy Vulnerability Reduction Fund

EVIS: Energy Vulnerability Information System

HBS: Household Budget Survey

MLSP: Ministry of Labour and Social Protection

MDL: Moldovan Lei

AIDS: Almost Ideal Demand System

QUAIDS: Quadratic Almost Ideal Demand System

CPI: Consumer price index

COICOP: Classification of Individual Consumption According to Purpose

LIHC: Low income-high costs

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Executive summary

Due to recent rise in energy prices on the continent, several European countries have taken significant steps to combat energy poverty. At the end of 2021, in addition to the COVID-19 pandemic and the related health crisis, the Republic of Moldova was faced with a significant increase of energy prices as a consequence of very tight global energy markets. The increase in the price of energy has had a domino effect on all other prices, by not only increasing the risks of energy poverty, but also food poverty in both rural and urban Moldova.

As a demand-side measure to tackle the impact of the energy crisis, the Moldovan Ministry of Labour and Social Protection (MLSP) with technical support from UNDP Moldova, introduced the Law on the Energy Vulnerability Reduction Fund. The Energy Vulnerability Reduction Fund (EVRF) plays a vital role in providing targeted support to those most affected by the crisis.

The aim of EVRF is to create an inclusive solution that minimizes the negative impacts of the sharp increase in energy prices on energy-vulnerable and income-poor households, therefore safeguarding social cohesion. In the longer term, the EVRF aims to incentivize the transition towards sustainable energy sources and to achieve higher levels of energy efficiency in the residential sector.

A micro analysis focused on evaluating the impact of the EVRF on income and energy poverty in Moldova was conducted. The first aspect of the analysis focused on the impact of the EVRF's energy compensation measures on energy poverty. This entailed studying how the subsidies have affected the affordability of energy services for vulnerable households before and after the implementation of the Fund in order to understand if it has reduced the number of households facing energy poverty. In addition, by comparing the income levels of beneficiaries before and after receiving energy subsidies, it is possible to evaluate if the Fund has contributed to reducing income poverty. This could help assess whether the compensation measures have positively affected household budgets, allowing them to allocate more resources to other essential needs. The second important aspect is related to the impact of the compensations on energy consumption at the household level.

The analysis relied on two main data sources. To study the effects of the EVRF, Household Budget Survey (HBS) data from 2019 to 2022 were used to simulate how and to what degree energy subsidies alleviate energy and income poverty. In addition, data from the Energy Vulnerability Information System (EVIS) were used to analyse the effects of compensation on changes in energy consumption between the last two winters.

Analysis of HBS data sets suggests that energy subsidies provided under the current mechanism of the EVRF have strong positive effects on reducing energy poverty, but with some differentiated effects by energy sources. The proportion of highly vulnerable households in energy poverty is reduced by 71 percentage points for gas and 10 percentage points for electricity because of the provided compensations. The current mechanism benefits more the category of high vulnerability households than the other energy vulnerability categories.

The overall effect of the decrease in income poverty is significant. This effect is seen across all four vulnerability categories. For the very high energy vulnerability category, the proportion of income-poor households decreased by 43 percent. It is important to highlight that the effect increases progressively with the vulnerability category, indicating that the energy compensations are well targeted and benefit more households in the high and very high energy vulnerability categories, a desired effect of the policy intervention.

The evaluation of EVRF data suggests that the impact of gas compensation varies depending on the level of vulnerability, suggesting that the energy subsidies have different effects on energy consumption for households with different degrees of vulnerability. For instance, natural gas subsidies led to a greater increase in consumption for low vulnerability households than for higher vulnerability households, suggesting that the mechanism can be further improved by revising the level and amount of the support granted to low vulnerability households using gas for heating. However, the magnitude of change, albeit statistically significant, is small across different vulnerability groups. This also holds true for electricity and thermal energy.

In summary, the evaluation conducted by UNDP Moldova provided critical insights and recommendations for the EVRF, emphasizing the importance of a more integrated and nuanced approach, the need for robust data governance and internal evaluation capacities, and the consideration of additional variables for the categorization algorithm that could be used in the analysis that could shed more light on the varying impact of energy subsidies. These measures are key to maximizing the EVRF's impact, expanding its coverage, and ensuring its continuous improvement.

1. Introduction

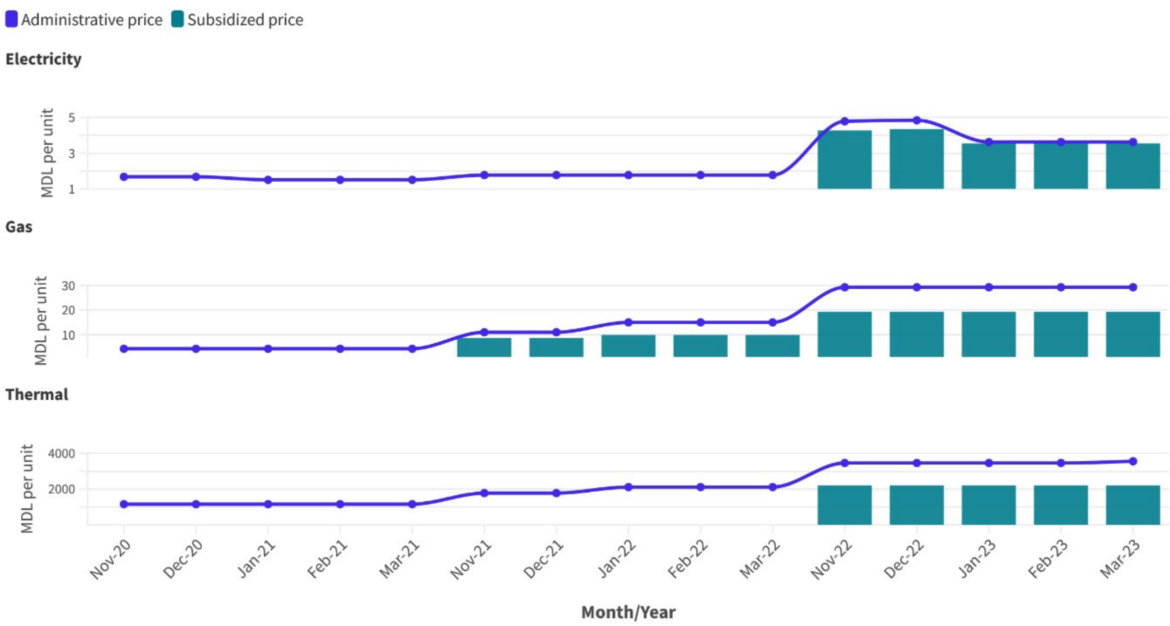
Energy security in Moldova is still being hampered by many challenges, including its dependence on imported energy. Still recovering from the pandemic-induced economic downturn in 2020, the Russian invasion of Ukraine has now led to the worst energy crisis ever experienced in Moldova. Starting from November 2022, the Russian Federation reduced the volume of gas delivered to Moldova by 49 percent, directly affecting the volume of electricity produced by the Cuciurgan Power Station. A major consumer of gas and supplier of electricity to Moldova is the Cuciurgan Power Station (or MGRES), situated on the left bank, which is not controlled by the authorities of the Republic of Moldova. Power supplies from MGRES covered, as a rule, between 70 percent and 80 percent of the consumption of the right bank of the Nistru River; the rest was covered by imports from Ukraine, unreliable today after the destruction of the Ukrainian infrastructure by the Russian bombings. The situation has placed energy vulnerability and energy poverty at the forefront of any policy debate in Moldova.

The immediate effect of the energy crisis in Moldova has been a rapid increase in the rate of inflation, driven by a quadrupling of electricity prices on the back of the gas supply shock. The increase in energy prices started winter of 2021–2022 and peaked in November 2022. The pre-existing socio-economic challenges such as food poverty in both rural and urban areas, the high proportion of the population living in poverty and the health crisis, exacerbated by the COVID-19, led to surge in prices, which has increased the level of energy poverty to over 60 percent in Moldova (Gray Molina, Montoya-Aguirre & Ortiz-Juarez, 2022).

Research conducted by the UNDP Global Policy Network (UNDP, 2022) highlighted that inflation figures in September 2022 – compared to September 2021 – showed an increase in overall utility prices of 105 percent. As a result, Moldovan households were reported to have started supplementing their additional spending on energy from less spending on other subsistence goods such as food, after already cutting spending on virtually all non-essential goods. The study suggests that under the current levels of inflation, the number of people living in poverty could increase by about 640,000, with approximately 35 percent of the Moldovan population at risk of falling below the poverty line (<US$5.50/day); if the energy crisis had not occurred, it was estimated that only over 10 percent of the population would have fallen below the poverty line.

To support households with rising energy bills and alleviate both energy and income poverty, Moldova introduced a demand-side measure to tackle the impact of the energy crisis. Energy subsidies were introduced for three energy sources, of which natural gas prices were subsidized much earlier. On average subsidies covered more than 30 percent of the average energy prices during the 2022–2023 winter period.

Figure 1. The evolution of energy prices



Units for electricity, gas and thermal are expressed in kwH, cubic meters and giga calories, respectively.

Given the significance of the residential sector in terms of energy consumption (around 50 percent of total energy consumption), a comprehensive understanding of households' energy consumption patterns and choices is imperative. As a point of departure, this policy brief provides an analysis and understanding of the Moldovan residential sector's energy characteristics considering their energy-use profile and other characteristics such as their geographical distribution and demographics.

More specifically, this policy brief aims to assess the **impact of the Moldovan Energy Vulnerability Reduction Fund (EVRF) on energy and income poverty.** First, it presents a background in the energy sector in Moldova and energy subsidies introduced by the Government – the EVRF. Then, it discusses the results of the microeconomic simulation conducted.

The main objective is to analyse the impact of the EVRF on energy and income poverty by focusing on two key research questions:

1) What is the impact of the energy compensation on poverty (energy and income poverty)?
   - What is the impact on households below the poverty line?
   - What has been the impact in terms of lifting those below the poverty line above the poverty line?
2) What is the impact of the energy compensation on energy consumption?

2. Energy consumption and energy poverty

2.1 Overview of the energy market and energy consumption patterns in Moldova

Moldova's energy profile is characterized by a heavy reliance on imported energy resources, limited domestic energy production, and efforts to diversify its energy mix. Moldova imports most of its energy resources, including natural gas, oil and electricity. It heavily relies on imports from the Russian Federation and other neighbouring countries to meet its energy needs. Natural gas is a significant energy source in Moldova, used for heating, electricity generation and industrial purposes. The country primarily imports natural gas from the Russian Federation through the Transnistrian region.

Moldova's electricity sector depends on a mix of sources, including imports, domestic generation and renewable energy. The country imports electricity from Ukraine and other neighbouring countries to supplement its domestic production.

In recent years, Moldova has been making efforts to diversify its energy mix and increase the share of renewable energy. It has significant potential for renewable sources such as hydropower, solar, wind and biomass. Several renewable energy projects have been implemented, including wind farms and solar power plants.

Additionally, Moldova has recognized the importance of improving energy efficiency to reduce energy consumption and dependency on imports. Various initiatives and programs have been implemented to promote energy-efficient technologies and practices in buildings, industry and transportation.

Moldova aims to enhance its energy security by reducing its reliance on imported energy resources, diversifying energy sources, and improving energy efficiency. The country has been exploring opportunities to increase domestic energy production and improve interconnections with neighbouring countries.

Moldova actively participates in regional energy cooperation initiatives, including the Energy Community and various projects aimed at enhancing energy connectivity in the region. It seeks to strengthen energy cooperation with neighbouring countries and diversify its energy supply routes.

Overall, Moldova faces challenges in terms of energy security, high dependence on imports, and limited domestic energy resources. However, the country is taking steps to diversify its energy mix, promote renewable energy, improve energy efficiency, and strengthen regional cooperation to ensure a more sustainable and secure energy future.

2.2 Description of the energy subsidy policy in Moldova and its goals

Tackling energy vulnerability and poverty in a crisis context is a highly complex issue that requires a multifaceted approach. This approach may consist of a combination of emergency measures to stabilize the situation with building longer-term solutions. The response may involve a variety of instruments, ranging from emergency relief efforts and increased access to renewables, to encouraging energy conservation and efficiency, and fostering community-led solutions and energy compensation mechanisms, both targeted and untargeted. However, testing such complementary approaches in a crisis context, such as the one in Moldova, is challenging due to limited fiscal space and capacities.

A combination of supply and demand interventions are needed to curtail the effects of the energy crisis and alleviate energy poverty. A situation where subsistence spending on one necessity (energy) must be carefully weighed against spending on another (food) is not a tenable situation and must be addressed with the utmost urgency.

As a demand-side measure and to tackle the impact of the energy crisis, the Moldovan Ministry of Labour and Social Protection (MLSP) with technical support from UNDP, introduced the Law on the Energy Vulnerability Reduction Fund in July 2022

(Law 241/2022), which came in force in September 2022. The Law aims to prevent and combat the population's energy vulnerability, to increase energy accessibility among vulnerable consumers, and to promote energy efficiency. The main objective of the Fund is to finance energy vulnerability reduction measures and programmes including compensations for the payment of energy bills for vulnerable energy consumers, subsidies to improve the efficiency of energy resource consumption and other measures of social assistance.

As part of the Law, the Government of Moldova launched the Energy Vulnerability Information System (EVIS) in October 2022, an online platform that allows to register and process requests for on-bill compensation of people's expenses towards energy-related consumption. The programme stipulates a differentiated compensation scheme with five categories of energy vulnerabilities for households: consumers with very high, high, medium, low energy, and no energy vulnerability. These categories are based on income level, the number of people within households, the number of assets (real estate) owned, and the main type of heating source and energy expenses, among others. Based on a ratio between energy expenses and disposable income of each family, households are classified into one of the five categories.[2] Once being assigned a vulnerability category, the household's energy tariff gets re-calculated with the actual subsidies and the consequent changes in tariffs by vulnerability category.

During the online registration process on the dedicated platform, data are automatically cross-referenced with other relevant official government data sets to ensure concordance of data and avoid mistakes and duplicated entries. As of the end of March 2023, over 763,000 households, i.e. almost 75 percent of Moldova's households according to national census data, had registered to benefit from the compensation scheme.

[2] The vulnerability category (R) is calculated as: R(%) = CEPRA/VDAE

Where:

CEPRA = ConsumTotalMdl = the household's estimated monthly expenditure on energy, obtained by multiplying last year's average monthly energy consumption (monthly average for November 2021 – March 2022) (in GCal, m^3, kWh) by current non-compensated rates (MDL/GCal, MDL/m^3, MDL/kWh), in MDL.

VDAE = VGL – MCF – RLCI

Where:

VDAE: the income available to pay for energy. The latter is equal to the household income after deducting the household's minimum expenditure level in the amount of MDL 3,340 for the main applicant and additional MDL 2,400 for each subsequent family member registered.

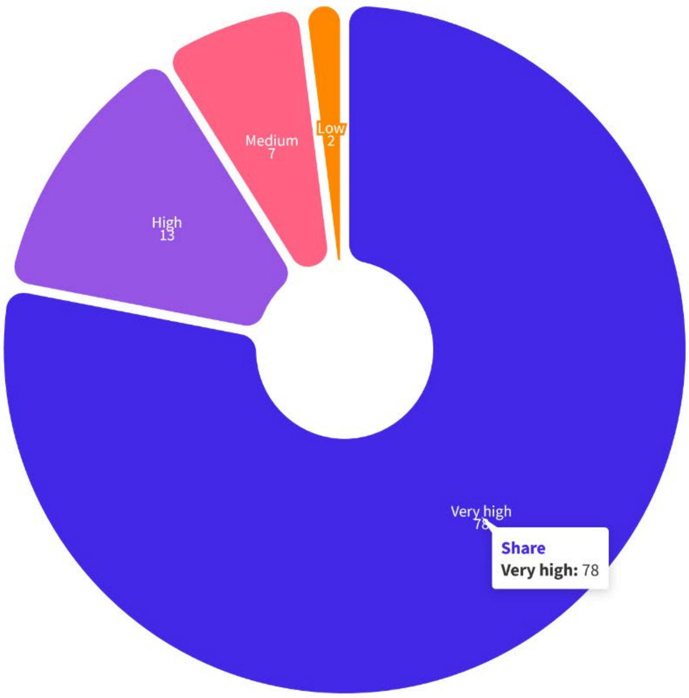
VGL: overall monthly household income

MCF: minimum expenditure level of the household = MDL 3,430 for the main applicant and 2400 MDL for each subsequent family member registered

RLCI: monthly mortgage payment

Ratio<0.20 => low vulnerability (category 1); 0.2 0 ≤ ratio <0.35 => medium vulnerability (category 2); 0.35 ≤ ratio < 0.90 => high vulnerability (category 3); ratio ≥ 0.90 => very high vulnerability (category 4).

Figure 2. Percentage of approved beneficiaries of the Energy Vulnerability Reduction Fund's by vulnerability category



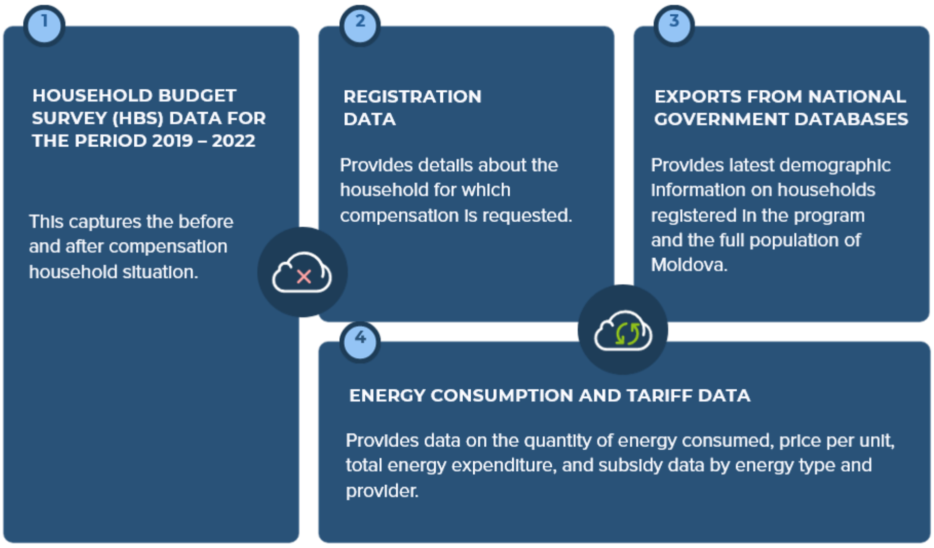
Vulnerability category	Number of households in each vulnerability category	Percentage of households in each vulnerability category (%)
4 - Very High	592 835	77.7
3 - High	97 715	12.8
2 - Medium	54 794	7.2
1 - Low	13 202	1.7
No vulnerability category	4 298	0.6
Total	**762 844**	**100**

As part of this scheme, the compensation is paid directly to the energy supplier, which credits the energy account of consumers. This helps households to retain some of their disposable income that would otherwise be spent on energy and allows them to substitute their expenditure towards purchasing food and other basic items. By subsidizing the energy bills of vulnerable households, the Moldovan Government is helping to keep these households afloat and reduce what would otherwise have been a massive increase in the national poverty rate.

3. Data and methodology

3.1 Data

Several types of data are used for the two-part analysis.



First, for the microsimulation analysis, the Moldova Household Budget Survey (HBS) data from 2019 to 2022 were used. The HBS is implemented by the National Bureau of Statistics of the Republic of Moldova and is nationally representative. The total sample size across the four waves was 16,648, distributed as follows: 2019 (n=4,408), 2020 (n=4,282), 2021 (n=4,079) and 2022 (n=3,879). This sample captures the before and during compensation household situation.

The Moldovan household budget survey collects a wide range of variables to capture various aspects of the population's living conditions, socio-economic status and well-being. Some of the key variables are:

1. Demographic variables: These include information about household members such as age, sex, marital status, educational attainment and relationship to the head of the household.

2. Economic variables: These variables focus on the economic activities and financial situation of households. They may include employment status, occupation, industry of employment, income sources and household expenditure patterns.

3. Housing variables: These variables provide insights into the housing conditions of households, including type of dwelling (e.g. house, apartment), housing quality, ownership status, rental costs, access to basic amenities (e.g. water, electricity) and sanitation facilities.

4. Assets and wealth variables: These variables capture information on household assets such as land, livestock, vehicles, savings and other financial holdings. They help assess the wealth and economic well-being of households.

5. Education variables: These variables cover educational indicators such as literacy rates, school enrolment, highest level of education completed, and educational aspirations of household members.

6. Health variables: These variables focus on the health status and healthcare utilization of household members. They may include information on self-reported health, disability status, access to healthcare services, and health insurance coverage.

7. Social assistance variables: These variables capture the participation of households in social assistance programmes or safety net initiatives, such as social pensions, child allowances and targeted cash transfer programmes.

8. Migration variables: Given the significance of migration in Moldova, surveys often collect information on migration patterns, including international and internal migration, remittances and the impact of migration on households.

9. Access to services variables: These variables assess the accessibility of households to essential services such as education, healthcare, clean water, sanitation and transportation.

10. Poverty and inequality variables: These variables are used to estimate poverty rates and measure income or wealth distribution within the population. They include variables related to income, consumption and wealth, and various poverty indicators.

These variables provide valuable insights into the social and economic conditions of households in Moldova, helping to inform policies and interventions aimed at improving the well-being of the population.

The data used in the second part of the survey, which analyses the effects of the compensation scheme on energy consumption, include:

1. Energy consumption data by distributor and energy type: This data set contains the respective quantities consumed and expenditure on gas, electricity, and thermal energy. The data cover the period from October 2021 to July 2022.

2. Energy consumption data by distributor and energy type for the period November 2022 to February 2023. The variables covered were as follows:

a. the total volume of the energy type delivered to the household consumer.
b. the volume of the energy type delivered within the limits of the maximum compensated.
c. the total expenditure in each energy type – electricity, gas and thermal by each household
d. the total energy expenditure by each household
e. the category of energy vulnerability as assigned by energy companies
f. the amount of compensation for maximum volume compensated per month (in MDL);
g. the name of the energy distributor.

3. Fund applicant registration data of 758,546 applicants (see https://compensatii.gov.md/en for the application site): This provides details about the household for which compensation is requested, as follows

a. average net monthly income of the household indicated by the applicant in the application form (calculated based on the last six monthly incomes, in MDL);
b. the household income (in MDL) used in the calculations to determine their category of energy vulnerability. If the income provided by government databases (CNAS, Fiscal Inspectorate) is higher than the income indicated in the application, then the higher income will be the one used in the calculations;
c. the household income (in MDL) after deducting MDL 3,430 from the household's minimum expenditure level for the main applicant and deducting MDL 2,400 for each subsequent family member registered);
d. the sum of social benefits that the household receives per month, as provided by The National House of Social Insurance (in MDL);
e. global monthly income reported by the household;
f. the household's estimated monthly expenditure on energy (in MDL), obtained by multiplying last year's average monthly energy consumption (monthly average for November 2021 to March 2022) (in GCal, m3, kWh) by current non-compensated rates (MDL/GCal, MDL/m3, MDL/kWh);
g. the category of the energy vulnerability attributed to the applicant for November, December, January and February, (0 – non-vulnerable; 1 – low vulnerability; 2 – medium vulnerability; 3 – high vulnerability; 4 – very high vulnerability;
h. number of household members;
i. dummy for at least one person in the household with a confirmed disability;
j. district name;
k. number of land plots registered per household;
l. number of cars owned by the household;
m. gender ratios in the household;
n. age brackets in the data.

4. Distributor and applicant identification: This contains the applicant's and the distributor's id variables, which were used to merge the data sets with the energy and applicant registration data.

3.2 Methodology

A demand systems framework is used as a starting point in the analysis because it provides essential information concerning the sensitivity of household energy demand relative to price changes and the expenditure of products contained in the basket of household goods, as well as interdependencies between energy types at this level.

The methodology used here to estimate the household demand for energy is based on the Almost Ideal Demand System (AIDS) model, which gives an arbitrary first-order approximation to any demand system derived from utility-maximizing behaviour. Also, its functional form is consistent with household budget data. Individuals are assumed to maximize their satisfaction level by the consumption of different goods such as energy, food and clothing. The utility maximization will be subject to a budget constraint determined by the individual's income or desired expenditure and the prices of the goods consumed.

The quadratic extension of the AIDS (QUAIDS) model chosen for this analysis is an extension of the AIDS model originally proposed by Deaton and Muellbauer (1980). Based on a non-parametric analysis of consumer expenditure patterns, Engel curves have been shown to be of higher rank than 2, thus requiring quadratic terms in the logarithm of expenditure.

To derive the budget shares in QUAIDS, the same procedure used for AIDS can be applied, which yields the following expenditure share equations:

$$w_i = a_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{X}{a(p)}\right) + \frac{\lambda_i}{b(p)}\left[\ln\left(\frac{X}{a(p)}\right)\right]^2$$

Where:

wi is the share of commodity i in a household budget, defined as:

$$w_i \ = \frac{p_i q_i}{m}\ and \sum_{i=1}^{n} w_i = 1$$

Pj is the market price for commodity j, M represents consumer total expenditures or income, and P is an overall price index. For prices, the Stone price index was used, defined as:

$$Log\ P = \sum_{i=1}^{n} W_i log p_i$$

Where:

wi is the budget share for good i and p is CPI index obtained from Moldova Statistical Office for each of 52 commodities reported on a monthly basis in the HBS.

For the analysis, the authors estimate budget share equations and obtain elasticities for electricity and gas, and group other commodities into the category "other".

In addition to price and income, the socio-demographic characteristics also alter spending in different ways. For instance, it is expected that a larger family increases its overall expenditure on energy compared to a smaller family with the same preferences. The socio-demographic variables included in the model are the size of the household, adults over age of 65, education, whether they live in urban or rural area and whether household head is women

In addition to elasticity estimation, which is a crucial input in microsimulation using HBS data, the panel random effects regression was used to estimate the effects of energy subsidies on the change in volumes consumed by households between current (November 2022 – February 23) and previous winter (November 2021 – February 2022) controlling for household characteristics. The latter technique is applied to registration data. The availability of repeated observations on the same units, in this case households, allows to enrich the model by inserting an additional term in the regression, capturing individual-specific, time-invariant factors affecting the dependent variable but unobserved to the econometrician. Generalized least squares estimators of the parameters of such a model are more efficient than those obtained in the simpler model neglecting these unobserved factors.

The random-effects model is an alternative to the fixed-effects model, which helps capture the effects of all variables that do not change over time. Hence, any variable that does not change over time at the household level, such as its location, would be captured by these fixed effects terms in the model. Therefore, it is not possible to separately estimate the effect of firms' location on their performance. Since this is restrictive for some applications, the random effects framework were adopted instead, even though these models impose stronger assumptions about the unobserved effects. The random-effects model allows for consistent and efficient estimate of regression coefficients and to identify the effect of the compensation by exploiting its variation across households when some of the control variables are time-invariant.

4. Empirical analysis

4.1 Descriptive statistics on the Moldovan Household Survey 2019–2022

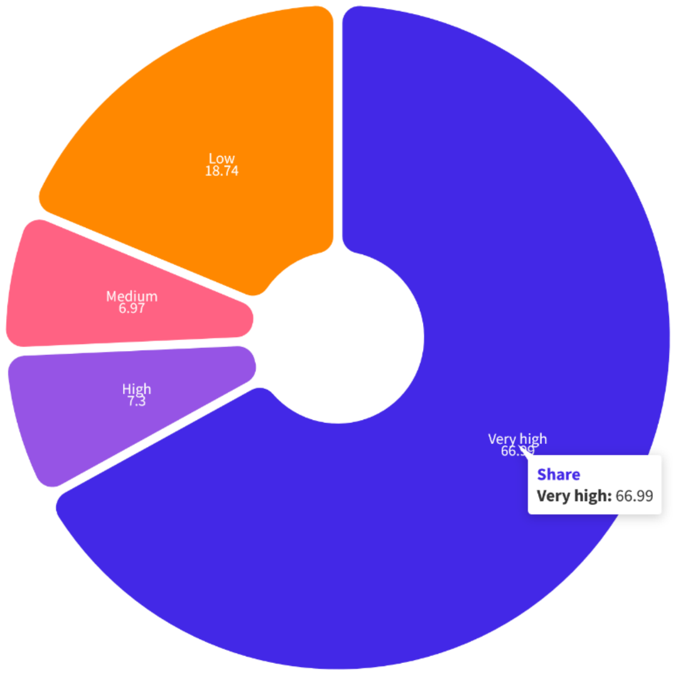
The descriptive statistics presented in this section are based on the data gathered from the National Bureau of Statistics for 2019, 2020, 2021 and 2022.

The total sample comprises 16,118 households. According to the HBS data, the the average household size is 2.34, ranging between 1 and 11 members. With 30 percent of households being single households; and almost 8 percent reported 5 members and more.

The average household monthly income was around MDL 7,379; the average household received MDL 1,848.66 in social benefits and spent an average of MDL 608.83 on energy.

With regard to the four categories of energy vulnerabilities for households (consumers with very high, high, medium, and low energy vulnerability), over 66 percent of households were classified as "very high vulnerability", 7 percent, "high vulnerability", and "medium vulnerability, and about 19 percent as "low vulnerability.

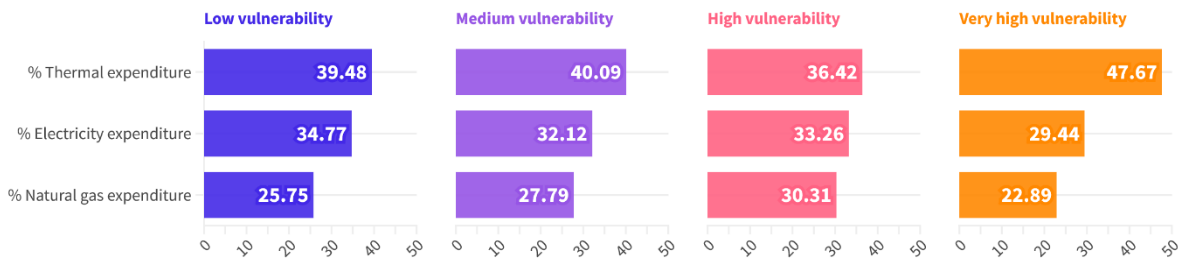
Figure 3. Percentage of vulnerable households in the Household Budget Survey



Given the surge in prices in the last two winters, household expenditure on all sources of energy increased significantly, peaking in the last two months of 2022, thus significantly affecting households' budgets.

An examination of energy expenditure by vulnerability category across winter periods from 2019 to 2022 shows that most of households' energy expenditure is related to electricity and thermal energy. On average, households in the medium vulnerability category spent more on energy. The share of thermal energy expenditure were higher than natural gas and electricity across all vulnerability categories, particularly for the very high vulnerability category.

Figure 4. Percentage of monthly energy expenditure by vulnerability group (%)



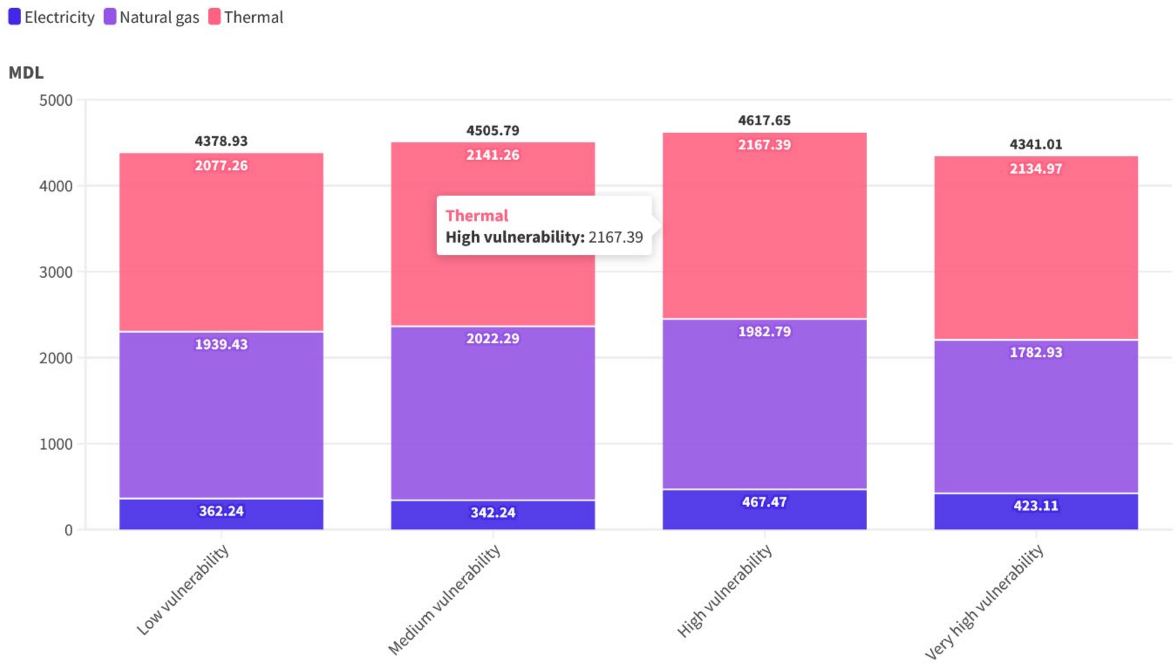
4.2 Descriptive statistics on registration data from the Moldovan Energy Vulnerability Reduction Fund – November 2022 to February 2023

The descriptive statistics presented in this section are based on the data gathered from the registrations in the EVIS for the period from November 2022 to February 2023. Registering and providing key data allowed households to qualify for energy compensations, based on their category of energy vulnerability.

The total sample comprises more than 700,000 observations. The data cover basic demographic characteristics of applicants such as household size, gender and age, and economic variables such as average household monthly income (declared and calculated, in the last six months), net expenditure, sum of monthly social benefits received, estimated expenditure on energy, and the vulnerability category based on the ratio of energy expenditure to net income (as calculated in the EVRF programme).

Figure 5 shows that household expenditures on thermal energy and gas were disproportionately higher than on electricity and do not significantly differ across vulnerability category.

Figure 5. Energy expenditure by vulnerability category – registration data



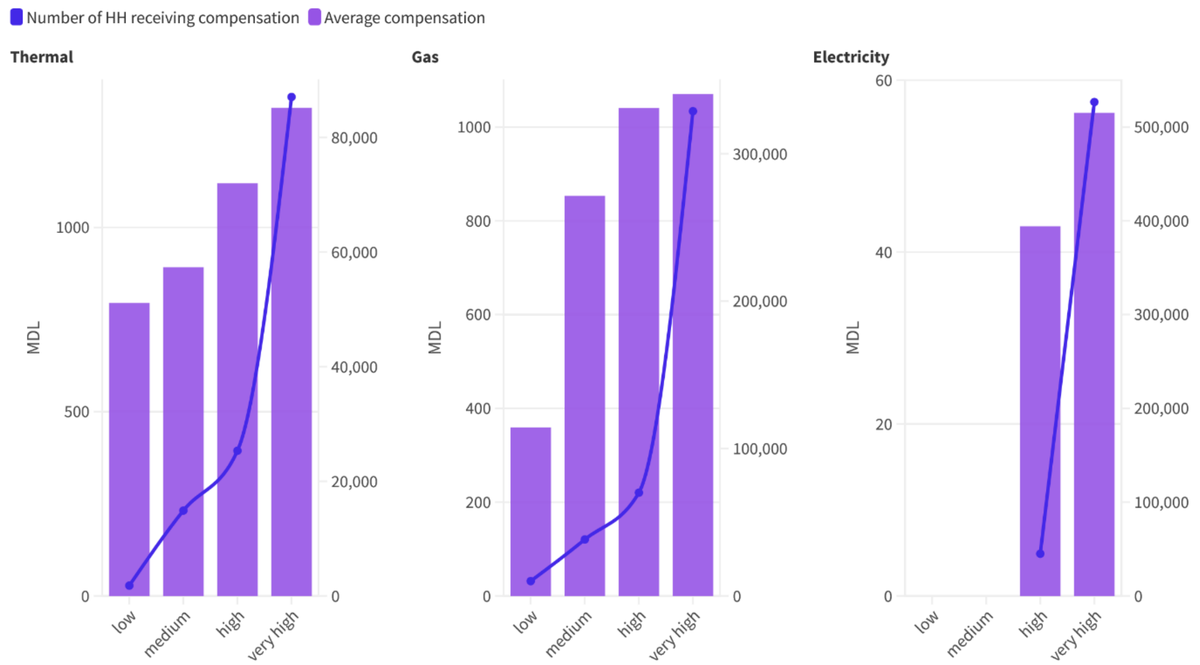
Most of the households received compensation in the form of subsidies, which varied according to vulnerability category and the type of energy used to heat their home.

The most vulnerable households consuming thermal energy and gas received between two and three times more, respectively, than low vulnerability households in order to prevent a negative impact on household budget and thus reduce energy poverty.

On average, highly vulnerable households consuming gas received over MDL 1,000 more than medium and low vulnerability households, which received MDL 853 and MDL 359, respectively. Similarly, very high vulnerable households using thermal energy saw their bills being reduced by MDL 1,324, while low vulnerable households received a compensation of MDL 795 on average.

In comparison to winter 2022, gas prices have risen significantly by MDL 15.87, or 118 percent. However, the Government's gas subsidies were able to cover 63 percent of this price increase. Hence, households were only left to bear 37 percent of the additional cost due to the higher gas prices. For households using thermal energy, the situation was more challenging, because the price of thermal energy saw a substantial increase of 75 percent. Nonetheless, the Government's subsidies covered 84 percent of this price hike. Electricity subsidies, although they covered a significant portion of the population, were not as effective in dealing with the rising electricity prices. They were only able to cover 11 percent of the price increase for electricity, leaving households to pay the remaining 89 percent of the increased costs.

Figure 6. Compensation by vulnerability category – registration data



4.3 Identification of vulnerable households

The previous section showed that the recent energy crisis put more households into energy poverty. Because the effects vary across households, the authors further explored the characteristics of the cohorts that are more likely to be in energy poverty and those that are negatively affected by the recent surge in energy prices to a larger extent. Econometric models were used for the analysis, and the regression specification is as follows:

$$y_{it} = X_{irt}\alpha + G_r\theta + T_t\delta + \varepsilon_{irt}$$

where y_{irt} is the outcome of interest for household at time t. X_{irt} is the vector of household socio-economic characteristics; G_r is the vector of geographical variables, including household specific effects.

The dependent variable is energy poverty defined as the share of energy expenses relative to its disposable income (income minus taxes). If the ratio is higher than the 10 percent threshold, which is fixed and independent of country-specific patterns, the household is considered energy-poor. This is a simple, easy-to-communicate indicator, which measures an absolute value for energy poverty that does not shift depending on the changes in the population. It has been widely used in research, although it is highly arbitrary. This ratio was used instead of the dummy variable for energy poverty because the value of the energy poverty dummy is based on a comparison of the ratio and the energy poverty line. Using an energy poverty dummy would omit more detailed information on the ratio.

The summary statistics of explanatory variables are presented in Table 1.

Table 1. Summary statistics of regression variables

	Low vulnerability	Medium vulnerability	High vulnerability	Very high vulnerability
MEAN CONTINOUS VARIABLES				
tenants	2.533	2.433	2.307	2.281
house size	73.336	73.612	73.150	70.935
Energy poverty	0.051	0.085	0.099	0.128
STANDARD DEVIATION CONTINOUS VARIABLES				
tenants	1.250	1.179	1.202	1.385
house size	25.929	25.558	28.011	24.412
Energy poverty	0.034	0.060	0.071	0.390
MEAN CATEGORICAL VARIABLES				
adult	0.233	0.246	0.292	0.375
education	2.241	2.195	2.163	2.094
single parent with children	0.013	0.015	0.019	0.023
married with children	0.169	0.190	0.162	0.166
single	0.319	0.265	0.305	0.309
married	0.290	0.301	0.313	0.271
rural	0.636	0.602	0.614	0.721
women	0.293	0.334	0.356	0.445

apartment	0.264	0.245	0.245	0.196
house	0.723	0.736	0.736	0.784
heating	0.599	0.546	0.564	0.678

The authors first investigate the characteristics of households that were more likely to have a high ratio of energy poverty before the programme. A multiple linear regression is adopted, and all the observed households in the regression for 2019–2022 are included. The results are shown in Table 2.

Table 2. Energy poverty before and during the energy crisis – OLS regression

	Before the energy crisis (2019–2021)	During the energy crisis (2022)
tenants	-0.007***	-0.018***
	-0.002	-0.003
adult	-0.001	-0.048***
	-0.009	-0.016
secondary education	0.022**	0.041***
	-0.009	-0.014
tertiary education	0.013	0.043**
	-0.009	-0.017
single parent with children	0.001	-0.026
	-0.008	-0.018
married with children	0.002	-0.005
	-0.006	-0.007
single	0.021***	0.036**
	-0.008	-0.018
married	0.011	0.009
	-0.01	-0.01
rural	-0.056***	-0.017
	-0.014	-0.012
women	0.006	0.024**
	-0.009	-0.01
apartment	-0.016*	-0.014
	-0.009	-0.022
house	0.004	0.026
	-0.007	-0.021
house size	0.000*	0.001***
	0	0
heating	-0.032***	-0.113***
	-0.008	-0.01
Medium vulnerability	0.016***	0.046***

	-0.002	-0.005
High vulnerability	0.026***	0.075***
	-0.003	-0.006
Very high vulnerability	0.069***	0.136***
	-0.003	-0.009
North	0	0
	(.)	(.)
Center	-0.012***	-0.015
	-0.004	-0.017
South	0.011	-0.007
	-0.014	-0.015
Chisinau	-0.055***	-0.088***
	-0.007	-0.013
Constant	0.081***	0.120***
	-0.024	-0.027
R-squared	0.019	0.115
Observations	12,355	3,758
*** p<0.1, ** p<0.05, *** p<0.01**		

In terms of household characteristics, Table 2 shows that, before the energy crisis (2019–2021), households with secondary education level were more likely to be in energy poverty. The regression results also show that households with more members tended to have a smaller energy expenditure/income ratio, indicating an economy of scale in heating. In addition, single households as well as urban households are more likely to experience energy poverty. Well-educated households and women-led households were also more likely to enter into energy poverty during the Russian aggression on Ukraine (2022).

It can also be observed that all categories of vulnerable households were spending more on energy as the share of their disposable income, with a gradual increase in probability of entering energy poverty across different degrees of vulnerability.

As shown in Table 3, the logit model yields similar findings when using a dummy variable to dependent variable used here, indicating whether or not the household is in energy poverty.

Table 3. Energy poverty marginal effects estimates before and during the energy crisis – logit regression

	Before the energy crisis (2019–2021)	During the energy crisis (2022)
tenants	-0.036***	-0.050***
	-0.004	-0.011
adult	-0.011	-0.029
	-0.009	-0.018
secondary education	0.082***	-0.005

	-0.027	-0.064
tertiary education	0.061**	0.04
	-0.029	-0.068
single parent with children	0.032	-0.017
	-0.028	-0.05
married with children	0.003	0.033
	-0.013	-0.025
single	0.089***	0.062*
	-0.014	-0.035
married	0.018	0.015
	-0.012	-0.028
rural	-0.167***	-0.034
	-0.011	-0.027
women	0.015*	0.012
	-0.009	-0.018
apartment	-0.096***	-0.103
	-0.025	-0.072
house	0.033	-0.006
	-0.028	-0.07
house size	0.001***	0.002***
	0	0
heating	-0.217***	-0.239***
	-0.012	-0.02
Medium vulnerability	0.075***	0.350***
	-0.011	-0.031
High vulnerability	0.191***	0.391***
	-0.014	-0.03
Very high vulnerability	0.359***	0.451***
	-0.006	-0.02
Center	-0.056***	-0.087***
	-0.01	-0.019
South	-0.025**	-0.036*
	-0.011	-0.02
Chisinau	-0.182***	-0.309***
	-0.012	-0.03
Observations	12,360	3,758

*** p<0.1, ** p<0.05, *** p<0.01**

4.4 Energy demand elasticities

There is extensive literature on the estimation of demand functions based on economic theory. Since the seminal work of Stone (1954), a significant amount of research has been produced, such as Deaton and Muellbauer's (1980) Almost Ideal Demand System (AIDS) and Banks et al.'s (1997) Quadratic extension of the AIDS (QUAIDS), among the more prominent ones. Estimating demand systems allows to compute demand elasticities for composite or individual commodities. These estimates are applied in analysing market changes, tax incidence, consumption patterns and international trade, among others.

The analysis is based on microdata from the continuous HBS cross-sectional household survey of the Moldovan statistical offices. The survey provides very detailed information on consumption expenditures, income, household composition, housing characteristics and other demographics.

Energy demand is considered to be driven by the need for energy services. Thus, household demand does not concern specific fuels, which would be zero for many households and for many fuels in any event; rather, it concerns heat and electricity for its appliances. Since gas is prevalently used as the source of heating, the authors analysed the demand for these two fundamental energy services separately.

Overall, the commodity aggregation should provide a realistic picture of household expenditures and avoid corner solutions (e.g. plausible zero expenditure observations) that would considerably bias the estimates. Thus, it is necessary to apply some form of aggregation and screening to the data to ensure proper identification of our parameters. Therefore, the expenditure on the rest of the Classification of Individual Consumption According to Purpose (COICOP) categories is grouped in the "Other" group and estimate income, own and cross-price elasticities for electricity, gas and other consumption categories.

A common limitation of HBS data is the lack of price information, an important variable in estimating demand systems. Several approaches are used in the literature to compensate for this lack of price data. Some collect data on both quantities purchased and expenditures, allowing for unit values to be calculated (expenditure divided by quantities) and used as proxies for prices. Another common approach is to incorporate external sources of price variability, such as consumer price indices (CPIs), to account for missing prices. However, studies conducted by Slesnick (2005) and Hoderlein and Mihaleva (2008) have found this approach to be problematic as it does not account for spatial and household variability.

This policy brief uses the approach proposed by Lewbel (1989) that allows for the construction of household-level price indices (Stone-Lewbel [SL] prices) for commodity groups using as inputs CPIs and the budget shares of the subgroups of the commodities of interest. The authors used CPI indices obtained for 52 expenditure categories across four years of data collected monthly to be used in the construction of the SL price index.

4.4.1 Estimation results

Regarding the elasticities, Table 4 shows the price elasticities for energy in the two expenditure categories across different vulnerable groups. Each cell in the table quantifies the change in demand of the commodity specified in each column in response to the change in energy prices. This is estimated for each vulnerability category, shown in each row.

Table 4. Uncompensated own and cross price elasticities

		Electricity	*Gas*	*Other*
Low vulnerability	Electricity	**-0.283*** **	-0.053***	-0.597***
	Gas	-0.071***	**-0.360*** **	-0.635***
	Other	-0.039***	-0.028***	**-0.934*** **
Medium vulnerability	Electricity	**-0.165*** **	-0.077***	-0.698***
	Gas	-0.095***	**-0.246*** **	-0.820***
	Other	-0.045***	-0.038***	**-0.911*** **
High vulnerability	Electricity	**-0.103*** **	-0.081***	-0.737***
	Gas	-0.100***	**-0.144*** **	-0.914***
	Other	-0.048***	-0.042***	**-0.905*** **
Very high vulnerability	Electricity	**-0.065*** **	-0.086***	-0.853***
	Gas	-0.099***	**-0.153*** **	-0.859***
	Other	-0.051***	-0.042***	**-0.900*** **

Increasing energy prices will reduce energy demand through two channels. In the face of higher prices, economic theory predicts a reduction in demand for the product. The purchasing power of vulnerable households will also be affected, yielding a further reduction in demand for the product. These two effects are summarized by the uncompensated elasticities displayed in Table 4. Note that the own price elasticity for the most vulnerable category (most energy-poor) has the smallest absolute value. Higher energy prices and low demand responses will expose vulnerable households to higher energy expenditure. This group already spends a higher proportion of their income on energy expenditure than do more affluent households. This implies that in the face of higher energy prices, households in these groups will face the largest burden given their inability to reduce energy consumption and the fact that they already spend a disproportionate share of their income on this commodity.

In general, households respond weakly to price changes for all energy items. Most own-price elasticities are below -1, with the strongest response observed for gas in the low vulnerability category (-0.360). Based on the estimations, it is expected to find some differences in energy poverty before and after the introduction of EVRF in November 2022. The evaluation of cross-price elasticities reveals that electricity and gas are weak complements, more so for households with higher vulnerability category. The cross-price elasticities between energy items and other categories clearly shows the important role of energy prices for other categories of expenditure. If energy prices decline because of energy subsidies, it is expected that households will increase their consumption of other goods.

Table 5 shows income elasticities. High income households' responses to gas use, with budget elasticities above 1 and rising over the vulnerability categories can be observed. Gas is clearly a luxury good for households of all incomes. Electricity also exhibits budget elasticities close to 1 and seems inevitable since the quantity demanded declines with rising income. However, for highly vulnerable households, electricity is a luxury good.

Table 5. Income elasticities

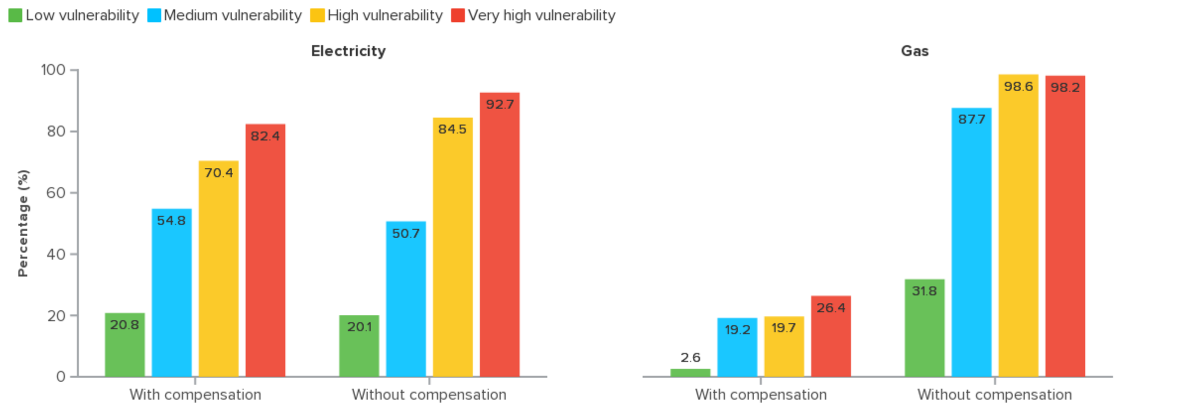
	Electricity	*Gas*	*Other*
Low vulnerability	0.932***	1.065***	1.001***
Medium vulnerability	0.941***	1.160***	0.995***
High vulnerability	0.920***	1.158***	0.996***
Very high vulnerability	1.004***	1.110***	0.994***

4.5 Microsimulation results

Based on the estimated price elasticity matrices reported in the previous section, t how much a household would have spent in November and December in 2022 if it had not received the reduced bills has been simulated: total expenditure on electricity and gas was simulated using market prices and whether or not EVRF had any effects in reducing energy poverty was evaluated. Market prices were obtained from energy distributors directly. For multiple gas and electricity distributors, the average value was taken for a specific month.[1] Since EVRF has been in operation since November 2022, the simulation of energy compensation on energy poverty was conducted using HBS data limited to the months of November and December 2022. Two metrics commonly used to estimate energy poverty were calculated. As a first indicator, the share of energy expenses relative to its disposable income (income minus taxes) is calculated (Charlier and Berengere, 2019). A common threshold of 10 percent was applied when categorizing household as energy-poor; however, this threshold should be set relative to the actual distribution in a specific country. The second indicator used was based on a minimum income standard. The most common indicator in this group is referred to as low income, high cost (LIHC). This measure is helpful in distinguishing energy poverty from generalized poverty because the household is not considered poor before the deduction of energy costs (poverty due to energy costs). The household is considered energy-poor if the equivalized income is less than 60 percent of the median household income and at the household's energy expenditure constitutes more than 60 percent of median energy expenditure.[3]

[3] The results provided in this section refer to energy poverty defined as the share of energy expenses relative to disposable income of over 10 percent.

Figure 7. Percentage of households in energy poverty



Note: **Energy poverty is when over 10 percent of the total disposable income is spent on electricity/gas**

Figure 7 shows the change in energy indicator (10 percent threshold) for the two simulated scenarios. It can be observed that energy subsidies have strong effects on the energy poverty rate. The proportion of very highly vulnerable households in energy poverty increases by 71 percentage points, or 272 percent, for gas consumption, whereas it increases by 12 percent for electricity consumption if they had not received subsidies. This implies that electricity price increases result in much lower energy poverty levels than gas price increases. By analysing different categories of vulnerability, it emerges that the impact of EVRF subsidy for gas gradually increases, i.e. the percentage increase in the number of low vulnerable households facing energy poverty after the price increase is several times higher than for very high vulnerability households, showing that EVRF has benefited the latter group to a greater extent.

However, there is a significant difference between the type of fuel being used. The increase in electricity prices benefit low and medium vulnerability households, while the increase in gas prices has a disproportionately higher detrimental impact on low vulnerability households, and to a certain extent, on medium ones.

Figure 8. Percentage of households in energy poverty that are below the absolute national poverty line: households consuming electricity (a) and households consuming gas (b)

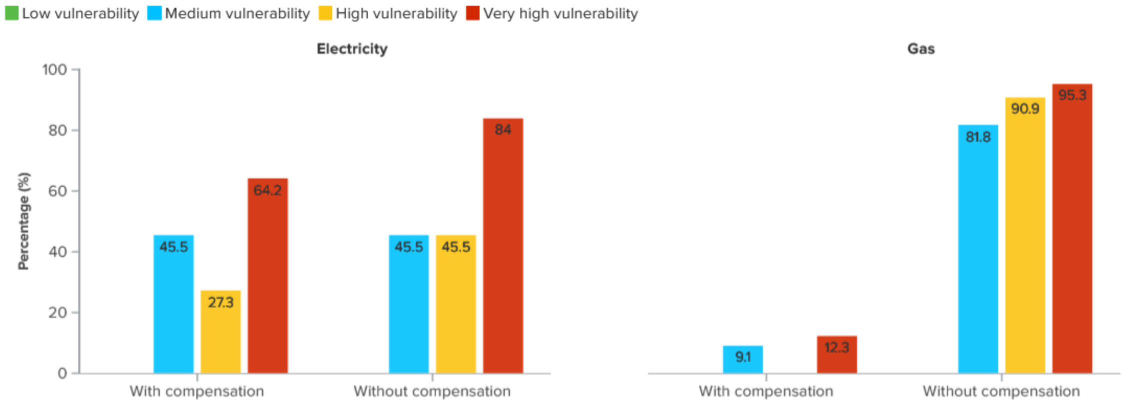
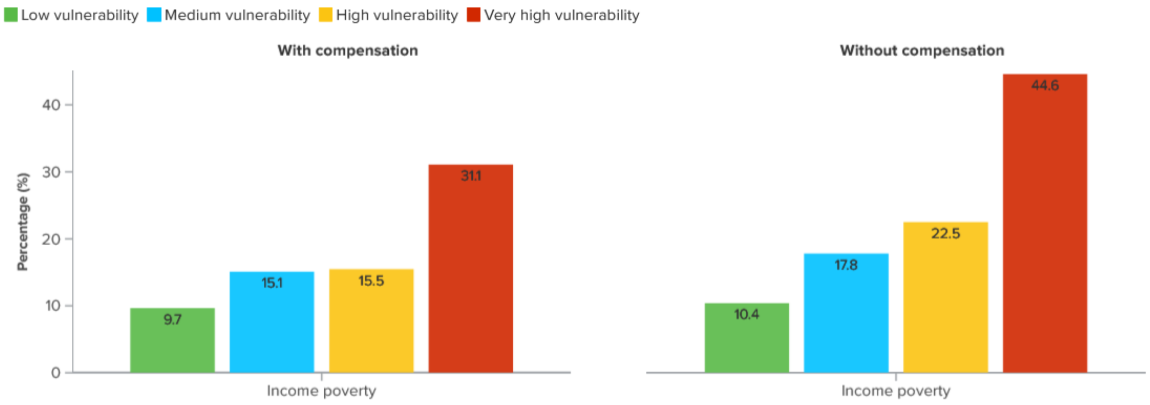


Figure 8 sheds more light on how compensation measures introduced in November 2022 affect poor households whose per capita expenditures is below the national poverty line. While for the low vulnerability group there were no energy-poor households, the impact of compensation starts to be noticeable for households who are highly vulnerable to energy poverty. As seen above, subsidies for gas have a higher impact on reducing energy poverty for households below the national income poverty line. For the highly vulnerable group, for instance, the gas compensation completely eliminates energy poverty, and for very high vulnerability households, it reduces energy poverty to 12 percent.

For households that consume electricity, the subsidies do not seem to impact low and medium vulnerable ones. However, for the most vulnerable households, the change in the number of energy-poor households is reduced by around 31 percent on average.

In addition, across all four vulnerability categories, the decrease in income poverty is substantial (Figure 9). For the very high vulnerability category, the proportion of poor households is decreased by 43 percent. More importantly, the decrease in income poverty becomes gradually greater as vulnerability increases, thus the compensation benefits high and very high vulnerability households to a greater extent.

Figure 9. Percentage of households in income poverty



4.6 Change in energy consumption due to compensation

To further examine the impact on energy subsidies, the authors used the data provided from Fund applicant registration data for the periods from November 2022 to February 2022, and from November 2022 tp February 2023. The data set described in more detail in Section 3.1 provides the opportunity to examine how energy compensation introduced in November 2022 affects energy consumption of households with different levels of vulnerability.

To this end, a panel data random effects model was used in which the dependent variable is one of the energy sources used in households for heating (electricity, gas or thermal energy), and the main explanatory variables are the amount of energy compensation and vulnerability category of households. In addition, household size and whether the applicant has a disability were considered control variables.

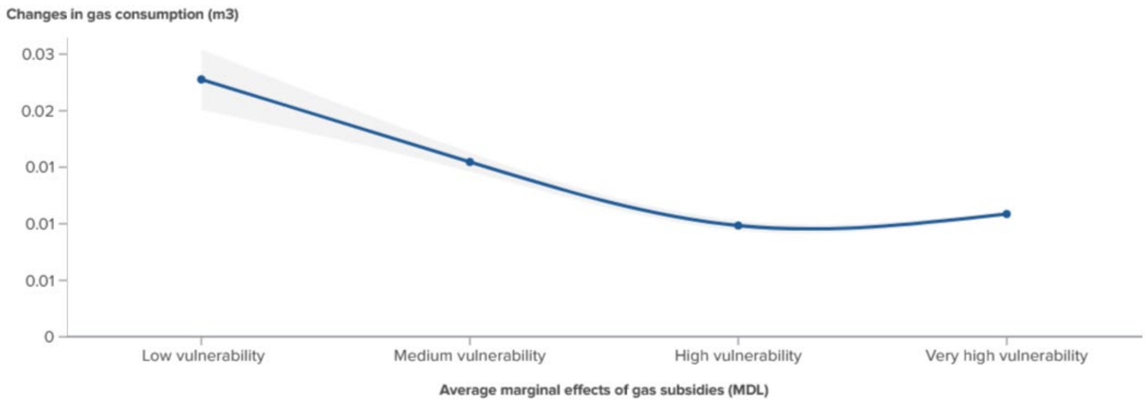
Figure 10 graphs show the effects of energy compensation on energy consumption across different energy sources for each vulnerability category. The effects of gas compensation decline by the level of vulnerability, in that the subsidies, although they increase energy consumption on gas for low and medium vulnerability households, start to decline with more severe levels of vulnerability.

The amount of compensation for electricity expenditure seems to decrease consumption for low vulnerability household but increase it for other groups, especially for medium vulnerability households.

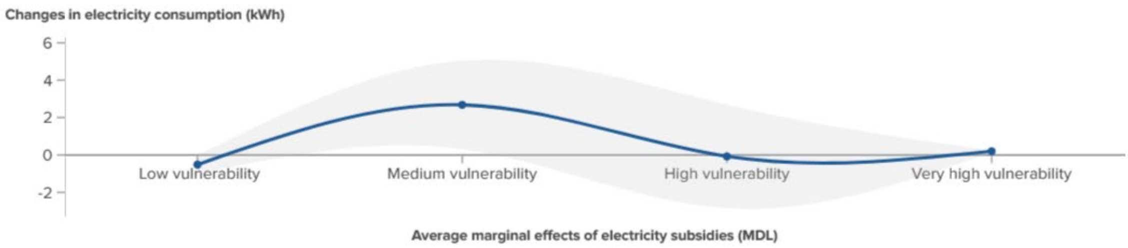
Subsidies related to thermal energy have opposite effects to those related gas and electricity because they seem to decrease the consumption across all vulnerability groups, but less so for the very high and high vulnerability groups than for the medium vulnerability group.

Figure 10. Impact of compensation on energy consumption

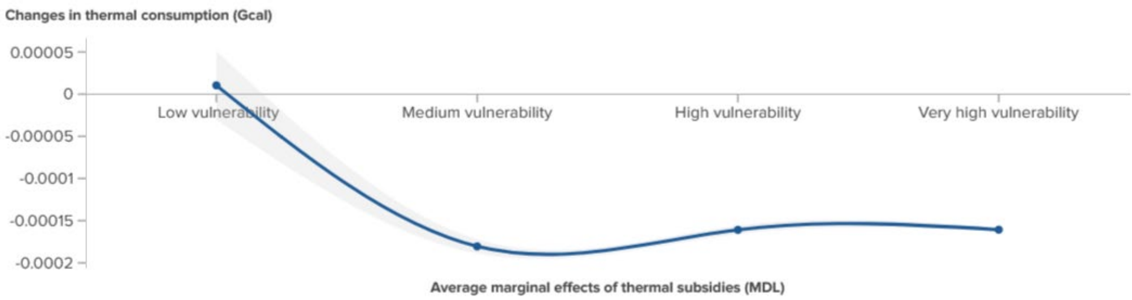
Impact of gas subsidy



Impact of electricity subsidy



Impact of thermal subsidy



5. Conclusions and recommendations

The effects of the Russian Federation-Ukraine war have exacerbated the already dire energy situation for Moldova. The country has experienced skyrocketing energy prices, which have contributed the rapid increase in the inflation rate, as well as energy supply shocks. Thus, it is not surprising that over 70 percent of the EVRF applicants were classified as very highly vulnerable to energy poverty. The EVRF aims to tackle the impact of the energy crisis through energy bill compensations. Consequently, the authors estimated a demand system for energy as well as the impact of the energy compensation on several outcomes, which include energy and income poverty, together with energy consumption. Data used in the analysis include the HBS data for the 2019–2022 period, EVRF applicant data, consumption expenditure by energy type and service provider, subsidy, tariff and compensation data. In principle, the analysis was conducted in three parts: Obtaining evidence of the determinants of energy poverty by examining household characteristics, microsimulation based on the HBS data, and energy consumption change based on EVRF data.

The results show that the energy poverty increases when moving across the vulnerability categories from low to very high. The characteristics of households more likely to experience energy poverty include those with more household members, single households, household head having secondary education, and households with a high degree of vulnerability.

Further, households respond weakly to price changes for all energy items. Most of the estimated own price elasticities are below -1, with the strongest response observed for gas in the low vulnerability category (-0.360). Moreover, the cross-price elasticities for electricity and gas indicate the two to be weak complements. This holds true especially for households in higher vulnerability categories. Additionally, estimated income elasticities indicate that there are high-income households' responsiveness to gas use, making it a luxury good for households regardless of income levels. In contrast, electricity seems inevitable since the quantity demanded declines with rising income. Regardless, electricity remains a luxury good for highly vulnerable households.

The microsimulation results show that energy subsidies have strong effects on the energy poverty rate, the proportion of energy-poor households below the national poverty line and those in income poverty. These impacts differ in magnitude by energy type. Without subsidies, the share of very highly vulnerable households in energy poverty increases much more for gas than for electricity. The proportion of very highly vulnerable households in energy poverty increases by 71 percentage points, or 272 percent, for gas consumption, whereas it increases by 12 percent for electricity consumption if they had not received subsidies. This implies that electricity price increases result in much lower energy poverty levels than gas price increases. Similarly, the number of energy-poor households below the national poverty line decreases with natural gas subsidies to 12 percent from 95 percent for very highly vulnerable households. For the same vulnerability, electricity subsidies result in around a 31 percent reduction in the proportion of very highly vulnerable households. The impact is also similar for households in income poverty. The reduction in the number of income-poor households rises progressively with vulnerability category.

The impact on energy consumption differs by energy type. For instance, the change in gas consumption declines by the level of vulnerability. In contrast, electricity consumption seems to decrease for low vulnerability households but then increases for other vulnerability categories, particularly for those in the medium vulnerability category. Unlike gas and electricity consumption, thermal energy subsidies seem to decrease consumption across all vulnerability groups.

Overall, the EVRF seems to benefit households in the very highly vulnerability category more. Given its success, it can be applied to other types of energy sources, but this would require a more detailed data set that would not only include household characteristics that are necessary for better targeting, but also details on households that did not receive such a compensation in order to evaluate the true causal impact of the scheme.

A caveat that concerns this analysis is that the microsimulation was conducted only for November and December 2022, without considering the entire winter period, from November 2022 to March 2023, due to data limitations at the time of conducting the analysis. In addition, the EVRF applicant registration data had limited household characteristics that could be useful to gauge the impact of the compensation to a more disaggregated level and by type of households, dwellings, etc. In general, there is also a lack of theoretical consistency with the existing energy poverty metrics; this requires research on the development of microeconomic foundations that allow transparency, homogeneity and replicability of these metrics.

Future research has the potential to tackle these challenges and push the boundaries by exploring the correlation between incorporating energy efficiency measures and the ability to curtail energy consumption in response to elevated energy prices, especially in cases of low energy efficiency levels.

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