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Energy poverty and impact of Covid-19 pandemics in Visegrad (V4) countries

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Abstract. The article aims to analyse the effect of COVID 19 pandemics on energy poverty in Visegrad (V4) countries, namely Poland, Hungary, Slovakia and Czech Republic. The literature review on energy poverty was performed and the main indicators energy poverty were discussed. The dynamics of the main indicators of energy poverty during COVID 19 pandemics and post pandemic period were critically analysed and compared among V-4 countries trying to identify the successful policies and measures helping to mitigate negative COVID 19 pandemics impact on energy poverty in analysed group of countries.

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1. INTRODUCTION

The International Energy Agency (OECD, 2010) deems that individuals or families are energy impoverished if they are forced to devote a disproportionate proportion of their total revenues for paying their energy services. Various authors (Birol, 2007; Bouzerovski, 2013; Bouzerovski, Petrova, 2015, Gonzalez-Eguino, 2015; Siksnelyte-Butkiene et al., 2021) prove that households suffering from energy poverty are not able to pay for their basic domestic energy needs. Also, it is reflected that energy vulnerability reveals the risk for families to fall into a condition under energy poverty which can be defined by variety of indicators as energy poverty is a multidimensional concept linked to energy affordability and other related issues like energy prices, the energy efficiency and quality of residential buildings etc. (Siksnelyte-Butkiene et al., 2021; Štreimikienė et al., 2021). All these factors cause increased efforts to develop awareness towards environmental taxation, environmentally responsible behaviour and related issues on energy efficiency policy (Krzymowski, 2020; Musova et al., 2021; Samusevych et al., 2021).

EU has set important policy priorities to mitigate energy poverty and ensure smooth low carbon transition (European Economic and Social Committee, 2011; European Commission, 2020, 2021). The broad survey was concluded in EU in 2020, which found that even 8% of EU residents are unable to keep their home sufficiently warm. Therefore, during the COVID 19 pandemics, energy poverty is a major

concern for policymakers. The help for the most vulnerable households is necessary to tackle the increase of energy poverty in the EU Member States (MS).

It is agreed among scholars that energy poverty is a result of low revenues and a high share of expenses of disposable income to satisfy energy as well as poor energy insulation of buildings. Therefore, households living in energy inefficient buildings suffer from cold and heatwaves. In addition, inappropriate heating comfort and bad sanitary conditions like insufficient indoor temperatures, bad indoor air quality due to burning solid fuels for cooking and heating purposes have negative health impacts, reduce work productivity, and increase the mortality and morbidity of EU inhabitants.

Several decades the problems of energy affordability and inability to pay for heating and other housing costs was observed in many EU Member States (BPI, 2014; Chkravatry & Tvoni, 2013; Walker, 2012). There is a negative impact on the mental health of the population because of continuous stress due to inability to pay energy bills. Except of negative influence on income inequality due to the possibilities to cover the living expenses (Mishchuk et al., 2018), this effect also deepens the negative perception of quality of life, being essential factor among other social constituents of QOL (Tvaronavičienė et al., 2021; Leelakulthanit, 2021). Due to many socioeconomic factors impacting poverty including energy poverty a multi-faceted approach is necessary to deal with energy poverty in the EU.

The Covid-19 pandemic has stressed the importance of energy poverty for the EU to ensure the needs of low-income vulnerable population (Stefan et al., 2020; Peng et al., 2021). Energy poverty levels need to be monitored during COVID 19 crisis, especially as more inhabitants in the EU might struggle for energy affordability with an increase of unemployment and reduction of income due to various restrictions and quarantines implemented in EU MS. Though there are many recent studies on energy poverty (Santini & Thomas, 2020; Sunderland et al., 2020; Bouzarovski & Thomson, 2020; Siksnelyte-Butkiene et al., 2021). There is a lack of studies analysing the energy poverty dynamics during the COVID-19 based on energy poverty indicators established by the European Commission recommendation (EC, 2020).

The paper aims to overcome this gap and presents a case study on comparative assessment and ranking of V4 countries (Poland, Hungary, Slovakia and the Czech Republic) on energy poverty. The group of V4 countries was selected as they include new EU Member states that accessed the EU in 2004 and have many problems linked to energy poverty, inherited from their socialist past. In addition, households in these countries face problems of cold winters and may suffer from extreme cold in winters. The impact of COVID-19 on energy poverty was assessed by analysing the dynamics of the main energy poverty indicators of Poland, Hungary, Slovakia and the Czech Republic. Policies and measures developed to address energy poverty were grouped and compared between V4 countries by providing policy implications based on research conducted. The rest of the article is organised as follows. Section 2 presents the literature review; Section 3 introduces data and methods; Section 4 presents the results; Section 5 discusses policies and measures for energy poverty alleviation; section 6 concludes.

2. LITERATURE REVIEW

Energy poverty is a significant problem throughout Europe, and Eastern Europe, in particular, is suffering from it. Households living at risk of poverty are often forced to limit the heating of their homes and suffer discomfort to reduce their energy costs and save means on other necessary needs or they cannot afford to meet other needs due to high energy prices, particularly district heating. According to many authors (Tirado Herrero & Urge-Vorsatz, 2012; Walker, Day, 2012; Bouzarovski & Tirado Herrero, 2015; Bouzarorovski & Cauvain, 2016). In Eastern European countries, there is a trap of inefficient heat consumption, as poor households usually live in old buildings and do not have enough income to renovate or move to better housing (Clinch & Healy, 2004; Bouzarovski, 2014). They also do not have the possibility

of controlling their heat use or changing the heat supply source, as it is forbidden to disconnect from the district heating system and switch to other heat sources (Tirado Herrero & Urge-Vorsatz, 2012). It must also be emphasized that rising energy prices do not affect the level of consumption because of low price elasticity and that energy is recognized as a necessary commodity for the households.

There is no commonly defined and decided term for the definition of energy poverty. However, in the scientific literature, household energy poverty usually means that households spend too much of their real income on energy needs or that families are unable to meet their basic energy needs, for example, to ensure necessary heating comfort in their homes due to insufficient revenues and/or high prices (Bouzarovski, 2014; Bouzarovski, & Petrova, 2015). Although the existence of problems of energy poverty or energy affordability is widely known around the world, there is still much discussion among scientists as to the meaning of energy or fuel poverty and its best measures and indicators.

Several methods are also used to define the level of energy poverty, which can be distinguished on the basis of physical energy needs or energy cost measurements (Hills, 2011; Nussbaumer et al., 2012; Anderson et al., 2012). A fairly popular way is to estimate the level of energy poverty by estimating energy costs as a share of total household expenditure (Barnes, 2007; Boardman, 2010). Energy poverty in less developed countries is also measured in terms of the type of energy consumed by households or in terms of the country-specific expenditure poverty line (Foster et al., 2000).

The main methods for defining energy poverty can be structured as follows (Gonzalez-Eguino, 2015): the quantity of physical energy necessary to meet all the energy needs of inhabitants, such as lighting, cooking heating etc.; a definite share of energy expenditure in total household expenditure; the quantity of physical energy consumed or the type of energy carrier used by inhabitants living at the income poverty; a level of revenues below which energy consumption and/or energy costs are not expected to change, indicating that the lowest possible level of energy consumption is being achieved.

It is possible to measure energy or fuel poverty by applying several ways. These main approaches are based on energy accessibility regarding of technological economic and economic limits (Gonzalez-Eguino, 2015). The technological approach is based on the problem linked to access to modern-day energy supply services like electricity, natural gas or district heating in contract to use solid fuels or biomass for cooking or heating of homes. The physical approach is linked to established necessary minimum energy consumption to satisfy basic needs of households. Households below this line is being treated as suffering from energy poverty. Economic approach is linked to the assessment of the energy spending burden of households compared to their income. Households bellow or above established line of energy spending to real income being treated as suffering from energy poverty.

Energy and fuel poverty are essential measures of the quality of life. They have a huge effect on human health and economic development, as well as environmental impact as energy poverty decreases labour and productivity and bounds economic development potential. The main energy poverty negative health effect is linked with indoor burning of solid fuels, like coal, wood and waste. Such fuel burning cause air pollution because of inefficient combustion of fuels (wood, coal, dung and wastes) and poor ventilation in homes. Therefore, energy poverty affects public health and productivity in all sectors and confines economic development potential in the country. Specific policies and measures are necessary to deal with energy or fuel poverty, especially programs created to avoid its negative health effects and their consequences (Reddy, 2000; Bhide, & Monroy, 2011).

Therefore, though there are many diverse descriptions and concepts of energy poverty, but they all are linked to affordability and accessibility of energy and problems related to insufficient energy consumption to meet their basic energy needs. According to Reddy, energy poverty can be outlined as "the absence of sufficient choice in accessing an adequate, affordable, reliable, high-quality, safe and environmentally benign energy services to support economic and human development". European Commission developed

recommendations for Member States to use energy poverty indicators available at Eurostat database for all EU Member States for monitoring progress in energy poverty and the assessing the effects of policies on energy poverty alleviation, which are especially important during COVID-19 pandemics and other crisis situations as the most vulnerable population are suffering most during the crisis.

3. METHODS AND DATA

The approach applied in this article – a comparative assessment of dynamics of the main energy poverty indicators during the COVID-19 pandemic in V 4 countries. The EUROSTAT, EU-SILC and Energy Poverty Observatory data was used for comparative assessment of results energy poverty.

Energy poverty indicators can be split into several clusters, as defined in the European Commission Recommendation (EC, 2020):

"1. *indicators comparing spending on energy with income*: these quantify energy poverty by comparing the amount households spend on energy with an income measure (e.g. percentage or number of households spending more than a certain proportion of their disposable income on domestic energy services)

2. *indicators based on self-assessment:* households are asked directly to what extent they feel able to afford energy (e.g. ability to keep the home warm enough in winter and cool enough in summer)

3. *indicators based on direct measurement*: these indicators measure physical variables to determine the adequacy of energy services (e.g. room temperature)

4. *indirect indicators*: these measure energy poverty by through associated factors, such as arrears on utility bills, number of disconnections, and housing quality"

European Commission recommends the EU Member States for monitoring of energy poverty to use the following 2 groups of indicators, combining indicators from all 4 clusters defined above (EC, 2020):

"1. Indicators focusing on the affordability of energy services

— Share of the population at risk of poverty (below 60% of national median equivalised disposable income) cannot keep their home adequately warm, based on the question 'Can your household afford to keep its home adequately warm?' (Eurostat, SILC 2021)

— Share of total population not able to keep their home adequately warm, based on the question 'Can your household afford to keep its home adequately warm?' (Eurostat, SILC 2021)

— Arrears on utility bills: share of the population at risk of poverty (below 60% of national median equivalised disposable income) having arrears on utility bills (Eurostat, SILC, 2021])

— Arrears on utility bills: share of population having arrears on utility bills (Eurostat, SILC, 2021)

— Expenditure on electricity, gas and other fuels as a proportion of total household expenditure (Eurostat, 2021)

— Proportion of households whose share of energy expenditure in income is more than twice the national median share (source Eurostat, Household Budget Surveys, 2015)

— Share of households whose absolute energy expenditure is below half the national median. (Eurostat, Household Budget Surveys, 2015)

2. Complementary indicators

— Electricity prices for household consumers – average consumption band (Eurostat, 2021)

— Gas prices for household consumers – average consumption band (Eurostat, 2021)

— Gas prices for household consumers, lowest consumption band (Eurostat, 2021)

— Share of the population at risk of poverty (below 60% of national median equivalised disposable income) with leak, damp or rot in their dwelling (Eurostat, SILC, 2021)
— Share of population with leak, damp or rot in their dwelling – total population (Eurostat SILC, 2021])
— Final energy consumption per square metre in the residential sector, climate-corrected (Odyssee-MURE project database)".

In Table 1 the framework of energy poverty indicators established by European Commission is provided (EC, 2020).

Table 1. Indicators of energy poverty of households

Indicators of energy service affordability	Complementary indicators
Portion of population at poverty risk, i.e. population with income below 60% of national median equivalised disposable income that is not able to keep their homes sufficiently or adequately warm, %	Households electricity prices based on the average consumption band, EUR/MWh
Portion of total population that are not able to keep their homes sufficiently warm, %	Households natural gas prices based on the average consumption band, EUR/MWh
Portion of population at poverty risk having arrears on utility bills, %	Household natural gas prices based on the lowest consumption band, EUR/MWh
Portion of total population having arrears on utility bills, %	Proportion of population at poverty risk with leak, damp or rot in their dwelling, %
Energy (electricity, gas and other fuels) expenditures as the share of total household expenditures, %	Proportion of total population with leak, damp or rot in their dwelling, %
Share of households whose share of energy expenditure in their real income is more than double of the national median (2M), %	Households final energy consumption per square metre in the residential sector estimated as climate-corrected, kgoe/m^2
Proportion of households whose absolute energy expenditure is below one-half of the national median (M/2), %	

Source: created by authors based on (EC, 2020)

Further, these indicators will be collected for EU-27 and V 4 countries to define the situation in 2019, assess the main trends of energy poverty indicators, and define the main differences in these trends. Comparison with EU-27 average allows having the benchmark for analysis. The reasons for the main differences among V7 countries will be further discussed and policy implications will be provided based on a comparative assessment performed among V4 countries. The comparative assessment of V4 countries and their ranking based on energy poverty indicators allows defining the best-performing country in terms of energy poverty during pandemics. The good practices in policies mitigating energy poverty can be shared among countries

4. ANALYSIS OF RESULTS

The main energy poverty indicators established by the European Commission recommendation for Member States (EC, 2020) were compared in V4 countries and EU-27 average in Table 2 for the year 2019.

Table 2. Energy poverty indicators for V 4 countries in 2019

No.	Area	**Hungary**	**Poland**	**Slovakia**	**Czech Republic**	**EU**
Indicators of energy service affordability						
1	Portion of population at poverty risk, i.e. population with income below 60% of national median equivalised disposable income that are not able to keep their homes sufficiently or adequately warm, %	14.0	11.5	28.6	9.0	18.2
2	Portion of total population that are not able to keep their homes sufficiently warm, %	5.4	4.2	7.8	2.8	6.9
3	Portion of population at poverty risk having arrears on utility bills, %	21.0	12.5	25.7	5.4	14.9
4	Portion of total population having arrears on utility bills, %	10.2	5.8	8.4	1.8	6.2
5	Energy (electricity, gas and other fuels) expenditures as the share of total household expenditures, %	4.4	4.7	7.1	0.9	3.7
6	Share of households whose share of energy expenditure in their real income is more than double of the national median, %	9.0	16.3	9.3	10.8	16.2
7	Proportion of households whose absolute energy expenditure is below one-half of the national median, %	9.3	19.5	7.9	9.2	14.6
Complementary indicators						
1	Households electricity prices based on the average consumption band, EUR/MWh	86.4	86.7	96.9	125.5	128.3
2	Households natural gas prices based on the average consumption band, EUR/MWh	26.3	37.4	40.1	48.5	49.7
3	Household natural gas prices based on the lowest consumption band, EUR/MWh	26.3	42.8	102.7	92.4	82.4
4	Proportion of population at poverty risk with leak, damp or rot in their dwelling, %	36.6	18.1	16.3	14.0	19.8
5	Proportion of total population with leak, damp or rot in their dwelling, %	22.3	10.8	5.7	7.3	12.7
6	Households final energy consumption per square metre in the residential sector estimated as climate-corrected, kgoe/m^2	20.6	20.6	14.8	21.5	14.4

Source: own work

As one can see from the information given in Table 2, the Czech Republic distinguishes with the lowest energy poverty indicators linked to energy affordability, except indicator showing the share of households whose portion of energy expenditure in real income is more than double the national median share or 2M indicator. Comparing energy poverty indicators linked to energy affordability of the Czech Republic with the EU-27 average one can notice that the Czech Republic performs better than the EU-27 based on all these indicators. According to complementary indicators of energy poverty, like electricity prices and natural gas prices for households, the Czech Republic distinguishes with the highest energy prices among other countries, though these prices are still more than half of EU-27 average. According to other complementary energy poverty indicators like share of population at risk of poverty with leak, damp or rot in their dwelling the Czech Republic exhibits good situation in comparison with other V4 countries and even EU-27 average. However, according to final energy consumption per square metre in the households sector, which is climate-corrected and indicates energy efficiency in households, the Czech Republic shows the worst result

among V4 countries, and final energy consumption per square metre in the household sector is almost twice higher than in EU-27. Therefore, more attention should be paid to energy efficiency improvement in the residential sector, especially renovation of multi-flat buildings.

Slovakia was the worst performing country according to the indicators of the portion of population at risk of poverty not able to keep their home sufficiently warm and the portion of total population that is not able to keep their home sufficiently warm as well according indicators of arrears on utility bills: share of population at risk of poverty, indicating that low-income population is suffering due to energy poverty at most in Slovakia and therefore, requires more support to increase energy affordability. Comparing these energy poverty indicators with EU-27 average, one can notice that they are higher, around 40% in Slovakia, therefore showing quite an alarming situation.

According to complementary indicators of energy poverty, like final energy consumption per square metre in the households sector, Slovakia is the best performing country among V4 countries and has a similar level of final energy consumption per square metre in the households sector with an EU-27 average.

In Poland, energy poverty indicators linked to energy affordability, like a portion of total population and population at risk of poverty which are not able to keep their home sufficiently warm are on average among V4 countries. Just M2 and M/2 indicators are the highest ones in Poland compared with other V4 countries. According to complementary indicators of energy poverty, Poland is again somewhere in the middle between V4 countries. Just the portion of population at poverty risk and all population that have the leak, damp or rot in their dwelling is quite high in Poland compared with other V4 countries; however, it is still lower than the EU-27 average indicating that country situation is not so bad or alarming.

Hungary distinguishes from other V4 countries with the lowest energy prices for households, the highest portion of the population at poverty risk and the portion of total population with a leak, damp or rot in their dwelling, indicating that country needs to strengthen policies to promote energy refurbishment of residential buildings.

As V4 countries are performing very differently according to specific energy poverty indicators and all these indicators are important as showing different issues of energy poverty relevant to specific policies and measures necessary for energy poverty alleviation, the ranking of countries based on all energy poverty indicators allows as to perform a general comparative assessment of energy poverty in V4 countries.

In Table 3, V4 countries were ranked based on each energy poverty indicator provided in Table 2. The goal of energy poverty reduction or decrease of energy poverty indicator is the main criteria of ranking. The best performing country, with the lowest specific energy poverty indicator is ranked as the first.

Table 3. Ranking of V4 based on energy poverty indicators in 2019

No.	Area	**Hungary**	**Poland**	**Slovakia**	**Czech Republic**	**Goal**
Indicators of energy service affordability						
1	Portion of population at poverty risk, i.e. population with income below 60% of national median equivalised disposable income that are not able to keep their homes sufficiently or adequately warm, %	3	2	4	1	Min
2	Portion of total population that are not able to keep their homes sufficiently warm, %	3	2	4	1	Min
3	Portion of population at poverty risk having arrears on utility bills, %	3	2	4	1	Min
4	Portion of total population having arrears on utility bills, %	4	2	3	1	Min
5	Energy (electricity, gas and other fuels) expenditures as the share of total household expenditures, %	2	3	4	1	Min
6	Share of households whose share of energy expenditure in their real income is more than double of the national median, %	1	4	2	3	Min
7	Proportion of households whose absolute energy expenditure is below one-half of the national median, %	3	4	2	1	Min
Complementary indicators						
1	Households electricity prices based on the average consumption band, EUR/MWh	1	2	3	4	Min
2	Households natural gas prices based on the average consumption band, EUR/MWh	1	2	3	4	Min
3	Household natural gas prices based on the lowest consumption band, EUR/MWh	1	2	4	3	Min
4	Proportion of population at poverty risk with leak, damp or rot in their dwelling, %	4	3	2	1	Min
5	Proportion of total population with leak, damp or rot in their dwelling, %	4	3	1	2	Min
6	Households final energy consumption per square metre in the residential sector estimated as climate-corrected, kgoe/m^2	2	2	1	3	Min
Sum of ranks		32	33	37	26	Min
Final rank of countries		2	3	4	1	Min

As one can see on the information given in Table 3, above the Czech Republic was overall the best performing country in terms of energy poverty in 2019. Slovakia was the worst performing country according to overall energy poverty indicators in 2019. If just energy poverty indicators linked to top energy affordability are addressed, the Czech Republic is also the best performing country. The same situation is for other V4 countries, their ranking remains the same by excluding complementary indicators. Therefore, the worst performing country according to poverty indicators linked to energy affordability remains Slovakia.

There are just several energy poverty indicators defined by the European Commission recommendation (EC, 2020), which data is available also for 2020. This allows tracking the changes of these energy poverty indicators before and during COVID-19 pandemics. In Figures 1-4 the dynamics of the 4 main energy poverty indicators linked to energy affordability in V4 countries is provided to track the impact of COVID-19 pandemics.

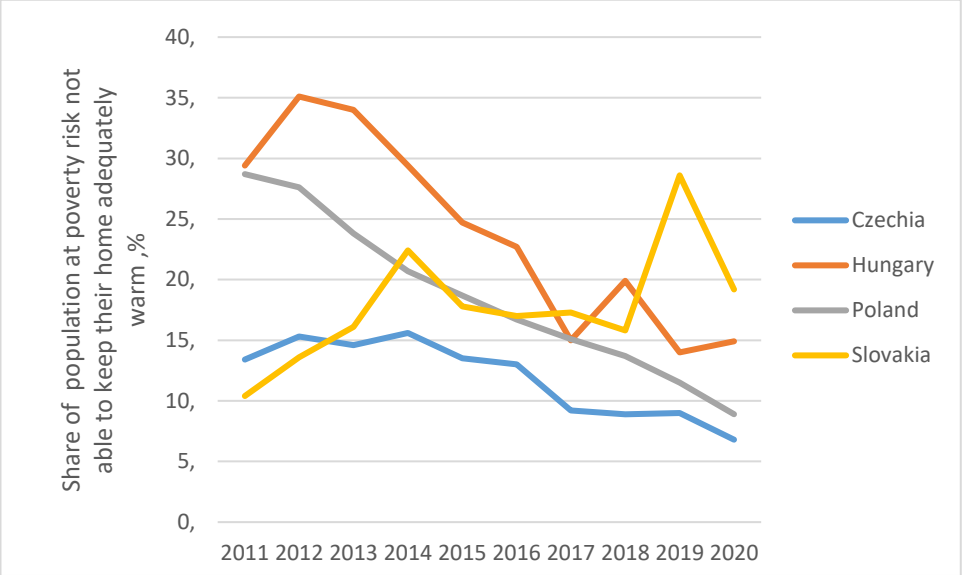

Figure 1. Dynamics of the proportion of population at poverty risk that are not able to keep their home sufficiently warm in V4 countries

As one can see from Figure 1 the dynamics of the proportion of the population at poverty risk that are not able to keep their home sufficiently warm was declining during COVID-19 pandemics in all V4 countries except Hungary.

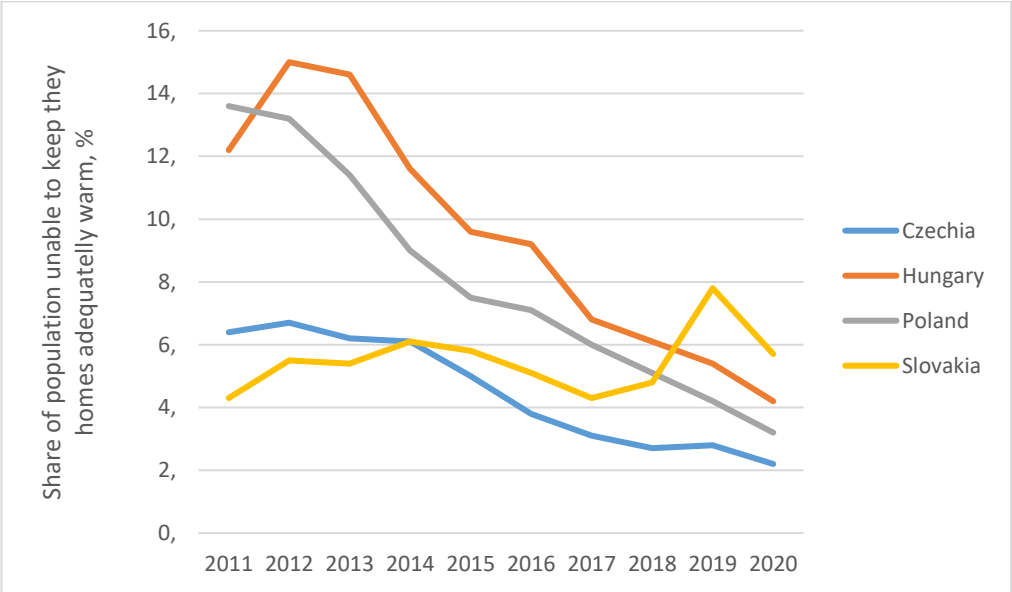

Figure 2. Dynamics of the proportion of total population that are unable to keep they homes sufficiently warm in V4 countries

Next indicator of energy poverty - the share of total population that is unable to keep their homes sufficiently warm was declining in all V4 countries during pandemics as well (see Figure 2).

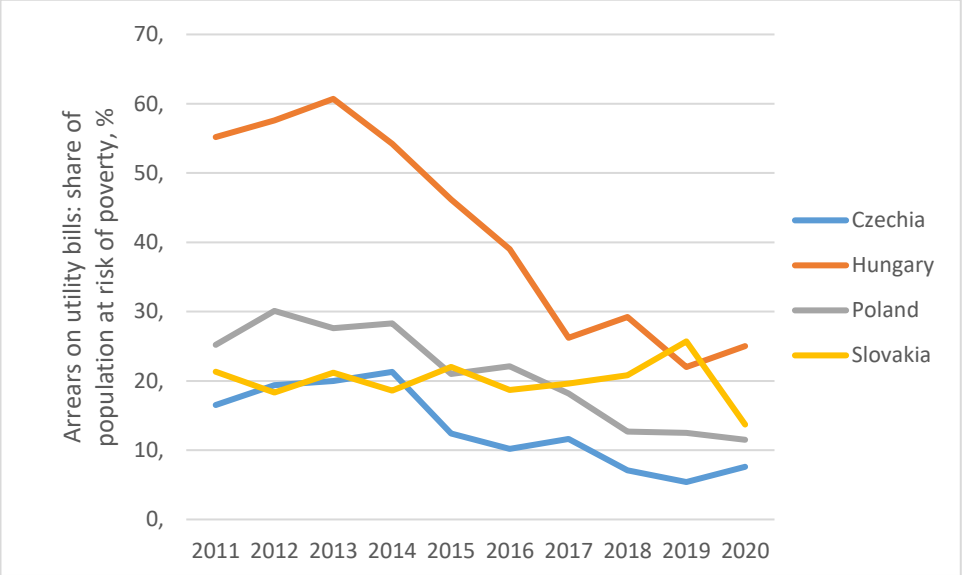

Figure 3. Dynamics of the hare of population at risk of poverty having arrears on utility bills V4 countries

The third energy poverty indicator - the proportion of population at poverty risk having the arrears on utility bills was declining in Poland and Slovakia, however in Hungary and Czechia, the increase of the portion of population at poverty risk with arrears on utility bills can be noticed during COVID-19 pandemics (see Figure 3).

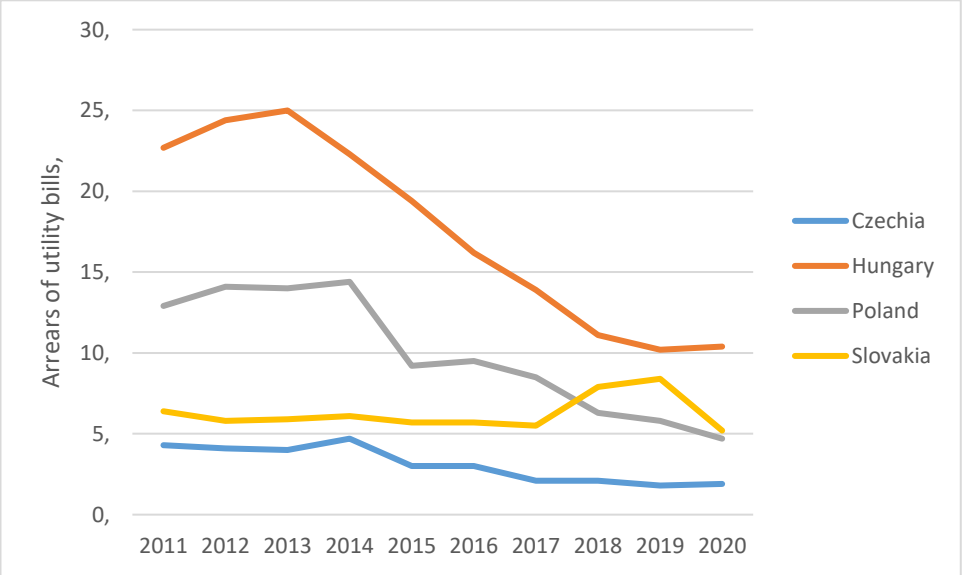

Figure 4. Dynamics of arrears of utility bills, share of total population in V4 countries

The fourth indicator of energy poverty, i.e. the proportion of the total population with arrears of utility bills, was decreasing in Slovakia and Poland during COVUD-19 pandemics and was slightly increasing in Hungary and Czechia in 2020 (see Figure 4).

In Figure 5-6 the dynamics of complementary indicators like the proportion of the population at poverty risk and the proportion of the total population with leak, damp or rot in their dwelling in V 4 countries is provided.

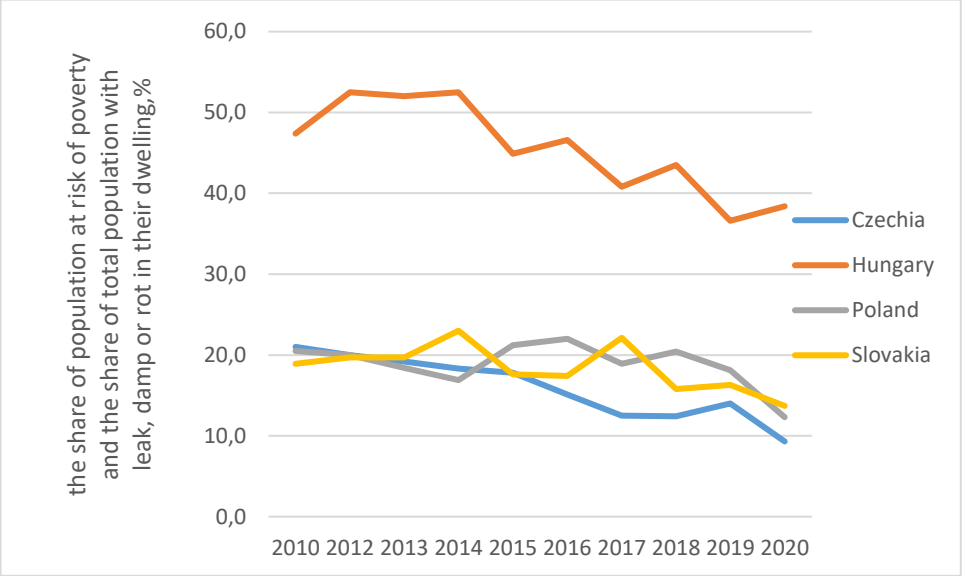

Figure 5. Dynamics of the proportion of population at poverty risk with leak, damp or rot in their dwelling in V 4 countries

As one can notice from Figure 5, the proportion of the population at poverty risk with leak, damp or rot in their dwelling was increasing during COVID-19 pandemics just in Hungary. In other V4 countries, this indicator was declining during 2020.

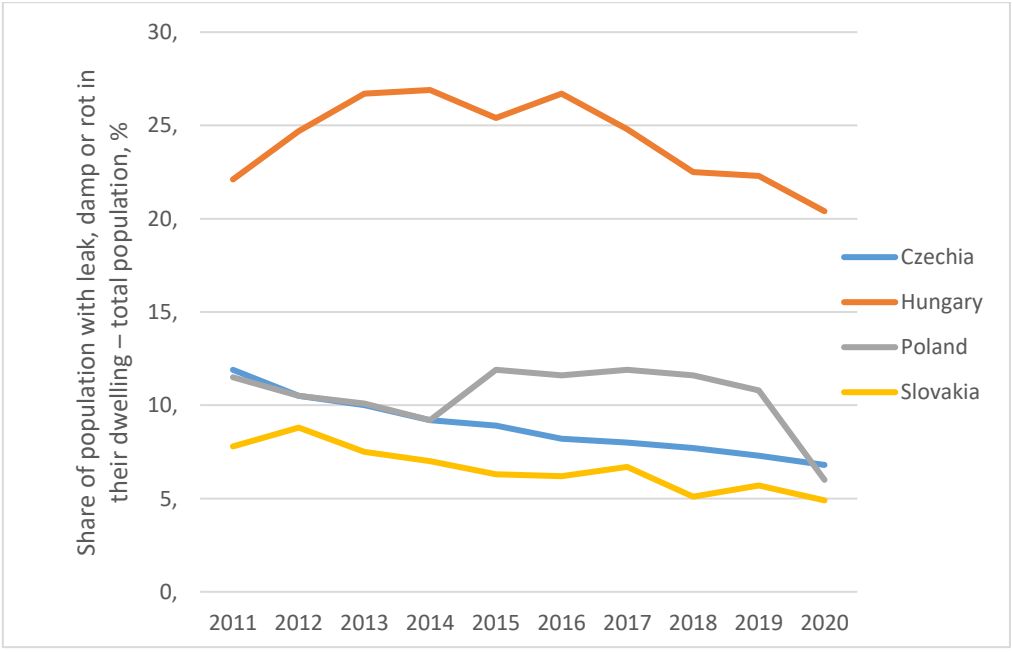

Figure 6. Dynamics of the proportion of total population with leak, damp or rot in their dwelling in V4 countries

As one can see from Figure 6, the share of proportion of the population with leak, damp or rot in their dwelling was decreasing during the COVID-19 pandemic in all V4 countries.

The analysis of the trends of the main 4 energy poverty indicators focusing on the affordability of energy services and two complementary energy poverty indicators for which data for 2020 was available in V4 countries revealed the worst situation in Hungary as all energy poverty indicators analysed were increasing during COVID-19 pandemics except the proportion of the total population with arrears of utility bills and the share of the total population with leak, damp or rot in their dwelling. The situation of the population at poverty risk (below 60% of national median equivalised disposable income) was worsening in Hungary according to all energy poverty indicators in 2020, therefore the urgent policies aiming at energy poverty alleviation of the most vulnerable low-income population are needed urgently in Hungary.

5. POLICIES AND MEASURES FOR ENERGY POVERTY ALLEVIATION IN V4

The main policies and measures to combat energy poverty can be divided into the following groups: general social support for low-income vulnerable population and measures to promote energy efficiency improvement and use of renewable energy technologies. The measures to promote energy efficiency and renewables can also be grouped in several categories like financial support in the form of subsidies or loans for renovation of residential buildings, improvement of district heating systems and installation of renewable energy technologies or soft measures of information dissemination and awareness raising among households about benefits of energy efficiency improvement and use of renewables and the main available measures to support investments in energy efficiency and renewables. Social support policies are mainly short-term policies. The priorities should be placed on long-term policies and measures of energy poverty alleviation provided by energy efficiency improvements and the use of renewables.

In Table 4 the main policies and measures to alleviate energy poverty in V4 countries were systematized and described.

As it is shown in Table 4 in all V4 countries have implemented short-term energy poverty alleviation policies like social support for low-income population and long-term energy poverty alleviation policies targeting promotion of energy efficiency and renewables.

Energy poverty is mainly tackled by social policies in the Czech Republic. The main measures are: The Living Allowances, Housing Allowances and Housing Supplement. The Living Allowances delivers financial aid to low-income, vulnerable households for paying their living expenses. The Housing Allowance and the Housing Supplement delivers financial support to low-income vulnerable households to pay additional housing expenditures linked to energy costs. The long-term energy efficiency and renewable programmes in the Czech Republic aim to encourage all households to save energy. The main project on energy efficiency for all households are: Integrated Regional Operational Programme, the New Green Savings, and the Operational Programme Environment. They all deliver financial aid to households to ensure energy savings, buildings renovations and improvement of district heating systems. These energy efficiency programmes are mainly supported by money from European Union Funds for Regional Development. There are also information dissemination campaigns for energy poor households, like the EFEKT programme aiming to raise awareness and promote energy-saving behaviour in the residential sector. This support is very relevant to energy pour households as they lack rational decision making experience due to stress linked to inability to pay their bills. Recently developed National Energy and Climate Plan includes energy poverty reduction targets in the Czech Republic as a priority.

Table 4. Policies and measures for poverty alleviation in V4 countries

Policies and measures	Target groups	Description
Czech Republic		
Integrated Regional Operational Programme	All population	The programme was initiated in 2009. During 2014-2016-year period, 18,357 projects for building insulation, heating system, renewable energy were approved from the programme by spending 4.16 billion CZK
EFEKT programme for energy audits, information and awareness	All population	EFEKT programme was initiated in 2000. Promotion of energy efficiency was implemented largely by raising awareness and delivering education on energy efficiency improvements in households
Operational Programme Environment	All population	Since 2015 programme financed heating system and renewable energy projects with the making aim - to replace 100,000 solid fuel boilers to renewable energy by year 2020.
Social support by Housing Supplement	Low-income households, Households on social benefits	Additional financial support to vulnerable households to secure their various housing payments, incorporating energy and heating bills, which were not fully addressed by support provided according to Housing Allowance measures
Social support by Living allowances	Low-income households	Financial support to vulnerable low-income households to protect their payments for various expenses linked to living.
Social support for Housing allowances	Low-income households	Financial support to vulnerable low-income households to secure their various housing expenditures incorporating energy and heating bills payments
Hungary		
Financial measures to promote energy efficiencv	All population	Financial support for buildings insulation and replacement of heating systems to more efficient one.
Protection for disabled consumers	Disabled	Disconnection from the grid protection for vulnerable (disabled) population in case of debts for heating, natural gas or electricity supply
Protection for indigent consumers	Households on social benefits,	Disconnection protection from the grid protection for vulnerable low-income households, receiving social benefits in case of debts for heating, natural gas or electricity supply
Rules on renewable production by households	All population	Promotion of renewable energy sources micro-generation technologies in households
Poland		
Clean Air programme	All population	Clean Air Program established in 2018, provides financial aid to households for improvement of their heating systems
Energy bill support by energy lump sum payments	Pensioners	Financial aid to cover energy bills to individuals which were former participating in military operations or wars.
Energy bill support by energy allowance/Housing allowance	Low-income households	These measures were implemented in 2014 and delivers financial aid to low-income households to cover their electricity bills
National support system for energy efficiency and RES information dissemination and awareness rising	All population	The aim of programme was to provide support to different stakeholders including households for improvement of energy efficiency. The main measures were linked to provision of guidance and information. Advisors were providing information for households about possible energy efficiency improvements.
Slovakia		
MunSEFF program me for building insulation	Apartment buildings	Financial aid for building insulation, heating system, renewable energy technologies in residential buildings initiated since 2011
SlovSFFF programme	Apartment buildings	Financial aid for energy efficiency improvement in residential buildings covering building insulation, heating system, renewable energy technologies initiated since 2007.
Operational Proaramme Environment	All population	Financial support for energy efficiency improvement in residential buildings covering building insulation, heating system, renewable energy technologies
Green for households programme	All population	Financial support for installation of renewable energy micro generation technologies in heating systems initiated since 2015
Price calculator for Information and awareness	All population	Price Calculator allows households to select a more affordable supplier by providing possibility for households to compare energy prices of different suppliers.
Live Energv programme for information and awareness	All population	Free advice for households on energy efficiency and renewables
Social support by assistance in case of material distress	Low-income households	Social support for low-income vulnerable population

In Hungary, vulnerable energy consumers, like pensioners or population living on social benefits, obtain the protection of Government versus disconnection from energy supply systems. Disabled consumers are not allowed to be disconnected from the energy supply due to arrears of energy bills. They also receive additional assistance by receiving additional, detailed information on the bill. There are also favourable financial conditions like loans or special accounts for the renovation of houses, covering energy insulation and upgrading of heating installations. There is also Rules on renewable production by households allowing the inhabitants to deduct the energy they produce from their energy bills.

In Poland, energy poverty is addressed by financial aid, covering energy bills and social aid. The energy and housing allowance offer financial support to inhabitants for their electricity bill payments. The energy lump sum payments are allocated for energy bills payment for people former involved in military operations or wars. There is also a special purpose allowance paid for vulnerable population in order to satisfy their basic needs, incorporating energy expenditures. The country has established a general program to increase energy efficiency and increase usage of renewables in households which also targets low-income energy poor inhabitants in Poland. In addition, the NGO are active in energy policy alleviation field in Poland. In 2017 project by NGO targeting energy poverty reduction in Poland was launched. The project provides several initiatives that ensure an enhanced understanding of energy poverty and active involvement of NGOs in solving energy poverty problems in Poland.

In Slovakia, energy poverty problems are mainly dealt through social support measures. There is a programme of Assistance in case of material distress that allocates aid for the low-income vulnerable population to pay for their living expenses, including energy and heating expenditures. *MunSEFF* and *StovSEFF* programmes aim at large-scale renovation for improving the energy efficiency of multi-flat buildings. The *MunSEFF* was initiated in 2011 and provided financial aid for energy efficiency improvement in municipalities. The *StovSEFF* programme delivers financial aid to energy efficiency improvement measures. It was initiated in 2007. There is an additional measure from the Operational Programme Environment provides financial support for various measures, incorporating increase of energy efficiency and use of renewable energy for heating from EU Structural Funds. The Green for households programme initiated in 2015 provides financial support to inhabitants to install micro renewable energy technologies. There are policies facilitating energy efficiency like Live Energy measures providing inhabitants with free advice on energy-saving measures and renewable energy microgeneration technologies. The Price Calculator measure permits inhabitants to equate different energy suppliers in terms of energy prices and to select the cheapest energy supplier.

6. CONCLUSION

European Commission proposed aggregate indicators to monitor energy poverty in the EU Member States. As energy poverty is a multi-facet fact, and no single indicator can completely show all its features. Member States should use defined aggregate energy poverty indicators and the Commission's guidance during the implementation of national energy and climate plans in agreement with Article 14 of Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action.

Analysis of energy poverty indicators in V4 countries showed that the Czech Republic was overall the best performing country according to energy poverty during all investigated periods and in 2019 and 2020. Slovakia was the worst performing country according to overall energy poverty indicators in 2019 following Hungary. If just energy poverty indicators linked to the affordability of energy services are addressed, the Czech Republic is also the best performing country. The same situation is for other V4 countries, their ranking remains the same by excluding complementary indicators. Therefore, the worst performing country according to poverty indicators linked to the affordability of energy services remains Slovakia.

Analyzing the main energy poverty indicators available for 2020 in V4 countries showed that Hungary is in the worst position among the four Visegrad countries. All 6 energy poverty indicators analysed were increasing during the COVID-19 pandemic except the share of the total population with arrears of utility bills and the share of total population with leak, damp or rot in their dwelling. The situation of population at poverty risk (below 60% of national median equivalised disposable income) was worsening in Hungary according to all energy poverty indicators in 2020 though it was the worst even before pandemics; therefore the urgent policies aiming at energy poverty alleviation of the most vulnerable low-income population are needed urgently in Hungary.

Policies and measures to alleviate energy poverty were analysed and compared in V4 countries. Analysis of policies and measures revealed that allV4 countries have employed short-term energy poverty alleviation policies like social support for low-income population and have some long-term energy poverty alleviation policies targeting promotion of energy efficiency and renewable energy sources. Hungary distinguishes with very few policies to promote energy efficiency improvement in households, mainly targeting building insulation. In this country, disconnection protection is the main policy of social protection for low income and disabled households. The Czech Republic distinguishes among V4 countries with quite wide diversity of energy efficiency support programmes for households and diversity of social support measures for low income households, which can be a good example for Hungary, as Czechia has the lowest indicators of energy poverty, including energy poverty indicators for the population at poverty risk, i.e. population with income below 60% of national median equivalised disposable income.

For energy poverty, alleviation Member States should supplement social policy measures with energy-saving measures that strengthen each other, especially in residential buildings. Promotion of investment in energy-efficient housing and energy renovation should be among priorities in energy poverty alleviation. It is necessary to investigate the role of energy service companies and contracts on energy performance by ensuring support of buildings renovation for energy poor low-income inhabitants unable to afford the high upfront costs of renovation. Therefore, National long-term energy renovation strategies for residential buildings established for morbidity meeting 2030 and 2050 energy and climate targets should be directed towards energy-poor vulnerable households. These strategies should empower energy pour households by supporting payments for energy costs and securing healthier living conditions. So, identifying energy pour households allows better management of financial support for energy efficiency improvement and renovation of residential buildings. The measures targeting vulnerable groups should be prioritized as energy pour vulnerable population has restricted savings and limited access to commercial loans.

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