Energy Poverty

National Indicators

Uncovering New Possibilities for Expanded Knowledge

Energy Poverty
Advisory Hub
October 2023

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Energy Poverty National Indicators: "Uncovering New Possibilities Expanded Knowledge" Published by the Energy Poverty Advisory Hub

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October 2023

Design and cover image: Climate Alliance

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Acronyms

AROPE	At risk of poverty or social exclusion
CDD	Cooling degree days
CoM	Covenant of Mayors for Climate and Energy in Europe
EP	Energy Poverty
EPAH	Energy Poverty Advisory Hub
EU	European Union
GEO	Geographical Entities
HDD	Heating degree days
Pop.Liv.	Population Living
NUT	Nomenclature of territorial units for statistics

1

Introduction

Energy Poverty (EP) is increasingly recognised as a pressing social issue within the policy strategies and legislative frameworks of the European Commission. Namely, in the new Energy Efficiency Directive (European Commission, 2021), the EED places a stronger emphasis on the need for alleviating EP and empowering consumers.

Diagnosis is a vital component of addressing EP and requires measurement and monitoring of its various dimensions. Indicators play a crucial role in this process, providing valuable insights into identifying and assessing the vulnerability of the energy-poor population.

Following the previous Energy Poverty Advisory Hub (Gouveia *et al.*, 2022) report on energy poverty indicators, "National Indicators: Insights for a more effective measuring", EPAH now presents a new report focusing on the latest updates and enhancements to our energy poverty indicators and dashboard. This revision effort aims to further develop the knowledge and tools provided by EPAH towards contributing to the improvement of EP measurements across the EU. It reorganises and updates existing indicators, removes redundant ones, and incorporates **new (sub)topics and indicators**. The update aims to deepen and broaden EP measurement by integrating more EP-related dimensions to equip policymakers, researchers, and practitioners with a toolkit that enables more comprehensive approaches.

By integrating new topics, refining indicators, and incorporating new features and metrics, the EPAH continues to fulfill its mission of providing knowledge that can support evidence-based decision-making and promote effective interventions.

The report is organised into the following three section:

2

Methodology

which outlines the approach and framework used to conduct the aimed updates to the national indicators and their respective topics.

3

New EPAH Indicators

presents each new indicator in detail, focusing on their respective relevance and implications for addressing EP.

4

Looking Ahead

highlighting suggestions for future work regarding the indicators and their integration in EP diagnosis at multiple scales.

2

Methodology

This report is complemented by the new online revised EPAH indicators dashboard, reflecting the ongoing enhancements to EP indicators. These updates follow the work conducted in the EPAH report "National Indicators: Insights for a more effective measuring"(Gouveia *et al*., 2022), including the **removal of indicators, code changes, the introduction of new disaggregation, the reorganization of indicators, incorporation of other spatial scales and the addition of new indicators across different topics and subtopics.**

In line with the present literature that highlights the benefits of holistic multi-indicator approaches to EP assessment (Rademaekers *et al.,* 2016; Castaño-Rosa *et al*., 2019; Koukoufiki and Uihlein, 2022), these updates aim to provide a more comprehensive methodology for understanding and addressing EP.

EPAH acknowledges the significance of adhering to fundamental principles when evaluating data and determining which indicators to incorporate into the dashboard. This includes taking into account factors like geographical distribution and data accessibility. Temporal distribution is also crucial for understanding trends, so it is important to have datasets covering different periods. Moreover, future data updates are essential for monitoring changes and evaluating the effectiveness of actions.

To enhance the organization and accessibility of the energy poverty indicators, EPAH has also implemented a new structure that aligns with the guidelines of the Covenant of Mayors on energy poverty indicators at the local level (CoM, 2022). All the indicators have been organized into specific **topics and subtopics**, enabling a more focused examination of the different EP dimensions and aspects that should be addressed in a more comprehensive EP framework. By aligning the EPAH indicators' topics and subtopics to the Covenant of Mayors local indicators proposal (CoM, 2022), the EPAH aims to provide a comprehensive and userfriendly resource that complements and works synergistically with other valuable efforts in the EU and across different spatial scales (EU, national, local).

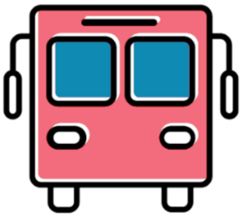
2.1 EPAH indicators' topics

All EP indicators included in the dashboard were categorized according to topics based on the macro areas identified by the **Covenant of Mayors** for EP diagnosis. These serve as a guiding framework for local actions on climate change and sustainable energy (CoM, 2022). However, EPAH has established a second degree of detail within these macro areas – the subtopics, to provide a more granular and accurate portrayal of the diverse EP dimensions and complementary indicators for better context framing and support analysis. EPAH aims to provide an increasingly comprehensive and robust framework that enables an in-depth analysis of EP, considering the unique problems and opportunities of various aspects within each macro-region.

Each topic encapsulates specific elements or aspects that contribute to the complexity of EP and that should be considered in holistic multi-scalar diagnosis approaches for addressing EP. The indicators have been classified into the following **four primary topics and respective subtopics**:

Climate: The Climate topic presents indicators that portray climate conditions and other climate-related phenomena. Climate conditions such as outside temperatures can impact households' energy needs and thermal comfort, potentially affecting EP vulnerability. For instance, colder climates increase the demand for heating, burdening families already struggling with high energy costs. On the other hand, hotter climates require additional energy for cooling, which can be unaffordable for those living in EP (Jessel *et al.*, 2019). This topic may become increasingly relevant due to the more frequent and impactful extreme weather events resulting from climate change.

Facilities/Housing *(subtopics Building Stock and Energy Consumption and Equipment):* This topic and subtopics focus on the building stock's characteristics, quality, and accessibility to housing and other facilities directly connected to EP. It addresses building conditions, conservation state, energy efficiency, fuel use, and consumption profiles in dwellings. The poor energy performance and efficiency of dwellings directly impact energy needs, raising energy consumption for maintaining thermal comfort. This may exacerbate a potential situation of EP, marked by overly high energy expenditure or an inability to attain such energy consumption levels. An increase in energy efficiency can lead to EP alleviation (*e.g.,* Boemi and Papadopoulos, 2019).



Mobility: This topic depicts vulnerability associated with transport and mobility, aiming to establish a link between transport poverty and EP in households. Transport poverty may refer to the inability of individuals or households to afford or access reliable transportation services, which can have significant implications for their energy poverty status (Martiskainen *et al.*, 2021). Energy-poor households face challenges in accessing affordable and reliable transportation options, limiting their ability to travel to work, school, healthcare facilities, and other essential services (Kaygusuz, 2011). Limited access to affordable and reliable mobility options for energy-poor households, often resulting in increased reliance on inefficient modes of transportation and higher energy costs and transportation expenses, can also strain the overall energy expenditure of low-income households, perpetuating the cycle of EP by diverting financial resources away from essential energy needs (Shi *et al.*, 2022). This topic delves into public transportation accessibility, affordability, and the influence of mobility choices on energy expenditure. Understanding the mobility aspect of energy poverty is critical for tackling transport impediments leading to social and economic exclusion (Kamruzzaman *et al.*, 2016). Furthermore, these indicators help evaluate cases of "double energy vulnerability" where consumers may simultaneously be at risk of transport and energy poverty (Simcock *et al.*, 2021). Despite the causes and policy solutions being, in most cases, divergent, integrating mobility indicators into the analysis of energy poverty may allow for a more holistic approach to understanding the complex dynamics and interdependencies between energy access, affordability, and transportation.

Socioeconomic aspects (Subtopics *Socioeconomic and Living Conditions, Energy Expenditure and Energy Markets,* and *Health*): This dimension encompasses a variety of socioeconomic variables that represent causes, drivers, or consequences of EP, thus shedding light on the social and economic impacts of EP and its effects on individuals and communities. This topic dives into the complex relationship between EP and several significant socioeconomic aspects such as energy prices, employment, income and economic hardship, housing and energy costs and affordability, and health impacts potentially related to lack of thermal comfort and indoor air quality. Some of the described factors are directly related to EP. In contrast, others, though not directly determining or stemming from EP, contribute to or arise from a vulnerability setting that creates or results from an EP situation (Rademaekers *et al.*, 2016). In some cases, there can be a bidirectional relationship creating a causal loop where the increased severity of EP worsens the particular cause of EP.

The assortment of the EPAH dashboard indicators by topic and subtopic is presented in

Table *1*. Each previously existent and new indicator has been assigned to a topic and subtopic based on its focus and scope. This table lets readers browse the indicators more easily and discover associated topics. It is worth noting that the "Final consumption expenditure of household's" indicator connects various themes, as indicated in the footnotes. Detailed explanation is further described in the next sections.

Table 1: INDICATORS' TOPICS
(the indicators that cross various themes have a related footnote)

Topic	Subtopic	Indicator
Climate		Cooling degree days
		Heating degree days
Facilities/ housing	Building Stock	Dwellings with energy label A
		Final consumption expenditure of households [1]
		Pop. Liv. Dwelling with presence of leak, damp and rot
		Pop. Liv. Dwelling equipped with heating
		Pop. Liv. Dwelling equipped with air conditioning
		Pop. considering their dwelling as too dark
	Energy Consumption and Equipment	Final consumption expenditure of households [2]
		Final energy consumption in households by energy use
		Final energy consumption in households by type of fuel
Mobility		Final consumption expenditure of households [3]
		Pop. who cannot afford a regular use of public transport
Socioeconomic aspects	Socio Economic and Living Conditions	Arrears on utility bills
		At risk of poverty or social exclusion
		Disposable annual household income
		Inability to keep home adequately warm
		Final consumption expenditure of households [4]
		Housing cost overburden rate
		Pop. Liv. Dwelling comfortably cool during summer time
		Pop. Liv. Dwelling comfortably warm during winter time
	Energy Expenditure and Energy Markets	Energy expenses by income quintile
		Energy Prices
		High share of energy expenditure in income (2M)
		Low absolute energy expenditure (M/2)
	Health	Causes of death
		Excess winter mortality/deaths
		Final consumption expenditure of households [5]
		Pop. Reporting a chronic disease

[1] Indicator's disaggregation: *Maintenance and repair of the dwelling* and *Goods and services for routine household maintenance*.

[2] Indicator's disaggregation: *Water supply and miscellaneous services relating to the dwelling* and *Electricity, gas and other fuels.*

[3] Indicator's disaggregation: *Purchase of vehicles*, *Operation of personal transport equipment* and *Transport services.*

[4] Indicator's disaggregation: *Food and non-alcoholic beverages*, *Actual rentals for housing* and *Imputed rentals for housing.*

[5] Indicator's disaggregation: *Health.*

2.2. National Indicators update

From the 2022 EPAH dashboard version, a few other improvements were developed and are listed and explained in the next subsections.

2.2.1 Indicators Removed

The first step in the current update of EPAH's indicators dashboard was the removal of redundant indicators, namely the indicators "**Number of rooms per person by ownership status**" and "**Dwellings in populated areas**". This decision is supported by the fact that these indicators individually do not provide any relevant insight into the EP vulnerability of the population. However, complemented with other indicators, they can still provide valuable information to characterize the context of vulnerability, and thus, they have been integrated as a disaggregation of other EP indicators on the EPAH dashboard (*e.g.* at risk of poverty and inability to keep home adequately warm).

This integration may contribute to increasing detail and nuance in EP assessment, shedding light on the potential connection between EP-affected regions or countries and the number of rooms per person and the distribution of dwellings in populated areas, uncovering possible leverage points that may enhance a diagnosis approach.

By integrating further indicators' disaggregation, the interconnectedness and comprehensiveness of the data and indicators presented in the EPAH dashboard are improved, facilitating a deeper cross-analysis and interpretation of EP trends and dynamics.

2.2.2 Code Changes

The current EPAH indicators dashboard has incorporated the revised "**At risk of poverty or social exclusion**" (AROPE) indicator, aligning it with the changes made to monitor the EU 2030 target on poverty and social exclusion (EUROSTAT, 2023).

In line with the European Pillar of Social Rights (European Commission, 2021a), which has set targets to be achieved by 2030, including the reduction of at least 15 million people at risk of poverty or social exclusion (with a focus on 5 million children), the AROPE indicator had undergone modifications. These modifications include a new severe material and social deprivation rate based on the percentage of the total population lacking at least seven out of thirteen material and social deprivation items. Additionally, the (quasi)-jobless household indicator has been defined as individuals aged 0-64 living in households where the adults, excluding certain categories such as students aged 18-24 and retired individuals, worked less than 20% of their total combined potential work-time during the previous year and relied primarily on pensions as their main source of income (EUROSTAT, 2023).

In addition, the AROPE indicator has also undergone code changes to accommodate the integration of a new disaggregation (see Section 2.1.3) and nomenclature of territorial units for statistics (NUT) within the EPAH's dashboard, as displayed in Table 1.

Table 2: AT RISK OF POVERTY OR SOCIAL EXCLUSION INDICATOR'S CODE CHANGES AND NEW DISAGGREGATION

Previous indicator code (<2023 EPAH version)	Current Indicator codes	Current indicator's disaggregation
ILC_PEPS01	ILC_PEPS01N	Persons at risk of poverty or social exclusion by age and sex
	ILC_PEPS03N	Persons at risk of poverty or social exclusion by income quantile and household composition
	ILC_PEPS07N	Persons at risk of poverty or social exclusion by tenure status
	ILC_PEPS11N	Persons at risk of poverty or social exclusion by NUTS regions
	ILC_PEPS13N	Persons at risk of poverty or social exclusion by degree of urbanisation

2.2.3 New disaggregation

New disaggregations have been added to the indicators "**At risk of poverty or social exclusion**," "**Inability to keep home adequately warm**," and "**Pop. Liv. dwelling with presence of leak, damp, and rot**" based on the same code source and/or after a code update. These modifications enable, for example, a more in-depth examination of the AROPE indicator, uncovering a wider range of factors that may be related to increased poverty and social exclusion. The updated AROPE indicator provides further information on the risk of poverty and its relation to other factors, potentially contributing to further understanding of EP within the broader context of poverty and social exclusion. This update aims to provide more detailed information and ensure a homogenous framework to analyse and compare different indicators presented by EPAH.

The disaggregation of indicators according to specific factors such as age, income, household composition, and housing conditions unlocks new insights into the specific populations and the contexts that EP affects. The disaggregation details are in **.**.

Table 3: NEW DISAGGREGATION of "At risk of poverty or social exclusion," "Inability to keep home adequately warm," and "Pop. Liv. dwelling with presence of leak, damp, and rot" indicators

Indicator	Indicator code(s)	Indicator's new disaggregation
At risk of poverty or social exclusion	ILC_PEPS01N	By age and sex: Males Females From 16 to 29 years From 16 to 64 years 65 years or over
	ILC_PEPS03N	By income quantile and household composition: First quintile Second quintile Third quintile Fourth quintile Fifth quintile Household composed of one adult with dependent children Household composed of two adults with three or more dependent children Household composed of one adult 65 years or over
	ILC_PEPS07N	By tenure status: Owner, with mortgage or loan Owner, no outstanding mortgage or housing loan Tenant, rent at market price Tenant, rent at reduced price or free
	ILC_PEPS11N	By NUTS regions
	ILC_PEPS13N	By degree of urbanisation: Cities Towns and suburbs Rural areas
Inability to keep home adequately warm	ILC_MDES01	By type of household: One adult 65 years or over Single person with dependent children Two adults with three or more dependent children By income situation in relation to the risk of poverty threshold: Below 60% of median equivalised income Above 60% of median equivalised income
Population Living in a dwelling with	ILC_MDHO01	By sex: Males

presence of leak, damp and rot		Females By age: Less than 18 years From 18 to 64 years 65 years or over By type of household: One adult 65 years or over Single person with dependent children Two adults with three or more dependent children By income situation in relation to the risk of poverty threshold: Below 60% of median equivalised income Above 60% of median equivalised income

2.2.4 New organisation

The previous EPAH indicators (*i.e.*, <2023 version) related to **household energy prices, including household electricity prices, household natural gas prices, biomass prices, fuel oil prices, coal prices,** and **district heating prices as standalone indicators**, have now undergone reorganization. They have been consolidated into a single indicator now called "**Energy prices**". This reorganization aims to streamline the presentation and analysis of energy price data within the EPAH indicator framework. By combining these indicators under a single category, it becomes easier to compare and evaluate the affordability and accessibility of different energy sources for households experiencing EP.

2.2.5 New indicators

The current EPAH indicator dashboard has been expanded with the addition of 11 new indicators, ranging from four Topics and five Subtopics, as explained previously. These indicators align with the European Commission's objectives, respond to new policy interests such as health, climate change and transportation, address pressing concerns related to climate change, and offer valuable insights into energy use and consumption patterns within individual countries. The new indicators and where they are considered are presented in Table 4.

Table 4: NEW INDICATORS, CODES AND (SUB)TOPICS

Topics	Subtopics	EPAH Indicator	EUROSTAT Code
Climate		Cooling degree days	NRG_CHDDR2_M
		Heating degree days	NRG_CHDDR2_M
Facilities/housing	Energy Consumption and Equipment	Final energy consumption in households by energy use	NRG_D_HHQ
	Energy Consumption and Equipment	Final energy consumption in households by type of fuel	NRG_D_HHQ
	Building Stock	Pop. considering their dwelling as too dark	TESSI295
Mobility		Pop. who cannot afford a regular use of public transport	ILC_MDES13A and ILC_MDES13B
Socio-economic aspects	Health	Causes of death	HLTH_CD_ASDR2
	Socio Economic and Living Conditions	Disposable annual household income	NAMA_10R_2HHINC
	Socio Economic and Living Conditions	Housing cost overburden rate	ILC_LVHO07A
	Health	Pop. reporting a chronic disease	HLTH_EHIS_CD1I
Socio-economic aspects Facilities/housing Mobility	Energy Consumption and Equipment Mobility Building Stock Health	Final consumption expenditure of households	NAMA_10_CO3_P3

The new indicators shed light on various untapped aspects of EP relevant to its underlying causes and effects:

1. **Cooling degree days [Number of days]:** This indicator is a measure of the number of degrees above a base temperature to quantify the energy necessary to cool a building to a comfortable indoor temperature.
2. **Heating degree days [Number of days]:** This indicator measures the number of degrees under a base temperature, representing the amount of energy needed to increase the temperature of a building to a comfortable indoor temperature.
3. **Final energy consumption in households by energy use [TJ- Terajoule]:** This indicator presents the households' final energy consumption per end use, such as space heating and cooling, lighting, and appliances.
4. **Final energy consumption in households by type of fuel [TJ- Terajoule]:** Represents the households' final energy consumption per energy source, including electricity, natural gas, biomass, fuel oil, and others.
5. **Pop. considering their dwelling as too dark [Population (%)]:** Captures the perception of individuals regarding the level of darkness in their homes.

6. **Pop. who cannot afford a regular use of public transport [Population (%)]:** This indicator focuses on the population facing financial challenges in accessing and affording public transportation services.
7. **Causes of death [number of deaths per 100,000 inhabitants]:** Provides the number of people diseased, such as asthma and stroke, per causes of mortality within a population.
8. **Disposable annual household income [Purchasing power standard (PPS, EU27 from 2020), per inhabitant]:** Measures the households' available annual income after deducting taxes and other mandatory payments.
9. **Housing cost overburden rate [Population (%)]:** This indicator identifies households that spend an excessively high proportion of their income on housing costs.
10. **Pop. reporting a chronic disease [Population (%)]:** This indicator shows the prevalence of reported chronic diseases in the population.
11. **Final consumption expenditure of households [Current prices, euro per capita]:** This indicator provides insights into the financial resources spent by households for various consumption purposes, including energy services.

In Section 3, a detailed explanation of the newly added indicators is provided, covering their relevance and implications in the context of EP measurement, as well as technical details, including the associated disaggregation, limits, and application suggestions.

3

New EPAH Indicators

This chapter follows a similar structure to the previous EPAH (2022) report (Gouveia *et al*., 2022) on energy poverty indicators, "**National Indicators: Insights for a more effective measuring**", as it delves into the exploration of the newly added indicators on the EPAH dashboard. Additionally, this report introduces information on the topic and subtopic for each indicator, which is a new feature discussed in the previous chapter. By analyzing each indicator, we aim to broaden the scope of analysis and explore the connections between EP and newly identified variables, providing insights into their significance for EP measurement and implications for policymaking.

In the "Current Situation" section, each indicator is presented alongside the latest map and bar chart, highlighting the results for EU countries based on the updated EPAH dashboard visuals. The subsequent technical details section offers statistical information that provides a deeper understanding of the indicators, including the relevant measurement methodology and data sources, thus also enhancing transparency and reliability. The subsequent section focuses on the limits and application suggestions, examining the strengths and weaknesses of each indicator for EP measurement and providing guidance for more effective and appropriate use, presenting various application cases to illustrate their potential uses. The "Updates and disclaimers" section offers a concise overview of the core information for each indicator and the update conducted. Concluding the indicator analysis, a headline quote(s) highlights the specific numbers pertaining to the indicator for the EU27 region.

Current situation	the most recent available data and definition for the indicator.
Technical details	statistical information is described.
Limits and application suggestions	strengths, shortcomings, and use cases of each indicator.
Updates and disclaimers	core information analysis summary.

3.1 Final consumption expenditure of households

3.1.1 Current Situation

The "Final consumption expenditure of households" refers to the total expenditure of households on goods and services for a specific consumption purpose, as defined by the Classification of Individual Consumption by Purpose (COICOP) system. The COICOP system classifies consumption expenditure into categories based on the purpose of consumption, such as food, housing, health, transport, and recreation.

Figure 1 and 2 present the last data available for the indicator in map and bar chart.

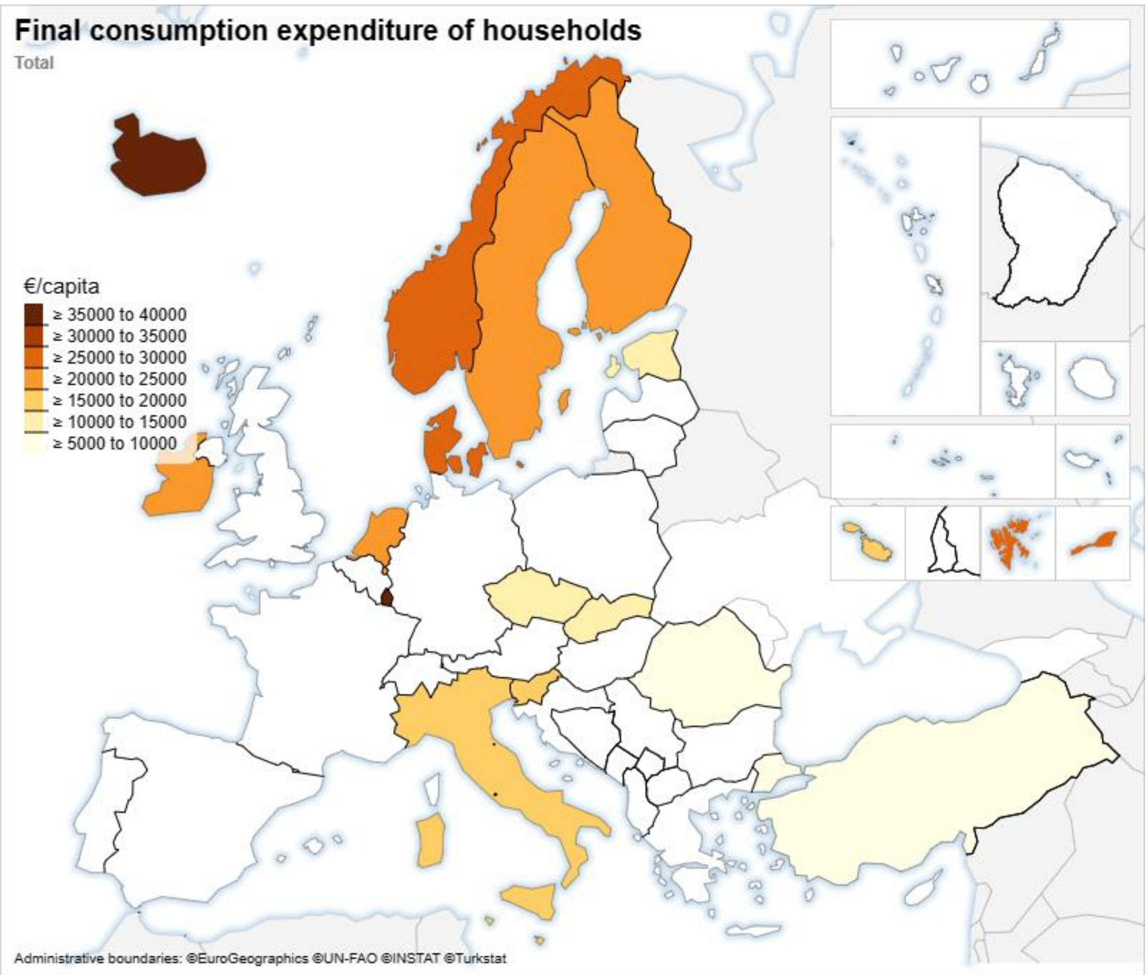


Figure 1: MAP OF FINAL CONSUMPTION EXPENDITURE OF HOUSEHOLDS (Total) in 2022

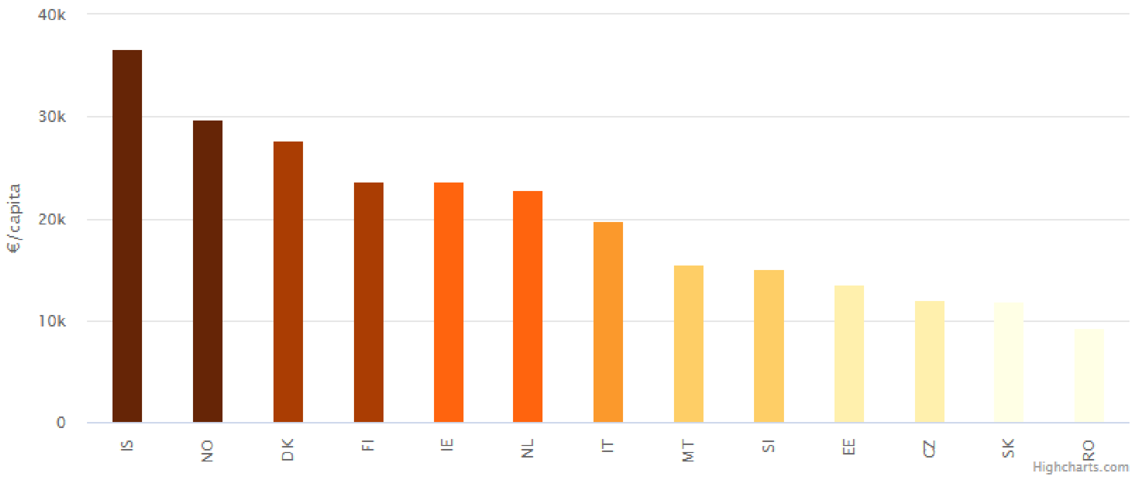


Figure 2: BAR CHART OF FINAL CONSUMPTION EXPENDITURE OF HOUSEHOLDS (Total) in 2022

3.1.2 Technical Details

Table 5 presents the technical details for the "Final consumption expenditure of households" indicator. They include the statistical code used in the indicator source, the indicators' topics, the identification name used on the national energy poverty indicator's dashboard section of the EPAH website, the timeline period with available data, the number of countries represented in the last update in relation to the maximum 44 GEO list and/or NUT, and the data sources used.

Table 5: FINAL CONSUMPTION EXPENDITURE OF HOUSEHOLDS' INDICATOR TECHNICAL DETAILS

Identification Code	**(Sub)**Topics	Name	Timeline	# GEO	Source
NAMA_10_CO3_P3	**Facilities/Housing** (Building Stock and Energy Consumption and Equipment) **Mobility** **Socioeconomic aspects** (Socio Economic and Living Conditions and Health)	Final consumption expenditure of households	2004-2022	39/44	EUROSTAT

The following options were selected from the EUROSTAT data source and are now available as disaggregation options under the following Topics (T) and Subtopics (S):

- Socioeconomic Aspects (T)
    - Socioeconomic and living conditions (S)
        - Food and non-alcoholic beverages
        - Actual rentals for housing
        - Imputed rentals for housing
    - Health (S)
        - Health
- Facilities/housing (T)
    - Building Stock (S)
        - Maintenance and repair of the dwelling
        - Goods and services for routine household maintenance
    - Energy Consumption and Equipment (S)
        - Water supply and miscellaneous services relating to the dwelling
        - Electricity, gas, and other fuels
- Mobility (T)

- Purchase of vehicles
- Operation of personal transport equipment
- Transport services

3.1.3 Limits and Application Suggestions

Energy poverty is a complex issue influenced by various factors, such as energy consumption, energy price, income, and energy efficiency. People living in EP may have lower incomes and consume less energy (Carfora *et al.*, 2022), making it difficult to obtain essential energy services such as heating and cooling, cooking, and lighting, as highlighted in Burlinson *et al.* (2022). The final consumption expenditure of households' indicator can help analyse national consumption profiles, household consumption choices, and families' economic well-being or lack thereof. The indicator provides information on household consumption patterns and can be used to examine spending trends over time and variations in spending patterns between other nations. High-income households tend to spend more on specific categories of goods and services, which show higher elasticity in relation to income; for instance, high-income households tend to use much more energy for transportation, namely aviation and motor vehicles, than the average household, while housing energy consumption tends to be less elastic (Ivanova and Wood, 2020). Issues of excess energy use in high-income groups are becoming an issue on their own, revealing another facet of the persistent inequality in energy consumption patterns, which is also shown by energy poverty (Baltruszewicz *et al.*, 2023).

A disaggregated analysis of this indicator focusing on expenditures such as "Food and non-alcoholic beverages" and "Actual rentals for housing, Imputed rentals for housing" might uncover negative impacts on basic needs and housing affordability. High rent payment contributes to EP, and tenants are one of the population groups with increased vulnerability to EP across the Global North (Drehobl *et al.*, 2020; Simcock *et al.*, 2021).

The indicators' disaggregation "Maintenance and repair of the dwelling" and "Electricity, gas and other fuels" provide information that can be more directly linked to a potential EP situation, as excessively high or abnormally low expenditures on dwelling maintenance or energy carriers can be a sign of difficulty to guarantee these needs. Building envelope characteristics and their maintenance determine the overall energy performance of a building (Košir *et al.*, 2018), impacting the level of thermal comfort experienced by individuals. On the other hand, expenditure on dwelling maintenance may or may not be related to improved energy performance, as research finds that a significant share of building renovations is focused on aesthetic aspects (Mahapatra *et al.*, 2019; Sequeira and Gouveia, 2022).

The energy efficiency of the buildings people inhabit and the appliances used within them is also important, as households that cannot afford efficient appliances or heating systems may face higher energy costs, exacerbating their poverty (Sareen *et al.*, 2020).

The indicator also provides information on mobility expenses, enabling the examination of potential transport energy poverty through the comparison of transport expenses, such as purchase and operation of vehicles and use of transport services, with household's income and mobility options (Mattioli *et al.*, 2018; Lowans *et al.*, 2021).

Energy poverty and health have a bi-directional relationship, with poor health conditions being both a causal factor and a proven negative consequence of EP (Oliveras *et al.*, 2020). In addition, people with chronic ill health and disabilities may have specific energy use needs, such as running energy-intensive medical equipment or spending longer periods at home

(Ivanova and Middlemiss, 2021), translating into added vulnerability. Therefore, higher expenditure on health can be partially an effect of EP but also exacerbate vulnerability to it. However, it should be noted that a wide range of other factors beyond EP impact household health expenses.

It is important to note that the indicator has limitations that should be considered. Low energy expenditure may be associated with an efficient and sustainable dwelling and its equipment and not a self-imposed restriction. On the other hand, high expenditures on rent, energy, and maintenance might result from lifestyle choices and not necessarily relate to a situation of hardship. This indicator should be complemented with other proposed EPAH indicators, such as income and energy prices, to understand the weight of each expense on the household’s available resources and identify potential financial strains, as it is difficult to understand if a certain expenditure is high or low. This indicator only portrays the economic dimension of EP. Therefore, it should be cross-analysed with indicators that capture the dwellings’ energy efficiency and perceived thermal comfort. It would also unlock further insight into the relationship between the level of these expenses and the existing conditions and their impact on well-being, allowing a more accurate identification of potential problems.

Example: a household with a poorly insulated building and inefficient appliances may consume more energy and, therefore, have a higher final energy expenditure than a household with a well-insulated building and efficient appliances, even if they have similar energy needs.

3.1.4 Updates and Disclaimer

The “Final Consumption Expenditure of households” has been added as a new indicator.

In 2021: Household consumption expenditure increased by 4.2 % in the EU compared with 2020 but was still 4.1% lower than before the COVID-19 pandemic in 2019.

'Housing, water, electricity, gas, and other fuels', 'Food and non-alcoholic beverages' and 'Transport' **account for more than half of the total household expenditure** (51.4 %).

Concerning expenditure on 'Transport', the **highest shares of household expenditure** were found in Slovenia (16.9 %), Lithuania (15.3 %) and Luxembourg (14.2 %). In comparison, the lowest levels were found in Slovakia (5.4 %), Croatia (7.6 %), as well as Czechia, Belgium and Ireland (all 9.6 %).

3.2 Disposable annual household income

3.2.1 Current Situation

The "Disposable annual household income" indicator refers to the total income received by all household members from all sources (such as wages, salaries, pensions, social benefits, etc.) minus any taxes, social security contributions, and other mandatory deductions.

Figure 3 and 4 present the latest data available for the indicator in the map and bar chart.

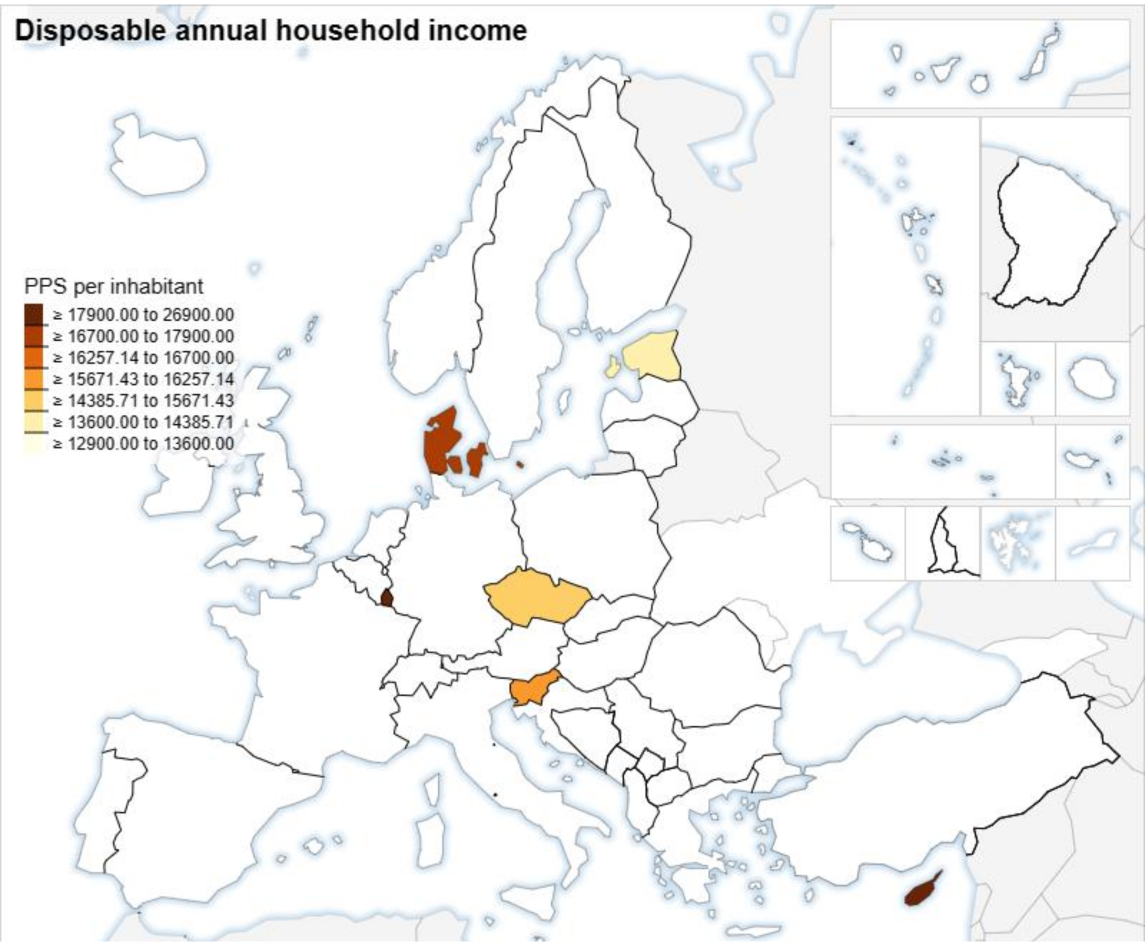


Figure 3 MAP OF DISPOSABLE ANNUAL HOUSEHOLD INCOME IN 2021

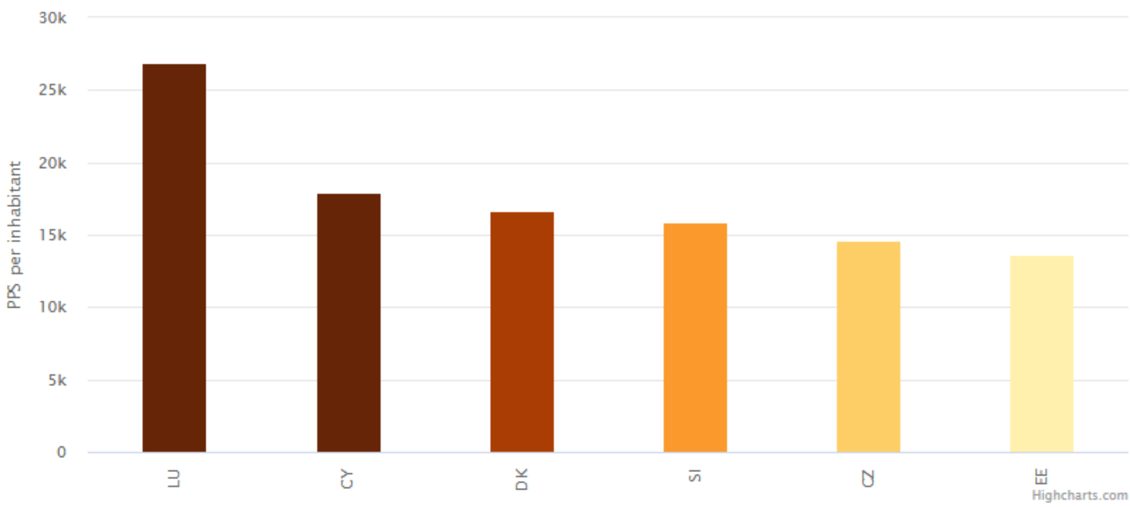


Figure 4: BAR CHART OF DISPOSABLE ANNUAL HOUSEHOLD INCOME IN 2021

3.2.2 Technical Details

Table 6 presents the technical details for the disposable annual household income indicator, namely the statistical code used in the indicator source, the indicators' topics, the identification name on the national EP indicator's dashboard section of the EPAH website, the timeline period with available data, the number of countries represented in the last update in relation to the maximum 44 GEO list and/or NUT, and the data sources used.

Table 6: DISPOSABLE ANNUAL HOUSEHOLD INCOME'S INDICATOR TECHNICAL DETAILS

Identification Code	**(Sub)**Topics	Name	Timeline	# GEO	Source
NAMA_10R_2HHINC	**Socioeconomic aspects** (Socio Economic and Living Conditions)	Disposable annual household income	2004-2021	30/44 NUTS 1 and 2	EUROSTAT

3.2.3 Limits and Application Suggestions

The "Disposable annual household income" indicator is a valuable tool for getting insight into the financial well-being of households in different regions of the European Union. Income is one of the main drivers of EP (Thomson *et al*., 2017). It can be useful to identify regions where households may be more likely to experience EP due to low disposable income levels. Nevertheless, it is not possible to capture the complete picture of energy poverty using this indicator alone, as EP results from the conflation of several other factors, as already seen, such as energy consumption, energy efficiency, and energy prices. Disposable income has some advantages in comparison with gross income, as it provides a clearer figure of the available financial resources that households have available to spend on basic services such as energy, by subtracting all mandatory deductions *a priori*. To assess the available amount in terms of its ability to cover the necessary energy expenses, it is necessary to cross reference this indicator with others, pertaining to the dwelling's energy efficiency, the household energy needs and costs, or even the indicators "arrears on utility bills" and "inability to maintain adequate temperatures in the winter and summer", which reflect the difficultly in accessing adequate energy services. Other factors such as household composition, dwelling type, and geographic location can also provide complementary insights regarding the relationship between income and the lived experience of consumers and how this may vary between different national, cultural and socioeconomic contexts. Identifying whether a household is in EP requires the selection and use of a threshold, as with all other objective indicators. Together with other EP drivers, this indicator can also be used in an area-based measurement approach that computes territorial levels of vulnerability by combining several indicators (as in Gouveia *et al*., 2019 and Martín-Consuegra *et al*., 2019) instead of being used for the direct headcount of EP prevalence.

Example: In cases where low-income householders reside in energy efficient homes, have no rental costs and have access to low-cost fuels the household would not be considered to be in EP.

3.2.4 Updates and Disclaimer

The “Disposable annual household income” has been added as a new indicator.

In 2021, the highest levels of inequality in terms of disposable income in the EU were experienced in Bulgaria (39.7 %), Latvia (35.7 %), Lithuania (35.4 %) and Romania (34.3 %).

3.3 Final energy consumption in households

3.3.1 Current Situation

The “Final energy consumption in households by energy use” indicator refers to the amount of energy consumed by households for all purposes, including space heating and cooling, water heating, cooking, lighting, and electrical appliances by energy use.

Figure 5 and 6 present the last data available (i.e. 2021) for the indicator in map and bar chart.

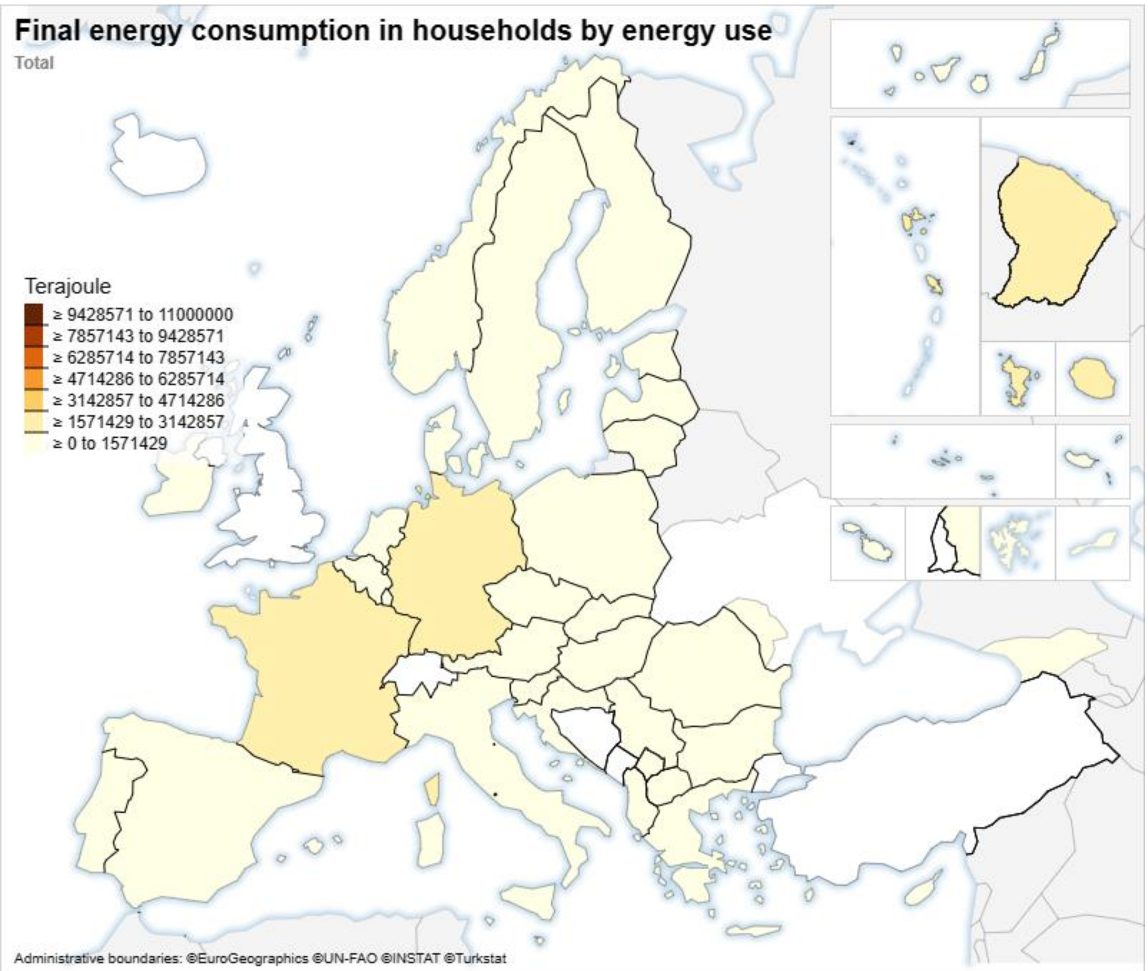


Figure 5 MAP OF FINAL ENERGY CONSUMPTION IN HOUSEHOLDS BY ENERGY USE (Total) in 2021

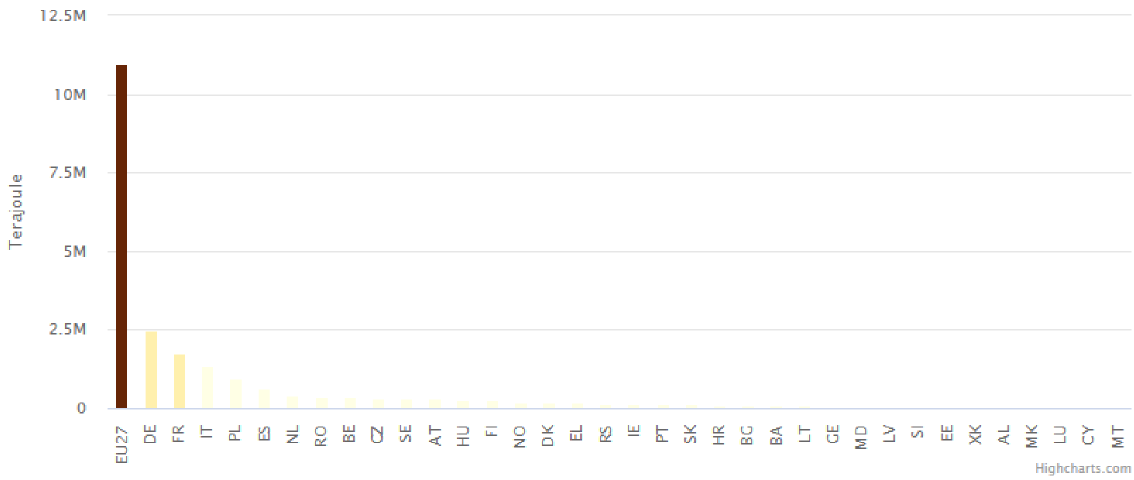


Figure 6: BAR CHART OF FINAL ENERGY CONSUMPTION IN HOUSEHOLDS BY ENERGY USE (Total) in 2021

The “Final energy consumption in households by type of fuel” indicator refers to the amount of energy consumed by households for all purposes, including space heating and cooling, water heating, cooking, lighting, and electrical appliances by energy use by type of fuel.

Figure 7 and 8 present the last data available for the indicator in map and bar chart.

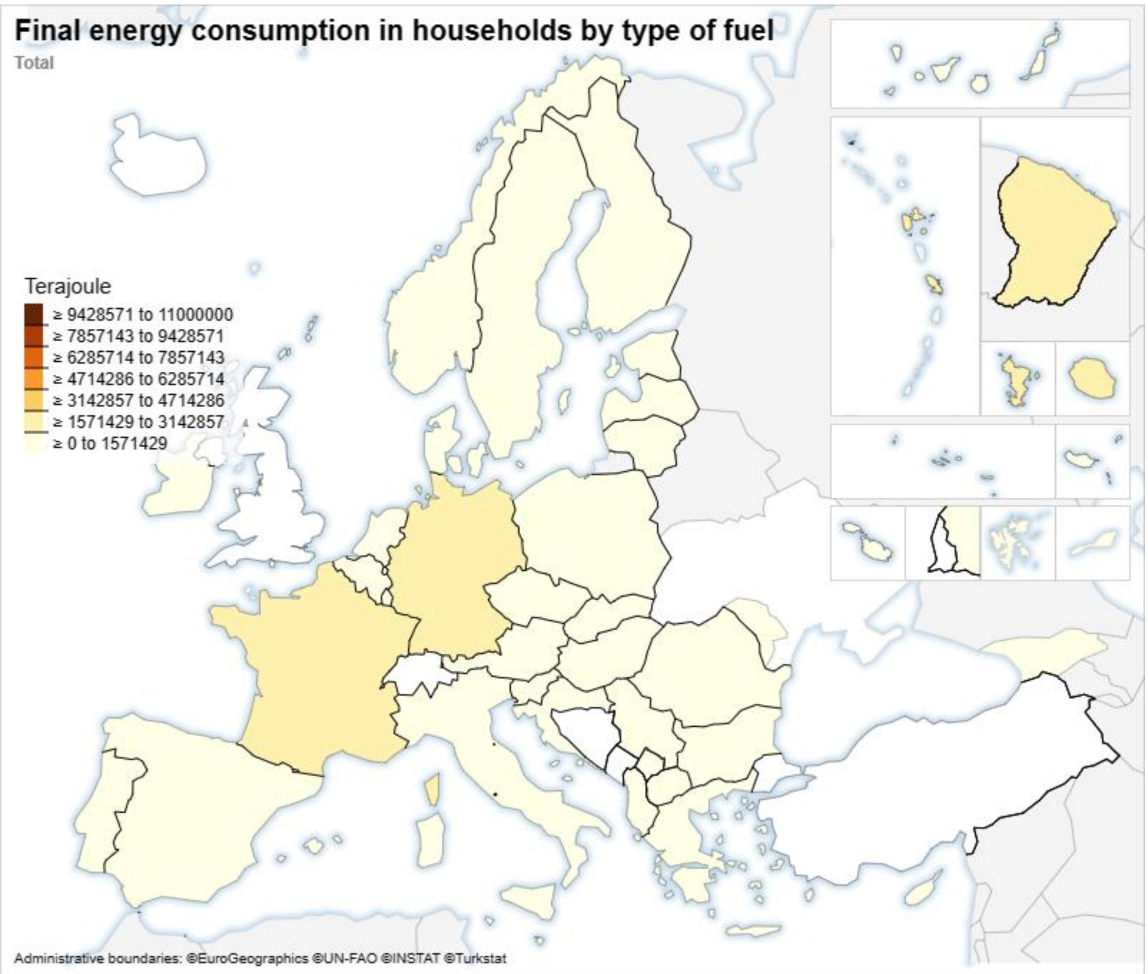


Figure 7: MAP OF FINAL ENERGY CONSUMPTION IN HOUSEHOLDS BY TYPE OF FUEL

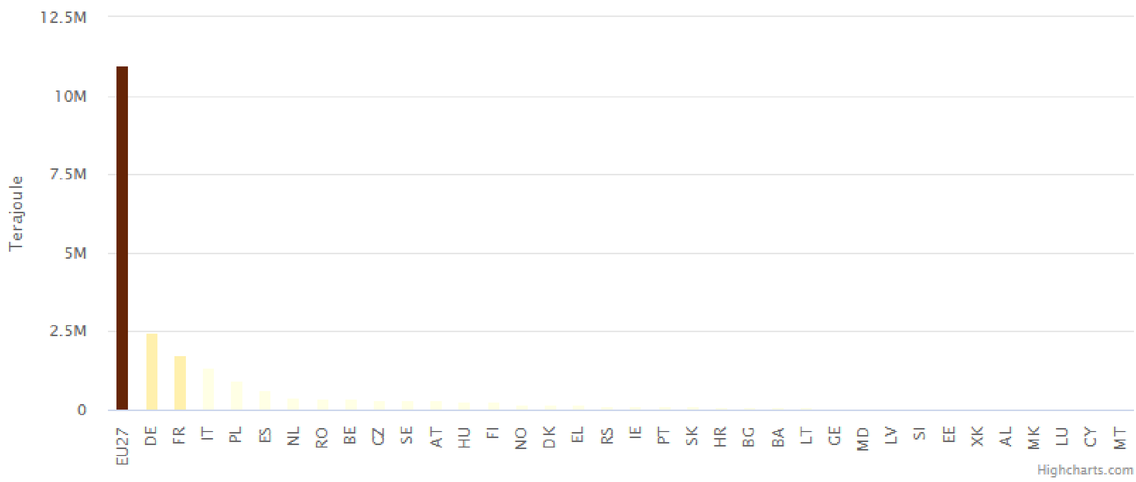


Figure 8: BAR CHART OF FINAL ENERGY CONSUMPTION IN HOUSEHOLDS BY TYPE OF FUEL (Total) in 2021

3.3.2 Technical Details

Table 7 presents the technical details for the “Final energy consumption in households” indicator. These are the statistical code used in the indicator source, the indicators’ topics, the identification name used on the national energy poverty indicator’s section of the EPAH website, the timeline period with available data, the number of countries represented in the last update in relation to the maximum 44 GEO list and/or NUT, and the data sources used.

Table 7: FINAL ENERGY CONSUMPTION IN HOUSEHOLDS’ INDICATORS TECHNICAL DETAILS

Identification Code	(Sub)Topics	Names	Timeline	# GEO	Source
NRG_D_HHQ	**Facilities/housing** (Building Stock)	Final energy consumption in households by type of fuel Final energy consumption in households by type of use	2010-2021	37/44	EUROSTAT

The following options were selected from their original source and are available as disaggregation:

- By Fuel
  - Total
  - Natural gas
  - Oil and petroleum products
  - Solar thermal
  - Ambient heat (heat pumps)
  - Primary solid biofuels
  - Biogases
  - Electricity
  - Heat
- By energy use
  - All
  - Space heating
  - Space cooling
  - Water heating
  - Cooking
  - Lighting and electrical appliances
  - Other end uses
  - Solid fossil fuels, peat, peat products, oil shale and oil sands

3.3.3 Limits and Application Suggestions

The "Final energy consumption in households" indicator is useful for analyzing household energy consumption in terms of the used fuel and energy service and monitoring trends over time.

The disaggregation by fuel and energy use enables a more detailed understanding of how energy is consumed in a specific country, accounting for historical choices or fuel availability. This disaggregation also provides useful insights into drivers of EP such as dependencies on expensive fuels like natural gas for space heating or biomass, where the latter in particular implies reduced combustion efficiency, access challenges and potential indoor air quality problems. It can also uncover potential effects of EP, such as abnormally low or high consumptions for a given energy service. At the same time, it also sheds light on the progress of the energy transition, namely the reduction of fossil fuel dependency, electrification of energy uses, and increase of renewable energy. Individually, this indicator does not provide sufficient information to discern whether a household is suffering from energy poverty or if the population of a region might be vulnerable to this problem. Actual energy consumption can be compared to a reference value, such as the calculated theoretical energy consumption for ensuring thermal comfort to calculate buildings energy performance gap (Palma *et al.*, 2019) or be used to estimate energy costs using data on energy prices (Ntaintasis *et al.*, 2019; Papada and Kaliampakos; 2019). This way, it can be used to identify cases of abnormally high or low energy consumption at the household scale.

At the national level, it is more likely that abnormal consumption is hidden in the total consumption of a region, which means the indicator loses effectiveness. It should also be noted that different countries have different energy access conditions and consumption habits. For instance, some regions lack access to networked heating infrastructures (Simcock *et al.*, 2021), natural gas grids, or simply rely on off-grid available fuels such as biomass. This can result in the mischaracterization of households which are energy-poor or an exaggeration of the potential vulnerability of households or regions. Nevertheless, wood is the main heating source for several energy-poor homes across Europe. Stojilvoska *et al. (*2023) describe fuelwood as a cultural norm to cope with EP. The analysis of this indicator should be conducted in light of other factors, such as dwelling characteristics and energy efficiency, income levels, expenditure on housing and other basic needs, and inability to obtain thermal comfort. Self-reported indicators can also enable a more informed overview of energy consumption considering a wider picture of the background context. Climate should also be considered, as it plays a significant role in the final energy consumption of households, impacting heating and cooling needs and potentially energy consumption. Household composition and dwelling type are also important factors potentially driving energy consumption.

Example: A household may record expected energy consumption levels compared to average, but if it is composed by a large number of family members living in a region where the climate is cold, and in a poorly insulated home, it may be in a situation of energy poverty.

3.3.4 Updates and Disclaimer

The “Final Energy Consumption Expenditure in households” has been added as a new indicator.

In 2020, the primary **use of energy by households** was for heating their homes (62.8% of final energy consumption in the residential sector), with renewables accounting for more than a quarter (26.8%) of space heating consumption in European Union (EU) households.

Natural gas accounted for 31.7% of the EU **final energy consumption in households**, electricity for 24.8%, renewables and wastes 20.3%, and oil and petroleum products 12.3%.

3.4 Housing cost overburden rate

3.4.1 Current Situation

The "Housing cost overburden rate" indicates the percentage of the population living in a household where the total housing costs (net of housing allowances) represent more than 40% of the total disposable household income.

Figure 9 and 10 present the last data available for the indicator in the map and bar chart.

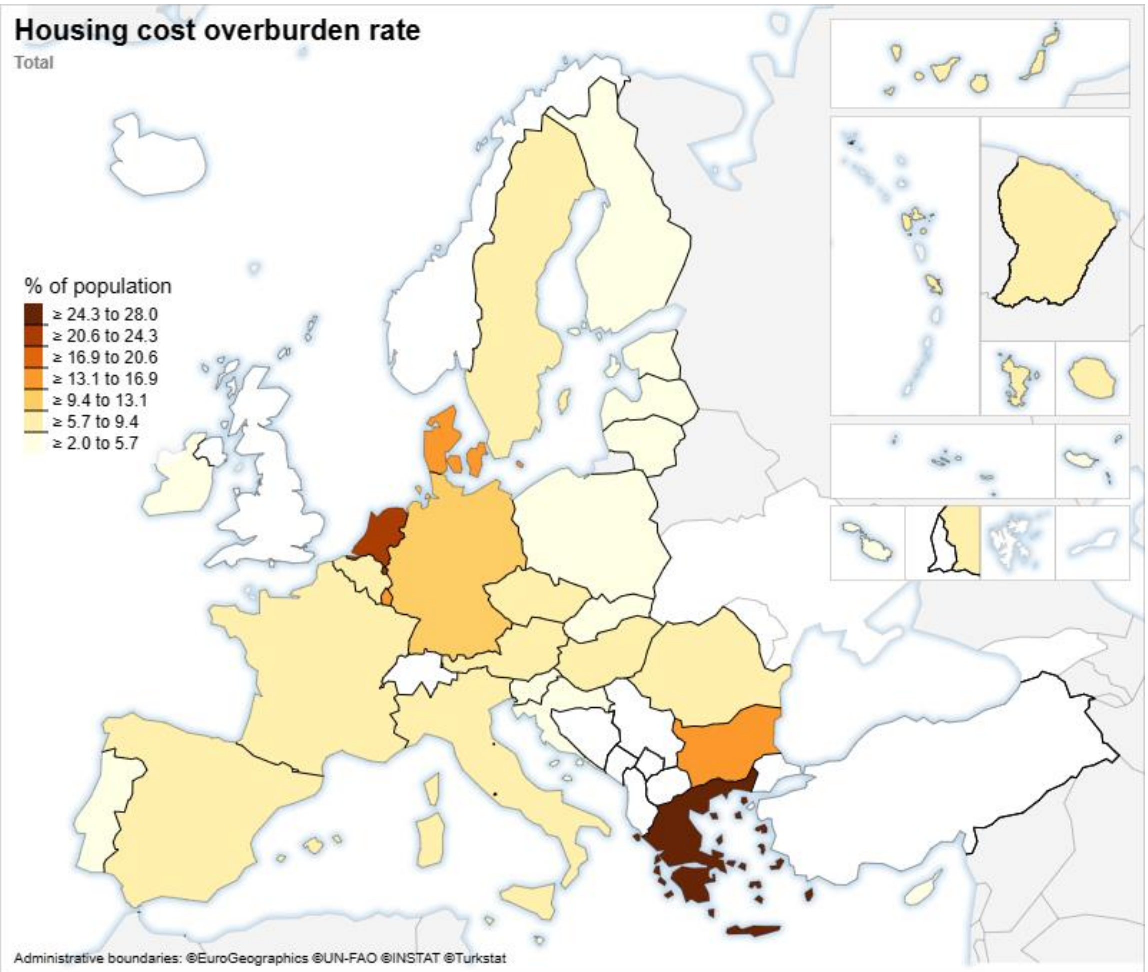


Figure 9: MAP OF HOUSING COST OVERBURDEN RATE (Total) in 2022

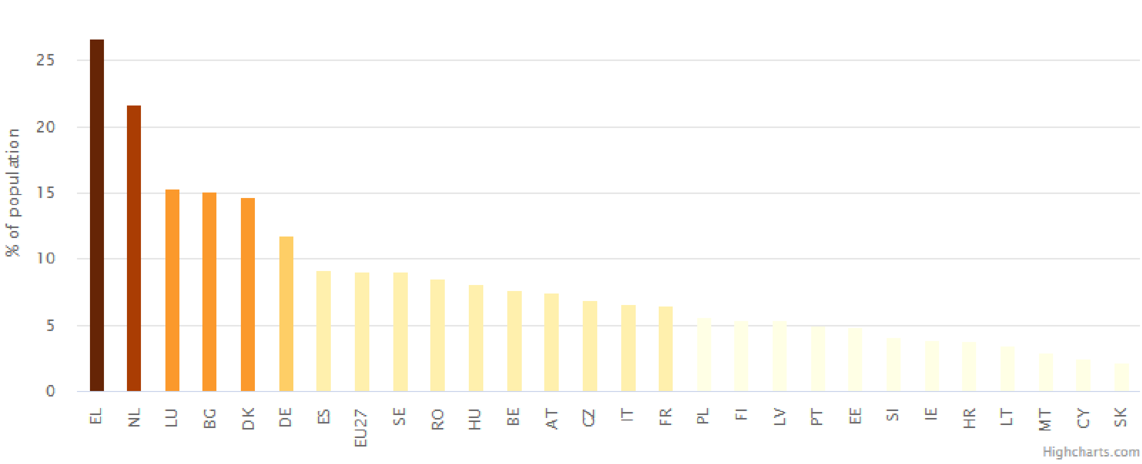


Figure 10: BAR CHART OF HOUSING COST OVERBURDEN RATE (Total) in 2022

3.4.2 Technical Details

Table 8 presents the technical details for the "Housing cost overburden rate" indicator – the statistical code used in the indicator source, the indicators' topics, the identification name used on the national energy poverty indicator's dashboard section of the EPAH website, the timeline period with available data, the number of countries represented in the last update in relation to the maximum 44 GEO list and/or NUT, and the data sources used.

Table 8: HOUSING COST OVERBURDEN RATE'S INDICATOR TECHNICAL DETAILS

Identification Code	(Sub)Topics	Name	Timeline	# GEO	Source
ILC_LVHO07A	**Socioeconomic aspects** (Socio Economic and Living Conditions)	Housing cost overburden rate	2004-2022	38/44	EUROSTAT

The following options were selected from their original source and are available as disaggregation:

- By age
  - From 16 to 29 years
  - From 16 to 64 years
  - 65 years or over
- By sex
  - Males
  - Females
- By income status
  - Below 60% of the median equivalized income
  - Above 60% of the median equivalized income

3.4.3 Limits and Application Suggestions

The "Housing cost overburden rate" measures housing affordability, identifying households with difficulty covering housing-related costs, such as rent, mortgage payments, utilities, and maintenance. High housing costs increase the probability of being trapped in persistent EP (Simcock *et al*., 2021). It contributes to increased vulnerability to EP by lowering disposable income and potentially placing households in a situation where they must choose between paying for fundamental needs such as food, healthcare, and energy (Karpinska and Smiech, 2020). Furthermore, households that spend a significant amount of their income on housing costs are more likely to live in inadequately insulated homes or have obsolete heating and cooling systems, which increases the risk of EP and the incidence of health concerns (Pereira and Marques, 2023).

While this indicator identifies households struggling to pay for housing-related expenses, it has its limits for measuring EP. It does not provide information on housing quality or energy efficiency, which is crucial for a more complete picture of the situation in the household. The high housing cost burden can be the consequence of the household's drop in income, a quick increase in housing cost due to a situation of market inflation or a ramp-up in interest rates, or even due to the household's decision to live in a better home with higher energy efficiency which requires a very limited amount of energy. Thus, it is essential to couple this indicator with indicators that provide information on income and energy efficiency regarding both the energy performance of the envelope and the energy efficiency of the equipment. With this combination of indicators, it would be possible to understand if there is indeed a connection between housing cost overburden, low income, and dwelling's lack of energy efficiency, which, if demonstrated, would most likely mean a situation of EP. Another viable option would be to perform a joint analysis of the "Housing cost overburden rate" with the consensual-based proxy EP indicators that portray the ability of households to maintain a comfortable temperature in the winter and summer or the ability to pay for energy bills. For an even deeper analysis, these should also be complemented with the energy affordability indicators (2M and M/2) to detect potential overconsumption, but especially underconsumption, potentially indicative of situations of hidden EP, given that housing costs which are overly burdensome are more likely to lead to self-restriction of other needs.

Example: A household spending a large portion of their income on housing costs due to high rents or mortgages due to rising interest rates may have
to restrain energy consumption to be able to make ends meet, thus being in a situation of EP.

3.4.4 Updates and Disclaimer

The "Housing cost overburden rate" has been added as a new indicator.

In 2021, **8.3%** of the population in the European Union were **overburdened by housing costs**, corresponding to 37.1* million Europeans.

**considering that the European Union population in 2021 was 447.0 million, according to EUROSTAT (2022i)*

3.5 Population considering their dwelling as too dark

3.5.1 Current Situation

The "Pop. Considering their dwelling as too dark" indicator refers to the percentage of the total population considering their dwelling as too dark and not having enough light.

Figure 11 and 12 present the last data available for the indicator in map and bar chart.

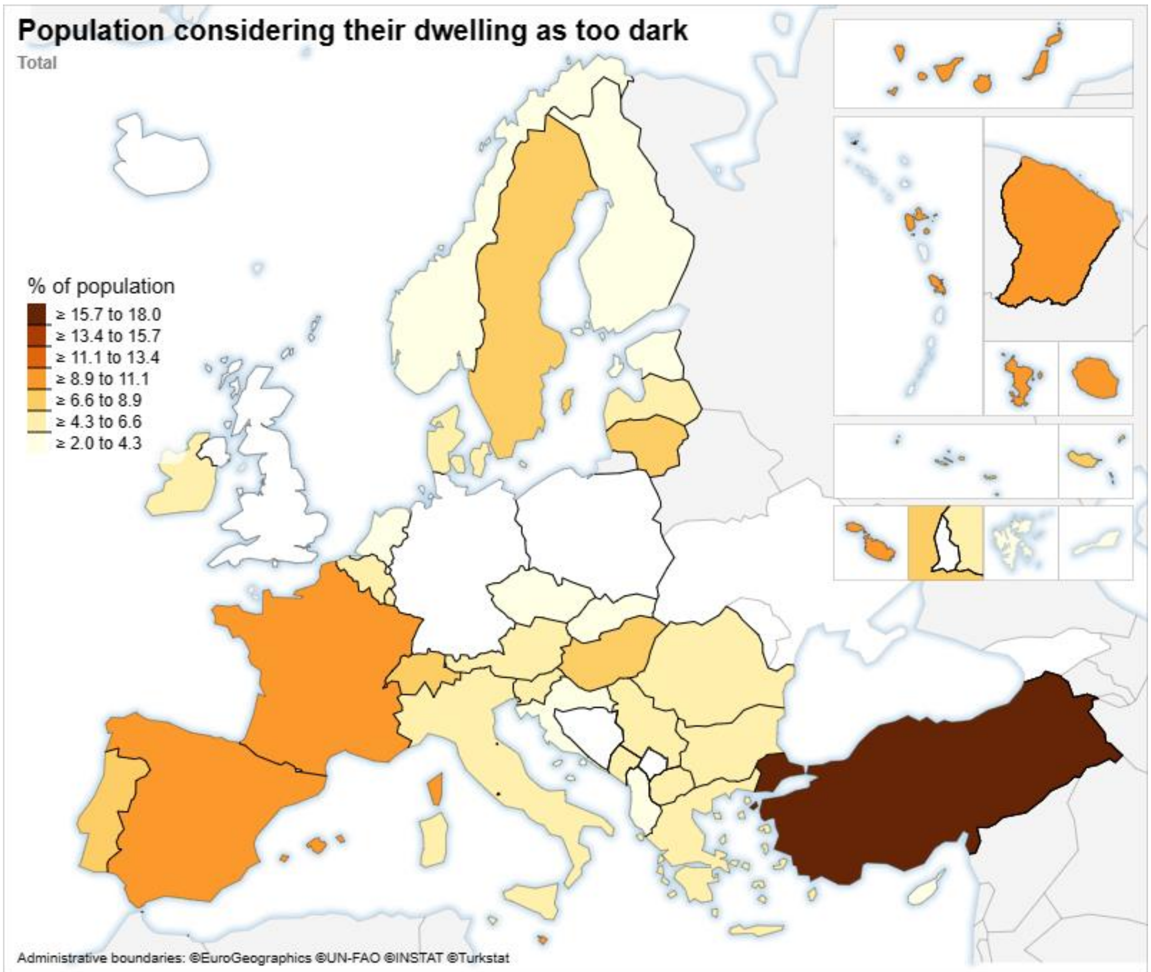


Figure 11: MAP OF POPULATION CONSIDERING THEIR DWELLING AS TOO DARK (Total) in 2020

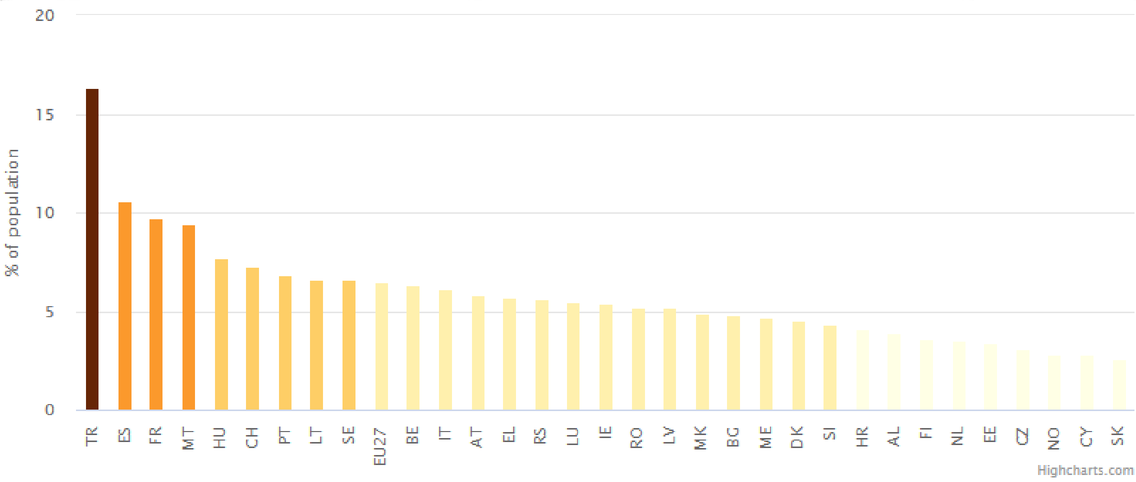


Figure 12: BAR CHART OF POPULATION CONSIDERING THEIR DWELLING AS TOO DARK (Total) in 2020

3.5.2 Technical Details

Table 9 presents the technical details for the "Pop. Considering their dwelling as too dark" indicator. It presents the statistical code used in the indicator source, the indicators' Topics, the identification name used on the national energy poverty indicator's section of the EPAH website, the timeline period with available data, the number of countries represented in the last update to the maximum 44 GEO list and/or NUT, and the data sources used.

Table 9: POP. CONSIDERING THEIR DWELLING AS TOO DARK TECHNICAL DETAILS

Identification Code	(Sub)Topics	Name	Timeline	# GEO	Source
TESSI295	**Facilities/Housing** (Building Stock)	Pop. Considering their dwelling as too dark	2010-2021	37/44	EUROSTAT

3.5.3 Limits and Application Suggestions

The "Pop. considering their dwelling as too dark" indicator can reflect housing conditions and the ability to provide adequate lighting, essential for people's health, quality of life, and capabilities to perform productive work (Pellicer-Sifres *et al.,* 2021). Inadequate lighting can stem from various factors, including the orientation and position of dwellings with sunlight, the presence and size of windows, and the number of light fixtures in the living spaces. The perception of a home being too dark can result from the lack of two different types of lighting – natural or artificial- whose lack can also be overlapped.

Inadequate lighting harms health since it can cause eye strain, weariness, and an increased risk of accidents and injuries. Moreover, it hampers educational opportunities, as poor lighting conditions hinder reading, studying, and overall academic performance (Katoch *et al.,* 2023). The lack of adequate lighting within households can limit social participation and community engagement, as individuals may feel reluctant to invite others into their poorly illuminated spaces or be unable to partake in social activities that require adequate lighting (Chen *et al.,* 2023)

When homes lack sufficient natural light due to inadequate orientation, limited window size, or inadequate sun protection equipment, occupants face dimly lit interiors during the day that hinder their ability to carry out daily activities comfortably. The dwelling's solar orientation impacts the amount of sunlight it receives and the heat energy it can obtain, which contributes to determining the necessary energy required to maintain thermal comfort. Hence, lower sunlight in a dwelling can mean higher necessary energy costs in the winter, but on the other hand, it can also decrease cooling energy needs in the summer. The use of sun protection equipment such as shutters and roller blinds and how the household uses them also impacts the natural lighting of the dwelling.

On the other hand, a household may purposely use less artificial lighting to cut down on energy costs, living in a darker home. This can be related to inefficient lighting solutions that significantly contribute to increased energy bills and the difficulty in affording their replacement with more efficient ones (Maxim *et al.*, 2016). On the other hand, a lack of lighting fixtures or incorrect placement of lighting points within the home also exacerbates the problem of inadequate lighting. In Europe, EP is often linked to a lack of space heating and cooling, as artificial lighting is generally easily accessible and more affordable. The lack of artificial lighting can then signify deep problems of hardship and economic poverty, translating to very limited resources and/or precarious energy infrastructure.

Example: A dwelling facing north in a cold climate receives less sunlight during the day, contributing to higher energy needs for space heating in the winter and higher necessary energy expenditure, potentially exacerbating affordability problems.

Example: A dark home during the nighttime might be a sign of energy consumption, self-restriction behavior, and hidden energy poverty, as the household tries to reduce its energy use by not using its energy inefficient lighting equipment, contributing to high energy bills.

When considering the utility of this indicator to asses EP, it is important to remember that the indicator is subjective and based on personal perception, with the inherent advantages and drawbacks of this type of indicator discussed in the previous report by (Gouveia *et al.*, 2022). This indicator does not address the underlying causes of the perceived lack of light, such as inadequate building design and orientation, inadequate shading equipment, or the decision to restrict artificial lighting consumption. To draw the connection between a dark dwelling and a potential situation of EP, it is essential to identify and analyse the causes, since not all these aspects necessarily reflect an EP problem. Also, a dark dwelling can result simply from the household's cultural habits and personal preferences, with no connection to affordability, building condition, or equipment problems. Thus, this indicator cannot be used to singlehandedly identify an EP problem. It should be used in conjunction with additional indicators such as income, energy affordability indicators, and ability to maintain thermal comfort and pay energy bills, to investigate a possible connection between affordability problems and lack of thermal comfort; if a connection is identified, the analysis should be pursued, and the indicator should also be cross analysed with indicators such as the dwelling characteristics and conditions, energy performance, and energy efficiency of building equipment, to explore a possible connection with poor housing conditions and poor home energy efficiency. This will help to pin down the underlying causes and rule out situations of personal preference or other issues unrelated to EP.

3.5.4 Updates and Disclaimer

The “Pop. Considering their dwelling as too dark” has been added as a new indicator.

In 2021, **6.7%** of the European Union population considered **their dwelling too dark, corresponding to 29.9* million** Europeans.

**considering that the European Union population in 2021 was 447.0 million, according to EUROSTAT (2022i)*

3.6 Population reporting a chronic disease

3.6.1 Current Situation

The "Pop. reporting a chronic disease" indicates the percentage of the population aged 15 years and over who report having at least one chronic disease or longstanding illness.

Figure 13 and 14 present the last data available for the indicator in map bar and chart for a selected disease (i.e., Asthma).

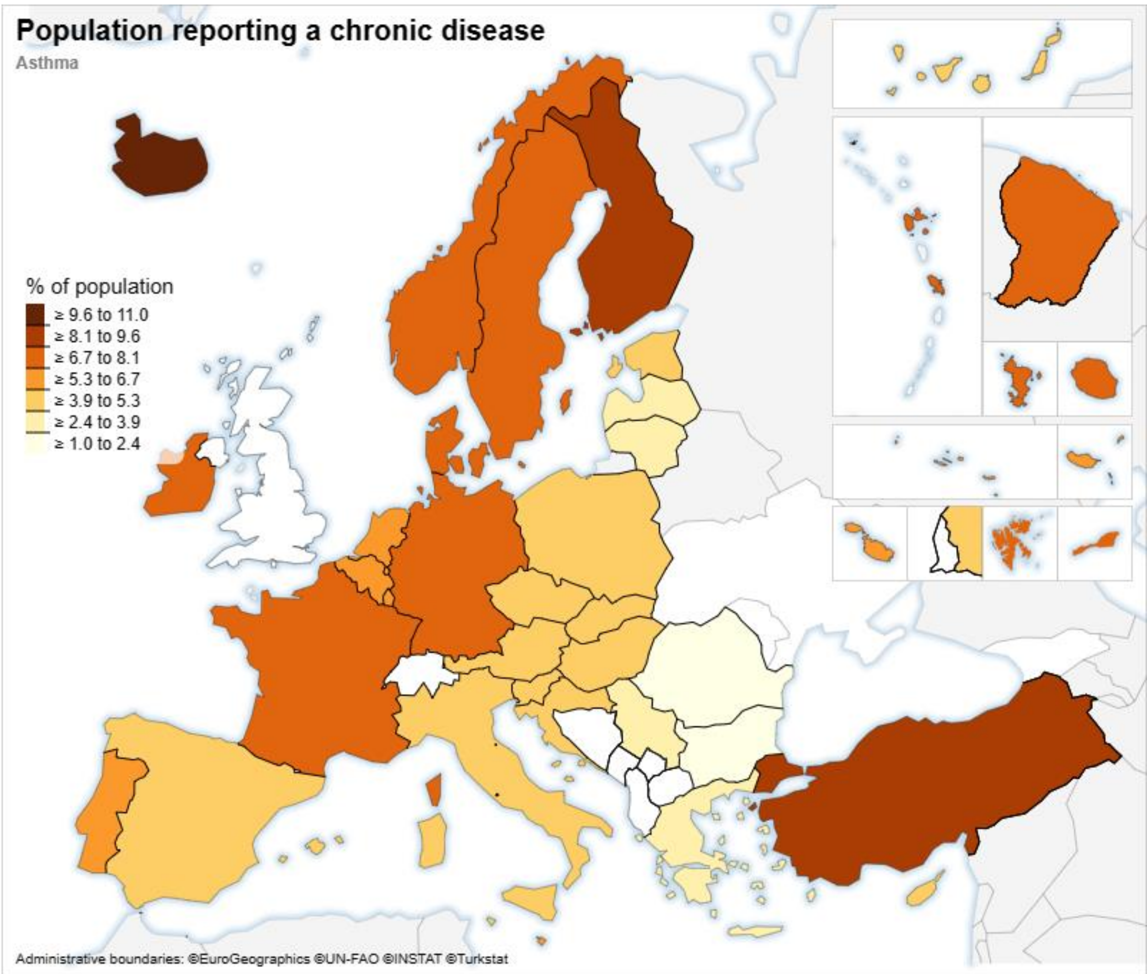


Figure 13: MAP OF POPULATION REPORTING A CHRONIC DISEASE (asthma) in 2019

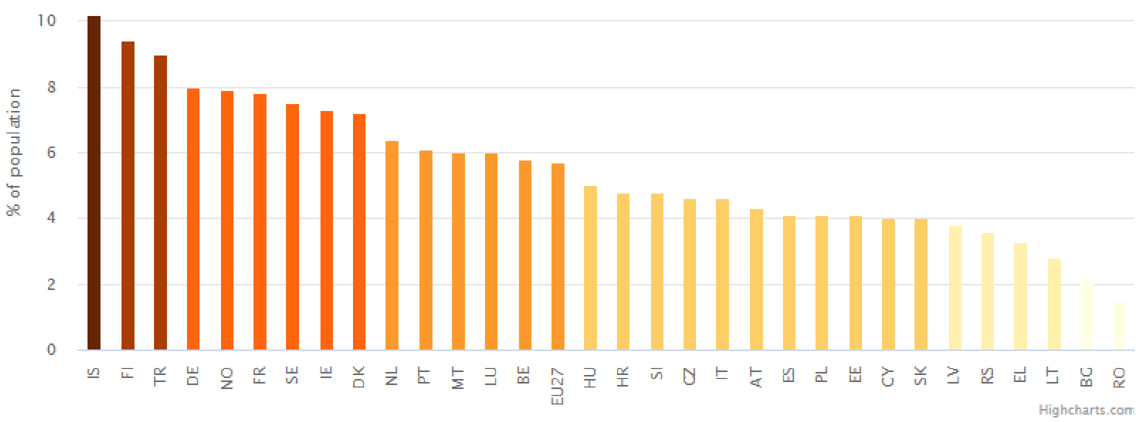


Figure 14: BAR CHART OF POPULATION REPORTING A CHRONIC DISEASE (asthma) in 2019

3.6.2 Technical Details

Table 21 presents the technical details for the “Pop. reporting a chronic disease” indicator to the maximum 44 GEO list, and the data sources used. The information presented includes the statistical code used in the indicator source, the indicators’ Topics, the identification name used on the national energy poverty indicator’s dashboard section of the EPAH website, the timeline period with available data, the number of countries represented in the last update in relation to the maximum 44 GEO list and/or NUT, and the data sources used.

Table 10: POP. REPORTING A CHRONIC DISEASE’S INDICATOR TECHNICAL DETAILS

Identification Code	(Sub)Topics	Name	Timeline	# GEO	Source
HLTH_EHIS_CD1I	**Socioeconomic aspects** (Health)	Pop. reporting a chronic disease	2014, 2019	32/44	EUROSTAT

The following options were selected from their original source and are available as disaggregation:

- By disease
    - Asthma
    - Chronic lower respiratory diseases (excluding asthma)
    - Heart attack or chronic consequences of heart attack
    - Coronary heart disease or angina pectoris
    - High blood pressure
    - High blood lipids
    - Stroke or chronic consequences of stroke

3.6.3 Limits and Application Suggestion

EP is not just a cause of ill health but also a consequence of a context that was determined by ill-health (Middlemiss and Gillard, 2015). Studies have shown that people living in EP are more likely to suffer from chronic diseases due to inadequate heating, poor air quality, and other environmental factors that can negatively impact their health (Bentley *et al.*, 2023). In fact, energy-poor households face challenges in maintaining a healthy indoor environment, which can increase the risk of chronic diseases (Hursthouse *et al.*, 2022). People living in EP often are subjected to difficult trade-offs between paying for energy and healthcare or other essential needs (Oliveras *et al.*, 2021). On the other hand, while someone may have a chronic disease that is not directly caused by energy poverty their health situation may cause them to have to spend prolonged periods of time in the home. In cases where homes are inefficient and/or the person’s disposable income is affected by their health status, they may be at increased risk of EP. While there is a diversity of experiences and lifestyles of people with disabilities and chronic ill-health, this group often has higher energy needs, dependence on healthcare and support services, lack of social relations, and moving limitations (Ivanova and Middlemiss, 2021). They also often have lower income levels than the general population – with these disadvantages being stronger among those with congenital or multiple disabilities

(Simcock *et al.*, 2021). Nevertheless, despite some studies showing correlations between EP and health problems (Ballesteros-Arjona *et al.,* 2022; Davillas *et al.*, 2022), it is difficult to establish causality as health problems are created by a multitude of factors across a long period of time.

Example: Households that cannot afford to properly ventilate or heat their homes may experience mold growth, dampness, or poor air quality, which can lead to respiratory problems or exacerbate existing conditions like asthma.

Although authors defend that health proxy indicators can be utilized to analyse and detect EP (Ballesteros-Arjona *et al.*, 2022), indicators such as the "population reporting a chronic disease" should be used with parsimony when used to measure EP. It has a complex nature and a not straightforward relationship with EP, and it does not provide detailed information about the root causes of chronic diseases. Furthermore, it solely relies on self-reported chronic diseases, which may not capture the entire prevalence of chronic illnesses within a population. Other shortcomings lie in its infrequent data collection and limited temporal coverage. To investigate the connection between this indicator and EP, other indicators should be cross-analysed regarding the ability to maintain thermal comfort, income, housing conditions, energy efficiency of the dwelling, and energy equipment, aiming to identify the context of vulnerability that may strengthen the hypothesis of an existing connection. Indicators that provide more detailed information on the root causes of chronic diseases should be prioritized. It is worth mentioning that the source of the indicator provides further disaggregation.

3.6.4 Updates and Disclaimer

The "Pop. reporting a chronic disease" has been added as a new indicator.

In 2021, more than one-third (**35.2 %**) of people in the European Union **reported having a long-standing** (chronic) health problem corresponding to 156* million Europeans.

**considering that the European Union population in 2021 was 447.0 million, according to EUROSTAT (2022i)*

3.7 Causes of Death

3.7.1 Current Situation

The “Causes of Death” indicator refers to the number of deaths per 100,000 inhabitants due to specific causes of death.

Figure 15 and 16 present the last data available for the indicator in map and bar chart.

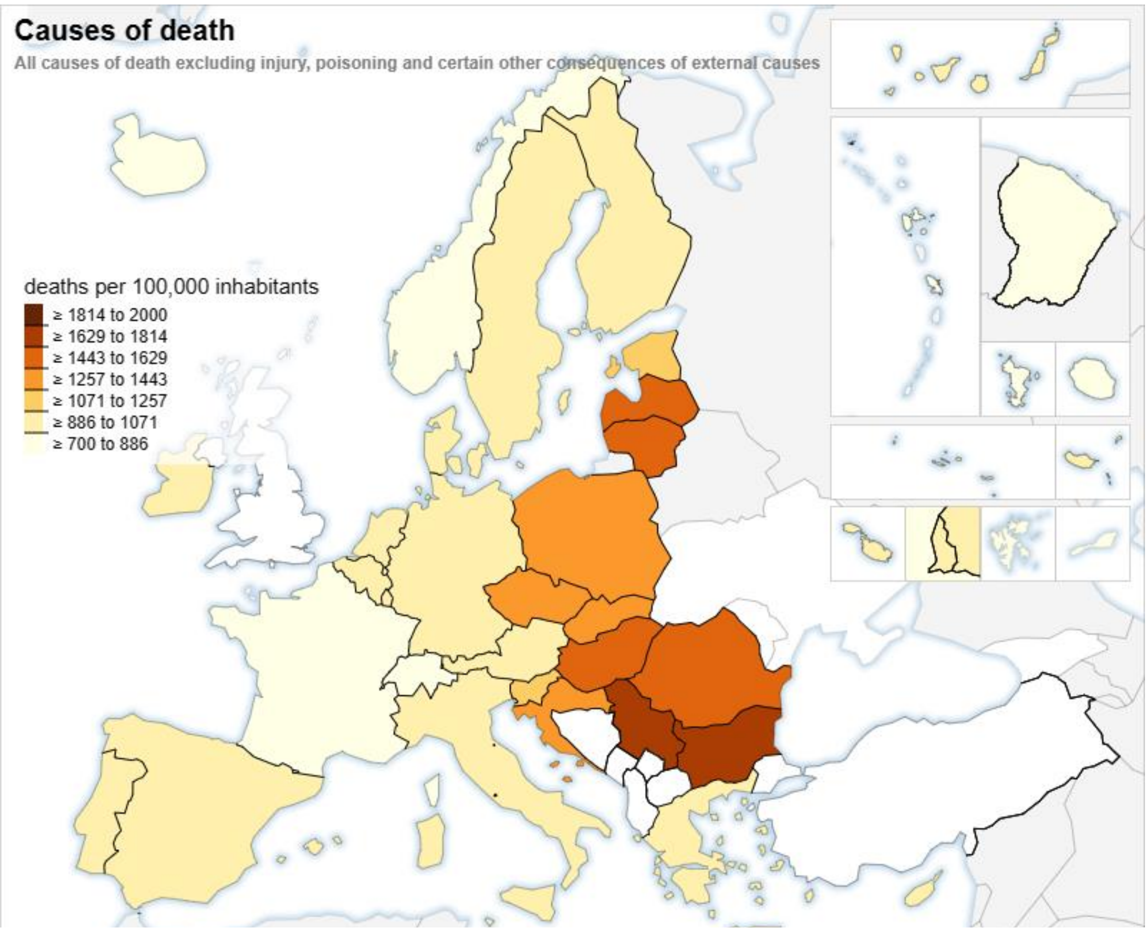


Figure 15: MAP OF CAUSES OF DEATH (all causes of death excluding injury, poisoning and certain other consequences of external causes) in 2020

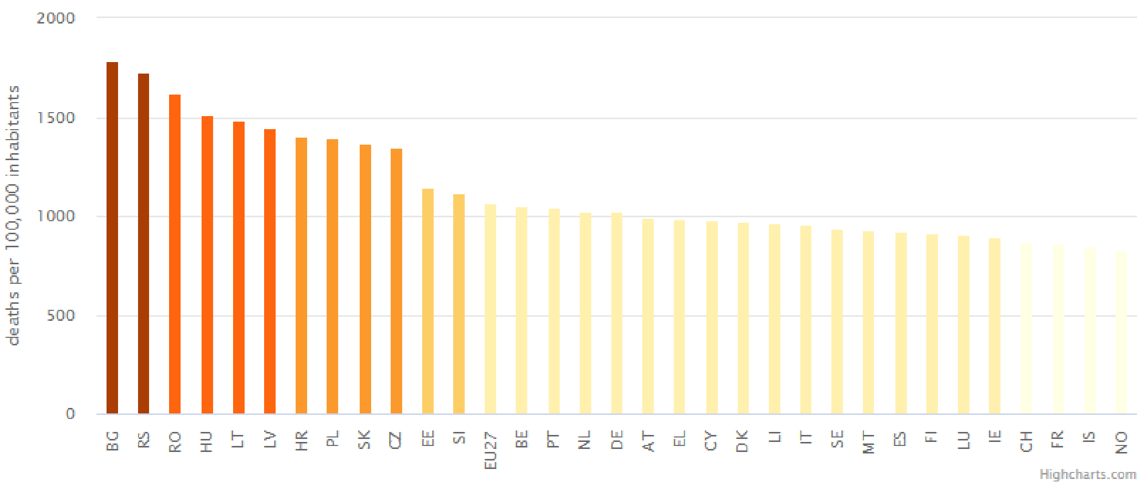


Figure 16: BAR CHART OF CAUSES OF DEATH (All causes of death excluding injury, poisoning and certain other consequences of external causes) in 2020

3.7.2 Technical Details

Table 11 presents the technical details for the "Causes of death" indicator such as the statistical code used in the indicator source, the indicators' Topics, the identification name used on the national energy poverty indicator's section of the EPAH website, the timeline period with available data, the number of countries represented in the last update in relation to the maximum 44 GEO list and/or NUT, and the data sources used.

Table 11: CAUSES OF DEATH'S INDICATOR TECHNICAL DETAILS

Identification Code	(Sub)Topics	Name	Timeline	# GEO	Source
HLTH_CD_ASDR2	**Socioeconomic aspects** (Health)	Causes of death	2011-2020	35/44 NUTS 1 and 2	EUROSTAT

The indicator's disaggregation was chosen based on scientific knowledge highlighting the connection between distinct health issues associated with EP (*e.g.* Oliveras *et al.*, 2020). The selected disaggregation details the respiratory and cardiovascular diseases that can be linked to EP and associated with increased morbidity and mortality rates. It is worth noting that the indicator's original source includes further disaggregation that might be used for a more in-depth examination of specific health issues associated with EP.

The following options were selected from its original source and are available as disaggregation:

- By disease
    - Tuberculosis
    - Mental and behavioral disorders
    - Diseases of the circulatory system
    - Diseases of the respiratory system
    - Diseases of the skin and subcutaneous tissue
    - Accidental poisoning by and exposure to noxious substances

3.7.3 Limits and Application Suggestions

The "causes of death" is another population-level health outcome indicator that can be used to assess the indirect health effects of living in EP. Individuals living in EP have an increased chance of death owing to respiratory ailments, cardiovascular disease, and other health issues (Whitehead *et al.*, 2022). This indicator has similar advantages and drawbacks to the indicator "population reporting a chronic disease", but with two main differences – it is not self-reported; thus, it is based on medical statistics, and it portrays a more severe potential consequence of EP, the death of a person. The indicator only captures the immediate cause of death, which can lead to underestimating the contribution of underlying or associated conditions (Oliveras *et al.*, 2021). In such cases, it may fail to identify all the health conditions contributing to the death. To address this limitation, it may be helpful to cross-analyse this indicator with the medically diagnosed conditions to provide a more comprehensive understanding of the factors contributing to mortality.

Along with variations in medical diagnosis and practice that could lead to unequal reporting across regions or countries, the "causes of death" indicator might not accurately reflect the burden of avoidable mortality (Thacker *et al.,* 2006). To overcome this constraint, it may be helpful to cross-analyse this indicator with the "Pop. reporting chronic disease" indicator to identify the reported diseases and potential contributing factors to mortality, possibly related to EP. Another limitation is that it may not capture deaths related to social determinants of health, such as poverty or inadequate housing. Thus, it may be useful to incorporate information on social determinants of health in mortality data collection and analysis to address this limitation.

Example: A person may die from a heat stroke, but one of the underlying causes may be the lack of access to air conditioning and a comfortable living environment during a heat wave.

Example: Burning firewood inside the dwelling in an old and inefficient fireplace, a situation that can be related to EP, can lead to a severe lack of indoor air quality and ultimately to the death of an occupant due to respiratory problems.

To improve its application for EP diagnosis, it may be useful to incorporate information on associated or underlying conditions and social determinants of health together with indicators that assess income, energy affordability, ability to maintain thermal comfort, housing and equipment energy efficiency, and important drivers of EP. Doing so makes it possible to investigate the correlation between these factors and the observed mortality, aiming to identify potential vulnerability to EP.

3.7.4 Updates and disclaimer

The "Causes of death" has been added as a new indicator.

In 2020, **respiratory and circulatory diseases represented 40% of causes of death** among European Union inhabitants.

3.8 Population who cannot afford a regular use of public transport

3.8.1 Current Situation

The "Pop. who cannot afford a regular use of public transport" indicator refers to the percentage of people aged 16 or over who report that they cannot afford to use public transport on a regular basis due to financial reasons.

Figure 17 and 18 present the last data available for the indicator in map and bar chart.

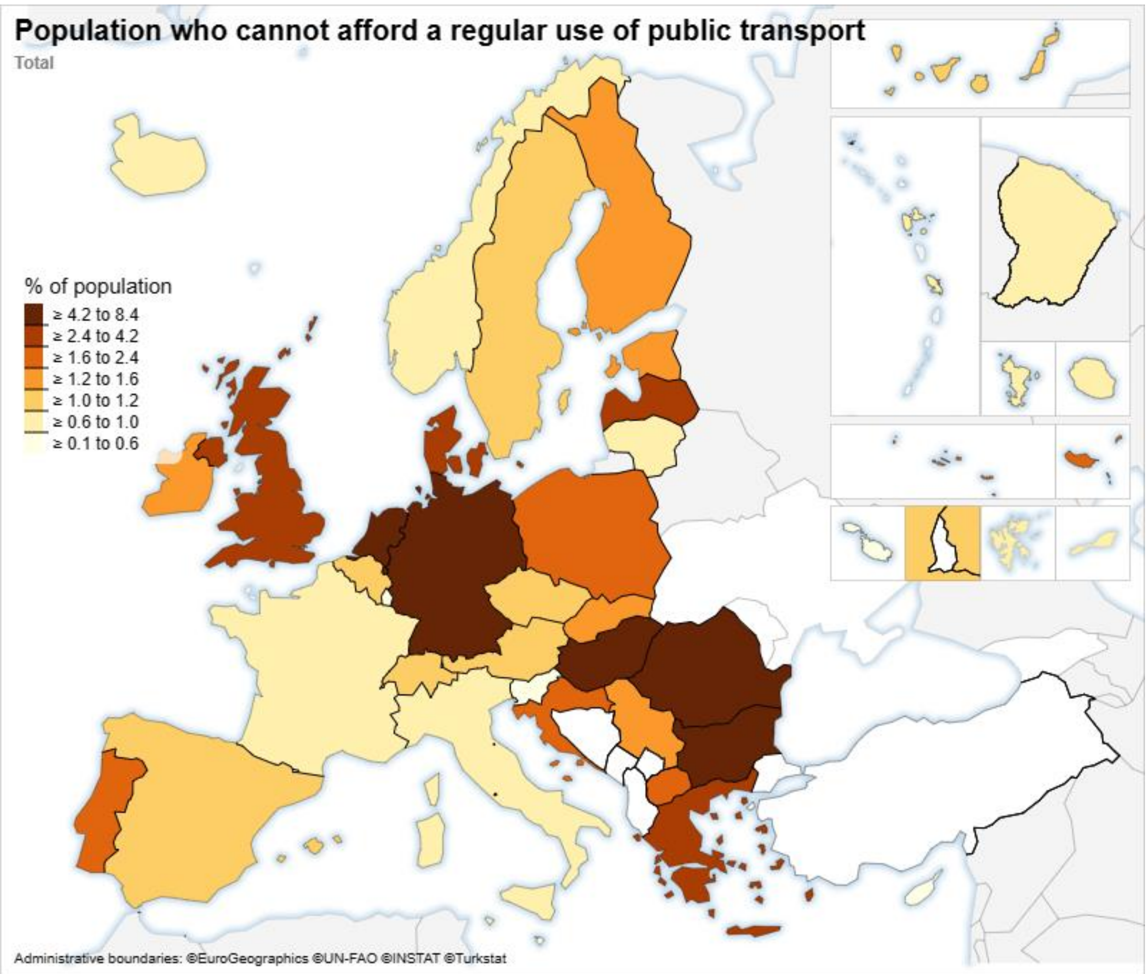


FIGURE 17: MAP OF POPULATION WHO CANNOT AFFORD A REGULAR USE OF PUBLIC transport (total) in 2014

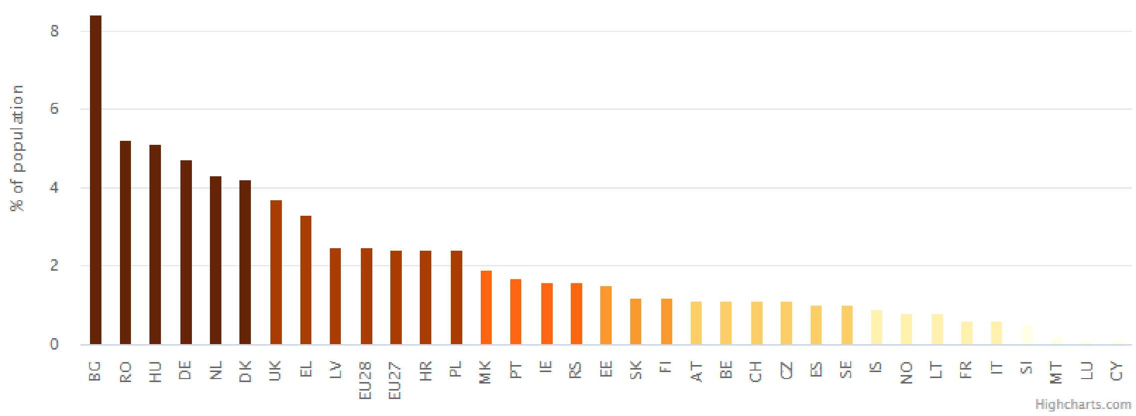


Figure 18: BAR CHART OF POPULATION WHO CANNOT AFFORD A REGULAR USE OF PUBLIC TRANSPORT (Total) in 2014

3.8.2 Technical Details

Table 12 presents the technical details for the "Pop. who cannot afford a regular use of public transport" indicator. The following information is presented: statistical code used in the indicator source, the indicators' topics, the identification name used on the national energy poverty indicator's section of the EPAH website, the timeline period with available data, the number of countries represented in the last update in relation to the maximum 44 GEO list and/or NUT, and the data sources used.

Table 12: POP. WHO CANNOT AFFORD A REGULAR USE OF PUBLIC TRANSPORT'S INDICATOR TECHNICAL DETAILS

Identification Code	(Sub)Topics	Name	Timeline	# GEO	Source
ILC_MDES13A and ILC_MDES13B	**Mobility**	Pop. who cannot afford a regular use of public transport	2014	34/44	EUROSTAT

The following options were selected from their original source and are available as disaggregation:

- By sex
  - Males
  - Females
- By age
  - From 16 to 29 years
  - From 16 to 64 years
  - 65 years or over
- By income status
  - Below 60% of the median equivalized income
  - Above 60% of the median equivalized income
- Status
  - Not employed persons
  - Unemployed persons
  - Retired persons
  - Other persons outside the labor force
- Income quintile
  - First quintile
  - Second quintile
  - Third quintile
  - Fourth quintile
  - Fifth quintile

3.8.3 Limits and Application Suggestions

Public transport is often the primary mode of transportation for low-income households, especially in urban areas where access to private transportation is limited or expensive (Albalate and Bel, 2010). Energy-poor families who cannot access public transport may be forced to rely on more polluting and energy-intensive modes of transportation, such as older and less fuel-efficient personal vehicles. This can increase mobility costs and exacerbate transport EP (Mattioli *et al.*, 2018). In some cases, this can result in so-called "double energy vulnerability", where consumers simultaneously suffer from domestic EP and transport poverty (Simcock *et al.,* 2021). Households experiencing EP may be unable to afford private transportation. Therefore, they rely heavily on public transport to meet their daily needs, such as commuting to work and school or accessing essential services. If energy-poor households cannot afford public transportation, they may be limited in accessing essential services such as healthcare, education, and employment opportunities. This can lead to social exclusion and reduced quality of life. This can be the case for rural households, where scarce or expensive public transportation and longer distances may increase vulnerability to transport poverty (Simcock *et al.*, 2021). Affordability of basic needs can be interconnected – a household may opt to spend on some needs in detriment of others (Oliveras *et al.*, 2021; Burlinson *et al.*, 2022), which implies the inability to afford the regular use of public transportation may reflect a situation where the household is prioritizing domestic energy services over transportation or that the household is unable to afford any of these basic needs, potentially even experiencing a problem where the lack of one exacerbates the lack of the other.

Example: If public transportation is unreliable, infrequent, or expensive, low-income households may be forced to rely on more costly or less efficient forms of transportation, such as personal vehicles, which can further strain their limited financial resources and even impact domestic energy use.

The indicator "Pop. who cannot afford regular use of public transportation" gives essential information on the transport-related issues that families experience. In contrast, the disaggregation of the indicators allows analysis of the impact on specific audiences, such as low-income families, women, or the elderly.

However, it is important to remember that this indicator solely accounts for the inaccessibility of public transportation due to financial constraints and does not consider other transportation-related issues, such as the availability of public transit in specific areas or the quality of transportation services. Nevertheless, considering that private transport is often more expensive than public, the inability to afford the regular use of public transport is already a sign of serious deprivation, which may be linked with other types of deprivations such as domestic EP. To discern compound vulnerabilities, it is suggested that this indicator be used in conjunction with indicators that reflect domestic EP, such as housing affordability, housing quality and efficiency, energy affordability, or inability to maintain thermal comfort in the winter and summer. Other general socioeconomic indicators, such as income or the risk of poverty, can also be helpful to provide a more complete picture of the hardship at the household level.

3.8.4 Updates and disclaimer

The "Pop. who cannot afford a regular use of public transport" has been added as a new indicator.

In 2014, **2.4%** of the European Union population could **not afford regular use of public transport,** corresponding to **12.2* millions Europeans.**

**considering that the European Union population in 2014 was 506.9 million, according to EUROSTAT (2022i)*

3.9 Cooling and heating degree days

3.9.1 Current Situation

The “Cooling and heating degree days” indicator refers to how much (in degrees) and for how long (in days), the outside air temperature was, respectively, higher/lower than a specific "base temperature" (or "balance point"). Degree days are used for calculations of the energy consumption requirements to heat and cool buildings to thermal comfort standards.

Figures 19 to 22 present the last data available for the indicator in map and bar chart.

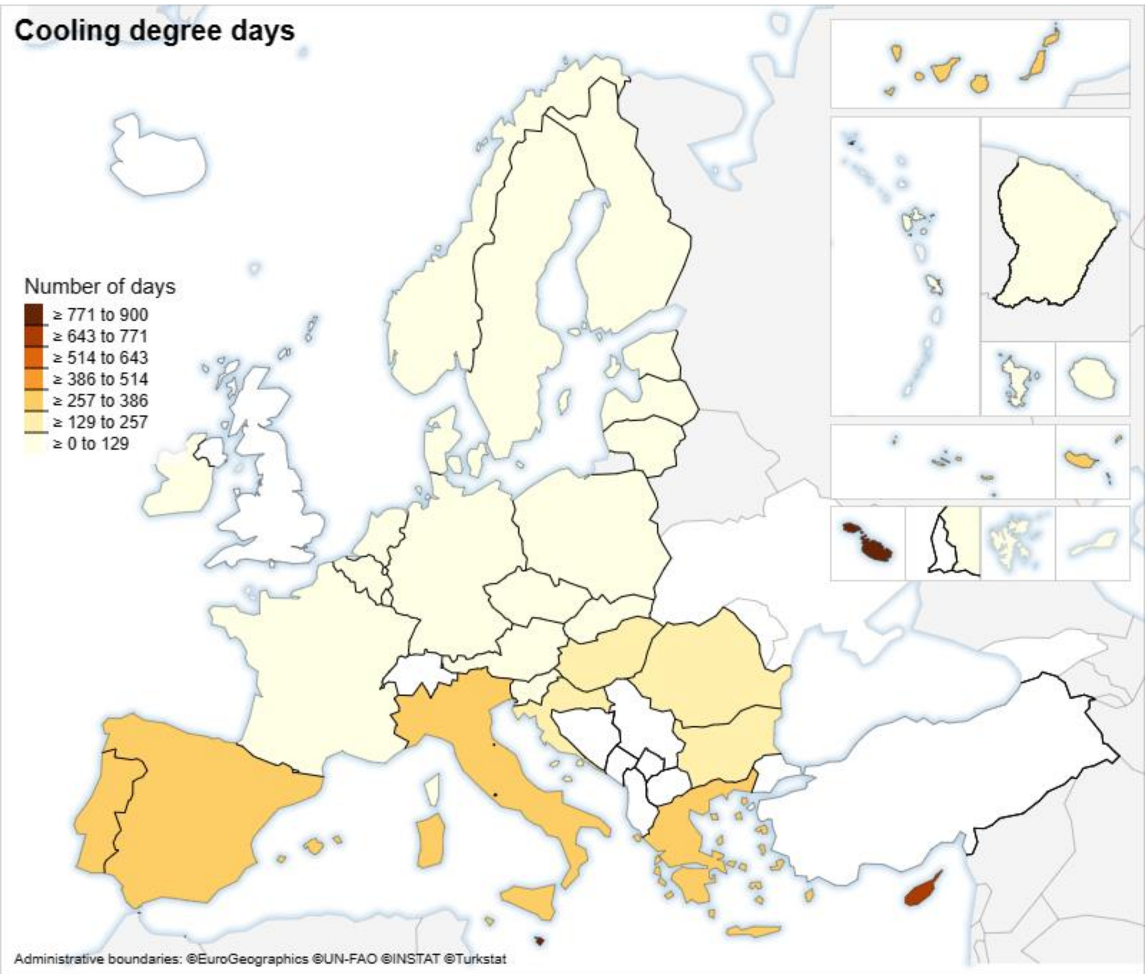


Figure 19: MAP OF COOLING DEGREE DAYS IN 2022

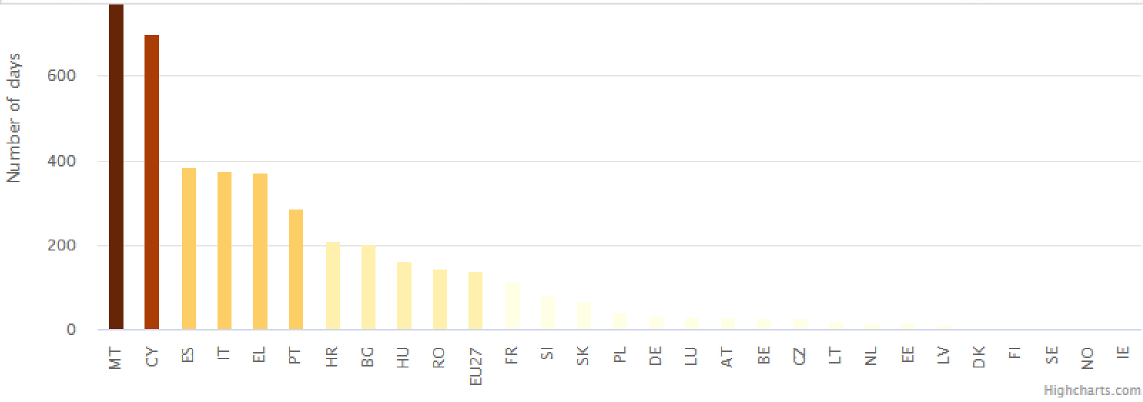


Figure 20: BAR CHART OF COOLING DEGREE DAYS IN 2022

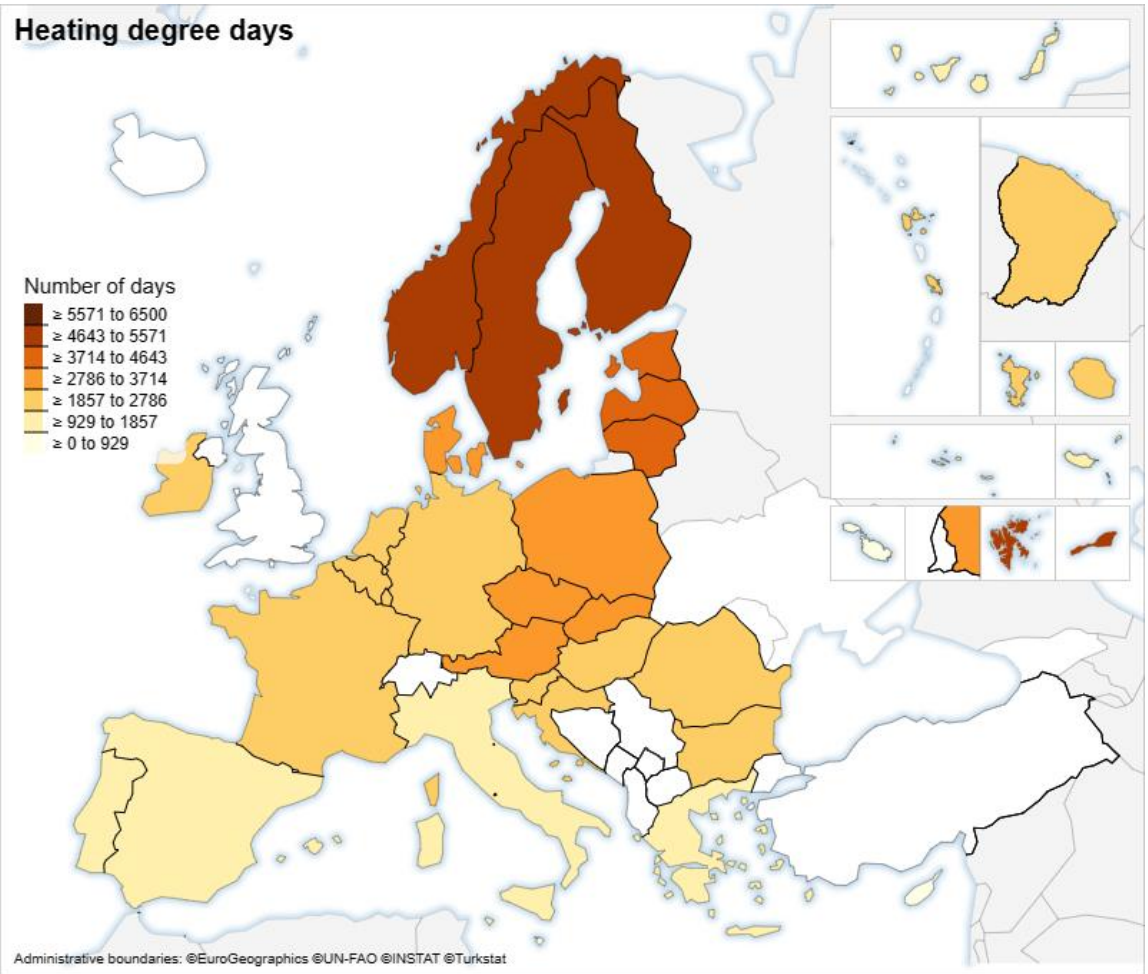


Figure 21: MAP OF HEATING DEGREE DAYS IN 2022

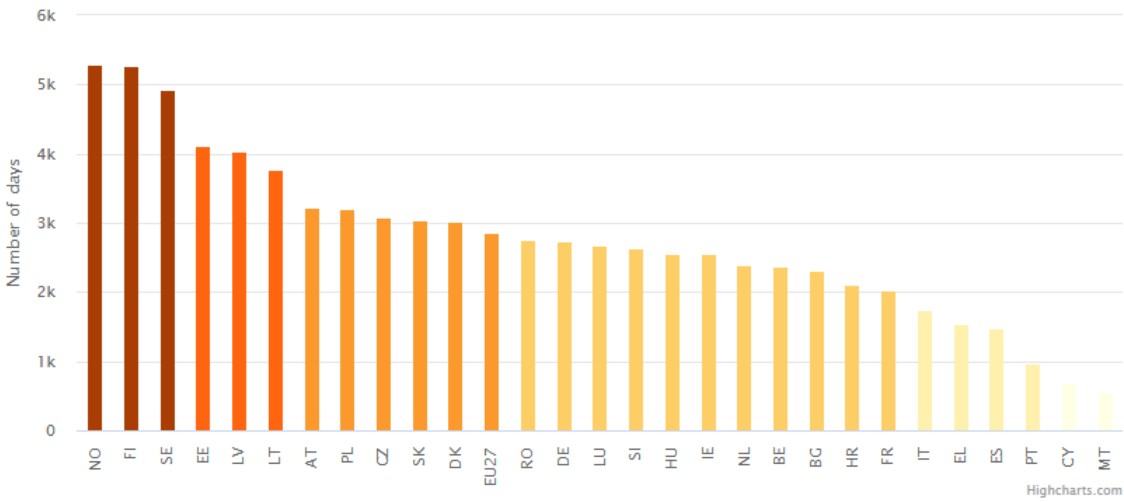


Figure 22: BAR CHART OF HEATING DEGREE DAYS IN 2022

3.9.2 Technical Details

Table 13 presents the technical details for the "Cooling and heating degree days" indicator. The information presented includes the statistical code used in the indicator source, the indicators' Topics, the identification name used on the national energy poverty indicator's dashboard section of the EPAH website, the timeline period with available data, the number of countries represented in the last update in relation to the maximum 44 GEO list and/or NUT, and the data sources used.

Table 13: COOLING AND HEATING DEGREE DAYS' INDICATORS TECHNICAL DETAILS

Identification Code	(Sub)Topics	Names	Timeline	# GEO	Source
NRG_CHDDR2_M	Climate	Cooling degree days Heating degree days	2004-2022	29/44 NUTS 1, 2 and 3	EUROSTAT

The following options were selected from their original source and are available as disaggregation:

- Cooling degree days
- Heating degree days

3.9.3 Limits and Application Suggestions

The "Cooling and Heating Degree Days" are a measure that is used to calculate heating and cooling energy needed to heat or cool a building to a base temperature, normally a temperature that represents thermal comfort. It has been used in EP measurements directly or to estimate energy needs or consumption in several geographical contexts (Simoes *et al.*, 2016; März, 2018; Mashhoodi *et al.*, 2019; Gouveia *et al.,* 2019; Papada and Kaliampakos, 2019; Spiliotis *et al.*, 2020; Castaño-Rosa *et al.*, 2021; Bardazzi *et al.*, 2021)

It is a direct reflection of the climate conditions of a country or region, enabling the comparison of energy needs only based on this aspect before considering the energy efficiency of buildings and equipment and the type of fuel being used. These indicators enable a deeper examination of estimated buildings' energy needs and the potential impact of solutions such as energy renovation across regions and countries. It is also relevant to assess the effects of climate change or any extreme climate events on the energy needs of homes. This indicator can help calculate necessary energy consumption and expenditure for achieving thermal comfort conditions and compare it to actual expenditure to identify potential gaps (as in Palma *et al.*, 2019).

On the other hand, it does not directly consider building energy performance and efficiency nor the population's ability to afford energy services, which can vary significantly even within the same region. For instance, a home might have significant energy needs because it has low energy efficiency or is large and located in a cold climate.

Furthermore, this indicator compares daily temperatures and does not fully reflect potentially significant hourly temperature changes, which can lead to the underestimation of households' energy needs and vulnerabilities. These changes can majorly impact residential energy consumption for heating and cooling during that period of the day. In events such as cold spells, houses may require greater heating energy to maintain comfortable indoor temperatures, whereas heat waves may result in higher cooling energy demand.

Example: If two households are living in two similar well-insulated homes in regions with different heating degree days' values, the one living in the milder winter climate region will more likely be less vulnerable to EP.

To assess EP, this indicator should be analysed in conjunction with data from shorter-span climate events to get a more comprehensive picture of the impact of climate on energy needs and equipment use. It should also be cross-assessed with indicators that represent buildings' energy performance and equipment efficiency, final energy consumption, and fuel type to understand how these energy needs are being met. Finally, it is important to draw the connection, if possible, to indicators portraying energy affordability and the inability to maintain thermal comfort to validate and confirm potential problems related to difficulty or inability to ensure the necessary energy needs.

3.9.4 Updates and disclaimer

The "Cooling and heating degree days" have been added as a new indicator with two disaggregations.

In 2022, the energy needs for **heating** a given building were approximately two-tenths lower and almost four times higher to **cool** than in 1979.

Finland had the **highest average annual HDD** value (5 656), while for Malta, the value of this index was 534.

Malta had the **highest average CDD** (580.4), and the lowest values for this index were calculated for Ireland (0.03)

4

Looking Ahead

The **EPAH indicator dashboard** serves as a crucial tool for diagnosing energy poverty and understanding its complex dimensions. It is important to consider the wealth of knowledge about energy poverty and apply it effectively to data analysis. The dashboard provides a comprehensive set of indicators that capture various aspects of energy poverty, allowing for a more holistic assessment of the issue. By leveraging this tool, we can gain valuable insights into the challenges faced by energy-poor households and design targeted interventions to address their specific needs.

To effectively utilize the EPAH dashboard, it is essential to have a strong understanding of energy poverty and the underlying factors that contribute to it. This knowledge helps in interpreting the data accurately and making informed decisions. It is crucial to consider the limitations of the indicators and understand their relevance within the context of energy poverty analysis. By incorporating the principles of geographical distribution, time distribution, validity, and reliability of data, we ensure the robustness and credibility of our analysis.

As we look forward, it is important to continuously update and improve the EPAH dashboard to align with evolving knowledge and emerging energy poverty trends. Regular evaluation and feedback from users and experts in the field can inform future updates and enhance the effectiveness of the tool. By keeping the dashboard dynamic and responsive to the changing landscape of energy poverty, we can ensure its continued relevance and value in informing evidence-based policies and interventions.

When analyzing energy poverty, it is beneficial to consider the following suggestions:

- **Employ a mixed indicators approach**: Ensure that indicators encompass all drivers and effectively identify vulnerable populations. By adopting a comprehensive and inclusive approach to energy poverty analysis, including, for example, indicators from each of the new EPAH suggested topic/subtopics, the multifaceted nature of the issue can be better captured.
- **Complement EU-wide datasets with national data sources**: Drawing from authoritative national datasets provides a robust and reliable foundation for further

analysis. Take into consideration the indicators presented in our EPAH dashboard and combine other data from national sources, capturing a broad and representative picture of energy poverty within a specific context, enhancing the accuracy and credibility of the analysis. Using local or national data might reduce comparisons between other countries or regions but will be beneficial for zooming in on specific topics.

- **Advantages and limitations of EU-wide datasets:** While EU datasets offer valuable advantages such as regular data collection, cross-country comparability, and methodological consistency, it is important to acknowledge their limitations. These limitations became evident when essential themes and comprehensive indicators were excluded from the analysis due to factors such as partial availability in specific member states, restricted access behind paywalls, or a lack of public accessibility. Examples include the absence of data on energy efficiency performance in building certification, incomplete energy consumption surveys, and gaps in records of extreme weather events.
- **Emphasize Data Gaps and Propose New Data Development Strategies:** Consider initiating surveys or data collection efforts to address critical data gaps, aligning with the data requirements for Member States in their National Energy and Climate Plans updates and legislative initiatives like the 'Fit for 55 Package.' These data development efforts should support the creation of Member State Social Climate Plans and the formulation of effective energy poverty strategies.
- **Establish connections between indicators and different stages**: Linking indicators to the various stages of addressing energy poverty, including diagnosis, planning, and monitoring, creates an integrated approach (EPAH, 2022). This seamless flow of information and insights enables policymakers and practitioners to make informed decisions based on a comprehensive understanding of energy poverty dynamics (Bessa and Gouveia, 2022).
- **Recognize the interconnectedness of energy poverty and climate change**: Highlight the linkages and dependencies between these critical issues (Streimikiene *et al*., 2020). Emphasize the importance of addressing energy poverty within the broader context of climate action and sustainability, as the EPAH indicators do.
- **Consider regional/local variations:** Energy poverty can manifest differently across regions and localities due to varying socio-economic conditions, climate, and energy infrastructure. Consider disaggregated data, such as by NUTs regions or urban/rural areas, to capture these variations and inform targeted interventions.
- **Explore different dimensions of energy poverty:** Energy poverty is a complex challenge that affects various vulnerable demographic groups, with women and girls (Petrova and Simcock, 2021), or students (Castro and Gouveia, 2023) serving as illustrative examples due to their distinctive social roles and responsibilities Employing disaggregation techniques, such as gender-based or age analysis, can reveal the particular hurdles confronted by women our young people, encompassing constrained access to resources, increased susceptibility, and uneven allocation of energy-related benefits. This approach highlights the significance of recognizing a wide range of dimensions within the realm of energy poverty to facilitate comprehensive comprehension and the development of effective mitigation strategies.

In conclusion, the EPAH indicators dashboard, supported by this and last year's report, provides a powerful platform for analyzing energy poverty, offering a wide range of indicators and disaggregation. By applying the knowledge of energy poverty and employing sound data analysis techniques, we can unlock valuable insights and drive meaningful actions to alleviate energy poverty, promote sustainable energy access, and improve the well-being of vulnerable populations. The EPAH dashboard stands as a vital resource in our collective efforts to address the challenges of energy poverty and achieve a more equitable and sustainable energy future.

5

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