SPES | Sustainability performances, evidence & scenarios

D 6.1

European energy divide: exploring determinants and dynamics of energy poverty

July 2024

Funded by European Union's Horizon Europe Programme under Grant Agreement No. 101094551

Authors

Gorana Krstić – full professor and researcher of the SPES project, University of Belgrade
Marko Vladisavljević – assistant professor and researcher of the SPES project, University of Belgrade
Nemanja Vuksanović – assistant professor and researcher of the SPES project, University of Belgrade
Jelena Žarković – full professor and researcher of the SPES project, University of Belgrade

Contributors and peer reviewers:
Therese Dokken, Oslo Metropolitan University; Amaia Palencia-Esteban, London School of Economics and Political Science; Katja Reuter, Social Platform; Mario Biggeri, University of Florence; Luca Tiberti, University of Florence.

Acknowledgements:
The authors would like to thank all SPES partners for their inputs provided in several SPES meetings and communications.

Cite as:
Krstić, G., Vladisavljević, M., Vuksanović, N. and Žarković, J. (2024). *European energy divide: exploring determinants and dynamics of energy poverty*. SPES Working paper no. 6.1, SPES project – Sustainability Performances, Evidence and Scenarios. Florence: University of Florence. Available at https://www.sustainabilityperformances.eu/publications-deliverables/

Disclaimer

The project SPES is funded by European Union's Horizon Europe Programme under Grant Agreement No. 101094551.

Table of contents

Abstract

During the energy transition process certain vulnerable groups will not be able to secure the appropriate level of energy services and will be exposed to energy poverty. Energy poverty can be related to significant negative development outcomes of a country in terms of its economic growth rate, income inequality, access to education and healthcare. The aim of this report is to identify parts of Europe that are more exposed to energy poverty as well as to identify socioeconomic and demographic groups that may lack resources to protect themselves from the costs of the energy transition (e.g. rising costs in electricity, fuels). This report contributes to the scarce literature on the drivers and dynamics of energy poverty in Europe.

Data from the European Survey on Income and Living Conditions between 2017 and 2020 are used to provide latest estimates of the energy poverty and its determinants by looking at socio-economic, demographic, and housing characteristics. We use subjective self-reported measure of energy poverty defined by the Energy poverty index which is calculated as the weighted sum of self-reported perception of (1) difficulty heating their home adequately warm, (2) paying utility bills and (3) poor housing conditions. Dynamic aspects of poverty are further investigated since distinction between short-term and persistent poverty might require different policy instruments. Energy poverty persistence exists among households that have been energy poor in a current year and at least two out of three previous years. The study reveals significant disparities among European countries in terms of prevalence and persistence of energy poverty.

Nevertheless, in most countries prevalence of energy poverty rises with the increase in the size of the household, share of low-educated, unemployed people and inactive people due to health issues in the household. Countries with higher energy poverty are also the ones with higher rate of households that persistently live in energy poverty. Short-term measures like energy subsidies can provide a temporary relief, while promotion of the energy efficient housing is needed to lift households permanently out of energy poverty.

1. Introduction

Over the past decade the European Union has increased its efforts to make energy poverty- a situation in which households are unable to access essential energy services and products- a key concept of the just and fair transition towards climate neutrality. Energy poverty was introduced in the EU energy policy agenda during with the adoption of the Energy Package for the functioning of the internal energy markets in 2009 (Koukoufikis at al., 2023). Launching of the Energy Poverty Observatory in 2016 was followed few years later by the request to member states to describe their policies and measures addressing energy poverty within the National Energy and Climate plans. The European Commission made energy poverty a policy priority with the introduction of the Clean Energy for all Europeans legislative package in 2019.

Similar ambition of putting a strong focus on the topic and protecting the vulnerable[1] is found in the European Green Deal, a set of policy initiatives aiming to make the EU climate-neutral by 2050. However, the focus of the European Green Deal remains insufficient to effectively tackle the problem as evidenced by the rising numbers of energy poor households in recent years. Moreover, we can expect to see these households being overwhelmed by the economic consequences of the different transition measures. As Social Platform (2004) argues, several initiatives such as the Energy Performance of Building Directive, the Energy Efficiency Directive, and the Renewable Energy Directive will set ambitious targets for better energy use, but without adequate support energy poor households will not be able to reach these targets.

One of the latest initiatives to help vulnerable households who will face higher costs due to additional carbon pricing for fossil fuels used for heating is the Social Climate Fund. By June 2025 EU countries who want to access the Fund must develop social climate plans outlining how they will use this money to support vulnerable communities (Keliauskaite et al., 2024)

Previous research has shown that spatial and social distribution of energy poverty is highly uneven across the EU (Bouzarovski and Tirado, 2017) which might require using different policies in different places. We see a divide among European countries in terms of the energy poverty, with Southern and Eastern European countries reporting higher levels of poverty. This is shown to be not only the consequence of differences in income levels between the regions, but also due to number of socio-economic and demographic characteristics prevailing in the area, as well as types and age of the residences where people live (Bouzarovski and Tirado Herrero, 2017; Healy and Clinch, 2002; Thomson and Snell, 2013). Additionally, discussions of the drivers of energy poverty have pointed out to the multiple transitions among EU member states with trends in the energy sector depending on the local and national circumstances. For instance, while Northern and Western countries have mostly relied on the decarbonization of their economies in the South, due to austerity measure introduced following the 2008 economic crisis, governments had to scale back support mechanisms for renewable technologies.

Following the start of Russia's invasion of Ukraine and rising energy prices there was an increase in the number of Europeans unable to keep their homes adequately warm, shifting from 6.9% in 2021

[1] https://energy.ec.europa.eu/topics/markets-and-consumers/energy-consumer-rights/energy-poverty_en#eu-measures-to-tackle-energy-poverty.

to 9.3% in 2022, or 40 million individuals.[2] This has forced EU countries not only to diversify energy sourcing but also to look for new types of energy such as nuclear power. Varying energy transition pathways will shape the existing energy poverty divide in Europe.

Our report has two aims. The first one is to provide the latest estimates of the energy poverty rates for all European Union countries[3] and several non-EU member states (Norway, Switzerland and Serbia). Second, we want to investigate dynamics of energy poverty by looking at its persistence. Persistent or long-term poverty (i.e., experienced repeatedly and over long periods of time) differs substantially from transitory or short-term poverty (i.e., experienced only once and for a short period of time). This distinction is important from a policy perspective as different policy instruments might be required to address each type of poverty (Giarda and Moroni, 2018). We investigate determinants of energy poverty duration states by looking at socio-economic, socio-demographic and housing characteristics.

This report on energy poverty aims to provide new evidence concerning the "equity" pillar of Sustainable Human Development (SHD) and the social dimension of the sustainability transition. As explained in SPES Working Paper 2.14, "Energy issues represent an illustrative example of links among SHD pillars. Energy efficiency is surely important for productivity and can be positively affected by technological improvements. Energy poverty is becoming an increasingly central policy issue in terms of equity, justice, and participation. Clean energy is fundamental for environmental sustainability and climate change purposes, while energy sources can be – and often are – causes of conflicts affecting human security."

To the best of our knowledge this is the first study to address dynamic aspects of energy poverty for all European countries given that so far only single-country studies have been produced: Phimister et al. (2015) for Spain, Roberts et al. (2015) for the United Kingdom, and Drescher and Janzen (2021) for Germany.

Using data from the European Survey on Income and Living conditions (EU-SILC) for 29 European countries in a time period between 2017 and 2020 we first develop a methodological framework for energy poverty measurement by calculating the Energy Poverty Index (EPI). The index is calculated as a weighted sum of several indicators that may indicate that a household is energy poor: the household's inability to adequately heat the home, the household's financial problems in terms of paying utility bills and the existence of damage to the home itself (such as leaking roof, damp walls/floors/foundation, or rot in window frames or floor). The EPI value was initially calculated at a household level within each selected country and then averaged at a country level for each year. Our results show a clear division among European countries in terms of EPI – in general Southern and Eastern countries have relatively high EPI score, on average six time larger than Northern European countries.

In the next step, we use regression analysis to identify factors that are correlated with the probability of a household to be energy poor as well as the level of energy poverty depending on a set of household-level socio-economic, demographic and housing characteristics. We defined energy poor

[2] https://energy.ec.europa.eu/news/commission-publishes-recommendations-tackle-energy-poverty-across-eu-2023-10-23_en.

[3] Cyprus is not included due to data limitations which hindered the calculation of energy poverty within the adopted methodological framework.

[4] https://www.sustainabilityperformances.eu/wp-content/uploads/2023/10/SPES-Working-paper-2.1_29th-September-2023_FINAL.pdf

household as those for which EPI value is greater than zero, while the level of energy poverty is defined by the EPI value. In most European countries, household size, household composition in terms of age, educational attainment, labor market status and presence of health problems, as well as household income are correlated with the probability and the level of energy poverty.

Finally, we look at dynamical aspects of energy poverty by investigating correlates of poverty persistence based on panel EU SILC data. Energy poverty persistence exists among households that have been energy poor in a reference year and at least two out of three previous years. We find that energy poverty persistence and the initial energy poverty have a strong effect on the current energy poverty of the household.

The remainder of this report is structured as follows. Section 2 reviews the literature, section 3 provides a methodological framework for measuring energy poverty, estimating determinants of energy poverty and assessing the persistence of energy poverty. Sections 4 includes a discussion of the results. Finally, section 5 concludes the report.

2. Background

Literature devoted to the conceptualization of the energy poverty and to the definition of appropriate indicators (Boardman, 1991; Nussbaumer et al., 2012; Hills, 2012; Bouzarovski and Herrero, 2017) has evolved over time towards three different methods for measuring energy poverty: (1) direct method, (2) expenditure-based method, and (3) consensual-based method. Direct based method tries to measure whether the actual energy consumption is sufficient to enable an adequate standard of living. It is difficult to apply since it requires use of precise information on energy services households use and household expenditures on energy services. Remaining two methods indirectly try to capture this domain of the poverty through expenses or inability to use certain energy services. Expenditure-based method looks at actual energy expenditures of the household in relation to the household income while consensual-based approach is established on household's self-reported inability to supply an appropriate degree of energy services. For example, according to the expenditure method, a household is energy poor if the share of household income on energy services exceeds 10%, while following a consensual based method, a household is energy poor if it reports being unable to adequately heat the home (Bouzarovski and Herrero, 2017). As Drescher and Janzen (2021) argue, both methods can be implemented relatively easily, although the expenditure-based method usually has certain limitations: it does not reflect the actual energy needs of the household and therefore tends not to include those households that under-consume energy services due to financial constraints (or it may happen that some households with a high income are labelled as energy poor due to relatively high expenditures for energy services).

Studies that focus on energy poverty prevalence across Europe usually rely on the comparable datasets and use subjective measures of energy poverty, such as the ability to keep homes warm. The application of expenditure-based method in comparative analysis is rare and requires additional assumptions (Karpinska and Smiech, 2021). Although a definition of energy poverty based solely on the household's inability to adequately heat home is a standard, it is not fully appropriate. Arguing that household is energy poor based exclusively on the fact that it cannot adequately heat home is not enough to cover the complex economic and social dimension of energy poverty. Starting from the understanding that energy poverty is defined as the household's inability to supply an adequate level of energy services (Bourdman, 2013), then it becomes evident that this aspect is insufficient to identify the most vulnerable households. It is necessary to look at other aspects like those related to financial and housing conditions so that energy poverty could be better measured (Thomson and Bouzarovski, 2018).

Some of the examples of addressing multifaceted nature of the problem are Meyer et al. (2018) who set up the Belgian energy poverty barometer intended to explore the idea that different people are affected by different kinds of energy poverty. Aristondo and Onaindia (2018) consider energy poverty as a multidimensional concept. They measure it in the case of Spain for 2004-2015 period by looking at three indicators: the ability to keep the home adequately warm, the arrears on utility bills (electricity, water, gas) and the presence of a leaking roof, damp walls or rotten windows. In case of Poland Karpinska and Smiech (2020) look at the concept of the so called hidden energy poverty (HEP) which is obtained after computing total housing costs based on the energy efficiency of dwellings, household characteristics and some external factors, like regions and degree of urbanization. Household is exposed to HEP if after deducting the expected housing costs, the

disposable income is below the established threshold set at 60% of a national median after housing costs equivalized total disposable income.

One of the first comparative studies in the context of the EU member states was the research by Healy and Clinch (2002) where the authors used a framework previously well established for measuring fuel poverty in UK and Ireland. Using longitudinal data over the years 1994-1997, they calculated the extent of fuel poverty in 14 European countries through six social indicators showing household finances (ability to pay utility bills and to afford to heat home adequately), the building fabric (presence of damp, rot, etc.) and the presence of adequate housing heating system. Each indicator is assigned a weight, and each weight varies in the sensitivity analysis in accordance with their relevance for the qualitative definition of fuel poverty. Results show that fuel poverty was the lowest in northern Europe and highest in the South (Portugal, Greece, Spain and Italy) with France, Belgium, the UK and Ireland also exhibiting relatively high incidences. With the inclusion of new EU members states in the European statistics similar research was performed a decade later. It showed that besides Southern countries, those in Central and Eastern Europe have one of the highest energy poverty rates, particularly Bulgaria and Romania (Thomson and Snell, 2013). Their regression modelling showed that location had the largest impact on whether households in the EU reported an inability to heat the home adequately, with residing in a rural area having the largest impact.

Further to that, Thomson and Snell (2013) results reveal the interaction between the three indicators: if a household is struggling to afford to heat their home adequately, and has arrears in paying utility bills, they are likely to restrict their use of heating, thereby causing damp and rot. Bouzarovski and Tirado (2017) first show that, compared to the period of Thomson's and Snell's (2013) research, the EU as a whole has experienced an increase in the levels of energy poverty as measured by the EU-SILC. They found important regional variation in poverty rates and thus challenge what previous literature has established as a divide of the EU states into clusters of a relatively well-off 'core' group of countries in Northern and Western Europe and a heterogeneous 'energy poverty periphery' in the South and East. Energy poverty is limited to specific demographic and housing groups in the more well-off countries, while in the periphery it is more pervasive across a range of social strata. Bouzarovski and Tirado (2017) explain the energy poverty divide among the analysed countries in terms of their exposure to the two factors: monetary deprivation rates and energy prices. In this case, specific policies for energy poverty are required.

A numerous research uses cross-sectional data and ignores the dynamic nature of energy poverty (Brown et al., 2020). Households that spend a large portion of their discretionary income on home energy services are forced to choose between cutting back on energy costs and other necessities such as food and education. Negative feedback loops are caused by these trade-offs. Thus, earlier experiences with energy poverty may really have a causal influence on future experiences with energy poverty. Identifying the energy poor in a static manner within a specific timeframe only gives part of the story, as it does not address the question of whether these households are unable to obtain appropriate domestic energy services on a long-term basis or just occasionally. If energy poverty is primarily a chronic condition, households that are energy impoverished on a long-term basis will employ most of income resources allocated to preventing new instances of energy poverty. Also, different strategies may be needed for households with chronic and intermittent energy poverty. Energy poverty can be instantly alleviated by short-term programmes such as energy vouchers, but long-term initiatives like encouraging energy-efficient housing are required to raise households out of it permanently (Drescher and Janzen, 2021).

Literature on dynamics of energy poverty in Europe is still scarce. Phimister et al. (2015) using Markov transition matrix study both income and energy poverty dynamics for Spain through the transitions into and out of poverty by looking at the share of individuals that remain in poverty status from year to year. From the survivor function estimates, the paper also looks at the probability of an individual who has just started a spell out of poverty to be in poverty after two time periods. Results on poverty dynamics show that there is greater movement out of the energy poverty relative to income poverty. Compared to an expenditure-based energy poverty measure, the re-entry rate of subjective energy poverty is substantially higher. Proportion of those in both income and energy poverty was low suggesting that policy measures aimed exclusively at addressing income poverty will miss many of those experiencing energy poverty and that instead policies aimed directly at reducing energy poverty are required. Finally, Phimister et al. (2015) look at individual and household characteristics of those who experienced energy poverty persistently during the four-year period finding that they are overrepresented among retired men and women, those in single person households and those who are inactive or unemployed.

Roberts et al. (2015) examined whether the incidence and dynamics of energy poverty varies between rural and urban areas in the UK. Using discrete hazard models of energy poverty exit and re-entry they found that the experience of energy poverty in urban areas was on average longer with a higher probability of energy poverty persistence. Living in private rental accommodation, in a flat and being over 65 is a more important determinant of energy poverty in rural areas than urban areas. Being in a household with an older head, or being in private rented accommodation (relative to owner occupancy) decreases the probability of an energy poverty exit.

Drescher and Janzen (2021) use dynamic random effects probit model to measure the persistence and dynamics of energy poverty in Germany and find that poverty is mostly a transitory state, with almost 80% of energy poor households facing it only temporarily. Also, they address determinants of energy poverty persistence and find that one-person households, lower educational attainment, unemployment and living in not-well insulated dwellings as well as using oil and electricity as main heating source increases the likelihood of facing chronic energy poverty.

3. Methodology and data

3.1 Measuring energy poverty

Measurement of energy poverty in this paper is in the line with the consensual-based method. An expenditure-based method was not applied as the EU-SILC database that we used for the estimation of energy poverty does not contain information regarding household expenditures on electricity, gas and heating. By observing energy poverty as a multidimensional concept that should include as many aspects of that poverty as possible, we calculated the energy poverty index (EPI). The EPI of a household was calculated following the conceptual framework presented by Bouzarovski and Herrero (2017). The index is a weighted sum of several indicators that may indicate that a household is energy poor. In addition to the usual aspect related to the household's inability to adequately heat the home, aspects related to the household's financial problems in terms of paying utility bills and the existence of damage to the home itself (such as leaking roof, damp walls/floors/foundation, or rot in window frames or floor) are included. Thus, EPI is defined as follows:

$$EPI=w_1*Inability+w_2*PaymentProblems+w_3*HousingFaults. \quad (3.1)$$

where

1. EPI is an energy poverty index that ranges between 0 and 1 (a higher value indicates a higher level of energy poverty);
2. The *Inability* indicator refers to the *Ability to keep the home adequately warm*, and takes the value of 1 if the household declared that it was unable to heat the home (0 otherwise);
3. The *PaymentProblems* indicator refers to *Arrears on utility bills*, and takes the value 1 if the household has reported that it has financial difficulties in meeting obligations (0 otherwise);
4. The *HousingFaults* indicator refers to *Living in a home with a leaking roof, or the presence of damp and rot*, and takes the value 1 if the household declared that the mentioned damage to the house exists (0 otherwise);
5. w_1, w_2 and w_3 are the corresponding weights with $w_1=0.5$, and $w_2=w_3=0.25$ as in Bouzarovski and Herrero (2017).

The *Inability* indicator was assigned the highest weight to reflect the greater importance given to self-reported discomfort resulting from an inadequately heated home. Twice as much importance is given to the impossibility of heating the home in an adequate manner compared to other two indicators, following other papers that investigated the same topic (Healy, 2004; Thomson and Snell, 2013; Bouzarovski and Herrero, 2017).

The EPI was then calculated for 29 European countries[5], mainly EU and several partner countries, using cross sectional data from the European Survey on Income and Living conditions (EU-SILC)[6]. The goal of the EU-SILC is to gather timely, comparable data on living conditions, social exclusion, poverty, and income and it contains questions necessary to build the energy poverty index[7]. We used the latest available microdata from EU-SILC covering the period 2017-2020. The sample size varies from around 3,600 (Luxembourg) to 20,000 (Greece).

3.2. Estimation of the determinants of energy poverty

To identify vulnerable groups in terms of energy poverty and how certain socioeconomic and demographic characteristics are associated with energy poverty levels, we estimate the following models:

$$EnergyPoor_i = \alpha + \beta SDC_i + \gamma HT_i + \varepsilon \quad (3.2)$$

and

$$EnergyPoverty_i = \alpha + \beta SDC_i + \gamma HT_i + \varepsilon, \quad (3.3)$$

$$i = 1, \dots, N.$$

Equation (3.2) is used to determine which selected characteristics affect the probability that the household will be energy poor, while equation (3.3) was developed to examine the impact of those characteristics on the level of energy poverty. In equations (3.2) and (3.3):

1. $EnergyPoor_i$ is a dependent dummy variable that takes the value 1 if the household is energy poor;

[5]Analysis includes following countries: AT-Austria, BE-Belgium, BG-Bulgaria, CH-Switzerland, CZ-Czech Republic, DE-Germany, DK-Denmark, EE-Estonia, EL-Greece, ES-Spain, FI-Finland, FR-France, HR-Croatia, HU-Hungary, IE-Ireland, IT-Italy, LT-Lithuania, LU-Luxembourg, LV-Latvia, MT-Malta, NL-Netherlands, NO-Norway, PL-Poland, PT-Portugal, RO-Romania, RS-Serbia, SE-Sweden, SI-Slovenia, SK-Slovak Republic.

[6] Data for the empirical research were obtained from Eurostat at the request of researchers (RPP 341/2023-EU-SILC). For more information on how to access data from Eurostat, see https://ec.europa.eu/eurostat/web/microdata/european-union-statistics-on-income-and-living-conditions

[7]Questions from the EU-SILC questionnaire used to measure energy poverty are: HH050 Ability to keep home adequately warm, HS021 Arrears on utility bills, and HH040 Leaking roof, damp walls/floors/foundation, or rot in the window frames or floor. Starting from 2021 the question HH040 is not available, making it impossible to calculate the tripartite EPI.

2. $EnergyPoverty_i$ is a dependent variable that refers to the level of energy poverty of the household;
3. SDC_i is a vector of independent variables reflecting socioeconomic and demographic characteristics of the household;
4. HT_i is a vector of independent variables concerning housing type;
5. α and ε represent the constant and random error of the model, respectively.

A household is energy poor if its level of energy poverty measured by EPI value is greater than zero. We use probit regression to estimate average marginal effects of selected independent variables in equation (3.2). Equation (3.3) was estimated by standard ordinary least square (OLS) regression.

For socioeconomic characteristics we use variables such as educational level and labour market status of household members, household income, social transfers, housing expenses and ownership. Demographic characteristics variables incorporated in the model are household size, age and gender structure of the household and self-reported health problems that limit labour market activity of household members. Variables related to the housing type such as the number of rooms, daylight level and dwelling type are also included. The list of variables is given in Table 3.2.

Table 3.2. Description of variables included in estimation of the models (3.2) and (3.3)

Variable	Description
Dependent variable	
Energy Poor	1 if EPI of the household is higher than 0, 0 otherwise (model 3.2)
Energy Poverty	EPI of a household (model 3.3)
Independent variable	
Demographic and socioeconomic characteristics	
Household size	Log value of the household size
Number of children 0-6 yrs	Number of children in the household ages 0-6
Number of children 7-14 yrs	Number of children in the household ages 7-14
Share of indv. Age 15-25 in hhs	Share of persons in the household ages 15-24 (out of age 15+)
Share of ind. Age 25-45 in hhs	Share of persons in the household ages 25-44 (out of age 15+)
Share of indv. Age 45-65 in hhs	Share of persons in the household ages 45-64 (out of age 15+)
Share of indv. Age 65+ in hhs	Share of persons in the household ages 65 and above (out of age 15+)
Share of females in hhs	Females to a total household size ratio
Share of males in hhs	Males to a total household size ratio
Share of primary education indv. In hhs	Share of persons in the household with primary education (out of total household)

Share of secondary education indv. In hhs	Share of persons in the household with secondary education (out of total household)
Share of tertiary education indv. In hhs	Share of persons in the household with tertiary education (out of total household)
Share of unemployed in hhs	Unemployed persons to a total household size ratio
Share of inactive in hhs	Inactive persons to a total household size ratio
Share of employed in hhs	Employed persons to a total household size ratio
Household income	Log value of a total household gross income
Household transfers	Log value of social transfers to a household
Housing costs	Log value of housing costs
Share of indv. With bad health in hhs	Share of persons with limitations in labour market activities because of health problems (out of total household)
High urbanization	1 if the household lives in high urban area, 0 otherwise
Owner	1 if the household owns a house, 0 otherwise
Mortgage	1 if the household owns a house with mortgage, 0 otherwise
Rent	1 if the household rents a house, 0 otherwise
Other tenure status	1 if the household lives in a house with other tenure status, 0 otherwise
Housing type	
Detached house	1 if the household lives in a detached house, 0 otherwise
Semidetached house	1 if the household lives in a semi-detached house, 0 otherwise

Flat	1 if the household lives in a flat, 0 otherwise
Other dwelling type	1 if the household lives in some other kind of accommodation, 0 otherwise
Dark house	1 if the house is with not enough light, 0 otherwise
Number of rooms	Number of rooms in the house

Empirical estimates were performed for each country individually where the EU-SILC cross sectional databases for the period from 2017 to 2020 were merged into a single database to increase the sample size, with defined dummy variables related to the survey year. Therefore, four survey waves were used with 2017 being a reference year. Also, in addition to the year dummy variables, dummy variables regarding the regions were also added in the assessment for each country. The analysis was conducted at the household level within each country allowing the identification of factors that in general affect the probability and intensity of energy poverty and factors that are country specific. The sample size ranges from 13,700 observations (Luxembourg) to 79,300 (Greece). The household weights were included in the estimation, and the robust standard errors were estimated.

Table A2 in the provides summary statistics.

3.3 Assessing the persistence of energy poverty

Following recent literature on poverty dynamics (Giarda and Moroni, 2018) and emerging single-country studies such as Drescher and Janzen (2021), we use dynamic random effects probit estimator to test the persistence and dynamics of energy poverty:

$$EnergyPoor_{it} = \alpha + \beta_1 EnergyPoor_{it-1} + \beta_2 EnergyPoor_{i1} + \gamma_1 SDC_{it} + \gamma_2 SDC_{i1} + \gamma HT_{it} + \varepsilon,$$

$$i = 1, \dots, N; t = 2, \dots, T. \qquad (3.4)$$

In equation (3.4):

1. $EnergyPoor_{it}$ is a dependent dummy variable that takes the value 1 if the household is energy poor in year *t*;
2. $EnergyPoor_{it-1}$ is an independent dummy variable that takes the value 1 if the household is energy poor in year *t-1*;
3. $EnergyPoor_{i1}$ is an independent dummy variable that takes the value 1 if the household is energy poor in the initial year;
4. SDC_{it} is a vector of independent variables capturing socioeconomic and demographic characteristics of the household in year *t*;
5. SDC_{i1} is a vector of independent variables regarding socioeconomic and demographic characteristics of the household in the initial year;
6. HT_{it} is a vector of independent variables concerning the housing type in which the household lives in year *t*;

7. α and ε represent the constant and random error of the model, respectively.

The equation (3.4) was estimated by random effects panel probit regression[8] which allows the estimation of the average marginal effects for the selected set of independent variables similar to the ones used in previous estimations.

The literature emphasizes an initial conditions problem in dynamic random effects models particularly when trying to identify genuine state dependence – so that the poverty experience of one period has a causal effect on future poverty (e.g., Fabrizi and Mussida, 2019; Alem and Demeke, 2020; Drescher and Janzen, 2021). This problem arises because the initial observation is influenced by factors not fully captured by the model leading to potential biases if not addressed properly. In our case, the initial observation $EnergyPoor_{it}$ may be correlated with the time-invariant individual-specific effect. This is due to the fact that $EnergyPoor_{it}$ does not necessarily correspond to the start of the stochastic process being observed. The process likely begins before the first observed period. Thus, $EnergyPoor_{it}$ could be influenced not only by the random intercept but also by responses before the observed period, especially when the total number of periods observed is small. Assuming, however, that the initial state of the dependent variable $EnergyPoor_{it}$ is exogenous (independent of other factors) can lead to inconsistent estimates. As Drescher and Janzen (2021) state, two approaches to address the initial conditions problem have evolved. Heckman (1987) proposed to model the initial dependent variable jointly with subsequent responses, while Wooldridge (2005) proposed modeling unobserved heterogeneity based on both the initial dependent variable and explanatory variables – this method is often referred to as the Wooldridge Conditional Maximum Likelihood (WCML) estimator. Wooldridge's approach is usually preferred due to its computational efficiency and ease of implementation, despite simulation experiments showing both methods perform similarly well (for instance the experiment performed by Arulampalam and Steward, 2009).

To overcome the initial condition problem in the estimation of energy poverty persistence in short panels, we opted for Wooldridge's approach. The model (3.4) therefore includes also initial dependent variable $EnergyPoor_{i1}$, some socioeconomic and demographic variables from the initial period SDC_{i1} – household size, unemployed ratio, inactive ratio, share of bad health household members, household income and social transfers. Additionally, since households' income and transfers are time-varying explanatory variables we modelled the within-means of these variables.

The model was evaluated for 26 European countries[9] based on EU-SILC panel data for the period 2017-2020. The two datasets that make up EU-SILC are cross-sectional and longitudinal. The longitudinal panel's integrated design yields the annual cross-sectional data. The rotational panel of four years in the longitudinal dataset of EU-SILC indicates that, for most countries, people are observed for a maximum of four years. For the cross-sectional database an extensive number of observations is possible because of the integrated design. Within the cross-sectional database, ¼

[8] The Hausman test was performed, and the results showed that random effects model estimation is preferred compared to fixed effects.
[9] The analysis does not include Germany (DE), Denmark (DK), and Romania (RO) since no panel data for these countries is available for the observed time period.

of the population is observed once, ¼ again, ¼ once more, and ¼ once more. By reducing sample attrition and cumulative respondent burden, this integrated approach mitigates measurement bias. The sample size varies between around 6,200 units (Ireland) to 27,600 (Greece). Model estimation was performed for each country individually, and assumptions of regional differences within a country dummy variables regarding the regions were also added in the assessment. The analysis was conducted at the household level within each country within a the time framework 2017-2020, allowing an evaluation of the determinants that affect persistency of energy poverty among European countries.

Table A3 in the Appendix provides summary statistics.

4. Results

4.1. Spatial disparities in energy poverty across Europe

Before calculating the EPI index, we present how countries stand with respect to three separate indicators (share of households reporting an inability to heat their home, problems to pay utility bills and having some housing faults) using 2020 EU-SILC data. Table 4.1 shows that in most countries housing faults are most common suggesting that this factor is the most important contributor to the EPI.

The highest share of population declaring an inability to heat their home properly is found in Bulgaria, followed by Lithuania, Portugal and Greece. For all other countries this share is much lower – 10% and less. Countries reporting the lowest level of such discomfort are Norway, Switzerland, and Austria. Anastasiou and Zaroutieri (2023) found similar results for Bulgaria. One of the possible explanations may be the high dependence of Bulgaria on the use of natural gas and coal for electricity production from Russia. The authors claim that the frequent disruptions on supply of those energy sources result in high energy prices. This explanation may also apply to the Baltic countries, especially Lithuania.

The top four countries in terms of the share of population reporting problems with paying the utility bills are Serbia, Greece, Bulgaria and Croatia. This could be due to low living standards in these countries with Bulgaria and Croatia being among the poorest EU member states. Greece experienced a major economic crises a decade ago which affected households' financial circumstances (Anastasiou and Zaroutieri 2023). In all other countries the population share is 6% or less with particularly small number of people having problems with paying utility bills in Czech Republic, Netherlands, Austria, and Sweden.

Finally, the highest share of population that reported some of the above-mentioned housing faults lives in Portugal, Slovenia, Hungary, Italy, and Spain, while the lowest share is observed in Finland, followed by Slovakia, and Norway. Portugal, Italy, and Spain are European countries with high rate of households living in homes with leaks, damp or rotten windows or floors, because houses are quite old (Bollino and Botti, 2017). There are large number of historical buildings with many of them traditionally built without heating systems or with only a fireplace. These are also some of the poorer European countries with significant number of households being unable to finance appropriate repairs due to financial constraints (Bollino and Botti, 2017). In general, the share of the population in Europe that reported the existence of some damage to the house is high, as in two thirds of the countries that share is greater than 10%.

Table 4.1. Share of households reporting an inability to heat their home, problems to pay utility bills and having some housing faults among European countries, 2020 (in %)

Country	Inability	Payment Problems	Housing Faults
Austria	1.49	1.13	7.87
Belgium	4.11	1.88	15.43
Bulgaria	30.22	11.19	10.56
Croatia	9.06	10.38	11.70
Czech Republic	2.72	0.49	6.64
Denmark	2.64	1.34	13.43
Estonia	2.92	2.19	12.45
Finland	1.73	4.04	3.92
France	7.03	3.13	16.62
Germany	6.29	1.29	5.64
Greece	20.44	14.58	14.12
Hungary	5.27	6.57	21.03
Ireland	3.13	4.55	15.86
Italy	8.14	3.44	18.89
Latvia	8.99	6.04	17.13
Lithuania	25.88	2.53	11.68
Luxembourg	3.52	1.29	14.01
Malta	8.21	3.45	7.00
Netherlands	2.18	0.55	12.81
Norway	0.6	1.61	5.77
Poland	4.93	2.48	6.45
Portugal	21.91	3.00	27.37
Romania	9.07	5.76	9.04
Serbia	10.51	16.93	11.62
Slovakia	6.95	3.79	5.25
Slovenia	3.35	6.57	22.31
Spain	9.87	5.50	18.63
Sweden	2.16	1.19	6.47
Switzerland	0.15	1.52	9.20

Source: Authors' calculations based on EU-SILC data.

Table A1 in the Appendix provides details about the correlation between different components of the EPI in 2020 among European countries. In Romania, Ireland, and Greece the correlation between reporting an inability to heat home and problems to pay utility bills is among the highest in Europe – the coefficient of correlation is above 0.25. Serbia, Romania, and Hungary are European countries that have very high correlation between reporting an inability to warm the house and having some housing faults, with the value of the coefficient higher than 0.22. Finally, the highest correlation between reporting some problems to pay utility bills and having some housing faults is noticed in Hungary, Serbia, and Bulgaria (the coefficient is above 0.15).

The EPI value was calculated at a household level within each selected country and then averaged at a country level for each year, with the use of weights to make country representative. Table 4.2 displays the results.

Table 4.2. The EPI among European countries, 2017-2020

Country	2017	2018	2019	2020	Difference (2020 cf. 2017) [10]
Austria	0.041	0.037	0.035	0.030	-0.01
Belgium	0.086	0.077	0.069	0.064	-0.02
Bulgaria	0.272	0.257	0.237	0.205	-0.07
Croatia	0.129	0.123	0.111	0.101	-0.03
Czech Republic	0.041	0.038	0.035	0.031	-0.01
Denmark	0.043	0.049	0.044	0.050	-0.01
Estonia	0.066	0.063	0.065	0.051	-0.01
Finland	0.030	0.029	0.028	0.029	0.001
France	0.064	0.067	0.072	0.085	0.02
Germany	0.047	0.046	0.041	0.049	0.002
Greece	0.217	0.201	0.177	0.174	-0.04
Hungary	0.126	0.115	0.111	0.095	-0.031
Ireland	0.070	0.069	0.066	0.067	-0.003
Italy	0.116	0.099	0.083	0.097	-0.02
Latvia	0.147	0.136	0.125	0.103	-0.04
Lithuania	0.201	0.196	0.188	0.165	-0.04
Luxembourg	0.059	0.060	0.051	0.056	-0.003
Malta	0.071	0.073	0.072	0.067	-0.004
Netherlands	0.044	0.047	0.049	0.045	0.001
Norway	0.019	0.022	0.024	0.021	0.002
Poland	0.085	0.075	0.065	0.047	-0.04
Portugal	0.190	0.186	0.176	0.185	-0.005
Romania	0.106	0.098	0.091	0.082	-0.02
Serbia	0.158	0.149	0.145	0.123	-0.03
Slovakia	0.049	0.058	0.074	0.057	+0.01
Slovenia	0.107	0.102	0.089	0.089	-0.02
Spain	0.081	0.095	0.085	0.110	+0.03
Sweden	0.028	0.030	0.027	0.029	0.001
Switzerland	0.031	0.026	0.026	0.026	-0.01

Source: Authors' calculations based on EU-SILC data.

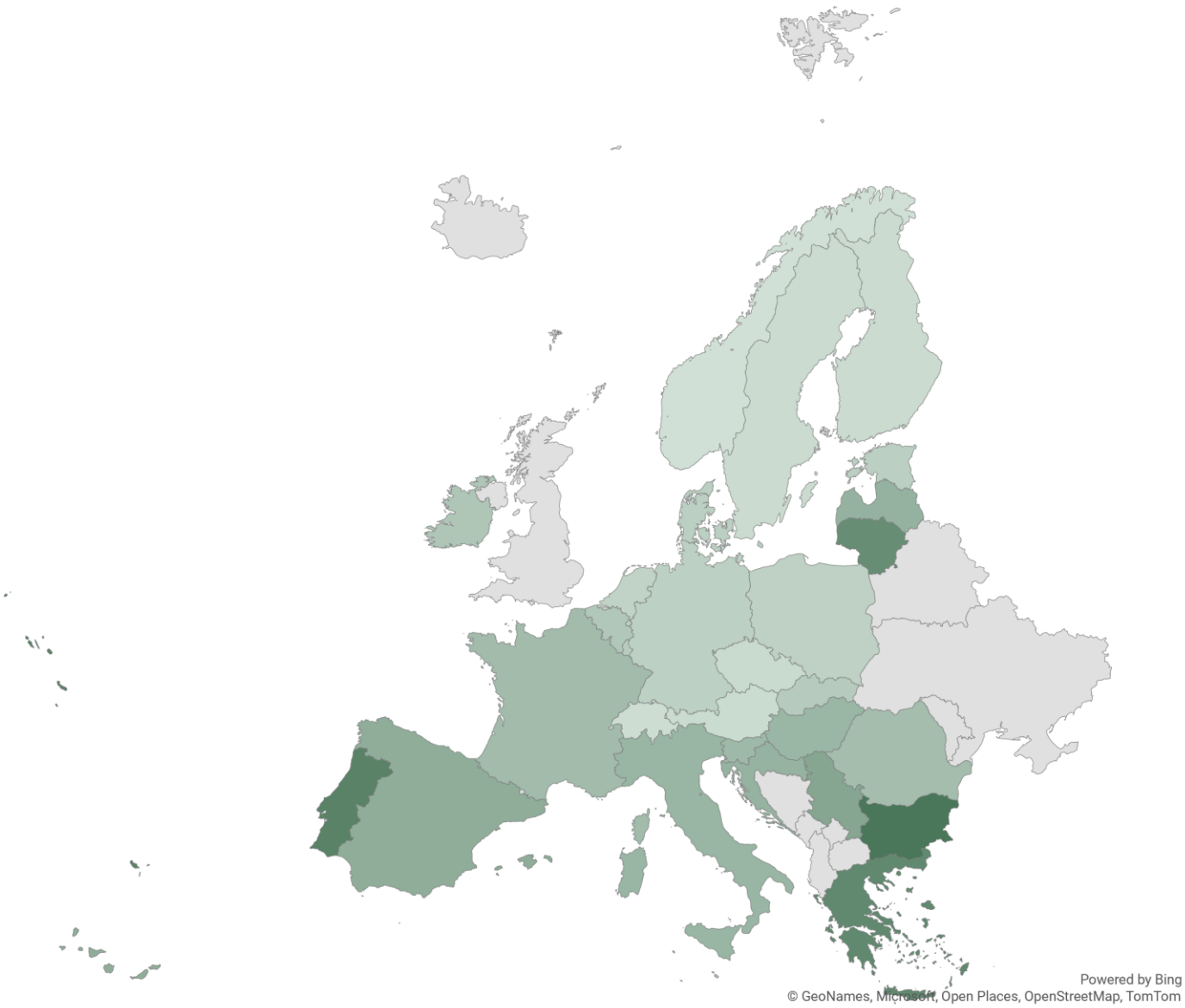
[10] The p-value from t-statistics for all analysed countries is 0.000 suggests that a difference between the means is statistically different from zero.

The EPI in 2020 varies between 0.02 and 0.21 with the highest index values recorded in Bulgaria and the lowest one in Norway. The top four European countries by EPI value are Eastern European countries like Bulgaria, Lithuania, Portugal and Greece, while Northern countries like Norway, Finland, Sweden and Switzerland were among the four countries with the lowest energy poverty. Bulgaria consistently has the highest EPI values over the period of analysis, with values ranging from 0.272 in 2017 to 0.205 in 2020.

In almost half of the countries in the sample EPI values are relatively stable over the period of observation. Those are mostly countries with low levels of energy poverty. In 12 out of 28 countries there is a decrease in the energy poverty levels with larger reductions observed for Bulgaria, Greece, Latvia, Poland and Serbia. Only few countries demonstrate an increase in the EPI value, with larger increase found in Spain and France.

To better understand how energy poverty is distributed across Europe, the Map 4.1 was created using the EPI value from 2020. The darker the shade of green, the higher the EPI value. The map indicates a clear North-South division in terms of energy poverty. In general, the countries in the South and East of Europe are the ones with the higher level of energy poverty, while Northern countries plus a few from Eastern Europe are those with lower level of energy poverty. If we consider that high levels of energy poverty are found among countries with EPI greater than 0.10, moderate level of energy poverty for EPI between 0.05 and 0.10, and low level of energy poverty for EPI is less than 0.05, then the largest number of European countries are in the group of countries with a moderate or low level of energy poverty.

Map 4.1. Energy poverty and division of Europe



Note: The map contains information on EPI from 2020.

Legend:

- EPI less than 0.05
- EPI between 0.05 and 0.15
- EPI more than 0.15

Source: Authors' calculation.

We find the same set of countries with the highest and the lowest levels of EPI as Bouzarovski and Herrero (2017) in their study for the EU28 countries over the period 2003-2013. Bouzarovski and Herrero measured the highest energy poverty levels in Central and Eastern Europe (CEE) and Mediterranean countries, such as Bulgaria, Lithuania, Greece, Portugal, and Spain. For CEE countries this might be due to a socialism legacy of poor thermal insulation and unstable energy supply which negatively affects the prices of energy services. The population of the Mediterranean countries despite having mild winters experience problems with heating their houses for several reasons - lower living standard due to higher levels of unemployment and lower average wages, higher energy prices compared to the EU average which altogether increases energy poverty (Martin et al., 2020). Finally, Norway, Sweden, Finland, Switzerland, and Austria record lower energy poverty due to significant reserves of oil and other energy sources and consequently relatively low energy prices, and by generous social welfare systems, with notable use of sustainable energy sources in accordance with the green agenda. In such countries, energy poverty is restricted to specific socioeconomic or demographic groups, or certain types of housing (Hoff, 2017).

To examine the robustness of the obtained results regarding the EPI value, another version of the energy poverty index – EPI2 – was calculated with equal weights to all three dimensions of energy poverty so that $w_1 = w_2 = w_3 = 0.33$). Table A4 in the Appendix provides a comparative view of the difference between EPI and EPI2. In most countries the difference between them appears to be on a small scale and statistically significant. The exceptions are Bulgaria and Lithuania (with the difference amounting to 0.033 index points), as they are the countries with the disproportionally higher value of the inability to keep the home adequately warm relative to other two components of the EPI index. This confirms the validity of previous results on energy poverty among European countries both in country rank and level of energy poverty.

4.2 Driving factors of energy poverty

Table 4.3 presents the average marginal effects from probit regression estimation used to determine which selected characteristics are associated with the probability that the household will be energy poor. Most variables appear statistically significant (coefficients having p-values less than 0.10) and estimated coefficients have the expected signs (for instance, it is expected that a household with a higher share of unemployed persons is more likely to be energy poor, so the sign of the estimated coefficient is positive).

In terms of demographic and socio-economic variables, education and labour market status of household members, limitations in labor market activities because of health problems of household members, social transfers and the size of the household are positively associated with the probability that the household will be energy poor. In contrast, the share of elderly people in the household and the household income are negatively associated with the probability of being poor, as well as housing costs in most countries. In terms of housing variables, renting a house and house

lighting are positively correlated with the probability of being energy poor, while households living in a flat and number of rooms appear to be negatively correlated. Regarding the magnitude of these effects, labour market status, education, health limitations of household members and house lightning stand out.

A higher share of low-educated (and medium-educated) people in the household increases the probability that the household will be energy poor after controlling for all household characteristics included in the model. The estimated average effect ranges from 0.03 (France) to 0.22 (Bulgaria) – meaning that in the case of Bulgaria an increase in the share of low-educated people by 0.1 increases the probability that the household will be energy poor by 2.2 percentage points, on average. However, in most countries with a low EPI value, the estimated coefficient for education is generally not statistically significant, probably due to a small share of households with many low-educated persons.

Households with the larger number of unemployed people have higher chance to be energy poor. The largest effect is observed in Romania and Hungary where an increase in the share of unemployed people in the household by 0.1 results in an increase in the probability that the household will be energy poor, on average, by about 2.8 and 2.7 percentage points respectively, keeping all other household characteristics unchanged. Furthermore, a higher share of people with limitations in labour market activities because of health problems is associated with greater probability of being energy poor. The largest effect is observed in Serbia, a country with a relatively high EPI value and the smallest in Germany, a country with low EPI value. In Serbia, an increase in this share by 0.1 leads to an increase in probability that the household will be energy poor by nearly 2 percentage points, on average, while in Germany, this effect is 0.3 percentage points. Households with low-educated, unemployed and members with health problems that limit their labour market activity appear to be among the most energy vulnerable groups.

The larger the household, the higher the probability of energy poverty – with an estimated average effect ranging from 0.01 (Spain) to 0.05 (Slovenia).

Household income, as expected, reduces the probability that the household will be energy poor controlling for other explanatory factors, with the estimated coefficient ranging from -0.01 (Switzerland) to -0.16 (Greece). Also, the greater the share of elderly people in the household (age 65+) as compared to the share of people aged 25-45, the lower the chances that the household will be in energy poverty. This effect is the most pronounced in Belgium and Netherlands, where the increase in the share of elderly people in the household reduces the probability that the household being energy poor by about 1.5 percentage points, on average.

In terms of housing variables, living in a house without enough natural lighting (i.e., a flat on the ground floor or a house with few windows) increases the average probability of being energy poor relative to the reference category (those living in a house with enough natural lighting) from about 8% in the case of Finland and Czech Republic to even 42% in the case of Italy. Regarding the tenure status, households that rent a house/apartment have more chance to be energy poor which is expected as vulnerable more often rent a house/apartment. The smallest average effect is observed in Germany and Latvia (about 4%) and the largest in Italy and Portugal (about 15%). In contrast, living in a flat as compared to the other dwelling type decreases the likelihood of being energy poor, on average, from 3% in France to 30% in Portugal. In addition, the higher the number of rooms in a

house, the lower the probability of a household being energy poor. The countries where this effect is the most pronounced are Bulgaria and Lithuania. If their household has one room more that decreases the likelihood of household living in energy poverty by around 3 percentage points, on average.

The estimated coefficient of social transfers and housing costs, although statistically significant, is not so large in most countries. Finally, household gender structure, number of children and most dwelling types have no statistically significant impact on energy poverty probability.

Table 4.3. Empirical estimation of factors affecting probability of being energy poor among Europe (marginal effects)

Dep. Variable	Energy Poor									
Indep. Variables	**AT**	**BE**	**BG**	**CH**	**CZ**	**DE**	**DK**	**EE**	**EL**	**ES**
Household size	0.015***	0.010	0.053***	0.020***	-0.001	0.021***	0.001	0.006	0.051***	0.015***
Number of children 0-6 yrs	0.001	0.010**	-0.008	0.000	0.052**	-0.006	0.018**	0.002	0.002	0.003
Number of children 7-14 yrs	0.001	0.005*	-0.015**	0.003	0.002	0.001	0.002	0.003	-0.005	0.001
Share of indv. Age 15-25 in hhs	0.047***	0.026	0.067*	-0.034***	0.008	-0.017	-0.062**	0.010	0.063**	0.106***
Share of indv. Age 45-65 in hhs	-0.023	-0.038***	0.030	-0.040***	-0.008	-0.033	-0.054***	0.013	-0.026	-0.002
Share of indv. Age 65+ in hhs	-0.069***	-0.149***	-0.001	-0.131***	-0.046***	-0.091	-0.176***	-0.073**	-0.102***	-0.073***
Share of females in hhs	0.016*	0.013	0.059***	-0.006	-0.002	0.009	-0.008	-0.002	0.029*	-0.004
Share of primary educ. Indv. In hhs	0.049	-0.003	0.218***	0.094*	0.006	0.089***	0.024	0.070	0.163***	0.097***
Share of secondary educ. Indv. In hhs	-0.011	0.021*	0.099***	0.041**	0.037***	0.015	0.042*	0.048***	0.121***	0.045***
Share of unemployed in hhs	0.090***	0.085***	0.201***	0.145***	0.089***	0.060***	0.077*	0.090*	0.202***	0.188***
Share of inactive in hhs	0.015	0.041***	0.046**	0.038***	0.016*	0.031**	0.044**	0.047*	0.079**	-0.003
Household income	-0.019***	-0.055***	-0.124***	-0.007	-0.032***	-0.058	-0.023***	-0.047***	-0.156***	-0.044***
Household transfers	0.003**	0.003*	0.013***	0.010***	-0.002*	-0.002	0.009***	0.014***	0.012***	0.008***
Housing costs	0.004	0.004	-0.055***	-0.014**	0.012*	0.014**	0.005	-0.011	-0.009	-0.034***
Share of indv. With bad health in hhs	0.102***	0.077***	0.053***	0.053***	0.058***	0.029***	0.073***	0.097***	0.143***	0.149***
High urbanisation	0.013*	0.029***	0.058***	0.014**	-0.005	excl	-0.007	-0.074**	-0.014***	0.025***

Owner	0.012	-0.084***	0.017	0.016	0.001	-0.035	-0.007	-0.004	-0.009	-0.059***
Mortgage	0.006	-0.082***	-0.012	0.019	0.005	-0.017	0.001	-0.011	0.068***	-0.001
Rent	0.040**	0.016	0.021	0.101***	0.047***	0.035*	0.078	-0.037*	0.067**	0.079***
Detached house	0.079*	0.103***	-0.060	0.021	0.027	-0.064***	0.129	0.042	-0.193**	0.001
Semidetached house	0.098*	0.112***	-0.100	-0.005	0.031	-0.051**	0.091	0.043	-0.186**	-0.002
Flat	0.052	0.017	-0.126*	-0.007	-0.020	-0.065***	0.100	0.028	-0.266***	-0.072
Dark house	0.132***	0.094***	0.284***	0.083***	0.196***	0.206***	0.185***	0.215***	0.275***	0.183***
Number of rooms	-0.01*	-0.005	-0.029***	0.005*	0.000	-0.005	0.001	-0.008**	-0.019***	-0.008***
N	24,158	25,751	29,213	30,175	34,631	21,569	23,596	24,642	79,384	57,485

Dep. Variable	**Energy Poor**									
Indep. Variables	**FI**	**FR**	**HR**	**HU**	**IE**	**IT**	**LT**	**LU**	**LV**	**MT**
Household size	0.015*	0.016***	0.004	0.009	0.009	0.027***	0.012	0.009	0.017*	0.015
Number of children 0-6 yrs	-0.002	0.007**	0.009	0.007	-0.004	-0.002	0.002	0.007	0.012*	-0.004
Number of children 7-14 yrs	0.002	0.006**	-0.001	0.008*	0.090*	-0.006*	0.012	0.006	0.016***	0.014*
Share of indv. Age 15-25 in hhs	-0.039*	0.039**	0.022	0.087**	0.083**	0.025	0.035	-0.003	0.069*	-0.022
Share of indv. Age 45-65 in hhs	-0.014	-0.008	-0.025	-0.017	-0.047*	0.013	-0.001	-0.018	0.008	0.028
Share of indv. Age 65+ in hhs	-0.092***	-0.087***	-0.119***	-0.077**	-0.091***	-0.059***	0.009	-0.086**	-0.114***	-0.006
Share of females in hhs	0.031*	0.020**	-0.024	-0.023	0.020	-0.003	-0.007	0.018	0.017	0.043
Share of primary educ. Indv. In hhs	excl.	0.031***	0.104***	0.109**	0.027	0.106***	0.081	0.0505*	0.167***	-0.022

Share of secondary educ. Indv. In hhs	0.047***	0.030***	0.028	0.048**	0.032*	0.049***	0.018	0.008	0.079***	0.012
Share of unemployed in hhs	0.129***	0.145***	0.155***	0.267***	0.112***	0.224***	0.131**	0.151***	0.149***	0.244**
Share of inactive in hhs	0.015	0.007	-0.019	-0.013	0.012	0.053***	0.032	0.010	0.041*	0.013
Household income	-0.044***	-0.075***	-0.120***	-0.083***	-0.058***	-0.039***	-0.091***	-0.031	-0.084***	-0.044***
Household transfers	0.010***	0.001	0.007***	0.013***	0.005*	0.004***	0.005	0.005	0.011***	0.012***
Housing costs	0.027***	0.001	0.024***	-0.069***	-0.008	-0.038	-0.007	-0.007	-0.048***	-0.014***
Share of indv. With bad health in hhs	0.042***	0.090***	0.106***	0.129***	0.142***	0.136***	0.007	0.076***	0.106***	0.123***
High urbanisation	-0.019***	-0.014*	-0.036***	-0.013	0.010	0.011*	0.011	-0.014	-0.026***	0.033**
Owner	-0.110***	-0.048**	-0.055***	-0.034*	-0.076***	-0.008	-0.012	0.048	-0.056***	-0.055***
Mortgage	-0.053	-0.054**	0.016	0.010	-0.064*	0.044***	-0.081***	0.068	-0.026	-0.073***
Rent	-0.036	0.035	0.002	0.104***	0.043	0.150***	0.047	0.114*	0.0401**	0.066***
Detached house	-0.029	-0.017	-0.037	-0.0795*	-0.087	0.079	-0.043	-0.077***	0.145	0.067
Semidetached house	-0.053	0.012	-0.044	-0.136**	-0.094	0.054	-0.004	-0.058	0.195	0.074
Flat	-0.078***	-0.032*	-0.068	-0.174***	-0.099	0.027	0.133**	-0.069*	0.113	0.039
Dark house	0.076***	0.178***	0.263***	0.352***	0.194***	0.420***	0.191***	0.183***	0.270***	0.103***
Number of rooms	0.003	-0.002	-0.014***	-0.025***	-0.004	0.001	-0.029***	0.012**	-0.012***	-0.019***
N	39,004	43,059	31,345	28,356	17,584	77,178	18,571	13,733	22,074	15,325

Dep. Variable	Energy Poor								
Indep. Variables	**NL**	**NO**	**PL**	**PT**	**RO**	**RS**	**SE**	**SI**	**SK**
Household size	0.017**	0.006	0.020***	0.028**	0.035**	0.008	0.015**	0.045***	0.021*
Number of children 0-6 yrs	-0.004	-0.001	0.001	-0.001	0.010	-0.003	0.002	0.002	0.002
Number of children 7-14 yrs	0.002	-0.001	0.003	0.000	0.004	0.002	-0.002	-0.006	-0.001
Share of indv. Age 15-25 in hhs	-0.062***	-0.029*	-0.028***	0.110***	0.016	0.052	-0.032	0.048	0.081**
Share of indv. Age 45-65 in hhs	-0.029*	-0.021*	-0.016	-0.022	0.003	-0.038	-0.008	0.006	0.022
Share of indv. Age 65+ in hhs	-0.148***	-0.059***	-0.098	-0.036	-0.087**	-0.091*	-0.030	-0.058*	0.012
Share of females in hhs	0.001	0.005	-0.004	0.022	-0.009	0.020	0.016	0.071**	-0.032
Share of primary education indv. In hhs	0.009	0.023	0.038***	0.082***	0.166***	0.112**	0.024	excl.	0.144*
Share of secondary education indv. In hhs	-0.003	0.014	0.075	0.032	0.069***	0.092***	0.019*	0.067***	0.025
Share of unemployed in hhs	0.142***	0.105***	0.214***	0.072**	0.282***	0.100***	0.075***	0.124***	0.236***
Share of inactive in hhs	0.067***	0.007	0.068***	-0.033	0.034	-0.040	0.010	-0.003	-0.031
Household income	-0.026***	-0.015***	-0.052***	-0.126***	-0.080***	-0.093***	-0.019***	-0.106***	-0.066***
Household transfers	0.008***	0.004***	0.007***	0.012***	0.005	0.007***	0.007***	0.011***	0.008***
Housing costs	-0.019**	0.020***	-0.029***	-0.026***	-0.021***	-0.014	-0.003	0.060***	-0.008
Share of indv. With bad health in hhs	0.058***	0.053***	0.089***	0.149***	0.113***	0.167***	0.062***	0.176***	0.093***

High urbanization	excl.	-0.001	-0.008	0.048***	0.033***	-0.011	0.007	excl.	-0.016
Owner	0.006	-0.050*	-0.098***	-0.026*	-0.073***	0.000	-0.086***	0.009	-0.035
Mortgage	0.040	-0.039	-0.118***	-0.022	-0.044	-0.040	-0.075***	0.022	-0.069**
Rent	0.133***	0.008	-0.048***	0.146***	-0.042	-0.026	excl.	0.036*	-0.003
Detached house	0.005	-0.026	0.026	-0.247	0.026	-0.076	0.007	0.004	0.075
Semidetached house	-0.008	-0.027	0.045	-0.278*	-0.034	-0.095	-0.008	-0.068	0.062
Flat	-0.055***	-0.058*	-0.053	-0.303*	-0.060	-0.161*	-0.038	-0.060	0.020
Dark house	0.148***	0.095***	0.162***	0.179***	0.187***	0.367***	0.087***	0.266***	0.225***
Number of rooms	-0.002	0.003	-0.023***	-0.009**	-0.035***	-0.013**	0.005*	-0.018***	-0.012***
N	52,157	23,777	58,500	38,625	29,011	20,161	22,503	34,516	22,266

Notes:

1. Average marginal effects from probit regression are estimated;
2. *, **, *** refer to statistically significant impact at 1%, 5% and 10 % significance level, respectively;
3. Robust standard errors were estimated;
4. Household weights were included in the estimation;
5. Year and region dummy variables were included in the estimation;
6. The reference categories are share of household persons ages 25-45, males to a total household size ratio, share of household persons with tertiary education, share of employed household persons, rural household, household with other tenure status, household lives in other dwelling type, and household lives in a house with enough light;
7. Excl. Stands for excluded variables from estimation due to collinearity problem;
8. In the case of germany, the estimation refers only to 2020.

Source: Authors' calculations based on EU-SILC data

Results from estimates of the model (3.2) regarding the assessment of the impact of socioeconomic and demographic characteristics and housing type on energy poverty intensity are given in the Table 4.4 which presents average effects from OLS regression estimation. Most variables are statistically significant and estimated coefficients have expected signs. The results also indicate that between 5% and 25% of the variation in energy poverty in terms of EPI is explained by the estimated model.

In the largest number of countries, the level of household energy poverty is influenced by the share of elderly people in the household, share of the unemployed in the household, household income and social transfers, participation of persons who are not active in the labour market due to illness, and natural lighting of the house. In many countries, variables such as household size, the share of low-educated (and medium-educated) people in the household, and renting the house have a statistically significant impact on the intensity of energy poverty. In Bulgaria, for instance, a country with the highest EPI value among European countries, an increase in the share of low-educated people and the share of unemployed people in a household by 0.1 leads to increase in EPI of a household by around 0.02, on average. An increase in share of persons with bad health in a household by 0.1 results in an increase of EPI of a household by 0.01 in Portugal and Serbia, for example.

Income also significantly affects the intensity of energy poverty, with the estimated average effect of -0.01 in the case of Norway or -0.1 in the case of Greece. The share of people being inactive on the labour market due some health limitations seems to have a large effect on the intensity of energy poverty with an estimated effect raging from around 0.05 (Finland) to 0.1 (Serbia). Natural lighting of the house is among the variables with the highest estimated impact on the household's EPI value. In most European countries, if household lives in a house with insufficient natural lighting this increases the EPI value by about 0.1 on average. In countries like Bulgaria and Serbia, the estimated effect is even close to 0.3.

If a household rents a house, it increases the EPI value by about 0.1 on average in the case of Portugal and Italy. Estimated impacts of social transfers, housing costs, household location, and number of rooms in the house, although statistically significant, are not so pronounced. The results also show that in most of European countries, household age and gender structure, number of children, and most of dwelling types have no statistically significant impact on intensity of energy poverty of a household.

Intensity of energy poverty increases with the increase in the size of the household, share of low-educated and unemployed people in the household, share of people with health issues who are not active on the labour market or in the case of household that rents a house. In contrast, the intensity of energy poverty decreases in the case of households with a higher share of elderly people, households with higher incomes, and in the case of households living in a house with enough natural lighting. This is the case in most of European countries regardless of the level of energy poverty of the country.

Our results are in line with findings from other studies that mostly focused on one or several countries, where they are mainly based on the examination of energy poverty factors at the country level. Legendre and Ricci (2015) showed that in case of French household’s employment status, tenure status, and some housing characteristics like roof insulation are associated the probability of being energy poor. Hill (2019) investigated the determinants of energy poverty of households in Austria and showed that household’s income and composition, as well as the type or age of the

building are factors that significantly impact the level of energy poverty. Bouzarovski (2014) points out that many studies examining the drivers of energy poverty in Europe confirmed that this type of poverty arises out of a combination of three factors: low income, inadequate building quality, and high energy prices. Additionally, it was shown that the specific needs of the household, which are related to some demographic characteristics, such as household size, gender, occupation, also have a key impact on energy poverty.

In general, the probability and intensity of energy poverty among European countries are influenced by variables that are directly or indirectly (such as education, labour market status, number of rooms in a house) related to household income.[11] Households with a higher share of low-educated, unemployed, sick, and households living in a rented house or in a house with insufficient natural lighting are likely to be poorer in terms of income, which then increases the probability and intensity of poverty. Many of the recent studies confirm this (Bacon and Kojima, 2016; Bouzarovski et al., 2018; Jenkins, 2018).

[11] Consequently, it is important to note that some of the variables included in the estimations are likely to be endogenous.

Table 4.4. Empirical estimation of factors affecting intensity of energy poverty in Europe

Dep. Variable	Energy Poverty									
Indep. Variables	**AT**	**BE**	**BG**	**CH**	**CZ**	**DE**	**DK**	**EE**	**EL**	**ES**
Household size	0.004*	0.005	0.030***	0.004**	-0.003	0.010***	0.001	-0.002	0.031***	0.006**
Number of children 0-6 yrs	0.000	0.003*	-0.004	0.001	0.002*	-0.003	0.007**	0.001	-0.001	0.002
Number of children 7-14 yrs	0.001	0.003**	-0.007*	0.001	0.001	0.002	0.001	0.003	-0.003	0.002*
Share of indv. Age 15-25 in hhs	0.018**	0.028***	0.037*	0.003	0.005	0.013	-0.017	-0.006	0.044***	0.052***
Share of indv. Age 45-65 in hhs	0.006	0.019***	-0.008	0.011***	0.001	0.014*	0.010	-0.004	-0.004	-0.004
Share of indv. Age 65+ in hhs	-0.018***	-0.065***	-0.027**	-0.026***	-0.017***	-0.032***	-0.055***	-0.033***	-0.048***	-0.049***
Share of females in hhs	0.010**	0.005	0.035***	-0.002	-0.001	0.001	-0.010	0.003	0.020*	-0.009
Share of primary education indv. In hhs	0.048	0.003	0.181***	0.028*	-0.004	0.059***	0.010	0.024	0.102***	0.051***
Share of secondary education indv. In hhs	0.000	0.003	0.063***	0.010*	0.024***	0.009*	0.022**	0.017***	0.066***	0.027***
Share of unemployed in hhs	0.071***	0.082***	0.165***	0.055***	0.088***	0.037**	0.053***	0.057**	0.146***	0.146***
Share of inactive in hhs	0.007	0.046***	0.026**	0.014***	0.004	0.024***	0.034***	0.022**	-0.042***	0.017*
Household income	-0.009***	-0.031***	-0.076***	-0.004**	-0.018***	-0.032***	-0.015***	-0.022***	-0.097***	-0.028***
Household transfers	0.001**	0.001	0.007***	0.002***	-0.001**	-0.003***	0.005***	0.005***	0.009***	0.005***
Housing costs	0.001	0.002	-0.043***	-0.005**	0.002	0.006***	0.005	0.001	0.016*	-0.023***
Share of indv. With bad health in hhs	0.041***	0.036***	0.040***	0.017***	0.024***	0.003	0.028***	0.034***	0.082***	0.080***

High urbanization	0.008**	0.010**	0.047***	0.005***	-0.001	excl.	-0.007*	-0.021***	-0.011***	0.010***
Owner	0.004	-0.033**	0.013*	0.004	0.004	-0.002	-0.004	-0.001	-0.024**	-0.032***
Mortgage	0.003	-0.032**	-0.010	0.005	0.006	-0.029	-0.004	-0.004	0.010	-0.005
Rent	0.015***	0.013	0.019	0.026***	0.023***	0.017	0.030	-0.017**	0.003	0.053***
Detached house	0.023**	0.030**	-0.058	0.005	0.006	-0.030***	0.029	0.006	-0.204**	0.006
Semidetached house	0.028***	0.035**	-0.095**	-0.001	0.011	-0.028**	0.009	0.006	-0.204**	0.006
Flat	0.014	-0.006	-0.120***	-0.002	-0.009	-0.035***	0.014	0.002	-0.247***	-0.015
Dark house	0.070***	0.057***	0.279***	0.036***	0.122***	0.104***	0.109***	0.113***	0.194***	0.106***
Number of rooms	-0.002	-0.002	-0.023***	0.002*	0.001	-0.003*	0.001	-0.003**	-0.015***	-0.002
Cons	0.084***	0.377***	1.094***	0.059***	0.191***	0.359***	0.130*	0.267***	1.209***	0,437***
N	24,158	25,751	29,213	30,175	34,631	21,569	23,596	24,642	79,384	57,485
R^2	0.083	0.127	0.234	0.043	0.083	0.071	0.074	0.073	0.161	0.163

Dep. Variable	**Energy Poverty**									
Indep. Variables	**FI**	**FR**	**HR**	**HU**	**IE**	**IT**	**LT**	**LU**	**LV**	**MT**
Household size	0.005*	0.004	0.005	0.005	-0.001	0.013***	0.007	0.001	0.004	0.007
Number of children 0-6 yrs	-0.001	0.003***	0.000	0.003	0.001	-0.002	-0.002	0.002	0.007**	0.000
Number of children 7-14 yrs	0.001	0.004	-0.002	0.007**	0.003	-0.003	0.006	0.003	0.005**	0.007*
Share of indv. Age 15-25 in hhs	-0.010	0.008	0.026*	0.028	0.070***	-0.006	0.026	0.006	0.026	-0.008
Share of indv. Age 45-65 in hhs	0.005	-0.006	0.008	-0.005***	0.015	-0.010	0.009	0.010	-0.010	-0.019

Share of indv. Age 65+ in hhs	-0.027***	-0.044***	-0.044***	-0.054	-0.025**	-0.039***	-0.006	-0.028***	-0.065***	-0.016
Share of females in hhs	0.016**	0.013***	-0.007	-0.002	0.003	-0.009	0.001	-0.001	0.014	0.016
Share of primary education indv. In hhs	excl.	0.009*	0.059***	0.056**	0.011	0.060***	0.021	0.025**	0.084***	-0.010
Share of secondary education indv. In hhs	0.015***	0.016***	0.000	0.014	0.017*	0.029***	0.010	0.009	0.026***	0.004
Share of unemployed in hhs	0.060***	0.125***	0.085***	0.225***	0.071***	0.150***	0.074**	0.085**	0.096***	0.188***
Share of inactive in hhs	0.008	0.018***	-0.018	0.008	0.009	0.025***	0.024	0.011	0.029***	0.012
Household income	-0.016***	-0.038***	-0.074***	-0.050***	-0.031*	-0.025***	-0.053***	-0.013***	-0.050***	-0.022***
Household transfers	0.004***	0.001	0.005	0.008***	0.003	0.003***	0.002	0.002	0.007***	0.005***
Housing costs	0.008***	0.002	0.001	-0.040***	-0.009*	-0.029***	0.000	-0.002	-0.021***	-0.007**
Share of indv. With bad health in hhs	0.014**	0.046***	0.052***	0.061***	0.069***	0.060***	0.016	0.020***	0.045***	0.057***
High urbanisation	-0.007***	-0.006*	-0.015***	-0.002	-0.003	0.009***	0.011	-0.001	-0.007*	0.014**
Owner	-0.041**	-0.017*	-0.033***	-0.009	-0.022	-0.006	0.004	0.019	-0.033***	-0.020*
Mortgage	-0.027	-0.017*	0.002	0.009	-0.011	0.023***	-0.037*	0.024	-0.008	-0.026*
Rent	-0.020	0.020*	0.004	0.053***	0.053***	0.096***	0.052*	0.041**	0.029***	0.046***
Detached house	-0.033	-0.006	-0.029	-0.029	-0.115	0.027	-0.061*	-0.039	0.048	0.058
Semidetached house	-0.040	0.008	-0.029	-0.048*	-0.115	0.012	-0.041	-0.030	0.058	0.057
Flat	-0.051*	-0.016*	-0.044	-0.083***	-0.126	0.002	0.042	-0.039	0.040	0.043
Dark house	0.040***	0.105***	0.182***	0.185***	0.110***	0.207***	0.113***	0.080***	0.138***	0.055***
Number of rooms	0.001	0.001	-0.004**	-0.009***	0.001	0.001	-0.012***	0.002	-0.002	-0.012***

Cons	0.187***	0.414***	0.842***	0.794***	0.512***	0.406	0.668***	0.178***	0.600***	0.296***
N	39,004	43,059	31,345	28,356	17,584	77,178	18,571	13,733	22.074	15,325
R^2	0.0468	0.1354	0.1608	0.1988	0.1101	0.1412	0.1168	0.0549	0.1451	0.0805

Dep. Variable	Energy Poverty								
Indep. Variables	**NL**	**NO**	**PL**	**PT**	**RO**	**RS**	**SE**	**SI**	**SK**
Household size	0.006**	0.001	0.007**	0.017***	0.019***	0.006	0.005*	0.014***	0.010*
Number of children 0-6 yrs	0.001	0.001	0.000	-0.004	0.007	-0.002	0.002	0.000	0.002
Number of children 7-14 yrs	0.002	0.000	0.001	0.000	0.005	0.000	-0.001	0.000	0.000
Share of indv. Age 15-25 in hhs	-0.032***	-0.008	-0.014	0.061***	-0.008	0.057**	-0.007	0.015	0.021
Share of indv. Age 45-65 in hhs	0.001	0.007	-0.001	-0.004	-0.008	0.028	0.003	-0.003	-0.007
Share of indv. Age 65+ in hhs	-0.060***	-0.015**	-0.047***	-0.018	-0.060***	-0.048**	-0.007	-0.031***	-0.016
Share of females in hhs	-0.005	-0.004	-0.006	0.019	-0.007	0.004	0.009	0.031**	-0.012
Share of primary education indv. In hhs	0.009	0.023	0.022***	0.044***	0.099***	0.041*	0.013	excl.	0.131**
Share of secondary education indv. In hhs	0.003	0.006	0.019	0.016	0.029**	0.006	0.006	0.023***	0.008
Share of unemployed in hhs	0.083***	0.054***	0.104***	0.073***	0.235***	0.060***	0.035**	0.075***	0.223***
Share of inactive in hhs	0.040***	0.008	0.033***	-0.003	0.022*	-0.012	0.003	0.004	-0.009
Household income	-0.013***	-0.006***	-0.038***	-0.076***	-0.045***	-0.058***	-0.008***	-0.050***	-0.046***
Household transfers	0.003***	0.002**	0.005***	0.005***	0.009***	0.003*	0.003***	0.005***	0.004***
Housing costs	-0.005*	0.006***	-0.022***	-0.023***	-0.013***	-0.026***	0.003	0.019***	-0.010***
Share of indv. With bad health in hhs	0.028***	0.023***	0.039***	0.084***	0.053***	0.106***	0.024***	0.076***	0.043***

High urbanization	excl.	-0.001	-0.001	0.027***	0.018***	-0.003	0.004	excl.	-0.008**
Owner	-0.016	-0.014*	-0.057***	-0.012	-0.057***	-0.001	-0.027***	0.005	-0.035*
Mortgage	-0.006	-0.011	-0.049***	-0.006	-0.023	-0.003	-0.026***	0.007	-0.048**
Rent	0.031*	0.009	-0.029***	0.107***	-0.025	-0.005	excl.	0.021**	-0.013
Detached house	-0.001	-0.025	0.001	-0.238**	-0.004	-0.023	-0.024	0.012	0.053
Semidetached house	-0.002	-0.024	0.008	-0.260***	-0.030	-0.023	-0.028	-0.014	0.050
Flat	-0.018***	-0.032	-0.035	-0.270***	-0.048	-0.072	-0.038*	-0.010	0.024
Dark house	0.074***	0.050***	0.121***	0.107***	0.136***	0.244***	0.043***	0.131***	0.201***
Number of rooms	-0.001	0.002*	-0.008***	-0.003	-0.017***	0.001	0.001	-0.007***	-0.006***
Cons	0.195***	0.068	0.569***	1.176***	0.550***	0.759***	0.117***	0.432***	0.495***
N	52,157	23,777	58,500	38,625	29,011	20,161	22,503	34,516	22,266
R^2	0.0700	0.0433	0.1055	0.1533	0.1024	0.1916	0.0384	0.1725	0.1605

Notes:

1. *, **, *** Refers to statistically significant impact at 1%, 5% and 10 % significance level, respectively;
2. Robust standard errors were estimated;
3. Household weights were included in the estimation;
4. Year and region dummy variables were included in the estimation;

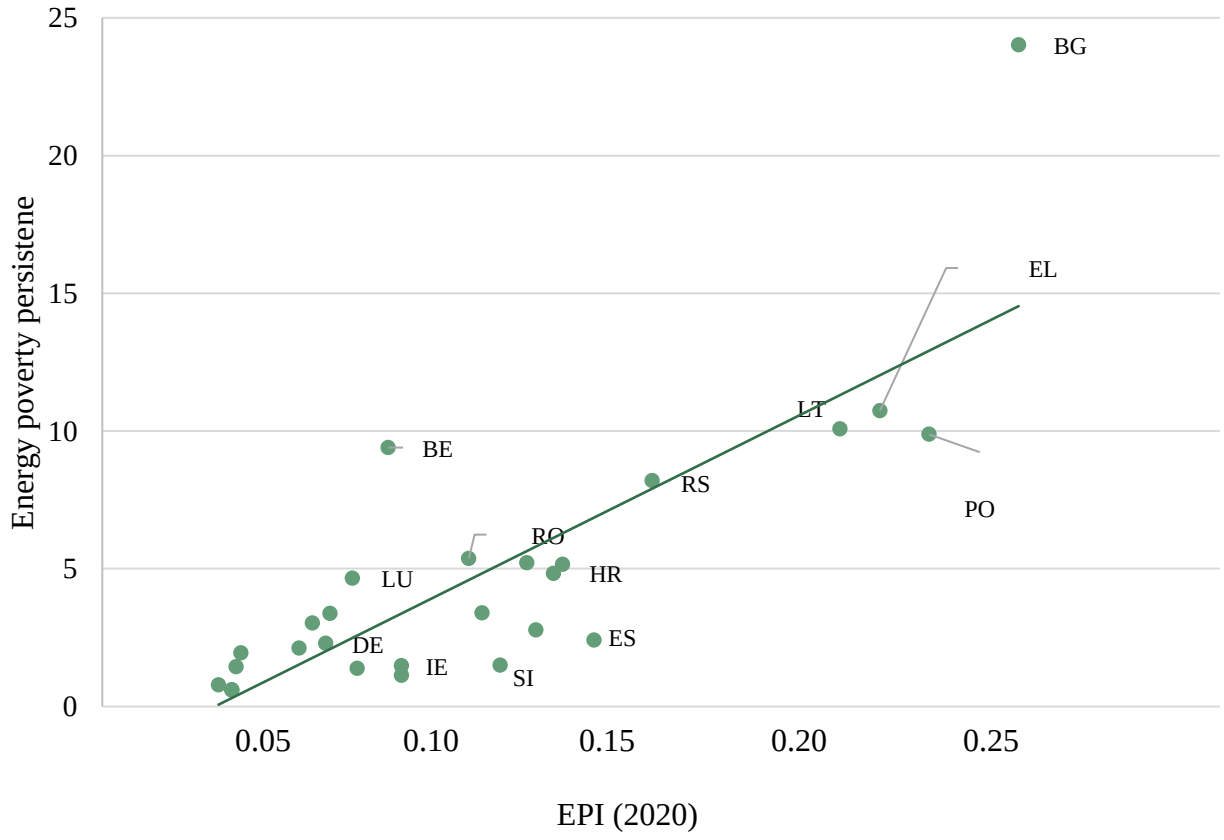
5. The reference categories are share of household persons ages 25-45, males to a total household size ratio, share of household persons with tertiary education, share of employed household persons, rural household, household with other tenure status, household lives in other dwelling type, and household lives in a house with enough light;
6. Excl. Stands for excluded variables from estimation due to collinearity problem;
7. In the case of Germany, the estimation refers only to 2020.

Source: Authors' calculations based on EU-SILC data.

4.3. Energy poverty dynamics in Europe

Before presenting the results of estimation of energy poverty dynamics, we established the relationship between energy poverty level and energy poverty persistency among European countries. Figure 4.1 indicates a positive link between EPI in 2020 and the rate of energy poverty persistence, showing that countries with higher energy poverty are also the ones with a higher rate of households that persistently live in energy poverty. The persistent energy poverty rate follows the EU-SILC methodology for calculating the rate of persistent poverty risk and shows the percentage of the population living in households that experienced energy poverty in the current year and in at least two of the previous three years. The highest persistent energy poverty rate can be noticed in Bulgaria (24%), Greece (10.7%), and Lithuania (10%). In almost two thirds of countries considered this rate is less than 5%. In Sweden, Finland, and Switzerland the persistent energy poverty rate is even less than 1%. This confirms a high divergence among European countries in terms of energy poverty persistence (the energy poverty persistence rate in Bulgaria is almost 40 times higher compared to Finland, for instance).

Figure 4.1. Relationship between EPI (2020) and energy poverty persistence



Source: Authors' representation.

Table 4.5 presents the results of the estimation of energy poverty persistence among European countries. The estimated effect refers to average marginal effects from dynamic random effects probit regression. Results are obtained employing the WCML estimator which specifies a distribution on heterogeneity conditional on the initial energy poverty status of a household.

There is a strong evidence of energy poverty persistency in all countries in the sample (except for Ireland). The estimated average marginal effect ranges from around 0.03 (Austria, Switzerland, Finland) to 0.23 (Bulgaria), which indicates that facing energy poverty in one period increases the probability of a household being energy poor in the subsequent period by 3% in Austria, being a low EPI country, and by 23% in Bulgaria, with high EPI values. Relatively high energy poverty persistence is noticed in Greece, Portugal and Malta, with estimated marginal effect of being energy poor in previous period ranging between 13-16%, on average. Results shows that in most of European countries the fact that a household was faced with energy poverty in previous year raises the likelihood of being energy poor in current year by around 5% or slightly more.

The estimated marginal effect of the initial energy poverty status is statistically significant in all countries, ranging from close to 0.1 to even 0.3. In the case of Lithuania, for example, being energy poor in the initial period increases the probability of being energy poor in the current period by about 30%. In other countries with high energy poverty, such as Bulgaria, Greece, Spain, Portugal and Serbia, initial energy poverty increases the chances that the household will be energy poor in the current year by an average of 15 to 25%. The value of the estimated marginal effect is not negligible even in the case of countries with low energy poverty. The estimated coefficient of initial energy poverty status is large in magnitude and higher than the coefficient of lagged energy poverty variable which confirms the strong evidence in favour of addressing the initial poverty problem.

Impact of other variables is mostly statistically significant and with the expected sign, so an increase in the share of low-educated people, share of the unemployed or the share of labour market inactive with health issues in the household increases the probability that the household will be energy poor. At the same time the increase in the share of the elderly in the household, the increase of both the initial and average income for the years other than initial year reduces the chance that the household will be marked as energy poor.

Our results are consistent with those found in similar single-country studies conducted for Spain (Phimister et al., 2015), Ethiopia (Alem and Demeke, 2020) and Germany (Drescher and Janzen, 2021).

Table 4.5. Empirical estimation of energy poverty persistence among European countries (marginal effects)

Dep. variable	Energy Poor_t								
Indep. variables	**AT**	**BE**	**BG**	**CH**	**CZ**	**EE**	**EL**	**ES**	**FI**
Energy Poor_t-1	0.035**	0.057***	0.232***	0.033**	0.080***	0.041*	0.160***	0.046**	0.030**
Energy poor_0	0.117***	0.159***	0.153***	0.111***	0.102***	0.174***	0.266***	0.176***	0.094***
Household size	0.006	-0.006	0.004	0.025	0.005	0.026***	0.011	0.059***	-0.004
Number of children 0-6 yrs	0.004	-0.002	0.005	0.002	0.000	0.006	0.005	0.011	0.001
Number of children 7-14 yrs	0.009	0.000	0.003	0.009*	-0.006	-0.002	0.019**	0.012	0.004
Share of indv. Age 15-25 in hhs	0.018	0.013	0.002	0.018	-0.013	-0.021	0.001	0.028	-0.006
Share of indv. Age 45-65 in hhs	0.001	-0.010	0.007	-0.011	0.000	0.010	0.010	-0.013	-0.009
Share of indv. Age 65+ in hhs	-0.009	-0.022**	-0.003	-0.050*	-0.014	-0.036***	-0.005	-0.027***	-0.033***
Share of females in hhs	-0.005	0.000	0.013	-0.013	0.003	0.032*	0.013	0.002	-0.002
Share of primary education indv. In hhs	0.068**	0.002	0.043**	0.003	0.228***	0.037***	0.064***	0.050***	excl.
Share of secondary education indv. In hhs	-0.010	-0.001	0.020**	0.010	0.013	0.014	0.043***	0.021	0.020***
Share of unemployed in hhs	0.016	0.004	0.113***	0.047**	0.001	0.058***	0.121***	0.126***	0.035***
Share of inactive in hhs	-0.024	0.016*	0.044	0.011	0.020	0.018	0.024	0.026	0.006
Share of indv. With bad health in hhs	0.036***	0.009*	0.018	0.026***	0.001	0.069***	0.069***	0.085***	0.010

High urbanisation	0.004	-0.005	0.017	0.016**	0.001	-0.034***	0.015*	0.016	-0.004
Owner	0.002	-0.014	-0.004	0.001	-0.007	0.002	-0.005	-0.052***	-0.020
Morgage	0.001	-0.014	0.016	-0.012	-0.005	0.006	-0.003	-0.034*	0.000
Rent	0.009	-0.003	0.006	0.008	0.014	-0.013	0.035**	0.060***	0.005
Detached house	0.094	0.034	-0.044	0.020	0.042	-0.019	-0.043	-0.013	-0.033
Semidetachhouse	0.110*	0.037*	-0.040	0.009	0.035	0.003	-0.035	-0.011	-0.030
Flat	0.087	0.014	-0.055	0.012	0.023	-0.035	-0.074	-0.081	-0.037
Number of rooms	-0.003	-0.002	-0.005*	-0.003	0.003	-0.005	-0.017***	-0.015***	0.004
Household size_0	0.007	0.003	0.028	0.001	0.010	0.019	0.015	-0.021	0.014
Share of unemployed in hhs_0	0.044**	0.011	-0.024	0.031	0.009	0.013	-0.007	0.011	0.014
Share of inactive in hhs_0	0.030*	-0.005	-0.031*	-0.013	-0.006	-0.015	-0.049**	-0.028	0.002
Share of indv. With bad health in hhs_0	0.009	0.003	0.003	0.017*	0.007	0.036**	-0.012	0.023	0.011
Household income_0	-0.011*	-0.003	-0.010	-0.013*	-0.023***	-0.031**	-0.023***	-0.030***	-0.014*
Household transfers_0	0.004**	0.003	0.000	-0.001	-0.002	0.000	-0.001	0.004	0.000
Household income_m	-0.001	-0.001	-0.034***	0.001	-0.004	-0.020**	-0.048***	-0.016***	-0.001
Householdransfers_m	0.001*	0.003	0.003	0.002	0.001	0.005***	0.010***	0.004	0.005***
N	8,320	15,038	14,609	9,634	12,676	8,893	27,613	15,891	13,565

Dep. Variable	Energy Poor_t								
Indep. Variables	FR	HR	HU	IE	IT	LT	LU	LV	MT
Energy Poor_t-1	0.060***	0.068***	0.083***	0.014	0.100***	0.091***	0.120***	0.106***	0.132***
Energy poor_0	0.206***	0.262***	0.228***	0.210***	0.073***	0.313***	0.154***	0.188***	0.093***
Household size	0.020***	0.001	-0.022	-0.009	0.001	-0.010	-0.009	0.022***	0.030***
Number of children 0-6 yrs	0.007	0.019	0.035***	0.015	-0.007	-0.046	0.020*	-0.002	-0.002
Number of children 7-14 yrs	0.004	0.001	0.034***	0.016	-0.003	-0.017	0.003	0.037*	0.023
Share of indv. Age 15-25 in hhs	0.007	0.037	0.102***	0.071*	-0.010	-0.025	0.008	-0.038	-0.005
Share of indv. Age 45-65 in hhs	-0.003	-0.012	-0.011	0.000	-0.002	0.024	0.008	0.007	0.002
Share of indv. Age 65+ in hhs	-0.016***	-0.021***	-0.024***	-0.029	-0.038***	0.026***	-0.006	-0.115***	-0.013
Share of females in hhs	0.009	0.011	-0.059***	-0.009	-0.011	-0.005	0.007	0.019	0.015
Share of primary education indv. In hhs	-0.010	0.057**	0.079**	0.004	0.017	0.018	0.029***	0.127**	-0.004
Share of secondary education indv. In hhs	0.001	0.022	0.026	-0.014	0.012	-0.020	0.002	0.043*	-0.008
Share of unemployed in hhs	0.049*	0.056**	0.146***	0.038	0.174***	0.083*	0.064*	0.186***	0.168**
Share of inactive in hhs	-0.028	0.007	0.027	-0.006	0.041***	0.069**	0.017	0.101***	0.066*
Share of indv. With bad health in hhs	0.054***	0.034***	0.043	0.069***	0.115***	-0.005	0.015	0.068***	0.058***
High urbanisation	-0.002	-0.016	0.017	0.018	0.014**	0.000	0.016	-0.003	0.007

Owner	-0.027	-0.018	-0.061*	-0.031	-0.007	-0.010	0.021	-0.088***	-0.006
Morgage	-0.036	0.002	-0.018	-0.052	0.030*	0.003	0.029	-0.054	0.000
Rent	0.036	-0.005	0.026	0.021	0.077***	0.023	0.042	-0.023	0.042
Detached house	-0.030	0.137	-0.077	0.065	0.118	-0.019	-0.045	0.107	-0.074
Semidetachhouse	-0.002	0.159	-0.121**	0.052	0.103	0.001	-0.050	0.135	-0.089
Flat	-0.038	0.145	-0.143***	0.054	0.082	0.058	-0.038	0.102	-0.107
Number of rooms	-0.006	-0.009**	-0.027***	-0.004	-0.005*	-0.010*	0.004	-0.021**	-0.012*
Household size_0	0.023	0.024	0.050	0.032	0.037**	0.044	0.035	0.075*	0.055
Share of unemployed in hhs_0	0.027	0.019	0.075	0.017	0.023	-0.012	0.035	-0.036	-0.023
Share of inactive in hhs_0	0.026	-0.019	-0.032	-0.006	-0.026*	-0.054*	-0.022	-0.008	-0.081**
Share of indv. With bad health in hhs_0	-0.006	0.019	0.030*	0.008	0.054***	0.044**	0.005	0.007	0.016
Household income_0	-0.041***	-0.028***	-0.034***	-0.015	-0.022***	-0.028*	-0.005	-0.030*	-0.032**
Household transfers_0	-0.001	-0.003	-0.002	-0.003	0.001	0,001	-0.002	-0.002	-0.004
Household income_m	-0.018*	-0.022***	-0.079***	-0.033**	-0.009***	-0.027*	-0.013*	-0.036***	-0.019
Householdransfers_m	0.001	0.006*	0.004	0.005	0.006**	0.005	0.012**	0.015***	0.014**
N	9,937	11,092	9,748	6,190	36,383	7,461	7,241	7,287	5,317

Dep. Variable	Energy Poor_t							
Indep. Variables	**NL**	**NO**	**PL**	**PT**	**RS**	**SE**	**SI**	**SK**
Energy Poor_t-1	0.065***	0.025	0.064***	0.134***	0.055*	0.015	0.057***	0.080***
Energy poor_0	0.157***	0.068***	0.150***	0.201***	0.202***	0.101***	0.243***	0.119***
Household size	0.007	0.011	0.001	0.079***	0.037	-0.019	0.090**	0.028
Number of children 0-6 yrs	-0.003	-0.004	0.003	0.004	-0.010	0.023***	0.004	0.009
Number of children 7-14 yrs	-0.004	-0.002	0.004	-0.001	-0.001	0.009	-0.011	0.009
Share of indv. Age 15-25 in hhs	-0.016	-0.011	0.006	0.062*	0.008	0.016	-0.002	0.038
Share of indv. Age 45-65 in hhs	-0.020*	0.005	-0.004	-0.011	-0.006	0.007	0.045*	0.008
Share of indv. Age 65+ in hhs	-0.053***	-0.023*	-0.021**	-0.015	-0.072*	-0.002	0.017	0.016
Share of females in hhs	0.007	0.009	0.000	-0.012	-0.038	0.006	0.022	-0.014
Share of primary education indv. In hhs	0.001	0.002	0.025	0.029***	0.084**	0.003	excl.	0.111*
Share of secondary education indv. In hhs	-0.008	0.005	0.011	-0.008	0.052*	-0.003	0.001	0.044***
Share of unemployed in hhs	0.041*	0.040*	0.078***	0.069***	0.123***	-0.017	0.075*	0.094**
Share of inactive in hhs	0.008	0.019*	0.028***	-0.015	0.056	-0.011	0.007	-0.031
Share of indv. With bad health in hhs	0.019*	0.016	0.029***	0.104***	0.077***	0.020	0.120***	0.042**
High urbanisation	excl.	0.002	0.008*	0.029***	-0.021	0.007	excl.	0.001
Owner	-0.002	-0.016	-0.030***	-0.022	-0.037*	-0.027	0.019	-0.035
Morgage	0.006	-0.007	-0.035***	-0.022	-0.133	-0.026	0.022	-0.055
Rent	0.037	0.023	-0.007	0.060***	-0.018	0.003	0.068***	-0.035
Detached house	0.011	0.026	0.007	-0.154	-0.111	-0.018	-0.049	-0.091
Semidetachhouse	0.004	0.025	0.021	-0.159	-0.091	-0.030	-0.079	-0.100

Flat	-0.023	0.015	-0.023	-0.197	-0.149	-0.038	-0.074	-0.106
Number of rooms	-0.002	0.002	-0.013***	-0.008***	-0.023***	0.000	-0.012*	-0.012**
Household size_0	0.012	0.000	0.018	-0.032	0.036	0.011	0.083**	0.007
Share of unemployed in hhs_0	0.000	0.018	0.017	0.046	0.015	0.061**	-0.004	0.087**
Share of inactive in hhs_0	-0.014	-0.004	-0.006	0.016	-0.032	0.011	-0.051	0.033
Share of indv. With bad health in hhs_0	0.019*	0.010	0.005	0.057***	0.002	0.014	0.047*	0.004
Household income_0	-0.017**	-0.009*	-0.013***	-0.012	-0.056***	-0.009	-0.061***	-0.027*
Household transfers_0	0.003*	0.003	-0.004	0.003	-0.004	-0.001	0.003	0.004
Household income_m	-0.007	-0.005	-0.019***	-0.082***	-0.054***	-0.004	-0.082***	-0.022
Householdransfers_m	0.001	-0.002	0.005***	0.012***	0.004	0.002	0.002	-0.001
N	17,625	7,504	32,776	17,342	7,119	7,049	11,893	7,999

Notes:

1. Average marginal effects from random effects panel probit regression are estimated;
2. *, **, *** refer to statistically significant impact at 1%, 5% and 10 % significance level, respectively;
3. Robust standard errors were estimated;
4. Household weights were included in the estimation;
5. Region dummy variables were included in the estimation;
6. The reference categories are share of household persons ages 25-45, males to a total household size ratio, share of household persons with tertiary education, share of employed household persons, rural household, household with other tenure status, household lives in other dwelling type;
7. Excl. Stands for excluded variables from estimation due to collinearity problem;

Source: Authors' calculations based on EU-SILC data.

5. Conclusions

Reducing energy poverty remains an important goal for policy makers. This is especially important having in mind that the situation in many countries has worsened due to high energy prices since mid-2021 and Russia's invasion of Ukraine, a time span not covered by our analysis. This report examines the level and persistence of energy poverty using the EU-SILC data for 29 European countries over the period between 2017 and 2020. Our measure of energy poverty is defined by the Energy poverty index which is calculated as the weighted sum of an households' self-reported perception of: (1) difficulty heating their home adequately warm, (2) paying utility bills and (3) poor housing conditions. The main advantage of using subjective self-reported measure of energy poverty is in identifying households that are self-rationing their energy use.

Regarding the extent of energy poverty, the first result of interest reveals a clear division between European countries. In general, southern and eastern countries have relatively high EPI value, on average six times larger than northern European countries. The highest energy poverty levels were found in Bulgaria, Lithuania, Portugal and Greece (ranging from 0.21 to 0.17) and the lowest in Norway, Finland, Sweden and Switzerland (going from 0.02 to 0.03). These are the same countries with the highest and the lowest levels of EPI as Bouzarovski and Herrero (2017) found in their study for the EU28 countries over the period 2003-2013.

Second, we find that poor housing conditions appeared to be the main component behind the energy poverty in most European countries. This result suggests that one of the priorities for policymakers to reduce energy poverty is to focus on the quality of housing conditions by increasing the energy performance of buildings and appliances. Energy efficiency measures, like those that improve the insulation of walls, are important tools to lower energy bills. This is especially important for vulnerable households knowing that the share of income spent on energy is much higher for poor individuals compared to high-income ones. Since vulnerable more often rent their apartments, this requires addressing properly the landlord-tenant relationship problem (Koukoufikis et al., 2023). Landlords have incentives to pass the costs of energy-efficient improvements onto tenants in the form of higher rents which can reduce the pool of affordable housing for more vulnerable households. Without the appropriate government support households that are already poor might be pushed into deeper poverty when exposed to additional costs related to housing renovations. Social Platform (2024) argues that financial support should be provided through the Social Climate Fund for those living in energy poverty and homes targeted for renovations. Policy tools such as climate housing allowances could be directed to households which need assistance with covering the costs of sustainable housing, ensuring that renewable energy sources are used in the process along with energy-efficient technologies.

Third, our analysis identifies that, regardless of the level of energy poverty of the country, the probability of a household being energy poor and intensity of energy poverty rises with the increase in the size of the household, share of low-educated, unemployed people and inactive people due to health issues in the household. These factors push households into financial difficulties making

them struggle to pay energy bills. With rising energy prices vulnerability of such households increases. Before the latest surge in energy prices following the war in Ukraine, over the last decade prices have risen mainly due to growth in network charges, taxes and levies.

Energy subsidies, which effectively reduce prices, or social tariff policies, that work through a discount of a customer's unit rate, standing charge, bill relief, or a combination of these, are the tools governments throughout Europe often use to mitigate energy poverty. Even though they provide a temporary relief for the poor if not combined with energy efficiency measures they remove the incentive to invest in housing renovations (Koukoufikis et al., 2023).

Our results of the energy poverty persistence suggest that countries with higher energy poverty are also the ones with a higher share of households that persistently live in energy poverty. Energy poverty persistence exists among households that have been energy poor in a reference year and at least two out of three previous years. The highest persistent energy poverty rate is observed in Bulgaria (24%), Greece (10.7%), and Lithuania (10%). In almost two thirds of countries this rate is less than 5%. Sweden, Finland, and Switzerland are the countries where the persistent energy poverty is not observed (rate is even less than 1%).

Using a dynamic random effects probit model, we further explored household characteristics that are associated with the experience of energy poverty. The first result of interest implies that household composition in terms of educational attainment, labor market status and health problems, as well as household income are correlated with energy poverty in most European countries.

Second, the estimated coefficient of initial energy poverty status is large in magnitude and statistically significant in all countries and appears higher than the coefficient of lagged energy poverty variable. In countries with high energy poverty, initial energy poverty increases the chances of the household being energy poor in the current year by an average of 15% to 30%.

Third, there is a strong evidence of energy poverty persistency in all countries (except for Ireland). Our results identify that in most European countries the fact that a household experienced energy poverty in previous year raises the likelihood of being energy poor in the current year by around 5% on average. The lowest estimated energy poverty persistence effect is found in Austria, Switzerland and Finland (3%), with a relatively high one observed in Greece, Portugal and Malta (13-16%), while the highest is observed in Bulgaria (23%).

Finally, the diversity among European countries in terms of persistent, i.e. long-term poverty has an important policy implications, as it requires different policy instruments to deal with underlying causes of short-term and persistent energy poverty. Lifting households out of persistent energy poverty and breaking the energy poverty trap - which is difficult to achieve without specific policy and legislative instruments - should be one of the priorities for policymakers (Drescher and Janzen, 2021). Short-term measures like energy subsidies can provide a temporary relief, while promotion of the energy efficient housing is needed to lift households permanently out of energy poverty.

There are several EU directives dealing with the energy efficiency of buildings but without adequate governmental support energy poor households will not be able to reach the targets related to energy efficient building stock. Revised Energy Efficiency Directive stipulates that energy efficiency must

be considered by EU countries in all relevant policy and major investment decisions taken in the energy and non-energy sectors.[12] According to the Energy Performance of Building Directive 75% of buildings in the EU have a poor energy performance. Knowing that buildings are the single largest energy consumer in Europe, promoting energy efficiency measures is not only instrumental in achieving climate goals but also key to saving energy and reducing bills.[13] To meet targets of the Energy Performance of Building Directive a mix of grants, preferential loans and obligations could bring optimal results, as renovations could hardly be intensified with single policy measure. Grants should be a priority for the buildings in the poorest conditions more often occupied by vulnerable consumers. This could not only produce climate benefits but also lower future government expenditures on reducing energy poverty (Keliauskaite et al., 2024).

As for further research on energy poverty, it would be useful to check the sensitivity of the results in terms of the definitions of energy poverty, and despite its limitations, examine the expenditure-based measure on energy poverty. Furthermore, for a new insight into drivers of energy poverty, an in-depth analysis of the role of energy prices in explaining the incidence and changes of energy poverty across Europe would be valuable. In terms of data availability, EU-SILC ad hoc modules carried out in 2023 on the ability to keep dwellings comfortably cool during summer and the household's capacity to afford sufficient level of energy consumption, or the one carried out in 2024 on energy efficiency provide additional tools for analyzing the multifaceted nature of energy poverty.

[12] https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficiency-targets-directive-and-rules/energy-efficiency-directive_en
[13] https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en

References

Alem, Y., & Demeke, E. (2020). The persistence of energy poverty: A dynamic probit analysis. *Energy Economics*, *90*, 104789.

Anastasiou, A., & Zaroutieri, E. (2023). Energy poverty and the convergence hypothesis across EU member states. *Energy Efficiency*, *16*(5), 38.

Aristondo, O. and Onaindia, E. (2018). Counting energy poverty in Spain between 2004 and 2015, *Energy Policy*, *113*(2018) Pages 420-429.
https://doi.org/10.1016/j.enpol.2017.11.027.

Bacon, R., & Kojima, M. (2016). Energy, economic growth, and poverty reduction. *World Bank Working Paper*, *104866*.

Boardman, B. (1991). Fuel poverty is different. *Policy Studies*, *12*(4), 30-41.

Boardman, B. (2013). *Fixing fuel poverty: challenges and solutions*. Routledge.

Bollino, C. A., & Botti, F. (2017). Energy poverty in Europe: A multidimensional approach. *PSL Quarterly Review*, *70*(283), 473-507.

Bouzarovski, S. (2014). Energy poverty in the European Union: landscapes of vulnerability. *Wiley Interdisciplinary Reviews: Energy and Environment*, *3*(3), 276-289.

Bouzarovski, S. and Herrero, S.T. (2017). The energy divide: Integrating energy transitions, regional inequalities and poverty trends in the European Union. *European Urban and Regional Studies* 2017, *24*(1) 69–86.
https://doi.org/10.1177/0969776415596449.

Brown, M. A., Soni, A., Lapsa, M. V., & Southworth, K. (2020). Low-income energy affordability: Conclusions from a literature review. Oak Ridge National Laboratory.

Drescher, K., & Janzen, B. (2021). Determinants, persistence, and dynamics of energy poverty: An empirical assessment using German household survey data. *Energy Economics*, *102*, 105433.

Fabrizi, E., & Mussida, C. (2020). Assessing poverty persistence in households with children. The Journal of Economic Inequality, 1*8*(4), 551-569.

Giarda, E., & Moroni, G. (2018). The degree of poverty persistence and the role of regional disparities in Italy in comparison with France, Spain and the UK. *Social Indicators Research*, *136*(1), 163-202.

Healy, J. D., & Clinch, J. P. (2004). Quantifying the severity of fuel poverty, its relationship with poor housing and reasons for non-investment in energy-saving measures in Ireland. *Energy policy*, *32*(2), 207-220.

Hills, J. (2012). Getting the measure of fuel poverty: Final Report of the Fuel Poverty Review.

Hoff, J. (2017). The green 'heavyweights': The climate policies of the Nordic countries. In *The Routledge Handbook of Scandinavian Politics* (pp. 49-65). Routledge.

Jenkins, K. (2018). Energy poverty and vulnerability: A global perspective. *Energy*, *147*, 388-389.

Karpinska, L., & Śmiech, S. (2021). Escaping Energy Poverty: A Comparative Analysis of 17 European Countries. *Energies*, *14*(18), 5761.

Keliauskaitė, U., McWilliams, B., Sgaravatti, G. & Tagliapietra, S. (2024). How to finance the European Union's building decarbonisation plan, Policy Brief 12/2024, Bruegel

Koukoufikis, G., Schockaert, H., Paci, D., Filippidou, F., Caramizaru, A., Della Valle, N., Candelise, C., Murauskaite-Bull, I. & Uihlein, A. (2023). *Energy Communities and Energy Poverty*, Publications Office of the European Union, Luxembourg

Martín, R. M., Molina, T. T. R., & López, A. M. (2020). Unemployment as a social problem in southern countries in the European Union: analysis of Spain, Greece, Italy and Portugal. In *Social Problems in Southern Europe* (pp. 104-117). Edward Elgar Publishing.

Meyer, S., Holzemer, L., Delbeke, B., Middlemiss, L. and Maréchal, K.(2018). Capturing the multifaceted nature of energy poverty: Lessons from Belgium*, Energy Research & Social Science*, 40, 273-283.

Nussbaumer, P., Bazilian, M., & Modi, V. (2012). Measuring energy poverty: Focusing on what matters. *Renewable and Sustainable Energy Reviews*, *16*(1), 231-243.

Phimister, E., Vera-Toscano, E. and Roberts, D. (2015). The Dynamics of Energy Poverty: Evidence from Spain*. Economics of Energy and Environmental Policy, 4*(1), 153-166.

Roberts, D., Vera-Toscano, E. & Phimister, E. (2015). "Energy poverty in the UK: Is there a difference between rural and urban areas?," 89th Annual Conference, April 13-15, 2015, Warwick University, Coventry, UK 204213, Agricultural Economics Society.

Social Platform (2004). *Position paper. Rebalancing the European Green Deal: Towards a Green and Social Deal*.
Available at: https://www.socialplatform.org/documents/position-paper-rebalancing-the-european-green-deal-towards-a-green-and-social-deal/

Thomson, H., & Bouzarovski, S. (2018). Addressing energy poverty in the European Union: State of play and action. *EU Energy Poverty Observatory, Manchester*.

Thomson, H., & Snell, C. (2013). Quantifying the prevalence of fuel poverty across the European Union. *Energy policy*, *52*, 563-572.

Appendix

Table A1. Correlation between different components of the EPI among Europe, 2020

Country	Inability and Arrears	Inability and HousingFaults	Arrears and HousingFaults
Austria	0.153	0.089	0.063
Belgium	0.176	0.120	0.062
Bulgaria	0.199	0.162	0.170
Croatia	0.208	0.184	0.144
Czech Republic	0.101	0.125	0.035
Denmark	0.212	0.108	0.086
Estonia	0.223	0.143	0.121
Finland	0.071	0.073	0.118
France	0.151	0.158	0.085
Germany	0.036	0.031	0.033
Greece	0.252	0.165	0.136
Hungary	0.211	0.216	0.276
Ireland	0.272	0.199	0.144
Italy	0.155	0.095	0.087
Latvia	0.192	0.098	0.126
Lithuania	0.077	0.079	0.142
Luxembourg	0.082	0.002	0.073
Malta	0.089	0.097	0.049

Netherlands	0.114	0.082	0.072
Norway	0.109	0.055	0.065
Poland	0.162	0.219	0.126
Portugal	0.111	0.167	0.097
Romania	0.284	0.231	0.137
Serbia	0.199	0.308	0.192
Slovakia	0.150	0.206	0.114
Slovenia	0.145	0.177	0.141
Spain	0.223	0.143	0.121
Sweden	0.104	0.077	0.042
Switzerland	0.021	0.010	0.058

Source: Authors' calculations based on EU-SILC data.

Table A2. Summary statistics, estimation of factors affecting probability and intensity of energy poverty

	AT		BE		BG		CH		CZ		DE		DK		EE		EL	
	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd
Energy poverty	0.035	0.112	0.073	0.165	0.243	0.301	0.028	0.086	0.036	0.120	0.047	0.132	0.047	0.127	0.061	0.141	0.195	0.280
Household size	1.419	0.707	1.352	0.731	1.285	0.583	1.688	0.540	1.543	0.698	1.462	0.657	1.606	0.544	2.007	0.431	1.876	0.494
Number of children 0-6 yrs	0.327	0.109	0.335	0.103	0.161	0.542	0.367	0.748	0.349	0.114	0.228	0.564	0.266	0.606	0.508	0.827	0.283	0.624
Number of children 7-14 yrs	0.413	0.126	0.475	0.131	0.274	0.719	0.540	0.939	0.469	0.135	0.319	0.682	0.469	0.853	0.732	1.000	0.512	0.872
Share of indv. Age 15-25 in hhs	0.083	0.200	0.096	0.200	0.067	0.139	0.109	0.154	0.070	0.168	0.084	0.148	0.104	0.160	0.136	0.142	0.090	0.125
Share of indv. Age 25-45 in hhs	0.276	0.406	0.296	0.412	0.198	0.270	0.290	0.275	0.249	0.376	0.223	0.276	0.218	0.255	0.269	0.215	0.224	0.210
Share of indv. Age 45-65 in hhs	0.360	0.414	0.329	0.393	0.329	0.333	0.345	0.255	0.297	0.380	0.378	0.298	0.340	0.272	0.329	0.212	0.326	0.217
Share of indv. Age 65+ in hhs	0.280	0.423	0.279	0.425	0.407	0.396	0.257	0.275	0.384	0.454	0.314	0.315	0.338	0.304	0.266	0.229	0.361	0.263
Share of females in hhs	0.539	0.327	0.518	0.320	0.549	0.264	0.524	0.175	0.554	0.307	0.526	0.210	0.513	0.177	0.533	0.138	0.524	0.151

Share of males in hhs	0.461	0.327	0.482	0.320	0.451	0.264	0.476	0.175	0.446	0.307	0.474	0.210	0.487	0.177	0.467	0.138	0.476	0.151
Share of prim. Educ. Indv. In hhs	0.005	0.053	0.109	0.275	0.059	0.188	0.010	0.050	0.002	0.027	0.026	0.101	0.088	0.164	0.023	0.063	0.351	0.258
Share of sec. Educ. Indv. In hhs	0.576	0.421	0.171	0.310	0.665	0.353	0.128	0.174	0.127	0.276	0.652	0.288	0.134	0.175	0.537	0.232	0.356	0.231
Share of tert. Educ. Indv. In hhs	0.324	0.399	0.387	0.427	0.214	0.322	0.387	0.267	0.179	0.335	0.322	0.283	0.367	0.272	0.343	0.222	0.204	0.208
Share of employed in hhs	0.506	0.430	0.458	0.431	0.415	0.360	0.520	0.271	0.460	0.424	0.497	0.316	0.507	0.291	0.545	0.222	0.352	0.232
Share of unemployed in hhs	0.043	0.154	0.047	0.169	0.065	0.164	0.017	0.068	0.018	0.095	0.032	0.111	0.029	0.091	0.033	0.076	0.092	0.132
Share of inactive in hhs	0.451	0.434	0.495	0.431	0.520	0.372	0.463	0.271	0.522	0.428	0.471	0.316	0.464	0.293	0.422	0.221	0.557	0.248
Household income	10.460	0.777	10.410	0.656	8.574	0.851	11.090	0.675	9.460	0.617	10.340	0.701	10.700	0.614	9.580	0.798	9.350	0.685
Household transfers	0.697	0.229	0.467	1.868	0.669	2.012	0.665	2.369	2.884	0.283	0.391	1.763	0.344	1.610	2.781	1.413	0.717	2.264
Share of indv bad health in hhs	0.364	0.375	0.283	0.360	0.239	0.312	0.279	0.235	0.277	0.359	0.200	0.242	0.209	0.220	0.358	0.227	0.309	0.241
High urbanisation	0.323	0.468	0.352	0.478	0.385	0.487	0.303	0.460	0.303	0.460	0.000	0.000	0.308	0.462	0.545	0.498	0.282	0.450

Detached house	0.424	0.494	0.310	0.463	0.464	0.499	0.226	0.418	0.384	0.486	0.097	0.296	0.540	0.498	0.397	0.489	0.407	0.491
Semidetachouse	0.073	0.260	0.381	0.486	0.117	0.322	0.117	0.321	0.100	0.301	0.044	0.206	0.148	0.355	0.041	0.197	0.104	0.305
Flat	0.498	0.500	0.298	0.457	0.415	0.493	0.615	0.487	0.509	0.500	0.219	0.413	0.307	0.461	0.557	0.497	0.489	0.500
Dark house	0.054	0.227	0.070	0.256	0.042	0.201	0.062	0.241	0.028	0.166	0.032	0.177	0.036	0.186	0.041	0.198	0.057	0.232
Owner	0.315	0.465	0.351	0.477	0.858	0.349	0.051	0.220	0.639	0.480	0.273	0.445	0.184	0.387	0.664	0.472	0.702	0.457
Morgage	0.199	0.399	0.329	0.470	0.013	0.111	0.406	0.491	0.135	0.342	0.212	0.408	0.445	0.497	0.146	0.353	0.100	0.300
Rent	0.394	0.489	0.305	0.460	0.026	0.158	0.530	0.499	0.162	0.368	0.486	0.500	0.370	0.483	0.069	0.254	0.126	0.332
Free	0.092	0.289	0.016	0.124	0.104	0.305	0.013	0.113	0.064	0.245	0.030	0.170	0.001	0.028	0.121	0.326	0.071	0.257
Number of rooms	3.497	1.358	4.480	1.358	3.038	1.170	4.109	1.301	3.493	1.254	3.593	1.417	4.001	1.374	3.842	1.255	3.157	0.933
Housing costs	6.092	0.618	6.142	0.528	4.653	0.535	7.040	0.573	5.355	0.480	6.305	0.609	6.771	0.315	4.931	0.596	5.815	0.467
N	24,158		25,874		29,236		30,299		34,660		22,788		23,890		24,926		80,048	

	ES		FI		FR		HR		HU		IE		IT		LT		LU	
	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd
Energy poverty	0.093	0.196	0.029	0.101	0.072	0.173	0.116	0.220	0.113	0.215	0.068	0.171	0.099	0.200	0.189	0.260	0.056	0.130
Household size	1.443	0.736	1.964	0.445	1.495	0.708	1.875	0.516	1.897	0.473	1.656	0.625	1.728	0.492	1.856	0.462	1.695	0.592
Number of children 0-6 yrs	0.298	0.969	0.478	0.838	0.347	0.110	0.278	0.631	0.336	0.710	0.482	0.859	0.251	0.566	0.311	0.629	0.469	0.811
Number of children 7-14 yrs	0.467	0.124	0.799	0.117	0.590	0.152	0.526	0.903	0.546	0.918	0.763	1.111	0.417	0.758	0.462	0.792	0.596	0.938
Share of indv. Age 15-25 in hhs	0.087	0.175	0.149	0.158	0.105	0.213	0.108	0.134	0.101	0.130	0.118	0.164	0.084	0.124	0.096	0.124	0.147	0.172
Share of indv. Age 25-45 in hhs	0.272	0.377	0.262	0.237	0.254	0.392	0.206	0.194	0.218	0.200	0.277	0.281	0.240	0.226	0.203	0.198	0.329	0.295
Share of indv. Age 45-65 in hhs	0.348	0.369	0.366	0.233	0.335	0.396	0.360	0.218	0.348	0.220	0.323	0.269	0.335	0.229	0.391	0.237	0.357	0.258
Share of indv. Age 65+ in hhs	0.293	0.412	0.223	0.230	0.307	0.437	0.326	0.262	0.333	0.252	0.282	0.305	0.341	0.273	0.310	0.248	0.167	0.247
Share of females in hhs	0.530	0.284	0.495	0.132	0.535	0.309	0.527	0.155	0.562	0.155	0.515	0.197	0.529	0.175	0.566	0.154	0.506	0.173
Share of males in hhs	0.470	0.284	0.505	0.132	0.465	0.309	0.473	0.155	0.438	0.155	0.485	0.197	0.471	0.175	0.434	0.154	0.494	0.173
Share of prim. Educ. Indv. In hhs	0.254	0.381	0.000	0.000	0.145	0.310	0.064	0.128	0.032	0.084	0.156	0.226	0.182	0.214	0.061	0.112	0.140	0.207
Share of sec. Educ. Indv. In hhs	0.390	0.388	0.489	0.243	0.146	0.275	0.664	0.223	0.713	0.220	0.409	0.282	0.665	0.251	0.565	0.246	0.401	0.278

Share of tert. Educ. Indv. In hss	0.302	0.383	0.401	0.235	0.304	0.400	0.160	0.189	0.168	0.192	0.417	0.295	0.153	0.191	0.301	0.234	0.342	0.287
Share of employed in hhs	0.447	0.396	0.542	0.240	0.461	0.423	0.356	0.232	0.423	0.238	0.484	0.294	0.449	0.254	0.494	0.243	0.540	0.282
Share of unemployed in hhs	0.102	0.212	0.052	0.102	0.055	0.169	0.096	0.137	0.031	0.079	0.049	0.120	0.053	0.107	0.057	0.107	0.036	0.100
Share of inactive in hhs	0.452	0.405	0.407	0.237	0.484	0.432	0.548	0.247	0.546	0.240	0.467	0.293	0.498	0.257	0.450	0.242	0.424	0.284
Household income	10.050	0.809	10.620	0.666	10.041	0.616	9.100	0.820	8.919	0.679	10.520	0.729	10.100	0.843	9.190	0.849	11.020	0.714
Household transfers	0.298	1.504	0.492	1.759	0.515	1.958	0.410	1.660	0.828	2.042	0.196	1.251	0.254	1.423	0.208	1.197	0.234	1.377
Share of indv. Bad health in hhs	0.227	0.314	0.177	0.166	0.277	0.346	0.409	0.259	0.335	0.236	0.210	0.239	0.254	0.239	0.352	0.245	0.262	0.251
High urbanization	0.499	0.500	0.355	0.478	0.379	0.485	0.226	0.418	0.281	0.450	0.321	0.467	0.325	0.468	0.406	0.491	0.154	0.361
Detached house	0.142	0.349	0.512	0.500	0.451	0.498	0.712	0.453	0.665	0.472	0.446	0.497	0.230	0.421	0.375	0.484	0.372	0.483
Semidetachouse	0.201	0.400	0.174	0.379	0.208	0.406	0.087	0.282	0.052	0.221	0.475	0.499	0.231	0.421	0.055	0.228	0.269	0.443
Flat	0.655	0.475	0.310	0.463	0.324	0.468	0.200	0.400	0.277	0.447	0.076	0.265	0.537	0.499	0.563	0.496	0.346	0.476
Dark house	0.065	0.246	0.035	0.185	0.078	0.269	0.057	0.233	0.079	0.270	0.054	0.227	0.038	0.190	0.060	0.238	0.072	0.258
Owner	0.543	0.498	0.379	0.485	0.424	0.494	0.876	0.330	0.800	0.400	0.514	0.500	0.656	0.475	0.854	0.353	0.350	0.477
Morgage	0.246	0.431	0.386	0.487	0.236	0.425	0.042	0.200	0.102	0.303	0.245	0.430	0.095	0.293	0.063	0.244	0.379	0.485
Rent	0.154	0.361	0.225	0.418	0.318	0.466	0.025	0.155	0.064	0.244	0.225	0.417	0.177	0.382	0.024	0.154	0.257	0.437
Free	0.056	0.231	0.010	0.102	0.022	0.148	0.057	0.233	0.034	0.181	0.016	0.126	0.072	0.259	0.058	0.234	0.015	0.121

Number of rooms	4.716	1.053	4.275	1.481	4.091	1.324	3.103	1.199	3.372	1.120	5.189	1.033	3.124	1.103	3.518	1.247	4.588	1.445
Housing costs	5.519	0.572	6.053	0.577	5.924	0.625	4.856	0.509	4.599	0.561	5.982	0.568	5.471	0.697	4.584	0.669	6.305	0.797
N	58,038		39,162		44,580		38,124		29,107		17,837		78,471		21,574		14,430	

	LV		MT		NL		NO		PL		PT		RO		RS		SE	
	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd
Energypoverty	0.128	0.223	0.071	0.174	0.046	0.123	0.021	0.084	0.067	0.175	0.184	0.259	0.095	0.210	0.144	0.246	0.029	0.101
Household size	1.770	0.528	2.132	0.372	1.561	0.586	1.681	0.558	1.991	0.528	1.794	0.545	2.114	0.339	2.318	0.431	1.655	0.573
Number of children 0-6 yrs	0.402	0.736	0.498	0.852	0.258	0.631	0.399	0.763	0.507	0.831	0.250	0.550	0.164	0.462	0.581	0.922	0.433	0.786
Number of children 7-14 yrs	0.522	0.835	0.317	0.609	0.471	0.892	0.618	0.980	0.690	0.977	0.501	0.786	0.479	0.809	0.832	1.127	0.658	1.017
Share of indv. Age 15-25 in hhs	0.091	0.128	0.084	0.106	0.125	0.170	0.163	0.185	0.112	0.133	0.114	0.138	0.095	0.109	0.126	0.117	0.143	0.180
Share of indv. Age 25-45 in hhs	0.243	0.225	0.197	0.170	0.220	0.268	0.288	0.280	0.269	0.219	0.237	0.231	0.244	0.176	0.274	0.159	0.278	0.289
Share of indv. Age 45-65 in hhs	0.345	0.242	0.228	0.165	0.359	0.276	0.344	0.266	0.337	0.222	0.349	0.236	0.344	0.190	0.335	0.161	0.308	0.265
Share of indv. Age 65+ in hhs	0.321	0.261	0.491	0.234	0.296	0.307	0.205	0.263	0.281	0.242	0.300	0.273	0.317	0.216	0.266	0.188	0.271	0.298
Share of females in hhs	0.575	0.174	0.507	0.126	0.522	0.192	0.498	0.169	0.535	0.145	0.538	0.161	0.522	0.121	0.511	0.119	0.500	0.171
Share of males in hhs	0.425	0.174	0.493	0.126	0.478	0.192	0.502	0.169	0.465	0.145	0.462	0.161	0.478	0.121	0.489	0.119	0.500	0.171
Share of prim. Education indv. In hhs	0.024	0.078	0.241	0.197	0.071	0.148	0.020	0.076	0.133	0.168	0.464	0.283	0.084	0.122	0.104	0.131	0.067	0.148
Share of sec. Education indv. In hhs	0.598	0.256	0.493	0.204	0.492	0.289	0.486	0.284	0.030	0.067	0.299	0.234	0.692	0.193	0.732	0.183	0.461	0.281

Share of tert. Education indv. In hhs	0.299	0.241	0.160	0.163	0.359	0.283	0.410	0.278	0.302	0.229	0.162	0.210	0.124	0.156	0.163	0.160	0.374	0.278
Share of employed in hhs	0.474	0.252	0.461	0.209	0.511	0.298	0.595	0.280	0.395	0.232	0.468	0.265	0.449	0.210	0.346	0.182	0.564	0.297
Share of unemployed in hhs	0.054	0.111	0.012	0.042	0.019	0.076	0.021	0.076	0.036	0.082	0.078	0.130	0.010	0.038	0.207	0.162	0.031	0.094
Share of inactive in hhs	0.472	0.251	0.527	0.210	0.469	0.299	0.384	0.278	0.569	0.237	0.454	0.267	0.541	0.210	0.447	0.190	0.404	0.295
Household income	9.100	0.891	10.010	0.714	10.460	0.662	11.000	0.751	9.220	0.704	9.580	0.728	8.500	0.812	8.480	0.864	10.590	0.677
Household transfers	0.810	2.251	0.207	1.271	0.586	2.059	0.356	1.600	0.361	1.575	0.337	1.579	0.082	0.710	0.526	1.772	0.332	1.540
Share of indv. With bad health in hhs	0.452	0.272	0.160	0.163	0.211	0.234	0.094	0.161	0.250	0.215	0.373	0.259	0.326	0.212	0.162	0.151	0.072	0.147
Healthshare	0.519	0.270	0.840	0.164	0.373	0.231	0.452	0.200	0.631	0.235	0.625	0.259	0.674	0.212	0.838	0.151	0.485	0.194
High urbanisation	0.614	0.487	0.886	0.318	0.000	0.000	0.303	0.459	0.334	0.472	0.338	0.473	0.306	0.461	0.299	0.458	0.400	0.490
Detached house	0.286	0.452	0.050	0.218	0.167	0.373	0.560	0.496	0.442	0.497	0.403	0.491	0.614	0.487	0.684	0.465	0.465	0.499
Semidetachouse	0.026	0.159	0.440	0.496	0.538	0.499	0.191	0.393	0.056	0.230	0.234	0.423	0.012	0.107	0.087	0.282	0.088	0.284
Flat	0.687	0.464	0.508	0.500	0.243	0.429	0.228	0.420	0.500	0.500	0.362	0.481	0.375	0.484	0.227	0.419	0.439	0.496
Dark house	0.077	0.267	0.088	0.284	0.035	0.184	0.030	0.171	0.032	0.177	0.111	0.314	0.043	0.204	0.072	0.259	0.058	0.235
Owner	0.724	0.447	0.656	0.475	0.121	0.326	0.235	0.424	0.737	0.440	0.486	0.500	0.964	0.185	0.850	0.357	0.156	0.363
Morgage	0.070	0.255	0.138	0.345	0.551	0.497	0.577	0.494	0.087	0.282	0.275	0.447	0.005	0.073	0.005	0.068	0.524	0.499

Rent	0.120	0.325	0.164	0.370	0.322	0.467	0.159	0.366	0.052	0.221	0.147	0.354	0.016	0.126	0.029	0.167	0.298	0.457
Free	0.085	0.279	0.043	0.202	0.007	0.083	0.013	0.113	0.124	0.329	0.091	0.288	0.014	0.118	0.116	0.320	0.007	0.083
Number of rooms	2.720	1.192	5.229	0.888	4.264	1.264	4.265	1.477	3.064	1.331	4.190	1.101	2.824	1.024	2.876	1.206	3.857	1.507
Housing costs	4.744	0.608	4.479	0.928	6.386	0.463	6.631	0.660	5.016	0.455	5.031	0.606	4.264	0.593	4.774	0.580	6.361	0.341
N	23,221		15,336		52,796		24,364		63,426		50,745		29,282		20,561		23,161	

	SI		SK	
	Mean	Sd	Mean	Sd
EnergyPoverty	0.097	0.177	0.059	0.164
household size	2.090	0.463	2.152	0.416
number of children 0-6 yrs	0.486	0.826	0.461	0.791
number of children 7-14 yrs	0.693	0.992	0.620	0.930
share of indv. age 15-25 in hhs	0.140	0.139	0.120	0.123
share of indv. age 25-45 in hhs	0.281	0.205	0.281	0.184
share of indv. age 45-65 in hhs	0.344	0.194	0.336	0.189
share of indv. age 65+ in hhs	0.235	0.221	0.262	0.211
share of females in hhs	0.512	0.128	0.540	0.129
share of males in hhs	0.488	0.128	0.460	0.129
share of primary education indv. in hhs	0.000	0.000	0.007	0.035
share of secondary education indv. in hhs	0.614	0.222	0.673	0.201
share of tertiary education indv. in hhs	0.255	0.208	0.192	0.178
share of employed in hhs	0.491	0.221	0.489	0.213
share of unemployed in hhs	0.063	0.103	0.043	0.088
share of inactive in hhs	0.446	0.223	0.468	0.212
household income	10.060	0.628	9.400	0.611
household transfers	0.309	1.489	0.404	1.636
share of indv. with bad health in hhs	0.149	0.149	0.377	0.213
high urbanization	0.000	0.000	0.263	0.440
detached house	0.680	0.466	0.425	0.494
semidetachouse	0.053	0.225	0.017	0.131
flat	0.264	0.441	0.556	0.497
dark house	0.046	0.210	0.029	0.169
owner	0.708	0.455	0.789	0.408
morgage	0.090	0.287	0.119	0.324
rent	0.082	0.274	0.079	0.270
free	0.119	0.324	0.013	0.112
number of rooms	4.051	1.221	3.262	1.225
housing costs	5.463	0.544	5.164	0.605
N	34,559		22,397	

Source: Authors' calculations based on EU-SILC data.

Table A3. Summary statistics, estimation of energy poverty persistence

	AT		BE		BG		CH		CZ		EE		EL		ES		FI	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Energy Poor_t	0.034	0.319	0.081	0.408	0.204	0.491	0.030	0.030	0.031	0.289	0.034	0.301	0.062	0.398	0.138	0.487	0.082	0.428
Energy Poor_t-1	0.032	0.323	0.082	0.411	0.210	0.489	0.031	0.030	0.030	0.292	0.032	0.312	0.062	0.411	0.113	0.486	0.082	0.419
Energypoor_0	0.032	0.338	0.088	0.421	0.204	0.484	0.031	0.032	0.031	0.294	0.031	0.328	0.062	0.416	0.122	0.487	0.082	0.426
Household size	1.577	0.523	1.687	0.558	1.709	0.567	1.690	0.542	1.768	0.529	1.658	0.531	1.747	0.554	1.680	0.526	1.823	0.528
Number of children 0-6 yrs	0.128	0.421	0.160	0.476	0.094	0.355	0.138	0.450	0.144	0.455	0.138	0.429	0.155	0.452	0.088	0.346	0.145	0.438
Number of children 7-14 yrs	0.156	0.484	0.219	0.574	0.154	0.458	0.208	0.574	0.247	0.631	0.180	0.498	0.221	0.546	0.154	0.474	0.226	0.547
Share of indv. Age 15-25 in hhs	0.080	0.207	0.094	0.204	0.060	0.148	0.082	0.192	0.130	0.250	0.070	0.179	0.113	0.226	0.074	0.193	0.089	0.181
Share of indv. Age 25-45 in hhs	0.273	0.413	0.298	0.418	0.192	0.307	0.294	0.419	0.268	0.410	0.254	0.386	0.264	0.385	0.200	0.343	0.271	0.379
Share of indv. Age 45-65 in hhs	0.365	0.428	0.327	0.400	0.323	0.377	0.332	0.399	0.357	0.405	0.288	0.388	0.314	0.389	0.302	0.372	0.344	0.375
Share of indv. Age 65+ in hhs	0.282	0.430	0.280	0.429	0.425	0.449	0.291	0.435	0.245	0.407	0.388	0.461	0.309	0.429	0.424	0.454	0.295	0.417

Share of females in hhs	0.540	0.335	0.516	0.322	0.555	0.305	0.533	0.309	0.500	0.275	0.553	0.311	0.552	0.291	0.542	0.303	0.529	0.285
Share of males in hhs	0.460	0.335	0.484	0.322	0.445	0.305	0.467	0.309	0.500	0.275	0.447	0.311	0.448	0.291	0.458	0.303	0.471	0.285
Share of prim. Education indv. In hhs	0.005	0.059	0.102	0.267	0.050	0.193	0.009	0.076	0	0	0.001	0.027	0.021	0.116	0.386	0.442	0.247	0.377
Share of sec. Education indv. In hhs	0.538	0.431	0.155	0.298	0.619	0.399	0.109	0.252	0.439	0.409	0.114	0.262	0.473	0.403	0.295	0.361	0.338	0.362
Share of tert. Education indv. In hhs	0.378	0.410	0.450	0.419	0.281	0.367	0.446	0.407	0.466	0.402	0.266	0.361	0.427	0.392	0.249	0.353	0.367	0.379
Share of unemployed in hhs	0.040	0.169	0.039	0.162	0.053	0.167	0.016	0.102	0.049	0.179	0.014	0.093	0.028	0.125	0.067	0.187	0.089	0.209
Share of inactive in hhs	0.523	0.421	0.588	0.390	0.592	0.386	0.549	0.395	0.514	0.387	0.604	0.395	0.526	0.381	0.663	0.370	0.557	0.361
Share of employed in hhs	0.437	0.418	0.373	0.386	0.356	0.374	0.435	0.393	0.437	0.382	0.382	0.392	0.447	0.380	0.269	0.342	0.354	0.347
Share of indv. With bad health in hhs	0.345	0.415	0.264	0.381	0.235	0.369	0.269	0.369	0.188	0.316	0.264	0.389	0.354	0.406	0.325	0.417	0.218	0.341
High urbanization	0.332	0.471	0.351	0.477	0.399	0.490	0.306	0.461	0.354	0.478	0.295	0.456	0.561	0.496	0.260	0.439	0.480	0.500
Detached house	0.407	0.491	0.311	0.463	0.457	0.498	0.228	0.419	0.514	0.500	0.384	0.486	0.396	0.489	0.394	0.489	0.151	0.358
Semidetachouse	0.076	0.265	0.380	0.485	0.113	0.317	0.122	0.327	0.170	0.376	0.097	0.297	0.040	0.196	0.108	0.310	0.210	0.407
Flat	0.510	0.500	0.298	0.458	0.426	0.495	0.607	0.488	0.312	0.463	0.496	0.500	0.558	0.497	0.497	0.500	0.638	0.480
Owner	0.310	0.463	0.351	0.477	0.858	0.349	0.050	0.218	0.377	0.485	0.627	0.484	0.654	0.476	0.719	0.449	0.545	0.498

Morgage	0.191	0.393	0.328	0.470	0.013	0.113	0.412	0.492	0.389	0.488	0.136	0.343	0.154	0.361	0.083	0.275	0.247	0.431
Rent	0.409	0.492	0.305	0.460	0.027	0.161	0.525	0.499	0.224	0.417	0.160	0.366	0.069	0.254	0.126	0.332	0.151	0.358
Number of rooms	3.442	1.348	4.461	1.365	3.036	1.167	4.125	1.297	4.276	1.483	3.512	1.256	3.808	1.260	3.169	0.942	4.743	1.038
Household size_0	1.566	0.522	1.681	0.555	1.726	0.564	1.681	0.541	1.763	0.531	1.655	0.527	1.742	0.552	1.677	0.524	1.807	0.527
Share of unemployed in hhs_0	0.040	0.168	0.047	0.178	0.061	0.179	0.017	0.105	0.056	0.189	0.017	0.101	0.028	0.127	0.074	0.196	0.092	0.213
Share of inactive in hhs_0	0.509	0.423	0.566	0.394	0.581	0.386	0.524	0.398	0.496	0.387	0.585	0.400	0.510	0.381	0.652	0.374	0.541	0.365
Share of indv. With bad health in hhs_0	0.339	0.414	0.251	0.374	0.239	0.368	0.263	0.367	0.182	0.313	0.264	0.389	0.354	0.408	0.290	0.403	0.212	0.341
Household income_0	10.405	0.819	10.365	0.666	8.534	0.897	11.096	0.667	10.622	0.672	9.421	0.612	9.525	0.785	9.303	0.696	10.006	0.821
Household transfers_0	0.683	2.267	0.509	1.943	0.674	2.016	0.729	2.468	0.487	1.754	0.827	2.829	0.331	1.526	0.667	2.187	0.283	1.465
Household income_m	10.457	0.825	10.428	0.710	8.603	0.810	11.070	0.732	10.636	0.675	9.265	1.524	9.635	0.848	9.326	0.834	10.032	0.952
Household transfers_m	0.679	2.082	0.448	1.677	0.646	1.696	0.613	0.881	0.456	1.523	0.958	2.632	0.265	1.228	0.679	2.022	0.287	1.357
N	8,320		15,038		14,609		9,634		12,676		8,893		27,613		15,891		13,565	

	FR		HR		HU		IE		IT		LT		LU		LV		MT	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Energy Poor_t	0.062	0.402	0.127	0.447	0.127	0.447	0.080	0.384	0.124	0.427	0.207	0.482	0.052	0.390	0.131	0.464	0.069	0.375
Energy Poor_t-1	0.064	0.394	0.129	0.454	0.129	0.454	0.079	0.384	0.112	0.432	0.218	0.485	0.052	0.395	0.133	0.469	0.076	0.381
Energy poor_0	0.061	0.401	0.130	0.459	0.130	0.459	0.088	0.390	0.126	0.438	0.204	0.487	0.052	0.404	0.133	0.469	0.079	0.395
Household size	1.683	0.549	1.771	0.564	1.771	0.564	1.772	0.585	1.615	0.539	1.699	0.516	1.912	0.522	1.623	0.557	1.813	0.519
Number of children 0-6 yrs	0.147	0.447	0.095	0.365	0.095	0.365	0.196	0.530	0.084	0.327	0.104	0.359	0.208	0.529	0.136	0.426	0.162	0.474
Number of children 7-14 yrs	0.242	0.595	0.179	0.512	0.179	0.512	0.323	0.701	0.137	0.429	0.146	0.439	0.271	0.609	0.164	0.455	0.159	0.450
Share of indv. Age 15-25 in hhs	0.111	0.232	0.080	0.170	0.080	0.170	0.090	0.191	0.063	0.162	0.079	0.178	0.127	0.214	0.069	0.175	0.106	0.199
Share of indv. Age 25-45 in hhs	0.266	0.405	0.187	0.307	0.187	0.307	0.270	0.394	0.243	0.378	0.205	0.341	0.340	0.416	0.219	0.355	0.253	0.365
Share of indv. Age 45-65 in hhs	0.337	0.407	0.352	0.373	0.352	0.373	0.320	0.391	0.320	0.388	0.381	0.406	0.349	0.370	0.341	0.404	0.310	0.367
Share of indv. Age 65+ in hhss	0.286	0.433	0.381	0.436	0.381	0.436	0.320	0.445	0.374	0.450	0.334	0.430	0.183	0.362	0.371	0.445	0.332	0.435
Share of females in hhs	0.529	0.315	0.540	0.293	0.540	0.293	0.520	0.312	0.538	0.337	0.582	0.291	0.509	0.259	0.603	0.325	0.516	0.277

Share of males in hhs	0.471	0.315	0.460	0.293	0.460	0.293	0.480	0.312	0.462	0.337	0.418	0.291	0.491	0.259	0.397	0.325	0.484	0.277
Share of prim. Education indv. In hhs	0.128	0.298	0.069	0.226	0.069	0.226	0.155	0.327	0.194	0.360	0.059	0.201	0.117	0.261	0.027	0.142	0.275	0.401
Share of sec. Education indv. In hhs	0.131	0.272	0.632	0.374	0.632	0.374	0.317	0.371	0.591	0.405	0.528	0.416	0.352	0.366	0.565	0.419	0.501	0.388
Share of tert. Education indv. In hhs	0.385	0.407	0.223	0.324	0.223	0.324	0.492	0.416	0.215	0.329	0.360	0.400	0.442	0.392	0.351	0.395	0.224	0.316
Share of unemployed in hhs	0.050	0.174	0.076	0.193	0.076	0.193	0.039	0.151	0.040	0.148	0.052	0.174	0.030	0.122	0.046	0.168	0.009	0.074
Share of inactive in hhs	0.566	0.393	0.650	0.354	0.650	0.354	0.598	0.373	0.562	0.403	0.520	0.395	0.541	0.353	0.570	0.395	0.635	0.356
Share of employed in hhs	0.384	0.386	0.275	0.325	0.275	0.325	0.363	0.366	0.398	0.398	0.428	0.389	0.430	0.348	0.384	0.388	0.355	0.353
Share of indv. With bad health in hhs	0.254	0.373	0.433	0.424	0.433	0.424	0.205	0.343	0.261	0.396	0.342	0.411	0.235	0.332	0.462	0.439	0.180	0.326
High urbanization	0.377	0.485	0.221	0.415	0.221	0.415	0.312	0.463	0.329	0.470	0.407	0.491	0.151	0.359	0.601	0.490	0.885	0.319
Detached house	0.451	0.498	0.705	0.456	0.705	0.456	0.447	0.497	0.230	0.421	0.381	0.486	0.373	0.484	0.290	0.454	0.050	0.218
Semidetachouse	0.200	0.400	0.096	0.295	0.096	0.295	0.480	0.500	0.229	0.420	0.053	0.223	0.273	0.446	0.026	0.160	0.447	0.497
Flat	0.345	0.475	0.198	0.398	0.198	0.398	0.071	0.257	0.539	0.498	0.559	0.497	0.340	0.474	0.682	0.466	0.499	0.500
Owner	0.401	0.490	0.871	0.335	0.871	0.335	0.514	0.500	0.655	0.475	0.849	0.358	0.349	0.477	0.724	0.447	0.668	0.471

Morgage	0.236	0.425	0.045	0.206	0.045	0.206	0.245	0.430	0.088	0.284	0.068	0.252	0.385	0.487	0.073	0.260	0.124	0.330
Rent	0.342	0.474	0.025	0.156	0.025	0.156	0.228	0.420	0.186	0.389	0.025	0.157	0.253	0.435	0.118	0.323	0.166	0.372
Number of rooms	4.062	1.347	3.098	1.203	3.098	1.203	5.175	1.036	3.088	1.097	3.545	1.256	4.620	1.428	2.698	1.196	5.234	0.884
Household size_0	1.674	0.547	1.775	0.561	1.775	0.561	1.767	0.582	1.618	0.541	1.706	0.514	1.907	0.522	1.620	0.554	1.816	0.519
Share of unemployed in hhs_0	0.052	0.180	0.086	0.205	0.086	0.205	0.044	0.159	0.043	0.153	0.055	0.178	0.031	0.128	0.051	0.179	0.012	0.084
Share of inactive in hhs_0	0.552	0.395	0.634	0.357	0.634	0.357	0.581	0.379	0.554	0.401	0.511	0.393	0.524	0.355	0.553	0.398	0.633	0.354
Share of indv. With bad health in hhs_0	0.251	0.371	0.420	0.420	0.420	0.420	0.191	0.333	0.267	0.399	0.328	0.404	0.234	0.330	0.448	0.440	0.179	0.326
Household income_0	10.384	0.644	9.090	0.819	9.090	0.819	10.508	0.715	10.093	0.827	9.179	0.849	11.069	0.730	9.047	0.891	9.978	0.699
Household transfers_0	0.547	2.010	0.430	1.692	0.430	1.692	0.186	1.224	0.283	1.497	0.236	1.268	0.255	1.447	0.679	2.070	0.230	1.335
Household income_m	10.392	0.682	9.130	0.881	9.130	0.881	10.555	0.695	10.034	1.087	9.281	0.872	11.071	0.853	9.112	0.955	10.031	0.755
Household transfers_m	0.518	1.834	0.379	1.453	0.379	1.453	0.195	1.084	0.246	1.264	0.174	0.959	0.183	1.033	0.880	2.048	0.187	10.075
N	9,937		11,092		9,748		6,190		36,383		7,461		7,241		7,287		5,317	

	NL		N0		PL		PT		RS		SE		SI		SK	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Energy Poor_t	0.043	0.350	0.018	0.272	0.086	0.365	0.192	0.494	0.153	0.471	0.029	0.287	0.103	0.451	0.053	0.360
Energy Poor_t-1	0.045	0.352	0.018	0.273	0.082	0.377	0.192	0.494	0.153	0.477	0.029	0.284	0.103	0.453	0.060	0.366
Energy poor_0	0.048	0.355	0.018	0.275	0.089	0.392	0.192	0.497	0.153	0.478	0.029	0.290	0.103	0.460	0.060	0.366
Household size	1.640	0.544	1.742	0.538	1.815	0.552	1.782	0.503	1.973	0.611	1.761	0.544	1.973	0.510	1.805	0.558
Number of children 0-6 yrs	0.091	0.369	0.159	0.471	0.161	0.461	0.091	0.329	0.161	0.495	0.173	0.490	0.164	0.476	0.135	0.434
Number of children 7-14 yrs	0.176	0.531	0.242	0.597	0.218	0.535	0.176	0.455	0.236	0.591	0.271	0.638	0.235	0.570	0.174	0.485
Share of indv. Age 15-25 in hhs	0.094	0.209	0.148	0.271	0.092	0.196	0.093	0.180	0.094	0.175	0.123	0.243	0.114	0.196	0.089	0.179
Share of indv. Age 25-45 in hhs	0.203	0.376	0.298	0.422	0.256	0.366	0.226	0.350	0.244	0.302	0.290	0.421	0.283	0.360	0.253	0.348
Share of indv. Age 45-65 in hhs	0.332	0.402	0.334	0.399	0.327	0.382	0.344	0.378	0.332	0.330	0.293	0.381	0.333	0.341	0.339	0.376
Share of indv. Age 65+ in hhs	0.371	0.466	0.221	0.398	0.325	0.424	0.336	0.433	0.330	0.391	0.294	0.438	0.270	0.392	0.319	0.422
Share of females in hhs	0.529	0.318	0.494	0.292	0.557	0.274	0.552	0.277	0.520	0.269	0.503	0.286	0.523	0.240	0.572	0.280
Share of males in hhs	0.471	0.318	0.506	0.292	0.443	0.274	0.448	0.277	0.480	0.269	0.497	0.286	0.477	0.240	0.428	0.280
Share of prim. Education indv. In hhs	0.067	0.220	0.022	0.107	0.130	0.287	0.456	0.425	0.109	0.261	0.067	0.220	0	0	0.007	0.066
Share of sec. Education indv. In hhs	0.458	0.418	0.434	0.415	0.020	0.081	0.254	0.326	0.637	0.356	0.400	0.395	0.574	0.371	0.643	0.376
Share of tert. Education indv. In hhs	0.419	0.416	0.470	0.412	0.367	0.378	0.234	0.329	0.254	0.318	0.452	0.404	0.328	0.352	0.257	0.343

Share of unemployed in hhs	0.015	0.101	0.018	0.106	0.028	0.115	0.065	0.176	0.159	0.254	0.026	0.127	0.050	0.150	0.032	0.127
Share of inactive in hhs	0.583	0.404	0.492	0.385	0.662	0.349	0.549	0.373	0.572	0.337	0.529	0.389	0.561	0.334	0.565	0.379
Employedratio	0.403	0.401	0.490	0.385	0.310	0.340	0.386	0.362	0.269	0.294	0.444	0.387	0.388	0.325	0.403	0.375
Share of indv. With bad health in hhs	0.224	0.363	0.103	0.260	0.260	0.371	0.374	0.399	0.169	0.305	0.076	0.232	0.160	0.280	0.387	0.407
Healthshare	0.367	0.361	0.433	0.332	0.538	0.372	0.527	0.381	0.727	0.317	0.461	0.318	0.273	0.265	0.519	0.386
High urbanisation	0	0	0.306	0.461	0.342	0.474	0.343	0.475	0.302	0.459	0.392	0.488	0	0	0.264	0.441
Detached house	0.169	0.375	0.557	0.497	0.437	0.496	0.400	0.490	0.677	0.468	0.457	0.498	0.680	0.467	0.413	0.492
Semidetachouse	0.542	0.498	0.194	0.396	0.056	0.230	0.239	0.426	0.082	0.274	0.091	0.288	0.054	0.227	0.018	0.134
Flat	0.244	0.430	0.230	0.421	0.505	0.500	0.360	0.480	0.239	0.426	0.443	0.497	0.264	0.441	0.568	0.495
Owner	0.131	0.337	0.234	0.423	0.734	0.442	0.483	0.500	0.855	0.352	0.155	0.362	0.705	0.456	0.765	0.424
Morgage	0.561	0.496	0.574	0.494	0.090	0.286	0.270	0.444	0.004	0.062	0.524	0.499	0.090	0.287	0.135	0.342
Rent	0.303	0.459	0.165	0.371	0.053	0.224	0.151	0.358	0.030	0.172	0.299	0.458	0.081	0.272	0.087	0.281
Number of rooms	4.294	1.268	4.240	1.489	3.062	1.335	4.187	1.112	2.874	1.201	3.843	1.517	4.050	1.221	3.251	1.235
Household size_0	1.632	0.542	1.757	0.542	1.815	0.547	1.776	0.500	1.961	0.604	1.755	0.541	1.964	0.509	1.811	0.553
Share of unemployed in hhs_0	0.017	0.111	0.019	0.109	0.032	0.123	0.069	0.183	0.170	0.262	0.027	0.127	0.056	0.160	0.037	0.138
Share of inactive in hhs_0	0.551	0.407	0.481	0.380	0.650	0.351	0.535	0.374	0.562	0.339	0.517	0.390	0.552	0.336	0.561	0.378

Share of indv. With bad health in hhs_0	0.231	0.366	0.096	0.251	0.253	0.367	0.376	0.399	0.185	0.311	0.077	0.234	0.172	0.286	0.377	0.403
Household income_0	10.465	0.653	11.004	0.768	9.163	0.699	9.552	0.740	8.386	0.862	10.591	0.693	10.025	0.620	9.351	0.603
Household transfers_0	0.613	2.107	0.408	1.703	0.377	1.605	0.358	1.627	0.456	1.654	0.310	1.496	0.322	1.519	0.400	1.628
Household income_m	10.495	0.753	11.008	0.790	9.263	0.756	9.622	0.683	8.531	0.998	10.574	0.722	10.103	0.603	9.425	0.600
Household transfers_m	0.486	1.791	0.325	1.462	0.337	1.402	0.328	1.423	0.548	1.557	0.406	1.612	0.288	1.299	0.422	1.613
N	17,342		7,504		32,776		17,342		7,119		7,049		11,893		7,999	

Source: Authors' calculations based on EU-SILC data.

Table A.4. Comparison of EPI and EPI2 for European countries, 2020

Country	EPI	EPI2	Difference
Austria	0.030	0.035	-0.005 (0.000)
Belgium	0.064	0.071	-0.007 (0.000)
Bulgaria	0.205	0.171	0.034 (0.000)
Croatia	0.101	0.103	-0.002 (0.000)
Czech Republic	0.031	0.032	-0.001 (0.000)
Denmark	0.050	0.057	-0.007 (0.000)
Estonia	0.051	0.058	-0.007 (0.000)
Finland	0.029	0.032	-0.003 (0.000)
France	0.085	0.088	-0.003 (0.000)
Germany	0.049	0.044	0.005 (0.000)
Greece	0.174	0.162	0.012 (0.000)
Hungary	0.095	0.108	-0.013 (0.000)
Ireland	0.067	0.078	-0.011 (0.000)
Italy	0.097	0.101	-0.004 (0.000)
Latvia	0.103	0.106	-0.003 (0.000)
Lithuania	0.165	0.132	0.033 (0.000)
Luxembourg	0.056	0.062	-0.006 (0.000)
Malta	0.067	0.062	0.005 (0.000)
Netherlands	0.044	0.051	-0.007 (0.000)
Norway	0.021	0.026	-0.005 (0.000)
Poland	0.047	0.046	0.001 (0.000)
Portugal	0.185	0.173	0.012 (0.000)
Romania	0.082	0.079	0.003 (0.000)
Serbia	0.123	0.129	-0.006 (0.000)
Slovakia	0.057	0.053	0.004 (0.000)
Slovenia	0.089	0.106	-0.017 (0.000)
Spain	0.110	0.112	-0.002 (0.000)
Sweden	0.029	0.032	-0.003 (0.000)
Switzerland	0.026	0.036	-0.010 (0.000)

Note: the p-value from t-statistics to compare a difference between the means is given in the brackets.

Source: Authors' calculations based on EU-SILC data.

SPES

Sustainability
performances,
evidence & scenarios

www.sustainabilityperformances.eu